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

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PREFACE

Chemical fertilizers are one of the important input constituents for plant growth and development. In Punjab, the monoculture of paddy-wheat has resulted in macro/ micro-nutrient(s) deficiencies in the soils which are often ameliorated by the application of these fertilizers. It has been verified over the years that a big chunk of conventional urea/ nitrogen applied is not assimilated by the plants and leaches into the soil, causing extensive ground water contamination. According to recent research, the ósustained releaseô nature of neem-coated urea has been beneficial for rice and wheat productivity enhancement. The neem-coating also preludes malpractices of the subsidized fertilizer being diverted for use in the chemical industry. It has become mandatory for all the indigenous manufacturers to produce neem-coated urea 2015 onwards. Various stakeholders in agricultural sector have been advocating the better results of NCU over normal urea (NU). Though farmers the ultimate users are the better judge while proving the new farm technology yet its excessive use and diversion should be closely monitored.

Since soils vary considerably in their capability to meet plants nutrient needs depending on factors such as soil parent material, texture, structure and current growing conditions, the soil test based application of such fertilizers in the form of óSoil Health Cardô is gaining importance. The need based use of fertilizers in the fields/ soil can result in significant cost saving/ profit increasing at the farmers level.

In view of the cited benefits of NCU and soil testing, the present study was undertaken with emphasis on the adoption of NCU, recommended doses of fertilizers by the farmers on soil test basis and their impact on cost reduction and yield improvements if any. This attempt would definitely be useful for further framing suitable policies for the benefit of the society in general and peasantry in particular.

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Authors

IMPACT OF NEEM-COATED UREA (NCU) ON PRODUCTION, PRODUCTIVITY AND SOIL HEALTH IN PUNJAB

Abstract

Punjab state is known for advent of green revolution in India but with the passage of time, the rice-wheat cropping system resulted in development of various agro-ecological problems. The excessive use of chemical fertilizers is one such issue which needs urgent attention in spite of the fact that the chemical fertilizers are the important source of nutrients for plant growth. From the year May, 2015 the entire production of urea has been converted as neem coated urea (NCU) to check its misuse in industries and benefits accrued in terms of increased production of crops. The present study was undertaken with the objectives; to analyze the trends in usage and prices of Urea versus NCU in Punjab, to analyze the adoption behavior of NCU among selected farmers in irrigated tracts, to analyze the impact of adoption of NCU on crop productivity and farmers' income, to document the status and implementation of soil health card scheme and to suggest suitable policy measures for adoption of NCU. The data were collected from randomly selected 200 farmers from four blocks of Ludhiana and Patiala districts where paddy is a major kharif crop which requires adequate doses of urea for its growth. The results of the study revealed that the consumption/ sale of urea in Punjab during the year 2007-08 was 2646.44 th. MT which rose to 3086.05 th. MT during the period 2007-08 to 2015-16 at an annual growth rate of 1.64 per cent. The urea prices increased significantly at the highest growth of 5.21 per cent per annum during the decade 1990-91 to 1999-2000 while during the period 1980-81 to 2015-16 the growth in urea prices was 3.33 per cent per annum. The analysis of the primary data revealed that the majority of the respondent farmers purchased NCU and NU from co-operative societies followed by private fertilizer dealers while the cost per bag of NCU, including transportation cost, worked out to be Rs. 289.69 while it was Rs. 276.58 per bag in case of NU. There was marginal increase in the productivity of paddy crop during the year 2015-16 as compared to the year 2014-15, however, it canôt only be attributed to the application of NCU because there are numerous factors influencing the yield of a crop The net returns per acre were estimated to be Rs. 31401 during the year 2015-16 and Rs. 29530 in 2014-15. As far as awareness about NCU was concerned, almost all the selected farmers were aware about the NCU and major source of awareness was co-operative societies. The major sign from which respondent farmers differentiated NCU from NU was leaf figure on bag. There was a significant increase in the application of NCU after 2015-16 in crops such as; paddy, wheat, basmati, sugarcane, potato, maize, sunflower and vegetables. Due to the application of NCU, only 5.29 per cent farmers reported about the increase in paddy yield while the cost of pest and disease control declined by 21 per cent. All the respondent farmers reported no decline in the cost of other fertilizers, improvement in the soil health, quality of grain and market acceptability of grains due to the application of NCU. Majority of the farmers reported about the quality of NCU being good, adequate, timely available, accessible in the market, its non-solidification and evenly distribution at the time of application being good points. It was found that none of the selected farmers reported about the use of NCU for other purposes such as; silage making, mixing with weedicides and for fishery feed preparation. There was increase in productivity of paddy crop where neem coated urea (NCU) was applied on the sample farms. Also, the NCU usage on the sample farms increased while cost of pest and disease control measures declined. The partial budgeting technique brought out that there were added returns of Rs. 718 per acre by application of NCU on the sample farms. It was also revealed by all the respondents that there was no change in the texture of the soil, soil moisture retention capacity, water infiltration rate, soil softness and decline in the compaction of the soil due to application of NCU but there was higher retention of nitrate in the soil and thereby its slow release to the crop. High price of NCU, inadequate/ shortage of supply during peak season and poor quality of NCU in some of the co-operative societies were the major problems reported by the respondents. Major suggestions were; assured/ timely and adequate supply of NCU to co-operative societies and organising training camps for spreading awareness. The information on soil health card revealed that only five farmers, out of 45 farmers who got their soils tested, received soil test report/ soil health card. It was found that 8.89 per cent of the sample farmers, who tested their soils, got information about soil testing from Agriculture Department. The most important reason of soil testing, as revealed by 31.11 per cent farmers, was ótо understand fertilizer requirement for the cropô while most important reason for not testing soil by 72.26 per cent farmers was that ósoil testing not required for my field as crop yield is goodô. It was observed that 91.11 per cent of the farmers, who got their soils tested, were not aware about the recommended dose of fertilizers (RDF) for paddy crop but were applying fertilizers based on their own perception while just 8.89 per cent of the farmers were actually aware about RDF on the basis of soil test report. Major problems faced in soil testing by the farmers was proper reports not being delivered and poor extension services while important suggestions were to deliver the soil health card on time and organizing awareness camps regarding soil testing. Major policy issue suggested was to lay emphasis on ensuring good quality, adequate quantity and timely supply of NCU along with bringing its price at par with NU. Besides, organising training camps for educating the farmers about benefits of soil testing and involving Gram panchayats in soil testing campaigns can be a few steps for better implementation of SHC scheme.

Chapter I

Preamble

1.1 Background of the study

Punjab state is well known for adoption of new farm technology which resulted in advent of green revolution thereby increasing dramatically the productivity and production of crops especially paddy and wheat. With the passage of time, rice-wheat cropping pattern resulted in appearance of macro and micro-nutrients deficiencies in the soil, resulting into an excessive application of chemical fertilizers as source of nutrients for plant growth. The total consumption of nitrogenous (N), phosphatic (P) potassic (K) fertilizers in the Punjab state increased from 2.13 lakh tonnes in 1970-71 to 17.14 lakh tonnes in 2013-14 (Anonymous, 2014). The per hectare consumption of these fertilizers in the state has increased merely from 43.12 Kg.N, 7.75 Kg. P and 1.73 Kg. K in 1970-71 to 329.15 Kg. N, 78.31 Kg. P and 5.54 Kg. K during the year 2013-14.The increased consumption of chemical fertilizers, which was a boon for increase in agricultural productivity in the state, has now become a bane due to the problems associated with its excessive use.

India is the second largest consumer of fertilizer in the world next to China and third largest producer of nitrogenous fertilizer behind China and USA. In terms of Nutrients, it stands second in consumption of N and P with the quantity of 16.75 million tonnes and 5.63 million tonnes, respectively. Total consumption of NPK fertilizers in the country during 2013 was 24.48 million tonnes (IFA, 2015). Urea is the most common nitrogen fertilizer used uniformly throughout the world. The wide acceptance of urea is because of its agronomic acceptability and relatively lower cost as compared to other fertilizers. Besides being widely used as an excellent fertilizer for plant growth, it can also be used among numbers of products such as animal feed, commercial products, glue, resin, cosmetics, pharmaceuticals, dish soaps, hair conditioners, tooth whiteners, etc.

With the increased cost of urea fertilizer and concern about its adverse environmental impact of nitrogen losses, there has been a great interest in improving the Nitrogen Use Efficiency (NUE) through optimization of nitrogen use. By doing so, higher yields can be achieved with less negative impacts like nitrogen leaching (Agostini *et al*., 2010; Burns, 2006; Neeteson *et al*, 1999; Rahn, 2002).

Keeping in view the low NUE, it has been felt to find out the use of some indigenous material and coating process for reducing the nitrogen losses from urea. In this endeavor,

National Fertilizer Limited (NFL) standardized the techniques for production of Neem Coated Urea (NCU) in the year 2002. Since then many changes have been made in the process and applicant solution to have uniform and consistent coating of neem oil on urea prills and to maintain the concentration of Neem oil content as per the specification prescribed in Fertilizer Control Order (FCO), 1985. The use of NCU has been found to improve the uptake of N, P and K significantly. Based upon the results of extensive field trials, NCU was found to be agronomically superior to normal prilled urea. Thus, NFL became the first company in India which was granted the permission to produce and market the NCU, vide Government of India Notification No S.O.807 (E) dated 9 July 2004. In the initial years, the total production of NCU was limited up to 35 per cent. Later, from March 2015, the Department of Fertilizer (DOF) has made it mandatory for all indigenous producers of urea to produce 75 per cent of their production as NCU and from 25th May, 2015 the cap was increased to 100 per cent. Neem acts as a nitrification inhibitor and its coating over urea minimizes loss due to leaching. Coating urea with neem prevents its misuse as well as puts the fertiliser in slow release mode thereby nourishing the saplings for a longer period. Thus avoids the repeated use of fertilizer and economize the quantity of urea required by crops (enhancing Nitrogen-Use Efficiency (NUE)). Besides, coating of neem oil also reduces the leaching of nitrates into the groundwater aquifers and thus, help in reducing its pollution.

1.2 Review of literature

In this section, various research studies undertaken on NCU has been reviewed and discussed in chronological order as under:

Singh and Singh (1989) conducted a study to compare the efficiency of neem oil coated urea (NOCU) with sulphur coated urea (SCU), lac coated urea (LUC) and neem cake blended urea (NCBU) on grain yield of nitrogen uptake and per cent recovery of N by wheat on a calcareous (23.7% CaCO3) soil. Significant increases in grain yield, nitrogen uptake and recovery of applied nitrogen were observed on application of these materials. Among the four modified materials, NOCU, SCU and LCU were equally effective. The NOCU, SCU and LCU maintained higher amounts of NO_3-N in the soil throughout the growth period of wheat as compared to urea and NCBU. N recovery by wheat from these materials was 30.8, 31.1 and 27.7 % for SCU, NOCU and LCU, respectively.

Tomar *et al* (1991) carried out a trial on a deep black vertisol in the year 1988-89 in wet season in Rajasthan. Rice variety Jaya was given 90, 120 or 150 kg N/ha as prilled urea

(PU) or neem extract-coated urea (NECU). Half of the PU was incorporated before transplanting and the remainder in equal top dressings at tillering and panicle initiation. Similarly, NECU was applied 50% before transplanting and 50% at tillering stage. Grain yields ranged from 3.6 t/ha in 1988 and 3.5 t in 1989. Also, there was a positive correlation between number of productive tillers and grain yield.

Kumar and Thakur (1993) conducted a field experiment on silty clay soil in 1990 at Pusa, Bihar. Rice variety cv. Rajshree was given 30 or 60 kg N/ha as Mussoorie phos-coated urea (MRPU), neem coated urea (NCU), gypsum coated urea (GCU), nimin coated urea (NMCU) or prilled urea (PU). 30 or 60 kg N was applied at transplanting or 60 kg N was applied in 2 equal splits at transplanting and maximum tillering. Split application of 60 kg N gave the highest grain yield of 4.51 t. Grain yields from the N sources were: MRPU, 4.02 t; NCU, 4.45 t; GCU, 4.21 t; NMCU, 4.38 t; and PU, 3.74 t. Thus, NCU gave highest grain yield.

Hooda and Srivastava (1998) assessed the impact of neem [Azadirachta indica] coated urea (NCU) and potash on the incidence of rice blast (Magnaporthe grisea) in Hisar during the crop year 1992-93. All 3 levels of NCU used (30, 60, 90 kg N/ha) were effective in reducing the disease. However, for neck and node blast incidence, NCU at 30 kg N/ha had no effect compared with controls. NCU at 60 and 90 kg N/ha significantly reduced disease compared with controls. Significant increases in yield were also produced by NCU rates of 60 and 90 kg N/ha. NCU affected biochemical constituents (cellulose, hemicellulose, lignin, silica, total proteins and total phenols) of the host plants. These changes were significant at 60 and 90 kg N/ha applied through NCU as compared with plain urea. The highest cost:benefit ratio was recorded for NCU at 60 kg N/ha, followed by 90 kg N/ha. The 3 rates of potash used (15, 30 and 45 K2O/ha) had no effect on the incidence of rice blast or yields.

Upadhyay and Tripathi (2000) conducted a field experiment during the kharif season of 1997 in Raipur, Madhya Pradesh, India. The application of neem extract coated urea (NCU) 50% basal + 25% at tillering + 25% at panicle initiation (PI) stage recorded the maximum grain (39.60 q/ha) and straw (63.90 q/ha) yield, grain (1.26%) and straw (0.19%) N concentration and uptake (62.04 kg/ha), nitrogen use efficiency (62.04 kg/ha) and nitrogen recovery (46.96%).

Sirisena *et al* (2003) evaluated the relative efficiency of granular urea, soil mixed urea and neem coated urea fertilizers compared with prilled urea on irrigated, transplanted paddy in Sri Lanka. It was found that among the tested urea sources, granular urea produced the best paddy yields (5.56 and 6.8 t/ha) during the study period. It also efficiently increased N use

efficiency of paddy (29.2 kg/ha). Although, granular urea performed well than prilled urea, use of prilled urea is still suggested when granular urea is not available.

Mangat and Narang (2004) have assessed the agronomical efficiency of NCU using rice and wheat as test crops during kharif and rabi seasons of 2002-2003 in Punjab and Haryana. Results indicated that high crop yield could be obtained in paddy and wheat when NCU was applied at 100% recommended level of N application. Even at 80% level of recommended dose urea application through NCU in paddy crop, the yield obtained were comparable when urea was applied at 100% level of recommended dose through normal prilled urea, i.e., urea dose can be reduced by 50 kg per hectare with marginal, non-significant reduction in yield when NCU was used. NCU, when applied at 100% level of recommended levels, gave significantly higher yield in wheat crop in Haryana but when NCU was applied at 80% level, the yield was reduced significantly.

Purakayastha and Katyal (2006) reported that urea was the most popular nitrogenous fertilizer among the Indian farmers because of its low cost and easy availability. However, the major disadvantage of urea was its high solubility in water, and it was very much susceptible to nitrogen loss through various pathways like leaching, ammonia volatilization, nitrification and denitrification. Among these, ammonia volatilization happens to be the dominant loss mechanism because of conventional methods of fertilizer application (wet soil surface broadcasting) and farmers encourage it. Modification of urea has been experimented extensively in India to increase its use efficiency by various crops. Nevertheless, different fertilizer application methods also have been attempted for the same purpose. In heavy textured soil, dry soil application followed by irrigation and puddling in rice crop could substantially decrease nitrogen loss vis-à-vis N use efficiency by rice. Neem cake and elemental sulphur has been used extensively as coating materials for modifying urea fertilizer. However, neem-coated or sulphur-coated urea could not succeed mainly because of inconsistent results and high costs involved particularly in the latter fertilizer material. Therefore, alternative chemical amendments, e.g. ammonium chloride, zinc sulphate, phosphogypsum, copper sulphate and potassium chloride etc., which are otherwise used as fertilizers by the farmers have been tried for making compacted urea fertilizers through dry compaction and granulation. Among these amendments, zinc sulphate, copper sulphate, potassium chloride and phosphogypsum proved to be effective in decreasing ammonia volatilization loss and N use efficiency by rice. This approach of dry compaction and granulation is very promising as it does not involve much cost; the only thing is to provide

every village a tablet machine so that the compacted urea fertilizers are to be available at the farmer's door step in the appropriate time.

Venkatesan and Veemaraj (2006) conducted a field experiment to study the effects of dicyandiamide (DCD) and neem coated urea (NCU, a slow release N fertilizer) on the unease activity of tea soils in Anamallais, Tamil Nadu, India. The treatments comprised N (urea) at recommended concentration, NK (urea and muriate of potash, MOP) at recommended concentrations of 1:1 and 4:1, N as urea-MOP along with DCD, and NCU+MOP at recommended concentration of 4:3. Soil samples were drawn on the 6th, 10th, 18th, 28th, 39th, 49th and 60th day after imposing the treatments and analysed for urease activity. Application of DCD along with urea-MOP and NCU along with MOP showed considerable activity till the 49th day, while in the other treatments; the activity reached the minimum level on the 39th day. This indicated that the interval between 2 successive fertilizer applications could be enhanced to 6-8 weeks when the NCU or DCD-blended urea was used.

Bhalla and Prasad (2008) reported the significant increase in the growth of paddy plant parts by halving the urea used and pelleting the remaining with neem cake prior to application. Results on a non-averaged dataset showed significant increase in leaf length, number of leaves, number of panicles, number of tillers and greenness of leaves. Averaged data showed similar results barring the number of panicles, which were not significantly different from the control. The results point to a higher availability of nitrogen in the treatment, even though half the amount of urea was applied as opposed to the control. This could be attributed to inhibition of de-nitrifying bacteria by neem as well as a slower continuous release of nitrogen when urea is pelleted with neem than when it is applied directly. The study makes a strong case for cutting down on nitrogen application in paddy using low-cost, readily available materials, without compromising on the yield.

Thind *et al* (2010) observed that modifications in fertilizer source and/or management can lead to reduced losses of N, high wheat yields and increased fertilizer N-use efficiency. Relative performance of neem (Azadirachta indica A Juss)-coated urea vis-à-vis ordinary urea applied to wheat (Triticum aestivum C. emend Fiori & Paol.) was studied when applied at different levels (48, 96 and 120 kg N/ha), drilled in between rows as a single dose of 96 kg N/ha and when applied in 3 split doses (48, 48 and 24 kg N/ha). The field experiments were carried out at 2 locations, i e Ludhiana-sandy loam soil and Gurdaspur - clay loam soil during 2005-08. When nitrogen was applied in 2 equal split doses at the time of sowing and first irrigation, the neem coated urea did not out perform urea in increasing grain yield at any level of N application at both the locations. Performance of neem coated urea @ 96 kg N/ha drilled

during sowing of wheat was better than neem-coated urea applied @ 120 kg N/ha in 2 split doses at Ludhiana. Better performance of urea and neem-coated urea applied in 3 rather than 2 split doses only in coarse-textured soil at Ludhiana suggests that losses of applied N via leaching can be substantial as compared to in the fine textured soil at Gurdaspur. This study suggests that neem-coated urea can lead to improved N-use efficiency when applied either in 3 split doses or drilled between rows as a single dose in coarse-textured soils rather than in fine-textured ones.

Sunita and Narang (2012) carried out an agronomical trial on rice and wheat crops with Neem Coated Urea (NCU) as source of nitrogen. It was observed that NCU applied field has produced significantly higher yields at research and farm level. Looking into the potential of Neem Coated Urea and its acceptance by the farmers, Ministry of Agriculture in July 2004, included the Neem Coated Urea in FCO. The use of Neem Coated Urea has been found to improve the uptake of N, P and K significantly. Since 2008 the, Ministry of Chemicals and Fertilizers allowed Neem Coated Urea manufacturer to sell NCU at 5% above the MRP, to recover the cost of coating, however cost of neem oil and production as such of Neem Coated Urea has increased significantly.

Sanjaykumar *et al* (2015) conducted a field experiment in Zonal Agricultural Research Station, Navile, Shivamogga to know the impact of different compost enrichment methods on productivity and NPK use efficiency and their uptake by maize. The different compost enrichment methods adopted were: compost alone, recommended package of practice (RPP), compost enriched with NPK fertilizers, compost enriched with neem oil coated urea (NOCU) + PK fertilizers and compost enriched with neem cake+PK fertilizers. Compost+NOCU+PK fertilizers recorded significantly higher grain yield (8626 kg ha-1) and also higher N (210.8 kg ha-1), P (65.4 kg ha-1) and K (205.8 kg ha-1) uptake by maize. The highest N, P and K use efficiency of 34.5, 59.9 and 118.1 kg grain per kg N, P and K applied respectively, was recorded in the compost+NOCU+PK fertilizers treatment. Compost+neem cake+PK fertilizers enrichment method recorded significantly higher available N (192.5 kg ha-1), available P (37.6 kg ha-1) and available K (182.2 kg ha-1) in soil over RPP (154.8 kg ha-1, 33.7 kg ha-1 and 161.4 kg ha-1 available N, P and K, respectively).

Most of the studies cited above revealed that neem coated urea (NCU) has been performing well over normal urea. It was observed that the grain yield of wheat, paddy, maize etc were significantly increased with the application of NCU over NC under different conditions by conducting number of experiments on trial fields in research station all over the states of India. Keeping in view the benefits of NCU, government of India has drawn back

the restriction cap of NCU production and allowed 100 per cent production and supply of neem coated urea to all the states w.e.f. 25-5-2015 in the interest of the farming community.

1.3 Need for the study

Punjab state being called food bowl of the country is also one of the largest consumer of chemical fertilizers in the country. But now it has been observed by agricultural scientists that the use of N fertilizers is proportionately higher than P and K fertilizers as compared to recommended level of N:P:K ratio for various crops. So, it is necessary to lay emphasis on judicious use of fertilizers especially urea. The Government of India included neem-coated urea, a slow release fertilizer, in the Fertilizer (Control) Order, 1985 and made it mandatory for all the indigenous producers of urea to produce their whole production of subsidized urea as NCU from 2015. Further, it has taken various steps to promote NCU, with a view to improve soil health status and also realise higher crop yield. There is a need to assess the impact of NCU on the production and productivity of major crops in Punjab. Therefore, the present study was undertaken to examine the coverage of NCU, its adoption behaviour and impact on yield of paddy crop in the state.

1.4 Objectives of the study

The specific objectives of the study are as follows:

1. To analyze the trends in usage and prices of Urea versus NCU in Punjab.
2. To analyze the adoption behavior of NCU among selected farmers in irrigated tracts of Punjab.
3. To analyze the impact of adoption of NCU on crop productivity and farmers' income.
4. To document the status and implementation of soil health card scheme.
5. To suggest suitable policy measures for adoption of NCU.

1.5 Limitation of the study

The present study relied on primary data collected from the farmers. In the process of data collection it was found that information on highly scientific parameters concerning soil health/ characteristics viz. soil texture, soil water/ moisture retention capacity/ infiltration rate, soil softness etc. regarding which farmerôs perception had to be obtained. Even after enquiring minutely, farmers were unable to identify/ pinpoint changes in soil characteristics due to the application of NCU. So, it was a challenge to identify any change in the soil health due to the application NCU from the farmerôs perspective.

1.6 Data and methodology

The present study relied on both primary and secondary data collected from various sources. The reference period for the study was kharif, 2015. Paddy crop in kharif season having highest use of urea in Punjab was selected for the study. Two districts namely Ludhiana and Patiala were selected based on the urea usage in paddy crop in the central belt of the state. From each selected district, two blocks were selected again based on the same criterion. Thus, Jagraon and Machhiwara blocks from district Ludhiana and Nabha and Rajpura blocks from district Patiala were selected for the study. Further from each block, two cluster of villages comprising 3-4 villages were selected for conducting the survey. A sample of 50 farmers from each block, which added up to 100 farmers in each district, totalling to 200 farmers for both the selected districts. Households were selected randomly for assessing the use of NCU fertiliser and its impact on crop production. While selecting the households, special care was taken to have the representation of the farmers with full use of NCU, part use of NCU and no use of NCU (those who have used simple urea). Thus, a total number of 200 NCU/partial NCU and Urea user farmers for paddy crop were interviewed. Adequate representation was given to different farm size groups classified based on operational land holding size. Hence, the sample includes 68 marginal/small, 117 medium and 15 large farm size groups.

1.7 Organisation of the report

The present report has been divided into seven chapters. First chapter relates to the background information related to importance of fertilizers, need for the study, review of literature, objectives and methodology undertaken. Second chapter is concentrated on the trends in urea consumption, price variation and distribution of NCU. Third chapter includes the socio economic characters of the respondent farmers, operational holding, cropping pattern, purchasing pattern and source of credit, input use and profitability from paddy crop. Fourth chapter relates to status of awareness and application of NCU while fifth chapter deals with awareness and adoption level of soil testing technology along with status of soil health related programmes and schemes. The impact of NCU application on crop production and soil health has been included in chapter sixth. Seventh chapter contains summary along with conclusions and policy suggestions.

Chapter II

Trends in Urea Consumption in the State

2.1 Trends in urea consumption and price variation

The district wise trends in consumption/ sale of urea in Punjab have been given in Table 2.1a. It was observed that during the year 2007-08 the consumption of urea was 2646.44 th. MT which rose to 3086.05 th. MT during the period 2007-08 to 2015-16 at an annual growth rate of 1.64 per cent. As far as district-wise analysis is concerned, the annual growth in urea consumption was 5.78 per cent in S.A.S., Nagar followed by 3.60 per cent in Rupnagar, 3.34 per cent in Barnala, 2.43 per cent in Moga, 2.62 per cent in Kapurthala, 2.11 per cent in Tarntaran, 2.07 per cent in Jalandhar, 2.02 per cent in Amritsar and 1.71 per cent in Firozpur and it was also statistically significant. In rest of the districts, although there was also growth in urea consumption but it was not significant statistically. So, it is clear from the analysis that growth in urea consumption was higher in those districts where mostly paddy-wheat crop rotation is followed by the farmers. These crops require sufficient doses of urea along with other fertilizers for overall plant growth and good productivity. In relative terms (Table 2.1b) the consumption/ sale of urea was 10.72 per cent of total consumption in district Firozpur during 2015-16 followed by other major consuming districts i.e. Sangrur (9.76%), Ludhiana (7.92%), Patiala (7.49%) and Bathinda (6.57%).

The trends in urea prices since 1981-82 to 20015-16 have been given in Table 2.2. A perusal of the table reveals that during the year 1980-81 the price of urea was Rs. 2350 per tonne which declined to Rs. 2150 per tonne in 1982-83 and again rose to Rs. 2350 per tonne during 1985-86. After remaining at this level for continuous four years the price of urea again shoot up to Rs. 3227 per tonne in 1990-91 but again declined to Rs. 2760 per tonne in the subsequent year and remained at this level for next four years i.e. up to the year 1995-96. From the year 1996-97, the price of urea increased to Rs. 3660 per tonne and remained increasing for next three years and was Rs. 4600 per tonne during the year 2000-01 and further increased to Rs. 4830 in the subsequent year. The price of urea remained at the level of Rs. 5070 per tonne from 2002-03 to 2008-09 and increased to Rs. 5310 per tonne in 2009-10 and remained at the same level for the next year. Again, urea price increased to Rs. 5360 per tonne in 2011-12 and remained same for the next three years and increased to Rs. 5628 per tonne in the year 2015-16.

Table 2.1a: District-wise trends in consumption/sale of urea in Punjab, 2007-08 to 2015-16

(000'MT)

District	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	CGR(%)
Firozpur	281.61	269.28	264.49	280.51	299.19	309.4	275.05	287.53	330.95	1.71*
Sangrur	253.41	268.42	230.12	271.71	280.76	267.54	251.65	260.84	301.21	1.29
Ludhiana	210.73	204.08	192.39	224.73	222.4	224.96	208.67	214.69	244.41	1.53
Patiala	221.03	199.77	196.52	212.55	226.08	220.18	211.77	204.56	231	0.72
Bathinda	159.78	167.18	155.1	175.09	175.34	185.18	162.82	176.49	202.61	2.13*
Moga	146.13	140.67	130.65	143.19	154.59	154.74	145.45	154.65	181.41	2.43*
Amritsar	160.45	137.78	138.12	145.63	153.91	162.7	149.54	161.37	179.84	2.02*
Gurdaspur	160.17	164.37	153.65	166.11	173.99	169.03	149.68	155.43	170.25	0.07
Muktsar	158.86	140.85	147.01	148.93	167.25	164.64	147.01	163.22	167.53	1.27
Jalandhar	136.54	132.15	127.42	145.28	146.55	150.96	139.13	152.16	158.37	2.07**
Tarntaran	114.45	108.35	104.78	116.19	120.47	124.5	114.45	117.43	138.67	2.11*
Mansa	127.7	118.12	118.33	137.6	128.75	129.27	126.94	128.78	138.4	1.1
Barnala	75.75	91.19	83.93	96.5	99.87	99.39	94.61	92.25	114.97	3.34**
Faridkot	90.99	96.03	76.99	95.39	95.43	101.24	81.02	92.26	105	1.03
Kapurthala	82.92	78.02	78.97	86.4	87.81	89.34	90.53	90.83	101.01	2.62**
Hoshiarpur	82.93	81.4	77.04	82.26	86.72	87.68	81.97	83.63	99.91	1.70*
Fatehgarh Sahib	71.86	67.07	65.3	67	70.88	70.21	67.01	68.39	75.61	0.6
Shaheed Bhagat Singh Nagar	50.91	51.08	49.83	54.43	58.43	55.8	49.01	52.95	60.13	1.28
Rupnagar	33.39	33.79	32.84	36.35	39.69	38.08	37.36	40.61	45.83	3.60**
Sahibzada Ajit Singh Nagar	26.84	27.32	22.29	34.59	37.58	38.14	35.66	36.19	38.94	5.78**
Punjab state	**2646.44**	**2576.9**	**2445.76**	**2720.44**	**2825.7**	**2842.97**	**2619.32**	**2734.26**	**3086.05**	**1.64***

Source: www.urvarak.in

**** and * significant at one and five per cent level of significance**

Table 2.1b: District-wise relative share in consumption/sale of urea in Punjab, 2007-08 to 2015-16

(% to total)

District	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Firozpur	10.64	10.45	10.81	10.31	10.59	10.88	10.50	10.52	10.72
Sangrur	9.58	10.42	9.41	9.99	9.94	9.41	9.61	9.54	9.76
Ludhiana	7.96	7.92	7.87	8.26	7.87	7.91	7.97	7.85	7.92
Patiala	8.35	7.75	8.04	7.81	8.00	7.74	8.08	7.48	7.49
Bathinda	6.04	6.49	6.34	6.44	6.21	6.51	6.22	6.45	6.57
Moga	5.52	5.46	5.34	5.26	5.47	5.44	5.55	5.66	5.88
Amritsar	6.06	5.35	5.65	5.35	5.45	5.72	5.71	5.90	5.83
Gurdaspur	6.05	6.38	6.28	6.11	6.16	5.95	5.71	5.68	5.52
Muktsar	6.00	5.47	6.01	5.47	5.92	5.79	5.61	5.97	5.43
Jalandhar	5.16	5.13	5.21	5.34	5.19	5.31	5.31	5.56	5.13
Tarntaran	4.32	4.20	4.28	4.27	4.26	4.38	4.37	4.29	4.49
Mansa	4.83	4.58	4.84	5.06	4.56	4.55	4.85	4.71	4.48
Barnala	2.86	3.54	3.43	3.55	3.53	3.50	3.61	3.37	3.73
Faridkot	3.44	3.73	3.15	3.51	3.38	3.56	3.09	3.37	3.40
Kapurthala	3.13	3.03	3.23	3.18	3.11	3.14	3.46	3.32	3.27
Hoshiarpur	3.13	3.16	3.15	3.02	3.07	3.08	3.13	3.06	3.24
Fatehgarh Sahib	2.72	2.60	2.67	2.46	2.51	2.47	2.56	2.50	2.45
Shaheed Bhagat Singh Nagar	1.92	1.98	2.04	2.00	2.07	1.96	1.87	1.94	1.95
Rupnagar	1.26	1.31	1.34	1.34	1.40	1.34	1.43	1.49	1.49
Sahibzada Ajit Singh Nagar	1.01	1.06	0.91	1.27	1.33	1.34	1.36	1.32	1.26
Punjab state	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 2.2: Trends in prices of urea, 1980-81 to 2015-16

Year	Price (Rs/tonne)
1980-81	**2350**
1981-82	2350
1982-83	2150
1983-84	2150
1984-85	2150
1985-86	2350
1986-87	2350
1987-88	2350
1988-89	2350
1989-90	2350
1990-91	**3227**
1991-92	2760
1992-93	2760
1993-94	2760
1994-95	2760
1995-96	2760
1996-97	3660
1997-98	3910
1998-99	4000
1999-2000	4600
2000-01	**4600**
2001-02	4830
2002-03	5070
2003-04	5070
2004-05	5070
2005-06	5070
2006-07	5070
2007-08	5070
2008-09	5070
2009-10	5310
2010-11	**5310**
2011-12	5360
2012-13	5360
2013-14	5360
2014-15	5360
2015-16	5628
CGR (%)	**3.33**

Source : www.indiastat.com

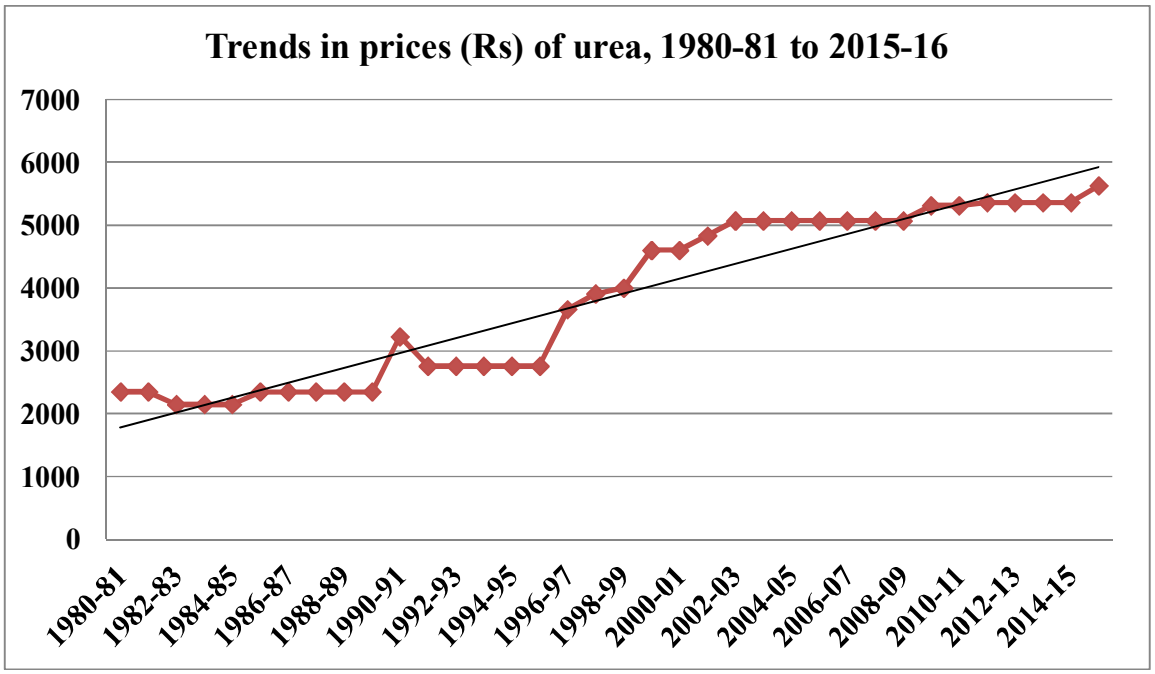

Figure-2.1

The compound growth rate of urea prices from 1980-81 to 2015-16 has been shown in Table 2.3. It was observed that the prices of urea increased at an annual growth rate of 0.49 per cent during the period 1980-81 to 1989-90 but this increase was not significant. It can be seen that prices of urea increased significantly at a growth rate of 5.21 per cent per annum during the period 1990-91 to 1999-2000. Also, from the year 2000-01 to 2015-16 prices of urea increased significantly at an annual growth of 0.92 per cent per annum. In overall, the prices of urea increased significantly at an annual growth rate of 3.33 per cent during the period 1980-81 to 2015-16.

Table 2.3: Compound growth rate of prices of urea, 1980-81 to 2015-16

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

****Significant at one per cent level of significance**

2.2 Trends in distribution of NCU (district-wise analysis)

The district-wise distribution of NCU/ NU has been given in Table 2.4. A perusal of the table reveals that largest share of 10.72 per cent NCU/ NU was distributed in Firozpur district of Punjab followed by Sangrur (9.76%), Ludhiana (7.92%), Patiala (7.49%), Bathinda (6.57%), Moga (5.88%), Amritsar (5.83%), Gurdaspur (5.52%) and Jalandhar (5.13%). In district Tarntaran the per cent share of NCU distribution was 4.49 per cent of total distributed in Punjab followed by Mansa (4.48%), Barnala (3.73%), Faridkot (3.40%), Kapurthala (3.27%), Hoshiarpur (3.24%), Fatehgarh Sahib (2.45%), SBS Nagar (1.95%), Rupnagar (1.49%) and SAS, Nagar (1.26%).

Table 2.4: District-wise distribution/consumption/sale of neem coated urea/normal urea in Punjab, 2015-16

(000MT)

District	Neem coated urea/ normal urea	% to total
Firozpur	330.95	10.72
Sangrur	301.21	9.76
Ludhiana	244.41	7.92
Patiala	231.00	7.49
Bathinda	202.61	6.57
Moga	181.41	5.88
Amritsar	179.84	5.83
Gurdaspur	170.25	5.52
Muktsar	167.53	5.43
Jalandhar	158.37	5.13
Tarntaran	138.67	4.49
Mansa	138.40	4.48
Barnala	114.97	3.73
Faridkot	105.00	3.40
Kapurthala	101.01	3.27
Hoshiarpur	99.91	3.24
Fatehgarh Sahib	75.61	2.45
Shaheed Bhagat Singh Nagar	60.13	1.95
Rupnagar	45.83	1.49
Sahibzada Ajit Singh Nagar	38.94	1.26
Punjab	**3086.05**	**100.00**

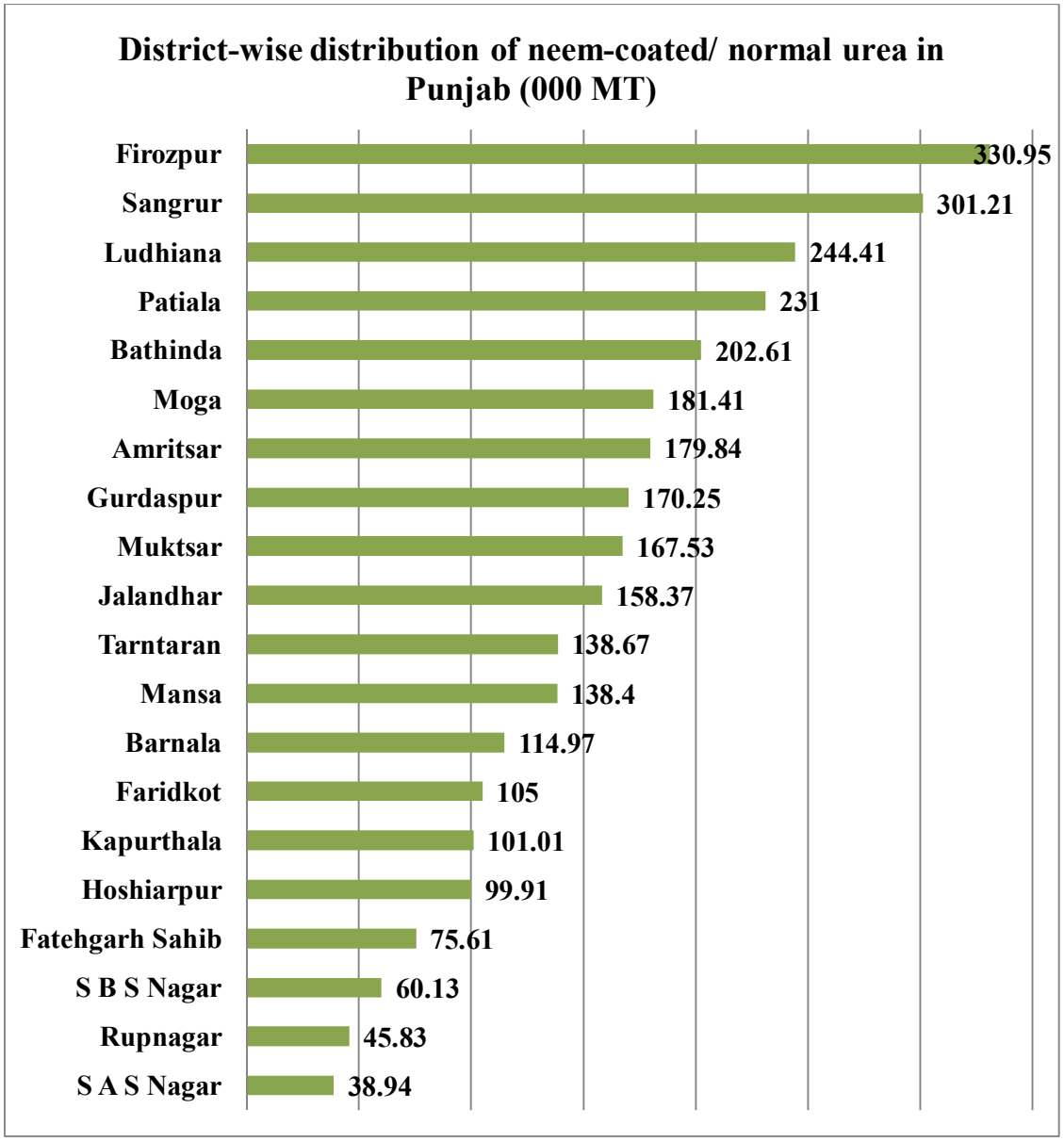
District-wise distribution of neem-coated/ normal urea in Punjab (000 MT)
Firozpur 330.95
Sangrur 301.21
Ludhiana 244.41
Patiala 231
Bathinda 202.61
Moga 181.41
Amritsar 179.84
Gurdaspur 170.25
Muktsar 167.53
Jalandhar 158.37
Tarntaran 138.67
Mansa 138.4
Barnala 114.97
Faridkot 105
Kapurthala 101.01
Hoshiarpur 99.91
Fatehgarh Sahib 75.61
S B S Nagar 60.13
Rupnagar 45.83
S A S Nagar 38.94

Figure-2.2

Chapter III

Socio-economic Characteristics of Sample Households

3.1 Socio-economic characteristics of sample households

Socio-economic characters of the respondents play an important role in adopting the new farm technology for betterment of farming community. General characteristics of sample households in Punjab have been shown in Table 3.1. A perusal of the table reveals that all respondents were males with average age of 46.83 years and average farming experience of 25.74 years. The average family members engaged fully in farming were 1.90 and average family size was 6.82. Thus, mostly respondent farmers were middle-aged having adequate farming experience to face new farm related challenges.

Table 3.1: General characteristics of sample households in Punjab, 2015-16

Particulars	
Average age of respondents (Years)	46.83
Male respondents (%)	100.00
Average family members engaged fully in farming (No.)	1.90
Average farming experience (Years)	25.74
Average family size (No.)	6.82

The education level of the respondent farmers is also an indicator of the pioneers in following new agricultural practices. The education level of the respondent farmers in Punjab has been given in Table 3.2. It can be seen from the table that 14.50 per cent of the respondent farmers were illiterate while 30.50 per cent were educated up to higher primary level followed by 26.50 per cent being matriculate and 25 per cent educated up to pre-university and above level. Mere 3.50 per cent farmers were educated up to primary level only.

Table 3.2: Education level of sample respondents in Punjab, 2015-16

Education level	**(%)**
Illiterates	14.50
Primary (1 to 4)	3.50
Higher primary (5 to 9)	30.50
Matriculation (10)	26.50
Pre University (10+2) & above	25.00
Total	**100.00**

The distribution of sample farmers in Punjab based on their caste category has been given in Table 3.3. A perusal of the table reveals that 84.50 per cent of the respondents belonged to general caste category followed by 10.50 per cent from other backward classes (OBC) category and five per cent from scheduled castes (SC) category. Thus, most of the respondent farmers belonged to the general castes category.

Table 3.3: Distribution of sample households based on their caste category in Punjab, 2015-16

Particulars	(%)
General	84.50
OBC	10.50
SC	5.00
Total	**100.00**

The occupational distribution of the sample households in Punjab has been shown in Table 3.4. It is quite obvious from the table that 92.50 per cent of respondents were engaged in agriculture and allied activities while three per cent were having salaried work and another three per cent were tiny shopkeepers, getting foreign remittances etc. Also, just one per cent respondents worked as agricultural labourers and a half per cent was self employed in small scale industries. Thus, a large majority of the respondent framers were engaged in agriculture and allied activities.

Table 3.4: Occupational distribution of the sample households in Punjab, 2015-16

Particulars	(%)
Agriculture & allied	92.50
Agricultural labour	1.00
Self employed in small scale industries	0.50
Salaried work	3.00
Other (Tiny shopkeeper, foreign remittance etc.)	3.00
Total	**100.00**

3.2 Details of operational land holdings

The details of average holding size of the sample households have been depicted in Table 3.5. A perusal of the table reveals that net operational area on the sample farms was 3.13 acre on marginal and small, 12.28 acre on medium, 36.70 acre on large and 11.00 acre in total. The leased-in land in total was 3.76 acre as compared to leased-out land which was just 0.02 acre on the sample farms. The entire operational area on the sample farms was irrigated and rental

Table 3.5: Average operational land holdings of the sample households in Punjab, 2015-16

(acre)

Particulars	Marginal & Small	Medium	Large	Overall
Owned land	2.84	8.17	20.17	7.26
Leased-in	0.35	4.10	16.53	3.76
Leased-out	0.06	0.00	0.00	0.02
Operational Area	3.13	12.28	36.70	11.00
% Irrigated	100.00	100.00	100.00	100.00
Rental value of leased-in land (Rs/acre)	37667	37063	37115	37134
Rental value of leased-out land (Rs/acre)	40000	-	-	40000

value of leased-in land was Rs. 37134 per acre in total while it was slightly higher (Rs. 37667) on marginal and small farms as compared medium and large farm categories. The rental value of leased-out land was Rs. 40000 per acre on the sample farms.

3.3 Cropping pattern and sources of irrigation

The sources of irrigation on the sample households in Punjab have been shown in Table 3.6. A perusal of the table reveals that on 79 per cent farms, the source of irrigation was only tube well/ bore well while on the remaining 21 per cent farms both tube well and canal irrigation was available.

Table 3.6: Sources of irrigation on the sample households in Punjab, 2015-16

Particulars	**%**
Bore well/ Tube well only	79.00
Both tube well and canal	21.00
Total	**100.00**

The cropping pattern of the paddy respondents during kharif season in Punjab has been depicted in Table 3.7. It can be seen from the table that 81.99 per cent of the operational holdings on marginal and small farms was under paddy crop while it was 85.37 per cent on medium and 86.19 per cent on large farms. Another major crop grown on the sample farms was basmati occupying 6.18 per cent of the operational holding on large farms followed by 4.66 per cent on medium and 1.76 per cent on marginal and small farms. Considerable area was under kharif fodder i.e. 14.27 per cent of total operational area on marginal and small

Table 3.7: Cropping pattern of respondents during kharif season in Punjab, 2015-16

(Acre)

Crops	**Marginal & Small**	**Medium**	**Large**	**Overall**
Paddy	2.56 (81.99)	10.49 (85.37)	31.64 (86.19)	9.38 (85.25)
Basmati	0.055 (1.76)	0.57 (4.66)	2.27 (6.18)	0.52 (4.76)
Maize	0.004 (0.12)	0.03 (0.28)	0.00 (0.00)	0.02 (0.19)
Sugarcane	0.00 (0.00)	0.04 (0.31)	1.03 (2.91)	0.10 (0.93)
Kharif Fodder	0.45 (14.27)	0.92 (7.50)	1.29 (3.45)	0.79 (7.15)
Vegetables	0.058 (1.86)	0.23 (1.88)	0.07 (0.18)	0.16 (1.45)
Others (poplar)	-	-	0.40 (1.09)	0.03 (0.27)
Total Sown Area (Acres)	3.13 (100.00)	12.28 (100.00)	36.70 (100.00)	11.00 (100.00)

Figures in parentheses are percentages of total sown area

farms, 7.50 per cent on medium and 3.45 per cent on large farms was under kharif fodder. Other important crops grown on the sample farms were; maize, sugarcane and vegetables. Thus, major share in operational area of crops grown during kharif season was under paddy and basmati crops.

3.4 Purchasing pattern and sources of purchasing

The purchase pattern of NCU on the sample farms for the year 2015-16 in Punjab has been depicted in Table 3.8. It can be seen from the table that NCU quantity bought by the selected households was quite high i.e. it was 1216 kg of NCU and 108 kg of NU. The price of NCU

Table 3.8: Purchase pattern of urea per household during 2015-16 in Punjab

Particular	NCU	NU
Quantity bought (Kgs)	1216	108
Price Rs per bag of 50kg	285	271
Distance from farm (Kms)	2.70	2.98
Transport cost (Rs per bag of 50kg)	4.69	4.95
Total cost (Rs per bag of 50kg)	289.69	276.58

was Rs. 285 per 50 kg bag while it was Rs. 271 per bag in case of NU. The distance covered by the households to fetch NCU was less i.e. 2.70 kms. for NCU and 2.98 kms. for NU which showed the availability of NCU at a nearby place than NU. The transportation cost incurred per bag (50 kg.) for NCU was Rs. 4.69 while it was Rs. 4.95 in case of NU. Thus, the total cost per bag of NCU worked out to be Rs. 289.69 while it was Rs. 276.58 per bag in case of NU.

The source of purchase of NCU/ NU in Punjab has been shown in Table 3.9. A perusal of the table reveals that 69.18 per cent of respondents purchased NCU from co-operative societies, 23.90 per cent from both private dealers and co-operative societies while 6.92 per cent

Table 3.9: Sources of purchase of NCU/Normal Urea in Punjab, 2015-16

Particulars	% farmers		
	NCU (N=159)	NU (N=11)	Both (N=30)
Private fertilizer dealers	6.92	9.09	0.00
Co-operative societies	69.18	90.91	53.33
Both private dealers and co-operative societies	23.90	0.00	46.67
Total	100.00	100.00	100.00

purchased exclusively from private fertilizer dealers. On the other hand, in case of NU, 90.91 per cent respondents purchased it from co-operative societies and 9.09 per cent from private fertilizer dealers. There were 53.33 per cent farmers who purchased both NCU & NU fertilizers from co-operative societies and remaining 46.67 per cent from both private dealers and co-operative societies.

Thus, majority of the respondent farmers purchased NCU and NU from co-operative societies followed by private fertilizer dealers.

3.5 Usage inputs and profitability of paddy crop

The input use, output and returns per acre realized by paddy farmers in Punjab have been depicted in Table 3.10. It can be seen from the table that during the year 2015, the hired

Table 3.10: Input use, output and returns realized by Paddy farmers in Punjab

(Rs./ acre)

Particular	2015-16				2014-15			
	Marginal & Small	Medium	Large	Overall	Marginal & Small	Medium	Large	Overall
Input use/ costs								
Ploughing and sowing charges (only machinery)	2415	2317	2177	2340	2286	2191	2080	2215
Seed cost/ purchase of seedlings	284	286	271	284	251	279	241	266
Organic/FYM	131	53	-	76	113	43	-	64
Urea/NCU	726	756	700	741	720	785	724	758
Chemical fertilizers (Other than Urea/NCU)	627	636	753	642	548	594	674	584
Plant protection chemicals	1785	1989	1963	1918	1735	1982	1967	1897
Irrigation charges	353	503	565	457	508	785	778	690
Harvesting & threshing charges	1024	1029	1013	1026	974	979	977	977
Hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting)	2379	2387	2567	2385	2216	2226	2233	2224
Imputed value of family labour	121	54	14	74	132	54	14	78
Hired labour (amount paid)	227	315	389	291	229	292	349	275
Maintenance costs on assets used for the reference crop	102	261	138	198	84	240	162	181
Total paid-out costs including imputed value of own labour	10174	10586	10550	10432	9796	10451	10199	10209
Returns								
Output (Main product) (Qtls)	28.62	28.85	29.87	28.85	27.84	28.53	29.73	28.39
By product	-	-	-	-	-	-	-	-
Gross returns	41496	41839	43307	41833	38976	39942	41627	39740
Net returns	31321	31253	32756	31401	29180	29491	31427	29530

labour charges, which included ploughing charges till planting and transplanting charges of paddy, was found to be Rs. 2385 per acre while it was Rs.2224 during the year 2014.Second major cost component was ploughing and sowing charges (only machinery) which worked out to be Rs. 2340 during the year 2015 and Rs 2215 in 2014. Expenses on plant protection measures being another constituent of total paid out costs, was estimated to be Rs. 1918 per acre during the year 2015 and Rs. 1897 in 2014 while for urea/ NCU the corresponding costs were estimated to be Rs.741 during 2015 and Rs. 758 in the year 2014 and harvesting charges for paddy crop worked out to be Rs. 1026 during 2015 and Rs. 977 in the year 2014, respectively. The output of the paddy crop was estimated to be 28.85 quintals per acre in 2015 while it was 28.39 quintals during the year 2014. Gross returns from paddy crop worked out to be Rs 41833 per acre during the year 2015 while it was Rs. 39740 in 2014. The net returns from paddy were estimated to be Rs. 31401 during the year 2015 and Rs. 29530 in 2014 on the sample farms.

The input use, output and returns per acre realized by paddy farmers in Punjab has been given in Table 3.11 A perusal of the table reveals that the quantity of urea/ NCU used per acre for paddy crop was 135.98 kg. during the year 2014 while its use declined during the year 2015 and was 130.88 kg. per acre on the sample farms. On the other hand, there was

Table 3.11: Input use, output and returns realized by Paddy farmers in Punjab

(Rs./ acre)

Particular	2014-15		2015-16	
	Qty	Value	Qty	Value
Input use and their costs				
Ploughing and sowing charges (only machinery)	-	2215		2340
Seed cost/ purchase of seedlings (Kg)	6.29	266	6.34	284
Organic/FYM	-	64	-	76
Urea & NCU (Kg)	135.98	758	**130.88**	741
Chemical fertilizers (Other than Urea/NCU) (Kg)	20.07	584	22.77	642
Plant protection chemicals	-	1897		1918
Irrigation charges	-	690		457
Harvesting & threshing charges	-	977		1026
Hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting)	-	2224		2385
Imputed value of family labour	-	78		74
Hired labour (amount paid)	-	275		291
Maintenance costs on assets used for paddy crop	-	181		198
Total paid-out costs including imputed value of own labour	-	10209		10432
Returns				
Output (Main product) (Qtls)	28.39	39740	28.85	41833
By product	-	-	-	-
Gross returns	-	39740	-	41833
Net returns	-	29530	-	31401

increase in the quantity of other fertilizers used in paddy crop which was 20.07 kg. in 2014 and 22.77 kg. per acre during the year 2015. There was also slight increase in the output of the paddy crop during the year 2015 as compared to the year 2014 which can not only be attributed to the application of NCU because there are numerous factors influencing the yield of a crop.

3.6 Details of agriculture credit availed

The credit detail of respondent farmers during 2015-16 has been given in Table 3.12 It can be seen from the table that total credit taken by the farmers during the year 2015-16 was Rs. 318565 per household. As far as institutional source of credit was concerned, commercial banks (Rs. 177500 per household) were the major source of credit followed by co-operative societies (Rs. 100755 per household). Traders/ commission agents (Rs. 36435 per household) were the main non-institutional sources of credit for the farmer households followed by friends and relatives (Rs. 3875 per household). Thus, commercial banks and co-operative societies were the major source of credit for the sample households.

Tables 3.12 Credit details of farmers during 2015-16 in Punjab

(Rs. / household)

Sources	**Amount**
Institutional sources:	
Commercial Banks	177500
Co-operative societies	100755
Regional Rural Bank	-
Non-Institutional sources:	
Money lenders	-
Friends & relatives	3875
Traders/commission agent	36435
Total	318565

The purpose of borrowing loans by sample households has been shown in Table 3.13 A perusal of the table reveals that seasonal crop cultivation was the purpose for which all the respondents have taken credit and the amount spent per household was 80.66 per cent of the total amount borrowed. For consumption expenditure, 14 per cent farmers have taken loan and share of consumption loan in total borrowed amount per household worked out to be 1.57 per cent. For purchase of tractor/ implements, 9.50 per cent farmers have taken loan which was 14.40 per cent of total loan amount while in case of purchase of livestock, 3.50 per cent farmers took credit which constituted 3.37 per cent of total loan taken per household. Therefore, seasonal crop cultivation was the major purpose for which majority of the farmers has taken credit followed by consumption expenditure, marriage/ social ceremonies.

Table 3.13: Purpose of borrowing loans by farmers during 2015-16 in Punjab

Purpose	% farmers (Multiple response)	% amount
Production Loan:		
Seasonal crop cultivation	100.00	80.66
Purchase of tractor and other implements	9.50	14.40
Purchase of livestock	3.50	3.37
Non-farm activity	-	-
Consumption expenditure, marriage/ social ceremonies	14.00	1.57

3.7 Training Programmes Attended on Fertilizers Application

Table 3.14 reveals that 70 per cent sample farmers attended training/ lecture(s) regarding application of fertilizers to paddy crop from the Department of Agriculture or State Agricultural University. Although, it was seen that 63 per cent of the farmers attended the training/ lecture(s) organised by the Department of Agriculture in which information regarding

Table 3.14: Trainings/ lecture(s) attended on application of fertilizers for paddy crop by respondents in Punjab, 2015-16

(% of farmers)

Sl. No	Name of the Organizer	Duration of training/ lecture(s) (days)	No.	%
1	State Agriculture Department	1	126	63.00
2	Punjab Agricultural University (FASC/ KVK)*	1	14	7.00

*Farm Advisory Service Centre/ Krishi Vigyan Kendra

judicious use of fertilizers was given by the agricultural scientists. Also, seven per cent farmers attended training/ lecture(s) organised by the Punjab Agricultural University (FASC/ KVK). However, no farmer attended any long duration training on application of fertilizers.

Chapter IV

Status of Awareness and Application of Neem-Coated Urea

4.1 Awareness & sources of information on NCU

The awareness and source of information about NCU among the respondent farmers has been given in Table 4.1. A perusal of the table reveals that all the large farmers were aware about the NCU while 99.15 per cent medium and 98.53 per cent marginal and small farmers were also aware of it. The major source of awareness concerning NCU was co-operative societies as 85.29 per cent marginal and small, 81.20 per cent medium and 55.34 per cent large farmers revealed co-operative society being a source of awareness. Input shop was second major source of information about NCU which was reported by 33.33 per cent large, 9.41 per cent medium and 4.42 per cent marginal and small farmers. Fellow farmers were also another source of awareness about NCU as revealed by 13.33 per cent large, 8.82 marginal and small and 6.84 per cent medium category farmers. Also, print and visual media, agricultural university were also sources of awareness as revealed by some of the medium category farmers. In overall, co-operative societies followed by input shop and fellow farmers were the major sources of awareness about NCU.

Table 4.1: Awareness and sources of information about Neem Coated Urea among the respondents in Punjab, 2015-16

(% of farmers)

Sources of Information	Marginal & Small	Medium	Large	Overall
% of farmers Aware	98.53	99.15	100.00	99.00
Sources of awareness				
Agricultural Officer	-	-	-	-
Farmer Facilitator	-	-	-	-
Fellow Farmers	8.82	6.84	13.33	8.00
Print & Visual media	-	0.85	-	0.50
Wall Writing	-	-	-	-
KVK official	-	-	-	-
Agricultural University		0.85		0.50
Input shop	4.42	9.41	33.33	9.50
Company (suppliers)	-	-	-	-
Any other (Cooperative society)	85.29	81.20	53.34	80.50

4.2 Status of Application of Urea versus NCU

The factors from which farmers differentiate NCU as compared to NU have been shown in Table 4.2. It is clear that all the large farmers followed by 94.87 per cent medium and 92.65 per cent marginal and small farmers noted difference in NCU as compared to NU. The major factor/ sign from which respondent farmers differentiated NCU from NU was leaf figure on

bag which was reported by 64.96 per cent medium, 54.42 per cent marginal and small and 40.0 per cent large farmers. Also, 55.33 per cent large, 29.41 per cent marginal and small and 23.93 per cent medium category farmers revealed that smell of neem in NCU differentiated it from NU and thus can easily be identified. The difference in price of NCU and NU was also one of the factors differentiating both and it was revealed by 8.82 per cent marginal and small, 6.67 per cent large and 5.98 per cent medium category farmers. Thus, in overall leaf figure on the bag and smell of neem in NCU were the major factors differentiating it from NU.

Table 4.2: Factors from which farmers differentiate NCU compared to Normal Urea in Punjab, 2015-16

(% of farmers)

Sources of Information	Marginal & Small	Medium	Large	Overall
% of farmers noticed difference in NCU	92.65	94.87	100.00	94.50
Factors				
Colour difference	0.00	0.00	0.00	0.00
Price difference	8.82	5.98	6.67	7.00
Leaf figure on the bag	54.42	64.96	40.00	59.50
Any other (Smell)	29.41	23.93	53.33	28.00

The application of NCU across different seasons by paddy respondents in Punjab has been shown in Table 4.3. It can be seen from the table that there was a significant increase in the application of NCU during 2015-16. In the year 2014-15 there were 81.50 per cent respondents who applied NCU to their paddy crop while during 2015-16 this number increased to 94.50 per cent on the sample farms. Similarly, in case of wheat crop, only 20 per cent farmers applied NCU during 2014-15 while this

Table 4.3: Application of NCU across different seasons by paddy respondents in Punjab, 2015-16

(% of farmers)

Name of the crops	2014-15		2015-16	
	No	%	No	%
Kharif season:				
Paddy	163	81.50	189	94.50
Basmati	1	0.50	22	11.00
Sugarcane	3	1.50	5	2.50
Maize	0	0.00	4	2.00
Rabi season:				
Wheat	40	20.00	192	96.00
Potato	6	3.00	13	6.50
Sunflower	0	0.00	1	0.50
Vegetables	7	3.50	19	9.50
Agro-forestry:				
Poplar	0	0.00	1	0.50

number swelled to 96 per cent in the year 2015-16. In case of other crops such as; basmati, sugarcane, potato, maize, sunflower and vegetables also the number/ per cent of respondents applying

NCU has also increased as revealed by the respondent farmers. Thus, in aggregate the application of NCU to almost all the crops sown on the sample farms has increased.

Method of application of NCU/ NU has been shown in Table 4.4. It is clear from the table that all the selected respondents applied NCU/NU to the paddy crop by broadcasting and none of the farmers sprayed, drilled and applied urea through fertigation.

Table 4.4: Method of Application of NCU/Normal Urea in paddy in Punjab, 2015-16

(Kgs/Acre)

Method of application	NCU qty	%	NU qty	%
Broadcasting	116.50	100.00	14.25	100.00
Spraying	-	-	-	-
Fertigation	-	-	-	-
Drilling	-	-	-	-
Total	-	-	-	-

The split doses of NCU and NU application has been shown in Table 4.5. It was observed on the sample farms that no basal application of NCU/ NU to paddy crop was applied by the sample farmers and the entire dose of urea was applied in with-in 45 days of the transplantation of the crop. Hence, 33 per cent of NCU and NU was applied to paddy crop after application of weedicide within two days of transplantation of crop and remaining 67 per cent of NCU and NU was applied during the vegetative growth of the crop. In aggregate, 116.50 kg. of NCU and 14.25 kg. of NU per acre was applied to paddy crop on the sample farms.

Table 4.5: Split doses of NCU / Normal Urea application by respondents in Punjab, 2015-16

(Kgs/Acre)

Crop Stages	NCU	%	NU	%
Basal application	-	-	-	-
After weeding	38.45	33.00	4.70	33.00
Vegetative growth	78.05	67.00	9.55	67.00
Maturity	-	-	-	-
Any other	-	-	-	-
Total	116.50	100.00	14.25	100.00

The comparative benefits of NCU over NU can be seen from Table 4.6. It is quite obvious that only 5.29 per cent of the sample farmers reported about the increase in paddy yield up to the extent of 2.40 per cent due to application of NCU while 94.71 per cent sample farmers revealed no change in the paddy yield. The cost of pest and disease control declined by 21 per cen by application of NCU, as revealed by 13.76 per cent respondents, while 86.24 per cent realized no change in cost on pest control. All the respondents reported no change in weed management due to application of NCU. Cost of NCU application was higher as compared to

urea, it was revealed by 89.42 per cent farmers and extent of increase was six per cent. On the contrary, 10.58 per cent farmers reported about the decline in cost of NCU due to application of lower doses of NCU as compared to urea and extent of decline was 14 per cent. All the respondent farmers revealed no decline in the cost of other fertilizers, improvement in the soil health, quality of grain and market acceptability of grains due to the application of NCU.

Table 4.6: Comparative Benefits of NCU over Normal Urea in case of Paddy in Punjab, 2015-16

(% of farmers)

Particulars	Increased	Decreased	No change	Extent of Increase (%)	Extent of Decrease (%)
Yield (quintals)	5.29	0.00	94.71	2.40	-
Cost of pest and disease control (Rs)	0.00	13.76	86.24	-	21.00
Weed management (Rs)	0.00	0.00	100.00	-	-
Cost of NCU compared to normal Urea (Rs)	89.42	10.58	0.00	6.00	14.00
Cost of other fertilizers (Rs)	0.00	0.00	100.00	-	-
Improvement in soil health	0.00	0.00	100.00	-	-
Quality of grain	0.00	0.00	100.00	-	-
Market acceptability of grain	0.00	0.00	100.00	-	-

4.3 Perception of Farmers about NCU and its Benefits compared to Urea

The perception about NCU versus NU has been shown in Table 4.7. A perusal of the table reveals that 79.37 per cent of the farmers reported about NCU quality being good followed by 10.58 per cent revealed no change in the quality of NCU vis-a-vis NU while 8.47 per cent reported NCU quality being bad. Only 1.58 per cent farmers revealed about NCU quality being very good. Regarding NCU availability, 69.84 per cent farmers reported its availability being adequate, 28.57 revealed it as inadequate and 1.59 per cent revealed no change in the NCU availability vis-a-vis NU. Also, 73.02 per cent farmers reported timely availability of NCU while remaining 26.98 per cent revealed availability of NCU not on time. Regarding price of NCU, 97.71 per cent farmers reported it to be high while 5.29 per cent revealed the price to be very high. Concerning benefits of NCU in terms of total fertilizer and urea usage, it was disclosed by 89.42 per cent farmers that there is no change in fertilizer and urea usage while 10.58 per cent revealed the decrease in fertilizer and urea usage due to application of NCU. Regarding pest and disease attack, 86.24 per cent farmers reported no change while 13.76 per cent farmers revealed that there was decline in pest and disease attack due to application of NCU. Another reason of preference of NCU by 46.03 per cent farmers was its non-solidification while 45.50 per cent reported about its evenly distribution while

broadcasting in the field. Also, 67.72 per cent farmers revealed about more easily accessibility of NCU while other 32.28 per cent farmers denied it.

Table 4.7: Perception about NCU versus Normal Urea in Punjab (N= 189)

Particulars	**No.**	**%**
Neem Coated Urea quality		
Very good	3	1.58
Good	150	79.37
Bad	16	8.47
No change	20	10.58
Neem Coated Urea availability		
Adequate	132	69.84
Inadequate	54	28.57
No change	3	1.59
Timely availability of Neem Coated Urea		
Yes	138	73.02
No	51	26.98
Neem Coated Urea Price		
Very high	0	0.00
High	179	94.71
Not very high	10	5.29
Same as urea	0	0.00
Benefits of NCU in terms of total fertilizer usage		
Increased	0	0.00
Decreased	20	10.58
No Change	169	89.42
Benefits of NCU in terms of Urea usage		
Increased	0	0.00
Decreased	20	10.58
No Change	169	89.42
Pest and diseases attack		
Increased	0	0.00
Decreased	26	13.76
No Change	163	86.24
Any others (mention)		
No solid form	87	46.03
Evenly distributed	86	45.50
No comments	16	8.47
NCU is more easily accessible in the market compared to normal Urea		
Yes (reason)	128	67.72
No	61	32.28

Thus, majority of the farmers reported about the quality of NCU being good, adequate, timely available, accessible in the market, its non-solidification and evenly distribution at the time of application found out to be positive points. On the other hand, NCU price being high along with no significant decline in fertilizer usage, urea usage and no change in pest/ disease incidence on the crop were other points to be looked into.

4.4 Diversions of NU & NCU other than crop purposes

All the selected farmers were asked about the usage of NCU for other than crop production purposes (Table 4.8). It was found during the survey that none of the selected farmers reported about the use of NCU for other purposes such as; silage making, mixing with weedicides and for fishery feed preparation.

Table 4.8: Usage of NCU for other than crop production purposes in Punjab, 2015-16

Purpose	% of farmers	% of total amount Used
Silages (Feed preparation of animals)	-	-
Mixed with weedicides	-	-
Fishery feed preparation	-	-
Others	-	-

4.5 Constraints and suggestions about NCU and its adoption

Major problems faced in the adoption of NCU fertilizer have been shown in Table 4.9. A perusal of the table reveals that 1.50 per cent farmers did not report any problem in adoption of NCU fertilizer. However, 94.71 per cent revealed high price of NCU fertilizer being major constraint in its adoption while 27 per cent reported inadequate/ shortage of supply during

Table 4.9: Major problems faced in adoption of NCU fertilizer in Punjab, 2015-16

(Multiple response)

Problems	(% of farmers)
No problem	1.50
High prices	94.71
Inadequate/shortage of supply during peak season	27.00
Poor quality*	8.50
Not aware about the uses and its benefits	5.50
Problems in application (very pungent smell during application)	5.00

*Powdery form (Manufacturing fault in a lot)

peak season as another problem. Poor quality of NCU available in co-operative societies was another problem revealed by 8.50 per cent farmers while 5.50 per cent farmers were not aware about the uses and benefits of NCU. Another problem about NCU fertilizer application, reported by five per cent farmers, was extremely pungent smell emanating during its broadcasting in the field.

Major suggestions for improving the NCU fertilizer usage have been given in Table 4.10. It can be seen that 27 per cent farmers suggested assured/ timely and adequate supply of quality NCU during peak season to co-operative societies for improving the NCU fertilizer usage. Also, 7.50 per cent farmers suggested about organising training camps for spreading awareness regarding NCU uses/ benefits among the farming community. Other suggestions

Table 4.10: Major suggestions for improving the NCU fertilizers usage in Punjab, 2015-16

(Multiple response)

Suggestions	**(% of farmers)**
Assured/ timely and adequate supply of quality NCU during peak season	27.00
Training camps regarding awareness of NCU uses and benefits should be organized	7.50
Quality of NCU should be improved	9.50
Decreasing the price of NCU	74.50
No response	1.50

were regarding improving the quality of NCU (9.50%) and decreasing the price of NCU (74.50%) for increasing its usage. However, there was no response by 1.50 per cent farmers when asked for giving suggestions for improving the NCU fertilizer usage.

Chapter V

Awareness and Adoption Level of Soil Testing Technology

5.1 Soil health related programmes and schemes - Implementation and performance in the state

The sources of soil sample collection and the details of soil health card among respondents have been shown in Table 5.1. It can be seen from the table that all the respondent farmers, who got their soils tested, were aware of correct method of soil sampling. The training source of soil sample collection, as revealed by 42.22 per cent farmers, was Agricultural Officer while 42.22 per cent farmers reported fellow farmers followed by farmer facilitator (8.89%) and getting training while attending PAU Kisan Mela (6.67%) as training source of soil

Table 5.1: Sources of soil sample collection and the details of soil health cards among respondents in Punjab (% of farmers who got tested their soil)

(n=45)

Particulars	**No.**	**%**
Sample size	200	-
No. of soil tested farmers	45	-
Before 2013-14	12	26.67
2013-14	6	13.33
2014-15	11	24.44
2015-16	16	35.56
% of farmers aware of correct method of soil sampling	45	100.00
Training sources of soil sample collection		
i. Agricultural Officer	19	42.22
ii Farmer Facilitator	4	8.89
iii.Fellow Farmers	19	42.22
iv. Others (PAU Kisan Mela)	3	6.67
Information on soil health card		
i. Number of farmers received soil health card	5	11.11
ii. Number of farmers possessing soil health card till now	5	11.11
iii. Number of farmers possessing SHC understand the information given in the soil health card	4	8.89
iv. Number of persons did not understand the information given in the soil health card for the reasons	1	2.22
a) Cannot read	0	0.00
b) Can read, but not able to understand the information given	1	2.22
% of farmers who were **verbally** explained about soil health card details	40	88.89
Sources of education on soil health card (n=5)		
i. Agriculture Officer	4	8.89
1i. KVK/PAU	-	-

sample collection. The information regarding soil health card revealed that only five farmers i.e.11.11 per cent, out of 45 farmers who got their soils tested, received soil health cards. Further, it was found that all the farmers possess soil health card when asked to produce by the field survey team. Also, only four farmers (8.89%) were able to understand the information given in the soil health card while one farmer (2.22%) was unable to understand the information provided in the card. Out of total number of farmers, who got their soils tested, 88.89 per cent were verbally explained about the soil health card details by the concerned department officials. Also, major source of education on soil health card was Agriculture Officer as revealed by 8.89 per cent farmers who received soil health card out of total number of farmers who got their soils tested.

5.2 Awareness on soil testing

The awareness of the sample farmers on soil testing from different sources has been given in Table 5.2. It is quite clear from the table that 75.56 per cent of the sample farmers, who tested their soils, got information about soil testing from Agriculture Department followed by 17.78 per cent from Punjab Agricultural University (PAU) and 6.66 per cent from private companies. The soil samples were collected themselves by 91.11 per cent farmers while 4.45 per cent farmers reported that soil samples were collected by the agricultural officials and 4.44 per cent revealed farm facilitator as the source who collected the soil sample.

Table 5.2: Sources of information about soil testing and soil sample collection on sample farms in Punjab

(n=45= 100%)
(% of farmers who got tested their soil)

Sources for soil testing	%
Punjab Agricultural University (PAU)	17.78
Private Companies	6.66
Agriculture Department	75.56
Who collected the soil	
Self	91.11
Agricultural Officials	4.45
Farmer Facilitator	4.44

5.3 Details of soil testing

The details of soil testing by the respondent farmers have been shown in Table 5.3. It was observed that during the period 2013-14 to 2015-16, about 73 per cent of the farmers got their soils tested while before 2013-14 nearly 17 per cent farmers tested their soils. All the respondents got soils tested only once in these years. Cost of soil testing under subsidy

scheme by the Dept. of Agriculture was only Rs 1.00 per sample while from Punjab Agricultural University it was Rs. 20 per soil sample. The cost of each sample tested within three years was Rs. 2.73 per sample while it was Rs. 3.33 for the samples taken before three years. The average distance of field to soil testing lab was 9.88 Kms for the samples collected during 2013-14 to 2015-16 while it was 9.54 Kms. for the samples taken before this period. The average soil samples taken were 6.27 with area covered being 6.48 acres for the samples taken from 2013-14 to 2015-16 while it was 2.83 and 7.88 acres for the samples taken before these years. Thus, during the last three years, more number of farmers got the soils of their fields tested with higher number of soil samples taken as compared to before three years.

Table 5.3: Details of soil testing by the respondents during study period (2013-14 to 2015-16) and before in Punjab

(n=45)
(% of farmers who got tested their soil)

Particulars	During 2013-14 to 2015-16	Before 2013-14
% of farmers done soil testing	73.33	26.67
Number of times soil testing done	once	once
Cost of soil testing (Rs/sample)*	2.73	3.33
Distance from field to soil testing lab (Kms)**	9.88	9.54
Samples taken for soil testing (Average Nos)	6.27	2.83
Area covered under soil test (all plots) (Average Acres)	6.48	7.88

***Range of cost of soil testing (Nil to Rs. 20 per sample), **Range of distance of soil testing lab (From 1Km to 40 Km)**

The sources from which the farmers got their soils tested have been depicted in Table 5.4. It was observed that 60 per cent of the farmers got soil testing done from the State Department of Agriculture while 11.11 per cent from the Punjab Agricultural University and 28.89 per cent through IFFCO either from the Punjab Agricultural University or Department of Agriculture.

Table 5.4: Places of soil testing of the sample farmers in Punjab

(n=45)
(% of farmers who got tested their soil)

Particulars	% farmers
Punjab Agricultural University (PAU)	11.11
Agriculture department/ District laboratories	60.00
Others (Soil testing through IFFCO)	28.89

5.4 Reasons for soil testing or not testing

The reasons of soil testing by the respondents have been shown in Table 5.5. A perusal of the table reveals that most important reason of soil testing as revealed by 31.11 per cent farmers

was ôto understand fertilizer requirement for the cropô followed by ômotivation from village demonstration/training/exposure visits to places with best farming practicesô by 20 per cent and ôfor availing benefit under subsidy schemesô by 17.78 per cent farmers. ôPoor crop yieldô was reported by 95.56 per cent farmers as least important reason of soil testing followed by ôFor availing benefit under subsidy schemesô by 77.78 per cent ôPeer farmers' group pressureô by 73.33 per cent farmers. Also, 77.50 per cent of the total sampled farmers were not aware of anything about soil testing and its use.

Table 5.5: Reasons for Soil testing by the respondents in Punjab, 2015-16

(n= 45)

(% of farmers who got tested their soil)

Reasons	**Most imp**	**important**	**least imp**
Not aware of anything about Soil testing and its use = 155 (77.50%)			
For availing benefit under subsidy schemes	17.78	4.44	77.78
Poor crop yield	2.22	2.22	95.56
Motivation from village demonstration/training/exposure visits to places with best farming practices	20.00	40.00	40.00
Peer farmers' group pressure	6.67	20.00	73.33
To understand fertilizer requirement for the crop	31.11	33.33	35.56

The reasons for not testing soil by the respondents have been given in Table 5.6. It was seen that 72.26 per cent of the respondents did not undertake soil testing as they thought that ôsoil testing not required for my field as crop yield is goodô while 7.74 per cent revealed ôsoil testing laboratories are located far awayô as the reason and 7.10 per cent reported ôdo not

Table 5.6: Reasons for not testing soil by the respondents in Punjab, 2015-16

(n= 155)

(% of farmers who did not got tested their soil)

Reasons	Most imp	Important	Least imp
Farmers who not tested their soil =155 (77.50%)			
Do not know whom to contact for details on testing	7.10	34.84	58.06
Do not know how to take soil samples	0.00	9.03	90.97
Soil testing laboratories are located far away	7.74	14.19	78.07
Soil testing not required for my field as crop yield is good	72.26	10.32	17.42

know whom to contact for details on testingô as the reason for not testing soil. So, majority of the farmers did not get the soils of their fields tested as they thought it not being necessary since they were getting good yield for their crops.

5.5 Adoption of recommended doses of fertilizer application based on soil test report

The explanation about recommended doses of fertilizers (RDF) for paddy crop (Table 5.7) was given by the Department of Agriculture to 60 per cent farmers, who got tested their soils, followed by 11.35 per cent from the Punjab Agricultural University/ KVK. Also, 27.65 per cent farmers came to know about RDF from co-operative societies through training programmes / camps organised by IFFCO.

Table 5.7: Elucidation of Recommended Doses of Fertilizers on paddy crop in Punjab, 2015-16

(n=45)

(% cent of farmers who got tested their soil)

Who explained to you	% farmers
Department of Agriculture	60.00
Punjab Agricultural University/KVK	11.35
Others (From co-operative societies through IFFCO)	27.65

Note : RDF(Recommended Doses of fertilizer)

The recommended doses of fertilizers adopted by the respondents have been given in Table 5.8. It was seen that 91.11 per cent of the farmers, who got their soils tested, were not aware about the recommended dose of fertilizers (RDF) for paddy crop but revealed about it on the basis of their own perception while just 8.89 per cent of the farmers were actually aware about RDF on the basis of soil test report. FYM application on the basis of farmer perception as well as per soil test report was 0.40 tonnes per acre. According to farmers perception 123.17 kg per acre of urea was applied to paddy crop while on the basis of soil test report it was 110 kg. per acre which shows 13.17 per cent higher use of urea as per farmers perception. Similarly, 11.22 kg. of di-ammonium phosphate (DAP), 0.95 kg. of Muriate of Potash (MOP) per acre was applied to paddy crop as per farmers perception while as per soil test report there was no recommendation of DAP and 11.75 kg. MOP was recommended dose for paddy crop. As per farmerôs perception, 6.00 kg zinc sulphate and no ferrous sulphate was applied to the paddy crop but as per soil test report, 8.75 kg. zinc sulphate and no ferrous sulphate was recommended dose. So, as per farmers perception higher dose of urea, DAP and lower dose of MOP and ZnSO4 was applied to paddy crop as compared to soil test report based recommendations.

Table 5.8: Farmers perception on fertilizers use and recommended doses based on soil test to paddy crop in Punjab, 2015-16

(% of farmers who got their soils tested) (n=45)

Particulars	Farmers perception (n=41)	As per Soil Test Report (n=4)	% deviation
% of farmers aware of RDF*	91.11	8.89	-
FYM (ton/ac)	0.12	0.40	0.28
Urea(kg/ac)	123.17	110.00	-13.17
DAP(Kg/ac)	11.22	0.00	-
MOP (Kg/ac)	0.95	11.75	10.80
MgSO4 (Kg/ac)	-	-	-
ZnSO4 (kg/ac)	6.00	8.75	2.75
FeSo4 (kg/ac)	-	-	-
Others(kg/ac)	0.37	1.13	0.76

*Recommended dose of fertilizer

The major problems faced in soil testing by the farmers (Table 5.9) was proper report not delivered as reported by 80 per cent farmers while 55.50 per cent revealed problem of poor extension services and 7.50 per cent complained about the soil test lab being far away. Also, five per cent farmers reported no problem in soil testing.

Table 5.9: Major problems faced in soil testing by farmers in Punjab, 2015-16

(% of farmers)

(Multiple response)

Problems	%
Poor extension services	55.50
Soil test lab is far away	7.50
Proper report not delivered	80.00
Not aware	0.00
No problem	5.00

Major suggestion as revealed by 86 per cent farmers was that soil health cards should be delivered to the farmers followed by 54.50 per cent farmers emphasising on improving the extension contacts while 45 per cent asked for organising awareness camps regarding soil test and 7.50 suggested that soil test labs should be near the village.

Table 5.10: Major suggestions for improving the soil health card scheme in Punjab, 2015-16

(% of farmers)

(Multiple response)

Suggestions	%
Awareness camp regarding soil test should be organized	45.00
Extension contacts should be improved	54.50
Soil health report card should be delivered	86.00
Soil test lab should be near the village	7.50

Thus, major suggestions by the farmers was to the agricultural department officials and allied departments to have better extension activities in order to improve their contact with farmers and also gave emphasis on delivering soil health card for proper implementation of soil health card scheme.

Chapter VI

Impact of NCU Application on Crop Production and Soil Health

6.1 Background

It is necessary to see the impact of NCU application on crop production and soil health. Although NCU was being produced since long but its use was meagre. Now it has almost replaced the NU just because of its better application and advocacy of positive impact on soil health by agricultural scientists, although it was also necessary to check urea misuse in many industries. Although there are so many factors which are responsible for improving the soil health but due to intensive cropping, especially in the green revolution belt of the country, NCU can be one of the important ingredients for increasing the production of crops, sustaining the soil health and controlling the incidence of pests/ diseases if any.

6.2 Impact on crop productivity

Productivity of paddy (Table 6.1) due to application of NCU was 2845 kg. per acre in 2014-15 while it increased to 2900 kg. per acre in the year 2015-16. Also, there was increase in productivity from 2786 kg. per acre in 2014-15 to 2872 kg. per acre in the year 2015-16 due to the application of NU. Hence, there was increase in productivity of paddy crop during 2015-16 where NCU as well as NU was applied on the sample farms. Although, yield was more on the farms where NCU was applied as compared to NU during these years.

6.3 Fertilizer use efficiency

The comparative use of NCU versus normal urea (NU) in paddy crop has been shown in Table 6.1. A perusal of the table reveals that NCU quantity applied per acre was 95.50 kg. per acre during the year 2014-15 while it increased to 116.50 kg. per acre in 2015-16. There was increase in NCU usage by 21.99 per cent in 2015-16 as compared to 2014-15 in case of paddy crop. Similarly, the NU quantity applied declined from 40.48 kg. per acre in 2014-15

Table 6.1: Comparative use of NCU versus Normal Urea in paddy crop in Punjab, 2015-16

(Kgs/acre)

Particulars	Year		
	2014-15	2015-16	% deviation
NCU quantity applied	95.50	116.50	21.99
NU quantity applied	40.48	14.38	-64.48
Total	135.98	130.88	-3.75
Productivity of NCU	2845	2900	1.93
Productivity of NU	2786	2872	3.09
Output per unit of NCU	29.79	24.89	-

to 14.38 kg per acre in 2015-16 and this decrease was to the extent of 64.48 per cent. In aggregate there was decline in total urea (NCU+NU) by 3.75 per cent. Thus, there was considerable increase in the application of NCU and decline in NU usage in paddy crop. Fertilizer use efficiency or output per unit of NCU was 29.79 kg in 2014-15 and 24.89 in 2015-16. Decline in NCU fertilizer use efficiency was due to higher NCU usage despite increase in paddy productivity by 1.93 per cent.

6.4 Impact of NCU application on production and marketing of paddy

The impact of NCU on production and marketing of paddy has been given in Table 6.2. The impact in terms of increased main product yield was observed on the farms where exclusively NCU was applied to paddy crop. Paddy yield obtained was 29 quintals per acre for the farmers exclusively using NCU while it was 28.72 quintals per acre for NU and 28.53 quintals for the farmers who applied both NCU and NU to their paddy crop. Thus, paddy yield was just 0.97 per cent higher on the farms exclusively using NCU as compared to NU but this difference was statistically non-significant. On the marketing front, there was no difference in the price received for the produce obtained while using NCU, NU or both since same minimum support price (MSP) of Rs. 1450 per quintal was received by the farmers. So, there was impact of NCU usage in terms of increased productivity of paddy and thereby increase in production also.

Table 6.2: Impact of Neem Coated Urea (NCU) on production and marketing of Paddy in Punjab, 2015-16

Qty (quintals)

Particular	NCU (n=159)	Normal Urea (n=11)	**% deviation**	Mean difference	t-statistic	Both (NCU and Normal Urea) (N=30)
Main product yield	29.00	28.72	**0.97**	0.28	0.246^{NS}	28.53
By product Yield	-	-	**-**			-
Price of main product	1450	1450	**-**			1450
Price of by product	**-**	**-**	**-**			**-**

NS: Non-significant

6.5 Impact on Cost of cultivation of paddy crop

The impact of NCU on input cost of paddy can be observed in Table 6.3. A perusal of the table reveals that the cost of pest and disease control in paddy was Rs. 1518 per acre on the farms where NCU was exclusively used while it was Rs. 1755 per acre for NU and Rs. 1412

for the farms where both NCU and NU were used. Similarly, cost of weed management was Rs. 411 for exclusively NCU using farms, Rs. 435 for NU using and Rs. 403 for using both

Table 6.3: Impact of Neem Coated Urea (NCU) on input cost of Paddy in Punjab, 2015-16

(Rs./ acre)

Particular	NCU (N=159)	Normal Urea (N=11)	% deviation	Mean difference	t-statistic	Both (NCU and Normal Urea) (N=30)
Cost of pest and disease control	1518	1755	-13.50	237	2.350*	1412
Cost of weed management	411	435	-5.52	24	1.543 NS	403
Cost of urea	742	652	13.80	90	2.059*	514
Cost of other fertilizers	678	653	3.83	25	0.128 NS	464

*Significant at five percent level of probability; NS: Non-significant

NCU and NU. Cost of NCU for the farms using it exclusively was Rs. 742 per acre which was higher than Rs. 652 for the farms using only NU while it was Rs. 514for the farms using both NCU and NU for their paddy crop. The cost of other fertilizers used was Rs. 678 on farms using NCU and Rs. 653 on farms using NU and Rs. 464 for the farms using both NCU and NU. Thus, there was decline in the cost of pest and disease control by 13.50 per cent and weed management by 5.52 per cent where NCU was exclusively applied to paddy crop as compared to NU but cost was least on the farms where NCU along with NU was applied. But only decrease in cost of pest and disease control and increase in cost of urea were found to be statistically significant. Although cost of NCU was more than NU but its impact was reflected in terms of lower cost of pest, disease control and weed management practices.

6.6 Economic feasibility of NCU using partial budgeting

The economic feasibility of NCU in paddy using partial budgeting framework has been given in Table 3.11(a). It can be seen from the table that there were numerous costs which were comparatively higher on the farms where exclusively NCU as compared to NU was applied by the farmers. These added costs were estimated at Rs. 326 per acre while there was also cost reduction on the farms where NCU was applied as compared to NU. The cost reduction was to the tune of Rs. 711 per acre. Thus, there was net cost reduction of Rs.385 per acre. On the other hand there were also higher gross returns on the farms using NCU as compared to NU. Added returns due to NCU amounted to Rs. 333. Therefore, there were added returns of Rs. 718 per acre by application of NCU on the sample farms and B:C ratio worked out to be 3.20.

Table 6.4: Economic feasibility of NCU in Paddy, using partial budgeting framework

(Rs/ acre)

A			B		
SlNo	**Added cost due to NCU**	**Costs (Rs.)**	**SlNo**	**Reduced cost due to NCU**	**Costs (Rs.)**
1	Ploughing Charges till planting	67	1	Cost of sowing/transplantation	86
2	Seed cost/ purchase of seedlings	18	2	Organic/Bio fertilizer/Manure/ City Compost/ Neem Cake	245
3	Neem Coated Urea	90	3	Irrigation Cost	87
4	Cost of other fetrilizers	25	4	Pesticides/Insecticides	236
5	Harvesting	18	5	Weedicide	24
6	Maintenance cost of tractor, thresher, pump set	106	6	Labour cost Owned	33
7	Labour cost Hired	2		-	-
	Added cost	326		Reduced cost	711
	Net cost reduction = 711- 326 = **Rs.385**				
SlNo	**Reduced return Due to NCU**	**Costs (Rs.)**	**SlNo**	**Added returns due to NCU**	**Returns (Rs.)**
1	-	-	1	Gross returns	333
2	-	-	2	-	-
	Total (A)	**326**		**Total (B)**	**1044**
	B-A				**718**

Additional return from NCU is About Rs.**333** per acre

An added return per acre is Rs. **718**

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

6.7 Impact on soil heath and crop growth

All the selected respondents were unanimous in giving their mind on the qualitative benefits of NCU on paddy growth in Punjab. It was revealed by all the respondents (Table 6.5) that there was neither improvement in the quality of paddy grain nor market acceptability due to better colour. Also, there was no change (Table 6.6) in the texture of the soil, soil moisture retention capacity, water infiltration rate, soil softness and decline in the compaction of the

Table 6.5: Qualitative benefits of NCU on paddy growth in Punjab, 2015-16

Particulars	% of farmers		
	Increased	Decreased	No change
Quality of grain	**-**	**-**	**100.00**
Market acceptability of grain colour	**-**	**-**	**100.00**

soil due to application of NCU as revealed by all the respondents. However, 13.76 per cent farmers reported longer retention of nitrate in the soil and its slow release to the paddy crop.

Table 6.6: Qualitative benefits in terms of soil health improvement in Punjab, 2015-16

(% of farmers)

Particulars	% farmers
Texture improved	-
Soil moisture retention increased	-
Improvement in water Infiltration	-
Improvement in soil softness	-
Compaction decreased	-
Others (Longer nitrate retention in soil)	**13.76**

Chapter VII Summary, Conclusions and Policy Suggestions

7.1 Background

Nitrogenous (N) fertilizer consumption especially NCU has increased considerably since it has become mandatory for all the indigenous producers of urea to produce their whole production of subsidized urea as NCU from 2015. Although agricultural scientists/ extension workers often advocate the better results shown by NCU as compared to NU yet it is necessary to verify this fact from the farmerôs perspective. It is a well known fact that farmers are better judge while proving the new farm technology developed from time to time. Importance of new farm inputs in agricultural development is vital in the present scenario of Indian agriculture in general and Punjab in particular.

7.2 Summary of findings

Punjab state is well known for adoption of new farm technology but with the passage of time, the rice-wheat cropping system resulted in appearance of macro and micro-nutrient deficiencies. The excessive use of chemical fertilizers is another problem which needs urgent attention of the various stakeholders in agricultural development, in spite of the fact that the chemical fertilizers are the important source of nutrients for plant growth. The total consumption of N, P, K fertilizers in the Punjab state increased from 2.13 lakh tonnes in 1970-71 to 17.14 lakh tonnes in 2013-14 (Anonymous, 2014). The per hectare consumption of these fertilizers in the state have increased merely from 43.12 Kg. N, 7.75 Kg. P and 1.73 Kg. K in 1970-71 to 329.15 Kg. N, 78.31 Kg. P and 5.54 Kg. K during the year 2013-14 . So, the increased consumption of chemical fertilizers especially nitrogenous (N) one had to be looked into to bring the N:P:K ratio to the recommendation level as per the requirement of various type of soils.

India is the second largest consumer of fertilizer in the world next to China, while it is the third largest producer of nitrogenous fertilizer in the world behind China and USA. In terms of Nutrient-wise also, it stands second in the consumption of N and P with the quantity of 16.75 million tonnes and 5.63 million tonnes, respectively. Total consumption of NPK fertilizers in the country in 2013 was 24.48 million tonnes (IFA, 2015). Urea is the most common nitrogen fertilizer used uniformly throughout the world. The wide acceptance of Urea is because of its agronomic acceptability and relatively lower cost as compared to other fertilizers. Besides being widely used as an excellent fertilizer for plant growth, it can also be

used among numbers of products such as animal feed, commercial products, glue, resin, cosmetics, pharmaceuticals, dish soaps, hair conditioners, tooth whiteners .

With the increased cost of urea fertilizer and concern about its adverse environmental impact of Nitrogen losses, there has been a great interest in improving the Nitrogen Use Efficiency (NUE) through optimization of nitrogen use. By doing so, higher yields can be achieved with less negative impacts (for eg. Nitrogen leaching) (Agostini *et al*., 2010; Burns, 2006; Neeteson *et al*, 1999; Rahn, 2002).

Keeping in view the low NUE, it has been felt to find out the use of some indigenous material and coating process for reducing the nitrogen losses from urea. In this endeavor, National Fertilizer Limited (NFL) standardized the techniques for production of NCU in the year 2002. Since then many changes have been made in the process and applicant solution, to have uniform and consistent coating of Neem oil on urea prills, to maintain the concentration of Neem oil content as per the specification prescribed in Fertilizer Control Order (FCO), 1985. The use of NCU has been found to improve the uptake of N, P and K significantly. Based upon the results of extensive field trials, NCU was found to be agronomically superior to normal prilled urea. Neem acts as a nitrification inhibitor and its coating over urea minimizes loss due to leaching. Coating urea with neem prevents its misuse as well as puts the fertiliser in slow release mode thereby nourishing the saplings for a longer period. Thus avoids the repeated use of fertilizer and economize the quantity of urea required by crops (enhancing Nitrogen-Use Efficiency (NUE)). Besides, coating of neem oil also reduces the leaching of nitrates into the groundwater aquifers and thus, help in reducing its pollution.

The objectives of the study were as follows:

1. To analyze the trends in usage and prices of Urea versus NCU in Punjab.
2. To analyze the adoption behavior of NCU among selected farmers in irrigated tracts of Punjab.
3. To analyze the impact of adoption of NCU on crop productivity and farmers' income.
4. To document the status and implementation of soil health card scheme.
5. To suggest suitable policy measures for adoption of NCU.

Keeping the importance of NCU in view, the present study was undertaken during kharif, 2015 for paddy crop in two districts namely Ludhiana and Patiala where there was maximum use of urea. A random sample of 50 respondents from two cluster of 2-3 villages, from each selected block, using NCU, NU and both were selected from four blocks of the selected districts, representing all the farm categories, thus making a sample of 200 respondents.

7.2.1 Trends in urea consumption and prices

The district wise trends in consumption/ sale of urea in Punjab showed that during the year 2007-08 the consumption of urea was 2646.44 th. MT which rose to 3086.05 th. MT during the period 2007-08 to 2015-16 at an annual growth rate of 1.64 per cent. As far as district-wise analysis is concerned, the annual growth in urea consumption during the period 2007-08 to 2015-16 was 5.78 per cent in S.A.S., Nagar followed by 3.60 per cent in Rupnagar, 3.34 per cent in Barnala, 2.43 per cent in Moga, 2.62 per cent in Kapurthala, 2.11 per cent in Tarntaran, 2.07 per cent in Jalandhar, 2.02 per cent in Amritsar and 1.71 per cent in Firozpur and it was also statistically significant. The largest share of NCU in Punjab was distributed in district Firozpur (10.72%) in the year 2015-16 followed by other major consuming districts i.e. Sangrur (9.76%), Ludhiana (7.92%), Patiala (7.49%), Bathinda (6.57%), Moga (5.88%), Amritsar (5.83%), Gurdaspur (5.52%) and Jalandhar (5.13%).

The urea prices increased significantly at the highest growth of 5.21 per cent per annum during the decade 1990-91 to 1999-2000 while during the period 1980-81 to 2015-16 the annual growth in urea prices was 3.33 per cent which was also statistically significant.

7.2.2 Socio-economic characteristics of sample households

Socio-economic characters of the respondents play an important role in adopting the new farm technology. It was found that mostly respondent farmers were middle aged having adequate farming experience to face new farm challenges. The education level of the respondent farmers is also an indicator of the pioneers in adopting new agricultural practices. It was observed that 14.50 per cent of the respondent farmers were illiterate while 30.50 per cent were educated up to higher primary level, 26.50 per cent up to matric and 25 per cent up to pre-university and above level. Mostly respondent farmers belonged to the general caste category. Occupational pattern of the respondents revealed that 92.50 per cent were engaged in agriculture and allied activities while three per cent were undertaking salaried work and another three per cent were tiny shopkeepers, getting foreign remittances etc. Also, just one per cent respondents worked as agricultural labourers and a half per cent was self employed

in small scale industries. Thus, majority of the respondents were engaged in agriculture and allied activities.

7.2.3 Size of holding and cropping pattern

As far as holding size of the respondents is concerned, net operational area on the sample farms was 3.13 acres on marginal and small, 12.28 acres on medium, 36.70 acres on large and 11.00 acres in total. The entire operational area on the sample farms was irrigated and rental value of leased-in land was Rs. 37134 per acre in total. The source of irrigation on the sample farms was tube well while some area was also irrigated by canals. The cropping pattern of the respondents showed that about 82 per cent of the operational holdings on marginal and small farms were under paddy crop while it was 85.37 per cent on medium and 86.19 per cent on large farms. Another major crop grown on the sample farms was basmati while considerable area was under kharif fodder. Other important crops grown on the sample farms were; maize, sugarcane and vegetables.

7.2.4 Purchasing pattern and sources of purchasing of NCU and NU

It was observed that 69.18 per cent of the selected respondents purchased NCU from co-operative societies, 23.90 per cent from both private dealers and co-operative societies while 6.92 per cent purchased exclusively from private fertilizer dealers only. On the other hand, in case of normal urea (NU), 90.91 per cent purchased from co-operative societies and 9.09 per cent from private fertilizer dealers. Thus, majority of the respondent farmers purchased NCU and NU from co-operative societies followed by private fertilizer dealers. The price of NCU was Rs. 285 per 50 kg bag while it was Rs. 271 per bag in case of NU. Total cost per bag including transportation cost worked out to be Rs. 289.69 for NCU while it was Rs. 276.58 per bag in case of NU.

7.2.5 Usage inputs and profitability of paddy crop

During the year 2015, the hired labour charges, which included ploughing charges till planting and transplanting charges of paddy, was found to be Rs. 2385 per acre while it was Rs.2224 during the year 2014. Second major cost component was ploughing and sowing charges (only machinery) which worked out to be Rs. 2340 during the year 2015 and Rs 2215 in 2014. Expenses on plant protection measures, being another constituent of total paid out costs, was estimated to be Rs. 1918 per acre during the year 2015 and Rs. 1897 in 2014 while for urea/ NCU the corresponding costs were estimated to be Rs.741 during 2015 and Rs. 758 in the year 2014. The harvesting charges for paddy crop worked out to be Rs. 1026 during 2015 and Rs. 977 in the year 2014. The output of the paddy crop was estimated to be 28.85

quintals per acre in 2015 while it was 28.39 quintals during the year 2014. Gross returns from paddy worked out to be Rs 41833 per acre during the year 2015 while it was Rs. 39740 in 2014. Also, the corresponding figures for net returns were estimated to be Rs. 31401 during the year 2015 and Rs. 29530 in 2014 on the sample farms.

The input use, output and returns per acre realized by paddy farmers in Punjab revealed that the quantity of urea/ NCU used per acre for paddy crop was 135.98 kg. during the year 2014 while its use declined during the year 2015 and was 130.88 kg. per acre on the sample farms. On the other hand, there was increase in the quantity of other fertilizers used in paddy crop which was 20.07 kg. in 2014 and 22.77 kg. per acre during the year 2015. There was also slight increase in the output of the paddy crop during the year 2015 as compared to the year 2014 which can not only be attributed to the application of NCU because there are numerous reasons/ factors influencing the yield of a crop.

7.2.6 Details of agriculture credit availed

Total credit taken by the farmers during the year 2015-16 was Rs. 318565 per household. As far as institutional source of credit was concerned, commercial banks (Rs. 177500 per household) were the major source of credit followed by co-operative societies (Rs. 100755 per household). Traders/ commission agents (Rs. 36435 per household) were the main non-institutional sources of credit for the respondents followed by friends and relatives. Seasonal crop cultivation was the purpose for which all the respondents have taken credit and the amount spent per household was 80.66 per cent of the total amount borrowed. For purchasing tractor/ implements, 9.50 per cent farmers have taken loan which constituted 14.40 per cent of the total loan taken per household. For consumption expenditure, 14 per cent farmers have taken loan and share of consumption loan in total borrowed amount per household worked out to be just 1.57 per cent.

7.2.7 Awareness & Sources of Information on NCU

It was found that all the large farmers were aware about the neem coated urea while 99.15 per cent medium and 98.53 per cent marginal and small farmers were also aware of it. The major source of awareness concerning NCU was co-operative societies while input shop was second major source of information about NCU. Besides, fellow farmers, print and visual media, agricultural university were other sources of awareness.

7.2.8 Status of application of urea versus NCU

The major factor/ sign from which respondent farmers differentiated NCU from NU was leaf figure on bag while farmers also revealed that smell of neem in NCU differentiated it from NU and thus can easily be identified. The difference in price of NCU and NU was also one of the factors differentiating both. As far as consumption of NCU is concerned, there was a significant increase in the application of NCU after 2015-16. Before 2015-16 there were 81.50 per cent respondents who applied NCU to their paddy crop while after 2015-16 this number increased to 94.50 per cent on the sample farms. In case of other crops such as; wheat, basmati, sugarcane, potato, maize, sunflower and vegetables, NCU consumption increased.

The split doses of NCU and NU application showed that no basal application of NCU/ NU to paddy crop was applied by the sample farmers and the entire dose of urea was applied in with-in 45 days of the transplantation of the crop. Hence, 33 per cent of NCU and NU was applied to paddy crop after application of weedicide within two days of transplantation of crop and remaining 67 per cent of NCU and NU was applied during the vegetative growth of the crop. In aggregate, 116.50 kg. of NCU and 14.25 kg. of NU per acre was applied to paddy crop on the sample farms. Due to the application of NCU, only 5.29 per cent farmers reported about the increase in paddy yield up to the extent of 2.40 per cent while 94.71 per cent revealed no change in the paddy yield. The cost of pest and disease control declined by 21 per cent by application of NCU but there was no change in weed management and cost of NCU application was higher as compared to urea. All the respondent farmers revealed no decline in the cost of other fertilizers, improvement in the soil health, quality of grain and market acceptability of grains due to the application of NCU.

7.2.9 Perception of farmers about NCU and its benefits compared to urea

It was seen that majority of the farmers reported about the quality of NCU being good, adequate, timely available, accessible in the market, its non-solidification and evenly distribution at the time of application found out to be positive points. On the other hand, NCU price being high along with no significant decline in fertilizer usage, urea usage and no change in pest/ disease incidence on the crop were other points to be looked into.

7.2.10 Diversions of urea & NCU other than crop purposes

It was found during the survey that none of the selected farmers reported about the use of NCU for other purposes such as; silage making, mixing with weedicides and for fishery feed preparation.

7.2.11 Constraints and suggestions about NCU and its adoption

It was found that only 1.5 per cent farmers did not report any problem in adoption of NCU fertilizer. However, 65.50 per cent revealed high price of NCU fertilizer being major constraint in its adoption while 27 per cent reported inadequate/ shortage of supply during peak season as another problem. Poor quality of NCU available in co-operative societies was another problem revealed by 8.50 per cent farmers while 5.50 per cent farmers were not aware about the uses and benefits of NCU. Another problem about NCU fertilizer application, reported by five per cent farmers, was extremely pungent smell emanating during its broadcasting in the field.

Major suggestions as revealed by 27 per cent farmers was assured/ timely and adequate supply of quality NCU during peak season to co-operative societies for improving the NCU fertilizer usage. Also, 7.50 per cent farmers suggested about organising training camps for spreading awareness regarding NCU uses/ benefits among the farming community. Other suggestions were regarding improving the quality (9.50%) of NCU and decreasing the price (74.50%) of NCU for increasing its usage.

7.2.12 Soil health related programmes and schemes - Implementation and performance in the state

The information on soil health card revealed that only five farmers, out of 45 farmers who got their soils tested, received soil health cards. Further, it was found that all the five farmers possess soil health card when asked to produce by the field survey team. Also, only four farmers were able to understand the information given in the soil health card while one farmer was unable to understand the information provided in the card. Out of total number of farmers, who got their soils tested, 88.89 per cent were verbally explained about the soil health card details by the concerned dept. officials while major source of education on soil health card was Agriculture Officer as revealed by 8.89 per cent farmers who received soil health card out of total farmers who got their soils tested.

7.2.13 Awareness on soil testing

It was found that 75.56 per cent of the sample farmers who tested their soils, got information about soil testing from Agriculture Department and soil samples were collected by 91.11 per cent farmers themselves. It was also observed that within the period 2013-14 to 2015-16, 73.33 per cent of the farmers got their soils tested while before 2013-14 only 16.67 per cent farmers tested their soils. All the respondents got soils tested only once in these years. The average cost of each sample tested between 2013-14 to 2015-16 period was Rs. 2.73 per sample while it was Rs. 3.33 for the samples taken before 2013-14. During the period 2013-14 to 2015-16 more number of farmers got the soil of their fields tested with higher number of soil samples taken as compared to before 2013-14.

The most important reason of soil testing as revealed by 31.11 per cent farmers was ótoo understand fertilizer requirement for the cropô followed by ómotivation from village demonstration/training/exposure visits to places with best farming practicesô by 20 per cent and ófor availing benefit under subsidy schemesô by 17.78 per cent farmers. óPeer farmers' group pressureô was revealed by 73.33 per cent farmers as least important reason for soil testing undertaken by sample farmers.

The reasons for not testing soil by the respondents was that 72.26 per cent of the respondents did not undertake soil testing as they thought that ósoil testing not required for my field as crop yield is goodô while 7.74 per cent revealed ósoil testing laboratories are located far awayô as the reason and 7.10 per cent reported ódo not know whom to contact for details on testingô as the reason for not testing soil.

7.2.14 Adoption of recommended doses of fertilizer application based on soil test report

The explanation about recommended dose of fertilizers (RDF) for paddy crop was given by the Department of Agriculture to 60 per cent farmers, who got tested their soils, followed by 27.65 per cent from co-operative societies during the training programmes organised by IFFCO while 11.35 per cent came to know about RDF from the experts of Punjab Agricultural University.

It was observed that 91.11 per cent of the farmers, who got their soils tested, were not aware about the recommended dose of fertilizers (RDF) for paddy crop but revealed about it on the basis of their own perception while just 8.89 per cent of the farmers were actually aware about RDF on the basis of soil test report. It was found that as per farmerôs perception, higher dose of urea, DAP and lower dose of MOP and ZnSO4 was applied to paddy crop as compared to soil test report based recommendation.

The major problems faced in soil testing as revealed by 80 per cent farmers was proper reports not being delivered followed by 55.50 per cent revealing poor extension services and 7.50 per cent complained about the soil test lab being far away. The major suggestions as revealed by 86 per cent farmers was that soil health cards should be delivered to the farmers while 54.50 per cent emphasised to improve the extension contacts and 45 per cent asked for organising awareness camps regarding soil test.

7.2.15 Impact on crop productivity

Productivity of paddy on sample farms due to application of NCU was 2845 kg. per acre in 2014-15 while it increased to 2900 kg. per acre in the year 2015-16. Also, there was increase in productivity from 2786 kg. per acre in 2014-15 to 2872 kg. per acre in the year 2015-16 due to the application of NU. Hence, there was increase in productivity of paddy crop during 2015-16 where NCU as well as NU was applied on the sample farms.

7.2.16 Fertilizer use efficiency

It was observed that NCU quantity applied per acre was 95.50 kg. per acre during the year 2014-15 while it increased to 116.50 kg. per acre in 2015-16 with an increase of 21.99 per cent. Similarly, the NU quantity applied declined from 40.48 kg. per acre in 2014-15 to 14.38 kg per acre in 2015-16. Thus, there was considerable increase in the application of NCU and decline in NU usage in paddy crop. In aggregate, there was decline in use of fertilizer (NCU+NU) by 3.75 per cent during 2015-16 as compared to 2014-15. Fertilizer use efficiency or output per unit of NCU was 29.79 kg. in 2014-15 and 24.89 kg. in 2015-16 due to higher NCU usage in 2015-16 despite higher average yield.

7.2.17 Impact of NCU application on paddy crop

The impact in terms of increased main product yield was seen for the farmers who exclusively applied NCU to paddy crop. Paddy yield obtained was 29 quintals per acre for the farmers exclusively using NCU while it was 28.72 quintals per acre for NU and 28.53 quintals for the farmers who applied both NCU and NU to their paddy crop. Thus, paddy yield was just 0.97 per cent higher on the farms exclusively using NCU as compared to NU but this difference was statistically non-significant. On the marketing front, there was no difference in the price received for the produce obtained while using NCU, NU or both since same minimum support price (MSP) of Rs. 1450 per quintal was received by the farmers. So,

there was impact of NCU usage in terms of increased productivity of paddy and thereby increase in production also.

7.2.18 Impact on cost of cultivation of reference crops

It was observed that the cost of pest and disease control in paddy was Rs. 1518 per acre on the farms where NCU was exclusively used while it was Rs. 1755 per acre for normal urea (NU) and Rs. 1412 for the farms where both NCU and NU were used. Similarly, cost of weed management was Rs. 411 for exclusively NCU using farms, Rs. 435 for NU using and Rs. 403 for using both NCU and NU. Cost of NCU for the farms where it was used exclusively was Rs. 742 per acre which was higher than Rs. 652 for the farms using only NU while it was Rs. 514 for the farms using both NCU and NU for their paddy crop. The cost of other fertilizers used was Rs. 678 on farms using NCU and Rs. 653 on farms using NU and Rs. 464 for the farms using both NCU and NU. Thus, there was decline in the cost of pest, disease control and weed management where NCU was exclusively applied to paddy crop as compared to NU but cost was least on the farms where NCU along with NU was applied. But only decrease in cost of pest and disease control and increase in cost of urea were found to be statistically significant. Although cost of NCU was more than NU but its impact was reflected in terms of lower cost of pest, disease control and weed management practices.

7.2.19 Economic feasibility of NCU using partial budgeting

The economic feasibility of NCU in paddy using partial budgeting framework brought out that added costs were estimated at Rs. 326 per acre while there was also cost reduction to the tune of Rs. 711 per acre. Thus, there was net cost reduction of Rs.385 per acre. Added returns due to NCU amounted to Rs. 333. Therefore, there were added returns of Rs. 718 per acre by application of NCU on the sample farms.

7.2.20 Impact on soil heath and crop growth

All the selected respondents were unanimous in giving their mind on the qualitative benefits of NCU on paddy growth in Punjab. It was revealed by all the respondents that there was neither improvement in the quality of paddy grain nor market acceptability due to better colour. Also, there was no change in the texture of the soil, soil moisture retention capacity, water infiltration rate, soil softness and decline in the compaction of the soil due to application of NCU, however, some of the farmers reported longer retention of nitrate in the soil and its slow release to the paddy crop.

7.3 Conclusions

The study brought to the following conclusions:

- The district wise trends in consumption/ sale of urea in Punjab showed that during the year 2007-08 the consumption of urea was 2646.44 th. MT which rose to 3086.05 th. MT during the period 2007-08 to 2015-16 at an annual growth rate of 1.64 per cent.

- The urea prices increased significantly at the highest growth of 5.21 per cent per annum during the decade 1990-91 to 1999-2000 while during the period 1980-81 to 2015-16 the growth in urea prices was 3.33 per cent per annum.
- Total credit taken by the respondent farmers was Rs. 318565 per household. As far as institutional source of credit was concerned, commercial banks (Rs. 177500) per household) was the major source of credit followed by co-operative societies (Rs. 100755 per household).

- Traders/ commission agents (Rs. 36435 per household) were the main non-institutional sources of credit for the respondents followed by friends and relatives.

- Majority of the respondent farmers purchased NCU and NU from co-operative societies followed by private fertilizer dealers.

- Total cost per bag of NCU, including transportation cost, worked out to be Rs. 289.69 while it was Rs. 276.58 per bag in case of NU.
- There was marginal increase in the output/ productivity of paddy crop during the year 2015-16 as compared to the year 2014-15 which canôt only be attributed to the application of NCU because there are numerous factors/ reasons significantly influencing the yield of a crop.

- Gross returns from paddy crop worked out to be Rs 41833 per acre during the year 2015-16 while it was Rs. 39740 in the year 2014-15. The corresponding figures for net returns were estimated to be Rs. 31401 during the year 2015-16 and Rs. 29530 in 2014-15 on the sample farms.

- All the large farmers were aware about the NCU while 99.15 per cent medium and 98.53 per cent marginal and small farmers were also aware of it.

- Major source of awareness regarding NCU was co-operative societies while input shop, fellow farmers, print and visual media and agricultural university were other sources of awareness.

- Major factor/ sign from which respondent farmers differentiated NCU from NU was leaf figure on bag while farmers also revealed that smell of neem in NCU differentiated it from NU and thus can easily be identified.

- As far as consumption of NCU is concerned, there was a significant increase in the application of NCU during 2015-16 in crops such as; paddy, wheat, basmati, sugarcane, potato, maize, sunflower and vegetables.

- Due to the application of NCU, only 5.29 per cent farmers reported about the increase in paddy yield. Also, the cost of pest and disease control declined by 21 per cent due to the application of NCU but there was no change in weed management.

- All the respondent farmers revealed no decline in the cost of other fertilizers, improvement in the soil health, quality of grain and market acceptability of grains due to the application of NCU.

- Majority of the farmers reported about the quality of NCU being good, adequate, timely available, accessible in the market, its non-solidification and evenly distribution at the time of application found out to be positive points.

- It was found that none of the selected farmers reported about the use of NCU for other purposes such as; silage making, mixing with weedicides and for fishery feed preparation.
- High price of NCU, inadequate/ shortage of supply during peak season and poor quality of NCU in some of the co-operative societies were the major problems reported by the respondents.

- Major suggestions for increasing NCU usage were; assured/ timely and adequate supply of quality NCU during peak season to co-operative societies, organising training camps for spreading awareness regarding NCU uses/ benefits among the farming community and decreasing the price of NCU for the benefit of the farmers.

- The information on soil health card revealed that only five farmers, out of 45 farmers who got their soils tested, received soil health cards. It was found that 8.89 per cent of the sample farmers, who got their soils tested, received information about soil testing from Agriculture Department.

- The most important reason of soil testing as revealed by nearly 31 per cent farmers was ótoo understand fertilizer requirement for the cropô while most important reason for not testing soil by about 72 per cent farmers was that ósoil testing not required for my field as crop yield is goodô.

- It was seen that 91.11 per cent of the farmers, who got their soils tested, were not aware about the recommended dose of fertilizers (RDF) to paddy crop but told about it on the basis of their own perception while just 8.89 per cent of the farmers were actually aware about RDF on the basis of soil test report.

- The major problems faced in soil testing by the farmers was proper reports not delivered as reported by about 80 per cent farmers since soil test reports were not delivered and suggested for ensuring delivery of soil health cards .

- There was increase in the productivity of paddy crop during the year 2015-16 as compared to 2014-15 where NCU was applied on the sample farms. Also, the NCU usage on the sample farms increased during this period while cost of pest/ disease control measures and weed management declined.

- The partial budgeting framework brought out that there were added returns of Rs. 718 per acre by application of NCU on the sample farms.

- There was neither improvement in the soil health nor change in the quality of paddy grain and its market acceptability due to the application of NCU.

- It was reported by all the respondents that there was no change in the texture of the soil, soil moisture retention capacity, water infiltration rate, soil softness and decline in the compaction of the soil due to the application of NCU. However, there was longer retention of nitrate in the soil and its slow release to the paddy crop.

7.4 Policy Recommendations

The above discussion brought out some policy issues which must be looked into to encourage the judicious use of NCU and for proper implementation of soil health card scheme:

- Since now whole urea fertilizer produced in the country is neem coated, therefore, there would not be any problem with regard to its use at the farmers level. But the major point which should be taken care of is its good quality, adequate quantity, timely supply of NCU along with bringing its price at par with NU.

- Farmers should be educated about the balanced use of NCU along with other fertilizers for decreasing the cost of production of crops.

- It should be ensured that soil testing reports/ soil health cards are delivered in time to the farmers along with laying emphasis on implementation of the SHC recommendations w.r.t. fertilizer use for amelioration of nutrient deficiencies in the soils.

- Special training programmes/ camps should be organised by the various stakeholders in agricultural sector to educate the farmers about the benefits of soil testing, balanced use of chemical fertilizers and knowledge about SHC recommendations.

- Gram panchayats should be involved in undertaking soil testing campaigns on a war footing alongside department of agriculture officials for proper and better implementation of soil health card scheme.

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Appendix I

Coordinator's Comments on the Draft Report

1. Title of the draft report examined:

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

2. **Date of receipt of the Draft report:** November, 2015

3. **Date of dispatch of the comments:** December 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) In chapter II, page 10 seems to be blank, kindly, remove if there is nothing to add.

(ii) Too much of space above and below the tables, specially from page 17-23 looks distracting, maintain the space at 1.5, kindly align the report as per standard guidelines.

(iii) In Chapter VII, the sub-headings may be numbered for a better presentation and easy understanding.

(iv) Kindly, provide policy recommendations point wise instead of paragraph.

(v) Please, do follow and incorporate the partial budgeting technique and respective tables in the report as followed in Karnataka state report (mail already sent across AERCs).

(vi) *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.

Appendix II

ACTION TAKEN ON THE COMMENTS BY AERC, LUDHIANA

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

The report has been revised in the light of the comments/ observations/ suggestions received from the coordinating centre. Point wise reply is as under:

(i) Needful has been done

(ii) Needful has been done.

(iii) Correction as suggested has been made.

(iv) Needful has been done.

(v) As desired, the partial budgeting technique has been incorporated along with statistical testing of impact tables

(vi) Report has been copy edited

D.K.Grover

AERC, Ludhiana