Research Study No. 41

IMPACT OF NEEM-COATED UREA ON PRODUCTION, PRODUCTIVITY AND SOIL HEALTH IN BIHAR

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FOREWORD

In recent past, several agronomical trials on agricultural crops with Neem Coated Urea (NCU) have significantly substantiated higher yields at different research and farm levels. Realizing the potential of NCU and its acceptance by the farmers, the Government of India mandated for all urea manufacturers of the country to produce and sell NCU since May, 2015. So, it is quite imperative on the part of the Government of India to get the policy feedback relating to impact of NCU on crop production and productivity on the one hand, and the status of soil health on other hand. The present study on **Impact of NCU on Production, Productivity and Soil Health in Bihar** conducted by *Agro-Economic Research Centre for Bihar & Jharkhand, T M Bhagalpur University, Bhagalpur (BIHAR)* gave me great pleasure and satisfaction for addressing the issues pertaining to the objectives of the study, and thereby arriving at meaningful findings. It is highly relevant and opportune, because the country is targeted to double farmers' income by 2022 in real terms. Application of NCU will, no doubt, increase the production and productivity of the crops, and decrease in cost of production by way of lesser use of urea fertilizer, reduced cost on pests and diseases. The result of the study relating to economic feasibility of NCU also suggests above view. Moreover, some constraints have also been reported and observed in course of the survey, which need to be attended.

I, thankfully, wish to commend the work of all the members of the Project Team, and particularly Dr. Ranjan Kumar Sinha, Project Leader of the study for successful completion of this Project. It is hoped that the findings of the study will be useful for the Ministries of Agriculture & Farmers' Welfare and Chemicals & Fertilizers, Government of India and the Department of Agriculture, Government of Bihar and for other research professionals as well.

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CHAPTER – I

PREAMBLE

1.1 Background of the Study

Chemical fertilizers are the immediate source of nutrients. All India consumption of fertilizers in terms of nutrients--- nitrogenous (N), Phosphatic (P) and Potassic (K) has increased from 65.6 thousand tonnes in 1950-51 to 25576.1 thousand tonnes in 2014-15, accounting for an increase of about 390 times during six and half decades. It was highest at 28122.2 thousand tonnes in 2011-12 but in 2014-15, it came down to 25576.1 thousand tones, a decline of 0.88 per cent over the year 2011-12. It is observed that while consumption of urea, which is the most common nitrogen fertilizer used throughout the world; has increased from 58.7 thousand tonnes in 1950-51 to 16945.4 thousand tonnes in 2014-15, an increase of 289 times. The consumption of both phosphatic (P) and potassic (K) fertilizers has also increased by 884 and 246 times respectively. Fertilizer (NPK) consumption in India was of 151.1 kg/ha of arable land and land under permanent crops, which is higher than the world average of 114.5 kg/ha in 2012. The obvious reason for high uses of urea and lower uses of phosphatic and potassic fertilizers are wide acceptance of urea because of its agronomic acceptability and relatively lower prices, apart from the fact that urea continues to be under statutory price control.

Environmental and socio-economic issues have underlined the urgent need to better understand the role and fate of nitrogen (N) in crop production systems. Nitrogen is the nutrient that most often limits crop production and its proper application can result in substantial economic returns to producers. However, adding more N to the soil than crops need may result in economic loss and negative environmental impacts as well as pose substantial risk to human health. Managing N inputs to achieve a balance between profitable crop production and environmental quality is a goal--- and a challenge. The behavior of N within the plant-soil systems is complex, and an understanding of the basic processes that regulate its fate is essential for developing an efficient N management programme *(Walsh & Belmont, 2015).* So how efficiently is N fertilizer used in an average agricultural system? Currently, 100 million tonnes of N are applied as fertilizer to agricultural fields worldwide every year. India shares about 17 per cent of it. Nitrogen use efficiency (NUE) has been estimated to be only about 40-50 per cent at best for major food crops. That efficiency could be viewed as a 50-60 per cent loss, as N is lost through run off and

leaching or as gas to the atmosphere, and is tied up by soil microorganisms and soil particles.

Despite the positive effects of N fertilizers on crops, there can be indirect negative effect on soil health arising from natural transformations of N in the soil. In recent years, much has been written about soil quality in relation to food security *(Lal & Stewart, 2010)* because of a renewed awareness of the relationship between human population and soil's capacity to produce enough food to sustain burgeoning population. Deteriorating soil health has been a cause of concern and that has been leading to sub-optional utilization of farming resources. Imbalanced use of fertilizers, low addition of organic matter and non-replacement of depleted micro and secondary nutrients over the years, have resulted in nutrient deficiencies and decrease in soil health in various parts of the country. So a sustainable soil health management system, which has the capacity to produce higher yields while using fewer external inputs, is the need of the time. It is in this context, the Government of India and state governments have implemented various schemes and programmes for creating awareness among the farmers about the importance of soil health management through soil test technology. GoI has established 1,244 soil testing laboratories constituting 1048 (82.24%) static and 196 (15.76%) mobile across the states till 2013-14. Out of it, Bihar has 39 static soil testing laboratories (STLs), which have utilized 108.13 per cent of its capacities against the all-India average of 75.83 per cent. Subsequently, on 19th February, 2015 the GoI has launched a Soil Health Card (SHC) scheme to provide every farmer a SHC in a mission mode, which will carry crop wise recommendations of nutrients/fertilizers required for farms, making it possible for farmers to improve productivity by using appropriate inputs.

Besides, impact of Neem coated urea on production and productivity on selected crops in Bihar this study has also covered the issues related to implementation of soil health programmes in the state.

1.2 Review of Literature

There exists a wide range of studies on excess fertilizer use, fertilizer management, management practices for improved NUE, potential of N fertilizer, integrated management of fertilizers etc. The use of organic manures as source of nutrients and its general benefit to the soil dates back to the beginning of settled agriculture, although at that time there was no understanding of how such manures were beneficial. Following the introduction of high yielding cereal varieties and widespread use of mineral fertilizers that provided NPK as the primary plant nutrient, organic manures were thought of as secondary source of nutrients. It is observed that where the supply of nutrients in the soil is adequate, crops are more likely to grow well and produce large amounts of biomass. Fertilizers are needed in those cases where nutrients in the soil are lacking and cannot produce healthy crops

and sufficient biomass. It suggests management of fertilizers for productivity, profitability, cropping system sustainability and a favourable biophysical and social environment. Sustainability refers to the medium and long term effects of fertilizers management options to maintain or increase the productivity and profitability of cropping systems. Indicators include trends through time in yield, input use efficiency, soil parameters such as N supplying capacity, the presence of organic matter and profitability. Best management practices for fertilizer support the realization of these objectives in terms of cropping and environmental health *(Bruulsema et.al. 2009*). Nutrient stewardship is the efficient and effective use of plant nutrients to achieve economic, social and environmental benefits with engagement from farmers and other stakeholders. This concept essentially describes the selection of the right source of nutrients for application at the right rate, at the right time and in right place *(Roberts, 2007).* As a practice, nutrients stewardship is dynamic and evolves as science and technology expands our understanding and opportunities; practical experience teaches the astute observer which practices work or do not work under specific local conditions *(Fixen, 2007).* Decision support systems guiding the adoption of fertilizer best management practices require a dynamic process of refinement. In a long term experiment, the highest organic matter content in the soil has been observed in plots to which NPK were applied in a balanced proportion *(Kumar & Yadav, 2001).* *Guo et. al. (2010)* reported severe soil acidification in China following application of heavy N fertilizer application rates. Soil acidification indirectly leads to reduced microbial N immobilization *(Venterea et. al. 2004).* Considerable evidence from N tracer investigations indicates that plant uptake is generally greater from native soil N than from N applied via fertilizers (*Stevens et. al; 2005*). Thus, native soil N dicates the efficiency of applied fertilizer N as well as the quantity of N lost from the soil-plant system. Loss of organic N decreases soil productivity and the agronomic efficiency of fertilizer N and has been implicated in yield stagnation and the decline of grain production *(Mulvaney et. al; 2009).* Moreover, N is an essential plant micronutrient required in the layer quantities (1-3% on a dry weight basis) by plants and is most limiting where maximal biomass production is desired *(Salisbury & Ross 1992; Hell & Hillebrand 2001)*. N availability influences several developmental proessers according to the species such as the number of leaves and their rate of appearance, the number of modes *(Snyder & Bunce, 1983; Mac 1997; Sagar et. al; 1993)* and the number of tillers *(Vas & Biemond, 1992; Trapari & Hall, 1996)* are reduced under N limiting conditions. Both in spring wheat (*Demotes-Mainard et. al; 1999; Martre et. al; 2003*) and in rice (*Mac, 1997*), grain number decreases under N deficiency conditions. According to *Lian et. al; (2006*) & *Kumar et. al; (2009*) that development of crop varieties with high nitrogen use efficiency (NUE) is imperative for sustainable agriculture. Rapid increasing world population needs crop genotypes that respond to higher nitrogen and show a direct

relationship to yield with use of nitrogen inputs, i.e., high nitrogen-responsive genotypes. Several other studies have also addressed the optimization of fertilizers and improvement of NUE of crops to achieve high yields with reduced N fertilization rates and limited environmental side effects related to N leaching (*Agostini et. al; 2010; Burns, 2006*; *Neeteson & Carton, 2001; Rahn, 2002*). However, a few experiments have examined NUE in all its aspects. N use efficiency is the result of two main components: N uptake efficiency, which is the ability of crops to take up N from the soil (*Burns, 2006; Greenwood et. al; 1989*), and use efficiency of the absorbed N, that is the efficiency with which crops use the absorbed N to grow and give yield (*Janseen, 1998; Schenk, 2006*). These efficiencies may differ with in the same crop because they depend on different organs and mechanisms and on different environmental factors as well.

In addition to considerable research to increase N use efficiency, some new methods have also taken place to increase the NUE in crops. Oil derived from seeds of neem (*Azadirachta indica*) contains melicians (generally kown as neem bitters) showed dose-dependent nitrification inhibition action (*Devakumar & Goswami, 1992*). It has been established that neem products when applied with urea are capable of enhancing NUE in crops (*Agrawal et. al; 1980; Singh & Singh 1986*). A significant increase in rice yield was observed with application of neem seed extract treated urea (*Bains et. al; 1971*), neem cake blended urea (*Ketkar, 1974*) and Nimin coated urea (*Vyas et. al; 1991*). These studies show superiority of NCU over ordinary urea. No doubt, *Bains et. al; (1971*) were the first to report increased NUE after treating urea with an ethanol extract of neem seed. Scientists at the IARI, New Delhi reported that the nitrification inhibiting properties of neem (*Reddy & Prasad, 1975; Thomas & Prasad, 1983*) and neem cake coated urea (NCU) was developed & found to have higher NUE than prilled urea (*Prasad & Prasad, 1983*). This has been accepted by the farmers. Scientists at IARI also experimented with neem, oil and urea neem oil product (10% by weight of urea) was developed and found superior to prilled urea for rice (*Prasad et. al; 1998*). NCU reduced the leaching and volatilization losses and also inhibit the nitrification process resulting increased availability and mobilization of nutrient from source. The findings are similar to those obtained by *Sharma & Prasad (1996*), *Jaiswal & Singh (2000*) *& Sujatha et. al; (2008*). Based upon the results of various studies and agronomical trials on crops, NCU was found superior over urea for higher yield at research and farm levels.

It is perhaps due to looking into the potential of NCU and its acceptance by the farmers, Ministry of Agriculture and Farmers Welfare, Government of India, in July, 2004 included the neem coated urea in FCO (Fertilizer Control Order). The use of NCU has been found to improve the uptake of N, P & K significantly. Since 2008,

the Ministry of Chemicals and Fertilizers, Government of India allowed NCU manufacturer to sell NCU at 5 per cent above the MRP to recover the cost of coating, however cost of neem kernel oil and production as such of NCU has increased significantly. As per the recent notification vide its No. 12012/20/2007-FPP dated 25th May, 2015 of the Department of Fertilizers, Ministry of Chemicals and Fertilizers, Government of India; all the urea producers in country shall now be producing 100 per cent urea as NCU in order to improve crop productivity and reduce the subsidy.

1.3 Need for the Study

Various studies conducted at research and farm levels by the Scientists world over have found that the coating of urea with neem formulations not only increases the grain yield, NUE and apparent N recovery but also helps in reducing the environmental hazards associated with the use of large amounts of urea. Though the commercial production of NCU requires large scale availability of neem oil and it can be ensured only by encouraging plantation of neem trees on a large scale. Growing of neem trees will definitely lead to increased carbon sequestration and help avoid climate change like effects. On other hand, the introduction of NCU has checked the diversion of urea into non-agricultural purposes. Though, it is yet to be confirmed in regard to its total stopping into industrial usage. Besides above gains, the amount of subsidies on urea is also likely to come down, which will certainly help the congestion of agricultural exchequer. In view of above considerations, the GoI made mandatory for all indigenous producers of urea to produce 100 per cent of their total production of subsidized urea as NCU. It has also led to the availability of the stocks in the remote areas as well as promoting soil health across the country. After notifying for its mandatory production, the INM division of the Ministry of Agriculture & Farmers Welfare, Government of India felt the need of examining its impact on production, productivity and soil health in selected states for policy feedback. In this background, this study was entrusted to six AERCs/Units in their respective states under the co-ordination of ADRTC, ISEC, Bengaluru.

1.4 Objectives of the Study

The specific objectives of the study are as follows:

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

1.5 Limitations of the Study

The study suffered with following limitations:

i. The results of the study were based on selected districts and crops, so it was limited to sample districts and crops only.

ii. Classification into NCU, NU and both NCU & NU users was difficult, mainly because of its overlapping among users and so it was limited to the relating perceptions of the sample farmers.

iii. The mandatory sale of NCU began in May 2015, but old socks were available during kharif, 2015. So, the impact of NCU on production and productivity of reference crops for kharif, 2015 was limited to a short period analysis.

iv. Some of the survey questions were qualitative in nature, which required a scientific analysis, so its finding was limited to the perceptions of the sample farmers exclusively.

1.6 Data and Methodology

The study is based on primary and secondary data collected from selected districts in Bihar. The reference period of the study is kharif, 2015. Irrigated and un-irrigated two kharif crops viz., paddy and maize respectively, with highest use of urea in the state were selected for the study. For each crop, two districts were selected based on area under the selected crop and their urea usage in the state. From each district, two blocks were selected following the same criteria. From the selected blocks, two clusters of villages comprising 2-4 villages per cluster were selected for survey purpose. A sample of 50 farm households from each block was selected adding up to 100 farm households in each sample district. In total 200 farm households for each selected crop were selected. These households were selected randomly for assessing the use of NCU fertilizers and its impact on production and productivity of the selected crops. While selecting sample households due care was been taken for having proportionate representation of the farmers as users of NCU and non-users (those who have used normal urea). Further, adequate care was taken to ensure that the selected crops were grown under chosen irrigated/non-irrigated conditions in the state. In this way a total of 200 NCU/NU farm households for each crop were interviewed. The samples were representative in terms of the size of their operational land holdings. The details of sample and its distribution are presented in table 1.1.

Table No. 1.1: Distribution of the Sample

SN	Sample			Sample			
	Region	Reference Crop	Sample Districts	Marginal & Small	Medium	Large	Total
1.	Irrigated	Paddy	Rohtas West Champaran	119 (59.50)	41 (20.50)	40 (20.00)	200 (100.00)
2.	Un-irrigated	Maize	Begusarai Bhagalpur	178 (89.00)	17 (8.50)	5 (2.50)	200 (100.00)
	Total	---	---	297 (74.25)	58 (14.50)	45 (11.25)	400 (100.00)

In brackets percentage to the total shown

1.7 Organization of the Report

The present report has been divided into seven chapters. First chapter is related to the background information on NCU, review of literature, need for the study, objectives, limitations and data & methodology of the study. Second chapter presents on trends in urea consumption in the state. Third chapter focuses on socio-economic characteristics of sample farm households. Status of awareness and application of neem coated urea have been presented in chapter four. Fifth chapter deals with awareness and adoption level of soil testing technology. Impact of NCU application on crop production and Soil Health has been discussed in chapter sixth. In seventh and final chapter focuses on the summary, conclusions and policy suggestions.

CHAPTER – II

TRENDS IN UREA CONSUMPTION IN BIHAR

2.1 Trends in Urea Consumption and Price Variation

Since the inception of Green Revolution in India, the use of fertilizer has played vital role in increasing productivity of the agricultural crops. In Bihar also, along with the use of better quality seeds, use of chemical fertilizers in optimum quantity has played a key role in increasing agricultural productivity of many crops. The consumption of fertilizers has been steadily increasing in recent years.

As regards, the consumption of urea fertilizer is concerned it has also substantially increased during the last one decade. In 2003-04 the total consumption of urea fertilizer in Bihar was 1178.43 thousand tonnes, which increased to 1940.40 thousand tonnes in 2014-15, registering an increase of 64.66 per cent in twelve years. During the triennium average of 2004-06, the consumption of urea fertilizers was 1280.02 thousand tonnes, which increased to 1969.00 thousand tonnes in triennium average of 2013-15, recording an increase of nearly 53.83 per cent during the period (table 2.1). Further, it is also revealed that urea takes the most important place and constitutes around 54.28 per cent of total fertilizer consumption during the triennium average of 2003-04 to 2005-06. However, it came down to 48.77 per cent of total fertilizer consumption during the triennium average of 2012-13 to 2014-15. During the triennium average of 2003-05 the consumption of urea fertilizer in total fertilizer decreased by 10.15 per cent over the triennium average of 2004-2006.

Table 2.1 also indicates that the consumption urea fertilizer was higher during the rabi season compared to kharif season during the period of 2003-04 to 2014-15. It ranged between 52 to 57 per cent in rabi season compared to 42 to 48 per cent in kharif season, although kharif crops are the most important crops in Bihar. Besides, the consumption of urea fertilizer has increased by 42.65 in triennium average of 2013-15 over the triennium average of 2004-06. Similarly in rabi season, the consumption of urea fertilizers has also increased by 64.14 per cent during the triennium average of 2013-15 over 2004-06. In 2014-15 the farmers used 160.82 kg/ha for total fertilizers whereas they used only 90.04 kg/ha of total fertilizers in 2003-04. It can also be noted that in 2014-15 the farmers used 138 kg/ha of chemical fertilizers for kharif crops and 182 kg/ha for rabi crops. The consumption of chemical fertilizers was increased from 100.99 kg/ha in triennium average of 2004-06

to 164.93 kg/ha in triennium average of 2013-15, registering an increase of about 63 per cent.

Table No. 2.1: Consumption of Urea in Bihar during 2003-04 to 2014-15

('000 MT)

Year	Total	Kharif	Rabi	Consumption of Total Fertilizers (Kg/ha)
2003-04	1178.43	579.12	599.31	91.04
2004-05	1280.37	616.76	663.61	92.15
2005-06	1381.26	647.32	733.94	119.78
Tri Avg. 2004-06	1280.02	614.40	665.62	100.99
	(100.00)	(48.00)	(52.00)	
2006-07	1598.10	666.51	931.59	141.70
2007-08	1851.72	783.80	1067.92	155.60
2008-09	1799.64	834.09	965.55	170.76
Tri. Avg. 2007-08	1794.82	761.47	988.35	156.02
	(100.00)	(43.52)	(56.49)	
2009-10	1701.10	759.10	942.00	181.11
2010-11	1691.21	664.40	1026.80	183.40
2011-12	1811.50	798.56	1012.94	157.89
Tri. Avg. 2010-12	1734.60	740.69	993.91	174.13
	(100.00)	(42.70)	(57.30)	
2012-13	2095.96	903.03	1192.93	183.76
2013-14	1870.64	861.95	1008.69	150.20
2014-15	1940.40	864.29	1076.11	160.82
Tri. Avg. 2013-15	1969.00	876.42	1092.58	164.93
	(100.00)	(44.51)	(55.49)	
% Change in tri. 2013-15 over tri. 2004-06	53.83	42.65	64.14	63.31

Source: Compiled by the author from Economic Survey (Bihar): 2008-09 to 2015-16.
In brackets percentage to total are shown.

As regards the price variation of urea fertilizer is concerned it was almost stagnant during the last five Years. Table 2.2 reveals that the MRPs of plain urea and neem coated urea were Rs. 281.55 per bag (50 kg.) and Rs. 295.63 per bag respectively in 2011. The revised MRP of neem coated urea was Rs. 298 per bag in 2015.

Table No. 2.2: MRPs of Urea and Neem Coated Urea in Bihar

In Rs./bag (50 kgs)

SN	Particulars	Plain Urea	Neem Coated Urea
1.	Since 01/04/2011	281.55	295.63
2.	Since May, 2015	---	298.00

Source: Directorate of Agriculture, Government of Bihar

2.2 Trends in Distribution of NCU since May 2015

Table 2.3 indicates the district wise and season wise consumption of urea fertilizer during 2010-11 to 2015-16. It was observed from the table that total consumption of urea fertilizer across the districts in 2011-12 was 16.91 thousand tonnes, which increased to 23.58 thousand tonnes in 2015-16, recording an increase of nearly 40 per cent during the last five years. It further reveals that the share in consumption of urea fertilizer in the state was higher in rabi season (53.92% to 60.72%) compared to kharif season (39.28 % to 46.08%), despite kharif crops having being highly important crops in three-fourth of the total districts (38) in the state.

In regard to total availability of urea and its distribution across the districts in the state during April to September, 2015 is concerned, it was observed that against the total availability (9.58 thousand tonnes) nearly 99.58 per cent (9.54 thousand tonnes) were distributed among the districts during the same period. The percentage of distribution among the districts in the state was the highest in the month of September (24.24%) followed by August (19.34%), June (17.37%), July (15.03%), May (12.69%) and April (12.69%). Since August and September, constitute nearly 44 per cent of the total transit mainly because of high growing stage of the kharif crops so remarkably high quantity of urea were found to have been used during these two months (table 2.4).

Table No. 2.3: District wise Consumption of Urea Fertilizer during 2010-11 to 2015-16

(Unit in MT)

SN	District	2010-11			2011-12			2012-13			2013-14			2014-15			2015-16		
		Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total
1.	Patna	26311	46909	**73220**	36565	47061	**83626**	37461	45285	**82745**	35686	33679	**69365**	32727	40792	**73520**	42605	58433	**101038**
2.	Nalanda	27418	46113	**73531**	33750	41954	**75704**	39931	46669	**86600**	39560	38995	**78555**	37820	36103	**73923**	42954	56299	**99253**
3.	Bhojpur	26285	35303	**61588**	32663	34786	**67449**	38565	49453	**88018**	37198	35410	**72608**	36314	34819	**71133**	36753	42566	**79319**
4.	Buxar	14693	19334	**34027**	16769	19484	**36253**	22265	31491	**53756**	23699	21716	**45415**	19850	22131	**41981**	23282	34389	**57671**
5.	Rohtas	30874	36017	**66891**	41319	44704	**86023**	41962	51709	**93671**	49924	43916	**93840**	46734	49542	**96276**	50803	59711	**110515**
6.	Bhabua	14890	21532	**36422**	18215	23643	**41858**	20347	25619	**45967**	26060	21886	**47946**	23307	23672	**46979**	24187	27718	**51906**
7.	Gaya	21587	34865	**56451**	33317	33811	**67128**	36816	33333	**70149**	27368	27870	**55237**	30138	25634	**55772**	36964	32708	**69672**
8.	Jehanabad	7691	10585	**18276**	12055	15335	**27390**	16972	13505	**30477**	11740	11497	**23236**	14474	13791	**28265**	16640	16233	**32874**
9.	Arwal	4801	7913	**12714**	8372	7787	**16159**	10920	9081	**20001**	9588	9058	18646	**11123**	12526	23649	**12626**	13278	**25903**
10.	Nawada	8197	13962	**22160**	15597	12561	**28158**	17090	17082	**34172**	13348	13368	**26716**	14116	14608	**28723**	16244	20707	**36951**
11.	Aurangabad	24580	29804	**54383**	3365	30739	**64104**	28196	31574	**59770**	328552	23021	**55872**	27605	27579	**55184**	29098	33332	**62430**
12.	Saran	19011	28405	**47416**	16504	26316	**42820**	21519	35637	**57155**	16837	27877	**44714**	21970	29274	**51244**	24225	38793	**63018**
13.	Siwan	15732	23990	**39722**	19654	21740	**41393**	16825	28445	**45270**	13478	18580	**32057**	17085	22763	**39847**	22892	29673	**52565**
14.	Gopalganj	14764	18296	**33060**	14660	13865	**28525**	11881	17689	**29570**	11008	14011	**25019**	10865	13394	**24259**	14691	18470	**33160**
15.	Muzaffarpur	31008	54832	**85840**	35271	46157	**81428**	39782	59057	**98839**	34392	45537	**79928**	31546	46159	**77705**	39079	48874	**87954**
16.	East Champaran	40493	45100	**85593**	47795	49053	**96847**	52158	51768	**103926**	48006	40207	**88212**	43555	45312	**88867**	47173	73335	**120508**
17.	West Champaran	52718	42018	**94736**	46315	42156	**88471**	48890	50822	**99712**	56235	29788	**86024**	50605	41946	**92551**	50450	55065	**105516**
18.	Sitamarhi	17820	26741	**44561**	20937	17332	**38269**	20462	31038	**51500**	20713	21269	**41982**	20901	21360	**42261**	21392	31844	**53236**
19.	Sheohar	2877	3792	**6670**	2820	4137	**6957**	3892	4454	**8346**	3038	3371	**6408**	3239	4780	**8019**	4898	6723	**11620**
20.	Vaishali	21384	49560	**70944**	26517	46369	**72886**	33283	52046	**85329**	26887	42586	**69473**	24088	42817	**66905**	33058	54146	**87204**
21.	Darbhanga	14209	26801	**41010**	20099	26628	**46726**	20673	26283	**46956**	17024	22347	**39371**	17114	25620	**42734**	22670	38778	**61447**
22.	Madhubani	11341	18410	**29751**	10710	18285	**28996**	13716	22731	**36447**	15511	21805	**37316**	17043	20390	**37432**	17893	32674	**50567**
23.	Samastipur	22253	53185	**75437**	27907	47789	**75696**	34533	62541	**97073**	24480	49610	**74090**	28402	46421	**74823**	34803	58498	**93302**
24.	Begusarai	19033	42059	**61092**	16021	41782	**57802**	25680	49308	**74987**	20061	36724	**56785**	21669	34552	**56221**	25067	53829	**78896**
25.	Munger	3648	5644	**9292**	5718	5512	**11231**	5806	6582	**12389**	5385	6929	**12314**	6618	9697	**16314**	8265	9062	**17866**
26.	Lakhisarai	4815	10633	**15448**	6072	9031	**15102**	7365	8086	**15451**	6922	8078	**15000**	6233	8245	**14478**	5750	8415	**14164**
27.	Sheikhpura	6773	9950	**16722**	9622	8977	**18599**	11158	10558	**21717**	12064	11271	**23334**	12186	13879	**26064**	13625	13500	**27125**
28.	Jamui	8460	15156	**23616**	20009	16553	**36563**	23881	21346	**45227**	17511	22330	**39841**	25562	28540	**54102**	20488	26287	**46775**
29.	Bhagalpur	23055	37477	**60532**	22848	33505	**56353**	25610	27942	**53551**	23775	36233	**60008**	32578	40109	**72687**	27098	42946	**70043**
30.	Banka	8533	15424	**23957**	13778	16124	**29903**	17602	17286	**34889**	14908	15663	**30571**	18598	20596	**39194**	18828	20468	**39295**
31.	Saharsa	11166	18482	**29648**	11657	21656	**33313**	16010	25169	**41179**	13118	20345	**33463**	11275	24638	**35913**	14668	29011	**43679**
32.	Supaul	6433	7806	**14239**	5987	12275	**18262**	8498	14632	**23130**	10008	14499	**24507**	8199	18240	**26439**	2855	24905	**37760**
33.	Madhepura	11601	20198	**31799**	15232	27649	**42881**	18722	31914	**50636**	18971	30543	**49515**	15764	32253	**48017**	19944	42107	**62051**
34.	Purnea	34990	41268	**76258**	36288	44266	**80554**	41515	55026	**96540**	46097	57502	**103599**	44177	55102	**99279**	39853	75619	**115472**
35.	Kishanganj	4823	7782	**12604**	5380	6826	**12206**	7858	7962	**15820**	7925	7174	**15099**	6412	13151	**19563**	9944	13910	**23853**
36.	Araria	11763	21033	**32796**	19122	22235	**41357**	20759	30739	**51498**	26936	37501	**64437**	25824	35417	**61240**	25175	47918	**73093**
37.	Katihar	22546	33761	**56306**	23923	26286	**50289**	25325	39340	**64665**	27095	39759	**66854**	**28389**	40982	**69371**	26459	52943	**79402**
38.	Khagaria	15830	46666	**62496**	15732	48573	**64306**	19104	49725	**68829**	16544	16733	**63277**	20190	39272	**59462**	20803	60159	**80963**
	Total	664405	1026807	**1691211**	798565	1012939	**1811504**	903029	1192925	**2095954**	861948	1008687	**1870634**	864291	1076105	**1940396**	954198	1403864	**2358062**
	%	39.28	60.72	**100.00**	44.08	55.92	**100.00**	43.08	56.92	**100.00**	46.08	53.92	**100.00**	44.54	55.56	**100.00**	40.47	59.53	**100.00**

Source: Directorate of Agriculture, Government of Bihar

Table No. 2.4: District wise Total availability and Transit of Urea Fertilizer up to 30.09.2015 in Bihar

(Unit in MT)

SN	Districts	Total Availability	Sale						
			April	May	June	July	August	Sept.	Total
1.	Patna	42709	3489	6525	8447	6948	6630	10566	42605
2.	Nalanda	42955	5397	5017	8921	8539	6287	8794	42954
	Bhojpur	36764	4296	5819	6837	6002	6393	7406	36753
4.	Buxar	23282	3005	3695	3754	4396	3635	4797	23282
5.	Rohtas	50920	4417	8453	9897	10898	9947	7192	50803
6.	Bhabua	24202	2353	3599	4272	4578	4822	4566	24187
7.	Gaya	36965	6432	4463	6463	4034	6920	8652	36964
8.	Jehanabad	16643	2428	1777	3067	1717	3605	4047	16640
9.	Arwal	12626	2106	1411	2640	1684	2206	2579	12626
10.	Nawada	16263	880	2369	4013	2177	1647	5158	16244
11.	Aurangabad	29103	3304	4545	4824	5334	6466	4625	29098
12.	Saran	24488	970	3062	4927	2441	5545	7281	24225
13.	Siwan	23069	1010	3016	3269	4160	5279	6158	22892
14.	Gopalganj	14919	960	1817	2700	1330	3517	4367	14691
15.	Muzaffarpur	39270	5560	4467	6773	4047	6725	11507	39079
16.	East Champaran	47177	4566	5495	8101	5831	9928	13251	47173
17.	West Champaran	50493	4921	9951	8127	12163	7715	7574	50450
18.	Sitamarhi	21583	3460	1867	3777	2138	3229	6922	21392
19.	Sheohar	5279	660	531	715	620	695	1677	4898
20.	Vaishali	33075	3782	3080	5932	3467	6887	9910	33058
21.	Darbhanga	22672	2211	2526	3452	2800	4853	6828	22670
22.	Madhubani	17893	1551	1260	2612	3208	3285	5978	17893
23.	Samastipur	34828	3883	3187	5857	4743	5128	12005	34803
24.	Begusarai	25071	2961	1842	6780	4504	2398	6582	25067
25.	Munger	8265	456	421	1148	846	2971	2425	8261
26.	Lakhisarai	5750	250	300	1274	347	2104	1475	5750
27.	Sheikhpura	13628	650	1266	3831	2073	2944	2862	13625
28.	Jamui	20488	2446	1435	3932	675	5948	6052	20488
29.	Bhagalpur	27275	1336	4529	3047	5242	6576	6367	27098
30.	Banka	18828	900	1900	2392	2837	5018	5781	18828
31.	Saharsa	4675	1860	1296	600	3428	2888	4597	14668
32.	Supaul	12855	1522	780	910	2850	2943	3850	12855
33.	Madhepura	21009	2767	1326	1434	4536	4250	5631	19944
34.	Purnea	40447	4355	6903	6456	4076	9838	8225	39853
35.	Kishanganj	9949	735	1474	1663	1244	2650	2178	9944
36.	Araria	25175	2837	3618	3493	3232	6227	5770	25175
37.	Katihar	26710	2998	4029	4707	2155	6567	6003	26459
38.	Khagaria	20811	4615	2525	5436	2679	655	4894	20803
	Total	958210	102326	121572	166476	143977	185317	234530	954198
	%	100.00	10.68	12.69	17.37	15.03	19.34	24.47	99.58

Source: Directorate of Agriculture, Government of Bihar

CHAPTER – III

SOCIO-ECONOMIC CHARACTERISTICS OF SAMPLE HOUSEHOLDS

This chapter is an attempt to cover and illuminate the following aspects directly or indirectly concerned with socio-economic characteristics of sample households. These are brief profile of the sample households, details of operational holdings, cropping pattern and sources of irrigation, purchasing pattern of NCU for the reference year and its sources, usage inputs and profitability of reference crops, details of agricultural credit availed by the sample households and the training programmes attended on fertilizer application.

3.1 Socio-Economic Characteristics of Sample Households

As already detailed in table 1.1 that of the total selected 400 households in the state, 297 (74.25%) were marginal and small farmers with operational holdings up to 5 acres, 58 (14.50%) medium farmers with operational area of 5-12.5 acres; and rest 45 (11.25%) large farmers operating above 12.5 acres of land. The average age of respondents was 49.04 years at overall farm households. It was 49.39 years for paddy respondents and 48.70 years for maize respondents. All the respondents were male irrespective of paddy, maize and overall farms. Average family size on overall farms was 6.55 persons. There was not much difference in case of paddy and maize households (6.41 & 6.69 persons respectively). The farming experience of sample respondents was 19.52 years In case of paddy respondents; it was 19.70 years and maize respondents 19.35 years. The average number of family members, who were fully engaged in farming activities, was 2.22 persons at overall farms, which slightly varied in case of paddy and maize farms i.e., 2.21 & 2.24 persons respectively (table 3.1).

Table 3.1: General characteristics of sample farmers (% of farmers)

Sl. No	Particulars	Paddy	Maize	Overall
1	Average age of respondents (Years)	49.39	48.70	49.04
2	Male respondents (% to the total)	100.00	100.00	100.00
3	Average family members engaged fully in farming	2.21	2.24	2.22
4	Average years of farming experience	19.70	19.35	19.52
5	Average family size (No.)	6.41	6.69	6.55

Table 3.2 illustrates about the educational level of sample farms. About 18.75 per cent of the sample households attained education up to primary level (1 to 4 class), 19 per cent higher primary level (5 to 9 class), 27.75 per cent were matriculate (10th

class) and 34.50 per cent up to pre-university and above levels of education at overall farms. In case of paddy households, 36 per cent were matriculate followed by 28 per cent pre-university and above, 20 per cent higher primary and 16 per cent primary. Similarly in case of maize respondents, 41 per cent were pre-university and above followed by 21.50 per cent primary, 19.50 per cent matriculation and 18 per cent higher primary level of education (table 3.2).

Table 3.2: Education level of sample farmers (% of farmers)

Sl. No	Education level	Paddy	Maize	Overall
1	Illiterates	0.00	0.00	0.00
2	Primary (1 to 4)	16.00	21.50	18.75
3	Higher primary (5 to 9)	20.00	18.00	19.00
4	Matriculation (10)	36.00	19.50	27.75
5	Pre University (10+2) & above	28.00	41.00	34.50
	Total	100.00	100.00	100.00

Social classification insinuates higher presence of other backward castes (61.25%) followed by general/upper castes (23.75%), scheduled Castes (10.50%) and Scheduled Tribes (4.50%) at overall farms. Crop wise analysis also revealed higher presence of other backward castes (64% and 58.50%) followed by general/higher castes (22% and 25.50%), scheduled castes (12.50% and 8.50%) and scheduled tribes (1.50 % and 7.50%) at paddy and maize farm respondents levels respectively (table 3.3).

Table 3.3: Distribution of sample farmers based on their category (% of farmers)

Sl. No	Particulars	Paddy	Maize	Overall
1	General	22.00	25.50	23.75
2	OBC	64.00	58.50	61.25
3	SC	12.50	8.50	10.50
4	ST	1.50	7.50	4.50
	Total	100.00	100.00	100.00

The data on occupational structure of sample respondents revealed that about 85.25 per cent were engaged in agriculture and allied vocations, 6.25 per cent self employed in small scale industries, 5.75 per cent agricultural labour, 0.50 per cent pensioners and 0.25 per cent were salaried at overall farms. Similarly in case of paddy and maize respondents 89 per cent and 81.50 per cent respectively were in agriculture and allied vocations and remaining in other different vocations. It was observed that agriculture & allied activities were the main vocation of the sample households across the crops and districts as well (tale 3.4).

Table 3.4: Occupational distribution of the sample farmers (% farmers)

Sl. No	Particulars	Paddy	Maize	Overall
1	Agriculture & allied	89.00	81.50	85.25
2	Agricultural labour	0.50	11.00	5.75
3	Self employed in small scale industries	7.00	5.50	6.25
4	Self employed in services	2.00	2.00	2.00
5	Non-agricultural casual labour	0.00	0.00	0.00
6	Salaried work	0.50	0.00	0.25
7	Household	0.00	0.00	0.00
8	Pensioner	1.00	0.00	0.50
9	Other	0.00	0.00	0.00
	Total	100.00	100.00	100.00

3.2 Details of Operational Land Holdings

The details of average operational land holdings of the sample farmers have been presented in table 3.5. At overall respondents' level, the average size of net operational area (NOA) of total farms was 5.23 acres. It was as high as 18.02 acres in case of large farmers, 8.60 acres of medium farms and 2.63 acres of marginal and small farmers. Of the NOA, the shares of fallow/uncultivated lands, leased-in and leased-out lands were meagre across the farm sizes at overall respondents. Respondents across the farm sizes largely owned their farms. In case of paddy respondents, the average size of NOA was a bit higher compared to overall respondents and maize respondents too. It was 6.80 acres at total farms and 17.80 acres, 9.15 acres and 2.29 acres were at large, medium and marginal & small farmers respectively. The average sizes of NOA amongst the maize respondents were 3.66 acres at total farms and 19.80 acres, 7.26 and 2.86 acres were large, medium and marginal & small farmers respectively. For both the crops, the share of fallow/uncultivated lands, leased-in lands and leased-out lands was either nil or negligible. As regards, the irrigational status of NOA is concerned; it was observed that about 66.43 per cent was irrigated of the total farms at the overall respondents' level however; it largely varied in case of paddy (93.12%) and maize (16.88%) respondents. Since paddy respondents were taken from irrigated tracts and maize respondents from un-irrigated tracts, which was the reason of wide gap in irrigation status between the two reference crop respondents. The rental value of leased in land, which was lower at total farms of overall respondents, was reported at about Rs. 5598 per acre. However, the rental value of leased out land of total farms at overall respondents, level was well higher than that of leased-in at about Rs. 8026 per acre. In case of paddy respondents, it was higher than that of maize respondents, which may be due to higher returns in case of paddy farms than that of maize farms.

Table 3.5: Average operational land holdings of the sample farmers (in acres)

Sl. No	Particulars	Paddy				Maize				Overall			
		Marginal & Small	Medium	Large	Total	Marginal & Small	Medium	Large	Total	Marginal & Small	Medium	Large	Total
1	Owned land	2.229	9.210	17.872	6.789	2.944	7.529	20.800	3.780	2.658	8.717	18.198	5.285
2	Uncultivated/Fallow	0.060	0.338	0.153	0.136	0.013	0.058	0.000	0.017	0.032	0.256	0.136	0.076
3	Leased-in	0.142	0.317	0.362	0.222	0.000	0.000	0.000	0.000	0.057	0.224	0.322	0.111
4	Leased-out	0.021	0.035	0.275	0.074	0.064	0.205	1.00	0.100	0.047	0.085	0.355	0.087
5	Net Operational Area (1-2+3-4)	2.290	9.154	17.806	6.801	2.867	7.266	19.80	3.663	2.636	8.600	18.029	5.233
6	% Irrigated	89.039	92.079	95.23	93.12	13.22	22.87	28.28	16.88	39.62	74.94	87.06	66.43
7	% Un Irrigated	10.961	7.921	4.77	6.88	86.78	77.13	71.72	81.12	60.38	25.06	12.94	33.57
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
8	Rental value of leased-in land (Rs/acre)	5088.23	5461.54	6317.24	5597.75	---	---	---	---	5088.23	5461.54	6317.24	5597.75
9	Rental value of leased-out land (Rs/acre)	12400.00	10344.82	9227.27	9866.22	8260.86	6857.14	2800.00	6650.00	9000.00	7878.79	7218.75	8025.75

3.3 Cropping Pattern and Sources of Irrigation

Cropping pattern was estimated at two counts viz., irrigated and rainfed and across the farm sizes. Amongst the paddy respondents, the total sown area was 1050.03 acres constituting 1006.22 acres (95.83%) irrigated area and 43.81 acres (4.17%) rainfed area (table 3.6). It is to be noted here that in both the sample districts of paddy respondents, only paddy was grown during kharif, 2015. So, all the sample households put their entire area under paddy crop only. Out of the total paddy farms area (1050.03 acres), marginal and small farm households grew paddy crop in 195.11 acres (18.58%), medium farm households (26.93%) and large farm households (54.49%). Similarly in irrigated conditions, out of the total 1006.22 acres, marginal & small farm households grew paddy in 177.45 acres (17.64%), medium farm households in 272.48 acres (27.08%) and large farm households (55.28%). In rainfed conditions (43.81 acres), small & marginal farm households grew paddy in 17.66 acres (40.31%), medium farm households in 10.32 acres (23.56%) and large farm households in 15.83 acres (36.13%). It is observed from the table that more than 50 per cent of total areas at total farm households' level and in irrigated conditions were cultivated by large farm households except in rainfed conditions, wherein 36.13 per cent area was being cultivated by large farm households.

Table 3.6: Cropping pattern of Paddy respondents during kharif season

(Area in acres & % in parenthesis)

SN	Name of the Crops	Irrigated			Rainfed			Total		
		Marginal & Small	Medium	Large	Marginal & Small	Medium	Large	Marginal & Small	Medium	Large
1.	Paddy	177.45	272.48	556.29	17.66	10.32	15.83	195.11	282.80	572.12
	Total (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Total Sown Area (Acres)	177.45 (17.64)	272.48 (27.08)	556.29 (55.28)	17.66 (40.31)	10.32 (23.56)	15.83 (36.13)	195.11 (18.58)	282.80 (26.93)	572.12 (54.49)

The cropping pattern of maize respondents is presented in table 3.7. Amongst the maize respondents, total sown area was 529.10 acres, constituting 124.00 acres (23.44%) under irrigated conditions and 405.10 acres (76.56%) under rainfed conditions. Paddy, maize and soyabean were the major crops grown by the sample households across the farm sizes during kharif, 2015. Of the total farms, about 55 to 84 per cent of the total respective farms' area was devoted for cultivation of paddy crop, 12 to 29 per cent for cultivation of maize crop and 4 to 19 per cent for cultivation of soyabean crop. The trend of cultivation of these crops either in irrigated or rainfed conditions or across the farm sizes was almost the same, as it was in total level. It is evident from the tale that paddy was the most important crop for all maize respondents irrespective of irrigated and rainfed conditions.

Table 3.7: Cropping pattern of the Maize respondents during kharif season

(Area in acres & % in parenthesis)

SN	Name of the Crops	Irrigated			Rainfed			Total		
		Marginal & Small	Medium	Large	Marginal & Small	Medium	Large	Marginal & Small	Medium	Large
1.	Paddy	46.97 (54.25)	12.56 (67.45)	14.00 (74.47)	168.79 (54.74)	39.40 (63.99)	31.50 (89.54	215.76 (54.63)	51.96 (64.80)	45.50 (84.29)
2.	Maize	33.41 (38.59)	4.36 (23.42)	4.40 (23.40)	81.31 (26.37)	8.67 (14.08)	2.08 (5.91)	114.72 (29.05)	13.03 (16.25)	6.48 (12.00)
3.	Soyabean	6.20 (7.16)	1.70 (9.13)	0.40 (2.13)	58.25 (18.89)	13.50 (21.93)	1.60 (4.55)	64.45 (16.32)	15.20 (18.95)	2.00 (3.71)
	Total (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Total Sown Area (Acres)	86.58 (69.82)	18.62 (15.02)	18.80 (15.16)	308.35 (76.12)	61.57 (15.20)	35.18 (8.68)	394.93 (74.64)	80.19 (15.16)	53.98 (10.20)

Having a glance on data in table 3.8, it was observed that bore well (79%) had been the most prominent source of irrigation for overall sample households followed by canal (27.50%) and open or dug well (8.50%). Amongst the paddy respondents, bore well (63.50%) remained the most important source but canal (55%) was also one of the important sources of irrigation. Only 3 per cent of the paddy respondents were found to be irrigating their fields by open or dug well source. In case of maize respondents, again bore well (94.50%) was the major source of irrigation. However, 14 per cent of the maize respondents were also using open/dug well source of irrigation for providing irrigation to their fields.

Table .3.8: Sources of irrigation of the sample farmers *(% of farmers)*

Sl. No	Particulars	Paddy	Maize	Overall
1	Open/ Dug well	3.00	14.00	8.50
2	Bore well	63.50	94.50	79.00
3	Canal	55.00	---	27.50
4	Tank	---	---	---
5	Others	---	---	---

3.4 Purchasing Pattern of NCU and NU and Sources of Purchasing

Since the Government has made mandatory for urea manufacturers to produce only NCU from May 2015 from 35 per cent in 2004 and then to 75 per cent in March 2015, it will be important to assess the purchasing pattern of NCU and NU of the sample households for understanding various dimensions of NCU vis-à-vis NU. It is observed from table 3.9 that per household bought 441.97 kg of urea (both) during the reference period at overall level. Out of the total purchase per household, 70.28 per cent (310.62 kg) comprised NCU and 29.72 per cent (131.35 kg) was NU. The price of NCU was reported at Rs. 338.73 per bag whereas that of NU Rs. 283.53 per bag. Total purchasing cost including transport cost was incurred at Rs. 345.94 per bag for NCU and Rs. 293.53 per bag for NU. Amongst the paddy respondents, per household bought 594.81 kg of urea (both) during the reference period and of the

total purchase, 78.87 per cent (469.15 kg) comprised NCU and 21.13 per cent (125.66 kg) was NU. In case of maize respondents, per household purchase was 239.85 kg of urea (both), comprising 43.64 per cent (104.66 kg) NCU and 56.36 per cent (135.19 kg) NU. As regards the prices of NCU and NU are concerned, the gap between the two was 16 to 22 per cent and it was of course, higher for NCU over NU. It is to be noted here that the price gap between the two was high against the stipulated gap of 5 to 6 per cent. Though, it may be due to carriage from the lifting points to sale points. It is also revealed from the analysis that per household purchase of NCU was around 90 per cent irrespective of crops and locations as well.

Table 3.9: Purchase pattern of NCU for the reference year *(Per Hh)*

Sl. No	Particular	Paddy		Maize		Overall	
		NCU	NU	NCU	NU	NCU	NU
1	Quantity bought (Kgs)	469.15	125.66	104.66	135.19	310.62	131.35
2	Price Rs per bag of 50kg	347.70	297.40	329.75	269.67	338.73	283.53
3	Distance from farm (Kms)	2.97	2.33	1.90	1.89	2.44	2.11
4	Transport cost (Rs per bag of 50kg)	7.54	7.92	9.89	12.06	8.72	10.00
	Total cost (Rs per bag of 50kg)	355.24	305.32	336.64	308.73	345.94	293.53

Further of the purchase volume, the sources of purchased of NCU/NU was also collected from the sample households. Data presented in table 3.10 showed that there were only two sources viz., license private fertilizer dealers and Primary Agricultural Co-operative Societies (PACS). Private fertilizer dealers were the major source from where 88.50 per cent of NCU and 90.65 per cent of NU were purchased by the overall respondents. About 11.50 per cent of NCU and 9.35 per cent of NU were purchased from the PACS by overall respondents. Almost similar pattern of sources of purchase of NCU/NU was indicated amongst the paddy and maize respondents. It is revealed that the access of the sample respondents for both types of urea was rather more for private fertilizer dealers than that of PACS. In fact PACS are mainly located at Panchayat headquarters' village, which covered sometimes 5-6 villages in its operational area.

Table 3.10: Sources of purchase of NCU/Normal Urea *(% of farmers)*

Sl. No	Particulars	Paddy		Maize		Overall	
		NCU	NU	NCU	NU	NCU	NU
1	Private fertilizer dealers	91.00	90.00	86.00	91.30	88.50	90.65
2	Cooperative societies	9.00	10.00	14.00	8.70	11.50	9.35
3	Raitha Samparka Kendra/ Agriculture Department	---	---	---	---	---	---
4	Others (Specify)	---	---	---	---	---	---
5	Total	100.00	100.00	100.00	100.00	100.00	100.00

3.5 Usage Inputs and Profitability of Reference Crops

In this section input use, output and returns in Rs/acre realized by paddy, maize overall and paddy and maize respondents have been presented for kharif 2015 and 2014.

3.5.1 Paddy Farmers

The data presented in table 3.11 showed the input use, output and returns per acre realized by paddy farmers. As is evident from the table that total paid-out costs including imputed value of own labour were estimated at Rs. 11086.29 per acre during kharif, 2014, which rose to Rs. 12009.48 per acre during kharif 2015 on total farms, registering an increase of about 8.33 per cent during 2015 over 2014. It may be due to hike in prices of various inputs used. Among the inputs, the highest cost was incurred on ploughing and sowing charge (26.83%) followed by harvesting and threshing (16.92%), costs of seeds (13.52%), hired labour charges (11.36%) and on other remaining items (31.37%) during kharif 2014 on total farms. During 2015, 68.02 per cent of the total paid out costs was incurred on ploughing and sowing (25.57%), harvesting & threshing (16.87%), costs of seed (13.30%) and costs of hired labour (12.28%) and on other remaining items 31.98 per cent on total farms. The total paid out costs including imputed value of own labour across the farm sizes varied slightly during both the period. During 2014, it was higher at marginal & small farms (Rs. 11809.69/acre) followed by medium farms (Rs. 10991.54/acre) and large farms (Rs. 10948.34/acre). In 2015, similar trend was indicated across the farm sizes. It was Rs. 12308.90/ acre on marginal & small farms followed by Rs. 11986.56/acre on medium farms and Rs. 11917.45/acre on large farms. It reveals that total paid-out costs decreases with the increase of farm sizes during both the periods.

As regards the returns per acre realized by the paddy respondents, table 3.11 indicates that during 2014, gross returns was estimated at Rs. 28042.22 whereas that during 2015 was Rs. 29739.84 on total farms, registering an increase in gross returns of 6.05 per cent during 2015 over 2014. It may be due to a bit increase in yield of paddy crop during 2015 over 2014 and so is the reason for increase in net returns (4.57%) in 2015 over 2014. The net return for 2014 was Rs. 16955.93/acre, whereas that of Rs. 17730.36/acre during 2015. The net return across the farm sizes was found to have increased with the increase in farm sizes in 2015 and 2014 also, barring on large farms in 2014.

Above analysis clearly indicates that despite increase in total paid costs by 8.33 per cent in 2015 over 2014 on total farms, the gross returns realized by the paddy farmers were higher by 6.05 per cent in 2015 over 2014 on total farms mainly due to increase in yield of paddy in 2015 over 2014. However, the net returns rose by only 4.57 per cent in 2015 over 2014 on total farms.

Table 3.11: Input use, output and returns per acre realized by Paddy farmers (Rs. per acre)

Sl. No	Particular	2015				2014			
		Marginal & Small	Medium	Large	Total	Marginal & Small	Medium	Large	Total
	Input use and their costs								
1	Ploughing and sowing charges (only machinery)	2764.96	3066.56	3178.54	3070.67	2700.81	2980.72	3039.56	2974.14
2	Seed cost/ purchase of seedlings	1329.14	1569.54	1703.30	1597.22	1168.65	1504.18	1578.31	1498.41
3	Organic/FYM	---	---	---	---	---	---	---	---
4	Urea/NCU	606.29	603.83	566.82	584.16	589.17	558.70	548.77	557.35
5	Chemical fertilizers (Other than Urea/NCU)	803.23	625.88	617.16	654.41	521.74	573.76	577.17	568.11
6	Plant protection chemicals	861.37	755.32	713.39	752.42	759.44	649.15	633.63	656.25
7	Irrigation charges	652.96	444.36	312.21	411.62	449.40	305.67	286.31	315.44
8	Harvesting & threshing charges	2214.08	2065.37	1942.60	2026.50	2165.56	1866.38	1807.85	1875.98
9	Hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting)	1124.73	1189.70	1232.93	1201.03	1441.00	1233.87	1226.25	1259.87
10	Imputed value of family labour	409.13	99.72	62.17	137.33	756.31	97.45	36.34	158.14
11	Hired labor (amount paid)	1351.10	1484.24	1512.68	1474.73	1081.92	1151.94	1166.26	1150.06
12	Maintenance costs on assets used for the reference crop	191.91	82.04	76.05	99.39	175.69	69.72	47.99	72.54
	Total paid-out costs including imputed value of own labour	12308.90	11986.56	11917.45	12009.48	11809.69	10991.54	10948.34	11086.29
	Returns								
1	Output (Main product)	26093.83	28671.55	29569.95	28676.64	28660.76	29084.83	26067.64	27247.95
2	By product	1185.58	1051.05	1027.00	1063.20	1180.82	706.79	736.94	794.27
3	Gross returns	27279.41	29722.60	30596.95	29739.84	29841.58	29791.62	26804.58	28042.22
4	Net returns	14970.51	17736.04	18679.50	17730.36	18031.89	18800.08	15856.24	16955.93

3.5.2 Maize Farmers

While taking a glance on table 3.12, it is revealed that total paid-out costs on used inputs for maize crop at total farms during 2014 was Rs. 13203.13 per acre, which came down to Rs,. 12311.69 per acre during 2015, registering a decrease of 6.75 per cent in 2015 over 2014 on total farms. Among the different inputs, about 64 per cnt of the total paid-out costs was incurred on costs of seeds (28.57%) followed by harvesting & threshing charges (16.80%), amount paid to hired labour (10.02%) and costs on ploughing and sowing (8.42%) in 2014 on total farms. On remaining items, about 36 per cent of the total paid-out cost was incurred. Similarly during 2015, almost same trend of paid-out costs was revealed. Across the farm sizes, total paid-out costs diminished with the increase of farm sizes in 2014, whereas a slight increase was seen with the increase of farm sizes, barring large farms in 2015. As regards, the gross returns realized by the maize respondents is concerned, it was Rs. 27012.14 per acre in 2014, whereas it was Rs. 29421.22 per acre, registering an increase of 8.92 per cent in 2015 over 2014 on total farms. Across the farm sizes, the gross returns slightly declined with the increase in farm sizes in 2014, whereas it indicated slight increase with the increase of farm sizes except on large farms in 2015. However, a net return was found to have increased by about 24 per cent in 2015 over 2014 on total farms. Across the farm sizes, net returns were found to have slightly diminished with the increase in farm sizes in 2014, whereas total showed slight increase with the increase of farm sizes, except on medium farms in 2015.

Above analysis clearly showed that despite a decrease in total paid-out costs by about 6.75 per cent in 2015 over 2014, the gross and net returns remarkably increased by 8.92 per cent and 23.90 per cent respectively in 2015 over 2014 on total farms. It is perhaps due to increase in yield of maize by about 5 per cent plus in 2015 over 2014 on total farms.

3.5.3 Overall Farmers

Usage inputs, output and returns realized by overall farmers (constituting paddy and maize farmers) have been presented in table 3.13. It can be clearly seen from the table that total paid-out costs incurred by overall farmers was Rs. 11326.56 per acre in 2014 and Rs. 12044.69 per acre in 2015, registering an increase in costs by about 6.34 per cent on total farms: It moderately varied across the farm sizes during both the years. In fact, it declined with the increase of farm sizes in both the periods except in case of large farmers compared to medium farmers in 2014. The data further revealed that gross returns have registered an increase of 6.39 per cent in 2015 over 2014 which increased from Rs. 27924.68 per acre to Rs. 29702.72 per acre on

Table 3.12: Input use, output and returns per acre realized by Maize farmers (Rs. per acre)

Sl. No	Particular	2015				2014			
		Marginal & Small	Medium	Large	Total	Marginal & Small	Medium	Large	Total
	Input use and their costs								
1	Ploughing and sowing charges (only machinery)	1182.03	1178.15	1210.67	1179.31	1132.11	935.33	1080.38	1111.24
2	Seed cost/ purchase of seedlings	3598.80	3747.80	3316.20	3600.12	3796.59	3774.52	3362.54	3771.74
3	Organic/FYM	---	---	---	---	---	---	---	---
4	Urea & NCU	1115.33	1176.44	1328.66	1131.10	1263.25	1156.39	1970.10	1290.54
5	Chemical fertilizers (Other than Urea/NCU)	959.68	901.19	933.80	952.84	1228.70	1223.60	1017.04	1217.10
6	Plant protection chemicals	486.10	518.21	425.00	486.38	448.71	485.17	416.94	450.40
7	Irrigation charges	844.04	876.73	892.05	849.42	865.09	922.41	665.43	859.88
8	Harvesting & threshing charges	1945.61	1980.81	1903.49	1947.06	2215.39	2354.35	2021.86	2218.03
9	Hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting)	333.30	321.90	350.02	332.19	308.33	297.89	294.21	306.63
10	Imputed value of family labour	370.62	283.37	93.45	349.37	406.13	309.44	96.46	389.55
11	Hired labor (amount paid)	1188.57	1134.79	1610.59	1202.89	1310.89	1291.70	1572.34	1322.86
12	Maintenance costs on assets used for the reference crop	288.34	246.08	218.07	281.01	283.10	249.77	0.00	265.15
	Total paid-out costs including imputed value of own labor	12312.42	12356.47	12282.00	12311.69	13258.29	13000.57	12497.30	13203.13
	Returns								
1	Output (Main product)	26499.64	26884.45	27144.08	26566.62	23345.38	24526.08	24502.67	23515.07
2	By product	2470.70	2519.01	1853.58	2854.60	3752.78	2086.06	1469.13	3497.07
3	Gross returns	28970.34	29403.46	28997.66	29421.22	27098.16	26612.14	25971.80	27012.14
4	Net returns	16657.92	17046.99	16715.66	17109.53	13839.87	13611.57	13474.50	13809.01

Table 3.13: Input use, output and returns per acre realized by Overall farmers (Rs. per acre)

Sl. No	Particular	2015				2014			
		Marginal & Small	Medium	Large	Total	Marginal & Small	Medium	Large	Total
	Input use and their costs								
1	Ploughing and sowing charges (only machinery)	2169.81	2981.07	3156.33	2850.35	2032.43	2893.61	3017.45	2763.15
2	Seed cost/ purchase of seedlings	2182.49	1668.15	1721.18	1830.53	2288.33	1600.88	1598.45	1756.40
3	Organic/FYM	---	---	---	---	---	---	---	---
4	Urea & NCU	797.68	629.75	575.27	647.87	876.37	584.16	564.81	640.39
5	Chemical fertilizers (Other than Urea/NCU)	862.05	638.34	620.67	689.17	822.95	601.44	582.13	641.62
6	Plant protection chemicals	720.96	744.59	710.19	721.43	627.05	642.17	631.18	632.94
7	Irrigation charges	724.80	463.93	318.64	462.62	626.57	331.94	290.59	377.10
8	Harvesting & threshing charges	2113.14	2061.54	1942.17	2017.25	2186.79	1887.16	1810.27	1914.72
9	Hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting)	827.17	1150.32	1223.14	1099.82	958.40	1194.01	1215.73	1151.90
10	Imputed value of family labour	394.65	108.03	62.52	162.03	607.11	106.48	37.43	184.35
11	Hired labor (amount paid)	1289.99	1468.42	1513.77	1443.06	1179.48	1157.89	1170.84	1169.63
12	Maintenance costs on assets used for the reference crop	228.17	89.47	77.62	120.56	221.45	77.39	47.45	94.36
	Total paid-out costs including imputed value of own labor	12310.91	12003.61	11921.49	12044.69	12426.93	11077.13	11966.33	11326.56
	Returns								
1	Output (Main product)	26246.40	28590.64	29543.05	28430.85	26396.04	28890.67	26049.98	26825.16
2	By product	1668.76	1117.51	1036.18	1271.87	2276.65	765.53	745.20	1099.52
3	Gross returns	27915.16	29708.15	30579.23	29702.72	28672.69	29656.20	26795.18	27924.68
4	Net returns	15604.25	17704.54	18657.74	17658.03	16245.76	18579.07	14083.65	16598.12

total farms. Similarly, the net returns realized by the overall farmers also registered an increase of 6.37 per cent in 2015 over 2014 on total farms which increased from Rs. 16598.12 per acre to Rs. 17658.03 per acre. Surprisingly, the increase in total paid-out costs, gross and net returns are almost same, despite increase in yields of both the reference crops (paddy and maize) by about 3.33 per cent and 5.30 per cent respectively. In fact it is because of abrupt fall in maize prices during kharif, 2015 the gross and net returns realized by the overall farmers, were somewhat low.

3.5.4 Paddy and Maize Farmers

The details of usage of inputs in terms of quantity and value, output and returns realized by the paddy and maize farmers separately for 2014 and 2015 have been depicted in table 3.14. It is observed from the table that the use of urea (NCU &NU) was lower in 2015 over 2014 in case of paddy farmers, whereas it was much lower in case of maize farmers. In fact the usage of urea was 6.74 per cent lower in case of paddy farmers in 2015 over 2014 but 10.51 per cent lower in case of maize farmers in 2015 over 2014. It will be important to note here that during 2015, all the sample households were using NCU besides NU. It was observed that paddy farmers particularly in Rohtas district were using neem oil mixed normal urea/NCU for the last 5-6 years and had experienced its impact on yield, which was not as per their expectations. So they were reluctant in changing the doses and application pattern of NU/NCU. But maize farmers were more enthusiastic in slashing the doses and pattern of application of NCU during 2015, which of course, slashed the quantity of urea while applying in their fields in 2015.

It is further revealed that the output of both the crops increased by 3.33 per cent (from 26.39 qtls/acre to 27.27 qtls/acre) and 5.30 per cent (i.e., from 23.02 qtls /acre to 24.24 qtls / acre) for paddy and maize crops respectively in 2015 over 2014.

3.6 Details of Agriculture Credit Availed

Tables 3.15 and 3.16 provide details of sources and purpose of borrowings by the sample households during the reference period of the study. About 14.75 per cent (59 Hhs) of the overall farmers had taken loans. Of them, paddy households were 29 (14.50%) and maize households 30 (15%). It is evident from the able 3.15 that amount of per household credit was Rs. 2443.75 on overall farms. It was higher at Rs. 3255 per household in case of paddy farmers and lower at Rs. 1632.50 per household for maize farmers. Among the different sources of credit, institutional credit constituted the major amount i.e., about 83 per cent and non-institutional had the contribution of only about 17 per cent on overall farmers. In case of paddy farmers, it was about 88 and 12 per cent respectively, whereas these were 74 and 26 per cent respectively in case of maize farmers. While examining the credit taken by purpose,

Table 3.14: Input use, output and returns per acre realized by Paddy & Maize farmers (Rs. per acre)

Sl. No	Particular	Paddy				Maize			
		2014		2015		2014		2015	
		Qty	Value	Qty	Value	Qty	Value	Qty	Value
	Input use and their costs								
1	Ploughing and sowing charges (only machinery)	---	2974.14	---	3070.67	---	1111.24	---	1179.31
2	Seed cost/ purchase of seedlings (kg)	71.80	1498.41	69.74	1597.22	7.88	3771.74	8.03	3600.12
3	Organic/FYM	---	---	---	---	---	---	---	---
4	Urea & NCU (kg)	93.96	557.35	87.63	584.16	153.91	1293.09	137.73	1131.10
5	Chemical fertilizers (Other than Urea/NCU)	44.76	568.11	48.22	654.41	91.30	1217.10	76.28	952.84
6	Plant protection chemicals	---	656.25	---	752.42	---	450.40	---	486.38
7	Irrigation charges	---	315.44	---	411.62	---	859.88	---	849.42
8	Harvesting & threshing charges	---	1875.98	---	2026.50	---	2218.03	---	1947.06
9	Hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting)	---	1259.87	---	1201.03	---	306.63	---	332.19
10	Imputed value of family labour	---	158.14	---	137.33	---	389.55	---	349.37
11	Hired labor (amount paid)	---	1150.06	---	1473.73	---	1322.86	---	1202.89
12	Maintenance costs on assets used for the reference crop	---	72.54	---	99.39	---	265.15	---	281.01
	Total paid-out costs including imputed value of own labor	---	11086.29	---	12009.48	---	13203.13	---	12311.69
	Returns								
1	Output (Main product in qtls)	26.39	27247.95	27.27	28676.64	23.02	23515.07	24.24	26566.62
2	By product (qtlt & atia)	4.77 & 2053	794.27	4.68 & 1918	1063.20	17.12	3497.07	16.21	2854.60
3	Gross returns	---	28042.22	---	29739.84	---	27012.14	---	29421.22
4	Net returns	---	16955.93	---	17730.36	---	13809.01	---	17109.53

it was observed that major part of about 84 per cent of the loans was spent on seasonal crop cultivation on overall farmers' level. It was about 83 per cent and 77 per cent in case of paddy and maize farmers respectively. It reveals that proportionately higher amounts of loan were used for productive purposes and lower amounts of loan in non-productive purposes like consumption expenditure, marriage & social ceremonies and other miscellaneous expenditures.

Tables 3.15: Credit details of farmers during the reference period (Rs per household)

Sl. No	Sources	Paddy	Maize	Overall
	Institutional sources			
1	Commercial Banks	2675	900	1787.50
2	Co-operative societies	100	200	150.00
3	Regional Rural Bank	75	100	87.50
	Total	*2850 (87.56)*	*1200 (73.51)*	*2025 (82.86)*
	Non-Institutional sources			
1	Money lenders	405	432.50	418.75
2	Friends & relatives	---	---	---
3	Traders/commission agent	---	---	---
4	Others	---	---	---
	Total	*405 (12.44)*	*432.50 (26.49)*	*418.75 (17.14)*
	Grand Total	*3255 (100.00)*	*1632.50 (100.00)*	*2443.75 (100.00)*

In parenthesis percentage figures are shown.

Table 3.16: Purpose of borrowing loans during the reference period

(% of farmers & % of amount (Rs/Hh)

Sl. No	Purpose	Paddy		Maize		Overall	
1	Seasonal crop cultivation	9.50	87.56	9.00	77.18	9.25	84.09
2	Purchase of tractor and other implements	---	---	---	---	---	---
3	Purchase of livestock-	---	---	---	---	---	---
4	Consumption expenditure	2.00	4.92	2.00	7.35	2.00	5.73
5	Marriage and social ceremonies	1.00	3.07	2.00	8.58	1.50	4.91
6	Non-farm activity	---	---	---	---	---	---
7	Other expenditure	2.00	4.45	2.00	6.89	2.00	5.27

3.7 Training Programme Attended on Fertilizer Application

No specific training programme was organized on fertilizer application in the study area. So, none of the sample farmers across the sampled districts and among the reference crops attended such programmes. However, on 5th December, International Soil Day was celebrated at every block/tehsil headquarters' level, wherein resource persons coming from the Department of Agriculture and KVK Scientists advised the farmers in regard to dosages of fertilizer application, and also the needed soil amendments.

CHAPTER – IV

STATUS OF AWARENESS AND APPLICATION OF NEEM COATED UREA

4.1 Awareness and Sources of Information on NCU

Participation of farmers in any of the programmes, be it new or old one, is determined by their awareness about the same. In course of our field survey, attempt was made to capture the awareness of farmers about the neem coated urea. The awareness and sources of information about NCU among the respondents are given in table 4.1. It is clearly evident from the table that all sample farmers were aware about NCU across the farm sizes and reference crop as well. It was further observed from the same table that input shop/dealers were the major source of information in case of marginal and small farmers (89.23%), medium farmers (94.83%) and large farmers (86.67%) at overall crops level. In case of marginal and small farmers, the second important source of information was print and visual media (38.38%) followed by fellow farmers (36.03%), Kisan Salahkaars (19.19%) and 2.02 per cent each for KVK scientists and others. Fellow farmers (48.28%), print and visual media (44.82%), Kisan Salahkaars (24.14%) and KVK scientists (1.72%) were next to input shops/dealers for medium farmers. Similarly in case of large farmers, next to input shops/dealers instrumental sources were print and visual media (57.78%), fellow farmers (42.22%) and farm facilitators (26.67%). Among paddy farmers input shops/dealers were also the major source of information across the farm sizes. In case of maize farmers, again input dealers were the major source of information. Print & visual media and fellow farmers followed by Kisan Salahkaars were the second & third sources of information across the farm sizes and reference crops. It is revealed that input dealers played an important role for making the farmers aware about the NCU in the state (table 4.1).

Besides awareness and sources of information about the NCU, the survey also tried to identify the factors which the sample which were responsible the farmers to differentiate NCU over normal urea (NU). These factors are presented in table 4.2. About 88 to 100 per cent sample farmers noticed the difference between NCU and NU across the farm sizes and reference crops.

Table 4.1: Awareness and sources of information about Neem Coated Urea among the respondents (% of farmers)

Sl. No	Sources of Information	Paddy			Maize			Overall		
		Marginal & Small	Medium	Large	Marginal & Small	Medium	Large	Marginal & Small	Medium	Large
	% of farmers Aware	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Sources of awareness									
1	Agricultural Officer (RSK)	---	---	---	---	---	---	---	---	---
2	Farmer Facilitator/Kisan Salahkaar	28.57	19.51	27.50	12.92	35.29	20.00	19.19	24.14	26.67
3	Fellow Farmers	33.61	48.78	45.00	37.64	47.06	20.00	36.03	48.28	42.22
4	Print & Visual media	36.97	39.02	57.50	39.32	58.82	40.00	38.38	44.82	57.68
5	Wall Writing	---	---	---	---	---	---	---	---	---
6	KVKScientists	2.52	---	---	1.69	5.88	---	2.02	1.72	---
7	Agricultural University	---	---	---	---	---	---	---	---	---
8	Input shops/Dealers	93.27	95.12	85.01	86.62	94.12	100.00	89.23	94.83	86.67
9	Company (suppliers)	---	---	---	---	---	---	---	---	---
10	Any other (Specify)	1.68	---	---	2.25	---	---	2.02	---	---

Table 4.2: Factors from which farmers differentiate NCU compared to Normal Urea (% of farmers)

Sl. No	Sources of Information	Paddy			Maize			Overall		
		Marginal & Small	Medium	Large	Marginal & Small	Medium	Large	Marginal & Small	Medium	Large
	% of farmers noticed difference in NCU	91.60	87.80	92.50	89.89	94.12	100.00	90.57	89.66	93.33
	Factors									
1	Colour difference	23.85	30.56	21.62	---	---	---	9.67	21.15	19.05
2	Price difference	22.94	16.67	21.62	21.25	---	20.00	21.93	11.54	21.43
3	Leaf figure on the bag	47.71	41.67	35.14	43.13	18.75	60.00	44.98	34.62	38.10
4	Any other (smell, etc.)	89.91	100.00	94.59	85.63	43.75	60.00	50.19	84.62	90.48

Considering both the reference crops, 90.57 per cent of marginal and small farmers, 89.66 per cent medium farmer and 93.33 per cent large farmers noticed the differences of NCU over NU. Smell, leaf figure on the bag, price and colour are the four major factors, which helped them to differentiate NCU over NU. Considering both the reference crops, i.e., large (90.48%), medium (84.62%) and marginal & small farmers (50.19%) followed by leaf figure on the bag (about 35 to 45%), price difference (about 12 to 22%) and colour difference (about 10 to 21%). In case of paddy and maize farmers separately, smell itself was the major factor followed by leaf figure on the bag and colour/price differences.

4.2 Status of application of Urea Vs. NCU

The status of application of Urea vs. NCU has been assessed with the application of NCU by the respondents, split doses of NCU/NU application by respondents and method of application of NCU/NU. The details of application of NCU for reference crops before and after 2015-16 are presented in table 4.3. It is noticed that there was a difference in usage of NCU across the crops, before and after 2015-16. This may be due to inadequate availability of NCU and existing old stocks of NU with the input dealers etc. before 2015-16 and change in mandatory production of NCU as per the government policy intervention since May, 2015. Among paddy farmers, 74.50 per cent accounted for NCU usage even before 2015-16 and after 2015-16 (82.50%) whereas 26.50 per cent of maize farmers used NCU before 2015-16, which increased to 74 per cent after 2015-16.

Table 4.3: Application of NCU across different seasons by paddy respondents

(% of farmers)

Sl.No	Name of the crops	Before 2015-16		After 2015-16	
		No.	%	No.	%
1	Paddy	149	74.50	165	82.50
2	Maize	53	26.50	148	74.00

Further, it was also tried to know the split doses of NCU/NU application by the respondents. As is evident from the table 4.4 a total of 81.74 kg/acre of NCU and 112.73 kg/acre of NU were applied by the overall farmers. Of the total consumption of NCU per acre, about 40.93 per cent (33.46 kg/acre) was used at vegetative growth stage crops followed by 34.67 per cent (28.33 kg/acre) after weeding and 24.40 per cent (19.95 kg/acre) at basel application stages at overall farmers. Similarly of the total consumption of NU per acre about 41.16 per cent (46.40 kg/acre) was applied at vegetative growth stage followed by after weeding (30.79%) and basel application (28.05%) stages at overall farms. In case of paddy respondents, the application of NCU was larger at vegetative growth stage (37.94%) followed by after weeding stage (33.66%) and 28.40 per cent at basel activities. Application of NU was again larger at

vegetative growth stage (39.51%) followed by basel (33.33%) and after weeding stages (27.16%). However, in case of maize crop, application of NCU was not noticed at basel application, rather 52.86 per cent of the total applied quantity was found at vegetative growth stage and the remaining 47.14 per cent after weeding stage. But out of the total consumption of NU, 41.20 per cent was at basel application stage followed by vegetative growth and after weeding stages. It clearly indicates that at vegetative growth stage higher application of NCU/NU was used in case of paddy and overall respondents. Though, it varied in case of maize, where higher doses were given at basel stage followed by vegetative and after weeding stages.

Table 4.4: Split doses of NCU / Normal Urea application by respondents (Kgs/Acre)

SN	Crop Stages	Paddy				Maize				Overall			
		NCU	%	NU	%	NCU	%	NU	%	NCU	%	NU	%
1	Basel application	21.80	28.40	32.83	33.33	0.00	0.00	59.42	41.20	19.95	24.40	31.62	28.05
2	Vegetative growth	29.13	37.94	38.92	39.51	69.38	52.86	43.08	29.88	33.46	40.93	46.40	41.16
3	After weeding	25.84	33.66	26.75	27.16	61.89	47.14	41.69	28.92	28.33	34.67	34.71	30.79
4	Maturity	---	---	---	---	---	---	---	---	---	---	---	---
5	Any other	---	---	---	---	---	---	---	---	---	---	---	---
	Total	76.77	100.00	98.50	100.00	131.27	100.00	144.19	100.00	81.74	100.00	112.73	100.00

While asking about method of application of NCU/NU in the reference crops and during the reference period, it was noticed by having a glance on table 4.5 that full quantity of NCU/NU was applied through broadcasting method by paddy respondents. About 59 to 77 per cent of per acre total consumption of NCU/NU were applied through broadcasting method and about 13 to 41 per cent was used through fertigation method by maize respondents. At overall farmers' level 73 to 92 per cent of its total per acre consumption was through broadcasting method and remaining 27 to 8 per cent through fertigation. It was also reported that the method of application changed with the change in moisture content in the soil.

Table 4.5: Method of Application of NCU/Normal Urea (Kgs/Acre)

Sl. No	Method of application	Paddy				Maize				Overall			
		NCU qty	%	NU qty	%	NCU qty	%	NU qty	%	NCU qty	%	NU qty	%
1	Broadcasting	76.77	100.00	98.50	100.00	100.92	76.88	85.61	59.37	74.84	91.56	82.43	73.12
2	Spraying	---	---	---	---	---	---	---	---	---	---	---	---
3	Fertigation	---	---	---	---	30.35	23.12	58.59	40.63	6.90	8.44	30.30	26.88
4	Drilling	---	---	---	---	---	---	---	---	---	---	---	---
	Total	76.77	100.00	98.50	100.00	131.27	100.00	144.19	100.00	81.74	100.00	112.73	100.00

4.3 Perception of Farmers about NCU and its benefits Compared to Urea

Farmers' perception about NCU versus Normal Urea is presented in table 4.6. Overall, 74.75 per cent of farm households have mentioned that quality of NCU was good and 17 per cent confirmed it to be very good. Only 5.50 and 2.75 per cent opined that quality of NCU was bad and has not changed respectively. Among

paddy respondents, 72 per cent opined that quality of NCU was good and 17 per cent termed as very good. Nearly 5.50 per cent opined equally that quality of NCU did not changed was bad respectively. Again 77.50 per cent maize farmers were of the view that quality of NCU was good 17 per cent as very good. About 5.50 per cent opined that the quality of NCU was bad.

Majority of overall farmers (81%) reported about adequate availability of NCU. Among paddy and maize farmers also, 80.50 per cent and 81.50 per cent respectively told about adequate availability of NCU. About 11 per cent of the overall farmers reported about no change in availability and 8 per cent as inadequate availability. Almost similar responses were noticed in case of paddy and maize farmers. While examining timely availability of NCU, about 80 per cent of overall farmers told in favour i.e., 'Yes' and 20 per cent as 'No.' Among paddy and maize surveyed farmers, 77 per cent and 84 per cent respectively told about its timely availability and 23 per cent and 16 per cent as untimely availability. About 42 per cent of overall farmers received NCU at a higher price over the price of NU. However, 58 per cent of overall farmers told that prices of NCU were not very high. Most of the overall farmers pointed out decrease in total quality of fertilizer usage after the launch of NCU, and urea usage in particular. Almost same were the views of paddy and maize surveyed households. While asking about benefits accrued from the NCU in terms of urea usage, 61.25 per cent of overall farmers told about no change and 38.75 per cent expressed as decrease in the use of urea after introduction of NCU. Pest and diseases attack had reduced after launch of NCU as reported by 78 per cent overall farmers. However, about 22 per cent told that there was no change in pest and diseases attack. NCU is easily accessible in the market compared to normal urea, which was noticed by nearly 72 per cent overall farmers and 28 per cent responded in no. The survey also tried to find out the reasons for easy accessibility of NCU in the market compared to normal urea, which included increase in NCU price (7.25%), decrease in other usage (31%), increase in supply (42.50%) and decrease in quantum of NCU compared to normal urea (13.50%) at overall farmers.

Table 4.6: Perception about NCU versus Normal Urea

Sl. No	Particulars	Paddy		Maize		Overall	
		No	%	No	%	No	%
1	**Neem Coated Urea quality**						
	Very good	34	17.00	34	17.00	68	17.00
	Good	144	72.00	155	77.50	299	74.75
	Bad	11	5.50	11	5.50	22	5.50
	No change	11	5.50	---	---	11	2.75
2	**Neem Coated Urea availability**						
	Adequate	161	80.50	163	81.50	324	81.00
	Inadequate	17	8.50	16	8.00	33	8.25
	No change	22	11.00	21	10.50	43	10.75
3	**Timely availability of Neem Coated Urea**						
	Yes	154	77.00	167	83.50	321	80.25
	No	46	23.00	33	16.50	79	19.75
4	**Neem Coated Urea Price**						
	Very high	---	---	---	---	---	---
	High	98	49.00	70	35.00	168	42.00
	Not very high	102	51.00	130	65.00	232	58.00
	Same as urea	---	---	---	---	---	---
5	**Benefits of NCU in terms of total fertilizer usage**						
	Increased	---	---	---	---	---	---
	Decreased	104	52.00	135	67.50	239	59.75
	No Change	96	48.00	65	32.50	161	40.25
6	**Benefits of NCU in terms of Urea usage**						
	Increased	---	---	---	---	---	---
	Decreased	48	24.00	107	53.50	155	38.75
	No Change	152	76.00	93	46.50	245	61.25
7	**Pest and diseases attack**						
	Increased	---	---	01	0.50	01	0.25
	Decreased	142	71.00	170	85.00	312	78.00
	No Change	58	29.00	29	14.50	87	21.75
9	**NCU is more easily accessible in the market compared to normal Urea**						
	Yes	146	73.00	143	71.50	289	72.25
	No	54	27.00	57	28.50	111	27.75

Table 4.7 presents the comparative advantages of NCU over normal urea in case of both the reference crops, viz., paddy and maize. It can be clearly seen from the table that 27.50 per cent of paddy farmers and 18 per cent of maize farmers confirmed increase in yield due to application of NCU. A higher proportion of both paddy and maize farmers opined that there was no change in yields (68% and 78% respectively) with the use of NCU as compared with the normal urea. In case of extent of increase

in yield, paddy farmers reported that it had increased by 7.74 per cent, whereas in case of maize farmers, 6.89 per cent increase was reported. The extent of decrease in yield was reported by 7.72 per cent for paddy farmers and 7.11 per cent in case of maize farmers. No change was confirmed by 58 per cent paddy farmers and 72 per cent of maize farmers with respect to cost of pest and disease control. However, 42 per cent of paddy farmers and 27.50 per cent of maize farmers were of the opinion that cost of pest and disease control had decreased. The extents of decrease were noticed by 8.13 per cent and 12.71 per cent of paddy and maize farmers respectively. With respect to weed management, 76.50 per cent paddy farmers and 85 per cent maize farmers found no change. About 33 per cent paddy farmers and 25 per cent maize farmers reported increase in cost of NCU compared to normal urea. However, 67 per cent and 75 per cent of paddy and maize farmers respectively reported no change in cost of NCU compared to normal urea. A large proportion of paddy and maize farmers (77.50% and 90.50% respectively) told that there was no change in cost of other fertilizers. Similarly, in case of improvement in soil, 90 per cent paddy farmers and 91 per cent maize farmers opined no change and a small proportion (10% and 9% respectively) told that it had improved. About 93 per cent paddy farmers and 96.50 per cent paddy and maize farmers respectively mentioned no change in quality of grain. No change in market acceptability of grain was reported by 87.50 per cent paddy farmers and 94.50 per cent maize farmers. It clearly reveals that impact of use of NCU was not apparent as the farmers started using NCU since kharif, 2015. Though, the policy intervention emerged with respect to 100 production and sale of NCU since May 2015, practically the distribution started after July, 2015. Besides, there were some old stocks of normal urea with the input dealers. Hence, there is possibility that all the sample farmers might not have used 100 per cent NCU alone during the reference season. Its' larger impacts would be visible w.e.f., next seasons.

4.4 Diversion of Urea and NCU from other than Crop Purposes

Considering overall crops, only 4 paddy farmers (1%) of Rohtas district reported that they had leased-in fish ponds where they use normal urea/NCU for growth of fishes at the rate of 2-2.5 kg/acre for 2 to 3 times only. They altogether had 5.25 acres of water area and used a total of 27 kg of NU/NCU during the reference period, which was negligible in total use of NU/NCU.

Table 4.7: Comparative Benefits of NCU over Normal Urea in case of Paddy & Maize (% of farmers)

Sl. No	Particulars	Paddy					Maize				
		Increased	Decreased	No change	Extent of Increase (%)	Extent of Decrease (%)	Increased	Decreased	No change	Extent of Increase (%)	Extent of Decrease (%)
1	Yield	27.50	4.50	68.00	7.74	7.72	18.00	4.00	78.00	6.89	7.11
2	Cost of pest and disease control	---	42.00	58.00	---	8.13	0.50	27.50	72.00	7.50	12.71
3	Weed management	23.50	---	76.50	7.99	---	8.00	7.00	85.00	7.52	12.69
4	Cost of NCU compared to Urea	33.00	---	67.00	12.64	---	25.00	0.00	75.00	11.52	0.00
5	Cost of other fertilizers	22.50	---	77.50	09.09	---	9.50	0.00	90.50	8.15	0.00
6	Improvement in soil health	10.00	---	90.00	---	---	9.00	0.00	91.00	---	---
7	Quality of grain	07.00	---	93.00	---	---	3.50	0.00	96.50	---	---
8	Market acceptability of grain	12.50	---	87.50	---	---	5.50	0.00	94.50	---	---

4.5 Constraints and Suggestions about NCU and its Adoption

Major problems faced by the farm households in adoption of NCU fertilizer have been presented in table 4.8. It is evident from the table that the sample households at overall crops noticed several problems like; lack of training for crop wise application of NCU (43.50%) followed by lack of irrigational facilities (39.25%), lack of fertilizer retail shops in and around the village (26%), lack of fertilizer and soil test laboratories (10.50%), during peak period--- black marketing of urea (9.50%) and sale of duplicate urea (5.25%). Among the paddy farmers, the major problems were lack of training for crop wise application of urea (39%) followed by lack of fertilizer retail shops (26%), black marketing of urea (19%) etc. In case of maize farmers, 60 per cent told about lack of irrigational facilities, 48 per cent about lack of training for crop wise application of NCU, 26 per cent about lack of fertilizer retails shops in and around the village etc. It is clearly found from the primary survey that in irrigated crop--- lack of training for crop wise application of NCU, lack of fertilizer retail shops in nearly villages/areas and black marketing of urea during the peak time were the major problems faced by the sample households. In fact, no specific programmes for crop wise application of urea have been undertaken in the study area causing poor awareness of the farmers in regard to application of NCU. However, in un-irrigated crop; lack of irrigational facilities and lack of awareness of crop wise application of urea etc., were the major constraints faced by the sample households. So, poor irrigational infrastructure and low level of awareness were the main concerns of the sample households in the study area.

Table 4.8: Major problems faced in adoption of NCU fertilizer (% of farmers)

Sl. No	Problems	Paddy	Maize	Overall
1	Lack of training for crop wise application of NCU	39.00	48.00	43.50
2	Lack of awareness about the benefits of NCU	8.50	36.00	22.25
3	Due to lack of irrigational facilities, the desired benefits of NCU are not be extracted/taken.	18.50	60.00	39.25
4	Price of NCU is higher than plain Urea	0.00	14.00	7.00
5	Due to lack of fertilizer retail shops in and around the village, it is bought from distant locations and high prices also.	26.00	26.00	26.00
6	During the scarcity period, black-marketing of urea is done, causing purchase of urea at higher prices	19.00	0.00	9.50
7	During peak demand, duplicate urea is sold	10.50	0.00	5.25
8	Lack of fertilizer & water testing laboratory	21.00	0.00	10.50
9	Differentiation between NCU & plain urea is difficult quite some times	10.50	2.00	6.25

Major suggestions as perceived by the sample households for improving the NCU fertilizer usage are presented in table 4.9. Table reveals that training relating to proper application of NCU in different crops (58.75%) is one of the major corrective measures at overall farmers. Availability of fertilizer in the nearby area preferably at central point of village or village panchayat level (42.75%) and creating awareness about to benefits of NCU (34%) were also the important suggestions. Since, usage of fertilizer and its benefits are directly linked to the irrigational facilities, so irrigational facilities are to be ensured at all farms, suggested by 17 per cent of overall farmers. If it is ensured, there will be improvement in usage of NCU fertilizer. Focused demonstrations for the use of NCU (12%), demand based availability of NCU (18.25%) etc. were also suggested by overall farmers. In case of paddy farmers, training for its use (57%) and availability of fertilizers in nearby area, preferably in village or central point of the respective village/panchayat were the main suggestions. Almost similar suggestions were obtained in case of maize farmers also.

Table 4.9: Major suggestions for improving the NCU fertilizers usage (% of farmers)

Sl. No	Problems	Paddy	Maize	Overall
1	Awareness campaign relating to the benefits of NCU usage be launched	37.50	30.50	34.00
2	Crop wise/season wise training is required for proper application of NCU	57.00	60.50	58.75
3	Availability of fertilizers at the village or panchayat level be ensured	48.50	37.00	42.75
4	Crop wise demonstration for the use of NCU may be made	18.00	6.00	12.00
5	Irrigational facilities be ensured to all the fields for improving the usage of NCU in particular and other fertilizers in general	10.50	23.50	17.00
6	Supply of NCU particularly in the months of Oct.-Nov. & Feb.-March be increased to avert the incidences of black marketing of NCU	13.00	9.50	11.25
7	Demand based availability of NCU be ensured in place of its rationing during peak times	23.00	13.50	18.25

CHAPTER – V

AWARENESS AND ADOPTION LEVEL OF SOIL TESTING TECHNOLOGY

5.1 Implementation and Performance of Soil Health Programme

Degradation of soil is an emerging area of concern. In fact, the quality of soil has deteriorated overtime due to a combination of factors such as injudicious use of fertilizer, accumulation of heavy metals and metalloids through various forms of emissions. On the other hand, due to lack of awareness among the farmers on the use of chemical fertilizers, environmental degradation is further aggravated. There needs to be a more concerted effort to educate public at large on synergy between fertilizers in relation to crop yield and health of the soil. Soil and other agronomical research have clearly indicated that sustainable agricultural intensification and a healthy environment are compatible goals.

Since 1955 Central as well as State Governments has tried to focus on these issues by motivating/encouraging farmers to apply balanced doses of fertilizers by regular testing of soil and adoption of recommended doses of the same. It in this context, several schemes have been implemented by the governments to built-up a sound infrastructure of soil testing laboratories across the states. In 2008-09, the central government launched National Project Management of Soil Health and Fertility (NPMSF). Till date Bihar has one central soil testing laboratory (CSTL) at Patna and 38 soil testing laboratories (STLs) for all 38 districts. During 2013-14, the state had 230 thousand annual analyzing capacities of soils. Of which, the utilization capacity was reported about 108.13 per cent.

Subsequently, on 15th February, 2015 Government of India launched a Soil Health Card (SHC) scheme in a mission mode. The card will carry crop wise recommendations of nutrients/fertilizers required for farms, making it possible for farmers to improve productivity by using appropriate inputs. Under this scheme, periodic soil testing and distribution of SHCs for every three years to all farmers of the country was proposed. Samples are drawn in a grid of 2.5 hectare in the irrigated areas and 10 hectare in case of rainfed areas with the help of mobile app.

As regards the performance of SHCs scheme in the state, the data on present status (table 5.1) indicate that about 61.80 per cent of the targets were met in terms of soil sample collection but the achievement on soil testing seems to be a bit lower

(59.45%) of it, may be due to shortage of staff in STLs. However, on an average five cards were printed per sample (grid) and all were distributed.

Table No. 5.1: Status of Soil Health Card Scheme in Bihar (As on 01/11/2016)

SN	Particulars	Figures
1.	Target of samples to be collected during 2015-16 & 2016-17 (In lakh)	13.09
2.	Samples collected (In lakh)	8.09
3.	Sample collected (%)	61.80
4.	Sampled tested (In lakh)	4.81
5.	Progress soil samples tested (%)	59.45
6.	Total SHCs printed	22.05
7.	Avg. SHCs printed per tested sample	4.58
8.	Total SHCs distributed	22.05
9.	SHCs distributed (%)	100.00

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

5.2 Awareness on Soil Testing

There are three major sources, which provided information to the farmers about soil testing and its advantages. Table 5.2 shows about these sources accessed by the sample households in the state. Among these sources, Krihi Vigyan Kendras (KVKs) tops the list wherein about two-third of overall soil tested farmers (66.67%) got the information about soil testing while among the soil tested paddy farmers 60 per cent and 73.68 per cent of soil tested maize farmers have got the information about soil testing from KVK source. Considering overall crops, neighbours (30.77) was the second most important sources followed by state department of agriculture (23.08%).

In case of paddy farmers again neighbours (40%) and state department of agriculture (35%) played important role in delivering the information on soil test. Similarly 21 per cent maize farmers were assisted by neighbours and 10.53 per cent by state department of agriculture. Moreover it is to be noted here that all the soil tested sample households were got the information from more than on sources. It is clearly revealed from the analysis that KVKs was the major source of information on soil test followed by neighbours and the state department of agriculture.

Besides sources of soil testing, proper method of soil sample collection is no doubt, important for correct result and thereby adoption of recommendations of the test. Its' awareness and education are thus necessary for the success of scheme. Therefore in all the soil test schemes including the SHCs, it is done free of cost/charge.

However, KVKs charge for the same but the same is proportionate to the cost involved herein. Due to education on collection of soil samples made be KVK scientists, progressive farmers and Kisan Salahkaar, about 36 per cent of soil tested farmers have collected their soil samples by themselves at overall farm level. However, about 64 per cent took the help of Kisan Salahkaar in collection of soil samples at overall farm level. In case of paddy farmers, 55 per cent of soil samples were collected by the Kisan Salahkaar and 45 per cent by themselves. Similarly in case of maize farmers, a large number of samples (74%) were collected by Kisan Salahkaar and only 26 per cent by themselves. Above analysis indicates that Kisan Salahkaar was the major player in collection of soil irrespective of the crops under reference who are contractual employee of the state department of agriculture.

Table 5.2: Different sources of information about soil testing and soil sample collection

(% of farmers who tested their soil)

Sl. No	**Sources for soil testing**	Paddy	Maize	Overall
1	State Agricultural Universities (SAUs)	---	---	---
2	Krishi Vigyan Kendra (KVKs)	60.00	73.68	66.67
3	Private Companies	---	---	---
4	Friends	---	---	---
5	Neighbors	40.00	21.05	30.77
6	Agriculture Department	35.00	10.53	23.08
	Who collected the soil			
1	Self	45.00	26.32	35.90
2	Raitha Samparka Kendra (RSK) Official (State Department of Agriculture Officers)	---	---	---
3	Farmer Facilitator/Kisan Salahkaar	55.00	73.68	64.10
4	Other (Specify)	---	---	---

In coarse of our field survey, soil tested farmers were asked about their awareness with respect to correct method of soil sampling, the details of their trainings, information on SHC and sources of education on SHC. The results of the survey are given in table 5.3. It can be described from the table that about 77 per cent of overall farmers were aware of correct method of soil sampling. Awareness was higher in case of paddy farmers (90%) whereas that of about 63 per cent for maize farmers. While asking for training sources of soil sample collection, Kisan Salahkaar (56.41%) tops among the sources followed by fellow farmers (23.08%), scientists (10.26%) and officer of the state agricultural department (5.13%) at overall farmers' level. In case of paddy farmers about 50 per cent of soil tested farmers were received the training by Kisan Salahkaar followed by scientist (20%) and 10 per cent each by agricultural

officers and fellow farmers. Similarly about 63 per cent of the soil tested maize farmers have got the training by Kisan Salahkaar and 40 per cent by fellow farmers.

It is also seen from table 5.3 that out of the total soil tested farmers (39), all (100%) farmers received SHCs but they did not obtain it on time. Further, it was also found that out of the farmers, who received SHC, cent per cent possessed the SHCs but they hardly follow the recommendations as noted in the card. Out of the SHCs possessing, 31 (79.49%) were able to understand the information given in the SHCs, constituting 16 (80%) the paddy farmers and 15 (78.95%) maize farmers. Those who did not understand the information given in the SHC, accounted for 4 (20%) paddy farmers and 4 (21.05%) maize farmers. The reason for not understanding the information given in the SHC was mainly due to inability in understanding despite the fact that they can read the information. It was further noticed that out of the farmers who received SHCs, about 71.79 per cent were trained and educated by Kisan Salahkaar at overall farmers level. It was highest (84.21%) for paddy farmers and about 60 per cent at maize farmers. About 23.08 per cent of the overall farmers were educated on SHCs by KVK scientists followed by fellow farmers (5.13%). It clearly reveals that Kishan Salahkaar has played an important role in extending education to sample households followed by KVK scientists.

5.3 Details of Soil Testing

With a view to understand the details of soil testing done by the sample households, the relevant data are presented in table 5.4. It is observed from the table that majority have not gone for soil testing despite implementation of the programmes in the state wherein free soil testing are done. The SHCs scheme is also one of such programmes. The percentage of farmers having conducted soil testing appears to be 39 (9.75%) at overall farmers constituting 20 (10%) among paddy farmers and 19 (9.50%) maize farmers. Sample farmers, irrespective of crops, reported that they incurred Rs. 30 per sample.

So far as the average distance from field to soil testing laboratories, it was higher (33.33 kms) for maize farmers whereas that of 17.55 kms for paddy farmers. Long distance hindering them to go for soil testing besides their sluggishness for the same. On an average, about four samples were taken by the paddy farmers for testing in an area of about 0.70 acre and two samples by the maize farmers for testing in an area of about 1.28 acres.

Table No. 5.3: Sources of Soil Sample collection and the details of SHCs among respondents (% of farmers who tested their soil)

SN	Particulars	Paddy	Maize	Overall
1	% of farmers aware of correct method of soil sampling	90.00	63.16	76.92
	Training sources of soil sample collection			
2	i. Agricultural Officer	10.00	0.00	5.13
3	ii. Farmer Facilitator/Kisan Salahkaar	50.00	63.16	56.41
4	iii. Fellow Farmers	10.00	36.84	23.08
	iv. Scientist	20.00	0.00	10.26
	Information on soil health card			
5	i. Number of farmers received soil health card	20.00	19.00	39.00
	ii. Number of farmers possessing soil health card till now	20.00	19.00	39.00
	iii. Number of farmers understand the information given in the soil health card	16.00	15.00	31.00
	iv. Number of persons did not understand the information given in the soil health card for the reasons	4.00	4.00	8.00
	a) Cannot read	---	---	---
	b) Can read, but not able to understand the information given	4.00	4.00	8.00
11	% of farmers who were explained about soil health card details	100.00	100.00	100.00
	Sources of education on soil health card			
i.	Agriculture Officer	---	---	---
ii.	Farmer Facilitator/Kisan Salahkaar	60.00	84.21	71.79
iii.	Family Member	---	---	---
iv.	Fellow farmer	10.00	---	5.13
v.	Friends	---	---	---
vi.	KVK Scientists	30.00	15.79	23.08

Table 5.4: Details of soil testing by the respondents (% of farmers who tested their soil)

Sl. No	Particulars	Within 3 yrs		Before 3 yrs	
		Paddy	Maize	Paddy	Maize
	% of farmers done soil testing	10.00	9.50	---	---
1	Number of times soil testing done	01	01	---	---
3	Cost of soil testing (Rs/sample)	30.00	30.00	---	---
4	Distance from field to soil testing lab (Kms)	17.55	33.33	---	---
5	Samples taken for soil testing (No.s)	4.00	2.00	---	---
6	Area covered under soil test (all plots) (Acres)	0.70	1.28	---	---

As regards the places of soil testing of the sample farmers, the data given in table 5.5 reveals that about 53.85 per cent of soil samples were tested at DSLs (District Soil Laboratories) and 46.15 per cent at KVKs. Among paddy farmers 55 per cent soil samples were examined at DSLs and 45 per cent at KVKs. Similarly in case of maize farmers, 52.63 per cent soil samples were tested at DSLs and 47.37 per cent at KVKs.

It is noticed from the table that both the agencies have almost played major role in testing the soil samples of the farm households equally in the study area.

Table 5.5: Places of soil testing of the sample farmers (% of farmers who tested their soil)

Sl. No	Particulars	Paddy	Maize	Overall
1	Krishi Vignan Kendras (KVKs)	45.00	47.37	46.15
2	Agricultural Universities	---	---	---
3	Raitha Samparka Kendra (RSK) / State Department of Agriculture	---	---	---
4	District Soil Laboratories	55.00	52.63	53.85
5	Private laboratories	---	---	---

5.4 Reasons for Soil Testing or Not-testing

Since a very small (9.50%) proportion of the sample households have tested their soil samples so it will be important to understand the reasons for conducting soil tests and also for not conducting soil tests. Table 5.6 presents the reasons for conducting soil tests. It is revealed from the table that the sample households have responded in favour of five reasons with their preferences as most important, important and least important. It is to be noted here that on and average a little higher than two reasons was told by them. The most important reason was to understand the fertilizer requirement for the crop (66.67%) followed by peer farmers' group pressure (51.28%), not aware of anything about soil testing and its use (38.46%), motivation from demonstration/training/exposure visits etc. (35.90%) and poor crop yield (17.95%) at overall farmers. Almost similar trend was noticed in both the reference crops. It is clearly found from the data that farmers are desirous to understand the requirement of fertilizer for crop were major reason, which prompted them for conducting soil tests. Peer farmers group pressure was the second important reason.

Table 5.6: Reasons for Soil testing by the respondents (% of farmers who tested their soil)

Sl. No	Reasons	Paddy			Maize			Overall		
		Most imp	Impor tant	least imp	Most imp	Impor tant	least imp	Most imp	Impor tant	least imp
1	Not aware of anything about Soil testing and its use	5.00	25.00	5.00	5.26	36.84	0.00	5.13	30.77	2.56
2	For availing benefit under subsidy schemes	---	---	---	---	---	---	---	---	---
3	Poor crop yield	---	15.00	---	---	21.05	---	---	17.95	---
4	Motivation from village demonstration/training/exposure visits to places with best farming practices	20.00	25.00	---	10.53	15.79	---	---	20.51	---
5	Peer farmers' group pressure	55.00	5.00	---	26.32	15.79	---	41.03	10.26	---
6	To understand fertilizer requirement for the crop	30.00	55.00	---	10.53	36.84	---	20.51	46.15	---

It is to be noted here that a large number of sample households (90.25%) did not tested soils of their fields despite various soil testing schemes including the SHCs wherein free of costs soil testing are made. So it will be again important to know the reasons for not testing the soils. While obtaining such reasons, majority of overall sample farmers told that they do not know to take soil samples (86.43%) followed by far away of STLs from the village (81.72%) and do not know whom to contact for details of soil testing (76.73%). About 10.53 per cent of the overall farmers opined that soil testing is not required for their fields as the crop yield is good and 6.37 per cent stated about other reasons like; no faith in soil testing, reports are not made available after collecting the soil samples, lack of knowledge for electronic mode of operation etc. Almost similar responses were obtained from sample households of both the reference crops. The reasons were duly classified into three categories as most important, important and least important (table 5.7). Majority of the farmers who stated about the reasons for not conducting the soil testing of their soil were largely found in important category. It was also found that the awareness and training & education on soil testing are the main hindrances for not conducting the soil tests of their fields.

Table 5.7: Reasons for not testing soil by the respondents

(% of farmers who did not tested their soil)

Sl. No	Reasons	Paddy			Maize			Overall		
		Most imp	Impor tant	Least imp	Most imp	Impor tant	Least imp	Most imp	Impor tant	Least imp
1	Do not know whom to contact for details on testing	16.11	52.22	3.33	24.86	56.35	0.55	20.50	54.29	1.94
2	Do not know how to take soil samples	17.78	53.89	1.11	23.76	72.38	3.87	20.78	63.16	2.49
3	Soil testing laboratories are located far away	15.00	43.33	5.00	23.76	70.72	5.52	19.39	57.06	5.26
4	Soil testing not required for my field as crop yield is good	0.55	2.22	4.44	3.31	9.39	1.10	1.94	5.82	2.77
5.	Any other	7.78	5.00	---	---	---	---	3.88	2.49	---

5.5 Adoption of Recommended Doses of Fertilizer application on Soil Test Report

Farmers were asked about the education of recommended doses of fertilizers (RDF) on reference crops. In response to this query 94.87 per cent of overall farmers reported that recommendations of their soil test reports were largely explained by the Kisan Salahkaar of the state department of agriculture and a few by private input dealers (2.56%) and fellow farmers (2.56%). In case of paddy farmers, 90 per cent of soil test reports were explained by the same fellow i.e., Kisan Salahkaar and 5 per cent each by private input dealers and fellow farmers. But in case of maize farmers cent per cent reports were explained by the Kisan Salahkaar, who used to pay regular visits to the fields for different businesses of the state department of

agriculture. It clearly reveals that RDF is mainly explained by the Kisan Salahkaar, who is at the doorsteps of the farmers for explaining the same, besides some other businesses of the state department of agriculture (table 5.8).

Table 5.8: Elucidation of Recommended Doses of Fertilizers (RDF) on reference crops

(% cent of farmers who tested their soil)

Sl. No	Who explained to you	Paddy	Maize	Overall
1	Department of Agriculture	90.00	100.00	94.87
2	Agriculture University	---	---	---
3	Cooperatives/ Growers' Association	---	---	---
4	Private dealers/retailers	5.00	---	2.56
5	Fellow Farmers	5.00	---	2.56
6	KVKs	---	---	---
7	Others	---	---	---

Note : RDF(Recommended Doses of fertilizer)

In regard to adoption of RDF by the respondents, out of the soil tested farmers for paddy and maize crops 80 per cent and 78.95 per cent respectively told that they are aware of RDF as per the soil test reports where as 20 per cent and 21.05 per cent are aware as per their own opinion. In case of both the reference crops, the sample respondents of respective crops stated that they have adopted the RDF for application of urea and DAP fertilizers only, which are almost similar to the opinions of the farmers. However, as per the farmers' opinion the sample households of the reference crops have adopted for farm yard manure, urea, DAP & MOP fertilizers, zinc and other, which varies between the reference crops (table 5.9).

Table 5.9: Recommended Doses of Fertilizer adopted by respondents

Sl. No.	Particulars	Paddy		Maize	
		As per Farmer opinion	As per Soil Test Report	As per Farmer opinion	As per Soil Test Report
	% of farmers aware of RDF	20.00	80.00	21.05	78.95
1	FYM (ton/ac)	4.00	---	10.00	---
2	Urea(kg/ac)	46.26	46.86	119.03	122.90
3	DAP(Kg/ac)	22.28	26.30	24.09	24.15
4	MOP (Kg/ac)	9.56	---	24.19	---
5	MgSO4 (Kg/ac)	---	---	15.00	---
6	ZNSO4 (kg/ac)	5.26	---	---	---
7	FeSo4 (kg/ac)	---	---	---	---
8	Others(kg/ac)	2.00	---	5.00	---

5.6 Constraints and Suggestions for SHC Scheme

The present survey also tried to understand the problems faced by the sample households relating to SHC scheme. In response to it, sample households have narrated about seven constraints, which are presented in table 5.10. The table

reveals that the results of soil tests done 2-3 years back have not yet made available to the respective farm households (34.50%) and samples of soil are not collecting from individual field (33%) particularly under the new scheme of SHC, launched in February 2015; wherein collection of soil samples are made through pointing of Grid of 2.5 ha (irrigated areas) and 10 ha (rainfed areas), are the major constraints. Besides, 23.75 per cent told about the lack of soil test laboratories in nearby area, KVKs charges fees for testing of soil (23.50%), lack of awareness about benefits of soil test (9.25%), due to allotment of wrong ID numbers (6.25%) and immature time for Grid system of sample collection (4.75%). Actually farmers' feelings of soil tests are better in favour of KVKs than STLs. But soil testing at KVK is chargeable, which does not support their notion for free soil testing.

Table 5.10: Major problems faced in soil testing by farmers (% of farmers)

Sl. No	Problems	Paddy	Maize	Overall
1	Lack of soil test lab in nearby area.	21.00	26.50	23.75
2	Results of soil tests (done 2-3 years back) have not yet been made available to the respective farmers	39.00	30.00	34.50
3	Samples of soils are not collecting from individual field.	37.50	28.50	33.00
4	Lack of awareness about the benefit of soil test	7.50	11.00	9.25
5	KVK charges fees for testing of soil	28.50	18.50	23.50
6	Due to allotment of wrong identification number (a technical fault of the samples of soil made under Grid system) results are not given to the respective farmers.	7.00	5.50	6.25
7	The time is not mature enough for the implementation of Grid system of soil sample collection, as it mixes the soils of other farmers' fields also.	6.50	3.00	4.75

To overcome the constraints, suggestions were also sought from the sample households, which are presented in table No. 5.11. It is revealed from the table that SHC scheme may be improved if it is made more transparent and instant in deliveries. It is obvious that overall farmers' desire soil testing camp at village level (37%) and results of sampled soil be delivered on-spot (37.25%). Besides, collection of soil samples is made in participatory mode (34.50%), receipt of soil samples may be given in hard copy in place of electronic communication (24.75%) because of their low level of operational knowledge of electronic gadgets. About 24.75 per cent of the overall farmers also suggested for displaying a total time schedule which should be strictly followed right from collection of the samples to distribution of soil test report and thereby its elucidation. No doubt, it is a mission mode scheme. So there is need for participation of farmers (26%).

Table 5.11: Major suggestion for improving the soil health card scheme (% of farmers)

Sl. No	Problems	Paddy	Maize	Overall
1	Soil testing camps at the village level may be arranged	41.00	33.00	37.00
2	Results of the sampled soils be delivered on spot	40.00	34.50	37.25
3	In place of electronic communication for sampled soils, the receipt may be given in hard copy	35.00	22.00	28.50
4	Collection of sample soils may be made in participatory mode	33.00	36.00	34.50
5	A total time schedule (right from collection of sample of the soils to the distribution of results of the tested soils) be widely announced/displayed (at a defined place)	32.50	17.00	24.75
6	After strengthening and streamlining of the previous system of SHC, the present Grid system of soil sample collection may be thought of.	7.00	3.50	5.25
7	Participation of farmers in soil testing may be encouraged	31.00	21.00	26.00

CHAPTER – VI

Impact of NCU Application on Crop Production and Soil Health

6.1 Background

The results of various scientific studies and agronomical trials at research and farm levels have proved that NCU is superior over NU for realizing higher yield and improving soil health status. As of now, NU has almost been replaced by NCU. It is perhaps due to this and thereby its application by the farmers, the present study was designed to assess its impact on crop production and soil health status. This chapter analyses the impact of NCU application on crop production, input usage and some other qualitative and quantitative advantages in production of paddy and maize crops in Bihar.

6.2 Impact on Yield of Reference Crops among Sample Households

After making mandatory production and sale of NCU since May, 2015; NCU and NU were available in the market during the reference period of the study i.e., kharif 2015. It is due to this, the present study has tried to compare the impact of NU and NCU on productivity of paddy and maize crops in Bihar. The relevant data in this regard are presented in tables 6.1 & 6.2. It is noticed from table 6.1 that there had been a positive impact on both the main product and by-product yield. The average yield of paddy was high in case of farmers who applied NCU (26.82 qtls/acre) as compared to those used NU (24.51 qtls/acre). Further, this increase in yield was found statistically significant at 10 per cent level. The percentage change in yield due to application of NCU over NU was calculated at 9.42. Similarly, the average by product yield showed an increase from 4.34 qtls./acre with the application of NU to 4.67 qtls/acre with the application of NCU. This increase in yield was also found statistically significant at 10 per cent level. Percentage change in by-product yield due to application of NCU over NU is 7.60. However, the prices of main and by-product were noticed almost the same for paddy (Rs. 1088 to Rs. 1092 and Rs. 197 to Rs. 198) respectively. Interestingly, both the prices were found statistically non-significant.

Table 6.1: Impact of Neem Coated Urea (NCU) on production and marketing of Paddy *(Qtls. per acre)*

Sl. No	Particulars	NCU	Normal Urea	Both (NCU and Normal Urea	t-Values	% change in NCU over NU
1	Main product yield	26.82	24.51	26.69	1.662*	9.42
2	By product Yield	4.67	4.34	4.66	1.658*	7.60
3	Price of main product (In Rs. /qtl.)	1092.83	1088.87	1092.62	1.003Ns	0.36
4	Price of by product (In Rs. /qtl.)	198.98	197.94	198.93	1.048Ns	0.52

*Note: * & ** indicate 10 and 5 per cent level of Significance respectively.*

Table 6.2 reveals the impact of NCU on production and marketing of maize crop. It is noticed from the table that there had been a positive impact on both the main product and by-product yield. Though, it was very low in case of by-product yield. The average yield of maize was high in case of farmers who applied NCU (25.25 qtl/acre) as compared to those used NU (23.38 qtl/acre) and was statistically significant at 5 per cent level. The percentage change in yield due to application of NCU over NU has been calculated at 7.99 per cent. However, the average by-product yield showed a marginal increase from 16.31 quintals/acre with the application of NU to 16.32 qtl/acre with the application of NCU and was found statistically significant at 10 per cent level. Percentage change in by-product yield due to application of NCU over NU is only 0.06. However, the price of main product was found low in case of farmers, who applied NCU (Rs. 1049.90/qtl) as compared to those who used NU (1076.88/qtl). The percentage change in price of main product was negative i.e., (-) 2.50, which may be attributed to differences in managerial and marketing practices. As regards the average price of by-product is concerned, the data indicates that it little higher in case of farmers, who applied NCU (Rs. 152.31/qtl) as compared to those used NU (Rs. 144.89/qtl). The percentage change in by-product price due to application of NCU over NU was 5.12. Interestingly the prices of both products were found statistically insignificant.

Table 6.2: Impact of NCU on production and marketing of Maize *(Qtls. per acre)*

Sl. No	Particulars	NCU	Normal Urea	Both (NCU and Normal Urea	t-Values	% change in NCU over NU
1	Main product yield	25.25	23.38	24.93	1.973**	7.99
2	By product Yield	16.32	16.31	16.31	1.654*	0.06
3	Price of main product (In Rs. /qtl.)	1049.90	1076.88	1054.11	0.798Ns	(-) 2.50
4	Price of by product (In Rs. /qtl.)	152.31	144.89	151.08	0.779Ns	5.12

*Note: * & ** indicate 10 and 5 per cent level of Significance respectively.*

6.3 Impact on Total Quantity Fertilizer used

In course of the study the data on quantity of fertilizers used, production, sale proceeds etc. were collected for two periods of time i.e., 2014 and 2015, with a view to compare the results separately for NCU appliers and NU appliers in two different years. The related data entailing these are presented in table 6.3. Table gives a comparison of NCU quantity applied, NU quantity applied, productivity of NCU and NU and output per unit of NCU or NU for 2014 and 2015. The results revealed that the application of NCU per acre of paddy crop has fell by 8.42 per cent whereas in case of maize crop it increased by 217 per cent and at overall crops it slightly increased by 0.22 per cent during 2015 over 2014. In case of per acre NU application,

the quantity of normal urea slashed by 5.37 per cent for paddy respondents, 45.89 per cent for maize respondents and 25.51 per cent for overall respondents during 2015 over 2014. However, the productivities of NCU appliers for paddy, maize and overall crops have increased by 1.97 per cent, 2.72 per cent and 1.79 per cent respectively during 2015 over 2014. In case of NU appliers, the productivity of paddy has increased by 0.42 per cent, for maize crop it decreased by 0.12 per cent and 0.16 decrease was found in case of overall crops during 2015 over 2014. Output per unit of NCU or NU also increased for paddy respondents (0.42%), maize respondents (5.30%) and overall respondents (5.89%). Above analysis reveals that quantity of NCU applied during 2015 over 2014 decreased in case of per acre paddy cultivation, surprisingly increased in case of per acre maize cultivation and at overall crops. In case of NU quantity application, it decreased moderately in paddy cultivation and high decrease was found in case of maize and overall crops. Per acre productivity of NCU has increased in both the reference crops. The productivity of NU was found to have increased in paddy and a bit decrease in maize crop. Output per unit of NCU or NU was found increased in regard to both the reference crops.

Table 6.3: Comparative use of NCU versus Normal Urea *(Kgs/acre)*

Sl. No	Particulars	2014			2015			% change in 2015 over 2014		
		Paddy	Maize	Overall	Paddy	Maize	Overall	Paddy	Maize	Overall
1	NCU quantity applied	83.83	41.34	81.56	76.77	131.27	81.74	(-) 8.42	217	0.22
2	NU quantity applied	104.09	266.49	151.34	98.50	144.19	112.73	(-) 5.37	(-) 45.89	(-) 25.51
3	Productivity of NCU	2630	2458	2620	2682	2525	2667	1.97	2.72	1.79
4	Productivity of NU	2440	2341	2411	2451	2338	2415	0.45	(-) 0.12	0.16
5	Output per unit of NCU or NU	2626	2302	2459	2627	2424	2604	0.42	5.30	5.89

6.4 Impact on NCU Application on Reference Crops

Impact on NCU application on reference crops was also assessed in terms of qualitative responses collected from the sample households of both the reference crops. The details are presented in table 6.4. It was collected on three variables such as improvement in soil health, quality of grain and market acceptability of grain colour. Since, it will be early to respond on these variables as noticed in course of the study, so majority of the paddy (87% to 90%) and maize (91% to 96%) farmers were of the view that there was no improvement in either soil health or quality of grain or market acceptability of grain colour.

Table 6.4: Qualitative benefits of NCU on Reference Crops *(% of farmers)*

Sl. No	Particulars	**Paddy**			**Maize**		
		Increased	Decreased	No change	Increased	Decreased	No change
1	Improvement in Soil health	10.00	---	90.00	9.00	---	91.00
2	Quality of grain	7.00	---	93.00	3.50	0.00	96.50
3	Market acceptability of grain color	12.50	---	87.50	5.50	0.00	94.50

6.5 Impact on Cost of Cultivation of Reference Crops

The impact of NCU on the input cost of paddy and maize crops are given in tables 6.5 & 6.6. With a view to assess the impact of NCU on input costs, variables like cost of pest and disease control, cost of weed management, cost of NCU/NU and cost of other fertilizers were considered. A comparison of input costs of paddy in respect of NCU ad NU appliers has been presented in table 6.3. The table reveals that out of all the selected inputs, the cost of other items alone accounted for more than 90 per cent (90.66% /Rs. 12608.36 per acre) in case of NCU farmers and about 88 per cent (88.12% /Rs. 10510.35 per acre) among NU farmers followed by the cost of NCU/NU that accounted for 4.12 per cent or Rs. 573.50 per acre in case of NCU farmers and 4.91 per cent or Rs. 588.16 per acre among NU farmers. It is important to note here that all selected input costs manifested decease in case of paddy crop. The extent of cost decrease on some of these selected inputs varied largely (5.29 % to 20.20 %) in respect of NCU over NU users. The fall in it was higher on cost of weed management (-20.20%) followed by cost of pest and disease control (5.29%), cost of NCU/NU (-2.49%) in respect to NCU vis-à-vis NU users. On overall also, the total cost of selected inputs revealed increase of 16.60 per cent with respect to NCU users as compared to NU users. But the cost of pest and disease control values were found statistically non-significant, the cost of weed management was found significant at 10 per cent level, the cost of NCU/NU was found significant at 5 per cent level, cost of other items was found significant at 10 per cent level and the total cost was also found significant at 5 per cent level.

Table 6.5: Impact of Neem Coated Urea (NCU) on input cost of Paddy *(per acre)*

Sl. No	Particulars	NCU		Normal Urea		t-Values	% Change in NCU over NU
		Value (Rs)	%	Value (Rs)	%		
1	Cost of pest and disease control	397.50	2.86	419.73	3.51	1.094Ns	(-) 5.29
2	Cost of weed management	327.66	2.36	410.62	3.44	1.659*	(-) 20.20
3	Cost of NCU / NU	573.50	4.12	586.16	4.91	1.981**	(-) 2.49
4	Cost of other items	12608.36	90.66	10510.36	88.12	1.701*	19.96
5	Total	13907.02	100.00	11926.87	100.00	1.991**	16.60

*Note: * & ** indicate 10 and 5 per cent level of Significance respectively.*

Similarly, a comparison of input costs of maize among NCU and NU users is presented in table 6.6. Like paddy crop, cost of other items was the major among the selected inputs in maize cultivation also i.e., 89.87 %/Rs. 11794.45 per acre in case of NCU users and 88.05%/Rs. 10108.58 per acre among NU users followed by cost of NCU or NU at 6.46/Rs. 847.55 per acre in case of NCU users and 7.03 per cent/Rs.

807.45 per acre among NU users. The third and fourth important costs were cost of pest and disease control and cost of weed management on both the NCU and NU users. Except the cost of NCU/NU, the cost of all other selected inputs decreased from 3.28 per cent to 22.19 per cent in respect to NCU users vis-à-vis NU users. The cost of NCU/NU indicated an increase of 4.97 per cent in respect to NCU users vis-à-vis NU users, which may be due to relatively higher price of NCU and or the practices of NCU usage. On overall also, the total cost of selected inputs showed an increase of 14.30 per cent with respect to NCU users as compared to NU users. However, the decrease in cost of pest and disease control and cost of weed management were found statistically insignificant. On the other hand, the increase in cost of NCU/NU was statistically significant at 5 per cent level. The cost of other items was also found statistically significant at 10 per cent level and the total cost was found significant at 5 per cent level.

Table 6.6: Impact of Neem Coated Urea (NCU) on input cost of Maize *(per acre)*

Sl. No	Particulars	NCU		Normal Urea		t-Values	% Change in NCU over NU
		Value (Rs)	%	Value (Rs)	%		
1	Cost of pest and disease control	267.97	2.04	344.41	3.00	1.394Ns	(-) 22.19
2	Cost of weed management	213.30	1.63	220.52	1.92	1.252Ns	(-) 3.28
3	Cost of NCU / NU	847.55	6.46	807.45	7.03	1.984**	4.97
4	Cost of other items	11794.45	89.87	10108.58	88.05	1.654*	16.67
5	Total	13123.27	100.00	11480.97	100.00	1.664**	14.30

*Note: * & ** indicate 10 and 5 per cent level of Significance respectively.*

6.6 Economic Feasibility of NCU: A Partial Budgeting Framework

A partial budget method was used with a view to assess the incremental income based on small change in farm activities mainly due to application of NCU. It includes variables like additional income reduced cost, reduced income and additional costs through the changes occurred in NCU use vis-à-vis NU. It has compared the change in effects of a change in NCU use in relation to NU on incremental income from the reference crops. The impact of NCU, based on a partial budgeting technique for paddy crop considering added and reduced costs due to NCU application was calculated in table 6.7. It can be observed from the table that there had been a positive impact of the economic feasibility of NCU on both the main product and by-product of paddy production. In the case of paddy crop, the added cost due to application of NCU amounts to Rs. 2098 per acre on the one hand whereas on the other side, reduced cost was noticed higher in respect of cost of weed management (Rs. 82.96/acre) followed by the cost of pest and disease control (Rs. 22.23/ acre) and the cost of NCU (Rs. 12.66/acre). Thus, the total added costs due to

application of NCU amounted to Rs. 2098 per acre and the total reduced cost to Rs. 117.85/acre. Moreover, there were no reduced returns in case of paddy rather, added returns by way of the yields of main and by-product as a result of application of NCU. Total added returns was estimated at Rs. 2590.09/acre. The difference in total added return and incremental cost was worked out to Rs. 609.94 per acre. Thus, the benefit cost ratio arrived at 1.29. It means for every one rupee of investment on NCU application, there was a rise in returns to the extent of Rs. 1.29 only. It clearly reveals that the application of NCU had a positive impact in terms of increased income by way of reduced costs to farmers who adopted NCU.

Table 6.7: Economic feasibility of NCU in Paddy, using partial budgeting framework

(Per acre)

A			B		
SlNo	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.)	SlNo	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			
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					

Similarly, the economic feasibility of NCU, using partial budgeting technique for maize crop has been presented in table 6.8. The table reveals that the added cost due to application of NCU amounted to Rs. 1685.87 per acre on the one hand. On the other side, a reduced cost was found noticed higher in respect of cost of pest and disease control (Rs. 76.44/acre) followed by cost of weed management (Rs. 7.23/acre). Thus, the total added cost due to application of NCU amounted to Rs. 1685.87 per acre and the total reduced cost to Rs. 83.67 per acre. Moreover, there were no reduced returns in case of paddy rather; added returns by way of the yields of main and by-product could be found due to application of NCU. The total added returns were calculated at Rs. 1964.83 per acre. The difference in total added return

and incremental cost was worked out to Rs. 362.63 per acre. Thus, the benefit cost ratio arrived at 1.21. It means for every one rupee of investment of NCU application, there was increased in returns to the extent of Rs. 1.21 only. It is a bit lower than paddy crop but it clearly indicates that the application of NCU had a positive impact in terms of increased income by way of reduced cost in case of the maize farmers who adopted NCU.

Table 6.8: Economic feasibility of Neem Coated Urea in Maize, using Partial Budgeting Framework

(per acre)

A			B		
SlNo	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 items	1685.87	4	Cost of other items	---
Total added costs		1685.87	Total reduced costs		83.67
Sl No	Reduced return Due to NCU	Costs (Rs.)	SlNo	Added returns due to NCU	Returns (Rs.)
1	Main product yield	---	1	Main product yields 1.87 qtls. x Rs. 1049.90	1963.31
2	By-product yield	---	2	By-product yield 0.01 qtl. x Rs. 152.31	1.52
Total of reduced returns		---	Total of added returns		1964.83
	Total (A)	1685.87		Total (B)	2048.50
	B-A	362.63			
Additional return from NCU is About Rs. 362.63 per acre An added return per acre is Rs. 2048.50 Benefit Cost Ratio B:C Ratio= B/A=1.21					

6.7 Impact on Soil Health

Despite socio-economic nature of the study some technical questions were also asked with a view to understand qualitative results. These questions were related to soil texture, moisture retention, water infiltration, soil softness and compaction. The results of the same are presented in table 6.9. It can be observed from the table that on overall farmers about 53 per cent had noticed an improvement in soil softness. About 48 per cent reported that the texture of the soil had improved. Nearly 48 per cent said about improvement in water infiltration and 43 per cent confirmed about increase in soil moisture retention capacity. In case of paddy farmers 66 per cent accepted improvement in soil softness followed by improvement in water infiltration (57.50%), increase in soil moisture retention capacity (54.50%), improvement in soil texture (53.50%) and only 11 per cent confirmed about decrease in compaction.

Similarly, in case of maize crop, 42 per cent accepted improvement in soil texture and 31 to 39 per cent of maize farmers reported about improvement in other characteristics.

Table 6.9: Impact of NCU on soil health improvement (% of farmers)

Sl. No	Particulars	Paddy	Maize	Overall
1	Texture improved	53.50	42.00	47.75
2	Soil moisture retention increased	54.50	31.00	42.75
3	Improvement in water Infiltration	57.50	34.00	45.75
4	Improvement in soil softness	66.00	39.50	52.75
5	Compaction decreased	11.00	38.00	24.50

CHAPTER – VII

SUMMARY, CONCLUSIONS AND POLICY SUGGESTIONS

7.1 Background

It has been established that neem products, when applied along with urea, are capable of enhancing nitrogen use efficiency (NUE). But large scale of neem products along with urea could not become possible as process for large scale coating of urea with neem products was not available. Also, large quantity of neem products required for coating 'coated products' were not available as per specifications laid down in the Indian Fertilizer Control Order (IFCL). Recently, IARI, perfected a urea coating technology employing neem oil emulsion at 0.5 to 1.0 kg neem oil per tonne of urea. In this technology, coating of urea is possible at the urea plant level, and the produced neem coated urea (NCU) meets the fertilizers' control order specifications. Coating of urea prills with neem oil in this manner is very economical. The National Fertilizer Ltd. adopted this technology at their plants and has started commercial production of NCU since July, 2004. Further, the Ministry of Chemicals and Fertilizers, Government of India has made it mandatory for urea manufacturers of the country to produce only NCU from May 2015, from 35 per cent in 2004 and then to 75 per cent in March 2015, and also permitted to sell NCU at 5 per cent higher the MRP as a part of meeting the cost of neem coating since 2008. The policy for encouraging production and availability of fortified and coated urea in the country is mainly aimed at controlling the excessive use of urea, which is deteriorating the soil health and thereby negatively affecting yields of crops. Further, there are various advantages of NCU as compared to NU as it turns fast releasing of nitrogen to sustained release of nitrogen, leaching of unabsorbed nitrogen to ground water aquifers or to open air by improving NUE both in terms of N-uptake and use efficiency of the crops. Simultaneously it improves deteriorating soil health, reduction in pest and disease attack, checks diversion of urea into other industrial uses and on exchequer front, it saves the amount of subsidy given for urea mainly because of reduced demand of urea fertilizer. Commercial production of NCU requires large scale availability of neem oil, which can be ensured only by encouraging plantation of neem trees on a large scale. Growing of neem trees will certainly lead to increased carbon sequestration and help avoid climate change like effects.

In consonance with it, the Central and State Governments have been implementing several programmes on improving the soil health. Of them, the recent one is Soil Health Card (SHC) scheme, launched in February, 2015 by the Government of India. The scheme is mainly aimed to promote soil test based balanced use of fertilizers. It was introduced to assist state governments to issue SHCs to all farmers in the country, which supplements the on-going scheme to create/strengthen capacity in terms of rapid and low-cost diagnostic techniques, mobile laboratories, portable soil testing kits and referral labs. Soil status will be assessed regularly every 3 years, so that nutrient deficiencies are identified and amendments applied.

It is in above backdrop, it was necessary to assess the impact of NCU on production, productivity and soil health with a view to improving the efficiency in implementation of these interventions (NCU & SHCs scheme). Thus, the Department of Fertilizers (DOF) and its own INM (Integrated Nutrient Management) Division of Ministry of Agriculture and Farmers Welfare assigned the study to six Agro-Economic Research Centres/Units for undertaking the same in their respective states under the co-ordination of the Agricultural Development and Rural Transformation Centre (ADRTC) of the Institute for Social and Economic Change (ISEC), Bengalure (Karnataka). Accordingly, the Agro-Economic Research Centre for Bihar & Jharkhand, T M Bhagalpur University, Bhagalpur (Bihar) has undertaken this study in Bihar.

7.2 Objectives and Methodology

The broad objective of the study is to assess the impact of NCU on production, productivity of Soil Health in Bihar. However, there are some specific objectives, which are as follow:

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

In order to pursue the objectives of the study, both primary and secondary data were collected from four districts of Bihar namely; Rohtas, West Champaran, Begusarai and Bhagalpur. Both irrigated (paddy) and un-irrigated (maize) crops with highest usage of urea in the state were selected for the study. The reference period for collection of primary data was kharif, 2015. Primary data were collected from 200 farm households for each of the selected crops, totalling to 400 farm households in

the state. The sample is consisted of 74.25 per cent (297 Hhs) marginal & small farmers, 14.50 per cent (58 Hhs) medium farmers and 11.25 per cent (45 Hhs) large farmers.

The report is drafted in seven chapters including the present one.

7.3 Summary of Findings

7.3.1 Trends in Urea Consumption in the State

- Consumption of urea has substantially increased by 64.56 per cent during the last one decade. It constitutes around 54 per cent of total fertilizer consumption during triennium average of (TA) of 2003-04 to 2005-06, which came down to 48.77 per cent of total fertilizer consumption during TA of 2012-13 to 2014-15. It was higher during the rabi season (52 to 57%) compared to the kharif season (43 to 48%). The rate of consumption of total fertilizers registered an increase of 63 per cent (from 100.00 kg/ha in TA 2004-06 to 164.93 kg/ha in TA 2013-15). The prices of NU and NCU were almost stagnant at around Rs. 282/bag and Rs. 295 to Rs. 298 per bag respectively during last five years. Out of the total availability of NCU during kharif 2015, the data for its month wise distribution across the districts revealed that it was highest in the month of September (24.24%) followed by August (19.34%), June (17.37%), July (15.03%), May (12.69%) and April (12.96%). It was 44 per cent of the total transit alone during August and September, mainly due to growing stages of paddy crop.

7.3.2 Socio-economic Characteristics of Sample Households

- All the respondents were male and their average age was 49.04 years. On an average, 2.22 persons were fully engaged in farming and the average size of family was 6.55 persons. About 34.50 per cent of overall farmers attained pre-university and above levels of education, 27.75 per cent matriculation and about 19 per cent each had higher primary and primary levels of education. Of the total sample 61.25 per cent belonged to other backward castes, 23.75 per cent general castes, 10.50 per cent scheduled castes only 4.50 per cent scheduled tribes. More than 85 per cent of the total respondents were engaged in agriculture and allied vocations.

- Net-operated area of total farms at overall level was estimated at 5.23 acres. It was 2.64 acres for marginal and small farmers, 8.60 acres for medium farmers and as high as 18.03 acres for large farmers at overall level. Data on irrigational status revealed that about 66.43 per cent of NOA were irrigated and 33.67 per cent un-irrigated on total farms at overall level. A wide gap in irrigational status between the crops was also noticed, which is quite natural

because selected crops belonged to two different regions, such as irrigated and un-irrigated.

- Cropping pattern of paddy respondents indicates that they only grew paddy during kharif season. Out of the total sown area, paddy was grown in 54.49 per cent by large farmers, 26.93 per cent by medium farmers and 18.58 per cent by marginal & small farmers. More than 95 per cent of the total net sown area of paddy respondents was found irrigated. The cropping pattern of maize respondents reveals that they grew paddy, maize and soyabean during kharif season. About 60 per cent of the total sown area was devoted for paddy, 25 per cent for maize and 15 per cent for soyabean cultivation. More than 75 per cent of total net sown area of maize respondents was under rainfed cultivation.
- Major sources of irrigation was noticed, viz., bore well (79%) at overall farms' level followed by canal (27.50%) and open/dug well (8.50%). Bore wells were again major sources of irrigation for paddy respondents (63.50%) and maize respondents (94.50%). However, 55 per cent of paddy respondents reported about canal to be one of the important sources of irrigation.
- The purchasing pattern of NCU & NU reveals that NCU was purchased in larger quantity (310.62 kg/household) as compared to 131.35 kg/household at overall farms. It accounted for 70.28 per cent for NCU and 29.72 per cent for NU. In case of paddy, it was 469.15 kg/household (78.87%) and 125.66 kg/household (21.13%) for NCU & NU respectively. Similarly, in case of maize, it was 104.66 kg/household (43.64%) for NCU and 135.19 kg/household (56.36%) for NCU.
- As regards the sources of purchase of NCU/NU, private fertilizer dealers were the major ones (90.65%) at overall farms' level as well as paddy & maize farms.
- Total paid-out costs borne by paddy respondents at total farms' level was Rs. 11086.29 per acre during 2014, which increased to Rs. 12009.48 per acre during 2015 registering an increase of about 8.33 per cent in 2015 over 2014. The gross and net returns realized by paddy respondents were calculated at Rs. 28042.22 per acre and Rs. 16955.93 per acre respectively at total farms during 2014, which increased to Rs. 29739.84 per acre and Rs. 17730.36 per acre respectively during 2015; indicating an increase of 6.05 per cent in gross returns and net-returns of 4.57 per cent in 2015 over 2014. The increase in both the returns may be due to increase in yield in 2015 over 2014.
- Similarly, total paid-out costs incurred by maize respondents at total farms was estimated at Rs. 13203.13 per acre during 2014, which came down to Rs. 12311.69 per acre during 2015, registering a decrease of 6.75 per cent in 2015 over 2014. The gross and net returns realized by maize respondents were

estimated at Rs. 27012.14 per acre and Rs. 13809.01 per acre respectively at total farms' level during 2014, which increased to Rs. 29421.22 per acre and Rs. 17109.53 per acre respectively during 2015, registering an increase of 8.92 per cent in gross returns and net returns of 23.90 per cent. It is probably due to increase in yield by over 5 per cent in 2015 over 2014 on total farms.

- Total paid-out costs incurred by overall respondents at total farms was calculated at Rs. 11326.56 per acre during 2014, which increased to Rs. 12044.69 per acre during 2015, registering an increase of about 6.34 per cent. The gross and net returns realized by overall farmers were estimated at Rs. 27924.68 per acre and Rs. 16598.12 per acre respectively at total farms during 2014, which increased to Rs. 29702.72 per acre and Rs. 17658.03 per acre respectively during 2015; indicating an increase of 6.37 per cent in gross returns and net returns of 6.39 per cent in 2015 over 2014. The increase in paid-out costs and gross and net returns were largely due to increase in yields of both the crops.
- About 14.75 per cent of the overall farmers had taken loan. The average amount of borrowing at overall farms' level was about Rs. 2444. Of the total borrowings, nearly 83 per cent were from the institutional sources and remaining 17 per cent from non-institutional sources. It is noticed that institutional sources of borrowings played a significant role in providing credit to the overall farmers during the reference period.
- None of the sample farmers attended training programme meant for fertilizer application mainly because of non-specific training schedule.

1.3.3 Status of Awareness and Application of NCU

- All sample farmers were aware of NCU across the farm sizes and reference crops as well. As regards the source of information, input shops/dealers were the major source in case of marginal & small farmers (89.23%), medium farmers (94.83%) and large farmers (86.67%) at overall crops' level. The second and third important sources were fellow farmers and print & visual media across the farm sizes at overall level. Almost same trend was noticed in case of paddy and maize farmers irrespective of farm sizes.
- About 90 per cent to 93 per cent of the overall farmers were able to differentiate NCU and NU across the farm at overall level. The major factor, which made them able to differentiate NCU over NU was smell (50% to 90%) across the farm sizes at overall crops' level. Almost similar factor was noticed in paddy and maize crops.
- Before 2015-16, 74.50 per cent of paddy farmers and 26.50 per cent of maize farmers applied NCU, whereas it was 82.50 per cent and 74 per cent respectively after 2015-16.

- Of the total quantity used, 41 per cent of NCU and 46 per cent of NU were used at vegetative growth stage followed by after weeding (31% to 35%) and 24 per cent to 28 per cent during Basel application stage at the overall crops' level.
- About 73 per cent to 92 per cent of NCU/NU was applied through broadcasting method and 8 per cent to 27 per cent by fertigation method at overall crops' level. In case of paddy, 100 per cent of the total quantity was applied through broadcasting method.
- As regards farmers' perception about NCU vis-à-vis NU 74.75 per cent of farm households at overall crops' level have mentioned that quality of NCU was good. About 81 per cent farmers at overall crops level reported adequate availability, 80.25 per cent told about timely availability and 58 per cent viewed the prices not to be very high. Nearly 59.75 per cent of the surveyed farmers at overall crops' level were benefitted from NCU in terms of decrease in total fertilizers usage. About 61.25 per cent reported for no change in the benefits of NCU in terms of urea usage. Decrease in pest and disease attack was noticed by 78 per cent of the sample households at overall crops level and 78.25 per cent reported about its (NCU) accessibility in the market compared to NU.
- The analysis of comparative benefits of NCU over NU revealed that 27.50 per cent paddy farmers had the advantage of 7.74 per cent yield increase. About 23.50 per cent told that benefit in weed management was also noticed to the extent of 7.99 per cent. The cost of NCU compared to urea was found to have increased to the extent of 12.64 per cent by 33 per cent of paddy farmers. Increase in cost of other fertilizer (9.09%) was also noticed by 22.50 per cent paddy farmers. About 90 per cent to 93 per cent of paddy farmers reported no change in soil health, quality and market acceptability of grain. In case of maize farmers, 18 per cent reported increase in yield to the extent of 6.89 per cent, 27.50 per cent found decrease in cost of pest and disease control to the extent of 12.71 per cent, 85 per cent reported no change in weed management, 25 per cent noticed increase in NCU cost as compared to urea to the extent of 11.52 per cent and 90 per cent to 96 per cent indicated no change in cost of other fertilizers, improvement in soil health, quality and market acceptability of grain.
- Analysis of constraints faced in course of adoption of NCU fertilizer revealed lack of training for crop wise application of NCU (43.50%) followed by lack of irrigational facilities (39.25%), lack of fertilizers retail shops in nearby areas (26%), lack of awareness about the benefits of NCU (22.25%), lack of fertilizer and water testing laboratories (10.50%) etc.

- Major suggestions for improving the NCU fertilizers' usage include crop wise/season wise training (58.75%), availability of fertilizers at village or panchayat level (42.75%), awareness campaign relating to benefits of NCU usage (34%), ensuring demand based supply of NCU (18.25%) etc.

7.3.4 Awareness and Adoption Level of Soil Testing Technology

- The performance of SHC scheme in the state reveals that 61.80 per cent of the target was achieved in terms of soil sample collection, but the achievement level was 59.45 per cent. On an average, five cards were printed per sample grid and all were distributed.
- Major sources of information about soil testing and soil sample collection were KVKs, neighbours and state department of agriculture as reported by about 67, 31 and 23 per cent of the sample households respectively at overall crops' level. Education on proper method of soil testing was largely extended by Kisan Salahkaars (64.10%) followed by farmers' themselves (35.90%).
- Out of the total sample, only 39 farmers (9.75%) got their soil-tested consisting of 20 farmers (10%) among paddy farmers and 19 (9.50%) maize farmers. Of the soil tested farmers at overall crops' level, 77 per cent were aware of appropriate method of soil sampling. Kisan Salahkaars of the state department of agriculture (56.41%) was the major source of education for soil sample collection. All the soil tested farmers had received the SHCs. About 31 soil tested farmers were able to understand the information given in SHCs at the overall crops' level. Kisan Salahkaars (71.79%) was the major player, who rendered their services in educating about SHCs.
- The average distances from field to STLs were found to be 18 kilometres and 33 kilometres in case of paddy farmers and maize farmers respectively. On an average, about four and two samples were taken for paddy & maize farmers respectively for testing an area of 0.70 acre and 1.28 acres respectively. About 54 per cent of the soil samples at overall crops' level were tested at DSLs.
- The reason for soil testing narrated by the respondents was mainly to understand fertilizer requirement for the crop (66.67%) and the major reasons for not testing soil were unawareness about the method of soil sample collection (86.43%), distantly located STLs (81.71%) and not knowing the contact person (76.73%) at overall crops' level.
- Major problems faced in soil testing by the sample farmers were related to non-distribution of SHCs (34.50%), no collection of sample from individual farmers (33%), lack of STLs in hereby areas (23.75%), chargeable soil testing (23.50%) etc.
- To improve the SHC scheme, the major suggestions extended were organization of soil testing camp at village level (37%), prompt distribution of

SHCs (37.25%), ensuring farmers' participation (34.50%), distribution of SHGs in hard copy in place of electronic communication (28.50%) etc.

7.3.5 Impact of NCU Application on Crop Production and Soil Health

- There had been a positive impact on yields of both the main and by-products of paddy and maize coops. The average yield of paddy, in which NCU was applied, is calculated at 26.82 quintals per acre as compared to those who used NU (24.51 qtls/acre), thus accounting for increase of 9.42 per cent in yield. Percentage change in yield of by-product was estimated at 7.60 per cent for NCU appliers over NU appliers. Similarly, the average yield of maize in case of those sample farmers, who applied NCU was calculated at 25.25 qtls per acre as compared to those used NU (23.38 qtls/acre). The percentage change in yield (main product) due to application of NCU was 7.99 per cent. The percentage change in yield of by-product was, however, 0.06 per cent only.
- Percentage change in comparative use of NCU vis-à-vis NU at overall crops' level was calculated at 0.22 per cent, which were (-) 8.42 per cent for paddy and 217 per cent for maize crops in 2015 over 2014. In case of NU, the same were (-) 25.51 per cent at overall crop level, (-) 5.37 per cent for paddy and (-) 45.89 per cent for maize crop. The productivity of NCU was found to have increased by 1.79 per cent, 1.97 per cent and 2.72 per cent for overall crops, paddy & maize crop respectively during 2015 over 2014. Similarly, the productivity of NU was found to have increased by 0.16 per cent for overall crop and 0.45 per cent for paddy during 2015 over 2014. However, a decrease of 0.12 per cent was found in case of maize crop in 2015 over 2014. Output per unit of NCU/NU was found at 5.89 at overall crop and 0.42 and 5.30 per cent at paddy & maize crops respectively.
- The qualitative benefits obtained from NCU was largely reported by no change for paddy crop (87% to 93%) and 91 per cent to 97 per cent for maize crop.
- Analysis of impact of NCU on input cost of paddy reveals that the cost of pest & disease control reduced by 5.29 per cent, 20.20 per cent in regard to cost on weed management and 2.49 per cent for cost of NCU/NU. However, increases of 19.96 per cent and 16.60 per cent were visible in case of cost of other items and total input costs respectively.
- Similarly, the analysis of impact of NCU on input cost of maize indicated decrease of 22.19 per cent and 3.28 per cent in costs of pest and disease control and weed management respectively. However, it increased in case of cost of NCU/NU by 4.97 per cent, cost of other items by16.67 per cent and in regard to total costs by 14.30 per cent.

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

7.4 Policy Suggestions

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

7.4.1 NCU

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

7.4.2 SHC

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

References

Walsh, O. S & Belmont, K. M (2015). Improving Nitrogen use Efficiency in Idaho Crop Production. *University of Idaho, Moscow. Bulletin No.* 899: 1-11.

Lal, R & B. A Stewart (2010). *Food Security and Soil Quality*. CRC Press, Boca Raton, FL. USA: 4.

Bruulsema, T. J. Lemunyon, & B. Herz (2009). Know your fertilizer rights. *Crops Soils (March-April)*: 13-17.

Roberts, T. L (2007). Right product, right rate, right time and right place …… the foundation of best management practices for fertilizer: 29-32. In fertilizer best management practices. *International Fertilizer Industry Association (IFA),* Paris, France.

Fixen, P. E (2007). Can we define a global framework within which fertilizer BMPs can be adapted to local conditions? Pp 77-86. In fertilizer best management practices. *International Fertilizer Industry Association (IFA)*, Paris, France.

Kumar A. & D. S. Yadav (2001). Long-term effects of fertilizers on the soil fertility and productivity of a rice-wheat system. *Journal of Agronomy Crop Science,* 186:47-54.

Guo, J. H; X. J. Liu, Y. Zhang, J. L. Shen, W. X. Han, W. F. Zhang, P. Christie, K.W.T. Goolding, P. M. Vitousek, & F. S. Zhang. Significant acidification in major Chinese croplands. *Science* 327: 1008-1010.

Venterea, R; P. Groffman, L. Verchot, A Magill, & J. Aber. Gross Nitrogen process rates in temperate forest soils exhibiting symptoms of nitrogen saturation. *Forest Ecology.* Manage. 196: 129-142.

Stevens, W.B; R. G. Hoeft, & R. L Mulvaney. Fate of nitrogen – 15 in a long term nitrogen rate study: II. Nitrogen uptake efficiency, *Agron. J.* 97: 1046-1053.

Mulvaney, R. L; S. A. Khan, & T. R. Ellsworth. Synthetic nitrogen fertilizer depletes soil nitrogen: a global dilemma for sustainable cereal production. *J. Environ. Qual.* 38: 2295-2314.

Salisbury & Ross (1992). Cited in Nitrogen Use Efficiency and Crop Production--- A Mini Review. Environ. *We Int. J. Sci. Tech.* 6 (2011): 167-174. Available online at www.ewijst.org

Hell & Hillebrand (2001). Cited in Nitrogen Use Efficiency and Crop Production--- A Mini Review. Environ. *We Int. J. Sci. Tech.* 6 (2011) : 167-174. Available online at www.ewijst.org

Snyder F. W, Bunce J. A (1983). Use of the plastochron index to evaluate effects of light, temperature and nitrogen on growth of Soyabean (Glycine max L. Merr.) *Annals of Botany 52*: 895-903.

Mae T (1997). Physiological nitrogen efficiency in rice: nitrogen utilization photosynthesis and yield potential. In: Ando T, ed. Plant nutrition for sustainable food production and environment. Dordrecht, *The Netherlands: Kluwer Academic Publishers* : 51-60.

Sagan M, Ney B, Due G (1993). Plant symbiotic mutants as a tool to analyze nitrogen nutrition and yield relationship in field-grown peas (Pisum Sativum L.). *Plant and Soil 153* : 33-45.

Demotes Mainard S D, Jenfrroy MH, Robin S. Spike and dry matter accumulation before anthesis in wheat as affected by nitrogen fertilizer: relationship to kernel per sike. *Field Crops Research 64:* 249-259.

Martre P, Porter JR, Jamieson PD, Triboi E (2003). Modeling grain nitrogen accumulation and protein composition to understand the sink/source regulations of nitrogen utilization in wheat, *Plant Physiology 133 :* 1959-1967.

Lian X, Wang S, Zhang J, Feng Q, Zhang L, Fan D, Li X, Yuan D, Han B, Zhang Q. Expression profiles of 10422 genes at early stage of low nitrogen stress in rice assayed using a CDNA microarry. *Plant Molicular Biology 60* : 617-631.

Kumar A; Gupta N; Gupta A. K; Gaur V. S (2009). Identification of biomarker for determining genotypic potential of nitrogen-use efficiency and optimization of nitrogen inputs in crop plants. *Journal of Crop Science and Biotechnology 12* : 183-194.

Agostini, F., Tei F, Silgram, M., Farneselli, M., Benincasa, P., & Alter, M. F., (2010). Decreasing N leaching in vegetable crops through improvements in N fertilizer management, Genetic Engineering, biofertilization, soil quality and organic farming ed. Lichtfouse E. (Springer, Dordrecht, The Netherlands) *Sustainable Agr. Rev. Vol. 4* : 147-200.

Burns, I.G (2006). Assessing N fertilizer requirements and the reliability of different recommendation systems. *Acta Hort.* 700 : 35-48.

Neeteson, J. J & Carton, O. T (2001). The environmental impact of nitrogen in field vegetable production. *Acta Hort*. 563:21-28.

Rahn, C (2002). Management strategies to reduce nutrient loses from vegetable crops. *Acta Hort.* 571: 19-25.

Greenwood, D. J., Kubo K., Burns I. G & Dray Cott, A (1989). Apparent recovery of fertilizer N by vegetable crops. *Soil Sci. Plant Nutr*. 35: 367-381.

Janssen, B. H (1998). Efficient use of nutrients: An art of balancing. *Field Crops Res. 56*: 197-201.

Schenk, M. K (2006). Nutrient efficiency of vegetable crops. *Acta Hort,* 700: 25-38.

Devakumar C & Goswami B K (1992). Nematicidal principles from Neem-isolated and bioassay of some melicians. *Pestic Res J 4* (2): 79-84.

Agarwal R R, Shankar H, Agarwal M M (1980). Effect of slow release nitrogen and nitrification inhibitors on rice-wheat sequence, *Indian Journal of Agronomy 35:* 337-340.

Singh M & Singh T A (1986). Leaching losses of nitrogen from urea as affected by application of neem-cake. *Journal Indian Society Soil Science 34:* 766-773.

Bains S S., Prasad R & Bhati P C (1971). Use of indigenous materials to enhance the efficiency of fertilizer nitrogen for rice. *Fert. News 16 (3):* 30-32.

Ketkar C M (1974). Neem cake blended urea for nitrogen economy. *Fertilizer News 19 (2):* 25-26.

Vyas B N., Godrej NB & Mistry K B (1991). Development and evaluation of neem extract as a coating for urea fertilizer. *Fertilizer News 36 (2):* 19-25.

Readdy, RNS & Prasad, R (1975). Studies on mineralization of urea, coated urea and nitrification inhibitor treated urea in soil. *Journal of Soil Science, 26 :* 305-312.

Thomas, J & Prasad, R (1983); Mineralization of urea, coated urea and nitrification inhibitors treated urea in different rice growing soil. Z. pflanzenernahr. Bodenkd; 146: 341-347.

Prasad, M & Prasad, R (1983). Removal of NPK by rice-wheat double cropping system as effected by duration of rice variety, method of planting rice and levels and sources of nitrogen. *Plant and Soil. 70 :* 287-295.

Prasad, R; Sexena, V.C & Devakumar, C (1998). Pusa neem golden urea for increasing nitrogen use efficiency in rice. *Current Science,* 75, 15.

Sharma & Prasad (1996). Cited in Effect of different Organic Manures and Fertilizers on yield and nutrient uptake of maize. *Asian Journal of Science and Technology, vol. 5, Issue 12*: 905-908, December.

Jaiswal, V.P & Singh, G. R (2000). Performance of super granule and prilled urea under different planting method in irrigated rice. *Indian Journal of Agril. Science 71 (3):* 187-189.

Sujatha, MG; Lingaraju, Y B; Palled, B Y & Ashalatha, K V (2008). Importance of integrated nutrient management practice in maize under rainfed condition. *Karnataka Journal of Agril. Science, 21 (3):* 334-338.

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Annexure – I

Comments on the report **"Impact of Neem Coated Urea on Production, Productivity and Soil Health in Bihar"** submitted by AERC, T M Bhagalpur University, Bhagalpur, Bihar.

1. **Title of the draft report examined:**

   Impact of Neem-Coated Urea on Production, Productivity and Soil Health in Bihar.

2. **Date of receipt of the Draft report:** December, 2016

3. **Date of dispatch of the Comments:** January, 2016

4. **Comments on the Objectives of the study:**

   All the objectives of the study have been addressed.

5. **Comments on the Methodology:**

   Common methodology proposed for the collection of field data and tabulation of results has been followed.

6. **Comments on analysis, organization, presentation etc:**

(i) The report has been structured in a good manner, and elucidation is suitable for the results obtained.

(ii) Please, provide suitable policy suggestions based on the results and align the complete report by following standard guidelines.

(iii) Kindly, follow the APA style for quoting references.

(iv) *It is suggested to **copy edit the report** before finalizing.*

7. **Overall view on acceptability of report:**

   Authors are requested to incorporate all the comments and submit the final report for consolidation.

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Annexure – II

Action Taken Report (ATR)

1.	Title of the Study	:	**Impact of Neem Coated Urea on Production, Productivity and Soil Health in Bihar**
2.	Date of Dispatch of the Draft Report	:	02/12/2016 (Soft Copy) & 03/12/2016 (Hard Copy)
3.	Date of Receipt of the Comments	:	07/01/2017
4.	Date of Dispatch of the Final Report	:	30/01/2017

5. Action Taken for Comments on Analysis, Organization, Presentation etc. given at SN. 6 of Annex. - I.

    i. No action is needed.
    ii. Aligned the complete report by following standard guidelines.
    iii. Followed the APA style for quoting references
    iv. Copy edit mode followed.

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