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ADOPTION OF RECOMMENDED DOSES OF FERTILIZERS ON SOIL TEST BASIS BY FARMERS FOR WHEAT AND RICE IN PUNJAB

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PREFACE

Fertilizers (Nitrogenous, Phosphatic and Potassic) have been the important ingredients making Punjab as the food bowl of the country. The monoculture of paddy-wheat has resulted in decline in soil fertility in terms of development of macro and micro-nutrient deficiencies which is often ameliorated by the application of chemical Fertilizers. The per hectare consumption of these fertilizers in the state have increased merely from 43.12 N, 7.75 P, 1.73 K in 1970-71 to 191.85 N, 60.02 P, 6.72 K in 2011-12. Since soils vary considerably in their capability to meet plants nutrient needs depending on factors such as soil parent material, texture, structure and current growing conditions, the soil test based application of such fertilizers have been recommended and gaining importance than ever before. Taking a soil test and using the recommendations that come with it help crop(s)/ plant(s) receive adequate amount of nutrients needed for the crop. Thus, soil testing is an important activity which should be undertaken by the farmers and results given in the soil health card if properly implemented by the farmers on their fields, can result in significantly cost saving anddecreasing the cost of cultivation of crop by optimum use of fertilizers and increase in crop yield due to applying nutrient(s) only when crop/ plant needed.

In view of the cited benefits of soil testing, the present study was undertakenwith emphasis on theadoption of recommended doses of Fertilizers by the farmers on soil test basis and their impact on cost reduction and yield improvements if any. This attempt would certainly be useful for framing suitable agricultural policies for the benefit of the farming community.

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ADOPTION OF RECOMMENDED DOSES OF FERTILIZERS ONSOIL TEST BASIS BY FARMERS FOR WHEAT AND RICE IN PUNJAB

ABSTRACT

Punjab being a state where the benefits of the green revolution reached the doorsteps of almost every farm household. Over time, rice-wheat monoculture resulted in the appearance of macro and micro-nutrient deficiencies in the soil which was replenished with the application of chemical Fertilizers. But balanced and soil test based application of Fertilizers has not been followed by the farmers in the state. The major objectives of the study were; to examine the level of adoption and its constraints in the application of recommended doses of Fertilizers based on soil test reports by the farmers. and to analyse the impact of adoption of recommended doses of Fertilizers on crop productivity and income of farmers. The present study relied on the primary data collected from the farmers and secondary data collected from various sources. The reference period for the study was 2012-13. The list of farmers who got their soils tested was collected from the Punjab Agricultural University, Ludhiana for the year 2011-12 to assess the adoption of recommended dose of Fertilizers. Paddy and wheat crops were selected for the study and districts selected were Ludhiana and Sangrur based on the crop area share within the state. A sample of 120 soil test farmers and 60 control farmers growing both paddy and wheat crops were selected representing all the farm categories. The trends in Fertilizer consumption revealed that at Punjab level, maximum growth in Fertilizer consumption was in phosphatic (P) Fertilizers followed by nitrogenous (N) and potassic (K) Fertilizers during last four decades and per hectare Fertilizer consumption has also increased. The analysis revealed that the major source of information about soil testing for soil test farmers was State Agricultural University (SAU) and soil testing was undertaken by the farmers due to motivation from village demonstration, training programmes attended and exposure visits to places with best farming practices. The major reason for not testing soil by control farmers was that they thought it was not required as they were getting good yield of the crops grown on their farms. Soil health card of soil test farmers showed that 70 83 per cent of the farmers reported nitrogen content in the soils as medium followed by 20.83 per cent as low and 8.34 per cent as high. The phosphorus content in the soils was relatively better with 58.34 per cent farmers reporting it as high followed by 25.83 per cent as medium and 15.83 per cent as low. Also, potassium was sufficiently available in the soils with 97.5 per cent of the farmers reporting potassium content as high and 2.50 per cent as low. In aggregate, only 40.83 per cent soil test farmers applied recommended doses of Fertilizers to paddy and wheat crops while according to farm categories 44 per cent medium, 41.56 per cent large, 35.71 per cent small and 25 per cent marginal category farmers applied recommended doses of Fertilizers to their paddy and wheat crops. The most important constraint revealed by 69.01 per cent soil test farmers in applying recommended doses of Fertilizers was the difficulty in understanding and following the recommended doses. The Fertilizer use in aggregate and according to farm categories was more on control farmers farms as compared to soil test farmers farms. All the Fertilizers were broadcasted evenly in the paddy and wheat fields by the farmers except drilling of DAP at the time of wheat sowing and manganese spray to ameliorate manganese deficiency in wheat. Mostly, FYM was applied by 43.33 per cent soil test and 40 per cent control group farmers to their paddy crop while FYM use was very low in case of wheat crop. The Fertilizers like urea and DAP were mostly purchased from the co-operative societies while other Fertilizers such as zinc, potsh, sulphur, bio-vita gypsum and manganese were mostly purchased from private fertilizer shop/ dealers by both soil test as well as control group farmers. As far as attending training programme is concerned, 41.67 per cent of the soil test farmers and 25 per cent control farmers attended one or two trainings of one day duration. In both paddy and wheat crops, average yield and value of output was more on soil test farmer farms as compared to control farmers farms and it was also higher according to farm categories. The impact of application of recommended doses of Fertilizers in terms of adopting the soil health card recommendations by soil test farmers showed that in case of paddy crop, in aggregate, increase in yield was 3.70 per cent while maximum increase in crop yield was observed on medium farms followed by small, marginal and large farms. In case of wheat crop, increase in yield was 6.16 per cent after following the soil health card recommendations while the highest increase in yield was observed on marginal farms followed by medium, large and small farms. The important changes observed by the soil test farmers after application of recommended doses of Fertilizers was the increase in crop yield and less incidence of pest and diseases for both paddy and wheat crops. Thus there was decline in fertiliser consumption on soil test farms for both paddy and wheat crops along with increase in yield which can be due to balanced use of macro and micro nutrients especially application of gypsum and green namuring of the fields by some of the soil test farmers. The major policy recommendations included; more trainings, exposure visits of farmers to the areas adopting good agricultural practices, adoption and implementation of soil health card results by farmers on their fields, visit by the scientists to the farmers fields for their motivation and incentives by the Govt. along with involvement of Gram Panchayats in promoting soil testing can be good steps in the direction of balanced use of nutrients for better crop productivity.

Chapter I: INTRODUCTION

1.1 Background

Punjab being a pioneer state resulted in ushering green revolution in the country with adoption of new farm technology resulting in increase in the productivity and thereby production of the rice and wheat crops. In the initial years of this technological breakthrough, output from the crops increased rapidly with no major impact on decline in soil fertility and thereby production. But with the passage of time, rice-wheat monoculture resulted in decline of soil fertility in terms of appearance of macro and micro-nutrient deficiencies, fast depleting ground water table and ecological and environmental problems. It is well known that the chemical fertilizers are the important source of nutrients for plant growth. With the advent of fertilizer responsive crop varieties, total consumption of nitrogenous (N), phosphatic (P) potassic (K) fertilizers increased from about 1.1 million tonnes in 1966-67 to 27.8 million tonnes in 2011-12. The all-India average consumption of fertilizers increased from 6.9 kg per ha of gross cropped area to 139.7 kg per ha over the same period (Fertilizer Statistics 2013). However, the level of consumption of fertilizers is highly varied within as well as between states. The consumption is varied from 243 Kg per ha in Punjab to 54 Kg per ha in Himachal Pradesh during 2011-12. The variability in consumption of fertilizers can be attributed to different cultivation methods, type of crops and subsidy on fertilizers. Further, the consumption of fertilizers has also varied across farm size groups with the highest amount of consumption recorded among small farmers.

There are concerns about the indiscriminate use of chemical fertilizers by farmers with a view to increase the crop yield. This has led to deterioration of soil structure, wastage of nutrients, destruction of soil micro-organisms and scorching of plants at the extreme cases. A combination of factors such as intensive cultivation of crops, differential pricing of fertilizers and subsidy, might have contributed to excessive/ unbalanced use of fertilizers by the farmers. At the same time, it is reported that many parts of India shown deficiency of not only primary nutrients (N,P,K) but also secondary (Sulphur, Calcium and Magnesium) and micro nutrients (Boron, Zinc, Copper and Iron). Government of India had undertaken initiatives to ameliorate the situation and encourage the farmers for balanced use of fertilizers. These initiatives among others, included decontrol of phosphatic and potassic fertilizers, promotion of integrated nutrient management, production and promotion of organic manures and bio-fertilizers, National Project on Management of Soil Health and

Fertility (NPMSF), and nutrient based subsidy (NBS) policy. Attempts have also been made to strengthen and revamp soil testing laboratories in various districts under NPMSF. Farmers are encouraged to test their soil periodically and apply fertilizers based on the deficiency of nutrients in soil. This is intended to ensure balanced supply of nutrients for maintaining soil health and improving crop productivity.

1.2 Review of Literature

Fertilizer use on the basis of soil testing is a crucial instrument for increasing the yield of crops. Chemical fertilizers along with manures, green manuring, bio fertilizers can augment the soil fertility in a significant way. Keeping this in view, review of various studies related to macro and micro-nutrients replenishment to soils have been undertaken which shows the importance of the soil testing for increasing farm productivity. Soil fertility varies on the same farm giving ample scope for preparing soil health card for each farmer.

Bhumbla and Makkar (1965) while comparing the application of fertilizer based on soil test recommendations versus state level recommendations in village Barewal distt. Ludhiana found that the application of fertilizer based on soil test not only gives higher yield but also gives higher net gain over state recommendations.

Sekhon *et al* (1969) observed on the basis of the experiments conducted on Punjab Agricultural University, Ludhiana farm and on the fields of cultivators in villages Parodi, Alamgir and Mangli Nichi, that fertilizer applied according to the soil test gave better returns as compared to generalized state recommendations. It was further observed that difference of net profits were for greater in case of dwarf wheat pointing to their much potential to assimilate fertilizer.

Reddy *et al* (1981) reported that the use of compost as one of the components of integrated nutrient application system reduced the soil pH significantly over the rest of the treatments. The reduction of soil pH was due to application of FYM along with other sources of nutrients may be attributed to the formation of acids by the reaction between inorganic fertilizers, release of organic acids on decomposition of added FYM and conversion of nutrient elements in the available form due to the activity of micro-organisms supplied through various fertilizers. Application of integrated nutrients significantly increased the electrical conductivity of the soil due to the dissolution of salts by the acids formed.

Prasad and Sinha (1995) indicated a decline of 23, 44 and 16 per cent in available N, P and K, respectively after six years where neither manures nor inorganic fertilizers were applied.

Application of graded doses of fertilizers (50, 100 and 150% NPK) either in presence or absence of FYM showed an average increase of about 10 per cent in available nitrogen after 21 years of continuous rice-wheat cropping.

Gopal Reddy and Reddy (1998) reported that available N, P and micronutrient cations in soil were significantly influenced by the type and levels of manures application in conjunction with fertilizer. In all types of manures, the treatment with 100 per cent level of manure which was on par with 75 and 50 per cent level of manure showed higher available macro and micronutrients at the end of two cropping cycle in maize-soybean cropping system. This was attributed to the direct addition and slow release of N, P and K from manures added to soil.

Yaduvanshi (2001) reported that application of inorganic fertilizers along or in combination with green manure or FYM significantly enhanced the uptake of N by rice and wheat crop as compared to N alone and control treatment. The mean increase in uptake of N over control with 50 per cent recommended treatment and its combined use with green manuring and FYM and 100 per cent recommended treatments was 39.3, 78.1 and 77.3 kg per ha in rice and 36.8, 47.2 and 76.4 kg per ha in wheat, respectively. Nitrogen uptake by rice from green manuring or FYM or FYM with 50 per cent recommended treatment was similar to that from 100 per cent recommended treatment. The uptake of P and K increased significantly with the application of NPK and its combined use with green manuring and FYM.

Sharma and Sharma (2002) reported that application of different combinations of N, P and K did not show any significant effect on available N content of soil, whereas, application of NPK+FYM significantly increased available N content of soil over all combinations of FYM in rice -wheat cropping system.

Kumar and Thakur (2004) observed that application of 150 per cent recommended fertilizer resulted in higher uptake followed by recommended fertilizer + 10 ton per ha FYM. In experiment on maize crop, Karki *et al* (2005) reported that N, P and K contents in grain and stover of maize and their uptake were maximum with the recommended dose of fertilizers which was on par with recommended dose of fertilizer +10 tons per ha FYM treatment.

Laxminarayana and Patiram (2006) reported that balanced fertilisation of N, P and K recorded a higher yield response (29 %) in comparison to NP (24 %) and N alone (18 %) over control in rice. They also observed that highest uptake of N, P and K by grains and straw (134.0, 58.4 and 109.2 kg per ha, respectively) was recorded with the application of NPK +

green manure over the rest of treatments. Incorporation of green manure enhanced the total uptake of N, P and K to the tune of l31, 27 and 34 per cent, respectively over that of 100 per cent NPK in rice.

Mann *et al* (2006) reported that available phosphorus content increased after 35 years to 15.1, 38.4, 27.4 and 38.7 kg per ha from the initial value of 13.7 in 50, 100, 150 per cent NP and 100 per cent NPK + FYM treatments, respectively. The higher build up of available phosphorus occur because phosphorus use efficiency range between 16 to 32 per cent during this period in soybean-wheat cropping system.

Mishra *et al* (2006) studied the effect of integrated nutrient management practices involving FYM and GM on yield and N nutrition of rice. It was observed that integrated use of urea with organic sources increased nitrogen use efficiency in rice.

Singh *et al* (2006) studied the impact of integrated management of fertilizers, FYM and GM on productivity of rice for two years. It was reported that application of recommended fertilizers along with FYM 5 tons per haand green manuring at 2.1 tons per ha gave more yield of rice as compared to chemical fertilizers only.

Babu *et al* (2007) conducted a field experiment on alluvial soils to study the effect of different organic manures along with inorganic fertilizers on physical, physico-chemical and chemical properties of alluvial soil. It was reported that application of poultry manure along with inorganic fertilizers resulted in higher cane yield in plant crop whereas application of FYM along with inorganic fertilizers resulted in the highest cane yield in ratoon crop.

Kumar *et al* (2008) conducted a long-term field experiment on integrated management of FYM, GM and crop residues with inorganic fertilizers in rice-wheat system. It was reported that long-term application of crop residues and organic manures increased organic carbon content of soil. Further, it was found out that combined use of crop residues, organic amendments and chemical fertilizers significantly increased the availability of N, P, K, S and micronutrients in soil over chemical fertilizer alone.

Singh and Chahal (2009) studied the extent of adoption of various recommended production technologies for wheat crop in Punjab. The data were collected from farmers for three years. The results revealed that nitrogen was being applied at more than the recommended level by the farmers while phosphorus was being applied at the recommended level and potash was not being applied by the farmers to wheat crop in Punjab. The study brought out that there

existed a number of gaps in the adoption of recommended production technology for wheat crop, which needed to be properly plugged to enhance productivity as well as net returns to wheat producers in the Punjab state.

Kumar and Singh (2010) conducted an experiment on long-term integrated nutrient management under rice-wheat cropping system to assess the direct and residual effect of green manures on crops with and without farmyard manure (FYM). The highest grain and straw yields of rice and wheat were obtained with the application of 100 per cent NPK along with 5 tons FYM per ha each year.

1.3 Need for the study

The overexploitation of natural resources due to intensive cultivation, their sustainable management holds the key for ensuring sustainable food production. Due to lack of awareness among the farmers, some problems such as; indiscriminate use of chemical fertilizers, agro-chemicals and over exploitation of ground water especially in the central zone of Punjab has perpetuated the agricultural scenario of the state. Especially, the over use of chemical fertilizers by Punjab farmers in the last few decades led to several problems affecting soil health, nutrient flow and environmental pollution. Emphasis should for laid for promoting balanced use of chemical fertilizers among farmers for increasing crop yield and decreasing the cost of cultivation of crops. Thus, it is high time to realize the importance of soil testing which can help in replenishing the soils with the required nutrients thereby increasing the income of the farmers by increasing crop productivity and thereby production. Although, soil testing is being promoted by the agricultural scientists since long, but most important aspect is the proper implementation of the recommendations at the farmers fields. Thus, there is a need to further expedite the extension efforts to implement the balanced/ soil test based use of fertilizers by the farmers in the country as a whole for the betterment of the farming community in general and country in particular.

It is suggested that farmers should go for regular soil testing and use recommended doses of fertilizers as advised by the agricultural scientists. So far, no systematic study has been undertaken in Punjab for evaluating the adoption of recommended doses of fertilizers by farmers based on the soil testing and application of soil test recommendations on their fields. Therefore, the present study examines the level of adoption and constraints in the application of recommended doses of fertilizers and its likely impact on crop productivity.

1.4 Objectives of the study

The objectives of the study are as follows:

1. To examine the level of adoption and its constraints in the application of recommended doses of fertilizers based on soil test reports by the farmers.
2. To analyse the impact of adoption of recommended doses of fertilizers on crop productivity and income of farmers.

1.5 Data and Methodology

The present study relied on the primary data collected from the farmers and secondary data collected from various sources. The reference period for the study was 2012-13. The list of farmers who got their soils tested was collected from the Punjab Agricultural University, Ludhiana for the year 2011-12 to assess the adoption of recommended dose of fertilizers. Paddy and wheat crops were selected for the study due to major chunk of area during *kharif* and *rabi* under these crops in the Punjab state. Since all the farmers grow paddy and wheat crops during an agricultural year in the state. Hence, for both the crops, Ludhiana and Sangrur districts were selected based on the crop area share within the state. A sample of 60 soil test farmers for both the crops were selected randomly from each district for assessing the application of recommended dose of fertilizers and its impact on crop production.

The survey also involved 30 control (no soil test) farmers, for both the crops from each district, selected randomly from the chosen villages for differentiating the effect of the application of the recommended dose of fertilizers on crop productivity and income. Thus, a total of 120 soil test farmers and 60 control farmers were selected for paddy as well as wheat crops who were interviewed to collect the relevant data. Special care was taken to give adequate representation to different farm size groups classified based on operational land holding. Therefore, under soil test farmers category, there were four marginal, 14 small, 25 medium and 77 large farmers growing both paddy and wheat while under control farmers category, there was one marginal, six small, 16 medium and 37 large farmers growing both paddy and wheat thereby fulfilling the required sample size for the study.

1.6 Organisation of the Report

The present report has been divided into seven chapters. First chapter relates to the background information related to soil testing including need for the study, objectives and methodology undertaken. Second chapter is concentrated on the trends in fertilizer consumption in the state. Third chapter includes the socio economic characters of the

respondent farmers, cropping pattern followed on farms, farm assets and details of credit availed by them. Fourth chapter relates to soil testing and recommended doses of fertilizers on soil test basis while fifth chapter deals in the adoption of recommended doses of fertilizers, constraints in following recommendations and training programmes attended by respondent farmers. The impact of adoption of recommended doses of fertilizers has been dealt with in chapter sixth. Seventh chapter contains summary along with conclusions and policy recommendations.

Chapter II: TRENDS IN FERTILIZER CONSUMPTION IN THE STATE

2.1 Trends in Fertilizer Consumption in the State

The trends in fertilizer consumption by product in the Punjab state have been given in Table 2.1. A perusal of the table reveals that in the selected district Ludhiana, consumption of nitrogenous fertilizer was 22.3 th. tonnes in 1970-71 which increased to 114 th. tonnes in 2011-12 with mean consumption of 82.1 th. tonnes while CGR was 3.88 per cent per annum. Phosphatic fertilizer consumption was 9.2 th. tonnes in 1970-71 while it was 37 th. tonnes in 2011-12 with mean consumption being 28.2 th. tonnes and this increase was at CGR of 2.40 per cent per annum. Potassic fertilizer consumption was 1.0 th. tonnes in1970-71 while it was 4.0 th. nutrients in 2011-12 with mean consumption being 3.7 th tonnes and this increase was at a CGR of 1.26 per cent per annum. In the selected district Sangrur, Consumption of nitrogenous fertilizer was 16.5 th. tonnes in 1970-71 which increased to 133 th. tonnes in 2011-12 with mean consumption of 81.7 th. tonnes which increased at a CGR of 4.83 per cent per annum. Phosphatic fertilizer consumption was 3.0 th. tonnes in 1970-71 in district Sangrur, it increased to 29 th. nutrients in 2011-12 with mean consumption being 24.7 th. tonnes and this increase was at CGR of 4.29 per cent per annum. Potassic fertilizer consumption in district Sangrur was 0.6 th. tonnes in1970-71 while it was 3.0 th. tonnes in 2011-12 with mean consumption being 1.7 th tonnes and this increase was at a CGR of 2.74 per cent per annum. Thus, growth in fertilizer consumption was more in district Sangrur as compared to district Ludhiana. At Punjab level, the consumption of nitrogenous fertilizer was 174.8 th. nutrients in 1970-71 which increased to 1416 th. tonnes in 2011-12 with mean consumption of 803.4 th. tonnes while this increase was at CGR of 4.52 per cent per annum. Phosphatic fertilizer consumption was 31.4 th. tonnes in 1970-71 while it increased to 448 th. tonnes in 2011-12 with mean consumption being 803.4 th. tonnes and this increase was at CGR of 4.66 per cent per annum. Potassic fertilizer consumption was 7.0 th. tonnes in 1970-71 while it increased to 54 th. tonnes in 2011-12 with mean consumption of 28.1 th tonnes and this increase was at a CGR of 2.70 per cent per annum.The growth in nitrogenous fertilizerconsumption as compared to phosphatic and potassic fertilizers was higher in Ludhiana and Sangrur districts while at Punjab level, growth in phosphatic fertilizer consumption was higher than nitrogenous and potassic fertilizers. In 1970-71 the use of N, P and K fertilizers was higher in Ludhiana district as compared to Sangrur district which can be

Table 2.1: Trends in Fertilizer Consumption by Product in Punjab.

(Th. nutrient tonnes)

Year	Ludhiana			Sangrur			Punjab		
	N	P	K	N	P	K	N	P	K
1970-71	22.3	9.2	1.0	16.5	3.0	0.6	174.8	31.4	7.0
1975-76	29.8	11.5	1.8	23.4	6.0	0.8	231.8	53.3	10.1
1980-81	55.3	28.0	4.3	50.3	21.8	1.9	518.3	206.7	28.6
1985-86	89.0	35.0	5.0	85.0	29.0	1.0	787.0	287.0	24.0
1990-91	101.2	39.6	2.9	89.3	37.8	0.6	877.2	327.9	14.5
1991-92	105.6	36.0	3.9	99.7	32.1	1.2	930.4	313.9	17.6
1992-93	101.4	27.5	1.7	93.9	23.2	0.9	934.5	254.3	10.6
1993-94	99.3	24.1	1.6	8.7	24.0	0.3	946.5	245.5	7.5
1994-95	103.2	26.3	2.1	104.8	29.0	0.6	1013.5	255.8	15.8
1995-96	107.0	22.0	3.0	109.0	26.0	1.0	1020.0	227.0	16.0
1996-97	87.7	22.2	2.4	109.0	25.5	0.4	961.8	228.4	17.4
1997-98	101.6	32.1	2.3	105.6	26.9	1.0	1004.8	287.4	22.2
1998-99	101.2	30.5	2.3	105.2	27.0	1.4	108.1	275.1	18.7
1999-00	107.6	36.0	3.0	122.0	41.5	2.6	1084.5	334.6	26.5
2000-01	98.9	28.9	2.5	103.1	30.2	1.7	1008.0	282.0	23.0
2001-02	95.0	32.0	3.0	123.0	33.0	2.0	1070.0	307.0	30.0
2002-03	110.7	27.1	2.2	75.8	33.6	2.0	1111.3	298.9	31.7
2003-04	102.7	33.9	3.6	130.3	32.4	3.0	1170.1	335.0	38.0
2004-05	111.0	36.0	6.0	131.0	37.0	3.0	1201.0	316.0	43.0
2005-06	128.0	34.0	3.0	124.0	36.0	3.0	1255.0	369.0	63.0
2006-07	111.0	29.0	3.0	139.0	31.0	4.0	1299.0	354.0	39.0
2007-08	113.0	29.0	3.0	141.0	31.0	4.0	1316.0	344.0	38.0
2008-09	107.0	38.0	7.0	122.0	27.0	3.0	1332.0	379.0	57.0
2009-10	108.0	39.0	8.0	126.0	30.0	4.0	1358.0	434.0	74.0
2010-11	119.0	40.0	8.0	132.0	30.0	3.0	1403.0	435.0	73.0
2011-12	114.0	37.0	4.0	133.0	29.0	3.0	1416.0	448.0	54.0
Mean	82.1	28.2	3.7	81.7	24.7	1.7	803.4	251.5	28.1
CGR (%)	3.88***	2.40***	1.26**	4.83***	4.29***	2.74***	4.52***	4.66***	2.70***

Note: *** shows significance at 1 per cent level and ** shows significance at 5 per cent level of significance

attributed to better awareness of the farmers while Sangrur farmers later picked pace and were recently using these fertilizers almost at the same level as that of their Ludhiana counterparts.

2.2 Trends in Fertilizer Consumption Per Hectare of Net Area Sown

The trends in fertilizer consumption per hectare of net area sown has been given in Table 2.2. It can be seen that per hectare consumption of nitrogenous fertilizer in district Ludhiana was 70.62 kg. per hectare in 1970-71 which increased to 381.27 kg. per hectare in 2011-12

Table 2.2: Trends in Fertilizer Consumption per ha of net sown area in Punjab

(Kg/ha)

Year	Ludhiana			Sangrur			Punjab		
	N	P	K	N	P	K	N	P	K
1970-71	70.62	29.04	3.03	36.73	6.62	1.36	43.12	7.75	1.73
1975-76	92.22	35.50	5.68	51.46	13.31	1.75	55.74	12.82	2.43
1980-81	169.03	85.76	13.01	109.54	47.41	4.04	123.66	49.33	6.83
1985-86	271.34	106.71	15.24	188.05	64.16	2.21	187.51	68.38	5.72
1990-91	311.29	121.80	8.88	194.55	82.25	1.22	207.97	77.73	3.45
1991-92	324.85	110.64	12.00	217.13	69.86	2.53	220.73	74.47	4.18
1992-93	318.82	86.62	5.38	208.14	51.50	1.95	225.79	61.43	2.55
1993-94	315.30	76.53	5.02	19.48	53.72	0.68	224.61	58.25	1.77
1994-95	331.74	84.57	6.82	237.08	65.65	1.27	240.73	60.77	3.75
1995-96	353.14	72.61	9.90	239.56	57.14	2.20	246.62	54.88	3.87
1996-97	284.70	72.06	7.87	240.06	56.11	0.81	227.76	54.09	4.13
1997-98	338.74	107.08	7.60	215.50	54.95	2.12	237.04	67.80	5.25
1998-99	331.89	99.90	7.65	241.83	61.96	3.10	25.34	64.51	4.39
1999-00	355.15	118.97	10.00	268.63	91.52	5.77	257.53	79.47	6.29
2000-01	325.18	95.14	8.27	226.03	66.26	3.76	237.18	66.35	5.41
2001-02	311.48	104.92	9.84	270.33	72.53	4.40	251.53	72.17	7.05
2002-03	361.63	88.42	7.31	172.27	76.35	4.48	264.53	71.16	7.56
2003-04	335.53	110.64	11.82	296.10	73.59	6.90	278.52	79.73	9.05
2004-05	362.75	117.65	19.61	297.73	84.09	6.82	285.95	75.24	10.24
2005-06	419.67	111.48	9.84	281.82	81.82	6.82	300.96	88.49	15.11
2006-07	363.93	95.08	9.84	441.27	98.41	12.70	310.47	84.61	9.32
2007-08	369.28	94.77	9.80	451.92	99.36	12.82	314.31	82.16	9.08
2008-09	349.67	124.18	22.88	392.28	86.82	9.65	319.35	90.87	13.67
2009-10	355.26	128.29	26.32	403.85	96.15	12.82	326.60	104.38	17.80
2010-11	395.35	132.89	26.58	421.73	95.85	9.58	337.42	104.62	17.56
2011-12	381.27	123.75	13.38	426.28	92.95	9.62	342.53	108.37	13.06
Mean	262.29	89.71	11.66	200.14	59.01	4.28	191.85	60.02	6.72
CGR (%)	4.11***	2.62***	1.48**	5.51***	4.97***	3.41***	4.48***	4.62***	2.66***

Note: *** shows significance at 1 per cent level and ** shows significance at 5 per cent level of significance

while mean consumption was 262.29 kg. and growth in consumption was 4.11 per cent per annum. Phosphatic fertilizer consumption increased from 29.04 kg. per hectare (1970-71) to 123.75 kg. per hectare (2011-12) with mean consumption being 89.71 kg. per hectare and this increase was at a growth of 2.62 per cent per annum. In case of potassic fertilizer , the consumption was 3.03 kg. per hectare in 1970-71 which increased to 13.38 kg. per hectare in 2011-12 with mean consumption of 11.66 kg. per hectare and this increase was at a growth of 1.48 per cent per annum. Further, the consumption of nitrogenous fertilizer in district Sangrur was 36.73 kg. per

hectare in 1970-71 which increased to 426.28 kg. per hectare in 2011-12 while mean consumption was 200.14. and growth in consumption was 5.51 per cent per annum. Phosphatic fertilizer consumption increased from 6.62 kg. per hectare to 92.95 kg. per hectare with mean consumption being 59.01 kg. per hectare and this increase was at a growth of 4.97 per cent per annum. In case of potassic fertilizer , the consumption was 1.36 kg. per hectare in 1970-71 which was 9.62 kg. per hectare in 2011-12 with mean consumption of 4.28 kg. per hectare and this increase was at a growth of 3.41 per cent per annum. Thus, per hectare consumption of all the fertilizers was more in district Ludhiana as compared to district Sangrur. At Punjab level, the consumption of nitrogenous fertilizer was 43.12 kg. per hectare in 1970-71 which increased to 342.53 kg. per hectare in 2011-12 while mean consumption level was 191.85 kg. per hectare and this increase was at an annual growth of 4.48 per cent. Similarly, in case of phosphatic fertilizer, the consumption was 7.75 kg. per hectare which increased to 108.37 kg. per hectare in 2011-12 and mean consumption was 60.02 kg. while this increase was at 4.62 per cent growth per annum. In case of potassic fertilizer, the consumption was merely 1.73 kg. per hectare which increased to 13.06 kg. per hectare in 2011-12 with mean value being 6.72 kg. per hectare and this growth was at CGR of 2.66 per cent per annum.In 1970-71, per hectare consumption of N, P and K fertilizers was more in district Ludhiana than Sangrur but recently N fertilizer consumption was more in Sangrur while P and K fertilizers consumption was more in Ludhiana which can also be attributed to soil type fertilizer requirements in these districts.

2.3 Trends in Fertilizer Consumption Per Hectare of Gross Cropped Area

The trends in fertilizer consumption per hectare of gross cropped area has been given in Table 2.3. A perusal of the table reveals that per hectare and per season consumption of nitrogenous fertilizer in district Ludhiana was 45.36 kg. per hectare per season in 1970-71 which was 190 kg. per hectare in 2011-12 with mean consumption of 138.72 kg. and growth in consumption was 3.53 per cent per annum. Phosphatic fertilizer consumption increased from 18.65 kg. per hectare per season in 1970-71 to 61.67 kg. per hectare in 2011-12 while mean consumption was 47.92 kg. per hectare and this increase was at a growth rate of 2.05 per cent per annum. In case of potassic fertilizer, the consumption was 1.95 kg. per hectare per season in 1970-71 which increased to 6.67 kg. per hectare in 2011-12 with mean consumption of 6.29 kg. per hectare and this increase was at an annual growth of 0.91 per cent. Also, the consumption of nitrogenous fertilizers in district Sangrur was 25.97 kg. per hectare per season in 1970-71 which increased to 213.48 kg. per hectare in 2011-12 with mean consumption of 105.44 and growth in consumption was 4.69 per cent per annum. Phosphatic fertilizer consumption

increased from 4.68 kg. per hectare per season to 46.55 kg. per hectare with mean consumption of 31.32 kg. per hectare and this increase was at a growth of 4.15 per cent per annum. In case of potassic fertilizers , the consumption was 0.96 kg. per hectare per season in 1970-71 which was 4.82 kg. per hectare in 2011-12 with mean consumption of 2.31 kg. per hectare and this increase was at an annual growth of 2.60 per cent. At Punjab level, the consumption of nitrogenous fertilizer was 30.78 kg. per hectare per season in 1970-71 which was 179.20 kg. per hectare in 2011-12 with mean consumption level of 107.12 kg. per hectare and this increase was at an annual growth of 3.70 per cent. Also, in case of phosphatic fertilizers, the consumption was 5.53 kg. per hectare per season which increased to 56.69 kg. per hectare in 2011-12 and mean

Table 2.3: Trends in Fertilizer Consumption per ha of gross cropped area in Punjab

(Kg/ha/ Season)

Year	Ludhiana			Sangrur			Punjab		
	N	P	K	N	P	K	N	P	K
1970-71	45.36	18.65	1.95	25.97	4.68	0.96	30.78	5.53	1.23
1975-76	55.06	21.20	3.39	32.49	8.41	1.11	37.05	8.52	1.62
1980-81	96.97	49.20	7.46	65.30	28.26	2.41	76.63	30.57	4.23
1985-86	149.58	58.82	8.40	104.04	35.50	1.22	109.95	40.09	3.35
1990-91	168.33	65.87	4.80	100.56	42.51	0.63	116.93	43.70	1.94
1991-92	173.64	59.14	6.41	112.23	36.11	1.31	123.75	41.75	2.35
1992-93	167.58	45.53	2.83	106.79	26.42	1.00	123.75	33.67	1.40
1993-94	164.43	39.91	2.62	9.96	27.48	0.35	124.17	32.20	0.98
1994-95	171.38	43.69	3.52	120.59	33.39	0.65	131.74	33.25	2.05
1995-96	178.33	36.67	5.00	125.58	29.95	1.15	132.26	29.43	2.07
1996-97	145.91	36.93	4.03	121.91	28.49	0.41	123.19	29.26	2.23
1997-98	169.65	53.63	3.81	106.98	27.28	1.05	128.28	36.69	2.84
1998-99	168.15	50.61	3.88	121.90	31.23	1.56	13.60	34.62	2.36
1999-00	178.16	59.68	5.02	137.19	46.74	2.94	138.20	42.65	3.38
2000-01	163.67	47.89	4.16	114.39	33.53	1.90	126.94	35.51	2.90
2001-02	157.02	52.89	4.96	139.46	37.41	2.27	134.74	38.66	3.78
2002-03	183.21	44.80	3.70	87.83	38.92	2.28	142.97	38.46	4.08
2003-04	169.71	55.96	5.98	149.41	37.13	3.48	148.02	42.37	4.81
2004-05	183.47	59.50	9.92	150.23	42.43	3.44	151.41	39.84	5.42
2005-06	213.33	56.67	5.00	141.39	41.05	3.42	159.51	46.90	8.01
2006-07	191.38	50.00	5.17	222.76	49.68	6.41	165.25	45.03	4.96
2007-08	189.92	48.74	5.04	228.53	50.24	6.48	167.22	43.71	4.83
2008-09	179.83	63.87	11.76	196.77	43.55	4.84	168.35	47.90	7.20
2009-10	180.90	65.33	13.40	203.23	48.39	6.45	172.42	55.10	9.40
2010-11	198.66	66.78	13.36	212.90	48.39	4.84	178.00	55.19	9.26
2011-12	190.00	61.67	6.67	213.48	46.55	4.82	179.20	56.69	6.83
Mean	138.72	47.92	6.29	105.44	31.32	2.31	107.12	33.60	3.82
CGR (%)	3.53***	2.05***	0.91*	4.69***	4.15***	2.60**	3.70***	3.84***	1.90***

Note: *** shows significance at 1 per cent level and ** shows significance at 5 per cent level of significance

consumption was 33.60 kg. while this increase was at CGR of 3.84 per cent. In case of potassic fertilizers, the consumption was 1.23 kg. per hectare which increased to 6.83 kg. per hectare in 2011-12 while mean value was 3.82 kg. per hectare and this growth was at 1.90 per cent per annum. Thus, at Punjab level, maximum growth in fertilizer consumption was in phosphatic fertilizers followed by nitrogenous and potassic fertilizers.

2.4 Summary

District level analysis showed that the growth in fertilizer consumption was more in district Sangrur as compared to district Ludhiana. At Punjab level, the consumption of nitrogenous fertilizer was 174.8 th. tonnes in 1970-71 which increased to 1416 th. tonnes in 2011-12 with mean consumption of 803.4 th. tonnes while this increase was at CGR of 4.52 per cent per annum. Phosphatic fertilizer consumption was 31.4 th. tonnes in 1970-71 while it increased to 448 th. tonnes in 2011-12 with mean consumption being 251.5 th. tonnes and this increase was at CGR of 4.66 per cent per annum. Potassic fertilizer consumption was 7.0 th. tonnes in 1970-71 while it increased to 54 th. tonnes in 2011-12 with mean consumption of 28.1 th tonnes and this increase was at a CGR of 2.70 per cent per annum. At Punjab level, maximum growth in consumption was in phosphatic fertilizers followed by nitrogenous and potassic fertilizers. As far as fertilizer consumption per hectare of net sown area and per hectare of gross cropped area was concerned, consumption was more in district Ludhiana while growth in consumption was more in district Sangrur. At Punjab Level, the consumption of nitrogenous fertilizer per hectare of net area sown was 43.12 kg. per hectare in 1970-71 which increased to 342.53 kg. per hectare in 2011-12 while mean consumption level was 191.85 kg. per hectare and this increase was at an annual growth of 4.48 per cent. Similarly, in case of phosphatic fertilizer, the consumption was 7.75 kg. per hectare which increased to 108.37 kg. per hectare in 2011-12 and mean consumption was 60.02 kg. while this increase was at 4.62 per cent growth per annum. In case of potassic fertilizer, the consumption was merely 1.73 kg. per hectare which increased to 13.06 kg. per hectare in 2011-12 with mean value being 6.72 kg. per hectare and this growth was at CGR of 2.66 per cent per annum. Also, the consumption of nitrogenous fertilizer per hectare per season of gross cropped area was 30.78 kg. in 1970-71 which was 179.20 kg. per hectare in 2011-12 with mean consumption level of 107.12 kg. per hectare and this increase was at an annual growth of 3.70 per cent. Also, in case of phosphatic fertilizers, the consumption was 5.53 kg. per hectare per season which increased to 56.69 kg. per hectare in 2011-12 and mean consumption was 33.60 kg. while this increase was at CGR of 3.84 per cent. In case of potassic fertilizers, the consumption was 1.23 kg. per hectare which increased to 6.83 kg. per

hectare in 2011-12 while mean value was 3.82 kg. per hectare and this growth was at 1.90 per cent per annum. Thus, fertilizer consumption has significantly increased in Punjab over the last four decades.Also, recently N fertilizer consumption per hectare was higher in district Sangrur while P and K fertilizer consumption was more in district Ludhiana which can also be attributed to the soil type fertilizer requirements in these districts.

Chapter III: SOCIO-ECONOMIC CHARACTERISTICS OF SAMPLE HOUSEHOLDS

3.1 Distribution of Sample Households by Farm Size Category

The distribution of sample households by farm size category has been given in Table 3.1. A perusal of the table reveals that in soil test farmers category, for both paddy and wheat crops, 3.33 per cent of the respondents belonged to marginal farm category followed by 11.67 per cent to small, 20.83 per cent to medium and 64.17 per cent to large farm category. Similarly, in control farmers category, 1.67 per cent respondents were from marginal farm category, 10 per cent from small, 26.67 per cent from medium and 61.66 per cent from large farm category. Thus, the proportion of soil test farmers belonging to large farm category was high showing their inclination towards getting their soils tested for attaining better productivity thereby higher production of crops on their farms.

Table 3.1: Distribution of Sample Households by Farm Size Category (% of households)

Particulars	**Paddy and Wheat**	
	Soil test farmers	Control farmers
Marginal	3.33	1.67
Small	11.67	10.0
Medium	20.83	26.67
Large	64.17	61.66
Total	100	100

3.2 Socio-economic Characteristics of the Sample Households

The socio-economic characteristics of sample households have been shown in Table 3.2 The average age of respondents in soil test farmers category was about 44 years while it was nearly 40 years in control farmers category and up to 43 years in overall situation. The average years of respondents education was nearly nine years in both soil test farmers and control farmers category and in overall scenario. Thus, majority of the respondents were educated below matric level. Also, all the respondents were males in both the categories and pursuing agriculture as their main occupation. The average family size was nearly seven and at least two family members were engaged in agriculture in both the categories. The average farming experience of the respondents was nearly 24 years in soil test farmers, about 20 years in control farmers category and almost 23 years in overall. Nearly 93 per cent of the respondents were members of some association in soil test farmers category while this figure was 95 per cent in control farmers and about 94 per cent in an overall situation. Among both soil test farmers and control farmers categories, 98.33 per cent of the respondents belonged to

general castes while remaining1.67 per cent were from other backward castes (OBC) category.

Table 3.2: Socio-economic Characteristics of Sample Households- Paddy and Wheat

Particulars	Soil Test Farmers	Control Farmers	Overall
Number of sample farmer households	120	60	180
Average age of respondent (years)	43.86	39.77	42.49
Average years of respondent education	8.99	9.27	9.08
Agriculture as main occupation (%respondents)	99.17	100.00	99.44
Gender (%respondents)			
Male	100.00	100.00	100.00
Female	-	-	-
Average family size	6.78	6.75	6.77
Average number of people engaged in agriculture	1.98	2.03	1.86
Average years of experience in farming	24.02	20.12	22.72
% of farmers being a member of any association	93.33	95.00	93.88
Caste (% of households)			
SC	-	-	-
ST	-	-	-
OBC	1.67	1.67	1.67
General	98.33	98.33	98.33

3.3 Details of Operational Land Holdings

The operational land holding of the sample households for paddy and wheat crops have been depicted in Table 3.3. It can be seen from the table that net operated area in soil test farmers category was 18.37 acres, out of which owned land was 11.09 acres, leased-in was 7.47 acres and leased-out was 0.19 acres while in control farmers category, net operated area was 16.81 acres constituting 10.26 acres owned land and 6.55 acres leased-in land. In overall, net operated area was 17.85 acres with 10.81 acres being owned land, 7.16 acres leased-in and 0.13 acres leased-out land. The whole net operated area was irrigated in both the categories and cropping intensity was 199 per cent in soil test farmers, 202 per cent in control farmers category and 200 per cent in overall scenario.

Table 3.3: Operational Landholding of the Sample Households (acres/household)- Paddy and Wheat

Particulars	Soil Test Farmers	Control Farmers	Overall
Owned land	11.09	10.26	10.81
Leased-in	7.47	6.55	7.16
Leased-out	0.19	-	0.13
Uncultivated/Fallow	-	-	-
Net operated area	18.37	16.81	17.85
Net irrigated area	18.37	16.81	17.85
Net un-Irrigated area	-	-	-
Gross cropped area	36.59	33.90	35.69
Cropping intensity (%)	199	202	200

3.4 Source(s) of Irrigation

Various sources of irrigation on the sample household farms have been shown in Table 3.4. A perusal of the table reveals that in soil test farmers category, source of irrigation on 99.59 per cent of the net irrigated area was bore well/ tube well while 8.95 per cent was irrigated through canal water. It should be noted that on some household farms, both bore well/ tube well as well as canal water were available for irrigating same piece of land. On control farmers category, entire net operated area was irrigated through bore well/ tube well while canal irrigation was also available on some farms, therefore, 5.95 per cent of the area was also irrigated through canal irrigation. In overall, 99.72 per cent area was irrigated through bore well/ tube well and 8.10 per cent through canal irrigation.

Table 3.4: Sources of Irrigation (% net irrigated area)- Paddy and Wheat

Particulars	Soil Test Farmers	Control Farmers	Overall
Open/ dug well	-	-	-
Bore well	99.59	100	99.72
Canal	8.95	5.95	8.10
Tank	-	-	-
River/Ponds and Others	-	-	-
Total	100	100	100

3.5 Cropping Pattern, Area under HYV and Value of Output

The cropping pattern of the sample households has been given in Table 3.5. It is quite obvious from the table that during *kharif* season in soil test farmers category, 43.64 per cent of the gross cropped area was under paddy crop followed by fodder (2.87%), basmati

Table 3.5: Cropping Pattern of the Sample Households (% GCA)- Paddy and Wheat

Season/crop	Soil Test Farmers	Control Farmers	Overall
Kharif			
Paddy	43.64	42.58	43.30
Basmati	2.80	3.77	3.11
Baby corn	0.09	-	0.06
Cotton	0.16	0.07	0.13
Fodder	2.87	3.26	3.00
Rabi			
Wheat	45.78	46.03	45.86
Potato	1.12	0.59	0.95
Fodder	2.65	3.05	2.78
Summer			
Spring Maize	-	0.10	0.03
Summer Moong	-	0.35	0.11
Annual/perennial			
Sugarcane	0.89	0.20	0.67
GCA	100.00	100.00	100.00

(2.80%), cotton (0.16%) and baby corn (0.09%). During *rabi* season, 45.78 per cent of the gross cropped area was under wheat crop followed by fodder (2.65%), potato (1.12%) while sugarcane (0.89%) being an annual crop, was also grown on soil test farms. On control farmers farms, during *kharif* season, 42.58 per cent of the gross cropped area was under paddy crop followed by basmati (3.77%), fodder (3.26%) and cotton (0.07%) while in *rabi* season, wheat was major crop sown on 46.03 per cent of the gross cropped area followed by fodder (3.05%) and potato (0.59%). During summer season, summer moong and spring maize were the crops grown on 0.35 and 0.10 per cent of the gross cropped area while sugarcane was the annual crop occupying 0.20 per cent area. In an overall scenario, during *kharif* season, paddy was major crop occupying 43.30 per cent of the gross cropped area followed by basmati (3.11%), fodder (3.00%), cotton (0.13%) and baby corn (0.06%) while during *rabi* season, 45.86 per cent of the area was under wheat crop followed by fodder (2.78%) and potato (0.95%). During summer season, summer moong and spring maize were the crops occupying 0.11 and 0.03 per cent area while area under sugarcane crop was 0.67 per cent.

In soil test farmers as well as control farmers category, entire area under various crops grown was under high yielding varieties (Table 3.6). This shows the adequate availability of HYV seeds to the sampled farm households.

Table 3.6. Area Under HYV of Major Crops (% cropped area)

Crop name	Paddy farmers	Wheat farmers
Soil Test Farmers		
Paddy	100.00	-
Basmati	100.00	-
Baby corn	100.00	-
Cotton	100.00	-
Wheat	-	100.00
Potato	-	100.00
Sugarcane	100.00	-
Control Farmers		
Paddy	100.00	-
Basmati	100.00	-
Cotton	100.00	-
Wheat	-	100.00
Potato	-	100.00
Sugarcane	100.00	-

The aggregate value of the crop output from paddy crop on sample farm households has been given in Table 3.7. A perusal of the table reveals that among soil test farmers, per acre value of the crop output was Rs. 42462 on medium farms preceded by small (Rs. 41380), marginal (Rs.40695) and large (Rs.40092) farms while value of crop output was Rs 40329 per acre in total. Similarly, the value of the output per household was Rs. 878603 on large, Rs. 274732 on medium, Rs. 158359 on small, Rs. 78846 on marginal farms and Rs.640790 in total. After keeping some quantity of output as seed for next year crop, domestic use, donation to religious places etc. the rest of the output was marketed surplus. Thus, the value of the output sold on various farm categories varied from Rs.42186 per acre on medium farms, which was highest, to Rs.40011 on large farms, which was lowest among farm categories.

On control farmers farms, per acre value of the crop output was Rs. 39857 on large farms followed by medium (Rs. 39188), marginal (Rs.37990) and small (Rs.37772) farms while value of crop output was Rs 39715 per acre in total. Also, the value of the output per household was Rs. 781242 on large, Rs. 278600 on medium, Rs. 132201 on small, Rs. 37990 on marginal farms and Rs.569913 in total. The value of the output sold on various farm categories varied from Rs.39781 per acre on large farms, being highest to Rs.37772 on small farms, being lowest among farm categories.

Table 3.7. Aggregate Value of Crop Output- Paddy

Particulars	Value of Output		Value of Output Sold	
	Rs/household	Rs/acre	Rs/household	Rs/acre
Soil Test Farmers				
Marginal	78846	40695	78600	40568
Small	158359	41380	155235	40564
Medium	274732	42462	272945	42186
Large	878603	40092	876842	40011
Total	640790	40329	638941	40212
Control Farmers				
Marginal	37990	37990	37990	37990
Small	132201	37772	132201	37772
Medium	278600	39188	278428	39164
Large	781242	39857	779769	39781
Total	569913	39715	568958	39649

The aggregate value of the crop output from wheat crop on sample farm households has been given in Table 3.8. It is quite obvious from the table that on soil test farmers farms, per acre value of the crop output was Rs. 29671 on marginal farms followed by large (Rs. 29405), small (Rs.29229) and medium (Rs.29005) farms while in total value of crop output was Rs 29438 per acre. Also, the value of the output per household was Rs. 673326 on large, Rs. 207967 on medium, Rs. 115350 on small, Rs. 57488 on marginal farms and Rs.490751 in total. Wheat being staple food of the farm households, some quantity of it was kept as seed for next year crop, for domestic consumption and donation to religious places etc. The rest of the output was marketed surplus. Thus, the value of the output sold per acre on various farm categories was highest (Rs.27737) on large farms and lowest (Rs.23484) on marginal farms. As far as control farmers farms was concerned, per acre value of the crop output was Rs. 29400 on marginal farms followed by small (Rs.28346), large (Rs.28188) and medium (Rs.27090) farms and value of crop output was Rs 28051 per acre in total. The value of output per household was Rs.599938 on large, Rs. 194031 on medium, Rs. 105117 on small, Rs. 29400 on marginal farms and Rs.432705 in total. The value of the output sold on various farm categories varied from Rs.25449 per acre on large farms, being highest to Rs.23981 on medium farms, being lowest.

Table 3.8. Aggregate Value of Crop Output- Wheat

Particulars	Value of Output		Value of Output Sold	
	Rs/household	Rs/acre	Rs/household	Rs/acre
Soil Test Farmers				
Marginal	57488	29671	45500	23484
Small	115350	29229	99825	25295
Medium	207967	29005	184590	25745
Large	673326	29405	63518	27737
Total	490751	29438	459166	27544
Control Farmers				
Marginal	29400	29400	11200	11200*
Small	105117	28346	86100	23218
Medium	194031	27090	179856	23981
Large	599938	28188	541649	25449
Total	432705	28051	390775	25191

* Average holding size was one acre per household

3.6 Farm Assets Holdings

Distribution of the farm assets for soil test farmers and control farmers has been given in Table 3.9. A perusal of the table reveals that on soil test farmers category, major farm asset included tractor, trailer/ trolley with average number per household being 1.30 and average value Rs. 345083 per household. Hence, every farm household owned a tractor. The second major farm asset was electric motor/ diesel engine with average number being 1.73 per household and valuated at Rs. 21021 per household. Harrow and cultivators was the major

Table 3.9: Distribution of Farm Assets- Paddy and Wheat

Particulars	Soil Test Farmers		Control Farmers	
	Number/ household	Value/ household (Rs)	Number/ household	Value/ Household (Rs)
Tractor, trailer/trolley	1.30	345083	1.27	319683
Harrow and cultivator	0.99	12493	1.03	13017
Electric motor/ Diesel Engine	1.73	21021	1.68	24900
Thresher	0.06	1392	0.03	800
Planker	0.79	3260	0.87	3467
Manual/power sprayer	1.19	300	1.15	299
Fodder chopper	0.79	2636	0.95	2988
Bullock cart	0.76	2420	0.82	2565
Drip/sprinkler system	-	-	-	-
Small tools (spade, hoe, sickle etc.)	6.88	1133	6.78	1148
Animal shed/pump house	1.07	8142	1.20	7567
Others	0.02	375	0	0
Total	-	398255	-	376434

farm implements with 0.99 numbers per households and valuated at Rs. 12493 per household. The other farm assets included thresher, planker, manual/ power sprayer, fodder chopper, bullock cart, animal shed/ pump house and small tools which were estimated at Rs. 19283 in aggregate. The total value of the farm assets was estimated at Rs. 398255 per household.

Also, on control farmers farms, tractor, trailer/ trolley were the most expensive farm assets with average number per household being 1.27 and average value Rs. 319683 per household. The second major farm asset was electric motor/ diesel engine with average number being 1.68 per household and valuated at Rs. 24900 per household. Major farm implements were harrow and cultivators with 1.03 numbers per households and valuated at Rs. 13017 per household. The other farm assets included thresher, planker, manual/ power sprayer, fodder chopper, bullock cart, animal shed/ pump house and small tools which were estimated at Rs. 18834 in aggregate. The aggregate value of the farm assets was estimated at Rs. 376434 per household.

3.7 Details of Agricultural Credit Availed

The information related to agricultural credit status of the sample households clearly bring out that invariably all the sample farmers depended on the crop loan offered by the co-operative credit societies. Besides, around 20 per cent sample households also used commercial banks as the source of agricultural credit. Money lenders/ commission agents of course have still an important role to play in the agricultural credit scenario in rural Punjab. Still around ten per cent of the sample households were using this source to meet their farm credit requirements. Agricultural credit outstanding has been given in Table 3.10. A perusal of the table reveals that on soil test farmers farms credit outstanding per household was maximum from commercial banks (Rs. 25833) followed by money lenders (Rs.9583),

Table 3.10: Agricultural Credit Outstanding by the Sample Households (Rs/household) – Paddy & Wheat

Sources	Soil Test Farmers	Control Farmers
Co-operative Credit Societies	2500	2917
Land development banks	-	-
Commercial banks	25833	24750
RRBs	-	-
Money lenders	9583	6750
Fiends/Relatives	-	-
Traders/Commission agents	7917	7083
Others	-	-
Total	45833	41500

traders/ commission agents (Rs.7917) and co-operative credit societies (Rs.2500). Similarly, on control farmers farms also, credit outstanding from commercial banks was maximum (Rs.24750) which was followed by traders/ commission agents (Rs. 7083), money lenders (Rs.6750) and co-operative credit societies (Rs.2917) per household. Thus, credit outstanding was more from commercial banks for both farmer groups.

The purpose of loan availed has been given in Table 3.11. A perusal of the table reveals that 83.67 per cent soil test farmers took loan for seasonal crop cultivation followed by 8.16 per cent for marriage and social ceremonies, 3.07 per cent for purchase of tractors/ implements and non-farm activities and 1.02 per cent for consumption expenditure and purchase of livestock. Similarly, 83.33 per cent control farmers took loan for seasonal crop cultivation followed by 9.26 per cent for marriage and social ceremonies, 5.56 per cent for non-farm activities and 1.85 per cent for land development.

Table 3.11: Purpose of Agricultural Loan Availed (% farmers)- Paddy and Wheat

Purpose	Soil Test Farmers	Control Farmers
Seasonal crop cultivation	83.67	83.33
Purchase of tractor and other implements	3.07	-
Purchase of livestock	1.02	-
Land development	-	1.85
Consumption expenditure	1.02	-
Marriage and social ceremonies	8.16	9.26
Non-farm activities	3.07	5.56
Other expenditures	-	-

3.8 Summary

In soil test farmers category, for both paddy and wheat crops, 3.33 per cent of the respondents belonged to marginal farm category followed by 11.67 per cent to small, 20.83 per cent to medium and 64.17 per cent to large farm category. Similarly, in control farmers category, 1.67 per cent respondents were from marginal farm category, 10 per cent from small, 26.67 per cent from medium and 61.66 per cent from large farm category. Thus, the proportion of soil test farmers belonging to large farm category was higher in both the categories.

The average age of respondents in soil test farmers category was about 44 years while it was nearly 40 years in control farmers category and overall up to 43 years. The average years of respondents education was nearly nine years in both categories as well as in overall scenario.

All the respondents were males and pursuing agriculture as their main occupation. The average family size was nearly seven and at least two family members were engaged in agriculture in both the categories. The average farming experience of the respondents was nearly 24 years in soil test farmers, about 20 years in control farmers and almost 23 years in overall. Nearly 93 per cent of the respondents were members of some association in soil test farmers category while this figure was 95 per cent in control farmers and about 94 per cent in overall. Among both the categories, 98.33 per cent of the respondents belonged to general castes while remaining 1.67 per cent were from other backward castes (OBC) category.

Net operated area in soil test farmers category was 18.37 acres out of which owned land was 11.09 acres, leased-in was 7.47 acres and leased-out was 0.19 acres while in control farmers category, net operated area was 16.81 acres constituting 10.26 acres from owned land and 6.55 acres from leased-in land. In overall, net operated area was 17.85 acres out of which 10.81 acres being owned land, 7.16 acres leased-in and 0.13 acres leased-out land. The whole net operated area was irrigated and cropping intensity was nearly 200 per cent in all the categories.

On soil test farmers farms, bore well/ tube well was source of irrigation on 99.59 per cent of the net irrigated area while 8.95 per cent was irrigated through canals. On some household farms, both bore well/ tube well as well as canal water was available for irrigating same piece of land. On control farmers farms, entire net operated area was irrigated through bore well/ tube well while canal irrigation was also available on some farms, therefore, 5.95 per cent of the area was also irrigated through canal irrigation. In overall, 99.72 per cent area was irrigated through bore well/ tube well and 8.10 per cent through canal irrigation.

The cropping pattern on the sample farm households showed that during *kharif* season, in soil test farmers category, 43.64 per cent of the gross cropped area was under paddy crop followed by remaining area under fodder, basmati, cotton and baby corn. During *rabi* season, 45.78 per cent of the gross cropped area was under wheat crop followed rest of the area under fodder, potato. Sugarcane which is annual crop was also grown on soil test farmers farms. On control farmers farms, during *kharif* season, 42.58 per cent of the gross cropped area was under paddy crop followed by basmati, fodder and cotton while in *rabi* season, wheat was major crop sown on 46.03 per cent of the gross cropped area followed by fodder and potato. During summer season, summer moong and spring maize were the crops grown while sugarcane was the annual crop occupying 0.20 per cent area. In an overall scenario, during

kharif season, paddy was major crop occupying 43.30 per cent of the gross cropped area followed by basmati, fodder, cotton and baby corn while during *rabi* season, 45.86 per cent of the area was under wheat crop followed by fodder and potato. During summer season, summer moong and spring maize were the crops grown while sugarcane was annual crop sown on sample farms. In soil test farmers as well as control farmers category, entire area under various crops grown was under high yielding varieties.

Among soil test farmers, per acre value of paddy output was Rs. 42462 on medium farms followed closely by small, marginal and large farms while value of crop output was Rs 40329 per acre in total. Similarly, the value of the paddy output per household was highest on large farms due to higher size of holding followed by other farm categories. The value of the paddy output sold on various farm categories varied from Rs.42186 per acre on medium farms, which was highest, to Rs.40011 on large farms, which was lowest among farm categories.

On control farmers farms, per acre value of the paddy output was Rs. 39857 on large farms followed by medium, marginal and large farms while value of crop output was Rs 39715 per acre in total. Also, the value of the paddy output per household was highest on large farms followed by other farm categories. The value of the paddy output sold on various farm categories varied from Rs.39781 per acre on large farms, being highest to Rs.37772 on small farms, being lowest among farm categories.

In wheat crop, on soil test farmers farms, per acre value of the crop output was Rs. 29671 on marginal farms followed by large, small and medium farms while in total value of paddy output was Rs 29438 per acre. Also, the value of the wheat output per household was highest on large farms due to higher holding size followed by other farm categories. The value of wheat output sold per acre on various farm categories was highest (Rs.27737) on large farms and lowest (Rs.23484) on marginal farms.

On control farmers farms, per acre value of the wheat output was Rs. 29400 on marginal farms followed by small, large and medium farms while the value of crop output was Rs 28051 per acre in total. The value of output per household was highest on large farms as compared to other farm categories due to size of holding. The value of wheat output sold on various farm categories varied from Rs.25449 per acre on large farms, being highest to Rs.11200 on marginal farms, being lowest.

On soil test farmers and control farmers category, major farm asset included tractor, trailer/ trolley with average number per household being 1.30 and 1.27, respectively and average value was Rs. 345083 and Rs.319683 per household. The second major farm asset was electric motor/ diesel engine with average number being 1.73 and 1.68 per household in both categories and valuated at Rs. 21021 and Rs. 24900 per household. Harrow and cultivators were the major farm implements with 0.99 and 1.03 numbers per households and valuated at Rs. 12493 and Rs. 13017 per household in both farmer categories. The other farm assets included thresher, planker, manual/ power sprayer, fodder chopper, bullock cart, animal shed/ pump house and small tools which were estimated at Rs. 19283 and Rs. 18834 in total. The total value of the farm assets was estimated at Rs. 398255 and Rs.376434 per household in both farmer categories.

On soil test farmers farms, credit outstanding per household was maximum from commercial banks (Rs. 25833) followed by money lenders, traders/ commission agents and co-operative credit societies). Similarly, on control farmers farms also, credit outstanding from commercial banks was maximum (Rs.24750) which was followed by traders/ commission agents, money lenders and co-operative credit societies per household. Thus, credit outstanding was more from commercial banks for both farmer groups. Most of the farmers have taken loan for seasonal crop cultivation and for marriage and social ceremonies among both the farmer categories.

Chapter IV: SOIL TESTING AND RECOMMENDED DOSES OF FERTILIZERS

4.1 Background

Soil testing is very important for sustaining crop productivity thereby production of all the crops. In Punjab, continuous practicing of monoculture (Paddy-wheat crop rotation) in the central zone had resulted in developing macro and micro-nutrient deficiencies in the soil. Farmers are advised to get their soils tested before sowing of the next crop when the fields are vacant and no fertilizer/ manure has been applied. As far as method of soil testing is concerned, farmers are suggested to dig soil from three or four places by making a 'V' shape cut, from a homogenous plot with not much variability, and mix the soil to make one soil sample. After analyzing the soil sample, soil health card is prepared and recommendation on fertilizer application is given to the farmer whether there is abundance, requisite level or scarcity of a particular nutrient.

4.2 Details of Soil Testing

The distribution of sample soil test farmers for both paddy and wheat crops have been shown in Table 4.1. It can be seen from the table that all the selected farmers from marginal, small, medium and large category got their soils tested during the last three years and average cost of soil testing was Rs. 20 per soil sample. Almost all the selected soil test farmers got their soils tested from Department of Soil Sciences, Punjab Agricultural University, Ludhiana and average distance covered from field to soil testing laboratory was 57.73 kilometers while according to farm categories, medium category farmers covered 64.80 kilometers, which was highest and marginal farmers covered 51.50 kilometers, which was lowest distance covered from field to soil testing lab under different farm size categories. The average area covered under soil testing was 1.88 acres on marginal, 4.39 acres on small, 5.49 acres on medium, 7.79 acres on large and 6.53 acres in overall situation. The area covered under soil testing as per cent of net operated area was highest (97.62%) on small farms and lowest (29.86%) on large farms while in overall, 35.54 per cent of the area was under soil testing. Also, all the soil test farmers have themselves collected soil samples from their fields.

Table 4.1: Distribution of Sample Soil Test Farmers- Paddy and Wheat

Particulars	Marginal	Small	Medium	Large	Total
% of farmers tested their soil in the last three years	100.00	100.00	100.00	100.00	100.00
Average cost of soil testing (Rs/sample)	20.00	20.00	20.00	20.00	20.00
Average distance from field to soil testing lab (kms)	51.50	61.14	64.80	55.45	57.73
Average number of soil samples taken per plot	1.00	1.43	2.04	2.58	2.25
Average no. of plots considered for soil testing	1.00	1.43	2.04	2.58	2.25
Average area covered under soil test (acre)	1.88	4.39	5.49	7.49	6.53
Area covered as % of net operated area	78.95	97.62	68.88	29.86	35.54
% of farmers who collected samples themselves	100.00	100.00	100.00	100.00	100.00
% of soil sample collected by the department officials	-	-	-	-	-

4.3 Source (s) of Information about Soil Testing by Soil Test Farmers

The source of information about soil testing by the sample households have been depicted in Table 4.2. A perusal of the table reveals that 57.14 per cent of the small farmers followed by 55.84 per cent large, 52 per cent medium, 50 per cent marginal farmers got information about soil testing from SAU, while this figure in overall scenario was 55 per cent. Also, the source of information of soil testing for 2.60 per cent large farmers was KVK's and for 3.90 per cent large farmers it was the state department. Besides, 8 per cent medium, 7.14 per cent small and 3.90 per cent large farmers got information about soil testing from private companies. Friends and neighbors were also source of soil testing information for 50 per cent marginal, 40 per cent medium, 35.72 per cent small, 33.76 per cent large and 35.83 per cent farmers in overall. Thus, SAU's and friends/neighbors were the major source of information about soil testing to the sample households.

Table 4.2: Source(s) of Information about Soil Testing by Sample Households (% farmers) - Soil Test Farmers

Sources	Marginal	Small	Medium	Large	Total
Paddy & Wheat					
SAUs	50.00	57.14	52.00	55.84	55.00
KVKs	-	-	-	2.60	1.67
State department	-	-	-	3.90	2.50
Private companies	-	7.14	8.00	3.90	5.00
Friends/neighbors	50.00	35.72	40.00	33.76	35.83
Total	100.00	100.00	100.00	100.00	100.00

4.4 Reasons for Soil Testing by Soil Test Farmers

The reasons for soil testing by sample soil test farmers for paddy and wheat crops have been given in Table 4.3. A perusal of the table reveals that 'Motivation from village demonstration/training/exposure visits to places with best farming practices' was ranked the most important reason of soil testing by 50 per cent farmers while 12.50 per cent ranked it as important. Another reason i.e. 'For increasing crop yield' was ranked most important by 35 per cent farmers and 50 per cent ranked it as important reason for undertaking soil testing.

Table 4.3: Reasons for Soil Testing by Sample Households (% of farmers)- Soil Test Farmers

Reasons	Paddy & Wheat			
	Most Important	Important	Least Important	Total
For availing benefits under subsidy schemes	3.33	0.00	14.17	17.50
For increasing crop yield	35.00	50.00	0.00	85.00
Motivation from village demonstration/training/exposure visits to places with best farming practices	50.00	12.50	0.00	72.50
Peer farmers' group pressure	0.00	9.17	70.00	79.17
Adopt new technological practices	1.67	5.83	8.33	15.83
Others (To reduce the fertilizer cost)	10.00	22.50	7.50	40.00

'To reduce the fertilizer cost' was ranked most important reason by 10 per cent farmers while 22.50 per cent ranked it as important and 7.50 per cent as least important. 'For availing benefits under subsidy scheme' was ranked most important reason by 3.33 per cent farmers while 14.17 per cent farmers ranked it as least important. Similarly, 'Adopt new technological practices' was reported by 1.67 per cent farmers as most important reason while 5.83 per cent ranked it as important and 8.33 per cent as least important. 'Peer farmers group pressure' was ranked important reason of soil testing by 9.17 per cent farmers while 70 per cent ranked it as least important reason. In total, 85 per cent farmers ranked 'for increasing crop yield' as the reason for soil testing with varying intensity followed by 79.17 per cent ranking 'peer farmers' group pressure', 72.50 per cent ranking 'motivation from village demonstration/training/exposure visits to places with best farming practices', 40 per cent ranking 'to reduce the fertilizer cost', 17.50 per cent ranking 'for availing benefits under subsidy schemes' and

15.83 per cent ranking 'adopt new technological practices' as reasons of soil testing with varying intensity.

4.5 Reasons for Not Testing Soil by Control Farmers

The reasons for not testing soil during the last three years by control farmers for both paddy and wheat crops have been given in Table 4.4. It is quite obvious from the table that 53.33 per cent farmers ranked the reason 'Soil testing not required for my field as crop yield is good' as most important while 1.67 per cent ranked it as important reason for not testing their soils. 'Soil testing laboratories are located far away' was another reason which was ranked by 21.67 per cent farmers as most important, 23.33 per cent as important and 1.67 per cent as least important. Another reason i.e. 'Do not know how to take soil samples' was ranked as most important reason by 15 per cent farmers while 23.33 per cent ranked it as important and 58.33 per cent as least important reason for not getting the soils tested. 'Do not know whom to contact for details on testing' was revealed by 5 per cent farmers as important, 51.66

Table 4.4: Reasons for Not Testing Soil during the Last Three Years (% Farmers)-Control Farmers

Reasons	Paddy & Wheat			
	Most Important	Important	Least Important	Total
Do not know how to take soil samples	15.00	23.33	58.33	96.66
Do not know whom to contact for details on testing	5.00	51.66	40.00	96.66
Soil testing laboratories are located far away	21.67	23.33	1.67	46.67
Soil testing not required for my field as crop yield is good	53.33	1.67	-	55.00
Others (No awareness of soil test)	5.00	-	-	5.00

per cent ranked it as important and 40 per cent as least important reason. Lastly, another reason i.e. 'No awareness of soil test' was rankled as most important reason by 5 per cent farmers for not testing soil during last three years.In total, thereasons 'do not know how to take soil samples' and 'do not know whom to contact for details on testing'were ranked by 96.66 per cent farmers with varying intensity as reasons of not testing soils followed by 55 per cent ranking 'soil testing not required for my field as crop yield is good', 46.67 per cent ranking 'soil testing laboratories are located far away' and 5 per cent ranking 'no awareness of soil test' with varying intensity as reasons of not getting their soils tested.

4.6 Status of Soil Health on the Sample Soil Test Farms

The status of soil health in terms of nutrients on the soil test farmers farms has been shown in Table 4.5. A perusal of the table reveals that for both paddy and wheat crops, as reported in

Table 4.5: Status of Soil Health in terms of Nutrients on the Sample Soil Test Farms (as reported in the soil health card)- Soil Test Farmers

(% Farmers)

Fertilizers	High	Medium/Normal	Low
Paddy and Wheat			
Nitrogen	8.34	70.83	20.83
Phosphorus	58.34	25.83	15.83
Potassium	97.5	-	2.50

the soil health card, 70 83 per cent of the farmers reported nitrogen content in the soils as medium followed by 20.83 per cent as low and 8.34 per cent as high. The status of phosphorus in the soils was relatively better with 58.34 per cent reporting it as high followed by 25.83 per cent as medium and 15.83 per cent as low. Similarly, potassium was sufficiently available in the soils with 97.5 per cent of the farmers reporting potassium content as high and 2.50 per cent as low.

4.7 Recommended Doses of Fertilizers on Soil Test Basis

The average quantity of recommended doses of fertilizers given based on soil test has been given in Table 4.6. In case of paddy crop, as reported in the soil health card, on an average112.33 kg. of urea was recommended for application. Besides, 25 kg. DAP, 20 kg. potash, 20 kg zinc and 120 kg. gypsum was also recommended for application to paddy crop on the sample soil test farmers farms. Similarly, in case of wheat crop, on an average 112.33 kg. urea was recommended for application on sample farms along with 51.17 kg. DAP, 20 kg. potash and 114.29 kg. gypsum, as reported in the soil test card.

Table 4.6: Average Quantity of Recommended Dose of Fertilizers Applied Based on Soil Test (as reported in the health card)-Soil Test Farmers

(Kg/acre)

Crop	**Paddy**	**Wheat**
Urea	112.33	112.33
DAP	25	51.17
Single Super Phosphate	-	-
Potash	20	20
Zinc	20	-
Gypsum	120	114.29

The average quantity of split doses of fertilizers recommended by stage of crop growth has been given in Table 4.7. It can be seen that in paddy crop, there was recommendation of basal application of average 48.25 kg. urea followed by 34.08 kg. after inter-cultivation and 30 kg.

Table 4.7: Average Quantity of Split Doses of Fertilizers Recommended by Stage of Crop Growth (Kg/acre)- Soil Test Farmers

Particulars	Basal application	After inter-cultivation (weeding, thinning etc)	Vegetative growth	Flowering	Grain formation
Paddy					
Urea	48.25	34.08	30.00	-	-
DAP	25	-	-	-	-
SSP	-	-	-	-	-
Potash	20	-	-	-	-
Zinc	20	-	-	-	-
Gypsum	120	-	-	-	-
Wheat					
Urea	48.25	34.08	30.00	-	-
DAP	51.17	-	-	-	-
SSP	-	-	-	-	-
Potash	20	-	-	-	-
Gypsum	114.29	-	-	-	-

during the vegetative growth of the crop. Also, for other nutrients, there was recommendation of basal application of 25 kg. DAP, 20 kg. potash, 20 kg. zinc and 120 kg. gypsum. In case of wheat crop, there was also recommendation of basal application of average 48.25 kg. urea followed by 34.08 kg. after inter-cultivation and 30 kg. during the vegetative growth of the crop. For other nutrients, there was recommendation of basal application of 51.17 kg. DAP, 20 kg. potash and 120 kg. gypsum as reported in the soil health card.

4.8 Summary

All the selected soil test farmers got their soils tested during the last three years and average cost of soil testing was Rs. 20 per soil sample with average distance covered from field to soil testing lab was 57.73 kilometers. The average area covered under soil testing was 1.88 acres on marginal, 4.39 acres on small, 5.49 acres on medium, 7.79 acres on large and 6.53 acres in overall situation. The area covered under soil testing as per cent of net operated area was highest on small farms and all the soil test farmers have themselves collected soil samples from their fields. The major source of information about soil testing was SAU followed by friends/ neighbours, private companies, state department and KVK's.

The major reasons for soil testing by sample soil test farmers for paddy and wheat crops was 'Motivation from village demonstration/training/exposure visits to places with best farming practices' which was ranked the most important reason of soil testing by 50 per cent farmers while another reason i.e. 'For increasing crop yield' was ranked most important by 35 per cent farmers 'To reduce the fertilizer cost' was ranked most important reason by 10 per cent.However, in total, 85 per cent farmers ranked 'for increasing crop yield' as the reason for soil testing with varying intensity.

The major reasons for not testing soil during the last three years by control farmers for both paddy and wheat crops was 'Soil testing not required for my field as crop yield is good' and 53.33 per cent farmers ranked the reason as most important while 'Soil testing laboratories are located far away' was another reason which was ranked by 21.67 per cent farmers as most important. Another reason i.e. 'Do not know how to take soil samples' was ranked as most important reason by 15 per cent farmers for not undertaking soil testing of their fields.In total, thereasons 'do not know how to take soil samples' and 'do not know whom to contact for details on testing'were ranked by 96.66 per cent farmers with varying intensity as reasons of not testing soils.

The status of soil health in terms of nutrients on the soil test farmers farms revealed that for both paddy and wheat crops, as reported in the soil health card, 70 83 per cent of the farmers reported nitrogen content in the soils as medium followed by 20.83 per cent as low and 8.34 per cent as high. The status of phosphorus in the soils was relatively better with 58.34 per cent reporting it as high followed by 25.83 per cent as medium and 15.83 per cent as low. Similarly, potassium was sufficiently available in the soils with 97.5 per cent of the farmers reporting potassium content as high and 2.50 per cent as low.

The average quantity of 112.33 kg. of urea was recommended for application to paddy crop in soil health card. Besides, 25 kg. DAP, 20 kg. potash, 20 kg zinc and 120 kg. gypsum was also recommended for application to paddy crop on the sample soil test farmers farms. Similarly, in case of wheat crop, on an average 112.33 kg. urea was recommended for application on sample farms along with 51.17 kg. DAP, 20 kg. potash and 114.29 kg. gypsum, as reported in the soil test card.

The average quantity of split doses of fertilizers recommended by stage of crop growth revealed that in paddy crop, there was recommendation of basal application of average 48.25 kg. urea followed by 34.08 kg. after inter-cultivation and 30 kg. during the vegetative growth

of the crop. Also, for other nutrients, there was recommendation of basal application of 25 kg. DAP, 20 kg. potash, 20 kg. zinc and 120 kg. gypsum. In case of wheat crop, there was also recommendation of basal application of average 48.25 kg. urea followed by 34.08 kg. after inter-cultivation and 30 kg. during the vegetative growth of the crop. For other nutrients, there was recommendation of basal application of 51.17 kg. DAP, 20 kg. potash and 120 kg. gypsum as reported in the soil health card.

Chapter V: ADOPTION OF RECOMMENDED DOSES OF FERTILIZERS AND ITS CONSTRAINTS

5.1 Background

As explained in the earlier chapter, after testing of soil, a soil health card is given to the farmer along with recommendations related to the application of various nutrients. The adoption of fertilizer application recommendations depend upon the personal thinking of the farmer and past farming experience. Sometimes farmers did not follow the recommendations just because of the lack of interest and problems associated with analyzing the soil health card. On the contrary, farmers who take keen interest in the entire exercise and thus reap dividends in terms of increased productivity of their crops and thereby production by applying recommended doses of fertilizers to their crops. Thus, soil testing is important but to follow the recommendations is key to increased productivity of the crops.

5.2 Application of Recommended Doses of Fertilizers by Soil Test Farmers

The application of recommended doses of fertilizers on paddy and wheat crops has been shown in Table 5.1. It can be seen from the table that in case of paddy and wheat crops, out of the total soil test farmers, only 44 per cent of the medium category farmers applied recommended doses of fertilizers and were also willing to continue applying the recommended dose in future. On other farm categories, 41.56 per cent large, 35.71 per cent small and 25 per cent of the marginal farm category farmers applied the recommended doses of the fertilizers along with willingness to continue applying in future also. In overall, 40.83 per cent farmers applied and showed willingness to apply recommended doses of fertilizers to paddy and wheat crops in the coming years. In paddy crop, the average area on which recommended doses of fertilizers were applied was 9.22 acres on large farms followed by 5.50 acres on medium, 4.30 acres on small, 2.0 acres on marginal and 7.73 acres in total. The area covered under recommended dose of fertilizers as per cent of net operated area in paddy crop was highest on small farms (34.13%) followed by medium (30.36%), marginal (21.05%) and large farms (15.27%) while in total it was 17.19 per cent of the net operated area. In case of wheat crop, the average area on which recommended doses of fertilizers were applied was 9.25 acres on large farms followed by 5.32 acres on medium, 4.30 acres on small, 2.0 acres on marginal farms and 7.71 acres in total. The area covered under recommended dose of fertilizers as per cent of net operated area in wheat crop was highest on small farms (34.13%) followed by medium (29.36%), marginal (21.05%) and large farms (15.32%) while it was

Table 5.1: Application of Recommended Doses of Fertilizers on Reference Crops- Soil Test Farmers

Particulars	Marginal	Small	Medium	Large	Total
PADDY					
% of farmers applied recommended doses of fertilizers	25.00	35.71	44.00	41.56	40.83
Average area (acre)	2.00	4.30	5.50	9.22	7.73
Area covered as % of net operated area	21.05	34.13	30.36	15.27	17.19
Average number of seasons applied	2	2	2	2	2
% of farmers willing to continue applying recommended doses of fertilizers	25.00	35.71	44.00	41.56	40.83
WHEAT					
% of farmers applied recommended doses of fertilizers	25.00	35.71	44.00	41.56	40.83
Average area (acre)	2.00	4.30	5.32	9.25	7.71
Area covered as % of net operated area	21.05	34.13	29.36	15.32	17.15
Average number of seasons applied	2	2	2	2	2
% of farmers willing to continue applying recommended doses of fertilizers	25.00	35.71	44.00	41.56	40.83

17.15 per cent in total. During an agricultural year, on an average, recommended doses of fertilizers were applied for two i.e. *kharif* and *rabi* crop seasons.

5.3 Constraints in Applying Recommended Doses of Fertilizers by Soil Test Farmers

The constraints in applying recommended doses of fertilizers have been given in Table 5.2. A perusal of the table reveals that all the soil test farmers ranked the reason 'adequate quantity of fertilizers not available' as least important showing adequate availability of fertilizers and thus not been a constraint in application of recommended dose of fertilizers. Similarly, 5.63 per cent of the farmers ranked the reason 'prices of fertilizers are high' as most important followed by 14.08 per cent ranking it as important and in total, 19.71 per cent of the soil test farmers showed it as a constraint . 'Lack of money to purchase fertilizers' was also ranked as most important reason by 2.82 per cent farmers followed by 9.86 per cent ranking it as important and in aggregate only 12.68 per cent of the farmers revealed it being a problem in applying recommended doses of fertilizers. 'No technical advice on method and time of fertilizer application' was reported as most important constraint by 11.27 per cent of the farmers while 12.68 per cent reported it as important and in total, 23.95 per cent farmers reported it as a constraint. However, 69.01 per cent farmers reported the reason 'difficult to understand and follow the recommended doses' as most important constraint in applying

Table 5.2: Constraints in Applying Recommended Doses of Fertilizers (% of farmers) -Soil Test Farmers

Reasons	Paddy and Wheat			
	Most Important	Important	Least Important	Total
Adequate quantity of fertilizers not available	-	-	100.00	100.00
Prices of fertilizers are high	5.63	14.08	-	19.71
Lack of money to purchase fertilizers	2.82	9.86	-	12.68
No technical advice on method and time of fertilizer application	11.27	12.68	-	23.95
Difficult to understand and follow the recommended doses	69.01	11.27	-	80.28
Other (Practical experience of last so many years)	11.27	52.11	-	63.38

recommended doses of fertilizers followed by 11.27 per cent farmers reporting it as important and in total, 80.28 per cent farmers revealed it being the constraint in applying recommended doses of fertilizers. The other reason being 'practical experience of last so many years' was ranked as most important reason by 11.27 per cent of the farmers followed by 52.11 per cent ranking it as important and in aggregate, 63.38 per cent of the soil test framers revealed that due to practical experience of farming they were reluctant to apply recommended dose of fertilizers to their crops. Thus, 'difficult to understand and follow the recommended doses' was the most important constraint followed by 'farmers practical experience' as important constraint in application of recommended doses of fertilizers on the sample soil test farmers farms.

5.4 Sources of Information About Recommended Doses of Fertilizers by Control Farmers

The sources of information about recommended doses of fertilizers by control farmers have been given in Table 5.3. A perusal of the table reveals that all the marginal farmers were aware about the recommended doses of fertilizers while 50 per cent small, 43.75 per cent medium, 35.14 per cent large and 40 per cent farmers in overall were also aware about the recommended doses of fertilizers. The source of information of recommended doses of fertilizers for marginal farmers was co-operatives (100%) while for small farmers it was Agricultural University (33.33%) and Department of agriculture (16.67%), for medium

category farmers it was Agricultural University (25%), fellow farmers (12.50%) and co-operatives (6.25%), for large farmers it was Agricultural University (16.22%), Department of agriculture (8.11%), fellow farmers (8.11%) and co-operatives (2.70%). In total, the source of information of recommended doses of fertilizers was State Agricultural University (20%), fellow farmers (8.33%), Department of agriculture (6.67%) and co-operatives (5%).

Table 5.3: Awareness and Sources of Information about Recommended Doses of Fertilizers by Sample Households (% of farmers)- Control Farmers

Sources	Marginal	Small	Medium	Large	Total
Paddy & Wheat					
% farmers aware	100.00	50.00	43.75	35.14	40.00
Source of information	-	-	-	-	-
Department of Agriculture	-	16.67	-	8.11	6.67
State Agricultural University	-	33.33	25.00	16.22	20.00
Cooperatives/Growers' Association	100.00	-	6.25	2.70	5.00
Private input dealers	-	-	-	-	-
Fellow farmers	-	-	12.50	8.11	8.33
NGO/Others	-	-	-	-	-
Total	100.00	50.00	43.75	35.14	40.00

5.5 Application of Actual Quantity of Fertilizers by Sample Households

The actual quantity of fertilizers applied to paddy crop by the sample farmers have been shown in Table 5.4. It is clear from the table that on soil test farmers farms, 112.50 kg. urea was applied per acre on marginal farms while it was 125 kg. on small, 124.20 kg. on medium, 123.96 kg. on large and 123.75 kg. on total soil test farmers farms. On control farmers farms, 125 kg. urea was applied to paddy crop on marginal farms and 130 kg. on small, 135.94 kg. on medium, 138.65 kg. on large and 136.86 kg. on total farmers farms. Thus, application of urea was more on control farmers farms as compared to soil test farmers farms. The application of DAP to paddy crop on soil test farmers farms was 5.33 kg. per acre in total while according to farm categories it was 6.25 kg. on marginal, 3.57 kg. on small, 7.20 kg. on medium and 5 kg. on large farms. On control farmers farms, the application of DAP was 16.67 kg. on small farms, 15.63 kg. on medium farms, 20.27 kg. on large farms and 18.33 in total farmers farms. In case of DAP also, the average dose applied per acre was more on control farmers farms as compared to soil test farmers farms. Some of the farmers also applied sulphur to their paddy crop. The sulphur application on the soil test farmers farms was 2.13 kg. per acre in total while it was 2.71 kg. on small, 1.80 kg. on medium and 2.25 kg. on large farms. On control farmers farms, sulphur application to paddy crop was 2.14 kg in

Table 5.4: Actual Quantity of Fertilizers Applied by the Sample Farmers during the Reference Year (Kg/acre)- Paddy

Crop	Marginal	Small	Medium	Large	Total
Soil Test Farmers					
Urea	112.50	125	124.20	123.96	123.75
DAP	6.25	3.57	7.20	5.00	5.33
Sulphur	-	2.71	1.80	2.25	2.13
Potash	6.25	-	5.60	3.57	3.67
Zinc	12.50	11.07	11.90	10.29	10.79
Gypsum	-	28.57	10.00	7.79	10.42
Bio-vita	-	0.57	0.60	0.71	0.65
Control Farmers					
Urea	125	130	135.94	138.65	136.86
DAP	-	16.67	15.63	20.27	18.33
Sulphur	-	0.83	-	3.34	2.14
Potash	-	4.17	-	3.38	2.50
Zinc	10	11.67	11.56	11.76	11.67
Gypsum	-	-	-	-	-
Bio-vita	-	-	0.50	0.49	0.43

total and on small farms it was 0.83 kg. and on large farms 3.34 kg. per acre. Thus, higher number of soil test farmers applied sulphur to their paddy crop as compared to farmers from the control group. The application of potash to paddy crop on soil test farmers farms was 3.67 kg. per acre in total while on marginal farms potash application was 6.25 kg., on medium farms 5.60 kg. and 3.57 kg. per acre on large farms. On control farmers farms, potash application was 2.50 kg. in total while on small farms it was 4.17 kg. and 3.38 kg. on large farms. Thus, potash application was more on soil test farmers farms as compared to control farmers farms in case of paddy crop. Zinc was also applied to paddy crop on both soil test and control farm categories. In total, 10.79 kg. zinc per acre was applied to paddy crop on soil test farmers farms and on marginal farms it was 12.50 kg., on small farms 11.07 kg, on medium farms 11.90 kg. and 10.29 kg. on large farms. On control farmers farms, 11.67 kg. zinc in total was applied per acre to paddy crop while it was 10 kg. on marginal farms, 11.67 kg on small farms, 11.56 kg. on medium farms and 11.76 kg. on large farms. Application of zinc was more on soil test farmers farms as compared to control farmers farms. Gypsum was also applied to paddy crop and the quantity applied per acre was 10.42 kg. in total, 28.57 kg. on small, 10 kg. on medium and 7.79 kg. on large farms. Gypsum was not applied by control farmers to their paddy crop. Bio-vita was also applied to paddy crop and the quantity applied on soil test farmers farms was 0.65 kg in total, 0.57 kg. on small, 0.60 kg. on medium and 0.71 kg. on large farms. Similarly, on control farmers farms, 0.43 kg. bio-vita was applied in total to paddy crop while it was 0.50 kg. on medium farms and 0.49 kg. on large farms.

Table 5.5: Actual Quantity of Fertilizers Applied by the Sample Farmers during the Reference Year (Kg/acre)- Wheat

Crop	Marginal	Small	Medium	Large	Total
Soil Test Farmers					
Urea	116.25	114.29	122	124.29	122.38
DAP	53.75	52.50	54.40	59.42	57.38
Sulphur	0.25	1.46	0.52	0.89	0.86
Potash	-	-	1.40	1.36	1.17
Zinc	-	0.04	-	0.14	0.09
Gypsum	-	28.57	10	7.79	10.42
Bio vita	-	-	-	0.13	0.08
Manganese	0.75	0.23	0.42	0.23	0.29
Control Farmers					
Urea	150	133.33	134.38	141.22	138.75
DAP	75	60	63.44	66.08	64.92
Sulphur	-	5	0.06	1.32	1.33
Potash	-	3.33	-	2.57	1.92
Zinc	-	-	-	0.81	0.50
Manganese	-	-	0.44	0.38	0.35

The actual quantity of fertilizers applied to wheat crop by the sample farmers have been shown in Table 5.5. A perusal of the table reveals that on soil test farmers farms, 116.25 kg.urea was applied per acre on marginal farms while it was 114.29 kg. on small, 122 kg. on medium, 124.29 kg. on large and 122.38 kg. on total soil test farmers farms. On control farmers farms, 150 kg. urea was applied to wheat crop on marginal farms and 133.33 kg. on small, 134.38 kg. on medium, 141.22 kg. on large and 138.75 kg. on total farmers farms. Thus, application of urea to wheat crop was more on control farmers farms as compared to soil test farmers farms. On soil test farmers farms, application of DAP to wheat crop was 57.38 kg. per acre in total while according to farm categories it was 53.75 kg. on marginal, 52.50 kg. on small, 54.40 kg. on medium and 59.42 kg. on large farms. The application of DAP on control farmers farms was 75 kg. on marginal, 60 kg. on small, 63.44 kg. on medium , 66.08 kg. on large and 64.92 kg. in total farmers farms. The average dose of DAP applied per acre was more on control farmers farms as compared to soil test farmers farms. The sulphur application to wheat crop on the soil test farmers farms was 0.86 kg. per acre in total while it was 0.25 kg. on marginal, 1.46 kg. on small, 0.52 kg. on medium and 0.89 kg. on large farms. On control farmers farms, sulphur application to wheat crop was 1.33 kg in total while on small farms it was 5 kg., on medium farms 0.06 kg. and on large farms 1.32 kg. per acre. Thus, sulphur application to wheat crop was more on soil test farmers farms as compared to control farmers. The application of potash to wheat crop on soil test farmers

farms was 1.17 kg. per acre in total while on medium farms potash application was 1.40 kg. and 1.36 kg. per acre on large farms. On control farmers farms, potash application was 1.92 kg. per acre in total while on small farms it was 3.33 kg. and 2.57 kg. on large farms. Thus, potash application was more on soil test farmers farms as compared to control farmers farms in case of wheat crop. Zinc was also applied to wheat crop on both soil test and control farm categories. In total, 0.09 kg. zinc per acre was applied to wheat crop on soil test farmers farms while according to farm categories, on small farms it was 0.04 kg. and 0.14 kg. on large farms. On control farmers farms, 0.50 kg. zinc in total was applied per acre to wheat crop while according to farm categories it was 0.81 kg. on large farms and it was not applied by the farmers from other farm categories. Gypsum was applied to wheat crop by soil test farmers and the quantity applied per acre was 10.42 kg. in total, 28.57 kg. on small, 10 kg. on medium and 7.79 kg. on large farms while gypsum was not applied by control farmers to wheat crop. Bio-vita was also applied to wheat crop and the quantity applied on soil test farmers farms was 0.13 kg. on large farms and 0.08 kg in total. Manganese application to wheat crop on soil test farmers farms was 0.29 kg. per acre in total while according to farm categories, 0.75 kg. manganese use was on marginal farms, 0.23 kg. on small, 0.42 kg. on medium and 0.23 kg on large farms. On control farmers farms, 0.35 kg. manganese was applied in total to wheat crop while it was 0.44 kg. on medium farms and 0.38 kg. on large farm category.

Thus, after soil testing there was significant decline in the application of fertilizers to both paddy and wheat crops on soil test farms as compared to control group and there was also increase in yield on soil test farms which can be due to balanced use of macro along with micro nutrients especially use of gypsum and green manuring in fields by some of the farmers.

The actual quantity of split doses of fertilizers applied by stage of crop growth in paddy crop has been depicted in Table 5.6. A perusal of the table reveals that after transplanting of paddy in the fields within ten days 48.17 kg. of basal dose of urea was applied by the soil test farmers and remaining 39.67 kg. was applied after inter-cultivation and remaining 35.92 kg. during the vegetative growth of paddy crop. Similarly, on control farmers farms, 49.44 kg. of urea was applied as basal dose to paddy crop followed by 46.08 kg. after inter-cultivation, 39.67 kg. during vegetative growth and 1.67 kg at the time of flowering. On soil test farmers farms, 5.33 kg. DAP, 3.67 kg. potash, 10.42 kg. gypsum were applied as basal dose only while 18.33 kg DAP was applied as basal dose to paddy crop on control farmers farms. On

soil test farmers farms, 0.25 kg. sulphur was applied as basal dose to paddy crop followed by 0.53 kg. after inter-cultivation and 1.35 kg. during vegetative growth of the crop. Similarly, on control farmers farms, 1.40 kg sulphur was applied to paddy crop as basal dose which was followed by 0.19 kg. after inter-cultivation and 0.55 kg. during vegetative growth of the crop. On soil test farmers farms, 7.21 kg. zinc was applied as basal dose to paddy crop while 3.58 kg. was used during vegetative growth of the crop. Similarly, on control farmers farms, 6.42 kg. zinc was applied as basal dose followed by 5.25 kg. during vegetative growth of the crop.

Table 5.6: Actual Quantity of Split Doses of Fertilizers Applied by Stage of Crop Growth during the Reference Year (Kg/acre)- Paddy

Particulars	Basal application	After inter-cultivation (weeding, thinning etc)	Vegetative growth	Flowering	Grain formation	Total
SoilTest Farmers						
Urea	48.17	39.67	35.92	-	-	123.75
DAP	5.33	-	-	-	-	5.33
Sulphur	0.25	0.53	1.35	-	-	2.13
Potash	3.67	-	-	-	-	3.67
Zinc	7.21	-	3.58	-	-	10.79
Gypsum	10.42	-	-	-	-	10.42
Bio vita	0.23	0.18	0.23	-	-	0.65
Control Farmers						
Urea	49.44	46.08	39.67	1.67	-	136.86
DAP	18.33	-	-	-	-	18.33
Sulphur	1.40	0.19	0.55	-	-	2.14
Potash	1.33	-	0.50	0.67	-	2.50
Zinc	6.42	-	5.25	-	-	11.67
Bio vita	0.27	-	0.16	-	-	0.43

Also, 1.33 kg potash was applied as basal dose to paddy crop on control farmers farms which was followed by 0.50 kg. during vegetative growth and 0.67 kg. during flowering of the crop. Bio-vita was also applied to paddy crop by both soil test and control farmers. Basal dose of bio-vita to paddy crop on soil test farmers farms was 0.23 kg. followed by 0.18 kg. after inter-cultivation and 0.24 kg. during vegetative growth of the crop. Similarly, on control farmers farms, 0.27 kg. basal dose of bio-vita was applied to paddy crop followed by 0.16 kg during vegetative growth of the crop.

The actual quantity of split doses of fertilizers applied by stage of crop growth in wheat crop has been depicted in Table 5.7. A perusal of the table reveals that 48.71 kg. of basal dose of urea was applied by the soil test farmers to wheat crop and remaining 41.13 kg. was applied

after inter-cultivation and remaining 35.54 kg. during the vegetative growth of wheat crop. Also, on control farmers farms, 50.50 kg. of urea was applied as basal dose to wheat crop followed by 47.92 kg. after inter-cultivation and 40.33 kg. during vegetative growth of the crop. On soil test farmers farms, 57.38 kg. DAP, 10.42 kg. gypsum and 0.09 kg. zinc were applied as basal dose only while 64.92 kg DAP, 0.50 kg.zinc was applied as basal dose to wheat crop on control farmers farms. On soil test farmers farms, 0.24 kg. sulphur was applied as basal dose to wheat crop followed by 0.41 kg. after inter-cultivation and 0.21 kg. during

Table 5.7: Actual Quantity of Split Doses of Fertilizers Applied by Stage of Crop Growth during the Reference Year (Kg/acre)- Wheat

Particulars	Basal application	After inter-cultivation (weeding, thinning etc)	Vegetative growth	Flowering	Grain formation	Total
Soil Test Farmers						
Urea	48.71	41.13	32.54	-	-	122.38
DAP	57.38	-	-	-	-	57.38
Sulphur	0.24	0.41	0.21	-	-	0.86
Potash	0.54	-	-	0.63	-	1.17
Zinc	0.09	-	-	-	-	0.09
Gypsum	10.42	-	-	-	-	10.42
Bio vita	-	0.08	-	-	-	0.08
Manganese	-	-	0.29	-	-	0.29
Control Farmers						
Urea	50.50	47.92	40.33	-	-	138.75
DAP	64.92	-	-	-	-	64.92
Sulphur	1.08	-	0.25	-	-	1.33
Potash	1.26	-	0.33	0.33	-	1.92
Zinc	0.50	-	-	-	-	0.50
Manganese	-	-	0.35	-	-	0.35

vegetative growth of the crop. Similarly, on control farmers farms, 1.08 kg sulphur was applied to wheat crop as basal dose which was followed by 0.25 kg. during vegetative growth of the crop. On soil test farmers farms, 0.54 kg. potash was applied as basal dose to wheat crop while 0.63 kg. was applied during flowering stage of the crop. Similarly, on control farmers farms, 1.26 kg. potash was applied as basal dose to wheat crop followed by 0.33 kg. during vegetative growth and 0.33 kg. during flowering stage of the crop. Bio-vita was also applied to wheat crop by soil test farmers. Bio-vita application was 0.08 kg. after inter-cultivation in case of wheat crop. Manganese was also applied to wheat crop by both soil test

and control farmers and its use was 0.29 kg. during vegetative growth of the crop on soil test farmers farms while it was 0.35 kg. in case of control farmers farms.

5.6 Method of Application of Chemical Fertilizers by Sample Farmers

The method of application of chemical fertilizers used by soil sample and control farmers category, in case of paddy and wheat crops has been given in Tables 5.8 and 5.9,

Table 5.8: Method of Application of Chemical Fertilizers (% of farmers)-Paddy

Method	Urea	DAP	Sulphur	Potash	Zinc	Gypsum	Bio-vita
Soil Test Farmers							
Broadcasting	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Dibbling	-	-	-	-	-	-	-
Fertigation	-	-	-	-	-	-	-
Line application	-	-	-	-	-	-	-
Spraying	-	-	-	-	-	-	-
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Control Farmers							
Broadcasting	100.00	100.00	100.00	100.00	100.00	-	100.00
Dibbling	-	-	-	-	-	-	-
Fertigation	-	-	-	-	-	-	-
Line application	-	-	-	-	-	-	-
Spraying	-	-	-	-	-	-	-
Total	**100**	**100**	**100**	**100**	**100**	**-**	**100**

Table 5.9: Method of Application of Chemical Fertilizers (% of farmers)-Wheat

Method	Urea	DAP	Sulphur	Potash	Zinc	Gypsum	Bio-vita	Manganese
Soil Test Farmers								
Broadcasting	100.00	-	100.00	100.00	100.00	100.00	100.00	-
Drilling	-	100.00	-	-	-	-	-	-
Dibbling	-	-	-	-	-	-	-	-
Fertigation	-	-	-	-	-	-	-	-
Line application	-	-	-	-	-	-	-	-
Spraying	-	-	-	-	-	-	-	100.00
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Control Farmers								
Broadcasting	100.00	-	100.00	100.00	100.00	-	-	-
Drilling	-	100.00	-	-	-	-	-	-
Dibbling	-	-	-	-	-	-	-	-
Fertigation	-	-	-	-	-	-	-	-
Line application	-	-	-	-	-	-	-	-
Spraying	-	-	-	-	-	-	-	100.00
Total	**100**	**100**	**100**	**100**	**100**	**-**	**-**	**100**

respectively. In case of paddy crop, those soil test farmers who have applied urea, DAP, sulphur, potash, zinc, gypsum and bio-vita to their crop, all of them used broadcasting method to evenly distribute the fertilizers in their fields. Similarly, in control farmers category, those farmers who have applied urea, DAP, sulphur, potash, zinc and bio-vita to their paddy crop, broadcasting method was used for their application to fields. In case of wheat crop, the soil test farmers who have applied urea, sulphur, potash, zinc and gypsum to their crop, all of them used broadcasting method to apply these fertilizers in their fields while DAP was drilled at the time of wheat sowing. Also, in control farmers category, the farmers who have applied urea, sulphur, potash and zinc to wheat crop, broadcasting method was used for application to fields while DAP was drilled at the time of wheat sowing.

5.7 Use of Organic Fertilizers by the Sample Households

The use of organic fertilizers in paddy crop by the sample farmers have been given in Table 5.10. A perusal of the table reveals that 43.33 per cent of the soil test farmers have applied farm yard manure (FYM) to their paddy crop covering 7.83 per cent of the net cropped area and the quantity applied was 498.77 kg. per acre with price being Rs.0.16 per kg. In control

Table 5.10: Use of Organic Fertilizers by the Sample Farmers- Paddy

Particulars	Farm yard manure	Vermi-compost/Biogas waste	Bio-fertilizer	Green manure	Other organic manure	Total
Soil Test Farmers						
% farmers applied	43.33	-	10.00	5.00	-	-
Quantity applied (Kg/acre)	498.77	-	0.04	0.03	-	-
Price (Rs/kg)	0.15	-	10.38	1	-	-
Area covered (% of net cropped area)	7.83	-	0.83	0.79	-	-
Control Farmers						
% farmers applied	40.00	-	5.00	-	-	-
Quantity applied (Kg/acre)	540.07	-	0.03	-	-	-
Price (Rs/kg)	0.16	-	7.69	-	-	-
Area covered (% of net cropped area)	7.68	-	0.64	-	-	-

farmers, FYM was applied by 40 per cent farmers to their paddy crop covering 7.68 per cent of the net cropped area while the quantity applied was 540.07 kg. per acre which was priced at Rs.0.16 per kg. Bio-fertilizer was also applied to paddy crop by 10 per cent soil test farmers covering just 0.83 per cent of the net cropped area while the quantity applied was 0.04 kg. per acre which was priced at Rs.10.38 per kg. Similarly, in control farmers group, bio-fertilizer was used by 5 per cent farmers in 0.75 per cent of the net cropped area while the

quantity applied was 0.03 kg. per acre which was valued at Rs. 7.69 per kg. Green manuring before paddy transplantation was undertaken by 5 per cent of the soil test farmers covering just 0.79 per cent of the net cropped area while the quantity of seed applied was 0.03 kg. per acre which was given to the farmers at a subsidized rate of Rs. 1 per kg.

The use of organic fertilizers in wheat crop by the sample farmers have been given in Table 5.11. It can be seen from the table that just 1.66 per cent of the soil test farmers have applied farm yard manure (FYM) to wheat crop covering 0.14 per cent of the net cropped area and the quantity applied was 13.50 kg. per acre which was priced at Rs.0.15 per kg. In control

Table 5.11: Use of Organic Fertilizers by the Sample Farmers- Wheat

Particulars	Farm yard manure	Vermi-compost/Biogas waste	Bio-fertilizer	Green manure	Other organic manure	Total
Soil Test Farmers						
% farmers applied	1.66	-	0.83	-	-	-
Quantity applied (Kg/acre)	13.50	-	0.002	-	-	-
Price (Rs/kg)	0.15	-	13	-	-	-
Area covered (% of net cropped area)	0.14	-	0.12	-	-	-
Control Farmers						
% farmers applied	3.33	-	-	-	-	-
Quantity applied (Kg/acre)	38.67	-	-	-	-	-
Price (Rs/kg)	0.16	-	-	-	-	-
Area covered (% of net cropped area)	0.69	-	-	-	-	-

farmers group, FYM was applied by 3.33 per cent farmers to their paddy crop covering 0.69 per cent of the net cropped area while the quantity applied was 38.67 kg. per acre which was priced at Rs.0.16 per kg. Bio-fertilizer was also applied to wheat crop by just 0.83 per cent soil test farmers covering a meagre 0.12 per cent of the net cropped area while the quantity applied was 0.002 kg. per acre which was priced at Rs.13 per kg.

5.8 Details of Fertilizers Purchased by the Sample Households

Sources of purchase of fertilizers have been shown in Table 5.12. A perusal of the table reveals that in soil test farmers category in total, 59.17 per cent farmers purchased fertilizers from private fertilizer shop/dealers while 92.86 per cent small, 68 per cent medium, 51.95 per cent large and 25 per cent marginal farmers also purchased fertilizers from this source. Also, 90 per cent soil test farmers in total also purchased fertilizers from co-operative societies while according to farm categories, 100 per cent small, 96 per cent medium, 90.91 per cent

large and 71.43 per cent small farmers purchased fertilizers from co-operative societies. On control farmers category in total, 93.33 per cent farmers purchased fertilizers from private fertilizer shop/dealers while according to farm categories, 100 per cent marginal and small, 93.75 per cent medium and 91.89 per cent large farmers purchased fertilizers from private fertilizer shops/ dealers. From co-operative societies, 91.67 per cent control group farmers in total purchased fertilizers from co-operative societies while according to farm categories, 100 per cent marginal and small, 93.75 per cent medium and 89.19 per cent large farmers purchased fertilizers from this source.

Table 5.12: Sources of Purchase of Fertilizers (% farmers)

(Multiple Response)

Sources	Marginal	Small	Medium	Large	Total
Soil Test Farmers					
Private fertilizer shops/dealers	25.00	92.86	68.00	51.95	59.17
Company authorized dealers	-	-	-	-	-
Co-operative societies	100.00	71.43	96.00	90.91	90.00
Government agency	-	-	-	-	-
Others	-	-	-	-	-
Control Farmers	-	-	-	-	-
Private fertilizer shops/dealers	100.00	100.00	93.75	91.89	93.33
Company authorized dealers	-	-	-	-	-
Co-operative societies	100.00	100.00	93.75	89.19	91.67
Government agency	-	-	-	-	-
Others	-	-	-	-	-

Quantity of fertilizers purchased by the sample farmers have been given in Table 5.13. It can be seen from the table that 92.17 per cent soil test farmers purchased urea from co-operative societies and 7.83 per cent from private fertilizer shops while from control farmers category, 81.67 per cent purchased urea from co-operative societies and 18.33 per cent from private fertilizer shops/ dealers. As far as purchase of DAP is concerned, 90.39 per cent soil test farmers purchased it from co-operative societies followed by 9.61 per cent from private fertilizer shop/ dealers while in control farmers category, 87.71 per cent purchased it from co-operative societies and 12.29 per cent from private fertilizer shops/ dealers. Similarly, 51.32 per cent soil test farmers purchased zinc from co-operative societies and 48.68 per cent from private fertilizer shops/ dealers while all the farmers under control farmers category purchased zinc from private fertilizer shops/ dealers. As far as purchase of potash, sulphur, bio-fertilizer, gypsum and manganese is concerned, all the farmers from both the categories purchased it from private fertilizer shops/ dealers.

Table 5.13: Quantity of Fertilizer Purchased by the Sample Farmers (Per cent)

Sources	Urea	DAP	Zinc	Potash	Sulpher	Bio-fert	Gypsum	Manganese
Soil Test Farmers								
Private fertilizer shops/dealers	7.83	9.61	48.68	100.00	100.00	100.00	100.00	100.00
Company authorized dealers	-	-	-	-	-	-	-	-
Co-operative societies	92.17	90.39	51.32	-	-	-	-	-
Government agency	-	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-	-
Total	100	100	100	100	100	100	100	100.00
Control Farmers								
Private fertilizer shops/dealers	18.33	12.29	100	100	100	-	-	100
Company authorized dealers	-	-	-	-	-	-	-	-
Co-operative societies	81.67	87.71	-	-	-	-	-	-
Government agency	-	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-	-
Total	100	100	100	100	100	-	-	100.00

The average price of fertilizers and transport cost incurred have been depicted in Table 5.14. A perusal of the table reveals that among soil test and control group farmers, the price of urea was Rs. 5.40 per kg. and that of DAP Rs.24.20 per kg. There was some variation in the average prices of Super, potash, zinc and manganese among both the farm categories. Price of gypsum was Rs.8.33 per kg. while that of bio-fertilizers was Rs. 31.08 per kg. as reported by control farmers. The transportation cost varied from Rs 0.088 per kg to Rs. 0.038 per kg for all the fertilizers among both the farm categories.

Table 5.14: Average Price of Fertilizers and Transport Cost Incurred (Rs/kg)

Fertilizer type	Soil Test farmers		Control farmers	
	Average Price	Transport cost	Average Price	Transport cost
Urea	5.40	0.041	5.40	0.038
DAP	24.20	0.036	24.20	0.085
Super	41.75	0.089	45.79	0.085
Potash	1.96	0.088	3.08	0.088
Zinc	15.68	0.083	23.15	0.087
Bio-fertilizers	31.08	0.088	-	-
Gypsum	8.33	0.087	-	-
Manganese	16.67	0.088	18.33	0.088

5.9 Training Programmes Attended

The training programmes attended on application of chemical fertilizers by the sample farmers have been given in Table 5.15. A perusal of the table reveals that 41.67 per cent of the soil test farmers attended various trainings programmes and number of trainings attended was 1.56 while average number of days of the training duration was 1.56 showing that all the farmers attended one day training. As far as control farmers group was concerned, 25 per cent of them attended various trainings programmes and average number of trainings attended was 1.33. Also, all the farmers attended one day training with average number of days of the training duration being 1.33 days.

Table 5.15: Training Programmes Attended on Application of Chemical Fertilizers by the Sample Farmers

Particulars	Paddy & Wheat
Soil Test Farmers	
Average number of trainings attended	1.56
% of farmers attended	41.67
Average number of days	1.56
Control Farmers	
Average number of trainings attended	1.33
% of farmers attended	25.00
Average number of days	1.33

5.10 Summary

In paddy and wheat crops, out of the total soil test farmers, only 44 per cent of the medium category farmers followed by large, small and marginal farmers applied recommended doses of fertilizers and were also willing to continue applying the recommended dose in future while in total, it was 40.83 per cent farmers. In paddy crop, the average area on which recommended doses of fertilizers were applied was 9.22 acres on large farms followed by other farm categories while the area covered under recommended dose of fertilizers as per cent of net operated area in paddy crop was highest on small farms while in total it was 17.19 per cent of the net operated area. In case of wheat crop, the average area on which recommended doses of fertilizers were applied was 9.25 acres on large farms followed by other farm categories and the area covered under recommended dose of fertilizers as per cent of net operated area in wheat crop was highest on small farms (34.13%) followed other farm categories while it was 17.15 per cent in total.

The constraints in applying recommended doses of fertilizers revealed that the reason 'adequate quantity of fertilizers not available' was ranked as least important by all the farmers while 5.63 per cent ranked the reason 'prices of fertilizers are high' as most important. 'Lack of money to purchase fertilizers' was also ranked as most important reason by 2.82 per cent farmers while 'no technical advice on method and time of fertilizer application' was reported as most important constraint by 11.27 per cent of the farmers However, 69.01 per cent farmers reported the reason 'difficult to understand and follow the recommended doses' as most important constraint in applying recommended doses of fertilizers. The other reason being 'practical experience of last so many years' was ranked as most important reason by 11.27 per cent of the farmers.

The source of information of recommended doses of fertilizers for control farmers was Agricultural University (20%), fellow farmers (8.33%), Department of agriculture (6.67%) and co-operatives (5%) while according to farm categories it was mainly co-operatives for marginal, Agricultural university for small, medium and large farmers.

The actual quantity of fertilizers applied by the soil test farmers to paddy crop per acre was 123.75 kg. urea, 5.33 kg. DAP, 2.13 kg. sulphur, 3.67 kg. potash 10.79 kg. zinc, 10.42 kg gypsum and 0.65 kg. bio vita. Farm category wise analysis showed that the use of urea was more on large farms, DAP use on medium, sulphur use on small, potash and zinc on marginal and bio-vita use was more on large farms as compared to other farm categories. Similarly, actual quantity of fertilizers applied by the control farmers to paddy crop was 136.86 kg. urea, 18.33 kg. DAP, 2.14 kg. sulphur, 2.50 kg. potash, 11.67 kg. zinc, 10.42 kg gypsum and 0.43 kg. bio-vita. Farm category wise analysis showed that the use of urea, DAP, sulphur, zinc and bio-vita was more on large farms while potash use was more on small farms as compared to other farm categories.

The actual quantity of fertilizers applied by the soil test farmers to wheat crop was 122.38 kg. urea, 57.38 kg. DAP, 0.85 kg. sulphur, 1.17 kg. potash 0.09 kg. zinc, 10.42 kg gypsum, 0.08 kg. bio vita and 0.29 kg. manganese per acre. According to farm categories, use of urea, DAP and zinc was more on large farms, sulphur and gypsum on small, potash on medium and manganese use on marginal farms as compared to other farm categories. Similarly, the fertilizers applied by the control farmers to wheat crop was 138.75 kg. urea, 64.92 kg. DAP, 1.33 kg. sulphur, 1.92 kg. potash, 0.50 kg. zinc and 0.35 kg. manganese. According to farm categories, use of urea, sulphur was more on large farms, DAP use on marginal, potash on

small and manganese on medium farms as compared to other farm categories. Thus, fertilizer use was more on control farmers farms as compared to soil test farmers farms for both paddy and wheat crops.

There was significant decline in the fertilizer application on soil test farms for both paddy and wheat crops and also there was increase in yield which can be attributed to the balanced application of macro along with micro-nutrients especially gypsum and green manuring of fields by some of the soil test farmers.

On soil test farmers farms, urea, sulphur and bio-vita were applied in three doses i.e. basal application, after inter-cultivation and during vegetative growth of the paddy crop. Zinc was also applied as basal dose and during vegetative growth of the crop. However, DAP, potash and gypsum were applied only as basal dose to paddy crop by the soil test farmers. On control farmers farms, urea was applied in four doses i.e. basal application, after inter-cultivation, during vegetative growth and flowering of the paddy crop. Sulphur was applied as basal dose, after inter-cultivation and during vegetative growth. Potash was applied as basal dose, during vegetative growth and flowering stage of paddy crop. However, DAP was applied only as basal dose and zinc and bio-bita were applied as basal dose and during vegetative growth of the paddy crop.

In case of wheat crop, on soil test farmers farms, urea, sulphur were applied in three doses i.e. basal application, after inter-cultivation and during vegetative growth of the crop while bio-vita was applied after inter-cultivation and manganese during vegetative growth of wheat crop. However, DAP, zinc and gypsum were applied only as basal dose while potash was applied as basal dose and during flowering of the crop by soil test farmers. On control farmers farms, urea was applied in three doses i.e. basal application, after inter-cultivation and during vegetative growth of wheat crop while DAP, zinc were applied as basal dose and manganese during vegetative growth of the crop. Sulphur was applied as basal dose and during vegetative growth while potash was applied as basal dose, during vegetative growth and flowering stage of wheat crop.

The method of application of chemical fertilizers by the soil test and control farmers who have applied urea, DAP, sulphur, potash, zinc, gypsum and bio-vita to their crop, all of them used broadcasting method to evenly distribute the fertilizers in their fields. Similarly, in case of wheat crop, the soil test or control group farmers who have applied urea, sulphur, potash,

zinc and gypsum to their crop, all of them used broadcasting method to apply these fertilizers in their fields while DAP was drilled at the time of wheat sowing.

Farm yard manure (FYM) was applied by 43.33 per cent soil test and 40 per cent control group farmers to paddy crop while bio fertilizer was applied by 10 per cent soil test and five per cent control farmers and only five per cent soil test farmers green manured their fields before paddy transplanting. Similarly, in wheat crop, FYM was applied by just 1.66 per cent soil test and 3.33 per cent control group farmers to wheat crop while bio fertilizer was applied by a megre 0.83 per cent soil test farmers to wheat crop.

Most of the soil test and control group farmers purchased fertilizers from co-operative societies and private fertilizer shop/ dealers while quantity of urea and DAP purchase was more from co-operative societies and zinc, potsh, sulphur, bio-vita gypsum and manganese from private fertilizer shop/ dealers.

As far as attending training programme is concerned, 41.67 per cent of the soil test farmers and 25 per cent control farmers attended one or two trainings of one day duration.

Chapter VI: IMPACT OF ADOPTION OF RECOMMENDED DOSES OF FERTILIZERS

6.1 Background

After undertaking the soil testing exercise, major emphasis of the farmers need to be the adoption of recommended doses of fertilizers. Use of recommended doses of fertilizers for each crop is very crucial for increasing productivity and reducing cost of the crops. It has been seen that productivity of the crops has increased on those farms where balanced use of nutrients has been applied.

6.2 Productivity of Reference Crops (Paddy and wheat) among the Sample Households

The productivity of the paddy and wheat crops during the year 2013-14 has been shown in Table 6.1. It can be seen from the table that in paddy crop, there was higher yield obtained on

Table 6.1: Productivity of the Reference Crops (Paddy and wheat) during the Study Year

Particulars	Average yield (Quintal/acre)			Average value of output (Rs/acre)		
	Soil test farmers	Control farmers	% difference in yield	Soil test farmers	Control farmers	% difference in value output
Paddy						
Marginal	30.88	29	6.09	40695	37990	6.65
Small	31.78	28.67	9.79	41380	37772	8.72
Medium	32.03	29.65	7.43	42462	39188	7.71
Large	30.68	30.08	1.96	40092	39857	0.59
Total	31.09	29.81	4.12	40329	39715	1.52
Wheat						
Marginal	21.25	21	1.18	29671	29400	0.91
Small	20.96	20.33	3.01	29229	28346	3.02
Medium	20.81	19.38	6.87	29005	27090	6.60
Large	20.96	20.03	4.44	29405	28188	4.14
Total	20.94	19.9	4.97	29438	28051	4.71

all farm categories and in total on soil test farmers farms as compared to control farmers farms. Highest difference in paddy yield was estimated on small farms (9.79%) followed by

medium (7.43%), marginal (6.09%) and large (1.96%) farms while in total, yield difference was 4.12 per cent. Similarly, difference in average value of output was also highest on small farms (8.72%) followed by medium (7.71%), marginal (6.65%) and large (0.59%) farms while in total, difference in value of output was 1.52 per cent. In case of wheat crop also, soil test farmers achieved higher yield vis-a-vis control farmers. On medium farms, highest difference i.e. 6.87 per cent in wheat yield was obtained followed by large (4.44%), small (3.01%) and marginal (1.18%) farms while in total, yield difference was 4.97 per cent. Also, difference in average value of output was highest on medium farms (6.60%) followed by large (4.13%), small (3.02%) and marginal (0.91%) farms while in total, difference in value of output was 4.71 per cent. Thus, soil test farmers obtained higher productivity of paddy and wheat crops as compared to control farmers.

6.3 Impact of Application of Recommended Doses of Fertilizers on Reference Crops

As given in Table 6.2, there were 40.83 per cent soil test farmers who have applied recommended doses of fertilizers after getting their soils tested. Hence, the impact of application of recommended doses of fertilizers to paddy and wheat crops was observed for these farmers (Table 35) for the yield obtained before and after soil testing . It can be seen from the table that in case of paddy crop, maximum increase in crop yield was observed on

Table 6.2: Impact of Application of Recommended Doses of Fertilizers on Reference Crop Yield - Soil Test Farmers

Particulars	Average yield (Quintal/acre)		% change in yield
	Before	After	
Paddy			
Marginal	32.00	33.00	3.03
Small	30.00	31.22	3.91
Medium	30.91	32.8	5.76
Large	30.38	31.31	2.97
Total	30.49	31.66	3.70
Wheat			
Marginal	18.00	20.00	10.00
Small	19.90	20.98	5.15
Medium	19.36	20.95	7.59
Large	19.08	20.23	5.68
Total	19.20	20.46	6.16

medium (5.76%) farms followed by small (3.91%), marginal and large (2.97%) farms while in total , increase in yield was 3.70 per cent. In case of wheat crop, the highest increase in yield was observed on marginal farms (10.00%) followed by medium (7.59%), large (2.97%) and small (5.15%) farms while in total, increase in wheat yield was 6.16 per cent. Thus, soil testing has shown an increasing impact on crop yield for both paddy and wheat crops on all

farm categories when farmers have applied the recommended doses of fertilizers to these crops.

The changes observed after the application of recommended doses of fertilizers on paddy and wheat crops have been given in Table 6.3. In case of paddy crop, 51.02 per cent farmers ranked 'increase in crop yield' as most important change while 10.20 per cent ranked it as least important. 'Less incidence of pest and diseases' was most important change observed by 24.49 per cent farmers followed by 18.37 per cent ranking it as important and 14.29 per cent as least important. Also, 'decrease in application of other inputs like seed, labour, pesticide etc.' was reported by 16.33 per cent farmers as most important while 24.49 per cent ranked it as important and 18.37 per cent as least important. 'Improvement in crop growth' was observed by 34.69 per cent farmers as important and least important by 16.33 per cent farmers. Similarly, 'improvement in grain filling' was reported by 12.24 per cent farmers as important and by 12.24 per cent farmers as least important. Thus, 'increase in crop yield' and 'less incidence of pest and diseases' were the two most important changes observed by the soil test farmers applying recommended doses of fertilizers. In total, the changes observed after the application of recommended doses of fertilizers to paddy crop as ranked by 61.22 per cent farmers with varying intensity was 'increase in crop yield' followed by 59.19 per cent ranking 'decrease in application of other inputs like seed, labour, pesticide etc.', 57.15 per cent

Table 6.3: Changes Observed after the Application of Recommended Doses of Fertilizers on Reference Crops (% of farmers)-Soil Test Farmers

Particulars	Paddy				Wheat			
	Most Important	Important	Least Important	Total	Most Important	Important	Least Important	Total
Increase in crop yield	51.02	-	10.20	61.22	48.98	-	8.16	57.14
Improvement in soil texture	8.16	10.20	28.57	46.93	6.12	10.20	32.65	48.97
Improvement in crop growth	-	34.69	16.33	51.02	-	30.61	16.33	46.94
Improvement in grain filling	-	12.24	12.24	24.48	-	10.20	10.20	20.40
Less incidence of pest and diseases	24.49	18.37	14.29	57.15	30.61	18.37	20.41	69.39
Decrease in application of other inputs like seed, labour, pesticide etc.	16.33	24.49	18.37	59.19	14.29	30.61	12.24	57.14

ranking 'less incidence of pest and diseases', 51.02 per cent ranking 'improvement in crop growth', 46.93 per cent ranking 'improvement in soil texture' and 24.48 per cent ranking 'improvement in grain filling' with varying intensity as the changes observed after the application of recommended doses of fertilizers to paddy crop.

In case of wheat crop, 48.98 per cent farmers observed 'increase in crop yield' as most important change after application of recommended doses of fertilizers while 8.16 per cent reported it as least important. 'Less incidence of pest and diseases' was most important change revealed by 30.61 per cent farmers followed by 18.37 per cent reporting it as important and 20.41 per cent as least important. 'Decrease in application of other inputs like seed, labour, pesticide etc.' was ranked by 14.29 per cent farmers as most important followed by 30.61 per cent ranking it as important and 12.24 per cent as least important. Also, 'improvement in crop growth' was ranked by 30.61 per cent farmers as important and by 16.33 per cent farmers as least important. Similarly, 'improvement in grain filling' was revealed by 10.20 per cent farmers as important and least important by 10.20 per cent farmers. Thus, in case of wheat crop also, 'increase in crop yield' and 'less incidence of pest and diseases' were the two most important changes seen by the soil test farmers who have applied recommended doses of fertilizers. In total, the changes observedafter the application of recommended doses of fertilizers to wheat crop as ranked by 69.39 per cent farmers with varying intensity was 'less incidence of pest and diseases' followed by 57.14per cent ranking 'increase in crop yield' 57.14 per cent ranking 'decrease in application of other inputs like seed, labour, pesticide etc.', 48.97 per cent ranking 'improvement in soil texture', 46.94 per cent ranking 'improvement in crop growth' and 20.40 per cent ranking 'improvement in grain filling' with varying intensity as the changes observed after the application of recommended doses of fertilizers to wheat crop.

6.4 Summary

In case of paddy crop, there was higher yield obtained on all farm categories and in total on soil test farmers farms as compared to control farmers farms. In total, yield difference was 4.12 per cent among soil test and control farmers while highest difference in paddy yield was estimated on small farms (9.79%) followed by medium, marginal and large farms and value of output was also highest on soil test farms. Also, in case of wheat crop, soil test farmers achieved higher yield vis-a-vis control farmers. On medium farms, highest difference i.e. 6.87 per cent in wheat yield was obtained followed by other farm categories and value of output obtained was also more on soil test farms as compared to control farmers.

The impact of application of recommended doses of fertilizers showed that in case of paddy crop, maximum increase in crop yield was observed on medium (5.76%) farms followed by small, marginal and large farms while in total, increase in yield was 3.70 per cent. In case of wheat crop, the highest increase in yield was observed on marginal farms (10.00%) followed by medium, large and small farms while in total, increase in wheat yield was 6.16 per cent. Thus, soil testing has shown an increasing impact on crop yield for both paddy and wheat crops. As far as changes observed after the application of recommended doses of fertilizers is concerned, 'increase in crop yield' and 'less incidence of pest and diseases' were the two most important changes observed by the soil test farmers who have applied recommended doses of fertilizers to both paddy and wheat crops. In aggregate, for both paddy and wheat crops, major changes observed after the application of recommended doses of fertilizers with varying intensity were; increase in yield, less incidence of pest and diseases, decrease in application of various inputs and improvement in crop yield.

Chapter VII: SUMMARY AND CONCLUSIONS

7.1 Background

Punjab being a pioneer state where green revolution resulted in following specialization in paddy and wheat crops and farmers reaped rich dividends in terms of increased productivity and production of these crops. But with the passage of time, intensive cultivation resulted in developing macro and micro-nutrient deficiencies in the soil which was evident from the soil testing and symptoms on crops. So, soil testing is being promoted by the agricultural scientists for balanced use of fertilizers. Although many farmers get their soils tested at their own level or sometimes soils of entire village is being tested under some soil testing campaign. But crux of the problem is the actual implementation of the soil testing results by the farmers on their fields. Non adoption of soil test recommendations by farmers results in making entire exercise futile and huge investment in terms of establishing soil testing laboratories by the Govt. is not giving the desired results. Soil testing results implementation on farmers fields can be helpful in decreasing the cost of cultivation as well as increase in food grain production in the country.

7.2 Summary of Findings

Trends in Fertilizer use:

District level analysis showed that the growth in fertilizer consumption was more in district Sangrur as compared to district Ludhiana. At Punjab level, the consumption of nitrogenous fertilizer was 174.8 th. tonnes in 1970-71 which increased to 1416 th. tonnes in 2011-12 with mean consumption of 803.4 th. tonnes while this increase was at CGR of 4.52 per cent per annum. Phosphatic fertilizer consumption was 31.4 th. tonnes in 1970-71 while it increased to 448 th. tonnes in 2011-12 with mean consumption being 251.5 th. tonnes and this increase was at CGR of 4.66 per cent per annum. Potassic fertilizer consumption was 7.0 th. tonnes in 1970-71 while it increased to 54 th. tonnes in 2011-12 with mean consumption of 28.1 th tonnes and this increase was at a CGR of 2.70 per cent per annum.At Punjab level, maximum growth in consumption was in phosphatic fertilizers followed by nitrogenous and potassic fertilizers. As far as fertilizer consumption per hectare of net sown area and per hectare of gross cropped area was concerned, consumption was more in district Ludhiana while growth in consumption was more in district Sangrur. At Punjab Level, the consumption of nitrogenous fertilizer per hectare of net area sown was 43.12 kg. per hectare in 1970-71 which increased to 342.53 kg. per hectare in 2011-12 while mean consumption level was 191.85 kg. per hectare and this increase

was at an annual growth of 4.48 per cent. Similarly, in case of phosphatic fertilizer, the consumption was 7.75 kg. per hectare which increased to 108.37 kg. per hectare in 2011-12 and mean consumption was 60.02 kg. while this increase was at 4.62 per cent growth per annum. In case of potassic fertilizer, the consumption was merely 1.73 kg. per hectare which increased to 13.06 kg. per hectare in 2011-12 with mean value being 6.72 kg. per hectare and this growth was at CGR of 2.66 per cent per annum. Also, the consumption of nitrogenous fertilizer per hectare per season of gross cropped area was 30.78 kg. in 1970-71 which was 179.20 kg. per hectare in 2011-12 with mean consumption level of 107.12 kg. per hectare and this increase was at an annual growth of 3.70 per cent. Also, in case of phosphatic fertilizers, the consumption was 5.53 kg. per hectare per season which increased to 56.69 kg. per hectare in 2011-12 and mean consumption was 33.60 kg. while this increase was at CGR of 3.84 per cent. In case of potassic fertilizers, the consumption was 1.23 kg. per hectare which increased to 6.83 kg. per hectare in 2011-12 while mean value was 3.82 kg. per hectare and this growth was at 1.90 per cent per annum. Thus, fertilizer consumption has significantly increased in Punjab over the last four decades. Also, recently N fertilizer consumption per hectare was higher in district Sangrur while P and K fertilizer consumption was more in district Ludhiana which can also be attributed to the soil type fertilizer requirements in these districts.

Socio-economic characters of respondents:

In soil test farmers category, for both paddy and wheat crops, 3.33 per cent of the respondents belonged to marginal farm category followed by 11.67 per cent to small, 20.83 per cent to medium and 64.17 per cent to large farm category. Similarly, in control farmers category, 1.67 per cent respondents were from marginal farm category, 10 per cent from small, 26.67 per cent from medium and 61.66 per cent from large farm category. Thus, the proportion of soil test farmers belonging to large farm category was higher in both the categories. Out of total sample of 180 households, 120 were from soil test farmers category and 60 from control farmers category. The average age of respondents in soil test farmers category was about 44 years while it was nearly 40 years in control farmers category and overall up to 43 years. The average years of respondents education was nearly nine years in both categories as well as in overall scenario. All the respondents were males and pursuing agriculture as their main occupation. The average family size was nearly seven and at least two family members were engaged in agriculture in both the categories. The average farming experience of the respondents was nearly 24 years in soil test farmers, about 20 years in control farmers and almost 23 years in overall. Nearly 93 per cent of the respondents were members of any

association in soil test farmers category while this figure was 95 per cent in control farmers and about 94 per cent in overall. Among both the categories, 98.33 per cent of the respondents belonged to general castes while remaining 1.67 per cent were from other backward castes (OBC) category. Net operated area in soil test farmers category was 18.37 acres out of which owned land was 11.09 acres, leased-in was 7.47 acres and leased-out was 0.19 acres while in control farmers category, net operated area was 16.81 acres constituting 10.26 acres from owned land and 6.55 acres from leased-in land. In overall, net operated area was 17.85 acres out of which 10.81 acres being owned land, 7.16 acres leased-in and 0.13 acres leased-out land. The whole net operated area was irrigated and cropping intensity was nearly 200 per cent in all the categories. On soil test farmers farms, bore well/ tube well was source of irrigation on 99.59 per cent of the net irrigated area while 8.95 per cent was irrigated through canals. On some household farms, both bore well/ tube well as well as canal water was available for irrigating same piece of land. On control farmers farms, entire net operated area was irrigated through bore well/ tube well while canal irrigation was also available on some farms, therefore, 5.95 per cent of the area was also irrigated through canal irrigation. In overall, 99.72 per cent area was irrigated through bore well/ tube well and 8.10 per cent through canal irrigation. The cropping pattern on the sample farm households showed that during *kharif* season, in soil test farmers category, 43.64 per cent of the gross cropped area was under paddy crop followed by remaining area under fodder, basmati, cotton and baby corn. During *rabi* season, 45.78 per cent of the gross cropped area was under wheat crop followed rest of the area under fodder, potato. Sugarcane which is annual crop was also grown on soil test farmers farms. On control farmers farms, during *kharif* season, 42.58 per cent of the gross cropped area was under paddy crop followed by basmati, fodder and cotton while in *rabi* season, wheat was major crop sown on 46.03 per cent of the gross cropped area followed by fodder and potato. During summer season, summer moong and spring maize were the crops grown while sugarcane was the annual crop occupying 0.20 per cent area. In an overall scenario, during *kharif* season, paddy was major crop occupying 43.30 per cent of the gross cropped area followed by basmati, fodder, cotton and baby corn while during *rabi* season, 45.86 per cent of the area was under wheat crop followed by fodder and potato. During summer season, summer moong and spring maize were the crops grown while sugarcane was annual crop sown on sample farms. In soil test farmers as well as control farmers category, entire area under various crops grown was under high yielding varieties. Among soil test farmers, per acre value of paddy output was Rs. 42462 on medium farms followed closely by small, marginal and large farms while value of crop output was Rs 40329

per acre in total. Similarly, the value of the paddy output per household was highest on large farms due to higher size of holding followed by other farm categories. The value of the paddy output sold on various farm categories varied from Rs.42186 per acre on medium farms, which was highest, to Rs.40011 on large farms, which was lowest among farm categories. On control farmers farms, per acre value of the paddy output was Rs. 39857 on large farms followed by medium, marginal and large farms while value of crop output was Rs 39715 per acre in total. Also, the value of the paddy output per household was highest on large farms followed by other farm categories. The value of the paddy output sold on various farm categories varied from Rs.39781 per acre on large farms, being highest to Rs.37772 on small farms, being lowest among farm categories. In wheat crop, on soil test farmers farms, per acre value of the crop output was Rs. 29671 on marginal farms followed by large, small and medium farms while in total value of paddy output was Rs 29405 per acre. Also, the value of the wheat output per household was highest on large farms due to higher holding size followed by other farm categories. The value of wheat output sold per acre on various farm categories was highest (Rs.27737) on large farms and lowest (Rs.23484) on marginal farms. On control farmers farms, per acre value of the wheat output was Rs. 29400 on marginal farms followed by small, large and medium farms while the value of crop output was Rs 28051 per acre in total. The value of output per household was highest on large farms as compared to other farm categories due to size of holding. The value of wheat output sold on various farm categories varied from Rs.25449 per acre on large farms, being highest to Rs.11200 on marginal farms, being lowest. On soil test farmers and control farmers category, major farm asset included tractor, trailer/ trolley with average number per household being 1.30 and 1.27, respectively and average value was Rs. 345083 and Rs.319683 per household. The second major farm asset was electric motor/ diesel engine with average number being 1.73 and 1.68 per household in both categories and valuated at Rs. 21021 and Rs. 24900 per household. Harrow and cultivators were the major farm implements with 0.99 and 1.03 numbers per households and valuated at Rs. 12493 and Rs. 13017 per household in both farmer categories. The other farm assets included thresher, planker, manual/ power sprayer, fodder chopper, bullock cart, animal shed/ pump house and small tools which were estimated at Rs. 19283 and Rs. 18834 in total. The total value of the farm assets was estimated at Rs. 398255 and Rs.376434 per household in both farmer categories. On soil test farmers farms, credit outstanding per household was maximum from commercial banks (Rs. 25833) followed by money lenders, traders/ commission agents and co-operative credit societies). Similarly, on control farmers farms also, credit outstanding from commercial banks was

maximum (Rs.24750) which was followed by traders/ commission agents, money lenders and co-operative credit societies per household. Thus, credit outstanding was more from commercial banks for both farmer groups. Most of the farmers have taken loan for seasonal crop cultivation and for marriage and social ceremonies among both the farmer categories.

Soil Testing and recommended dose of fertilizers:

All the selected soil test farmers got their soils tested during the last three years and average cost of soil testing was Rs. 20 per soil sample with average distance covered from field to soil testing lab was 57.73 kilometers. The average area covered under soil testing was 1.88 acres on marginal, 4.39 acres on small, 5.49 acres on medium, 7.79 acres on large and 6.53 acres in overall situation. The area covered under soil testing as per cent of net operated area was highest on small farms and all the soil test farmers have themselves collected soil samples from their fields. The major source of information about soil testing was SAU followed by friends/ neighbours, private companies, state department and KVK's. The major reasons for soil testing by sample soil test farmers for paddy and wheat crops was 'Motivation from village demonstration/training/exposure visits to places with best farming practices' which was ranked the most important reason of soil testing by 50 per cent farmers while another reason i.e. 'For increasing crop yield' was ranked most important by 35 per cent farmers 'To reduce the fertilizer cost' was ranked most important reason by 10 per cent.However, in total, 85 per cent farmers ranked 'for increasing crop yield' as the reason for soil testing with varying intensity. The major reasons for not testing soil during the last three years by control farmers for both paddy and wheat crops was 'Soil testing not required for my field as crop yield is good' and 53.33 per cent farmers ranked the reason as most important while 'Soil testing laboratories are located far away' was another reason which was ranked by 21.67 per cent farmers as most important. Another reason i.e. 'Do not know how to take soil samples' was ranked as most important reason by 15 per cent farmers for not undertaking soil testing of their fields. In total, the reasons 'do not know how to take soil samples' and 'do not know whom to contact for details on testing' were ranked by 96.66 per cent farmers with varying intensity as reasons of not testing soils. The status of soil health in terms of nutrients on the soil test farmers farms revealed that for both paddy and wheat crops, as reported in the soil health card, 70 83 per cent of the farmers reported nitrogen content in the soils as medium followed by 20.83 per cent as low and 8.34 per cent as high. The status of phosphorus in the soils was relatively better with 58.34 per cent reporting it as high followed by 25.83 per cent as medium and 15.83 per cent as low. Similarly, potassium was sufficiently available in the soils

with 97.5 per cent of the farmers reporting potassium content as high and 2.50 per cent as low. The average quantity of 112.33 kg. of urea was recommended for application to paddy crop in soil health card. Besides, 25 kg. DAP, 20 kg. potash, 20 kg zinc and 120 kg. gypsum was also recommended for application to paddy crop on the sample soil test farmers farms. Similarly, in case of wheat crop, on an average 112.33 kg. urea was recommended for application on sample farms along with 51.17 kg. DAP, 20 kg. potash and 114.29 kg. gypsum, as reported in the soil test card. The average quantity of split doses of fertilizers recommended by stage of crop growth revealed that in paddy crop, there was recommendation of basal application of average 48.25 kg. urea followed by 34.08 kg. after inter-cultivation and 30 kg. during the vegetative growth of the crop. Also, for other nutrients, there was recommendation of basal application of 25 kg. DAP, 20 kg. potash, 20 kg. zinc and 120 kg. gypsum. In case of wheat crop, there was also recommendation of basal application of average 48.25 kg. urea followed by 34.08 kg. after inter-cultivation and 30 kg. during the vegetative growth of the crop. For other nutrients, there was recommendation of basal application of 51.17 kg. DAP, 20 kg. potash and 120 kg. gypsum as reported in the soil health card.

Adoption of recommended doses of fertilizers:

In paddy and wheat crops, out of the total soil test farmers, only 44 per cent of the medium category farmers followed by large, small and marginal farmers applied recommended doses of fertilizers and were also willing to continue applying the recommended dose in future while in total, it was 40.83 per cent farmers. In paddy crop, the average area on which recommended doses of fertilizers were applied was 9.22 acres on large farms followed by other farm categories while the area covered under recommended dose of fertilizers as per cent of net operated area in paddy crop was highest on small farms while in total it was 17.19 per cent of the net operated area. In case of wheat crop, the average area on which recommended doses of fertilizers were applied was 9.25 acres on large farms followed by other farm categories and the area covered under recommended dose of fertilizers as per cent of net operated area in wheat crop was highest on small farms (34.13%) followed other farm categories while it was 17.15 per cent in total. The constraints in applying recommended doses of fertilizers revealed that the reason ‘adequate quantity of fertilizers not available’ was ranked as least important by all the farmers while 5.63 per cent ranked the reason ‘prices of fertilizers are high’ as most important. ‘Lack of money to purchase fertilizers’ was also ranked as most important reason by 2.82 per cent farmers while ‘no technical advice on

method and time of fertilizer application' was reported as most important constraint by 11.27 per cent of the farmers However, 69.01 per cent farmers reported the reason 'difficult to understand and follow the recommended doses' as most important constraint in applying recommended doses of fertilizers. The other reason being 'practical experience of last so many years' was ranked as most important reason by 11.27 per cent of the farmers. The source of information of recommended doses of fertilizers for control farmers was Agricultural University (20%), fellow farmers (8.33%), Department of agriculture (6.67%) and co-operatives (5%) while according to farm categories it was mainly co-operatives for marginal, Agricultural university for small, medium and large farmers. The actual quantity of fertilizers applied by the soil test farmers to paddy crop per acre was 123.75 kg. urea, 5.33 kg. DAP, 2.13 kg. sulphur, 3.67 kg. potash 10.79 kg. zinc, 10.42 kg gypsum and 0.65 kg. bio vita. Farm category wise analysis showed that the use of urea was more on large farms, DAP use on medium, sulphur use on small, potash and zinc on marginal and bio-vita use was more on large farms as compared to other farm categories. Similarly, actual quantity of fertilizers applied by the control farmers to paddy crop was 136.86 kg. urea, 18.33 kg. DAP, 2.14 kg. sulphur, 2.50 kg. potash, 11.67 kg. zinc, 10.42 kg gypsum and 0.43 kg. bio-vita. Farm category wise analysis showed that the use of urea, DAP, sulphur, zinc and bio-vita was more on large farms while potash use was more on small farms as compared to other farm categories. The actual quantity of fertilizers applied by the soil test farmers to wheat crop was 122.38 kg. urea, 57.38 kg. DAP, 0.85 kg. sulphur, 1.17 kg. potash 0.09 kg. zinc, 10.42 kg gypsum, 0.08 kg. bio vita and 0.29 kg. manganese per acre. According to farm categories, use of urea, DAP and zinc was more on large farms, sulphur and gypsum on small, potash on medium and manganese use on marginal farms as compared to other farm categories. Similarly, the fertilizers applied by the control farmers to wheat crop was 138.75 kg. urea, 64.92 kg. DAP, 1.33 kg. sulphur, 1.92 kg. potash, 0.50 kg. zinc and 0.35 kg. manganese. According to farm categories, use of urea, sulphur was more on large farms, DAP use on marginal, potash on small and manganese on medium farms as compared to other farm categories. Thus, fertilizer use was more on control farmers farms as compared to soil test farmers farms for both paddy and wheat crops.There was significant decline in the fertilizer application on soil test farms for both paddy and wheat crops and also there was increase in yield which can be attributed to the balanced application of macro along with micro-nutrients especially gypsum application and green manuring of fields by some of the soil test farmers. On soil test farmers farms, urea, sulphur and bio-vita were applied in three doses i.e. basal application, after inter-cultivation and during vegetative growth of the paddy crop. Zinc was

also applied as basal dose and during vegetative growth of the crop. However, DAP, potash and gypsum were applied only as basal dose to paddy crop by the soil test farmers. On control farmers farms, urea was applied in four doses i.e. basal application, after inter-cultivation, during vegetative growth and flowering of the paddy crop. Sulphur was applied as basal dose, after inter-cultivation and during vegetative growth. Potash was applied as basal dose, during vegetative growth and flowering stage of paddy crop. However, DAP was applied only as basal dose and zinc and bio-bita were applied as basal dose and during vegetative growth of the paddy crop. In case of wheat crop, on soil test farmers farms, urea, sulphur were applied in three doses i.e. basal application, after inter-cultivation and during vegetative growth of the crop while bio-vita was applied after inter-cultivation and manganese during vegetative growth of wheat crop. However, DAP, zinc and gypsum were applied only as basal dose while potash was applied as basal dose and during flowering of the crop by soil test farmers. On control farmers farms, urea was applied in three doses i.e. basal application, after inter-cultivation and during vegetative growth of wheat crop while DAP, zinc were applied as basal dose and manganese during vegetative growth of the crop. Sulphur was applied as basal dose and during vegetative growth while potash was applied as basal dose, during vegetative growth and flowering stage of wheat crop. The method of application of chemical fertilizers by the soil test and control farmers who have applied urea, DAP, sulphur, potash, zinc, gypsum and bio-vita to their crop, all of them used broadcasting method to evenly distribute the fertilizers in their fields. Similarly, in case of wheat crop, the soil test or control group farmers who have applied urea, sulphur, potash, zinc and gypsum to their crop, all of them used broadcasting method to apply these fertilizers in their fields while DAP was drilled at the time of wheat sowing. Farm yard manure (FYM) was applied by 43.33 per cent soil test and 40 per cent control group farmers to paddy crop while bio fertilizer was applied by 10 per cent soil test and five per cent control farmers and only five per cent soil test farmers green manured their fields before paddy transplanting. Similarly, in wheat crop, FYM was applied by just 1.66 per cent soil test and 3.33 per cent control group farmers to wheat crop while bio fertilizer was applied by a megre 0.83 per cent soil test farmers to wheat crop. Most of the soil test and control group farmers purchased fertilizers from co-operative societies and private fertilizer shop/ dealers while quantity of urea and DAP purchase was more from co-operative societies and zinc, potsh, sulphur, bio-vita gypsum and manganese from private fertilizer shop/ dealers. As far as attending training programme is concerned, 41.67 per cent of the soil test farmers and 25 per cent control farmers attended one or two trainings of one day duration.

Impact of adoption of recommended doses of fertilizers:

In case of paddy crop, there was higher yield obtained on all farm categories and in total on soil test farmers farms as compared to control farmers farms. In total, yield difference was 4.12 per cent among soil test and control farmers while highest difference in paddy yield was estimated on small farms (9.79%) followed by medium, marginal and large farms and value of output was also highest on soil test farms. Also, in case of wheat crop, soil test farmers achieved higher yield vis-a-vis control farmers. On medium farms, highest difference i.e. 6.87 per cent in wheat yield was obtained followed by other farm categories and value of output obtained was also more on soil test farms as compared to control farmers. The impact of application of recommended doses of fertilizers showed that in case of paddy crop, maximum increase in crop yield was observed on medium (5.76%) farms followed by small, marginal and large farms while in total, increase in yield was 3.70 per cent. In case of wheat crop, the highest increase in yield was observed on marginal farms (10.00%) followed by medium, large and small farms while in total, increase in wheat yield was 6.16 per cent. Thus, soil testing has shown an increasing impact on crop yield for both paddy and wheat crops. As far as changes observed after the application of recommended doses of fertilizers is concerned, 'increase in crop yield' and 'less incidence of pest and diseases' were the two most important changes observed by the soil test farmers who have applied recommended doses of fertilizers to both paddy and wheat crops. In aggregate, for both paddy and wheat crops, major changes observed after the application of recommended doses of fertilizers with varying intensity were; increase in yield, less incidence of pest and diseases, decrease in application of various inputs and improvement in crop yield.

7.3 Conclusions

- At Punjab level, maximum growth in fertilizer consumption was in phosphatic fertilizers followed by nitrogenous and potassic fertilizers during last four decades. Also, fertilizer consumption per hectare in Punjab has increased significantly after the advent of green revolution.
- The major source of information about soil testing for soil test farmers was SAU followed by friends/ neighbours, private companies, state department and KVK's.
- The major reasons for soil testing by sample soil test farmers for paddy and wheat crops was 'Motivation from village demonstration/training/exposure visits to places with best farming practices'.
- The major reasons for not testing soil during the last three years by control farmers for both paddy and wheat crops was 'Soil testing not required for my field as crop yield is good'.
- The status of soil health in terms of nutrients, as reported in the soil health card of soil test farmers, showed that 70 83 per cent of the farmers reported nitrogen content in the soils as medium followed by 20.83 per cent as low and 8.34 per cent as high.
- The status of phosphorus in the soils was relatively better with 58.34 per cent reporting it as high followed by 25.83 per cent as medium and 15.83 per cent as low. Similarly, potassium was sufficiently available in the soils with 97.5 per cent of the farmers reporting potassium content as high and 2.50 per cent as low.
- In paddy and wheat crops, out of the total soil test farmers, only 44 per cent of the medium category farmers followed by large (41.56%), small (35.71%) and marginal (25%) farmers applied recommended doses of fertilizers while in total it was 40.83 per cent farmers.
- The most important constraint in applying recommended doses of fertilizers as revealed by 69.01 per cent soil test farmers was 'difficult to understand and follow the recommended doses'.
- The fertilizer use was more on control farmers farms as compared to soil test farmers farms for both paddy and wheat crops.
- There was significant decline in the fertilizer application on soil test farms for both paddy and wheat crops and also there was increase in yield which can be attributed to the balanced application of macro along with micro-nutrients especially gypsum application and green manuring of fields by some of the soil test farmers.

- The method of application of chemical fertilizers by the soil test and control farmers for paddy and wheat crops was broadcasting except that DAP was drilled in case of wheat sowing and manganese was sprayed to control manganese deficiency.
- Farm yard manure (FYM) was applied by 43.33 per cent soil test and 40 per cent control group farmers to paddy crop and FYM application in wheat was meager.
- Most of the soil test and control group farmers purchased fertilizers from co-operative societies and private fertilizer shop/ dealers.
- The quantity of urea and DAP purchase was more from co-operative societies while zinc, potash, sulphur, bio-vita gypsum and manganese were purchased from private fertilizer shop/ dealers.
- As far as attending training programme is concerned, 41.67 per cent of the soil test farmers and 25 per cent control farmers attended one or two trainings of one day duration.
- In both paddy and wheat crops, average yield and value of output was more on soil test farmer farms as compared to control farmers farms and it was also higher according to farm categories.
- The impact of application of recommended doses of fertilizers showed that in case of paddy crop, maximum increase in crop yield was observed on medium (5.76%) farms followed by small, marginal and large farms while in total, increase in yield was 3.70 per cent after adopting the soil health card recommendations by the soil test farmers.
- In case of wheat crop, the highest increase in yield was observed on marginal farms (10.00%) followed by medium, large and small farms while in total, increase in wheat yield was 6.16 per cent after implementing the soil health card recommendations by the soil test farmers.
- As far as changes observed after the application of recommended doses of fertilizers is concerned, 'increase in crop yield' and 'less incidence of pest and diseases' were the two most important changes observed by the soil test farmers who have applied recommended doses of fertilizers to both paddy and wheat crops.

7.4 Policy Recommendations

Farmers should be made aware about the benefits of balanced use of fertilizer use and harmful effects of excessive dose of fertilizers for crops and humans in case of leaching particularly of nitrogenous fertilizers. For this, more farmers training camps should be organized. Extension efforts by the State Agricultural University and Department of Agriculture need to be further strengthened in terms of organizing exposure visits and new training programmes emphasizing the importance of soil testing to motivate farmers for soil testing. It should be ensured that the recommendations of the soil health card are properly adopted by the farmers on their fields. For its proper implementation, a visit to the farmers fields by the scientists to encourage them in case of non-adoption of recommendations. Gram panchayats should be involved in undertaking soil testing campaigns for making soil testing as a mass movement for the benefit of the farming community as a whole. The support/ incentives of the state in this regard can go a long way to encourage more and more farmers to go for soils testing at their own level which can also result in decreasing their cost as well as increasing the crop production.

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Appendix I

Coordinator's Comments on the Draft Report

1. Title of the draft report examined:

Adoption of Recommended Doses of Fertilizers on Soil Test Basis by Farmers inPunjab

2. Date of receipt of the Draft report: January 20, 2015

3. Date of dispatch of the comments: March 17, 2015

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) **Chapter II**- The content of the tables are just stated throughout the chapter, rather explaining the trend would give better understanding of the situation in the state.

(ii) **Chapter III**- Table 3.2 shows that, the pool of sample did not contain any sample from SC snd ST category. The reasons for the same can be explained or supported with demographic profile of that particular region.

(iii) In Table 3.7, the value of output sold among control farmers in table (Rs.37742) is misinterpreted in text (Rs.37772) .

(iv) In Table 3.10, the percentage of farmers out of total sample who availed loan from any source to be mentioned in the note below for better understanding of the situation.

(v) **Chapter IV**- Table 4.3 and Table 4.4: A column indicating total, which shows the percentage of farmers opining that particular reason among total sample, must be added and the percentage must be distributed among the ranking they have given.

(vi) Chapter V- Table 5.2: A column indicating total, which shows the percentage of farmers opining that particular reason among total sample, must be added and the percentage must be distributed among the ranking they have given.

(vii) In Table 5.12, the row indicating total percentage of sources to be removed as it is adding to more than 100 percent.

(viii) **Chapter VI-** Table 6.3: A column indicating total, which shows the percentage of farmers opining that particular reason among total sample, must be added and the percentage must be distributed among the ranking they have given.

(ix) **Chapter VII-** Authors are suggested to edit the chapter based on corrections made in the previous chapters and support the findings with suitable reasons.

(x) Authors should provide economic explanation of data presented in all the chapters. It is suggested to copy edit the report before finalizing.

7. Overall view on acceptability of report

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

Appendix II

ACTION TAKEN ON THE COMMENTS BY AERC, LUDHIANA

Adoption of Recommended Doses of Fertilizers on Soil Test Basis by Farmers in Punjab

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

(i) Detailed explanations have been incorporated as desired.

(ii) Very few farmers in the state actually belong to this particular category and their non inclusion in the sample is just a matter of chance.

(iii) Correction as suggested has been made.

(iv) Needful has been done.

(v) Needful has been done.

(vi) Needful has been done.

(vii) Needful has been done.

(viii) Needful has been done.

(ix) Needful has been done.

(x) The required explanation has already been given at the relevant places to interpret the data for their economic implications.

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