Gokhale Institute of Politics and Economics
(Deemed to be University)
Pune – 411 004

AERC Report

Agro-Economic Research Centre (AERC)

Impact of Neem-coated Urea on Production, Productivity and Soil Health in India - A Case of Sugarcane and Tur in Selected Districts of Maharashtra

Jayanti Kajale
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February 2017

Submitted to
Department of Agriculture, Cooperation and Farmers Welfare
Ministry of Agriculture and Farmers Welfare
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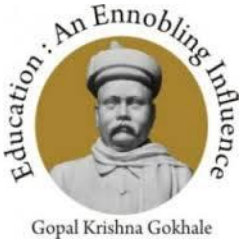

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Foreword

The Government of India made it mandatory for all the indigenous producers of urea to produce 100 percent of their total production of subsidized urea as Neem Coated Urea (NCU) in 2015. The usage of neem oil coating on urea reduces the release of nitrogen from urea and therefore reduces consumption of the fertiliser thereby increasing its use efficiency. In view of this, the present study was undertaken to examine the coverage of NCU, its adoption behaviour, its impact on yield of selected sugarcane and tur farmers and to study the status of implementation of the soil health card scheme in Maharashtra.

The analysis of the primary data reveals lower but increasing adoption of NCU and reduced per acre consumption of total urea by NCU farmers as compared to the Non-NCU farmers. For both the crops, application of NCU had positive impact on returns of the NCU farmers. Farmers appeared to be satisfied with the quality of NCU used. The data however revealed that only around 37 percent of the farmers had got their soil tested since 2013-14. Out of the total farmers who got their soil tested, only 54 percent possessed the soil health card at the time of survey and only 58 percent could understand the information given on it. The responses reveal inadequate outreach of the machinery in creating awareness about soil testing.

The policy implications therefore include creating more awareness about NCU and its benefits as compared to urea and ensuring adequate and timely availability of NCU. Fertiliser training camps need to be organized so that the farmers are given suggestions about judicious fertiliser usage under changing weather conditions and are convinced about benefits of soil test based nutrient management. There is a need for increasing manpower resources engaged in collection of soil samples and distribution of soil health cards, more soil testing labs and capacity building of the staff so that the cards are distributed before the sowing season.

This study would be very useful for the researchers as well as policy makers. I thank Jayanti Kajale, Sangeeta Shroff and Varun Miglani for undertaking this study.

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List of Acronyms

CoC	Cost of Cultivation
DAP	Diammonium Phosphate
FAI	Fertilizer Association of India
GCA	Gross Cropped Area
GIA	Gross Irrigated Area
GoI	Government of India
GoM	Government of Maharashtra
HH	Household
K	Potassium
MOP	Muriate of Potash
MRP	Maximum Retail Price
N	Nitrogen
NCU	Neem Coated Urea
NFL	National Fertilizers Limited
NOA	Net Operated Area
Non-NCU	Normal Urea
NUE	Nitrogen-Use Efficiency
P	Phosphorus
PACs	Primary Agricultural Cooperatives
t	T-Statistic
T.E.	Triennium Ending

Executive Summary

In 2015, Government of India made it mandatory for all the indigenous producers of urea to produce 100 percent of their total production of subsidized urea as NCU and took various steps to promote NCU with a view to improve soil health status and also realise higher yield per hectare. The present study was undertaken by the Ministry of Agriculture and Farmers Welfare, Government of India to examine the coverage of NCU, its adoption behaviour and its impact on yield among the selected crops. The study was conducted for the state of Maharashtra which is the second largest fertiliser consuming state of India.

Objectives of the Study

1. To analyze district wise and state level trends in usage of urea and Neem Coated urea and trends in prices of urea in Maharashtra.
2. To analyze the adoption behavior of NCU sample farmers in irrigated and unirrigated tracts.
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.

Data and Methodology

The study relies on secondary as well as primary data collected from the sample households for the reference period kharif 2015. Irrigated and unirrigated kharif crops in the state using urea were to be selected. Accordingly, sugarcane was selected which is a 100 percent irrigated crop. Tur was selected as an unirrigated crop as the area under irrigation was only 1.6 percent of total tur area in 2012-13. Based on the urea usage as well as discussions with state government officials, for sugarcane, districts Ahmednagar and Kolhapur were selected. For tur, districts Yavatmal and Latur were selected. From each of the districts, two talukas were selected. From each of the selected talukas, two clusters of villages comprising three to four villages per cluster were selected for conducting the survey. Fifty farmers from each taluka, and a total of 100 farmers in case of each district, and a total of 200 farmers for each crop were selected. Thus in all, a sample consisting of 400 households was selected. Households were selected randomly for assessing the use of

NCU fertilisers and its impact on crop production. Care was taken to select NCU users as well as urea users (Non-NCU farmers) for comparing the impact of NCU usage and urea usage. For sugarcane out of a total of 200 sample farmers, 68 percent farmers were NCU users and 32 percent were Non-NCU users. In case of tur, 42 percent were NCU users and 58 percent were Non-NCU users. Thus, a total of 220 farmers (55 percent) were NCU users in the total sample of 400 farmers. Households from different farm size groups were selected.

Major Findings of the Study

Major findings emerging from analysis of the secondary data

- It is observed from the analysis of the secondary data that although Maharashtra is the second largest fertilizer consuming and third largest urea consuming state in the country, it's per hectare fertilizer and urea consumption was about 120.5 kg and 108.6 kg respectively for the T.E. 2014-15, which was 7.6 percent and 29.3 percent respectively less than the all India average.
- The urea consumption in the state increased at the rate of 4.1 percent per annum during the period 2000-01 to 2015-16. Across years, urea consumption seems to have been affected by occurrence of droughts, since 2009.
- The district-wise data for T.E. 2014-15 reveals that district Kolhapur had highest per hectare usage of urea which is followed by Nandurbar and Jalgaon districts with 188.3 and 171.4 kg per hectare respectively. These are the only districts with more than all India consumption per hectare average.
- From 2009-10 to 2015-16, the rate of increase in urea price was 17.5 percent, which was quite less as compared to that in MRP of DAP (171.2 percent) and MOP (277.6 percent).

Major findings that emerged from the analysis of the primary data.

The Socioeconomic Characteristics

- The analysis reveals that 57 percent of the sugarcane farmers belong to general category. Though they owned comparatively smaller size of landholdings, the extent of the land irrigated was very high i.e. around 90 percent. The tur farmers belonged to general (43 percent) as well as OBC (29 percent) categories. Their landholding size was comparatively bigger than the sugarcane farmers. However, the extent of irrigation was only 38 percent for these farmers.

- For both the crops, the extent of higher education as well as the extent of irrigation was higher for the sugarcane and tur NCU farmers.
- The analysis revealed that overall the NCU farmers had a better socioeconomic background.

Costs, Returns and Fertiliser Usage

- The output and the net returns were higher for the NCU farmers than the Non-NCU farmers for both the crops in 2014 as well as 2015. The extent of increase in output and in net returns from 2014 to 2015 was also higher as well for the NCU farmers.
- The difference between output efficiency of urea (in 2015) of NCU farmers and Non-NCU farmers was significant for sugarcane as well as tur and indicated reduced usage of total urea consumption in case of NCU farmers (without adversely impacting the yield) as compared to Non-NCU farmers.
- The difference between productivity was significant only for tur farmers. For sugarcane, the difference was non-significant. This indicated that usage of NCU had not impacted productivity of sugarcane NCU farmers significantly and that factors other than NCU usage could have played an important role in causing production levels to be the same.
- For sugarcane, urea cost per acre was significantly lower for NCU farmers and they benefited mainly due to reduced usage of total urea. However the difference was non-significant in case of main and by product yield, prices and overall gross returns. For tur, the total input cost, yield as well as gross returns were significantly higher for the NCU farmers. The increase in the gross returns is mainly due to the yield effect rather than the price effect.
- The data relating to application of recommended doses of fertilisers based on soil test report showed that there had been either under application or over application of various fertilisers including urea in comparison to the recommended doses of fertilisers by the farmers. In case of urea, there was underestimation for sugarcane and overestimation for tur.
- The partial budgeting exercise revealed that the incremental net added returns were higher than the incremental net costs by more than 10 times for the NCU sugarcane farmers and by 30 times for NCU tur farmers. Thus, for both the crops, application of NCU had positive impact on returns of the NCU farmers.

Awareness and Perceptions about NCU

- Around 70 percent of the sugarcane and 42 percent of the tur farmers were aware about the NCU. All the farmers were able to differentiate between NCU and Non-NCU. The consumption of NCU was very low in the year 2014 for sugarcane and nil for tur and that of urea was higher. It increased in 2015 for both the crops.
- Overall, farmers appeared to be satisfied about quality and availability of NCU and majority (above 80 percent) of them thought that the application of NCU led to improvement is soil health.

Problems in adoption of NCU

- About 53 percent of the farmers were unable to report any problem in adoption of NCU. The major problem reported by 37 percent of the farmers was that there was shortage of NCU.

Soil Health Cards

- The secondary data relating to distribution of soil health cards showed that for the state as a whole, the soil sample collected was more than the target set. Overall, 94 percent of the sample that was collected was tested. Nearly 85 percent of the samples that were collected were distributed at the state level. However, in a number of districts, the targets have not been met and this clearly suggests need for strengthening of the distribution machinery.
- Primary data revealed that only 74 sugarcane farmers (37 percent) and 72 tur farmers (36 percent) got their soil tested since 2013-14.The main sources of information on NCU were the state agricultural department and Agricultural universities.
- It was observed that around 87 percent of the soil tested farmers got the soil tested for understanding the fertiliser requirement of their soil. 254 (64.5 percent) farmers did not get their soil tested for various reasons as mainly they did not know whom to contact and that the testing labs were not available in the vicinity.
- 79 percent of the farmers felt that soil testing was not required as their respective soils were in good condition.

Policy Implications

(i) Secondary data shows that per hectare consumption of fertilisers is comparatively lesser in Maharashtra. As per hectare urea / fertiliser consumption is largely related to availability of water, increasing the extent of irrigation along with increasing

area under the crop is important to increase per hectare usage of urea wherever necessary.

(ii) With production of 100 percent urea as NCU, all the farmers would be now using NCU. Overall, the analysis of the primary data revealed that majority of the NCU farmers were satisfied with the quality of NCU and were unable to report any problem. The only problem reported by 37 percent of the farmers was shortage of NCU. Thus, it is essential to ensure adequate timely supply of NCU at village level.

(iii) In view of the difference between actual usage and recommended doses of fertilisers, and for increasing output efficiency and productivity of urea and judicious use of all fertilisers, there is need for organising fertiliser training camps at regular intervals at the village level so that farmers can be given suggestions about its usage (recommended doses of fertilisers) under changing weather conditions. All the farmers need to be given information about relative benefits of NCU over urea and accordingly about requirement of doses of NCU as compared to urea.

(iv) Only around 37 percent of the sugarcane as well as tur farmers got their soil tested since 2013-14. This percentage is very low. The responses reveal inadequate outreach of the machinery in creating awareness about soil testing. Hence, the outreach of the extension machinery needs to be improved so that the target set for soil testing is fulfilled and all the farmers get their soil health cards before the sowing season. Also, there is a need to convince the farmers about benefits of soil test based nutrient management.

(v) Out of the total farmers who got their soil tested, only 54 percent possessed the soil health card at the time of survey and only 58 percent could understand the information given on it. Thus, there is need to educate the farmers about benefits of possessing soil health card and about its contents.

(vi) There is a need for increasing manpower resources engaged in collection of soil samples and distribution of soil health cards, more soil testing labs and capacity building of the staff so that the cards are distributed before the sowing season.

Chapter 1

Introduction

1.1 Background of the Study

The Indian agricultural sector at the time of independence was characterized by stagnant yields and production levels. The agricultural policy, therefore, was aimed at initiating growth process. Whereas the initial three Five Year Plans focused on increasing food grains production along with institutional reforms across the agricultural sector, in the late 1960s, focus of the agricultural policies were mainly on increasing investment in infrastructure and increasing availability and consumption of inputs such as water, seeds and fertilisers. As a result of these planned efforts and implementation of seed-water-fertiliser technology, growth rate of the agricultural sector, which was 0.3 percent per annum, increased to around 2.7 percent per annum in the post-independence period. The production of food grains increased from 50.8 million tonnes in 1950-51 to about 199.3 million tonnes in 1996-97. The production of commercial crops like cotton, oilseeds, sugarcane, fruits and vegetables, besides livestock products and fisheries, also recorded significant increases during the same period (Planning Commission, 1997).

Fertilisers as an important input group providing nutrients essential for balanced growth of crops has played an important role in supplementing the Indian soil with macronutrients as well as micronutrients. It is well known that the Indian soils are deficient in nutrients and therefore timely and adequate application of fertilisers is extremely essential for increasing agricultural production. Application and increased usage of fertilisers were instrumental in increasing crop yield and production especially in the late 1960s and 1970s. With increasing production of food grains and non-food grain crops fertiliser consumption in India has been increasing. The total fertiliser consumption (i.e. nitrogen (N), potash (K), and phosphorous (P)) has increased from 65.6 thousand metric tonnes (MT) in 1951-52 to 25.6 million MT in 2014-15. Per hectare consumption of fertilisers (NPK) also increased from less than 0.5kg per hectare to 131.6 kg per hectare during this period (FAI, 2015). Data on fertiliser statistics also shows that India is an important player at global level as far as production, consumption and import of fertilisers are concerned. During the period 2001-2012, India has been the second highest producer of nitrogenous fertilisers (producing 10-11 per cent of world production), third highest producer of phosphatic fertilisers (producing around 7 per cent of total world production in 2012). India is the second biggest consumer of nitrogenous

and phosphatic fertilisers (14.1 per cent and 14.5 per cent of world consumption in 2012 for nitrogenous and phosphatic fertilisers respectively) as well and the fourth biggest consumer of potassic fertilisers (7 per cent of world consumption in 2012). However, with growing demand for fertilisers, India had to depend on imports for satisfying domestic demand. As a result, India has become an important importer of all the macronutrients. It is the second highest importer of nitrogenous nutrients (11 per cent of world import in 2012), highest importer of phosphatic nutrients (7 per cent of the world import in 2012) and third highest importer of potassic nutrients importer (6 per cent of world import in 2012) (Gulati and Banerjee, 2015).

Since independence, the government policies have been directed towards regulating sale, prices and distribution of fertilisers with the objective of encouraging investment in fertiliser industry and ensuring availability of fertilisers at affordable prices through payment of subsidies. Fertilisers have been declared as an essential commodity under the Essential Commodities Act, 1957. The major focus of the policy has been on the primary macronutrients such as N, P, K. The main objective of the Department of Fertilizers is to ensure adequate and timely availability of fertilizers at affordable prices for maximizing agricultural production in the country (GoI, n.d.). With the implementation of the Retention Price Scheme in 1977, the government started providing price support to the fertiliser industry which resulted in an increase in the domestic production capacity and as well as production of fertilisers. This was accompanied by significant increase in food grains production as well as subsidy burden and fiscal deficit of the government. With the initiation of economic reforms, the government decontrolled prices and distribution of fertilisers except that of urea. This, however, resulted in increased consumption of N fertilisers and reduction in P and K fertilisers. The New Pricing Scheme of 2003 which was a concession scheme for urea, further increased the distortions in the market. The policy regime encouraged partial decontrol/ deregulation of P and K fertilisers, complete decontrol of complex fertilisers and controls on urea. In 2010, to promote balanced use of fertilisers, Nutrient Based Subsidy scheme was announced according to which the government fixes subsidy on an annual basis based on the weights of different macro/ micro nutrients in fertiliser. However, the scheme does not cover urea.

Urea is the most widely used N fertiliser. Among the straight N fertilisers, urea has highest i.e. 46 percent nitrogen content. In 2015-16, urea had highest installed capacity of 207.5 lakh MT per annum which was 59 percent of the total capacity and had

constituted around 61 percent of the total production of fertilisers (GoI, 2016a). Urea accounted for 57.3 percent of the total fertiliser application during 2014-15. India however, is not self-sufficient in urea production as its consumption has been rising steadily since 2003-04. This is clear from Table 1.1 as well as Figure 1.1. The compound annual growth rate (CAGR) of all India urea production and consumption were 1.76 percent and 4.41 percent per annum respectively for the period 2003-04 to 2014-15. This led to widening of gap between production and consumption, which forced the government to increase its urea imports. It is observed that urea imports have increased from 1.43 lakhs MT in 2003-04 to 87.5 lakhs MT in 2014-15, registering a CAGR of 38.9 percent per annum.

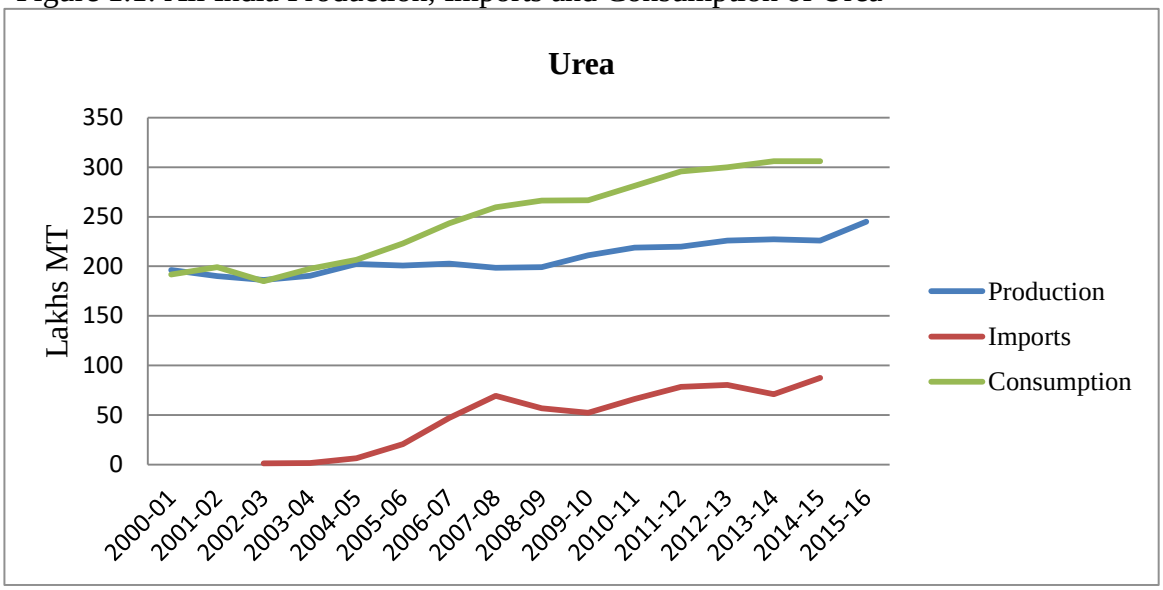
Table 1.1: All India Urea Production, Imports, and Consumption (lakhs MT)

Year	Production	Imports	Consumption
2000-01	196.24	5.33	191.86
2001-02	190.03	NA	199.17
2002-03	186.21	1.19	184.93
2003-04	190.38	1.43	197.67
2004-05	202.39	6.41	206.65
2005-06	200.85	20.57	222.98
2006-07	202.71	47.19	243.38
2007-08	198.39	69.28	259.63
2008-09	199.23	56.67	266.49
2009-10	211.21	52.10	266.73
2010-11	218.73	66.10	281.13
2011-12	219.92	78.34	295.65
2012-13	225.87	80.44	300.02
2013-14	227.19	70.88	306.00
2014-15	225.93	87.49	306.10
2015-16	245.00	NA	NA

Source : FAI, 2015; GoI, 2016b

In order to make urea available at affordable prices to farmers, it has been controlled and is sold at statutory notified uniform sale price. However, due to the difference between the average cost of production and retail price of urea, the government has been heavily subsidizing this sector as against P and K fertilisers which are partially decontrolled. For e.g. from 2010 to 2016, the rate of increase in urea price was mere seven percent, which is quite less as compared to the MRP of P and K fertilisers. At the same time, subsidy regime has led to distortions in the NPK use ratio which normally should be 421(Figure 1.2). The NPK ratio has increased from 4.11.91.0 in 2009-10 to 4.61.70.7 in 2014-15 in lieu of increasing consumption of urea (computed from data in Fai [2015]).

Figure 1.1: All India Production, Imports and Consumption of Urea

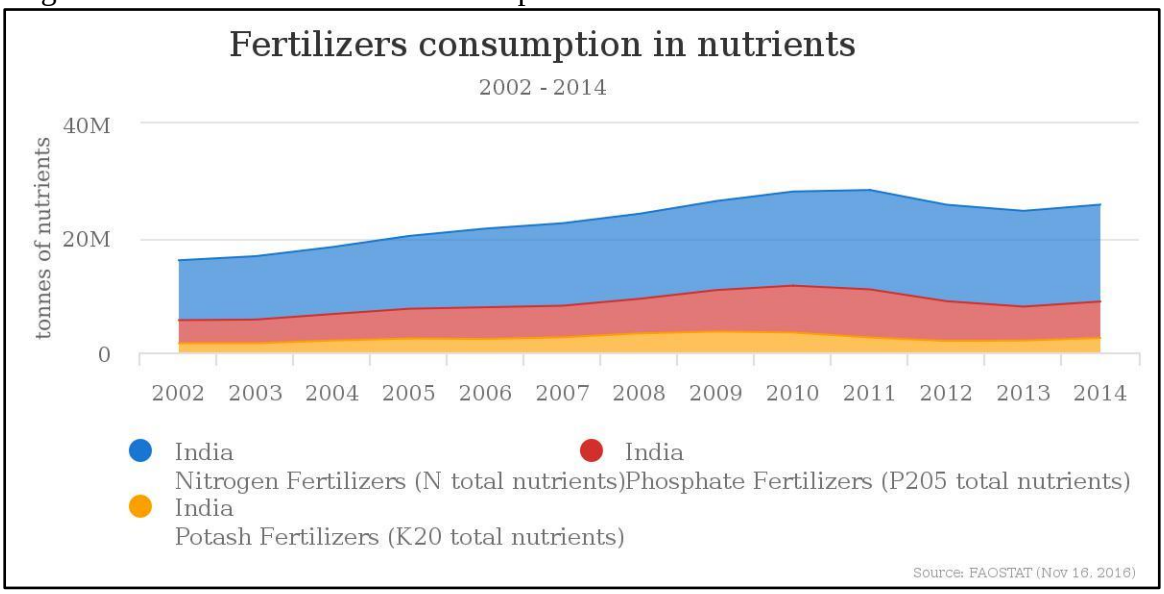


Source: FAI, 2015

The government, therefore, implemented Investment Policy for urea 2012 in May 2015 with revised energy consumption norms to make urea production energy efficient, rationalize the subsidy burden and to increase its production. Moreover, the Government made it mandatory for all the indigenous producers of urea to produce 100 percent of their total production of subsidized urea as neem coated urea (NCU) as well as to neem coat imported urea from May 2015 for encouraging efficient use of fertilizers and reduction in subsidies. The NCU has benefit of slow release of nitrogen and hence its consumption is less compared to un-coated urea. Moreover, as NCU cannot be used for industrial purposes, the illegal diversion of subsidized urea to non-agricultural use could be curbed (GoI, 2016b).

The year-wise available data from 2006-07 on NCU production and sale is presented in Table 1.2. The production of NCU has been gradually increasing. It reduced to 2.9 lakh MT in 2008-09 from around 6 lakh MT in 2006-07. It started increasing to reach a level of 59.9 lakh MT in 2013-14.Thus, it increased almost tenfold during 2006-07 to 2013-14.

Figure 1.2: All India Fertilizer Consumption of Nutrients for 2002 to 2014



Source: Food and Agricultural Organisation of United Nations (2016)

Table 1.2: Production and Sale of NCU in India (units in Lakh MT)

Year	Production	Sales
2006-07	5.97	6.0
2007-08	2.9	2.9
2008-09	2.9	2.9
2009-10	9.2	9.2
2010-11	12.1	11.9
2011-12	34.9	34.2
2012-13	46.8	48.0*
2013-14	59.9	59.8

Note: *Sales might be greater than production due to release of inventory.
Source: Fertilizer statistics, 2014-15 (FAI, 2015)

The government, in May 2015 made it mandatory for all the indigenous producers of urea to produce 100 percent of their total production of subsidized urea as NCU. The imported urea is also being coated and thus 100 percent NCU is being supplied for agricultural use. As per the officials of fertilizer department, government of Maharashtra (GoM), the production of NCU was 220 lakh MT in 2015-16 and thus constituted around 90 percent of the total urea production (245 lakh MT) at all India level.

1.2 Review of Literature

Fertilisers being an important chemical input for growth of crops, a number of studies encompassing varied issues have been carried out. These include investment in and efficiency of Indian fertiliser industry, pricing and regulation of the industry, trends in supply of various fertilisers, prices, fertiliser consumption and impact of fertilisers on crop growth etc. The most important issue that has been discussed relates to fertiliser

subsidy given so as to keep the prices affordable to the farming community and for encouraging investment in the industry with the ultimate objective of increasing fertiliser usage and reducing fiscal burden. It has been observed that over the years, fertiliser consumption has increased and has contributed to the increase in production and yield. However, over the years, our import dependency has not reduced. Similarly, the fertiliser pricing policy has led to an imbalance in the use of nutrients.

The recent studies therefore have suggested several measures to revive the fertiliser sector and make it sustainable. One of the major policy recommendations has been the use of NCU (Gulati and Banerjee, 2015). It is observed that spraying urea with neem oil slows the release of nitrogen, by about 10 to 15 per cent, concomitantly reducing consumption of the fertiliser.

The studies relating to nitrogen indicate that its recovery under irrigated and submerged conditions is hardly 35 per cent due to various kind of loses due to the processes of de-nitrification, ammonia volatilization and leaching. Use of neem oil has been found useful in reducing the release of nitrogen from urea and increase its use efficiency. National Fertilizers Limited (NFL) was the first company in India to get permission to produce and market NCU in 2004 based on the results of extensive field survey. Earlier trials on paddy and wheat crops with NCU as source of N produced significantly higher yield during research and at farm level. Since 2004-5, NFL has been regularly conducting 200 to 250 front line demonstrations, at farmers' fields, in close collaborations with the respective state agriculture universities, in the states of Punjab, Haryana, Rajasthan, UP, MP, and Chattisgarh. The yields in the treatment where NCU has been used, has increased from 6-11 percent depending upon crop and location (National Fertilizers Limited, n.d.).

Many research studies in India have conclusively established that neem oil acts as an effective nitrification inhibitor if coated onto urea (Kumar, 2015). According to a recent study also, the sustained release nature of NCU has seen rice yields jump by 9.6 per cent and wheat by 6.9 per cent (Datta, 2016).

Therefore, it is expected that usage of NCU will reduce total consumption of urea and prevent its diversion to industrial uses. However, a recent scientific study in its review of the benefits of NCU, expresses its doubt about decline in the consumption of NCU. According to the study, the perception that when farmers get higher yields, they would reduce dose of NCU may not work if the gains due to replacing of urea with NCU are small and not visible. Similarly, farmers may not cut the dose of NCU to avoid any

yield risk arising from cutting down the doses. Hence it is felt that application of site specific nutrient management principles would lead to higher yield levels when NCU is used in place of urea (Singh, 2016).

According to some of the researchers, mandating NCU, though beneficial, is unlikely to help in solving the problem given the various dimensions of the problem. The real problem, it is felt, is price differential between urea and other fertilisers and between imported and domestic fertilisers leading to imbalanced use of fertilisers. Allowing the industry to charge market prices and paying farmers a direct subsidy is one solution that economist and some manufacturers suggests as a via media (Datta, 2016).

1.3 Need for the Study

As has been mentioned earlier, Nitrogen is the most popular fertiliser used by the farmer. Neem acts as a nitrification inhibitor and its coating over urea minimizes losses due to leaching, prevents its misuse as well as puts the fertiliser in slow release mode thereby nourishing the saplings for a longer period. It thus avoids repeated use of fertilizer and economises the quantity of urea required by crops leading to enhancement in nitrogen-use efficiency (NUE). Besides, coating of neem oil also reduces the leaching of nitrates into the groundwater aquifers and thus, helps in reducing its pollution.

With this background, Government of India (GoI) made it mandatory for all the indigenous producers of urea to produce 100 percent of their total production of subsidized urea as NCU from 2015 and took various steps to promote NCU, with a view to improve soil health status and also realise higher yield per hectare. There is need for a study assessing the impact of NCU on the production and yield of major crops in India. Maharashtra is the second largest fertiliser consuming state of India. It accounts for eight per cent of the total urea consumption in the country. The present study examines the coverage of NCU, its adoption behaviour and its impact on yield among the selected crops in the state of Maharashtra. Besides, the status and implementation of soil health card scheme is also studied in case of Maharashtra.

1.4 Objectives of the Study

1. To analyze district wise and state level trends in usage of urea and NCU and trends in prices of urea in Maharashtra.
2. To analyze the adoption behavior of NCU sample farmers in irrigated and unirrigated tracts.

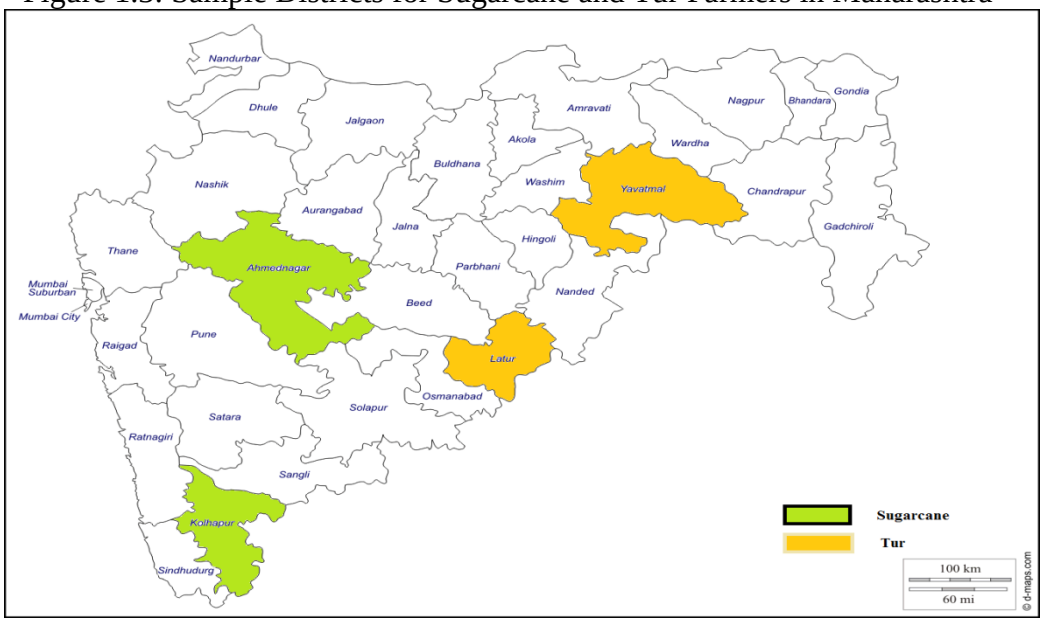
3. To analyze the impact of adoption of NCU on crop productivity and farmers' income.
4. To document the status and implementation of soil health card scheme.
5. To suggest suitable policy measures for adoption of NCU.

1.5 Data and Methodology

The study relies on secondary as well as primary data collected from the sample households for the reference period kharif 2015. Irrigated and unirrigated kharif crops in the state using urea were to be selected. Accordingly, from amongst the irrigated crops sugarcane was selected. The share of sugarcane in the cropping pattern (gross cropped area (GCA)) in 2014-15 was 4.5 percent (GoM, 2016) and 100 percent of the sugarcane area was irrigated as per the data available (GoI, 2016c). The other crop that was selected was tur which occupied 5.2 percent of the GCA of Maharashtra in 2014-15 (GoM, 2016). The area under irrigation for this crop was only 1.6 percent of total tur area in 2012-13 (GoI, 2016c).

For each crop, two districts were selected based on the urea usage within the state. Based on the discussions with state government officials, for sugarcane, districts Ahmednagar and Kolhapur were selected. Similarly, for tur, districts Yavatmal and Latur were selected. The geographical location of these sample districts in Maharashtra is shown in Figure 1.3.

Figure 1.3: Sample Districts for Sugarcane and Tur Farmers in Maharashtra



From each of the districts, two talukas were selected again based on the urea usage. From each of the selected talukas, two clusters of villages comprising of four villages per cluster were selected for conducting the survey. Fifty farmers from each

taluka, and a total of 100 farmers in case of each district, totaling to 200 farmers for each crop were selected. Thus in all, data was collected form the sample consisting of 400 households. Households were selected randomly for assessing the use of NCU fertilisers and its impact on crop production. Care was taken to select NCU users as well as ordinary urea users (Non-NCU farmers) for comparing the impact of NCU usage and urea usage. This is presented in Table 1.3.

For sugarcane out of a total of 200 sample farmers, 136 (68 percent) farmers were NCU users and 64 (32 percent) were Non NCU users. In case of tur, 84 farmers (42 percent) were NCU users and 116 farmers were Non-NCU users (58 percent). Thus, a total of 220 farmers (55 percent) were NCU users in the total sample of 400 farmers. Households from different farm size groups were to be selected. Table 1.4 shows the land size class wise sampling design for the sugarcane and tur farmers.

Table 1.3: The Sampling Design

District	Taluka	No of Famers		
		NCU	Non-NCU	Total
Sugarcane				
Ahmednagar	Newasa	34	16	50
	Shrigonda	34	16	50
Kolhapur	Hatkanangale	34	16	50
	Shirol	34	16	50
Total (a)		136 (68)	64 (32)	200 (100)
Tur				
Yavatmal	Pusad	25	25	50
	Yavatmal	25	25	50
Latur	Aausa	16	34	50
	Nilanga	18	32	50
Total (b)		84 (42)	116 (58)	200 (100)
Grand Total (a+b)		220 (55)	180 (45)	400 (100)

Table 1.4: Land Size Class wise Classification of Sample Farmers

Category	Sugarcane		Tur		Total	
	NCU	Non-NCU	NCU	Non-NCU	NCU	Non-NCU
Marginal and Small (0-5 acres)	85	46	31	58	116	104
Medium (5-12.49 acres)	42	17	38	43	80	60
Large (12.5 and more)	9	1	15	15	24	16
Total	136	64	84	116	220	180

1.6 Limitation of the study

The study is mainly based on adoption behaviour of farmers and their perceptions about change in output, yield, costs, fertiliser usage etc. after adopting NCU as the fertiliser. The changes in these variables in 2015 as compared to 2014 could have taken place due other factors also. However, the study does not analyse various causes leading to change in indicator in 2015 Also, the study mainly is concerned with economics behind usage of NCU and does not refer to/analyse in detail the scientific evidence relating to usage and impact of NCU. Hence, care should be taken while interpreting these results as outcome of usage of NCU.

1.7 Organisation of the Report

Chapter one on introduction is followed by chapter two which analyses district wise and state level trends in urea consumption and the prices in Maharashtra. Socio-economic characteristics of sample households are studied in chapter three. Chapter four on status of awareness and application of NCU analyses our observations on awareness among the sugarcane and tur farmers regarding usage, benefits and impact of NCU. The focus of chapter five is on awareness about and status of adoption of soil health technology by the farmers. Responses relating to the impact of NCU application on crop production and soil health for the farmers are studied in chapter six. The last chapter i.e. chapter seven presents summary and conclusions and the emerging policy recommendations.

Chapter 2

Trends in Urea Consumption in the Maharashtra State

2.1 Introduction

The state of Maharashtra accounts for 12 percent of the total GCA. The total fertiliser consumption (total product) of the state was 58.2 lakh MT in TE 2014-15 which accounted for 11.2 percent of the all India level consumption. Maharashtra was the second largest fertilizer consuming state next to Uttar Pradesh. However, it is observed that state fertilizer consumption per hectare was about 7.6 percent less than that at all India level. The average per hectare consumption of fertilisers in the state was 120.5 kg for the T.E. 2014-15 (GoM, 2016, 2015) and the state held 12th position in that respect (FAI, 2015).

With this background, we study the trends in total urea consumption in Maharashtra and it's per hectare usage during 2000-01 and 2015-16.

2.2 Trends in Urea Consumption

Maharashtra accounted for about 8.3 percent of the total urea consumption in the country for the T.E. 2014-15, and occupied the position of third largest urea consuming state in the country next to Uttar Pradesh and Punjab. Total urea consumption in Maharashtra was 25.2 lakh MT for the T.E. 2015-16.

The year-wise data on urea consumption of Maharashtra from 2000-01 to 2015-16 is presented in Table 2.1. The urea consumption in the state has increased from around 16 lakh MT in 2000-01 to 23 Lakh MT in 2015-16 with a CAGR of 4.1 percent per annum. This can be observed from Figure 2.1 also. The urea consumption reduced in 2003-04 to 14 lakh MT but started rising then onwards. It increased continuously till 2010-11, after which it declined. The consumption peaked in 2013-14 to become 26.5 lakh MT. Fluctuations in the urea consumption in Maharashtra seem to be related to the occurrence of droughts. One of the major reason for reduction in urea consumption in 2003-04, 2009-10, 2012-13, 2014-15, and 2015 appear to be the onslaught of severe droughts in these years (GoI, 2015).

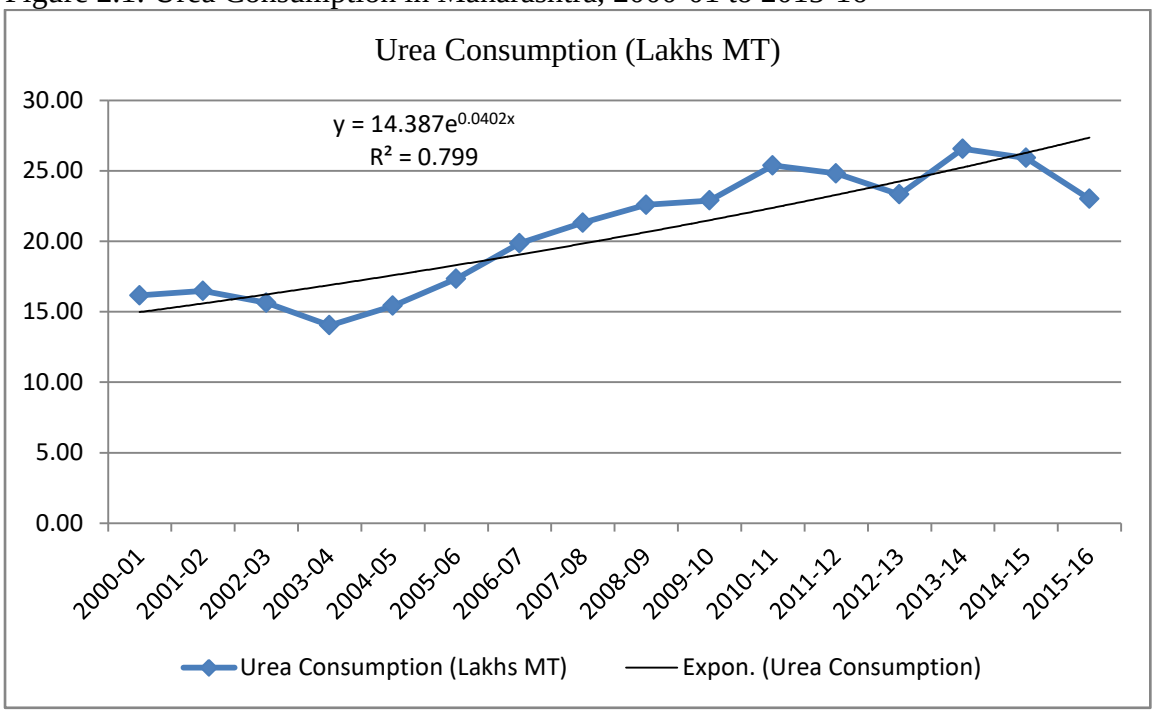
Per hectare urea consumption increased from 74.7 kg in 2000-01 to 111.3 kg in 2014-15, with a CAGR of 3.9 percent. The average urea consumption per hectare of GCA for the T.E. 2014-15 for Maharashtra was 108.6 kg per hectare as compared to 156.4 kg per hectare of India. Thus, overall fertilizer as well as urea consumption per hectare of GCA of Maharashtra is lower when compared to all India figures.

Table 2.1: Year wise Urea Consumption of Maharashtra, 2000-01 to 2015-16 (lakh MT)

Year	Urea (lakh MT)	Urea consumption per hectare (kgs)
2000-01	16.15	74.7
2001-02	16.48	78.5
2002-03	15.63	74.7
2003-04	14.03	63.2
2004-05	15.42	68.9
2005-06	17.34	76.9
2006-07	19.85	88.0
2007-08	21.31	94.1
2008-09	22.58	100.6
2009-10	22.89	101.2
2010-11	25.38	109.5
2011-12	24.81	107.4
2012-13	23.32	100.9
2013-14	26.55	113.6
2014-15	25.72	111.3
2015-16	23.00	NA

Note: NA Not available, as data on GCA was unavailable at the time of writing of the report.
Source: Officer of Commissionerate of Agriculture, GoM, Pune

Figure 2.1: Urea Consumption in Maharashtra, 2000-01 to 2015-16



Source: Based on data provided by office of Commissionerate of Agriculture, GoM, Pune

2.3 Urea Use by Districts

As has been already mentioned above, urea usage in Maharashtra for the period 2000-01 to 2015-16 increased at a CAGR of 4.1 percent. This rate of growth was not uniform across the districts of the state. The variation in the rates of growth of urea usage within the state can be attributed to the inter-district variation in various agro-climatic

and socio-economic factors such as weather (rainfall), irrigation, cropping pattern, etc. Sharma and Thaker (2011, p. 22) found that irrigation was the most important factor influencing fertiliser demand, followed by cropping intensity at all India level.

The division-wise and district wise data on urea consumption are shown in Table 2.2. It is observed that for the T.E. 2015-16, Nasik division had the highest urea consumption followed by Pune division. Konkan division had the least urea consumption as well as lowest share in total GCA of the state. It is noted that the agriculturally well-developed divisions of the state such as Nasik, Pune and Kolhapur have contributed proportionately more to the total urea consumption than to the GCA. However, the contribution of less developed divisions of the state viz. Marathwada (central Maharashtra) and Vidarbha (Eastern Maharashtra) to the total GCA is proportionately more than their respective urea consumption. It is interesting to note that the growth rate of urea consumption is less than that of the all India average for Kolhapur division and Latur division. For the state as a whole, urea consumption has been growing at the rate of 4.30 percent per annum.

It is observed that the percentage share of urea consumption in total fertiliser consumption is 42 percent at the state level. In majority of the districts, it is 30 percent or more. The share is higher in the districts of Konkan division. Overall, the Table indicates the importance of urea in fertiliser consumption in various districts of the state.

The urea application per hectare of GCA was highest in Kolhapur district (198.9 kg) followed by Nandurbar and Jalgaon districts (188.3 and 171.4 kg respectively). These are the only three districts in the state which had higher per hectare consumption of urea compared to that of all India average. These are also the districts with diversified cropping pattern and higher intensity of irrigation. Urea application per hectare of GCA is found be lower in districts such as in Osamanabad, Beed, Latur and Hingoli which are the economically backward and largely rainfed districts of the state.

Table 2.2: District-wise Consumption of Urea in Maharashtra for the T.E. 2015-16

Districts /Division	Urea consumption (000 tonnes)	percent share to State		% share of urea in total fertilizer consumption T.E. 2015-16	CAGR of urea consumption (2001-02 to 2015-16) (%)	Urea consumption per hectare (kgs) T.E. 2014-15
		Urea consumption	Gross Cropped Area			
Thane*	33.55	1.33	1.06	79.08	1.33	138.82
Raigad	24.60	0.98	0.93	71.42	0.59	110.99
Ratnagiri	12.72	0.51	1.14	63.56	-0.45	45.70
Sindhudurg	9.42	0.37	0.68	54.84	2.33	56.47
Konkan	**80.29**	**3.19**	**3.81**	**70.39**	**0.92**	**89.50**
Nasik	133.64	5.31	4.25	39.96	3.71	135.36
Dhule	73.81	2.93	2.31	48.45	1.68	136.95
Nandurbar	70.97	2.82	1.57	52.37	6.56	188.28
Jalgaon	199.13	7.92	5.00	41.89	4.92	171.44
Nasik Div.	**477.55**	**18.99**	**13.13**	**43.51**	**4.18**	**155.70**
Ahmadnagar	133.09	5.29	6.28	38.29	2.98	94.82
Pune	150.30	5.98	5.03	42.64	4.79	131.21
Solapur	146.83	5.84	5.01	46.69	5.49	128.12
Pune Div.	430.22	**17.11**	**16.32**	**42.41**	4.39	**116.29**
Satara	80.62	3.21	2.82	43.89	3.82	125.34
Sangli	90.96	3.62	3.02	40.16	4.49	136.44
Kolhapur	123.62	4.91	2.77	43.79	3.14	198.90
Kolhapur	**295.20**	**11.74**	**8.61**	**42.63**	**3.72**	**152.86**
Aurangabad	151.86	6.04	4.85	47.52	7.63	127.87
Jalna	94.67	3.76	3.52	41.57	4.50	104.88
Beed	75.64	3.01	4.42	40.00	5.06	77.28
Aurangabad	**322.16**	**12.81**	**12.80**	**43.75**	**5.99**	**103.94**
Latur	41.75	1.66	3.28	32.52	3.18	62.97
Osmanabad	29.57	1.18	4.02	37.21	7.08	36.36
Nanded	136.96	5.45	3.95	40.43	3.90	143.90
Parbhani	57.18	2.27	3.79	42.35	1.59	68.65
Hingoli	29.13	1.16	2.41	34.43	4.37	59.24
Latur Div	**294.59**	**11.71**	**17.45**	**38.45**	**3.66**	**75.73**
Buldhana	84.04	3.34	4.08	33.37	4.11	92.94
Akola	33.60	1.34	2.86	29.96	0.87	51.95
Washim	27.38	1.09	2.30	31.46	6.29	54.57
Amravati	62.07	2.47	4.23	34.02	6.03	63.28
Yavatmal	109.88	4.37	4.27	43.82	5.94	112.08
Amravati	**316.97**	**12.60**	**17.75**	**35.85**	**4.78**	**78.89**
Wardha	60.56	2.41	2.01	39.99	7.18	122.25
Nagpur	76.77	3.05	2.78	42.68	5.39	113.47
Bhandara	36.44	1.45	1.09	40.77	4.00	136.80
Gondia	33.49	1.33	1.03	45.48	2.14	131.94
Chandrapur	57.36	2.28	2.29	45.41	4.11	103.14
Gadchiroli	31.64	1.26	0.92	51.30	6.64	134.90
Nagpur	**296.26**	**11.78**	**10.13**	**43.42**	**4.89**	**119.22**
Maharashtra	**2515.12**	**100.00**	**100.00**	**42.00**	**4.30**	**108.59**

Note: 1. percent share of district GCA to State is for the T.E. 2014-15 2. * The 36th district of Maharashtra i.e., Palghar was formed out of Thane district on 1 August 2014. The data on urea consumption of Palghar district is available for 2015-16. This data has been clubbed into Thane district for the purpose of calculations.

Source: Office of Commissionerate of Agriculture, GoM, Pune

2.4 Pricing of Fertilisers

As urea is one of the widely used fertilizer products accounting for 57 percent of total fertilizer consumption in 2014-15 (FAI, 2015), for the overall welfare of the farmers, it has been the policy objective of the government to keep the fertilizers prices at affordable levels. To satisfy this objective, the government has been controlling the price of urea which is sold at statutory notified uniform sale price. The decontrolled P and K fertilizes are sold at indicative maximum retail prices (MRPs). The statutorily notified sale price and indicative MRP are generally less than the cost of production of the respective manufacturing units. The difference between the cost of production and the selling price/MRP is thus paid as subsidy/concession to manufacturers.

Table 2.3 shows prices of urea and NCU which are fixed by the government and are changed at intervals of time. It can be seen that the price of NCU has been fixed at five percent above the price of urea.

Table 2.3: Prices of Urea and NCU (Rs.)

Period	Urea		NCU	
	Per tonne	Per bag (50kg)	Per tonne	Per bag (50kg)
Feb. 29, 2000	4,600	230	-	-
Feb 28, 2001	4600	230		
Feb. 28, 2002	4,830	242	-	-
Feb. 28, 2003	5,070	254	-	-
March 12, 2003	4,830	242	-	-
April 01, 2010	5,310	266	-	-
Nov. 01, 2012	5,360	268	-	-
April 01, 2013	5360	268	-	-
May, 2014	5,680	284	5,968	298
June, 2015	5,680	284	5,970	298
April 01,2016	5,685	284	5,980	299

Source: Fertilizer statistics, 2014-15 (FAI, 2015)

It can be observed from the data that the urea prices have been increasing marginally across years after 2000. In 2010, the government introduced product-based subsidy regime for P and K fertilisers such as DAP and MOP respectively. The MRP of P and K fertilisers (and their complexes) were left open to be fixed at a 'reasonable rate' by fertiliser companies on the basis of the demand-supply, after incorporating the subsidy element, which remains fixed. However, urea prices are still controlled by the government. From 2009- 10 to 2015-16, the rate of increase in urea price was 17.5 percent, which is quite less as compared to that in MRP of DAP (171.2 percent) and MOP (277.6 percent). With the rising prices of fertilizers in global market, the prices of P and K fertilisers increased considerably in the domestic market also. It was observed

that in April 2010, almost 38 per cent (in case of DAP) and 25.6 per cent (in case of MOP) of the total cost of fertilisers under nutrient based subsidy regime was borne by the farmers. By 2012-13, the percentage of the total cost paid by farmers became 66.58 per cent and 61.1 per cent for DAP and MOP respectively (Gulati and Banerjee, 2015). The rising prices of DAP and MOP compared to urea is considered to be one of the main reasons for the imbalance in the usage of fertilisers.

In view of this, the importance of NCU can be highlighted as its usage expected to get reduced not only in the agricultural sector but also to prohibit the diversion of urea (due to neem coating) into other sectors for various purposes.

2.5 Concluding Remarks

It is observed from the analysis of the secondary data that although Maharashtra is the second largest fertilizer consuming and third largest urea consuming state in the country, it's per hectare fertilizer (NPK) and urea consumption was about 120.5 kg and 108.6 kg respectively for the T.E. 2014-15, which was 7.6 percent and 29.3 percent respectively less than the all India respective averages.

The urea consumption in the state increased at the rate of 4.1 percent per annum during the period 2000-01 to 2015-16. Across years, urea consumption appears to have been affected by occurrence of droughts, since 2009. Moreover, the rate of growth of urea consumption is not uniform across the divisions and districts of the state. The variation in the rates of growth of urea usage within the state can be attributed to inter-district variation in various agro-climatic and socio-economic factors. The district-wise data for T.E. 2014-15 reveals that only three districts Kolhapur, Nandurbar and Jalgaon within the state had higher per hectare consumption of urea compared to that of all India average. The lowest urea application per hectare of GCA was found in Osamanabad district.

From 2009-10 to 2015-16, the rate of increase in urea price is 17.5 percent, which is quite less as compared to that in MRP of DAP (171.2 percent) and MOP (277.6 percent). The rising prices of DAP and MOP compared to urea is considered to be one of the main reasons for the imbalance in the usage of fertilisers.

In view of this, the importance of NCU can be highlighted as its usage not only is expected to reduce in the agricultural sector but also prohibit the diversion of urea (due to neem coating) into other sectors for various purposes.

Socio-economic Characteristics of Sample Households

3.1 Socio-economic Characteristics of the Sample Households

This Chapter studies various socio economic characteristics of the sample households' analyses data on usage of inputs and profitability of crops. The socio economic characteristics of the sample households are presented in Table 3.1. The data shows that the average age of the respondents is around 48 years and that majority of the respondents are male respondents. The family size of the households is above six and more than 50 per cent of the households are engaged in farming. The Table also shows that the number of years of experience of the overall respondents is around 26.

Table 3.1: General Characteristics of the Sample Farmers

Particulars	Sugarcane			Tur			Overall		
	NCU	Non-NCU	All	NCU	Non-NCU	All	NCU	Non-NCU	All
Age (years)	45.4	50.0	46.9	52.2	49.6	50.7	48.0	49.7	48.8
Male (% sample)	98.5	100.0	99.0	95.2	96.6	96.0	97.3	97.8	97.5
Family size (no)	6.8	6.5	6.7	6.7	6.8	6.8	6.7	6.7	6.7
Family members engaged in farming (no)	3.1	3.2	3.1	3.1	3.3	3.2	3.1	3.3	3.2
Farming experience (yrs)	24.8	28.1	25.9	27.8	25.7	26.6	26.0	26.6	26.2

Table 3.2 clearly brings out overall higher level of education among sugarcane farmers from western Maharashtra as compared to the tur farmers from Marathwada and Vidarbha. The percentage of illiterate farmers is higher i.e. 14 percent in case of tur farmers compared to 2 percent in case of sugarcane farmers. Similarly, the Table also shows higher percentage of farmers in pre university category in case of sugarcane as against the tur farmers. Overall, 5.5 percent of NCU and 11.7 percent of Non-NCU farmers were illiterate. Around 41 percent of NCU and 27 percent of Non-NCU farmers had taken education up to pre-university level and above. Overall, the data shows that the NCU farmers were better of as far as the level of education is concerned.

The caste composition of the sample farmers is presented in Table 3.3. In case of sugarcane, it is dominated by general category farmers. In case of tur, majority of the farmers belong to the general category (42 percent) as well as OBC category (28.5 percent). Thirty percent of the farmers belong to other social groups also. It is observed that total sample households mainly belong to general category (58 percent) and OBC category (28 percent)

Table 3.4 shows that for nearly 98 percent of the total sugarcane and tur households, agriculture was main occupation. The data shows that only in case of NCU sugarcane farmers, three per cent of the farmers were either self-employed in services or were engaged in salaried work. In case of tur, extent of farmers working under other categories was negligible. Overall, 98 per cent of the farmers worked in the agricultural and allied sector.

Table 3.2: Education Level of Sample Farmers (% farmers)

Education level	Sugarcane			Tur			Overall		
	NCU	Non-NCU	All	NCU	Non-NCU	All	NCU	Non-NCU	All
Illiterates	2.2	1.6	2.0	10.7	17.2	14.5	5.5	11.7	8.3
Primary	5.1	12.5	7.5	16.7	13.8	15.0	9.5	13.3	11.3
Higher primary	15.4	26.6	19.0	28.6	20.7	24.0	20.5	22.8	21.5
Matriculation	27.2	25.0	26.5	19.0	25.9	23.0	24.1	25.6	24.8
Pre-university and above	50.0	34.4	45.0	25.0	22.4	23.5	40.5	26.7	34.3

Note: Primary Class 1 to 4; Higher Primary Class 5 to 9; Matriculation Class 10 passed; Pre-university Class 11 and above

Table 3.3: Distribution of Sample Farmers based on their Social Category (% farmers)

Particulars	Sugarcane			Tur			Overall		
	NCU	Non-NCU	All	NCU	Non-NCU	All	NCU	Non-NCU	All
General	75.0	67.2	72.5	38.1	45.7	42.5	60.9	53.3	57.5
OBC	14.0	14.1	14.0	31.0	26.7	28.5	20.5	22.2	21.3
NT/VJNT	3.7	3.1	3.5	15.5	8.6	11.5	8.2	6.7	7.5
ST	0.7	0.0	0.5	9.5	9.5	9.5	4.1	6.1	5.0
SC	3.7	4.7	4.0	2.4	6.9	5.0	3.2	6.1	4.5
Minorities	2.2	6.3	3.5	1.2	0.9	1.0	1.8	2.8	2.3
SBC*	0.7	4.7	2.0	2.4	1.7	2.0	1.4	2.8	2.0

Note : * Special backward castes

Table 3.4: Main Occupational Distribution of the Sample Farmers (% farmers)

Particulars	Sugarcane			Tur			Overall		
	NCU	Non-NCU	All	NCU	Non-NCU	All	NCU	Non-NCU	All
Agri and allied	97.0	100.0	98.0	97.6	97.4	97.5	97.3	98.3	97.8
Agri labour	0.0	0.0	0.0	1.2	0.9	1.0	0.5	0.6	0.5
Self-employed in SSI	0.0	0.0	0.0	0.0	0.9	0.5	0.0	0.6	0.3
Self-employed in services	1.5	0.0	1.0	0.0	0.9	0.5	0.9	0.6	0.8
Salaried work	1.5	0.0	1.0	1.2	0.0	0.5	1.4	0.0	0.8

Note: Agri –Agriculture, SSI- small scale industries

3.2 Details of Operational Land Holdings

It is observed from Table 3.5 that the average size of landholding for tur farmers is greater than that of the sugarcane farmers. This reflects the difference between the average size of land holding in western Maharashtra on one hand and Vidarbha (eastern region) and Marathwada (central region) on the other.

For the sugarcane NCU and Non-NCU farmers, average size of landholding is 6.19 acres and 4.77 acres respectively. The extent of leasing in and leasing out is negligible. Similarly more than 90 per cent of the total owned land is under irrigation. For tur however, the average size of owned land is 8.49 acres and 7.18 acres for NCU and Non-NCU farmers respectively. The percentage of land under irrigation is less (72 per cent) in case of tur farmers and is increasing with the size class of landholding. Overall, for all the farmers, the average size of landholding is 6.33 acres and only around 53 per cent of the land is under irrigation.

3.3 Cropping Pattern and Sources of Irrigation

Table 3.6 shows the category wise and overall extent of irrigation in case of the sample farmers. It is observed that around 89 per cent of the net operated area of all the sugarcane farmers was irrigated as the cropping pattern of these farmers includes rainfed crops also. For tur, only around 38 per cent of the area is irrigated. In both the cases percentage of area irrigated was higher for the NCU farmers. Overall only 37 per cent of the total sample net operated area was under irrigation.

The data on sources of irrigation shows that for sugarcane apart from open and bore well, other public sources such as river, canal and tank are also important. In case of tur however, the farmers have to rely on private sources like wells for satisfying the irrigation needs. Again this also reveals regional differences in area irrigated, sources of irrigation and differences in public investment in irrigation in Maharashtra.

Table 3.5: Average Operational Land Holdings of the Sugarcane and Tur Farmers (acres)

Particulars	NCU				Non-NCU			
	Small	Medium	Large	All	Small	Medium	Large	All
Sugarcane								
Owned land (a)	3.19	8.45	24.00	6.19	3.00	8.10	30.00	4.77
Uncultivated (b)	0.07	0.13	0.67	0.13	0.10	0.20	0.00	0.13
Leased-in (c)	0.00	0.21	0.00	0.07	0.00	0.18	0.00	0.05
Leased-out (d)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NOA (a-b+c-d)	3.12	8.55	23.33	6.14	2.89	8.12	30.00	4.70
% Irrigated	96.89	88.31	85.71	90.38	92.11	78.26	100	86.54
% Un Irrigated	3.11	11.69	14.29	9.62	7.89	21.74	0.00	13.46
Total	100	100	100	100	100	100	100	100
Rental leased-in land (Rs/acre)	0.00	1095.24	0.00	338.24	0.00	1352.94	0.00	359.38
Rental leased-out land (Rs/acre)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tur								
Owned land (a)	3.79	8.95	17.03	8.49	3.26	8.00	20.00	7.18
Uncultivated (b)	0.03	0.38	0.73	0.32	0.05	0.17	2.10	0.36
Leased-in (c)	0.00	0.00	1.33	0.24	0.00	0.07	0.00	0.03
Leased-out (d)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NOA (a-b+c-d)	3.76	8.57	17.63	8.41	3.23	7.90	17.90	6.86
% Irrigated	67.28	47.10	41.97	48.46	35.05	25.77	25.51	27.89
% Unirrigated	32.72	52.90	58.03	51.54	64.95	74.23	74.49	72.11
Total	100	100	100	100	100	100	100	100
Rental leased-in land (Rs/acre)	0.00	0.00	900.00	160.71	0.00	0.00	0.00	0.00
Rental leased-out land(Rs/acre)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Overall (total of sugarcane and tur farmers)								
Owned land (a)	3.35	8.69	19.65	7.07	3.14	8.03	20.63	6.33
Uncultivated (b)	0.06	0.25	0.71	0.20	0.07	0.18	1.97	0.28
Leased-in (c)	0.00	0.11	0.83	0.13	0.00	0.10	0.00	0.03
Leased-out (d)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NOA (a-b+c-d)	3.27	8.54	19.77	6.99	3.10	7.98	18.66	6.11
% Irrigated	87.96	68.78	61.33	71.22	58.56	40.91	33.00	43.94
% Unirrigated	12.04	31.22	38.67	28.78	41.44	59.09	67.00	56.06
Total	100	100	100	100	100	100	100	100
Rental leased-in land (Rs/acre)	0.00	575.00	562.50	270.45	0.00	383.33	0.00	127.78

Note : NOA= net operated area

Table 3.6: Extent of Irrigation among Sample Farmers (In percent)

Particulars	Sugarcane			Tur			All		
	NCU	Non-NCU	Total	NCU	Non-NCU	Total	NCU	Non-NCU	Total
Irrigated	90.38	86.54	89.37	48.46	27.89	37.52	71.22	43.94	37.52
Unirrigated	9.62	13.46	10.63	51.54	72.11	62.48	28.78	56.06	62.48
Total	100	100	100	100	100	100	100	100	100

Table 3.7: Sources of Irrigation of the Farmers (Percentage of farmers)

Particulars	Sugarcane			Tur			Overall		
	NCU	Non- NCU	All	NCU	Non-NCU	All	NCU	Non-NCU	All
Open well	50.0	41.3	47.2	89.8	86.0	88.1	55.0	38.9	47.8
Bore well	30.9	38.1	33.2	32.2	38.0	34.9	27.7	23.9	26.0
Canal	11.8	4.8	9.6	0.0	0.0	0.0	7.3	1.7	4.8
Tank	0.7	1.6	1.0	1.7	0.0	0.9	0.9	0.6	0.8
River/lift	67.7	57.1	64.3	1.7	0.0	0.9	42.3	20.0	32.3

Note: Multiple responses were reported

Tables 3.8 and 3.9 present the cropping pattern of sugarcane and tur the sample households respectively. Overall for NCU and Non-NCU farmers, 66 per cent and 65 per cent of the area respectively was under sugarcane. Other important crops were cereals, oilseeds and horticultural crops. Sugarcane was an irrigated crop and for all categories of farmers, area under this crop is fully covered under irrigation for NCU as well as Non-NCU farmers and its share was around 70 per cent in the cropping pattern for area under irrigation. It is observed that the area under majority of other crops (mainly cereals and pulses) is rainfed for NCU and Non-NCU farmers.

In case of tur farmers, around 17 percent of the total area is under tur. For these farmers, oilseeds (mainly soybean) are the most important category in the cropping pattern. For NCU and Non-NCU farmers, 46 percent and 55 percent of the area is under oilseeds respectively. The other major crops are cereals and cotton. It is observed that the extent of area under irrigation is very low in case of tur farmers. Whereas the total sown area under irrigation is 1.92 acres, that under rainfed conditions is 4.97 acres for Non-NCU farmers. For NCU farmers however, it is almost equally divided into irrigated area and rainfed area.

Table 3.8: Cropping Pattern of Sugarcane Respondents during Kharif Season, 2015-16 (Average area in acres and % in parenthesis)

Name of the Crops	Irrigated				Rainfed				Total			
	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large	All
NCU												
Sugarcane	2.15 (74.0)	4.98 (66.7)	10.67 (55.8)	3.59 (70.6)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	2.15 (71.8)	4.98 (58.9)	10.67 (47.5)	3.59 (66.2)
Cereals	0.18 (6.1)	0.66 (7.5)	3.39 (16.0)	0.54 (7.2)	0.05 (54.5)	0.31 (31.0)	2.11 (63.3)	0.27 (45.5)	0.24 (7.1)	0.97 (10.6)	5.5 (21.0)	0.81 (9.1)
Pulses	0.06 (1.4)	0.05 (0.8)	0.0 (0.0)	0.05 (1.1)	0.00 (0.0)	0.1 (9.5)	0.22 (6.7)	0.04 (7.5)	0.06 (1.4)	0.14 (1.4)	0.22 (0.4)	0.10 (1.3)
Oilseed	0.31 (9.0)	0.74 (9.6)	2.94 (11.4)	0.62 (9.3)	0.04 (36.4)	0.45 (45.2)	0.44 (13.3)	0.19 (32.4)	0.34 (10.1)	1.2 (14)	3.39 (12)	0.81 (11.4)
Cotton	0.13 (3.9)	0.22 (3.2)	0.11 (1.1)	0.15 (3.5)	0.01 (9.1)	0.00 (0.0)	0.00 (0.0)	0.01 (0.9)	0.14 (4.1)	0.22 (2.9)	0.11 (0.6)	0.16 (3.5)
Horticulture and others	0.19 (5.5)	0.90 (12.2)	2.89 (15.7)	0.59 (8.2)	0.00 (0.0)	0.14 (14.3)	0.56 (16.7)	0.08 (13.7)	0.19 (5.5)	1.04 (12.2)	3.44 (18.6)	0.67 (8.4)
Total Sown Area	3.02 (100)	7.55 (100.0)	20.00 (100)	5.55 (100)	0.10 (100)	1.00 (100)	3.33 (100)	0.59 (100)	3.12 (100)	8.55 (100)	23.33 (100)	6.14 (100)
Non-NCU												
Sugarcane	1.85 (75.6)	3.88 (64.8)	15.00 (50.0)	2.59 (72.3)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	1.85 (70.8)	3.88 (48.4)	15.00 (50.0)	2.59 (64.6)
Cereals	0.18 (5.1)	1.24 (15.6)	13.00 (43.3)	0.66 (8.5)	0.09 (38.1)	0.62 (35.0)	0.00 (0.0)	0.23 (35.8)	0.27 (6.8)	1.85 (21.6)	13.00 (43.0)	0.89 (11.3)
Pulses	0.02 (0.5)	0.06 (0.8)	0.00 (0.0)	0.03 (0.6)	0.00 (0.0)	0.12 (6.7)	0.00 (0.0)	0.03 (4.9)	0.02 (0.5)	0.18 (1.5)	0.00 (0.0)	0.06 (0.8)
Oilseed	0.15 (5.0)	0.41 (8.5)	0.00 (0.0)	0.22 (5.9)	0.12 (52.4)	0.79 (45.0)	0.00 (0.0)	0.30 (46.9)	0.27 (8.3)	1.21 (15.6)	0.00 (0.0)	0.52 (10.1)
Cotton	0.20 (5.3)	0.29 (3.4)	0.00 (0.0)	0.22 (4.7)	0.00 (0.0)	0.24 (13.3)	0.00 (0.0)	0.06 (9.9)	0.20 (5.3)	0.53 (6.0)	0.00 (0.0)	0.28 (5.4)
Horticulture and others	0.27 (8.5)	0.47 (6.8)	2.00 (6.7)	0.35 (8.0)	0.02 (9.5)	0.00 (0.0)	0.00 (0.0)	0.02 (2.5)	0.29 (8.3)	0.47 (6.8)	2.0 (6.7)	0.37 (7.9)
Total Sown Area	2.66 (100)	6.35 (100)	30.0 (100)	4.07 (100)	0.23 (100)	1.76 (100)	0.00 (0.0)	0.63 (100)	2.89 (100)	8.12 (100)	30 (100.0)	4.7 (100)

Table 3.9: Cropping Pattern of the Tur Respondents during Kharif Season, 2015-16 (Average area in acres and % in parenthesis)

Name of the Crops	Irrigated				Rainfed				Total			
	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large	All
NCU												
Tur	0.45 (18)	0.55 (13.6)	1.2 (16.2)	0.63 (15.5)	0.24 (19.5)	0.86 (19.0)	1.63 (16.0)	0.77 (17.8)	0.68 (18.5)	1.4 (16.4)	2.83 (16.1)	1.39 (16.6)
Cereals	0.19 (7.8)	0.13 (3.3)	0.37 (5.0)	0.20 (4.8)	0.22 (18)	0.74 (16.4)	2.07 (20.2)	0.78 (18.2)	0.41 (11.1)	0.87 (10.2)	2.43 (13.8)	0.98 (11.7)
Other pulses	0.13 (5.2)	0.12 (3.0)	0.00 (0.0)	0.10 (2.5)	0.01 (0.7)	0.36 (7.9)	0.80 (7.8)	0.31 (7.1)	0.14 (3.7)	0.47 (5.6)	0.80 (4.5)	0.41 (4.9)
Oilseeds	0.87 (35.1)	1.67 (41.6)	3.9 (52.7)	1.78 (43.8)	0.44 (36.5)	2.3 (51.1)	5.07 (49.5)	2.11 (48.9)	1.32 (35.6)	3.97 (46.6)	8.97 (50.9)	3.88 (46.4)
Cotton	0.84 (33.8)	1.09 (27.0)	0.97 (13.1)	0.97 (24.0)	0.31 (25.3)	0.23 (5.1)	0.67 (6.5)	0.34 (7.8)	1.15 (31.1)	1.32 (15.4)	1.63 (9.3)	1.31 (15.7)
Horticulture and others	0.00 (0.0)	0.46 (11.5)	0.97 (13.1)	0.38 (9.4)	0.00 (0.0)	0.03 (0.6)	0.00 (0.0)	0.01 (0.3)	0.00 (0.0)	0.49 (5.7)	0.97 (5.5)	0.39 (4.7)
Total Sown Area	2.49 (100)	4.01 (100)	7.4 (100)	4.06 (100)	1.21 (100)	4.51 (100)	10.23 (100)	4.31 (100)	3.7 (100)	8.52 (100)	17.63 (100)	8.37 (100)
Non-NCU												
Tur	0.18 (15.4)	0.31 (15.4)	0.53 (11.7)	0.27 (14.3)	0.49 (23.3)	0.99 (16.9)	2.1 (15.8)	0.89 (17.9)	0.67 (20.5)	1.31 (16.5)	2.63 (14.7)	1.16 (16.9)
Cereals	0.02 (1.5)	0.13 (6.3)	1.1 (24.1)	0.2 (10.3)	0.28 (13.0)	0.74 (12.6)	1.57 (11.8)	0.61 (12.4)	0.29 (9.0)	0.87 (10.9)	2.67 (14.9)	0.81 (11.8)
Other pulses	0.00 (0.0)	0.08 (4.0)	0.13 (2.9)	0.05 (2.5)	0.02 (0.8)	0.51 (8.7)	0.57 (4.3)	0.27 (5.5)	0.02 (0.5)	0.59 (7.5)	0.7 (3.9)	0.32 (4.6)
Oilseeds	0.55 (48.1)	1.15 (56.1)	2.27 (49.6)	0.99 (51.7)	1.12 (52.8)	2.96 (50.3)	8.97 (67.3)	2.82 (56.7)	1.67 (51.1)	4.1 (51.8)	11.23 (62.8)	3.81 (55.3)
Cotton	0.31 (26.7)	0.12 (5.7)	0.4 (8.8)	0.25 (12.9)	0.20 (9.3)	0.62 (10.5)	0.13 (1.0)	0.34 (6.9)	0.5 (15.4)	0.73 (9.3)	0.53 (3.0)	0.59 (8.6)
Horticulture	0.09 (8.3)	0.26 (12.5)	0.13 (2.9)	0.16 (8.3)	0.02 (0.8)	0.06 (1.0)	0.00 (0.0)	0.03 (0.6)	0.11 (3.4)	0.31 (4.0)	0.13 (0.7)	0.19 (2.8)
Total Sown Area	1.15 (100)	2.04 (100)	4.57 (100)	1.92 (100)	2.12 (100)	5.88 (100)	13.33 (100)	4.97 (100)	3.27 (100)	7.92 (100)	17.9 (100)	6.89 (100)

3.4 Purchasing Pattern and Sources of Purchasing

Table 3.10 shows purchase pattern of NCU and urea per household in the reference year. It is observed that per household usage of NCU is higher for the NCU sugarcane farmers than the tur NCU farmers as sugarcane is a fully irrigated crop. The respondents reported that they used urea in addition to NCU whenever they faced shortages of NCU. The total quantity (NCU plus urea) purchased by the sugarcane cultivators is more than 10 times of that purchased by the tur farmers. The government declared price for NCU and urea is Rs. 298 and Rs. 285 per bag of 50 kg respectively. However, it was reported that the actual price charged by the sellers was generally marginally higher than the maximum retail price (MRP) and depended on the transport cost incurred for delivering the stock into the village and also on the scarcity of the fertiliser in the season.

The transport cost incurred for procuring urea by tur farmers is higher compared to sugarcane farmers. This might be because of lesser usage of fertiliser for the crop, lesser demand for fertilisers during the drought years and hence less number of outlets within the village. As a result, the total cost incurred by all sugarcane farmers was (Rs. 311.1) less than the total cost incurred by the tur farmers (Rs.341.7).

Table 3.10: Purchase Pattern of NCU Farmers for the Reference Year (Rs. per Household)

Particular	Sugarcane				Tur				Overall			
	NCU			Non-NCU	NCU			Non-NCU	NCU			Non-NCU
	NCU	Urea	Total Urea	Urea	NCU	Urea	Total Urea	Urea	NCU	Urea	Total Urea	Urea
Quantity (Kgs)	711.4	58.8	770.2	616.4	60.3	1.5	61.8	48.6	462.8	36.9	499.7	250.5
Price*	300.1	286.3	299.3	284.6	324.6	300.0	324.0	299.9	309.5	288.1	307.9	294.4
Distance #	5.4	2.8	5.4	6.0	10.3	12.7	10.3	9.9	7.3	4.0	7.3	8.5
Transport*	12.1	8.3	11.8	12.7	17.7	18.3	17.7	17.2	14.2	9.6	13.9	15.6
Total cost*	312.2	294.5	311.1	297.3	342.3	318.3	341.7	317.1	323.7	297.6	321.8	310.0

Note : * Rs. per bag of 50 kg; # Distance from farm to fertilizer shop in kms;

Most of the sugarcane farmers (NCU as well as Non-NCU) have purchased urea from private fertilizer dealers and cooperative societies. For tur, all the purchases are from private dealers. It was observed that due to drought and consequent low demand for fertilizers, various village cooperative societies were not working in case of sample tur areas. The farmers reported that they purchased fertilisers whenever needed from private dealers at taluka place (which led to higher transport cost for these farmers as

compared to the sugarcane farmers). Overall, 76 percent of NCU and 88 percent of the Non-NCU farmers purchased urea from private fertilizer dealers.

Table 3.11: Sources of Purchase of NCU/Non-NCU (Percentage of farmers)

Sl. No	Particulars	Sugarcane		Tur		Overall	
		NCU	Non-NCU	NCU	Non-NCU	NCU	Non-NCU
1	Private fertilizer dealers	74.3	65.6	100.0	100.0	76.4	87.8
2	Cooperative societies	35.3	40.6	0.0	0.0	21.8	14.4
3	Agriculture Department	0.0	0.0	0.0	0.0	0.0	0.0

Note: Multiple responses were generated

3.5 Usage of Inputs and Profitability of Reference Crops

This section discusses cost of cultivation (CoC) of the of the sugarcane and tur farmers for the reference years 2014 and 2015. The Tables 3.12 to 3.15 present CoC and share of inputs in the paid out cost for sugarcane and Tables 3.16 to 3.19 present data relating to tur farmers.

It is observed that the CoC for sugarcane in 2015-16 was around Rs. 39,900 per acre for all the farmers (Table 3.12). For the year 2015, category wise, CoC per acre for NCU farmers was higher than the CoC of Non-NCU farmers. Similar pattern is observed for output per acre. Though CoC is higher for the NCU farmers, output as well as gross returns are higher and hence the net returns for NCU farmers are higher than Non-NCU farmers. The major items of expenditure in the paid out costs were seed, fertilisers, weeding- sowing. Overall, around four percent of the expenditure was incurred on NCU and urea. Overall, the pattern of distribution of costs under various headings was similar for various category farmers. Data for the year 2014 (Table 3.13) shows a similar pattern of expenditure, gross and net returns and of output.

Tables 3.14 and 3.15 present summary of Tables 3.12 and 3.13. It is observed from Table 3.14 that the shares of expenditure items have remained similar for both the years for NCU and Non-NCU farmers. It is observed that the net returns and the output of sugarcane were higher in the year 2015 than in 2014 for NCU as well as Non-NCU farmers. However, the extent of increase was much higher in case of NCU farmers. This could be explained in terms of higher prices and higher output in the latter year.

Table 3.12: Input Use, Output and Returns per Acre of Sugarcane Farmers (2015) (Rs. per acre)

Particular	NCU				Non-NCU				Overall			
	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large	All
Ploughing charges	4085 (10.6)	4739 (11.1)	3865 (10.1)	4287 (10.8)	4087 (9.8)	3952 (10.4)	3150 (8.8)	3935 (9.8)	4085 (10.4)	4621 (11.0)	3533 (9.5)	4200 (10.5)
Seed cost	5466 (14.2)	5715 (13.4)	5301 (13.8)	5539 (13.9)	5988 (14.4)	6043 (15.9)	3750 (10.5)	5690 (14.2)	5605 (14.3)	5764 (13.7)	4581 (12.3)	5576 (14.0)
Organic/FYM	2547 (6.6)	3198 (7.5)	3398 (8.8)	2804 (7.0)	2693 (6.5)	2239 (5.9)	0 (0)	2243 (5.6)	2586 (6.6)	3054 (7.3)	1819 (4.9)	2665 (6.7)
Urea and NCU	1609 (4.2)	1503 (3.5)	1435 (3.7)	1565 (3.9)	1752 (4.2)	1418 (3.7)	1900 (5.3)	1714 (4.3)	1647 (4.2)	1490 (3.6)	1651 (4.4)	1602 (4.0)
Chemical fertilizers	5845 (15.2)	5981 (14.0)	6062 (15.8)	5900 (14.8)	6078 (14.6)	4350 (11.5)	5015 (14.1)	5628 (14)	5907 (15)	5736 (13.7)	5575 (15)	5833 (14.6)
Plant protection chemicals	1331 (3.5)	1675 (3.9)	1498 (3.9)	1452 (3.6)	1338 (3.2)	1247 (3.3)	0 (0)	1138 (2.8)	1333 (3.4)	1611 (3.8)	802 (2.2)	1374 (3.4)
Irrigation charges	2170 (5.6)	3334 (7.8)	2684 (7.0)	2577 (6.5)	2526 (6.1)	2235 (5.9)	100 (0.3)	2141 (5.3)	2265 (5.8)	3169 (7.6)	1484 (4.0)	2469 (6.2)
Harvesting [a]	--	--	--	--	--	--	--	--	--	--	--	--
Hired labour (HL), sowing	3686 (9.6)	3711 (8.7)	3462 (9.0)	3683 (9.2)	3771 (9.1)	3717 (9.8)	3750 (10.5)	3759 (9.4)	3709 (9.4)	3712 (8.8)	3596 (9.7)	3702 (9.3)
HL (weeding, others)	4273 (11.1)	5024 (11.8)	3494 (9.1)	4477 (11.2)	4645 (11.2)	4196 (11.1)	5833 (16.4)	4730 (11.8)	4372 (11.1)	4900 (11.7)	4581 (12.3)	4540 (11.4)
Family labour (FL)	2097 (5.5)	2525 (5.9)	2265 (5.9)	2246 (5.6)	2890 (7.0)	3000 (7.9)	3833 (10.7)	3039 (7.6)	2308 (5.9)	2597 (6.2)	2994 (8.1)	2442 (6.1)
Maintenance costs	1982 (5.2)	1964 (4.6)	2458 (6.4)	2001 (5)	1992 (4.8)	1717 (4.5)	1833 (5.1)	1922 (4.8)	1985 (5.1)	1927 (4.6)	2168 (5.8)	1981 (5.0)
Other costs	3386 (8.8)	3298 (7.7)	2506 (6.5)	3312 (8.3)	3794 (9.1)	3783 (10)	6500 (18.2)	4164 (10.4)	3495 (8.9)	3371 (8.0)	4361 (11.7)	3522 (8.8)
Total paid-out costs +FL	38477 (100)	42668 (100)	38427 (100)	39842 (100)	41554 (100)	37897 (100)	35665 (100)	40103 (100)	39296 (100)	41951 (100)	37144 (100)	39906 (100)
Output (tons)	52.57	57.08	50.51	53.93	51.62	49.13	52.78	51.34	52.31	55.89	51.56	53.29
Output	114,934	128,382	113,171	119,231	108,659	106,084	128,333	110,912	113,263	125,031	120,214	117,175
By product (Qtl)	0.97	0.22	2.94	0.83	0.81	1.57	0.00	0.83	0.93	0.42	1.57	0.83
By product	426	101	870	343	315	459	0	297	397	155	466	332
Gross returns	115,360	128,483	114,041	119,574	108,973	106,543	128,333	111,209	113,660	125,187	120,680	117,506
Net returns	76,883	85,815	75,613	79,732	67,419	68,646	92,668	71,107	74,364	83,235	83,536	77,600

Note: [a] harvesting was carried out by sugarcane factory; figures in parenthesis are percentages of the category total

Table 3.13: Input Use, Output and Returns per Acre of Sugarcane Farmers (2014) (Rs. per acre)

Particular	NCU				Non-NCU				Overall			
	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large	All
Ploughing charges	3788 (10.6)	4220 (10.9)	4038 (10.5)	3960 (10.7)	3769 (9.8)	3722 (10.5)	2694 (8.3)	3599 (9.7)	3782 (10.4)	4145 (10.8)	3264 (9.3)	3860 (10.4)
Seed cost	4928 (13.8)	5091 (13.1)	5962 (15.6)	5033 (13.6)	5597 (14.6)	5512 (15.6)	3722 (11.4)	5300 (14.3)	5135 (14.1)	5154 (13.4)	4672 (13.4)	5107 (13.8)
Organic/FYM	1901 (5.3)	2435 (6.3)	4151 (10.8)	2197 (5.9)	2804 (7.3)	2220 (6.3)	0 (0)	2282 (6.2)	2180 (6.0)	2403 (6.3)	1760 (5.0)	2220 (6.0)
Urea and NCU	1733 (4.9)	1798 (4.6)	1621 (4.2)	1753 (4.7)	1626 (4.2)	1403 (4)	1932 (5.9)	1634 (4.4)	1700 (4.7)	1739 (4.5)	1800 (5.1)	1720 (4.6)
Chemical fertilizers (other than urea)	4817 (13.5)	5375 (13.8)	4346 (11.3)	5006 (13.5)	4853 (12.7)	3385 (9.6)	3589 (11)	4411 (11.9)	4828 (13.2)	5078 (13.2)	3910 (11.2)	4841 (13.1)
Plant protection chemicals	1033 (2.9)	1163 (3)	1200 (3.1)	1089 (2.9)	1041 (2.7)	1024 (2.9)	0 (0)	881 (2.4)	1036 (2.8)	1142 (3.0)	509 (1.5)	1031 (2.8)
Irrigation charges	2032 (5.7)	3071 (7.9)	1955 (5.1)	2418 (6.5)	2147 (5.6)	2410 (6.8)	100 (0.3)	1884 (5.1)	2068 (5.7)	2972 (7.7)	886 (2.5)	2270 (6.1)
Harvesting [a]	--	--	--	--	--	--	--	0 (0)	--	--	--	--
HL (sowing)	3484 (9.8)	3345 (8.6)	3321 (8.7)	3425 (9.3)	3590 (9.4)	3463 (9.8)	3306 (10.2)	3526 (9.5)	3517 (9.6)	3362 (8.8)	3312 (9.5)	3453 (9.3)
HL (weeding, others)	4100 (11.5)	4648 (12)	3396 (8.9)	4276 (11.6)	4419 (11.5)	3829 (10.8)	5417 (16.7)	4468 (12.1)	4199 (11.5)	4526 (11.8)	4560 (13)	4329 (11.7)
Family labour (FL)	2280 (6.4)	2534 (6.5)	2453 (6.4)	2382 (6.4)	2798 (7.3)	2902 (8.2)	3417 (10.5)	2909 (7.9)	2440 (6.7)	2589 (6.7)	3008 (8.6)	2528 (6.8)
Maintenance costs	1893 (5.3)	1759 (4.5)	2226 (5.8)	1857 (5.0)	1794 (4.7)	1610 (4.5)	1833 (5.6)	1768 (4.8)	1862 (5.1)	1737 (4.5)	2000 (5.7)	1832 (5.0)
Other costs	3714 (10.4)	3432 (8.8)	3623 (9.5)	3604 (9.7)	3911 (10.2)	3951 (11.2)	6500 (20)	4307 (11.7)	3774 (10.3)	3510 (9.2)	5280 (15.1)	3799 (10.3)
Total paid-out costs+FL	35703 (100)	38872 (100)	38291 (100)	37000 (100)	38349 (100)	35432 (100)	32509 (100)	36970 (100)	36520 (100)	38358 (100)	34961 (100)	36992 (100)
Output (tons)	48.40	52.13	44.53	49.64	48.00	46.54	52.39	48.41	48.28	51.29	49.06	49.30
Output (Rs.)	97,527	110,496	96,294	102,334	100,716	91,466	116,383	101,488	98,511	107,655	107,866	102,099
By product (Qtl)	0.47	0.14	1.96	0.41	0.55	1.56	0.00	0.64	0.49	0.35	0.83	0.47
By product (Rs.)	344	59	566	247	210	415	0	214	303	112	240	238
Gross returns	97,871	110,555	96,860	102,581	100,927	91,880	116,383	101,702	98,814	107,767	108,106	102,337
Net returns	62,168	71,684	58,569	65,580	62,578	56,448	83,874	64,732	62,295	69,409	73,145	65,345

Note: [a] harvesting was carried out by sugarcane factory; figures in parenthesis are percentages of the category total

Table 3.14: Cost of Cultivation of Sugarcane, Overall Farmers (percentage share)

Particulars	2014		2015	
	NCU	Non-NCU	NCU	Non-NCU
Ploughing charges	10.7	9.7	10.8	9.8
Seed cost	13.6	14.3	13.9	14.2
Organic/FYM	5.9	6.2	7.0	5.6
Urea and NCU	4.7	4.4	3.9	4.3
Chemical fertilizers	13.5	11.9	14.8	14.0
Plant protection chemicals	2.9	2.4	3.6	2.8
Irrigation charges	6.5	5.1	6.5	5.3
Harvesting	--	--	--	--
Hired labour (sowing)	9.3	9.5	9.2	9.4
Hired labour (weeding, others)	11.6	12.1	11.2	11.8
Family labour (FL)	6.4	7.9	5.6	7.6
Maintenance costs	5.0	4.8	5.0	4.8
Other costs	9.7	11.7	8.3	10.4
Total paid-out costs +FL (Rs.)	100.0 (37,000)	100.0 (36,970)	100.0 (39,842)	100.0 (40,101)

Table 3.15: Summary of Cost and Returns, Sugarcane (Rs/Acre)

Particulars	2014		2015		% change over 2014 NCU	% change over 2014 Non-NCU
	NCU	Non-NCU	NCU	Non-NCU		
Output (ton)	49.6	48.4	53.9	51.3	8.6	6.1
Output price (Rs.)	2,062	2,096	2,211	2,160	7.2	3.0
Output (Rs.)	102,334	101,488	119,231	110,912	16.5	9.3
By product (Qtl)	0.4	0.6	0.8	0.8	102.4	29.7
By product price (Qtl)	606	332	415	356	-31.6	7.2
By product (Rs.)	247	214	343	297	38.9	38.8
Total paid-out costs	34,618	34,061	37,597	37,062	8.6	8.8
Total paid-out costs+FL	37,000	36,970	39,842	40,101	7.7	8.5
Gross returns	102,581	101,702	119,574	111,209	16.6	9.3
Net returns (paid costs)	67,963	67,641	81,977	74,147	20.6	9.6
Net returns (paid costs +FL)	65,581	64,732	79,732	71,108	21.6	9.8

In case of tur, it is seen that the CoC is around Rs.11, 000 for all the farmers for the year 2014 and is generally declining with the size of landholding (Table 3.16). For both the years, category wise, CoC for NCU farmers is higher than the respective Non- NCU farmers. Though CoC is higher for the NCU farmers, output as well as gross returns are higher and hence the net returns for NCU farmers are higher than Non-NCU farmers. The major items of expenditure in the paid out costs are seed, fertilisers, weeding and sowing. Overall, around two to three percent of the

expenditure is incurred on NCU and urea. Overall, pattern of distribution of costs under various headings is similar for various category farmers. For the year 2014 also, similar pattern of expenditure and returns was observed.

It is observed from summary Tables 3.18 and 3.19 that the net returns and the output of tur is higher in the year 2015 than in 2014 for NCU as well as Non-NCU farmers. However, the extent of increase is much higher in case of NCU farmers. This could be explained in terms of higher prices and higher output in the latter year.

Table 3.16: Input Use, Output and Returns per Acre Realized by Tur Farmers (2015) (Rs. per acre)

Particular	NCU				Non-NCU				Overall			
	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large	All
Ploughing charges	2529 (15.9)	2016 (15.5)	2162 (21.1)	2162 (17.3)	2254 (17.1)	1757 (18.2)	1727 (20)	1892 (18.2)	2351 (16.6)	1883 (16.7)	1952 (20.6)	2018 (17.7)
Seed cost	709 (4.5)	775 (6)	785 (7.7)	766 (6.1)	667 (5.1)	690 (7.1)	656 (7.6)	673 (6.5)	682 (4.8)	731 (6.5)	723 (7.6)	717 (6.3)
Organic/FYM	732 (4.6)	762 (5.9)	506 (4.9)	664 (5.3)	535 (4.1)	393 (4.1)	68 (0.8)	339 (3.3)	605 (4.3)	573 (5.1)	295 (3.1)	490 (4.3)
Urea and NCU	353 (2.2)	311 (2.4)	219 (2.1)	285 (2.3)	274 (2.1)	222 (2.3)	274 (3.2)	252 (2.4)	302 (2.1)	265 (2.3)	245 (2.6)	268 (2.3)
Chemical fertilizers (other than urea)	1403 (8.8)	1523 (11.7)	1136 (11.1)	1361 (10.9)	1071 (8.1)	1195 (12.4)	995 (11.5)	1101 (10.6)	1188 (8.4)	1355 (12)	1068 (11.3)	1222 (10.7)
PPC	1241 (7.8)	1277 (9.8)	762 (7.4)	1083 (8.6)	1123 (8.5)	808 (8.4)	634 (7.3)	848 (8.2)	1165 (8.2)	1036 (9.2)	701 (7.4)	958 (8.4)
Irrigation charges	339 (2.1)	306 (2.4)	259 (2.5)	295 (2.4)	136 (1.0)	142 (1.5)	68 (0.8)	119 (1.1)	208 (1.5)	222 (2.0)	167 (1.8)	201 (1.8)
Harvesting and threshing	2200 (13.8)	1867 (14.3)	1368 (13.3)	1746 (13.9)	1773 (13.4)	1363 (14.1)	1197 (13.9)	1433 (13.8)	1923 (13.6)	1608 (14.2)	1286 (13.6)	1579 (13.9)
HL (sowing)	1110 (7.0)	785 (6.0)	673 (6.6)	803 (6.4)	1017 (7.7)	738 (7.6)	730 (8.5)	816 (7.9)	1050 (7.4)	761 (6.7)	701 (7.4)	810 (7.1)
HL (weeding, others)	1733 (10.9)	1164 (9.0)	946 (9.2)	1188 (9.5)	1312 (9.9)	844 (8.7)	954 (11.0)	1012 (9.7)	1461 (10.3)	1000 (8.9)	950 (10.0)	1094 (9.6)
Family labour (FL)	1328 (8.3)	1200 (9.2)	748 (7.3)	1059 (8.4)	1358 (10.3)	862 (8.9)	689 (8.0)	955 (9.2)	1348 (9.5)	1026 (9.1)	720 (7.6)	1003 (8.8)
Maintenance costs	577 (3.6)	396 (3.0)	275 (2.7)	385 (3.1)	395 (3.0)	274 (2.8)	215 (2.5)	292 (2.8)	459 (3.2)	333 (3.0)	246 (2.6)	335 (2.9)
Other costs	1663 (10.4)	627 (4.8)	412 (4.0)	737 (5.9)	1276 (9.7)	386 (4.0)	430 (5.0)	656 (6.3)	1412 (10)	503 (4.5)	421 (4.4)	694 (6.1)
Total paid-out costs +FL	15918 (100)	13009 (100)	10251 (100)	12535 (100)	13192 (100)	9675 (100)	8639 (100)	10388 (100)	14153 (100)	11297 (100)	9474 (100)	11386 (100)
Output (Main, Qtl)	5.23	5.55	4.05	4.95	4.22	3.11	2.46	3.24	4.57	4.30	3.28	4.03
Output (Main Rs.)	45,411	48,661	36,231	43,555	35,793	30,069	21,772	29,291	39,186	39,111	29,266	35,921
By product (Qtl)	2.45	2.71	1.29	2.15	2.55	1.01	0.81	1.40	2.52	1.84	1.06	1.75
By product (Rs.)	1,625	1,920	953	1,515	1,986	1,220	425	1,208	1,859	1,560	699	1,351
Gross returns	47,036	50,581	37,184	45,070	37,779	31,289	22,197	30,500	41,045	40,671	29,965	37,272
Net returns	31,119	37,572	26,932	32,535	24,587	21,613	13,559	20,111	26,891	29,374	20,490	25,886

Note : Figures in parenthesis are percentages of the category total

Table 3.17: Input Use, Output and Returns per Acre Realized by Tur Farmers (2014) (Rs. per acre)

Particular	NCU				Non-NCU				Overall			
	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large	All
Ploughing charges	2195 (15.6)	1800 (15.7)	1687 (17.5)	1840 (16.2)	1982 (16.5)	1604 (18.2)	1532 (19.7)	1695 (17.9)	2058 (16.1)	1700 (16.8)	1607 (18.5)	1761 (17.0)
Seed cost	646 (4.6)	624 (5.4)	634 (6.6)	631 (5.6)	560 (4.7)	587 (6.7)	543 (7.0)	566 (6.0)	591 (4.6)	605 (6.0)	587 (6.8)	596 (5.8)
Organic/FYM	747 (5.3)	539 (4.7)	306 (3.2)	502 (4.4)	359 (3.0)	266 (3.0)	141 (1.8)	257 (2.7)	499 (3.9)	401 (4.0)	222 (2.6)	369 (3.6)
Urea and NCU	352 (2.5)	309 (2.7)	234 (2.4)	292 (2.6)	273 (2.3)	219 (2.5)	271 (3.5)	251 (2.7)	302 (2.4)	263 (2.6)	253 (2.9)	270 (2.6)
Chemical fertilizers (other than urea)	1127 (8.0)	1336 (11.6)	1090 (11.3)	1212 (10.7)	945 (7.9)	952 (10.8)	828 (10.6)	913 (9.7)	1010 (7.9)	1142 (11.3)	956 (11.0)	1050 (10.2)
PPC	954 (6.8)	1103 (9.6)	721 (7.5)	945 (8.3)	999 (8.3)	745 (8.5)	532 (6.8)	758 (8.0)	983 (7.7)	930 (9.2)	624 (7.2)	847 (8.2)
Irrigation charges	260 (1.9)	257 (2.2)	242 (2.5)	253 (2.2)	119 (1.0)	111 (1.3)	51 (0.7)	96 (1.0)	170 (1.3)	183 (1.8)	145 (1.7)	167 (1.6)
Harvesting and threshing	2060 (14.7)	1674 (14.6)	1791 (18.6)	1790 (15.7)	1795 (14.9)	1329 (15.1)	1188 (15.3)	1426 (15.1)	1890 (14.8)	1499 (14.8)	1483 (17.1)	1593 (15.4)
HL (sowing)	958 (6.8)	691 (6.0)	662 (6.9)	734 (6.5)	894 (7.4)	685 (7.8)	661 (8.5)	740 (7.8)	917 (7.2)	688 (6.8)	662 (7.6)	737 (7.1)
HL (weeding, others)	1226 (8.7)	1068 (9.3)	782 (8.1)	1003 (8.8)	1330 (11.1)	873 (9.9)	600 (7.7)	928 (9.8)	1349 (10.6)	924 (9.1)	827 (9.5)	1001 (9.7)
Family labour (FL)	1538 (11.0)	1064 (9.3)	813 (8.4)	1073 (9.4)	1243 (10.3)	788 (9.0)	841 (10.8)	939 (9.9)	1293 (10.1)	969 (9.6)	689 (7.9)	963 (9.3)
Maintenance costs	446 (3.2)	322 (2.8)	260 (2.7)	326 (2.9)	324 (2.7)	245 (2.8)	176 (2.3)	248 (2.6)	368 (2.9)	283 (2.8)	217 (2.5)	283 (2.7)
Other costs	1534 (10.9)	695 (6.1)	420 (4.4)	769 (6.8)	1206 (10)	386 (4.4)	412 (5.3)	638 (6.8)	1324 (10.4)	538 (5.3)	416 (4.8)	698 (6.8)
Total paid-out costs +FL	14042 (100)	11483 (100)	9642 (100)	11370 (100)	12030 (100)	8790 (100)	7775 (100)	9455 (100)	12753 (100)	10126 (100)	8688 (100)	10336 (100)
Output (Main, Qtl)	5.25	4.81	4.20	4.69	4.55	3.94	3.29	3.93	4.80	4.37	3.74	4.28
Output (Main Rs.)	27,229	24,850	21,368	24,150	24,238	20,469	16,771	20,495	25,312	22,629	19,019	22,170
By product (Qtl)	3.16	2.81	1.27	2.36	2.77	2.25	1.61	2.21	2.36	1.82	1.08	1.72
By product (Rs.)	1,460	1,727	813	1,367	1,440	2,005	759	1,467	1,740	1,546	714	1,333
Gross returns	28,689	26,576	22,181	25,517	25,677	22,474	17,529	21,962	27,052	24,175	19,733	23,503
Net returns	14,647	15,094	12,539	14,147	13,647	13,685	9,754	12,507	14,299	14,049	11,045	13,167

Note: Figures in parenthesis are percentages of the category total

Table 3.18: Percentage Share of Various Inputs in Total Cost for Overall Tur Farmers

Particulars	2014		2015	
	NCU	Non-NCU	NCU	Non-NCU
Ploughing charges	16.2	17.9	17.3	18.2
Seed cost	5.6	6.0	6.1	6.5
Organic/FYM	4.4	2.7	5.3	3.3
Urea and NCU	2.6	2.7	2.3	2.4
Chemical fertilizers	10.7	9.7	10.9	10.6
Plant protection chemicals	8.3	8.0	8.6	8.2
Irrigation charges	2.2	1.0	2.4	1.1
Harvesting	15.7	15.1	13.9	13.8
Hired labour (sowing)	6.5	7.8	6.4	7.9
Hired labour (weeding, others)	8.8	9.8	9.5	9.7
Family labour (FL)	9.4	9.9	8.4	9.2
Maintenance costs	2.9	2.6	3.1	2.8
Other costs	6.8	6.8	5.9	6.3
Total paid-out costs +FL (Rs.)	100.0 (9,455)	100.0 (10,336)	100.0 (12,535)	100.0 (10,388)

Table 3.18 shows that for tur, as in case of sugarcane, labour charges is an important constituent of total cost of cultivation. However, the share of fertilisers along with urea (around 12 percent) is less than that in case of sugarcane (around 16 percent). The data on costs and net returns for tur depicts similar results as in case of sugarcane. Output as well as net returns are higher for NCU farmers. The extent of increase over the year 2014 is also higher for NCU farmers. The Table shows that it is almost double for the NCU farmers.

Table 3.19: Summary of Costs and Returns of Tur Farmers (Rs. Per acre)

Particulars	2014		2015		% change over 2014 NCU	% change over 2014 Non-NCU
	NCU	Non-NCU	NCU	Non-NCU		
Output (Qtl)	4.7	3.9	5.0	3.2	5.5	-18
Output Price (Rs/Qtl)	5,146	5,216	8,807	9,046	71.1	73.4
Output Value(Rs.)	24,150	20,495	43,555	29,291	80.4	42.9
By product (Qtl)	2.4	2.2	2.2	1.0	-8.9	-54.8
By product price per Qtl	579	662	705	863	21.9	30.3
By product (Rs.)	1,367	1,467	1,515	1,208	10.8	-17.7
Total paid-out costs	10,296	8,516	11,476	9,433	11.5	10.8
Total paid-out costs +FL	11,370	9,455	12,535	10,388	10.2	9.9
Gross returns	25,517	21,962	45,070	30,500	76.6	38.9
Net returns (paid costs)	15,221	13,446	33,594	21,067	120.7	56.7
Net returns (paid costs +FL)	14,147	12,507	32,535	20,112	130.0	60.8

3.6 Details of Agriculture Credit Availed

The data in Table 3.20 shows that mostly, sugarcane as well as tur farmers have availed of agricultural credit from institutional sources. Whereas in case of sugarcane, almost 78 percent of the loan is availed from cooperative societies, in case of tur, commercial banks are the main source for availing agricultural credit.

Table 3.20: Credit Details of Total Farmers during the Reference Period

(Rs. Per household)

Sl. No	Sources	Sugarcane	Tur	Overall)
a.	Institutional sources			
1	Co-operative societies	1,13,219 (78)	23,605 (26)	68,412 (58)
2	Land development Bank	-	-	-
3	Commercial Banks	31,980 (22)	60,866 (67.6)	46,423 (39.5)
4	Regional rural Bank	0	3,190 (3.5)	1,595 (1.4)
5	LIC	0	85 (0.09)	43 (0.04)
b.	Non-Institutional sources			
6	Money lenders	0	2,350 (2.6)	1,175 (1.0)
	Total	1,45,199 (100)	90,096 (100)	117,647 (100)

It is observed that majority of the sugarcane and tur farmers have taken loan for seasonal crop cultivation and the expenditure incurred on the same is also higher. Overall, only 21 percent of the total farmers have taken loan for investment purposes such as purchasing tractor/implements and livestock

Table 3.21: Purpose of Borrowing Loans during the Reference Period

Purpose	Sugarcane		Tur		All	
	(% of total farmers)	(% of total amount Rs. 145,199)	(% of total farmers)	(% of total amount Rs. 90,096)	(% of total farmers)	(% of total amount Rs. 117,647)
Seasonal crop cultivation	84.0	73.8	74.50	73.12	85.5	73.5
Purchase of tractor and other implements	9.0	21.1	8.50	18.37	9.1	20.0
Purchase of livestock	1.5	1.5	0.50	0.22	1.1	1.0
Consumption expenditure	2.0	3.6	5.00	8.29	3.7	5.4
Did not take credit	13	-	16	-	14	-

Note : Multiple responses elicited

Training Programmes Attended on Fertilizers Application

The farmers were asked about the details of training programmes attended on fertiliser application. It was observed that only 20 sugarcane (10 percent of total sample) and 16 tur (8 percent of total sample) farmers had attended any training programme. Thus, out of the total sample of 400 farmers, only 36 i.e. 9 percent have attended the training programme.

Table 3.22: Training/s Attended on Application of Fertilizers by Respondents

Sl. No	Name of the Organizer	Average duration of training (No. of days)		Sugarcane (n=200)		Tur (n=200)		All (n=400)	
		Sugarcane	Tur	Nos	%	Nos	%	Nos	%
1	Government of Maharashtra	3	3.2	16	80.0	13	81.3	29	80.5
2	IFCO	1	-	1	5.0	-	-	1	2.8
3	PACs	1	-	1	5.0	-	-	1	2.8
4	sugar factory	3	-	2	10.0	-	-	2	5.5
5	KVK	-	3	-	-	1	6.2	1	2.8
6	Rashtriya Chemicals Fertilizers	-	4	-	-	1	6.2	1	2.8
7	Reliance NGO	-	2	-	-	1	6.3	1	2.8
	Total			20	100	16	100	36	100

Note : PACs - Primary Agricultural Co-operatives

3.7 Concluding Remarks

The analysis of this chapter reveals differences in the socioeconomic characteristics between sugarcane and tur farmers. These differences largely represent differences in the regional characteristics. The analysis also reveals differences in the performance of the NCU and Non NCU farmers.

It is observed that the sugarcane farmers are comparatively better off than the tur farmers as far as their educational level is concerned. They mainly belong to general category. Though they own comparatively smaller size of landholdings, the extent of the land irrigated is very high i.e. around 90 percent. Their cropping pattern consists of besides sugarcane, cereals, oilseeds and horticultural crops. The tur farmers, belong to general as well as OBC category. Their landholding size is comparatively bigger than the sugarcane farmers. However, the extent of irrigation is only 38 percent for these farmers.

For both the crops, it is observed that the extent of higher education is higher for the NCU farmers. Similarly, the extent of irrigation is also higher for the

sugarcane and tur NCU farmers. The data on costs and returns of the households shows that the output and the net returns are higher for the NCU farmers than the Non NCU farmers for both the crops. The extent of increase in output and net returns from 2014 to 2015 is also higher as well for the NCU farmers. The analysis thus reveals that the NCU farmers have a better socioeconomic background and have been able to get higher net returns and output than the Non NCU farmers in the year 2015 as compared to 2014.

Chapter 4

Status of Awareness and Application of Neem Coated Urea

4.1 Awareness and Sources of Information on NCU

This chapter analyses our observations on awareness among the sugarcane and tur farmers regarding usage of NCU. We analyse the responses of farmers regarding sources of information on NCU, factors which help farmers differentiate between NCU and urea, differences in application of NCU Urea and perceptions of farmers about NCU and its benefits.

It is observed from Table 4.1 that overall around 55 percent of the farmers are aware about the NCU. Crop wise data shows that the percentage of farmers aware is increasing with size class of landholding in case of sugarcane as well as tur. It also shows that the extent of awareness is more in case of sugarcane as it is a fully irrigated cash crop cultivated in the developed regions of western Maharashtra. Its requirement of urea is much higher than that of tur. For sugarcane, per acre requirement of urea varies from 650 kg is per hectare to 1081 kg per hectare depending on the variety of sugarcane. For tur, it is just 32.55 kg per hectare (Office of Commissioner Agriculture, GoM, Pune).

As far as source of awareness is concerned, it is observed that agricultural officers (48 percent) and input shops (41 percent) are the main sources of information in case of sugarcane. In contrast for tur, only 13 percent of the farmers reported agricultural officers as the source. The main source for these farmers is fellow farmers (55 percent) and input shops (37 percent).This perhaps indicates that the extension machinery of the government in sugarcane growing regions is stronger than that in tur growing regions of Marathwada and Vidarbha.

Table 4.2 shows that almost all the farmers could differentiate between NCU and urea. For majority of the farmers (around 90 percent), price difference was the main factor that helped them to differentiate. This was followed by the leaf figure on the NCU bag. Around 88 percent of the sugarcane farmers and 89 percent of the tur farmers could differentiate because of this factor. This signifies that the farmers are able to distinguish between NCU and Non-NCU based on price and packaging aspect.

Table 4.1: Awareness and Sources of Information about NCU (Percentage of farmers)

Sl. No	Sources of Information	Sugarcane				Tur				Overall			
		Small	Medium	Large	All	Small	Medium	Large	All	Marginal & Small	Medium	Large	All
	% of farmers aware@	65.6	76.3	80.0	69.5	34.8	46.9	50.0	42.0	53.2	59.3	57.5	55.8
Category wise sources of awareness													
1	Agricultural Officer	48.8	46.7	50.0	48.2	12.9`	13.2	13.3	13.1	39.3	31.3	26.1	35.1
2	Input shop	41.9	37.8	50.0	41.0	29.0	36.8	53.3	36.9	38.5	37.3	52.2	39.5
3	Fellow Farmers	20.9	24.4	50.0	23.7	58.1	57.9	40.0	54.8	30.8	39.8	43.5	35.4
4	Print & visual media	3.5	2.2	12.5	3.6	12.9	18.4	13.3	15.5	6.0	9.6	13.0	8.1
5	Farmer Facilitator	4.7	0.0	0.0	2.9	6.5	2.6	0.0	3.6	5.1	1.2	0.0	3.1
6	Sugar factory staff	1.2	4.4	0.0	2.2	0.0	0.0	0.0	0.0	0.9	2.4	0.0	1.3
7	Wall Writing	1.2	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.4
8	PACs	1.2	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.4

Note : 1. @ % of the category total , 2. multiple responses elicited, 3.Out of 200 sugarcane farmers, 139 were aware of NCU but only 136 farmers were actual users of NCU during the reference period

Table 4.2: Factors from Which Farmers Differentiate NCU Compared to Normal Urea (in percent)

Sl. No	Sources of Information	Sugarcane				Tur				Overall			
		Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large	All
	Category wise % farmers noticed difference in NCU and Urea	99.2	100.0	100.0	99.3	100.0	100.0	100.0	100.0	99.1	100.0	100.0	99.6
	Factors												
1	Price difference	90.6	95.6	100.0	92.8	93.5	86.5	93.8	90.5	91.4	91.5	95.8	91.9
2	Leaf figure on the bag	82.4	95.6	100.0	87.7	93.5	83.8	93.8	89.3	85.3	90.2	95.8	88.3
3	Colour difference	12.9	4.4	0.0	9.4	0.0	0.0	0.0	0.0	9.5	2.4	0.0	5.9
4	Does not vanish quickly	11.8	0.0	0.0	7.2	6.5	8.1	6.3	7.1	10.3	3.7	4.2	7.2
5	Less usage	8.2	0.0	0.0	5.1	0.0	10.8	0.0	4.8	6.0	4.9	0.0	5.0
6	Larger size of grains	2.4	2.2	0.0	2.2	0.0	0.0	0.0	0.0	1.7	1.2	0.0	1.4

Note: 1. Multiple response question, 2.This question was applicable to those who were aware of NCU i.e. 139 and 84 sugarcane and tur farmers respectively. Out of 200 sugarcane farmers, 139 were aware of NCU but only 136 farmers were actual users of NCU during the reference period. For tur, all 84 NCU aware farmers were also the actual users of NCU.

4.2 Status of Application of Urea versus NCU

It is observed from Table 4.3 that the sugarcane farmers started applying NCU in the year 2014-15.The tur farmers however started the application in the year 2015.

Table 4.3: Application of NCU across Different Seasons by Total Sugarcane and Tur Respondents (% of NCU farmers)

Sample farmers	Name of the crops	2013-14*		2014-15*		2015-16*#	
		No.	% (n=200)	No.	% (n=200)	No.	% (n=200)
Sugarcane	Sugarcane	6	3.0	136	68.0	46	23.0
	Other crops	0	0.0	30	15.0	5	2.5
Tur	Tur	0	0.0	0	0.0	84	42.0
	Other crops	0	0.0	0	0.0	40	20.0

Note: *sowing year; # Crop was to be harvested at the time of Survey

The purchase pattern of NCU per household is presented in Table 4.4. The total quantity of urea purchased per household is higher for the NCU farmers than for the Non-NCU farmers for both the crops as the former have purchased urea also along with NCU.

Price of NCU is higher than that of urea. The NCU price faced by the sugarcane NCU farmers is around Rs. 300 and for tur around Rs. 325. As is already mentioned, the government notified price of NCU and urea is Rs.298 and Rs.284 per bag of 50 kg for 2015-16.

Table 4.4: Purchase Pattern of NCU for the Reference Year (Rs, per Household)

Item	Sugarcane				Tur				Overall			
	NCU			Non-NCU	NCU			Non-NCU	NCU			Non-NCU
	NCU	Urea	Total	Urea	NCU	Urea	Total	Urea	NCU	Urea	Total	Urea
Quantity (kgs)	711	59	770	616	60	2	62	49	463	37	500	251
Price*	300	286	299	285	325	300	324	300	310	288	308	294
Distance (km)	5	3	5	6	10	13	10	10	7	4	7	9
Transport*	12	8	12	13	18	18	18	17	14	10	14	16
Total cost*	312	295	311	297	342	318	342	317	324	298	322	310

Note : *per bag of 50 kg

Application of NCU and urea across different growth stages of sugarcane and tur is presented in Table 4.5.

Table 4.5: Split Doses of NCU / Urea Application (Kgs per acre) 2015-16

Crop Stages	NCU				Non-NCU	
	NCU	Urea	Total Urea	% of Total Urea	Urea	% of urea
Sugarcane						
Basal application	66.99	6.52	73.51	27.97	82.90	27.50
Vegetative growth	80.79	7.28	88.07	33.51	97.42	32.32
After weeding	70.63	4.64	75.27	28.64	88.63	29.40
Maturity	24.34	1.63	25.97	9.88	32.47	10.77
Total	242.75	20.07	262.82	100.00	301.43	100.00
Tur						
Basal application	29.28	0.00	29.28	65.32	30.81	73.58
Vegetative growth	5.73	0.00	5.73	13.16	5.05	12.08
After weeding	6.92	1.07	7.99	18.37	6.01	14.39
Maturity	1.37	0.00	1.37	3.14	0.00	0.00
Total	43.30	1.07	44.37	100.00	41.87	100.0

It is observed that for sugarcane, the NCU and urea doses are applied during basal application, vegetative growth and after weeding are the three important doses and constitute around 90 percent of the total quantity of doses. The total quantity of urea applied NCU sugarcane farmers is 262.82 kg per acre and is less for the Non-NCU farmers (301.4 kg per acre).

For tur however, the basal application dose is the most important dose for NCU and Non-NCU farmers. The total quantity of urea applied by NCU farmers is only 44 kg. per acre and is marginally higher than the quantity applied by the Non-NCU farmers.

The farmers were asked about the sources of purchase of NCU and urea. Table 4.6 shows that for sugarcane NCU and Non-NCU farmers, private dealers is the main source and is followed by cooperative societies. For tur however, the only source of purchase is private dealers. It was observed during the field survey that the cooperative societies were almost nonexistent in the tur growing sample regions as has been already mentioned.

Table 4.6: Sources of Purchase of NCU/Non-NCU (Percentage of farmers)

Sl. No	Particulars	Sugarcane		Tur		Overall	
		NCU	Non-NCU	NCU	Non-NCU	NCU	Non-NCU
1	Private fertilizer dealers	74.3	65.6	100.0	100.0	76.4	87.8
2	Cooperative societies	35.3	40.6	0.0	0.0	21.8	14.4
3	Agriculture Department	0.0	0.0	0.0	0.0	0.0	0.0

Note: Multiple responses were generated

As far as the method of application of NCU / urea is concerned, it was found that for sugarcane as well as tur, broadcasting was the most important method of application. More than 90 percent of the quantity applied for both the categories of farmers was through broadcasting method.

Table 4.7: Method of Application of NCU/ Urea (Kg/ acre, 2015-16)

Crop Stages	NCU				Non-NCU	
	NCU	Urea	Total Urea	% of Total Urea	Urea	% of Urea
Sugarcane						
Broadcasting	231.14	10.41	241.55	91.91	283.09	93.92
Spraying	10.98	8.91	19.88	7.57	15.66	5.20
Fertigation	0.50	0.75	1.25	0.48	2.67	0.89
Drilling	0.13	0.00	0.13	0.05	0.00	0.00
Total	242.75	20.07	262.82	100.00	301.43	100.00
Tur						
Broadcasting	42.66	1.07	43.73	98.55	41.63	99.42
Spraying	0.64	0.00	0.64	1.45	0.24	0.58
Fertigation	0.00	0.00	0.00	0.00	0.00	0.00
Drilling	0.00	0.00	0.00	0.00	0.00	0.00
Total	43.30	1.07	44.37	100.00	41.87	100.00

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

Farmers' perception about quality, availability and various benefits of NCU as against that of urea were documented in Table 4.8. Majority of the farmers seemed to be satisfied with the quality of NCU. Overall, 87 percent of the farmers reported that the quality was 'good'. Majority of the sugarcane and tur farmers also reported that NCU availability was adequate (85 per cent) and timely as well (80 per cent). As regards price of NCU, the opinion of the farmers seems to be divided. More than 50 per cent of the sugarcane and tur farmers felt that the price was not very high. However, more than 40 per cent of the farmers for the both the crops reported that the price was 'high'.

Table 4.8: Perception about NCU versus Urea

Sl. No	Particulars	Sugarcane		Tur		All	
		No	%	No	%	No	%
1	NCU quality						
	Very good	19	14	8	9.5	27	12.3
	Good	116	85.3	76	90.5	192	87.3
	Bad	0	0	0	0	0	0.0
	No change	1	0.7	0	0	1	0.5
2	NCU availability						
	Adequate	113	83.1	74	88.1	187	85.0
	Inadequate	23	16.9	10	11.9	33	15.0
	No change	0	0	0	0	0	0.0
3	Timely availability of NCU						
	Yes	108	80	69	82.1	177	80.5
	No	28	20	15	17.9	43	19.5
4	NCU Price						
	Very high	2	1.5	3	3.6	5	2.3
	High	61	44.9	34	40.5	95	43.2
	Not very high	69	50.7	47	56	116	52.7
	Same as urea	4	2.9	0	0	4	1.8
5	Benefits of NCU in terms of total fertilizer usage						
	Increased	125	91.9	75	89.3	200	90.9
	Decreased	2	1.5	1	1.2	3	1.4
	No Change	9	6.6	8	9.5	17	7.7
6	Benefits of NCU in terms of Urea usage						
	Increased	123	91.1	76	90.5	199	90.5
	Decreased	7	5.2	0	0	7	3.2
	No Change	5	3.7	8	9.5	13	5.9
7	Pest and diseases attack						
	Increased	5	3.7	31	36.9	36	16.4
	Decreased	55	40.4	18	21.4	73	33.2
	No Change	76	55.9	35	41.7	111	50.5
8	NCU is more easily accessible in the market compared to normal Urea (for the current year)						
	Yes	35	25.7	9	10.7	44	20.0
	No	101	74.3	75	89.3	176	80.0

All the farmers appear to be convinced about the fact that benefits of NCU in terms of total fertiliser usage and urea usage have increased. The data shows that around 91 percent of the total farmers felt that these benefits have increased.

About 33 per cent of the total farmers felt that pest and disease attacks had decreased. However, 50 per cent of the farmers felt that there was no change in the attacks. Thus, the perception of the farmers was not unanimous in this regard. Eighty

per cent of the farmers did not feel that NCU was more easily accessible. Overall, the farmers seemed to be satisfied with the quality and availability of NCU but they were not unanimous with respect to pest and disease attack.

Table 4.9 shows the comparative use of NCU and urea by the sample farmers in 2014 and 2015. It can be seen that the consumption of NCU was very low in the year 2014 for sugarcane and nil for tur and that of urea was higher i.e. 97 percent of the total consumption for sugarcane and 100 percent for tur. Consumption of NCU increased in 2015 for both the crops. It was more than 92 percent of the total urea consumption for sugarcane and nearly 100 percent for tur.

Table 4.9: Comparative Use of NCU versus Urea (kgs/acre)

Particulars	2014		2015	
	Sugarcane	Tur	Sugarcane	Tur
NCU Farmers				
NCU quantity applied	9.46	0	242.75	43.3
Urea quantity applied	297.77	48.54	20.07	1.1
Total Urea quantity applied	307.23	48.54	262.82	44.37
Non-NCU Farmers				
Urea quantity applied	287.57	41.74	301.43	41.87

Farmers' responses on comparative benefits of NCU over Urea for the two crops are presented in Tables 4.10 and 4.11 respectively. It is observed that for sugarcane, majority of the farmers responded positively about improvement in soil health and quality of grain. Ninety-eight percent of the farmers reported that yield had increased. However, majority of the farmers either were not sure or reported 'no change' in case of cost of weed management and pest and disease control. Similar pattern of responses is observed for tur farmers. Around 62 percent of the farmers reported that yield had increased with the usage of NCU. Overall, for both the crops, majority of the farmers felt that comparative benefits of NCU have increased.

Table 4.10: Farmers' Response on Comparative Benefits of NCU over Urea, Sugarcane

(% of NCU farmers)

Particulars	Increased	Decreased	No change	Can't say/ not sure	Extent of Increase (%)	Extent of Decrease (%)
Yield (quintals)	98	0	2	0	10	0
Cost of pest & disease control	2	16	33	49	*	*
Weed management	2	13	35	50	*	*
Cost of NCU compared to Urea	69	24	5	2	5	0
Cost of other fertilizers	30	8	10	52	*	*
Improvement in soil health	88	2	5	5	*	*
Quality of grain	74[a]	0[b]	13[c]	13	*	*
Market acceptability of grain color	61[a]	0[b]	18[c]	21		

Note: a attractive, b dull, c no change, *Farmers were unable to report extent of increase or decrease

Table 4.11: Farmers' Response on Comparative Benefits of NCU over Urea, Tur

(% of NCU farmers)

Particulars	Increased	Decreased	No change	Can't say/ not sure	Extent of Increase (%)	Extent of Decrease (%)
Yield (quintals)	62	18	17	4	25	18
Cost of pest & disease control	2	11	33	54	*	*
Weed management	0	5	42	54	*	*
Cost of NCU compared to Urea	67	7	7	19	8	0
Cost of other fertilizers	60	4	4	33		
Improvement in soil health	91	1	2	6	*	*
Quality of grain	89[a]	0[b]	4[c]	7	*	*
Market acceptability of grain colour	86[a]	0[b]	5[c]	9		

Note: a attractive, b dull, c no change; Farmers were unable to report extent of increase or decrease.

Responses relating to benefits of NCU in soil health improvement show that majority of the sugarcane and tur farmers felt that the texture had improved with the usage of NCU (Table 4.12). As far as other benefits are concerned, less than 50 percent of the sugarcane farmers reported that NCU was beneficial. In case of tur however, the percentage of farmers perceiving that NCU was beneficial was more.

Table 4.12: Relative Benefits of NCU in Soil Health Improvements over Urea

Sl. No	Particulars	Sugarcane		Tur		Overall	
		Nos	%	Nos	%	Nos	%
1	Texture improved	124	91.2	73	86.9	197	89.5
2	Soil moisture retention increased	67	49.3	57	67.9	124	56.4
3	Improvement in water Infiltration	64	47.1	56	66.7	120	54.5
4	Improvement in soil softness	60	44.1	52	61.9	112	50.9
5	Compaction decreased	55	40.4	41	48.8	96	43.6

4.4 Diversions of Urea and NCU Other than Crop Purposes

One of the major objectives of the government policy on urea is to reduce the diversion of urea to other (industrial) purposes than crop production. It is felt that coating of urea with neem would reduce the same and save diversion of government subsidy to sectors other than agriculture. With an objective of understanding about usage of NCU in sectors other than crop production, the farmers were asked about the same. Table 4.14 shows that sugarcane as well as tur farmers have not used NCU for other purposes.

Table 4.13: Usage of NCU for other than Crop Production Purposes

(Percentage of farmers)

Sl. No	Purpose	% Farmers	% of total amount Used
1	Silages (Feed preparation of animals)	0	0
2	Mixed with weedicides	0	0
3	Fishery feed preparation	0	0
4	Others	0	0

4.5 Constraints and Suggestions about NCU and its Adoption

All the farmers were asked about constraints faced in adoption of NCU. Table 4.14 shows that 37 percent of the total farmers reported that there was shortage of NCU. However, majority of them (53 percent) either did not think that there was a problem or they were unable to report about any of the problem. The data thus indicates absence of any major problem faced in adoption of NCU.

Suggestions for improving the NCU fertiliser usage were elicited from the farmers (Table 4.15). However, majority of the farmers (65 percent) were unable to give suggestion regarding improvement in NCU usage. Overall, 25 percent of the farmers suggested that availability of NCU should be ensured. Around 5 percent of the farmers thought that creating awareness about NCU was necessary. Another 4 percent suggested that price of NCU should be reduced.

Table 4.14: Major problems faced in adoption of NCU fertilizer

(Percentage of farmers)

No	Problems	Sugarcane	Tur	Overall
1	Shortage of NCU	35.0	39.0	37.0
2	Unaware about NCU	5.0	5.5	5.3
3	Less usage of NCU	1.5	2.0	1.8
4	Higher price of NCU	3.5	0.0	1.8
5	Fertilizer shop far away	0.5	0.5	0.5
6	Fertilizer dealer forcing us to buy other fertilizers along with NCU	1.0	0.0	0.5
7	No problems/can't say	53.5	53.0	53.3

Table 4.15: Major Suggestions for Improving the NCU Fertilizers Usage

(Percentage of farmers)

No	Problems	Sugarcane (n=200)	Tur (n=200)	Overall (n=400)
1	Ensuring adequate availability of NCU	20.0	30.0	25.0
2	Reduce price of NCU	7.0	1.5	4.3
3	Advertise and create awareness about NCU	5.0	4.5	4.8
4	Timely Availability of NCU in peak season	2.0	1.0	1.5
5	Training and guidance about the use of NCU	0.5	2.0	1.3
6	Increase irrigation*	0.0	0.5	0.3
7	No suggestion/ can't say	65.5	64.0	64.8

Note : Multiple response question; *One tur farmer noted that increase in irrigation would improve NCU usage

4.6 Concluding Remarks

Our analysis of observations on awareness among the sugarcane and tur farmers regarding usage of NCU suggests that around 70 percent of the sugarcane and 42 percent of the tur farmers were aware about the NCU and agricultural officers, input shops were seen to be the main source of information about NCU. All the farmers were able to differentiate between NCU and Non-NCU. It was observed that the sugarcane farmers started the application of NCU in 2014-15; in case of tur, the NCU was used mainly in the year 2015-16.

The observations also provided important insights on the perception of the farmers about benefits of NCU as compared to urea. It was revealed that majority of the farmers were convinced about the benefits of NCU in terms of yields and total fertiliser usage, indicating decline in the latter leading to increased efficiency of fertiliser usage. Overall, farmers appeared to be satisfied about quality and availability

of NCU and majority (above 80 percent) of them thought that the application of NCU led to improvement is soil health. The consumption of NCU was very low in the year 2014 for sugarcane and nil for tur and that of urea was higher. The results show that consumption of NCU increased in 2015 for both the crops. It was more than 92 percent of the total urea consumption for sugarcane and nearly 100 percent for tur. In all, total quantity of urea consumed by NCU farmers declined by 17 percent. This is a positive sign as it indicates efficiency of NCU in terms of its requirement as compared to Urea. However, for Non-NCU farmers, the urea usage increased by 4 percent. About 53 percent of the farmers were unable to report any problem in adoption of NCU. The major problem that was reported by 37 percent of the farmers was that there was shortage of NCU. As a result, the major suggestion for improving NCU fertiliser usage was about ensuring adequate availability of the stock . About 65 percent of the respondents were unable to report any problem.

The analysis therefore reveals increasing adoption of NCU and reduced per acre consumption of total urea by NCU farmers as compared to the Non-NCU farmers and that the farmers were overall satisfied about usage of NCU and expressed need to ensure adequate and timely availability and create more awareness about NCU.

Chapter 5

Awareness and Adoption Level of Soil Testing Technology

5.1 Soil Health Related Programmes and Schemes - Implementation and Performance in the State

Testing of soil is an integral part of fertiliser management policy. Fertilisers have to be applied depending upon the type of soil. Therefore, soil test based application of fertilisers is extremely important for increasing efficiency of fertiliser usage and increasing the crop output. The Soil Testing Programme was started in India in 1955-56 and 16 soil testing laboratories were set up under 'Determination of Soil Fertility and Fertility Use' programme. In 2012-13, the soil analysing capacity of the country was 128.31 lakh samples per annum. The states have been advised to strengthen their soil testing programme and prepare district wise/ block wise fertility maps.

The centrally sponsored Soil Health Card Scheme was launched by the Government in February 2015. Table 5.1 presents the district wise soil health card progress report. It is observed that for the year 2015-16, majority of the soil sample collected (more than 90 percent in majority of the districts) has been tested. The percentage is lowest in Yavatmal (42 per cent), one of the districts in Marathwada region of the state.

As far as the distribution of soil health cards is concerned, in all more than 39 lakh soil health cards were issued to the farmers at the state level. This constitutes 85 percent of the target of soil health cards to be distributed. Nasik and Kolhapur are the divisions in which the performance of districts shows that the targets have been more than achieved. However, in a number of other districts, the targets have not been met and this clearly suggests strengthening of the distribution machinery.

Table 5.1: District wise Soil Health Card Progress Report for 2015-16, Maharashtra

Sr. No.	Name of District/ Division	Target of Soil Samples (No)	Soil Sample collected	Soil Sample Tested	Share of soil sample tested to that collected (%)	Target of Soil Halth Card (No)	Soil Health Card Issued to farmers	Soil Health Card Issued %
1	Thane	5853	4241	4241	100.00	62449	42269	67.69
2	Palghar	2359	4819	3897	80.87	30769	31386	102.01
3	Raigad	13433	11697	9444	80.74	103883	45627	43.92
4	Ratnagiri	25342	22999	19554	85.02	151276	110381	72.97
5	Sindhudurga	5128	9450	8752	92.61	92851	87060	93.76
Kokan		52115	53206	45888	**86.25**	441227	316723	**71.78**
6	Nasik	53817	53630	53194	99.19	214221	216228	100.94
7	Dhule	19927	22037	21956	99.63	78666	125700	159.79
8	Nandurbar	14440	17587	17587	100.00	49041	73009	148.87
9	Jalgaon	40613	40613	40613	100.00	146211	126212	86.32
Nasik		128797	133867	133350	**99.61**	488139	541149	**110.86**
10	Ahemadnagar	74641	95653	92912	97.13	318698	188347	59.10
11	Pune	54872	61221	60578	98.95	247746	175934	71.01
12	Solapur	68574	74859	64575	86.26	222637	278060	124.89
Pune		198087	231733	218065	**94.10**	789081	642341	**81.40**
13	Satara	36987	35223	31780	90.23	287435	310180	107.91
14	Sangli	35908	37820	37820	100.00	179545	245536	136.75
15	Kolhapur	29089	26266	25900	98.61	212761	191116	89.83
Kolhapur		101985	101072	97128	**96.10**	679741	746832	**109.87**
16	Aurangabad	28301	30508	28473	93.33	176620	123000	69.64
17	Jalna	22879	23879	23123	96.83	136781	150000	109.66
18	Beed	30327	27700	27104	97.85	217261	81312	37.43
Aurangabad		81507	82087	78700	**95.87**	530662	354312	**66.77**
19	Latur	22056	27986	27986	100.00	129639	134532	103.77
20	Osmanabad	23542	27214	26280	96.57	118860	126680	106.58
21	Nanded	26012	25412	25412	100.00	194067	118795	61.21
22	Parbhani	17963	24701	19061	77.17	115973	95305	82.18
23	Hingoli	11972	12013	12013	100.00	71034	43264	60.91
Latur		101545	117326	110752	**94.40**	629572	518576	**82.37**
24	Buldhana	30796	30937	30937	100.00	143396	145239	101.29
25	Akola	17714	17468	17468	100.00	80751	54742	67.79
26	Washim	12267	12655	12267	96.93	65475	66209	101.12
27	Amravati	34883	32581	31579	96.92	138619	94099	67.88
28	Yeotmal	40500	40580	17321	42.68	126228	86605	68.61
Amravati		136160	134221	109572	**81.64**	554469	446894	**80.60**
29	Wardha	15836	15836	15835	99.99	65403	36528	55.85
30	Nagpur	26046	25568	25568	100.00	89522	45569	50.90
31	Bhandara	14895	14895	14895	100.00	72891	75707	103.86
32	Gondia	14204	14204	14204	100.00	79254	69222	87.34
33	Chandrpur	26350	17967	17008	94.66	101409	75024	73.98
34	Gadchiroli	13659	13659	13659	100.00	44952	46524	103.50
Nagpur		110989	102129	101169	**99.06**	453431	348574	**76.87**
Total Maharashtra		911184	955641	894624	93.62	4566322	3915401	85.75

Note : Office of the Commissioner Agriculture, GoM, Pune

5.2 Awareness on Soil Testing

The state government has been implementing the soil health programme by collecting the sample and distributing the cards. It is essential to observe the impact of the scheme on awareness of the farmers about the scheme. Hence, the sample farmers were asked questions relating to different sources of information on soil testing and soil sample collection. For sugarcane, around 60 per cent of the farmers reported that department of agriculture and agricultural universities were the major sources of information on soil testing. Around 24 per cent of the farmers reported that the source of information was sugar factories. For tur however, state agricultural department seems to be playing important role in providing the information about soil testing. The other source of information is the private companies especially the fertiliser companies as well as NGOs like Reliance Foundation.

Table 5.2: Different Sources of Information about Soil Testing and Soil Sample Collection (Percentage of farmers who tested their soil)

Sl. No	Particulars	Sugarcane	Tur	Overall
Sources of information about soil testing				
1	Agriculture Department	33.8	70.8	52.0
2	Sugar Factories	24.3	0.0	12.3
3	State Agricultural Universities (SAUs)	31.1	2.8	17.1
4	Krishi Vignan Kendra (KVKs)	2.7	5.8	4.2
5	Private Companies (mainly fertiliser companies)	5.4	15.3	10.3
6	Friends	8.1	2.8	5.5
7	Neighbours	4.1	0.0	2.1
8	Reliance Foundation (NGO)	0.0	8.3	4.1
Who collected the soil				
7	Self	67.6	87.5	77.4
8	Agriculture Officers (State Department)	13.5	8.3	10.9
9	Farmer Facilitator	2.7	0.0	1.4
10	Sugar Factory official	17.6	0.0	8.9
11	Private company	0.0	4.2	2.1

Note: Multiple response questions

The data also shows that for tur, around 88 percent of the soil sample is collected by the farmers themselves. The department of agriculture and other private facilitators have minimum role to play. In contrast, in case of sugarcane farmers,67 percent of the farmers have collected their soil sample. For rest of the farmers, sample was collected by various other agencies. The data indicates presence of better extension machinery and other agencies in the sugarcane growing regions of the state as compared to the tur growing regions.

5.3 Details of Soil Testing

From table below, it is observed that out of the total sample, around 34 percent of the sugarcane as well as tur farmers got their soil tested during 2013-14 to 2015-16. In the earlier years however, this percentage was very low; 3.5 and 2.5 respectively for sugarcane and tur farmers. The average number of sample collected was also very low for both the crops.

Table 5.3 Details of Soil Testing by the Respondents

(Percentage of farmers who got their soil tested)

Sl. No	Particulars	2013-14 to 2015-2016		2012-13 and before		All (All time periods)	
		Sugarcane	Tur	Sugarcane	Tur	Sugarcane	Tur
1	Percentage of farmers for whom soil testing was conducted	33.5	33.5	3.5	2.5	37.0	36.0
2	Average Cost of soil testing (Rs/per sample)	147.8	51.3	78.6	80	138.3	53.3
3	Average distance from field to soil testing lab (Kms)	33.7	61.2	30.6	50.8	33.4	58.7
4	Samples taken for soil testing (Average No)	4.1	4.4	5.0	3.2	4.2	4.3
5	Area covered under soil test (all plots, total acres)	202.8	300.0	17.8	19.5	220.5	319.5
6	Total area covered under soil test/Net operated area of the sample farmers (%)	45.5	20.5	50.7	1.3	45.8	21.3

It is seen that the average cost of soil testing was lower than that of sugarcane for tur, but the average distance from field to soil testing lab was higher for tur NCU farmers. The percentage of total area covered for soil testing as percentage of net operated area was very low for tur. Overall, the table highlights need for improvement in the soil health card scheme being conducted by the government.

The data relating to places of soil testing reveals important role played by the sugar factories in testing the soil of the sugarcane farmers. It was observed that in case of sugarcane, almost 91 per cent of the farmers' soil testing was conducted at the sugar factories. For tur however, main place of soil testing was the agricultural department. Nearly 76 per cent of the farmers sent their soil to agricultural department of the state government.

Table 5.4: Places of Soil Testing of the Sample Farmers

(Percentage of farmers who got their soil tested soil)

Sl. No	Particulars	Sugarcane	Tur	All
1	Sugar Factories	90.5	0.0	45.9
2	Agricultural Universities	5.4	2.8	4.1
3	Maharashtra government	2.70	76.4	39.0
4	Private laboratories	1.4	11.1	6.2
5	Reliance NGO	0.0	9.7	4.8
	Total	100.00	100.00	100.00

With a view to test the knowledge of the farmers about soil health cards, farmers were asked about the correct method of soil sampling and their understanding of the soil health report given in the soil health cards. This can be seen from table 5.5.

Table 5.5 : Awareness about Soil Health Cards among Respondents

(Percentage of farmers who got their soil tested)

No	Particulars	Sugarcane	Tur	Overall
1	% of farmers aware of correct method of soil sampling	82.4	72.2	77.4
	Training sources of soil sample collection *			
2	Agricultural Officer (RSK)	61.8	42.4	52.4
3	Fellow Farmers	27.3	53.9	40.2
4	Sugar factory official	7.3	0.0	3.8
5	Farmer Facilitator	1.8	1.9	1.9
6	Fertilizer dealer	1.8	0.0	0.9
7	RCF person	0.0	3.9	1.9
	Information on soil health card			
8	Number of farmers received soil health card	63 (85.1)	32(44.4)	95 (65.1)
9	Number of farmers possessing soil health card till now	50 (67.6)	29(40.3)	79(54.1)
10	Number of farmers understand the information given in the soil health card	59(79.7)	26(36.1)	85(58.2)
11	Number of persons did not understand the information given in the soil health card for the reasons			
	a) Cannot read	0.0	0.0	0.0
	b) Can read, but not able to understand the information given	9 (6.8)	6(8.3)	15(10.3)
12	% of farmers who were explained about soil health card details	68.3	59.4	65.3
*Sources of education on soil health card$ (% of farmers who received soil health cards)				
	Agriculture Officer	28.6	21.9	26.3
	Sugar factory officials	15.9	0.0	10.5
	Family Member	7.9	0.0	5.2
	Fellow farmer	3.2	34.4	13.7
	Farmer Facilitator	3.2	0.0	2.1
	Fertilizer dealer	3.2	0.0	2.1
	RCF official	0.0	3.1	1.0

Note : * Multiple response question; units in parenthesis are percentage of farmers who got their soil tested, $ responses as percent of cases who were explained soil health card; units in parenthesis explain

Seventy-seven percent of the total farmers who got their soil tested were aware of the correct method of soil sampling. The source of training for sugarcane farmers was the agricultural officers (62 percent) followed by the fellow farmers (27 percent).In case of tur, it was found that the source of training was mainly agricultural officers and fellow farmers.

It is observed that 85 percent of cane and 44 percent of tur farmers who got their soil tested have ever received soil health cards. However, the percentage of farmers who still possess them is lower. It is observed that majority of the farmers can read and understand the information given in the soil health cards and around 65 percent of the farmers were explained about the card details.

5.4 Reasons for Testing or Not Testing the Soil

Responses relating to reasons for testing soil were elicited from the farmers. They were asked to grade the reasons as important, most important and least important. As per the responses, understanding the fertiliser requirement of the crops is the most important reason for testing the soil. Fifty percent of overall farmers (who got their soil tested) farmers also reported that they were motivated to get the soil tested due to the training programmes/demonstrations relating to soil testing. However, there were farmers (46 percent and 43 percent of sugarcane and tur respectively) who got their soil tested because they did not know anything about soil testing. For all the sugarcane and 68 percent of tur farmers this was the most important and important reason for getting the soil tested.

The farmers who did not get their soil tested were asked questions relating to the same. More than 80 percent of the sugarcane farmers reported that they did not know whom to contact for soil testing and that the laboratories were located far away. Around sixty two percent of the respondents did not feel the need to get the soil tested as they thought that the current crop yield was good and this was the most important reason for 86 percent of these farmers. Fifty-nine percent of the farmers reported that they did not know how to take the soil sample and for more than 50 percent of these respondents this was the ‘important’ reason. Similar pattern of responses is noted for tur farmers. Mainly, it was revealed that they did not know whom to contact, the laboratory was far away and did not know how to take the sample. As in case of sugarcane, 63 percent of the tur farmers did not feel the need to get the soil tested.

Table 5.6 : Reasons for Soil Testing by the Respondents (Percentage of farmers who got their soil tested)

Reasons	Sugarcane				Tur				Overall			
	Nos (%)	Most imp	Imp	Least imp	Nos	Most imp	Imp	Least imp	Nos	Most imp	Imp	Least imp
To understand fertilizer requirement for the crop	64 (87)	90.6	4.7	4.7	65 (90)	95.3	3.1	1.6	129 (88)	93.0	3.9	3.1
Motivation from village training/ demonstration/ visits to places with best farming practices	34 (46)	29.4	64.7	5.9	39 (54)	0.0	97.4	2.6	73 (50)	13.7	82.2	4.1
Not aware of anything about Soil testing and its use	34 (46)	61.8	38.2	0.0	31 (43)	45.1	22.6	32.3	65 (45)	53.8	30.8	15.4
For availing benefit under subsidy schemes	9 (12)	66.7	33.3	0.0	4 (6)	0.0	25.0	75.0	13 (9)	46.1	30.7	23.2
Poor crop yield	7 (10)	28.5	57.2	14.3	1 (1)	0.0	100.	0.0	8 (5)	24.9	62.6	12.5
Peer farmers' group pressure	2 (3)	50.0	0.0	50.0	1 (1)	0.0	100.	0.0	3 (2)	33.2	33.5	33.2
Reliance NGO got soil testing done	0 (0)	--	--	--	8 (11)	37.5	37.5	25.0	8 (5)	37.5	37.5	25.0

Note: Multiple response question; imp important; Figures in the table are absolute numbers and in parenthesis are the percentages.

Table 5.7 : Reasons for not Testing the Soil by the Respondents

	Sugarcane				Tur				Overall			
Farmers not tested their soil (% in parenthesis)	126 (63.0)+				128(64.0)+				254(63.5)*			
Reasons for not testing soil	Nos (%)	Most imp	Imp	Least imp	Nos	Most imp	Imp	Least imp	Nos	Most imp	Imp	Least imp
Do not know whom to contact for details on testing	107 (85)	62.4	18.8	18.8	117 (91)	88.1	9.4	2.5	223 (88)	75.7	13.9	10.4
Soil testing laboratories located far away	102 (81)	37.3	36.3	26.4	100 (78)	5	60.1	35	202 (80)	21.3	48.1	30.7
Soil testing not required for my field as crop yield is good	79 (63)	83.6	11.3	5.1	79 (62)	88.7	7.6	3.7	158 (62)	86	9.5	4.5
Do not know how to take soil samples	72 (57)	19.4	56.9	23.6	79 (62)	6.3	45.5	48.1	151 (59)	12.6	50.9	36.5
Own experience/knows which fertilizer to use	8 (6)	87.5	0.0	12.5	2 (2)	0	100	0	10 (4)	70	20	10
Additional expenditure	3 (2)	100.0	0.0	0.0	0 (0)	--	--	--	3 (1)	100	0	0
Sugar factory not giving proper report	1 (1)	100.0	0.0	0.0	0 (0)	--	--	--	1 (0)	100	0	0
Nobody to guide, where to go	7 (6)	57.1	42.9	0.0	9 (7)	22.5	22.5	54.9	16 (6)	37.5	31.3	31.3
No drip, so not done	1 (1)	100.0	0.0	0.0	0 (0)	--	--	--	1 (0)	100	0	0
Not the member of sugar factory	1 (1)	100.0	0.0	0.0	0 (0)	--	--	--	1 (0)	100	0	0
Small land holding	1 (1)	0.0	100.0	0.0	5 (4)	20	40	40	6 (2)	16.7	50	33.3
Perception of reports unreliable / report not being given.	0	--	--	--	6 (5)	66	0	34	4 (2)	100	0	0

Note : Units are percentage of farmers not tested their soil; + n= 200; * n=400

5.5 Adoption of Recommended Doses of Fertilizer Application Based on Soil Test Report

Table 5.9 presents the responses of the farmers regarding recommended doses of fertilisers (RDF). It is observed that the farmers have received information on RDF from a number of sources such as department of agriculture, fellow farmers, sugar factories, private dealers etc. However, a considerable number-around 30 percent of the overall farmers reported that they had knowledge about RDF based on their own experience. For tur farmers, fellow farmers as well as private dealers were important source of information regarding RDF.

Table 5.8: Elucidation of Recommended Doses of Fertilizers (RDF) on Reference Crops (% farmers who know RDF)

Who explained to you	Sugarcane (n=73)	Tur (n=51)	Overall (n=124)
Own experience	34.2	23.5	29.8
Department of Agriculture	17.8	13.7	16.1
Fellow Farmers	16.4	41.2	26.6
sugar factory person	12.3	0.0	7.2
Private dealers/retailers	9.6	37.3	21.0
Cooperatives/ Growers' Association	5.5	2.0	4.1
Agriculture University	1.4	0.0	0.8
NGOs	0.0	5.9	2.4
Did not answer	2.7	0.0	1.6

Note : Multiple response question; There were farmers who didn't test soil, but knew about RDF.

Farmers were asked to report the doses of fertilisers as per their opinion and as per the soil test report. Table 5.9 shows the comparison between the two for the two crops. As far as urea is concerned, for sugarcane, the dose applied by the farmers is lower than that recommended. In case of tur however, farmers have overestimated the requirement of urea. In case of other chemicals, especially the micronutrients, farmers have underestimated their requirement. The Table underlines the importance of fertiliser training.

The farmers reported various problems they faced in soil testing. It can be seen from Table 5.10 that for nearly 42 percent of the farmers the major problem in testing the soil was that the laboratory was far away. Fourteen per cent of the farmers reported that they were unaware about soil testing and its benefits. However, 45 per cent of the farmers were unable to report any problem.

In case of tur, 16 per cent of the farmers reported that the reports of the soil testing were not given to them after testing and was one of the major problems faced by the farmers. Distance of the testing lab was also one of the main problems faced by these farmers. In this case also, 54 per cent of the farmers were unable to any major problem.

Table 5.9 : Recommended Doses of Fertilizer Adopted by All Respondents

(Kg per acre)

Particulars	Sugarcane		Tur	
	As per Farmer opinion	As per Soil Test Report	As per Farmer opinion	As per Soil Test Report
% of total farmers aware of RDF	23.5	11.00	20.0	3.5
FYM (ton)	4.0	4.6	1.1	1.1
Urea(kg)	231.2	262.1	40.2	30.4
DAP(Kg)	112.4	111.1	51.9	42.2
MOP (Kg)	113.7	146.6	24.6	25.3
MgSO4 (Magnesium) (Kg)	0.4	9.8	2.5	5.8
FeSo4 (kg)	0.5	1.8	0.3	3.5
ZNSO4 (Zinc) (kg)	0.4	2.6	0.7	0.9
SSP(kg)	18.9	1.8	0.0	0.0
Mixture & Others (kg)	44.8	37.7	0.4	0.5
Nimbodi Paint (kg)	0.8	0.0	0.0	0.0
Sulphur (kg)	0.0	0.9	0.0	0.0

Table 5.10 : Major Problems Faced in Soil Testing by Farmers

(Percentage of farmers)

No	Problems	Sugarcane	Tur	Overall
1	Testing lab far away	41.5	15.5	28.5
2	Unaware about soil testing and its benefits	14.0	11.0	12.5
3	Reports not given even after testing	1.0	16.0	8.5
4	No guidance	1.5	7.0	4.3
5	Unauthentic reports	0.0	2.0	1.0
6	Timely report not received	0.0	1.0	0.5
7	Land not on his name/records required	0.0	0.5	0.3
8	Unable to report any problem	44.5	54.0	49.3

Note. Multiple response questions

Table 5.11 shows major suggestions from the farmers regarding improvement in the scheme. According to 16 percent of the total farmers, soil testing should be conducted by the government. Implementing measures for increasing awareness about soil testing and increasing availability of laboratories were other major suggestions. It

can be noted that more than 50 percent of the total farmers had no suggestion to offer and were unable to comment.

Table 5.11: Major Suggestion for Improving the Soil Health Card Scheme

(Percentage of farmers)

No	Problems	Sugarcane (n=200)	Tur (n=200)	Overall (n=400)
1	Increase awareness about soil testing	20.0	1.0	10.5
2	Soil testing should be conducted by Govt.	15.5	16.5	16.0
3	Lab availability nearby needed	8.5	11.5	10.0
4	Free soil testing needed	5.5	1.5	3.5
5	demonstration of soil testing needed	3.0	0.5	1.8
6	Mobile soil testing van within village	1.5	3.0	2.3
7	There is need to test every farmer soil	0.0	1.5	0.8
8	Soil testing at market place	0.0	0.5	0.3
9	Authenticate soil testing and reporting	0.0	0.5	0.3
10	No suggestion and can't say	48.5	61.5	55.0

Note: Multiple response questions.

5.6 Concluding Remarks

The data relating to distribution of soil health cards shows that for the state as a whole, the soil sample collected is more than the target set. Overall, 94 percent of the sample that was collected was tested. Nearly 85 percent of the samples that were collected were distributed at the state level. However, in a number of districts, the targets have not been met and clearly suggest need for strengthening of the distribution machinery.

As far as the primary data is concerned, it is observed that only 74 sugarcane farmers (37 percent) and 72 tur farmers (36 percent) got their soil tested since 2013-14.This percentage is very low. The major sources of information on NCU are the state agricultural department and Agricultural universities. It is observed that around 87 percent of the farmers who got their soil tested, reported that the main reason for getting the soil tested was for understanding the fertiliser requirement of their soil. However, it has to be noted that 254 (64.5 percent) farmers did not get their soil tested for various reasons. Mostly, the farmers reported that they did not know whom to contact and that the testing labs were not available in the vicinity. It is interesting to note that 62 per cent of the farmers felt that soil testing was not required as their respective soils were in good condition.

The responses relating to problems faced and suggestions reveal the inadequate outreach of the government machinery in creating awareness about soil testing and in testing their soil and hence underlines need to strengthen the extension machinery.

Chapter 6

Impact of NCU Application on Crop Production and Soil Health

6.1 Background

This chapter discusses observations from the field relating to impact of usage of NCU vis-à-vis that of urea by the respective sugarcane and tur farmers on their yield, fertiliser usage, cost of cultivation etc. The chapter also analyses the difference in various indicators in 2015 over 2014 for the NCU and Non-NCU farmers. Paired sample (for the years 2014 and 2015 for both the categories of farmers) and independent sample *'t' test* (between NCU and Non-NCU farmers for the year 2015) have been used to observe the significance of the difference between the two time periods and two categories of farmers respectively with respect to various indicators.

6.2 Impact on Yield of Reference Crops among the Sample Households

Table 6.1 shows changes in the yield of the sample crops during 2014 and 2015. Whereas in case of sugarcane, the productivity per acre of NCU farmers increased by 8 per cent; in case of Non-NCU farmers, it increased by 6 percent in 2015 as compared to 2014. The output per unit of total urea increased by 21 percent in case of NCU farmers as against one percent in case of Non-NCU farmers during this period. Thus, considerable difference can be observed in the results of NCU and Non-NCU farmers.

Table 6.1: Impact of Application of NCU on Yield of Sample Crops (Kg/ acre)

Particulars	NCU			Non-NCU			Difference in NCU and Non-NCU (2015)	
	2014	2015	% change	2014	2015	% change	*t*-values	% Difference
Sugarcane								
Productivity	49,635	53,933	8***	48,410	51,339	6***	0.26	5.1
Output per unit of total urea	162	205	21***	168	170	1	2.95***	20.6
Tur								
Productivity	469	495	6**	393	324	-18***	2.45**	56.3
Output per unit of total urea	10	11	10	9	8	-11***	1.68*	37.5

Note : 1. Output per unit of urea is calculated by dividing total main output by total quantity of urea used 2.*, **, *** indicate significance level at 10, 5,and 1 percent respectively.

In case of tur also, similar results are observed. The percentage change in the productivity per acre and output per unit of total urea is positive as against negative in case of Non-NCU farmers. The table shows that the temporal changes for both the categories of farmers in case of yield were significant. The change is insignificant in case of output efficiency of urea for NCU tur and Non-NCU sugarcane farmers.

The Table also shows the significance levels of difference in the NCU and Non-NCU farmers as far as productivity and output per unit of total urea are concerned. The *t values* show that output efficiency of urea for NCU farmers was significantly higher than the Non NCU farmers for both the crops indicating reduced usage of total urea consumption in case of NCU farmers (without adversely impacting the yield) as compared to Non NCU farmers.

It is observed that although average yield was higher in case of NCU sugarcane farmers than the Non-NCU farmers, the difference was insignificant. This indicates that in case of sugarcane, usage of NCU had not impacted productivity of NCU farmers significantly and that factors other than NCU usage could have played an important role in production levels not significantly different. However, for tur, the difference in yield is significant.

6.3 Impact on Total Quantity of Fertilisers Used

With an objective to understand the impact of NCU on total quantity of fertilisers used, the NCU and Non-NCU farmers were asked to report the consumption of all the fertilisers used in the years 2014 and 2015.This is shown in Table 6.2

It can be seen that for sugarcane NCU farmers, the consumption of NCU increased by more than 2000 percent in 2015 (as it was very low in 2014) and the total urea consumption declined by around 15 percent. In case of Non-NCU farmers however, consumption of urea increased by around 5 percent. Paired sample *t*-test results indicated that decline and increase in urea consumption of NCU and Non-NCU farmers respectively were significant. It was also observed that the percentage increase in the overall consumption of other fertilisers was higher for the Non-NCU farmers than the NCU farmers.

Similar pattern of consumption is observed for tur. Consumption of NCU was nil in 2014. With its usage in 2015, quantity of urea consumed declined drastically. Whereas the total quantity of urea has reduced for NCU farmers, it has marginally increased for Non-NCU farmers. Paired sample *t*-test results indicated that decline in

urea consumption of NCU farmers was significant. The total other fertiliser consumption has also increased by higher percentage in case of Non-NCU farmers.

It is observed from table 6.2 that for sugarcane NCU farmers, the total urea consumption significantly declined and total other fertiliser consumption significantly increased in 2015. In 2015, it was significantly lower for the NCU farmers than the Non NCU farmers.

In case of tur also, the total urea consumption declined significantly in 2015 for the NCU farmers. In 2015, the difference in the total urea consumption was nonsignificant. NCU farmers were found to be consuming significantly higher quantities of other fertilizers compared to Non-NCU farmers. This difference was however significant in case of other fertilisers.

Table 6.2: Total quantity of fertilizer used by NCU and Non-NCU farmers (2014 and 2015) (Kgs/acre)

Particulars	NCU			Non-NCU			Difference in NCU and Non-NCU 2015	
	2014	2015	% change	2014	2015	% change	% Difference	*t*- values
Sugarcane								
NCU	9.5	242.8	2466.1***	0	0	-	242.8	36.93***
Urea	297.8	20.1	-93.3***	287.6	301.4	4.8*	-281.3	-16.25***
Total Urea (a)	307.2	262.8	-14.5***	287.6	301.4	4.8	-38.6	-3.05***
DAP (b)	78.1	85.4	9.4	67.7	81.4	20.2	4.0	-0.67
SSP (c)	80.8	87.2	7.9	97.2	80.2	-17.5**	7.0	1.01
Potash (d)	80.3	96	19.5***	79	73.7	-6.7*	22.3	1.76*
Mixture (e)	59.5	78.5	32.0*	40.6	101.6	150.1**	-23.1	-1.14
Total other fertilisers (f =b+c+d+e)	299.7	347.2	15.8***	285.6	337	18***	10.2	-0.28
Total (a+f)	607.0	610.0	0.5***	573.1	638.4	11.4*	-28.4	-1.174
Tur								
NCU	0	43.3	--	0	0	0.0	43.3	23.37***
Urea	48.5	1.1	-97.8***	41.7	41.9	0.3	-40.8	-20.07***
Total Urea (g)	48.5	44.4	-8.6*	41.7	41.9	0.3	2.5	0.92
DAP (h)	29.9	35.7	19.4***	21.1	25.9	22.5**	9.8	2.64***
SSP (i)	1.1	3.3	193.7	1.1	0.8	-28.8	2.5	1.50
Potash (j)	6.3	6.1	-3.5	3	2.2	-27.9	3.9	1.86*
Mixture (k)	22	20.7	-5.6	16.3	20.2	24.3	0.5	0.70
Total other fertilisers (l=h+i+j+k)	60.3	65.8	9.2**	42.6	49.1	15.4**	16.7	2.87***
Total (g+l)	108.8	110.2	1.3	84.3	91.0	7.9***	19.2	3.03***

6.4 Impact on Cost of Cultivation of the Reference Crops

This section discusses economic impact of NCU on costs and returns of the farmers. It is seen from Table 6.3 that in case of sugarcane, for NCU farmers, total cost has increased over the year 2014 by 14 percent. However, the extent of increase was higher for Non-NCU farmers (22 per cent). In absolute terms, the individual as well as total costs except that of urea were lower for the Non-NCU farmers as compared to the respective costs for NCU farmers, but the percentage change in case of total costs and other fertilisers and micronutrients was higher for them. For both the categories of farmers, the percentage change total input cost is significant. Decrease in cost of urea and increase in that of NCU (due to adoption of NCU in 2015-16) for the NCU farmers and increase in cost of urea for Non-NCU farmers is significant.

Table 6.3 also shows significance levels of *t values* of the difference between NCU and Non-NCU sugarcane farmers relating to various types of costs. It is observed that the urea costs per acre were significantly lower for NCU farmers as compared to Non-NCU farmers. Although cost of micronutrients per acre was higher, its share in the total cost was only around 4 percent. Rests of the input costs were not significantly different for NCU and Non-NCU farmers. The analysis shows that the NCU farmers have benefited mainly due to reduced usage of total urea consumption.

Table 6.3: Impact of NCU on Input Cost of Sugarcane, 2015 (Rs. acre)

Particular	NCU			Non-NCU			Difference in NCU and Non-NCU	
	2014	2015	% change over 2014	2014	2015	% change over 2014	*t*-values	% Difference 2015
Pest and disease control	430	501	17	363	409	13	0.30	22.5
Weed management	499	607	22	497	604	22	0.62	0.5
NCU	57	1451	2446***	0	0	0	-	-
Urea	1,696	114	-93***	1,634	1714	5*	-	-93.3
Total Urea	1,753	1,565	-11***	1,634	1714	5*	- 2.34**	-8.7
Other fertilizers	5,006	5900	18***	4,411	5628	28***	-1.02	4.8
Micro-nutrients	160	344	115***	22	126	473***	1.86*	173.0
Total	7,848	8,918	14***	6,927	8,479	22***	-0.76	5.1

Note : *, ** , *** indicate significance level at 10, 5,and 1 percent respectively

The paired sample *t test* results indicate that the main product yield, price and value of main product for sugarcane were significantly higher in 2015 for both the categories of farmers. However, the change in these indicators was higher for the NCU farmers than the Non-NCU farmers in 2015 (Table 6.4).

The independent sample *t tests* indicate that the differences between NCU and Non-NCU farmers for main and by-product yield, prices and overall gross returns were insignificant. This again shows that the gains from usage of NCU were limited to reduction in total urea consumption and did not have a significant impact on yield of sugarcane as compared to Non-NCU farmers.

Table 6. 4: Impact of NCU on Production and Marketing of Sugarcane, 2015 (Rs. acre)

Particular (Costs)	NCU			Non-NCU			Difference in NCU and Non-NCU (2015)	
	2014	2015	% change	2014	2015	% change	*t*-values	% difference
Main product yield (Qtl)	496	539	8.6***	484	513	6.1***	0.26	5.1
By-product Yield (Qtl)	0.4	0.8	102.4	0.6	0.8	29.7	-0.99	0.0
Price of main product (Rs./Qtl)	206.2	221.1	7.2***	209.6	216.0	3.0*	-0.07	2.4
Price of by-product (Rs/ Qtl)	606	415	-31	332	356	7.2	0.54	16.6
Value of main product	102,334	119,231	16.5***	101,488	110,912	9.3***	-0.03	7.5
Value of by-product	247	343	38.9	214	297	38.8	0.33	15.5

In case of tur, it is observed that the cost of total urea significantly reduced for NCU farmers in 2015 as against an increase in case of Non-NCU farmers. The total input costs of NCU farmers were higher than that of the Non-NCU farmers (Table 6.5). The percentage change in total cost was also higher for the latter in 2015, mainly due to costs incurred on other fertilisers. However, the difference over 2014 was significant for both the categories of farmers as far as total costs are concerned.

It is also observed from Table 6.5 that the total input costs and costs on weed management, total urea and other fertilisers were significantly higher for NCU farmers than the Non-NCU farmers. The difference in the total cost is mainly on account of other fertilisers which have a share of around 50 percent in case of both the categories of farmers in both the years.

Table 6.5: Impact of NCU on Input Cost of Tur (2015) (Rs.acre)

Particular (Costs)	NCU			Non-NCU			Difference in NCU and Non-NCU (2015)	
	2014	2015	% change over 2014	2014	2015	% change over 2014	*t*-values	% difference
Pest and disease control	864	972	13***	758	833	10**	1.0	16.7
Weed management	62	68	9	0	4	--	1.95*	1600.0
NCU	0	278	--	0	0	--	-	-
Urea	292	6	-98***	251	252	1	-	-97.6
Total Urea	292	284	-3**	251	252	1	2.00**	12.7
Other fertilizers	1,212	1,361	12***	913	1101	21***	2.11**	23.6
Micro-nutrients	26	43	64	0	11	--	1.30	290.9
Total	2,457	2,728	11***	1,921	2,201	15***	2.25**	23.9

Note : *, **, *** indicate significance level at 10, 5, and 1 percent respectively

Table 6.6 shows that the yield of the main product is higher in case of NCU tur farmers than the Non-NCU farmers in both the years. Moreover, the percentage increase of around 6 percent in case of the former and percentage reduction of 23 percent in case of the latter was found to be statistically significant.

A comparison of yields and gross returns of NCU and Non-NCU farmers shows that they significantly higher for the NCU farmers than the Non-NCU farmers. The increase in the gross returns is mainly due to the yield effect rather than the price effect.

Table 6.6: Impact of NCU on Production and Marketing of Tur, 2015 (Rs./acre)

Particular (Costs)	NCU			Non-NCU			Difference in NCU and Non-NCU (2015)	
	2014	2015	% change	2014	2015	% change	*t*-values	% difference
Main product yield (Qtl.)	4.7	5.0	5.5**	3.9	3.2	-23.1***	2.75***	56.3
By-product Yield (Qtl)	2.2	2.4	0.9	2.2	1.4	-36.4***	0.76	71.4
Price of main product (Rs./ Qtl)	5,146	8,807	71.1***	5,216	9,046	73.4***	-0.89	-2.6
Price of by-product	579	705	21.8***	662	863	30.4***	-1.05	-18.3
Value of main product	24,150	43,555	80.5***	20,495	29,291	42.9***	2.45**	48.7
Value of by-product	1,367	1,515	10.8***	1,467	1,208	-17.7	-0.15	25.4

Note : *, ** , *** indicate significance level at 10, 5,and 1 percent respectively

6.5 Economic Feasibility of NCU A Partial Budgeting Framework

The partial budget framework is a method that evaluates the impact of incremental changes in costs and resources. It deals with only those resources that are changed. In this section, we use this framework to analyse the impact of incremental costs and returns and reduced costs and returns due to the usage of NCU and with the help of this, net additional return per acre and per unit of money invested for the year 2015 is found out. Tables 6.7 and 6.8 show added costs and returns and reduced costs and returns due to usage of NCU for sugarcane and tur farmers respectively. The added costs and reduced returns due to NCU adoption are presented on the left side of the tables, whereas the reduced costs and added returns are mentioned on the right side of the tables. The cost variable included costs of pest and disease control, weed management, NCU, other fertilisers and micronutrients i.e. the costs that seem to get affected due to usage of NCU. Those costs which are incremental (higher for NCU farmers than Non-NCU farmers) are mentioned under 'added costs', whereas those costs which are lower have sbeen mentioned under 'reduced costs'. Added returns are found out by multiplying the average price received by NCU farmers by the difference (between NCU and Non-NCU farmers) in yield per acre. If the difference in yield is positive (negative) i.e., NCU farmers have higher (lower) yield than Non-NCU farmers, this creates added returns (reduced returns). Additional returns from NCU are found out by net reduced returns from net added costs.

Table 6.7: Economic Feasibility of NCU in Sugarcane (using a partial budgeting framework) (Rs./acre)

A			B		
Sl. No	Added cost due to NCU	Costs (Rs.)	Sl. No	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	92	1	Cost of pest and disease control	-
2	Cost of weed management	3	2	Cost of weed management	-
3	Cost of Urea (NCU+ Urea)	-	3	Cost of Urea (NCU+ Urea)	149
4	Cost of other fertilizers	272	4	Cost of other fertilizers	-
5	Cost of Micro-nutrients	218	5	Cost of Micro-nutrients	-
	Total added Costs	585		Total Reduced cost	149
Sl. No	Reduced return Due to NCU	Costs (Rs.)	Sl. No	Added returns due to NCU	Returns (Rs.)
1	Main product	-	1	Main product 2.6 tonnes *Rs. 2211	5,749
2	By-product yield	-	2	By-product yield 0 Qtl * 415	0
	Total of reduced return	-		Total of added returns	5,749
	Total (A)	585		Total (B)	5,898
	B-A	5,313			
Additional return from NCU is about Rs.5,313/- per acre Added return per acre is Rs. 5,898/- *Benefit Cost Ratio BC Ratio= B/A=10.11*					

For sugarcane, it is observed that on the cost side, there is an addition on account all types of costs except that of total urea. As there was an increase in returns, reduction in returns is nil. Hence, the net addition (net of reduced returns) to costs due to usage of NCU for NCU farmers is Rs.585/-.On the other hand, there is a reduction in the cost of total urea in case of NCU farmers due to reduced usage of total urea. On the returns side, there is an addition on account of yield of the main product, which is higher by 2.6 tonnes as compared to Non-NCU farmers. Considering the reduced costs and added returns due to NCU, the total added return per acre is Rs.5898/- After considering net added costs and net reduced costs due to NCU, it is seen that an additional return of Rs.5313/- per acre was obtained by the NCU farmers. The incremental net added return is higher than the incremental net cost by more than 10 times for the NCU sugarcane farmers. The benefit cost ratio is greater than 1 and takes the value of 10.3. This means that a rupee of variable cost has generated ten rupees of added returns. The main factor explaining the benefit cost ratio is the added returns due to increment in average yield for NCU farmers.

In case of tur, per acre cost has increased for the NCU farmers and hence there is no reduction in cost for these farmers (Table 6.8).

Table 6.8: Economic feasibility of NCU in Tur (using a partial budgeting framework)

(Rs./acre)

A			B		
Sl. No	Added cost due to NCU	Costs (Rs.)	Sl. No	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	139	1	Cost of pest and disease control	-
2	Cost of weed management	64	2	Cost of weed management	-
3	Cost of total urea	32	3	Cost of total urea	-
4	Cost of other fertilizers	260	4	Cost of other fertilizers	-
5	Cost of Micro-nutrients	43	5	Cost of Micro-nutrients	-
	Total added Costs	538		Total Reduced cost	0
Sl. No	Reduced return Due to NCU	Costs (Rs.)	Sl. No	Added returns due to NCU	Returns (Rs.)
1	Main product	-	1	Main product 1.8 Qtl * 8807	15,853
2	By-product yield	-	2	By-product yield 1 Qtl * 705	705
	Total of reduced return	-		Total of added returns	16,558
	Total (A)	538		Total (B)	16,558
	B-A	16,020			
Additional return from NCU is about Rs. 16,020/- per acre An added return per acre is Rs. 16,558. *Benefit Cost Ratio BC Ratio= B/A=30.81*					

Similarly, there has been no reduction in returns. In fact, the returns have increased by Rs.16, 558/- The net added cost is Rs. 806 as against the net added returns of Rs. 16558/-.Therefore, additional return from NCU is Rs. 16020/- per acre and the benefit cost ratio is 30.8 indicating that the additional returns are around 31 times higher than the costs or in other words, for one rupee of variable cost, around 31 rupees of returns are obtained. The main factor that explains the level of benefit cost ratio is the added returns due to increment in average yield for NCU farmers.

It is observed from Tables 6.7 and 6.8 that in case of both the crops, application of NCU had positive impact on returns of the NCU farmers. The additional return (in absolute terms) and the benefit cost ratio were higher for tur than sugarcane. As the analysis shows (Table 6.4 and 6.6), this is mainly due to significantly higher yields for tur NCU farmers and higher price of the produce in 2015.

Impact on Soil Heath and Crop Growth

Responses of the farmers relating to soil health and crop growth (Table 6.9) show that majority of the sugarcane and tur farmers felt that there was an improvement in soil health, that the quality of grains was good and the market acceptability had increased. The data thus shows that farmers had accepted NCU and did not have any complain about quality of NCU. In fact, the NCU users felt that there were benefits in terms of improvement in structure, moisture retention soil softness and decrease in the soil compaction.

Table 6.9 : Relative Benefits of NCU on Soil Health Improvements over Urea

Sl. No	Particulars	Sugarcane		Tur		Overall	
		Nos	%	Nos	%	Nos	%
1	Texture improved	124	91.2	73	86.9	197	89.5
2	Soil moisture retention increased	67	49.3	57	67.9	124	56.4
3	Improvement in water Infiltration	64	47.1	56	66.7	120	54.5
4	Improvement in soil softness	60	44.1	52	61.9	112	50.9
5	Compaction decreased	55	40.4	41	48.8	96	43.6

6.6 Concluding Remarks

The analysis of this chapter relating to impact of NCU usage on yield, fertiliser consumption and costs reveals that the performance of the NCU farmers was better in 2015 as compared to 2014 in relation to the Non-NCU farmers. The *t values* of difference between output efficiency of urea (2015) in case of NCU farmers and Non-NCU farmers was significant for sugarcane as well as tur indicating reduced

usage of total urea consumption in case of NCU farmers (without adversely impacting the yield). However, the difference between productivity was significant only for tur farmers. For sugarcane, the difference is non-significant. This indicates that usage of NCU has not impacted productivity of NCU farmers significantly and that factors other than NCU usage could have played an important role in causing production levels to be same.

Data on fertiliser inputs show that in 2015 as compared to 2014, the total urea consumption declined significantly for NCU farmers, whereas for Non-NCU farmers, it increased. However, the difference in urea consumption in both the categories was found to be significant for sugarcane. For tur it was insignificant. In case of both the crops, fertiliser usage total other fertilisers increased in2015 over 2014 for NCU and Non NCU farmers. However, the difference between NCU and Non NCU other fertiliser usage is significant only for tur farmers. Thus, it is observed that even with lower consumption of urea and other fertilisers, yields were higher in case of NCU sugarcane farmers.

Data on input costs shows the urea costs per acre were significantly lower for sugarcane NCU farmers and that they benefited mainly due to reduced usage of total urea. However, the *t values* for main and by-product yield, prices and overall gross returns were insignificant. This again probably indicates that the gains from usage of NCU were limited to reduction in total urea consumption as the yields were not found to be significantly different. For tur, *t values* indicate that the total input cost, yield as well as gross returns were significantly higher for the NCU farmers. The increase in the gross returns is mainly due to the yield effect rather than the price effect.

The partial budgeting exercise reveals that the incremental net added returns are higher than the incremental net costs by more than 10 times for the NCU sugarcane farmers and by 30 times for NCU tur farmers. Thus, for both the crops, application of NCU had positive impact on returns of the NCU farmers. The main factor explaining the benefit cost ratio is the added returns due to increment in average yield for NCU farmers. It is also observed that the additional return (in absolute terms) and the benefit cost ratio are higher in case of tur. As the analysis shows, this is mainly due to significantly higher yields and higher price of the produce in

50 percent or more respondents thought that as compared to urea, there was an improvement in soil health due to use of NCU.

Chapter 7

Summary, Conclusions and Policy Suggestions

7.1 Introduction

Urea is the most widely used nitrogen fertiliser. It accounted for 57.3 percent of the total fertiliser application during 2014-15. India however, is not self-sufficient in urea production as its consumption has been rising steadily since 2003-04. The CAGRs of all India urea production and consumption were 1.76 percent and 4.41 percent per annum respectively for the period 2003-04 to 2014-15. This led to widening of gap between production and consumption, which forced the government to increase its urea imports. It is observed that urea imports have increased from 1.4.3 lakhs MT in 2003-04 to 87.5 lakhs MT in 2014-15, registering a CAGR of 38.9 percent per annum.

In order to make urea available at affordable prices to farmers the government has been heavily subsidising this sector as against P and K fertilisers which are partially decontrolled. This has led to an imbalance in the use of nutrients and has contributed to the fiscal burden. The recent studies therefore have suggested several measures to revive the fertiliser sector and make it sustainable. One of the major policy recommendations has been the use of NCU. Neem acts as a nitrification inhibitor and its coating over urea minimizes losses due to leaching, prevents its misuse as well as puts the fertiliser in slow release mode thereby nourishing the saplings for a longer period. It thus avoids repeated use of fertilizer and economises the quantity of urea required by crops enhancing nitrogen-use efficiency. Besides, coating of neem oil also reduces the leaching of nitrates into the groundwater aquifers and thus, helps in reducing its pollution.

With this background, Government of India (GoI) made it mandatory for all the indigenous producers of urea to produce 100 percent of their total production of subsidized urea as NCU from 2015 and took various steps to promote NCU, with a view to improve soil health status and also realise higher yield per hectare. The imported urea is also being coated and thus 100 percent NCU is now being supplied for agricultural use. As per the officials of fertilizer department, GoM, the production of NCU was 220 lakh MT in 2015-16 and thus constituted around 90 percent of the total urea production (245 lakh MT at all India level).

There is need for a study assessing the impact of NCU on the production and yield of major crops in India. Maharashtra is the second largest fertiliser consuming state of India. It accounts for eight per cent of the total urea consumption in the country. The present study examines the coverage of NCU, its adoption behaviour and its impact on yield among the selected crops in the state of Maharashtra. Besides, the status and implementation of soil health card scheme is also studied in case of Maharashtra.

7.2 Objectives of the Study

1. To analyze district wise and state level trends in usage of urea and Neem Coated urea and trends in prices of urea in Maharashtra.
2. To analyze the adoption behavior of NCU sample farmers in irrigated and unirrigated tracts.
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.

7.3 Data and Methodology

The study relies on secondary as well as primary data collected from the sample households for the reference period kharif 2015. Irrigated and unirrigated kharif crops in the state using urea were to be selected. Accordingly, from amongst the irrigated crops sugarcane was selected. The share of sugarcane in the cropping pattern area (GCA) in 2014-15 was 4.5 percent (GoM, 2016) and 100 percent of the sugarcane area was irrigated as per the data available (GoI, 2016c). The other crop that was selected was tur which occupied 5.2 percent of the GCA of Maharashtra in 2014-15 (GoM, 2016). The area under irrigation for this crop was only 1.6 percent of total tur area in 2012-13 (GoI, 2016c).

Based on the urea usage and discussions with state government officials, for sugarcane, districts Ahmednagar and Kolhapur were selected. Similarly, for tur, districts Yavatmal and Latur were selected. From each of the districts, two talukas were selected again based on the urea usage. From each of the selected talukas, two clusters of villages comprising three to four villages per cluster were selected for conducting the survey. Fifty farmers from each taluka, and a total of 100 farmers in case of each district, adding up to 200 farmers for each crop were selected. Thus in all, data was collected form the sample consisting of 400 households. Households

were selected randomly for assessing the use of NCU fertilisers and its impact on crop production. Care was taken to select NCU users as well as urea users (Non-NCU farmers) for comparing the impact of NCU usage and urea usage.

For sugarcane, out of a total of 200 sample farmers, 68 percent of the farmers were NCU users and 32 percent were Non-NCU users. In case of tur, 42 percent were NCU users and 58 percent were Non-NCU users. Thus, a total of 220 farmers (55 percent) were NCU users in the total sample of 400 farmers. Households from different farm size groups were selected.

7.4 Major Findings of the Study

Major findings emerging from analysis of the secondary data are as follows

- It is observed from the analysis of the secondary data that although Maharashtra is the second largest fertilizer consuming and third largest urea consuming state in the country, it's per hectare fertilizer and urea consumption was about 120.5 kg and 108.6 kg respectively for the T.E. 2014-15, which was 7.6 percent and 29.3 percent respectively less than the all India average.
- The urea consumption in the state increased at the rate of 4.1 percent per annum during the period 2000-01 to 2015-16. Across years, urea consumption seems to have been affected by occurrence of droughts, since 2009.
- Moreover, the rate of growth of urea consumption is not uniform across the divisions and districts of the state. The variation in the rates of growth of urea usage within the state can be attributed to the inter-district variation in agro climatic and socio economic factors such as weather (rainfall), irrigation, cropping pattern etc.
- The district-wise data for T.E. 2014-15 reveals that district Kolhapur has highest per hectare usage of urea which is followed by Nandurbar and Jalgaon districts with 188.3 and 171.4 kg per hectare respectively. These are the only districts with more than all India consumption per hectare average. The lowest urea application per hectare of GCA is found in Osamanabad. It is interesting to note that the growth rate of urea consumption is less than that of the all India average for Kolhapur division and Latur division
- From 2009-10 to 2015-16, the rate of increase in urea price was 17.5 percent, which was quite less as compared to that in MRP of DAP (171.2 percent) and MOP (277.6 percent).

- With the rising prices of fertilizers in the global market, prices of P and K fertilisers increased considerably in the domestic market also. The rising prices of DAP and MOP compared to urea is considered to be one of the main reasons for proportionately higher usage of urea and the imbalance in the usage of fertilisers.
- In view of this, the importance of NCU can be highlighted as its usage not only is expected to reduce in the agricultural sector but also prohibit the diversion of urea (due to neem coating) into other sectors for various purposes.

Following were the major findings that emerged from the analysis of the primary data.

- ***The Socioeconomic Characteristics***

- The differences in the socioeconomic characteristics of sugarcane and tur farmers largely represent differences in the regional characteristics. The analysis also reveals differences in the performance of the NCU and Non-NCU farmers.
- It is observed that the sugarcane farmers were comparatively better off than the tur farmers as far as their educational level was concerned. They mainly belonged to general category. Though they owned comparatively smaller size of landholdings, the extent of the land irrigated was very high i.e. around 90 percent. Their cropping pattern consisted of besides sugarcane, cereals, oilseeds and horticultural crops. The tur farmers belonged to general as well as OBC category. Their landholding size is comparatively bigger than the sugarcane farmers. However, the extent of irrigation was only 38 percent for these farmers.
- For both the crops, it was observed that the extent of higher education was higher for the NCU farmers. The extent of irrigation was also higher for the sugarcane and tur NCU farmers.
- The analysis revealed that overall, the NCU farmers had a better socioeconomic background.

- ***Costs and Returns***

- The data on costs and returns of the households shows that the output and the net returns were higher for the NCU farmers than the Non-NCU farmers for both the crops. The extent of increase in output and in net returns from 2014 to 2015 was also higher as well for the NCU farmers.
- The *t values* of difference between output efficiency of urea (in 2015) in case of NCU farmers and Non-NCU farmers was significant for sugarcane as well as

tur indicating reduced usage of total urea consumption in case of NCU farmers (without adversely impacting the yield) as compared to Non-NCU farmers.

- The difference between productivity of NCU and Non NCU farmers was significant only for tur farmers. For sugarcane, the difference was non-significant. This indicates that usage of NCU has not impacted productivity of sugarcane NCU farmers significantly and that factors other than NCU usage could have played an important role in causing production levels to be same.
- Data on input costs shows that the urea cost per acre was significantly lower for sugarcane NCU farmers and that they benefited mainly due to reduced usage of total urea. However, the differences in the two categories of farmers in case of main and by product yield, prices and overall gross returns were insignificant. This again probably indicates that the gains from usage of NCU were limited to reduction in total urea consumption as the yields were not found to be significantly different.
- For tur, *t values* indicate that the total input cost, yield as well as gross returns were significantly higher for the NCU farmers. The increase in the gross returns was mainly due to the yield effect rather than the price effect.
- The partial budgeting exercise reveals that the incremental net added returns were higher than the incremental net costs by more than 10 times for the NCU sugarcane farmers and by 20 times for NCU tur farmers. Thus, for both the crops, application of NCU had positive impact on returns of the NCU farmers. The main factor explaining the benefit cost ratio was the added returns due to increment in average yield for NCU farmers.
- It was also observed that the additional return (in absolute terms) and the benefit cost ratio were higher in case of tur than sugarcane. As the analysis shows, this was mainly due to significantly higher yields and the price received in 2015 in case of tur NCU farmers as compared to Non-NCU farmers as against in case of sugarcane.

➢ ***Awareness and Perceptions about NCU***

- Our analysis of observations on awareness among the sugarcane and tur farmers regarding usage of NCU suggested that around 70 percent of the sugarcane and 42 percent of the tur farmers were aware about the NCU and agricultural officers,

input shops were seen to be the main source of information about NCU. All the farmers were able to differentiate between NCU and Non-NCU.

- The observations also provided important insights on the perception of the farmers about benefits of NCU as compared to urea. It was revealed that majority of the NCU farmers were convinced about the benefits of NCU in terms of total fertiliser usage indicating decline in the latter leading to increased efficiency of fertiliser usage. Overall, farmers appeared to be satisfied about quality and availability of NCU and majority (above 50 percent) of them thought that the application of NCU led to improvement in soil health as compared to that of urea.
- The consumption of NCU was very low in the year 2014 for sugarcane and nil for tur and that of Urea was higher. The results showed that consumption of NCU increased in 2015 for both the crops. The percentage change was more than 2000 percent for sugarcane and the total quantity of urea consumed by NCU farmers declined by around 15 percent. This is a positive sign as it indicates efficiency of NCU in terms of its requirement as compared to urea. However, for Non-NCU farmers, the urea usage increased by 4 percent. For tur NCU farmers also, total urea consumption declined in 2015. For NCU farmers of both the crops, other fertiliser usage increased but to a lesser extent than the Non-NCU farmers.

➢ ***Problems in adoption of NCU***

- About 53 percent of the farmers were unable to report any problem in adoption of NCU. The major problem that was reported by 37 percent of the farmers was that there was shortage of NCU.
- As a result, the major suggestion for improving fertiliser usage was about for improving NCU usage by 25 percent of the farmers. About 65 percent of the respondents were unable to report any problem.
- The analysis therefore revealed increasing adoption of NCU and reduced per acre consumption of total urea by NCU farmers as compared to the Non-NCU farmers. It also revealed that the farmers were overall satisfied about usage of NCU and expressed need to ensure adequate and timely availability and create more awareness about NCU.

➢ ***Soil Health Cards***

- The secondary data relating to distribution of soil health cards shows that for the state as a whole, the soil sample collected was more than the target set in 2015-

16. Overall, 94 percent of the sample that was collected was tested. Nearly 85 percent of the samples that were collected were distributed at the state level. However, in a number of districts, the targets have not been met and clearly suggest need for strengthening of the distribution machinery.

- As far as the primary data is concerned, it is observed that only 74 sugarcane farmers (37 percent) and 72 tur farmers (36 percent) got their soil tested since 2013-14.This percentage is very low. The major sources of information on NCU were the state agricultural department and Agricultural universities.
- It was observed that around 87 percent of the farmers who got their soil tested, reported that the main reason for getting the soil tested was for understanding the fertiliser requirement of their soil. However, it has to be noted that 254 (64.5 percent) farmers did not get their soil tested for various reasons. Mostly, the farmers reported that they did not know whom to contact and that the testing labs were not available in the vicinity.
- It is interesting to note that 79 percent of the farmers felt that soil testing was not required as their respective soils were in good condition.
- The responses relating to problems faced and suggestions reveal the inadequate outreach of the government machinery in creating awareness about soil testing and hence underlines need to strengthen the extension machinery.

7.5 Conclusions

The secondary data reveals that though Maharashtra is the second highest fertiliser consuming state, the per hectare urea consumption is lower than the national average. This highlights the scope for increasing urea consumption in the state. Usage of NCU can be expected to bring out nitrogen use efficiency in the consumption urea.

The analysis of the primary data reveals that overall 55 percent of the farmers (69 percent and 42 percent of sugarcane and tur farmers respectively) were aware about NCU. However, it also reveals increasing adoption of NCU and reduced per acre consumption of total urea by NCU farmers as compared to the Non-NCU farmers. The analysis indicated positive impact of NCU usage on sugarcane farmers in terms of reduced usage of total urea consumption. The usage of NCU has not impacted productivity of sugarcane NCU farmers significantly and that factors other than NCU usage could have played an important role in causing production levels to be same.

For tur however, yield as well as gross returns were significantly higher for NCU farmers.

The NCU farmers did not seem to be having major complaints about adoption and usage of NCU. The data also revealed need for creating more awareness about NCU and need to ensure adequate and timely availability of NCU.

The secondary data relating to distribution of soil health cards shows that for the state as a whole, nearly 85 percent of the samples that were collected were distributed at the state level in the year 2015-16. However, in a number of districts, the targets have not been met and clearly suggest need for strengthening of the distribution machinery. Field level data showed that percentage of farmers who got their soil tested was very low and underlines need for increasing outreach of the extension machinery for testing the soil and distribution of soil health cards.

7.6 Policy Implications

Following are the policy suggestions that emerge from the study.

(i) Secondary data shows that per hectare consumption of fertilisers is comparatively lesser in Maharashtra. As per hectare urea / fertiliser consumption is largely related to availability of water, increasing the extent of irrigation along with increasing area under the crop is important to increase per hectare usage of urea wherever necessary.

(ii) With production of 100 percent urea as NCU, all the farmers would be now using NCU. Overall, the analysis of the primary data revealed that majority of the NCU farmers were satisfied with the quality of NCU and were unable to report any problem. The only problem reported by 37 percent of the farmers was shortage of NCU. Thus, it is essential to ensure adequate timely supply of NCU at village level.

(iii) In view of the difference between actual usage and recommended doses of fertilisers, and for increasing output efficiency and productivity of urea and judicious use of all fertilisers, there is need for organising fertiliser training camps at regular intervals at the village level so that farmers can be given suggestions about its usage (recommended doses of fertilisers) under changing weather conditions. All the farmers need to be given information about relative benefits of NCU over urea and accordingly about requirement of doses of NCU as compared to urea.

(iv) Only around 37 percent of the sugarcane as well as tur farmers got their soil tested since 2013-14. This percentage is very low. The responses reveal inadequate outreach of the machinery in creating awareness about soil testing. Hence, the outreach of the extension machinery needs to be improved so that the target set for soil testing is fulfilled and all the farmers get their soil health cards before the sowing season. Also, there is a need to convince the farmers about benefits of soil test based nutrient management.

(v) Out of the total farmers who got their soil tested, only 54 percent possessed the soil health card at the time of survey and only 58 percent could understand the information given on it. Thus, there is need to educate the farmers about benefits of possessing soil health card and about its contents.

(vi) There is a need for increasing manpower resources engaged in collection of soil samples and distribution of soil health cards, more soil testing labs and capacity building of the staff so that the cards are distributed before the sowing season.

References

Datta, K. (2016, February 17). Neem-coated truth Urea policy isn't a game-changer. *Business Standard*.

Dillon, J., & Hardaker, J. (1980). *Farm management research for small farmer development.* Rome Food and Agriculture Organisation of the United Nations.

FAI. (2015). *Fertilizer Statisitcs 2014-15.* Delhi Fertilizer Association of India.

Food and Agricultural Organisation of United Nations. (2016). *Country Indicators India*. Retrieved November 2016, from FAOSTAT http//www.fao.org/faostat/en/#country/100

GoI. (2015, November 02). *Districts drought Details declared by States*. Retrieved November 2016, 14, from Farmers' Portal "One stop shop for farmers" http//farmer.gov.in/drought/droughtreport.aspx

GoI. (2016a). *Annual Report 2015-16.* New Delhi Government of India, Department of Fertilizers, Ministry of Chemicals and Fertilizers.

GoI. (2016b, March 31). Highest ever production of Urea of 245 lakh MT in 2015-16. Retrieved November 16, 2016, from Press Information Bureau, Government of India, Ministry of Chemicals and Fertilizers http//pib.nic.in/newsite/PrintRelease.aspx?relid=138461

GoI. (2016c). *Agricultural Statistics at a Glance 2015.* Delhi Government of India, Ministry of Agriculture & Farmers Welfare, Directorate of Economics and Statistics.

GoI. (n.d.). *About us*. Retrieved November 16, 2016, from Government of India, Department of Fertilizers, Ministry of Chemicals and Fertilizers http//fert.nic.in/page/about-us

GoM. (2015). *Economic Survey of Maharashtra 2014-15*. Mumbai Directorate of Economics and Statistics, Government of Maharashtra.

GoM. (2016). *Economic Survey of Maharashtra 2015-16.* Mumbai Directorate of Economics and Statistics, Government of Maharashtra .

Gulati, A., & Banerjee, p. (2015). *Rationalising Fertiliser Subsidy in IndiaKey Issues and Policy Options.* New Delhi Indian Council for Research on International Economic Relations.

Kumar, D. (2015, July 11-17). Neem Coated Urea Uses and Benefits. *Employment News, XL*(15), p. 64.

National Fertilizers Limited. (n.d.). *Neem Coated Urea*. Retrieved from National Fertilizers Limited http//www.nationalfertilizers.com/

Planning Commission. (1997). *Nineth Five Year Plan (Vol-2).* New Delhi GoI.

Sharma, V. P., & Thaker, H. (2011). *Demand for fertiliser in India determinants and outlook for 2020.* Indian Institute of Management, Ahmedabad.

Singh, B. (2016). *Agronomic Benefits of Neem Coated Urea – A Review.* Paris, France International Fertilizer Association.

Annexure I

Comments on the report **"Impact of Neem Coated Urea on Production, Productivity and Soil Health in India"** submitted by AERC, Maharashtra.

1. Title of the draft report examined

Impact of Neem-coated Urea on Production, Productivity and Soil Health in India – A Case of Sugarcane and Tur in Selected Districts of Maharashtra.

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

3. Date of dispatch of the comments January, 2017

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 Summary, Conclusions and Policy Suggestions, whole introduction chapter is reproduced. Better to avoid tables and figures in this Chapter. Summarize the results obtained in a précised manner with a suitable policy suggestions based on the results obtained.

(ii) The partial budgeting framework adopted seems to be incomplete (Table 7.5). Estimations should be reported indicators-wise using partial budgeting (i.e., Added costs due to NCU in different indicators such as cost on pest & diseases, labor costs, fertilizers etc. should be reported separately). Kindly, recheck the BC ratios; it should be in the form benefits obtained for per rupee investment. Accordingly, revise the Tables 6.7 and 6.8.

(iii) In Page No. 88 and 89, complete phrase is highlighted and is in italics, which is not required. Hence, align the complete report by following the standard guidelines.

(iv) Please, provide suitable policy suggestions in the last Chapter based on the results obtained.

(v) 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 along with soft copy of the data for consolidation.

Annexure II

Action Taken Report by the Authors

Comments on analysis, organization, presentation etc.

1.All the tables in the chapter 'summary, conclusions and Policy Implications' have been removed and results are summarised in a precise manner. Suitable policy suggestions based on results obtained.

2. Table 7.5 has been removed and tables 6.7 and 6.8 have been revised suitably.

3. Suitable changes have been made on pages 88 and 89 of the draft report.

4. Suitable policy suggestion mentioned.

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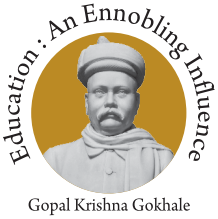

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