IMPACT OF SOIL HEALTH CARD SCHEME ON PRODUCTION, PRODUCTIVITY AND SOIL HEALTH IN INDIA

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LIST OF ACRONYMS AND ABBREVIATIONS

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

MOP	Muriate of Potash
MP	Madhya Pradesh
MRP	Maximum Retail Price
MT	Million Tonnes
N	Nitrogen
NFL	National Fertilizer Limited
NI	Nitrification Inhibition
NMSA	National Mission for Sustainable Agriculture
NPK fertilizers	Nitrogen, Phosphorus and Potassium fertilizers
NPMSF	National Project on Management of Soil Health and Fertility
NUE	Nitrogen Use Efficiency
OBC	Other Backward Classes
P	Phosphate
PCARDBs	Primary Cooperative and Agricultural Development Banks
PCFs	Polymer-Coated Fertilizers
POP	Package of Practices
RDFs	Recommended Doses of Fertilizers
RSKs	Raitha Samparka Kendra’s
SAUs	State Agricultural Universities
SC	Schedule Caste
SCU	Sulphur Coated Urea
SDA	State Department of Agriculture
SHC Scheme	Soil Health Card Scheme
SHCs	Soil Health Cards
SSP	Single Super Phosphate
ST	Schedule Tribes
STFs	Soil-tested Farmers
STLs	Soil Testing Laboratories
STLs	Soil Testing Laboratories
USDA	United States Department of Agriculture
$ZnSO_4$	Zinc Sulphate

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ACKNOWLEDGEMENT

The present study entrusted by the Department of Fertilizers (DoF) and its own Integrated Nutrient Management (INM) division of the Ministry of Agriculture and Farmers Welfare (MoA & FW) to the Agricultural Development and Rural Transformation Centre (ADRTC) of the Institute for Social and Economic Change (ISEC), Bengaluru. The specific objectives of the study are to assess the impact of Soil Health Card (SHC) scheme on production, productivity and soil health in India. The reference period for the study is Kharif 2015. In this report, awareness, adoption and impact of SHC Scheme have been documented. In the course of study immense support was received from all the officials of the State Department of Agriculture, Government of India and the MoA & FW. In addition, our heartfelt thanks to all the participating AERCs and their team for their support and active involvement in the study. We sincerely thank them for their cooperation. We would also like to thank Dr. I. Maruthi, Associate Professor and Head; Prof. Parmod Kumar, ADRTC, Prof. M. G. Chandrakanth, Director, ISEC and Sri P. C. Bodh, Advisor, AER Division, MoA & FW for sustained support and encouragement throughout this study.

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Authors

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EXECUTIVE SUMMARY

BACKGROUND

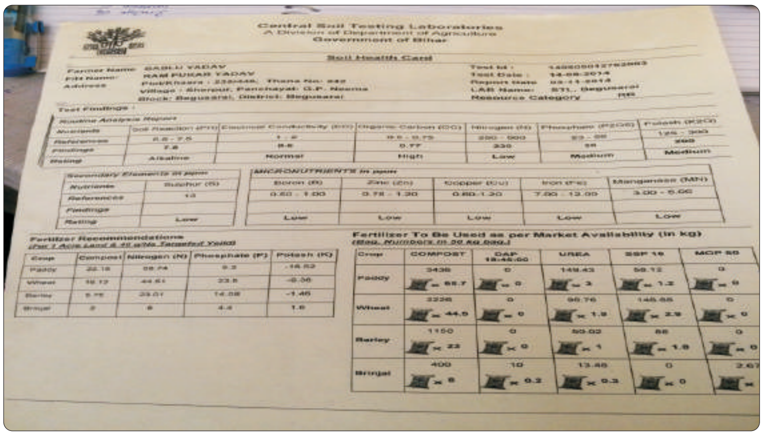
In view of a steady shrinkage of agricultural land over time, the biggest challenge before the world today is to ensure enough food for an ever-growing population. The presence of healthy, fertile soils has now become a greater necessity than ever before and hence, understanding the health status of our soil systems assumes significance, especially from the view-point of increasing the agricultural production. Frequent testing of soil quality is the only option for farmers to know how best to treat their soil so that in turn it can give them the maximum yield they need. Realizing the issues and challenges involved in the implementation of soil health programmes over the time, the Government of India launched a Soil Health Card Scheme on 19th February, 2015 with a focused attention on the soil health of agricultural areas across the country with a view to enhancing agricultural productivity through a judicious use of inputs, especially fertilizers. Under this scheme, the cropped area is divided into grids of 10 ha for rainfed and 2.5 ha for irrigated with only one soil sample taken from each grid and the test results are made known to all the farmers falling under either the grids. The reports are given in the form of a Soil Health Card (SHC), which contains crop-wise recommendations for fertilizer use. In this study, an attempt has been made to understand and document the issues related to implementation, awareness, adoption and impact of the SHC scheme on the farming community across India.

The specific objectives of the study are as follows:

1. To examine the status and implementation of the Soil Health Card Scheme in the country.
2. To examine the level of adoption of soil health card scheme and constraints involved in the distribution of soil health card to farmers.
3. To analyze the impact of adoption of recommended doses of fertilizers on crop productivity and income of soil-tested farmers.

METHODOLOGY

The study relied upon both the primary and secondary data. The selected states under the study included Karnataka, Maharashtra, Punjab, Madhya Pradesh, Bihar and Assam. A multi-stage sampling procedure was adopted as part of the sampling framework. In the first stage, six states were selected. In the second stage, two districts from each state were



selected based on the progress and implementation status of the SHC scheme in each state. Similarly, from each district, two taluks/tehsils were selected in the third stage according to the same criterion. Lastly, from among the selected taluks, two clusters of villages comprising 3-4 villages per cluster were selected for conducting the primary survey. A total of 30 farmers, who had tested their soil-systems under the SHC scheme were selected randomly for each district. At the same time, the survey also included 30 control (not soil-tested) farmers from each state and district, selected randomly from the chosen clusters for differentiating the effect of the application of recommended doses of fertilizers on crop productivity and income. The study covered a total of 120 sample farmers per state, representing 60 soil-tested farmers (under SHC Scheme) and 60 control farmers. In total, the sample farmers selected to represent India numbered 720. Further three major crops from each state were considered for an impact analysis of the SHC scheme.

MAJOR FINDINGS

Status of SHC scheme implementation:

- SHC Scheme is being implemented in the country over a two-period Cycles. Targets set for the Cycle I (from 2015-16 to 2016-17) (253 lakhs) have been met to the extent of cent per cent in terms of sample collection; 99 per cent in respect of sample testing and printing of SHCs, but the distribution is found limited to 98 per cent as on 13th March 2018. On the other hand, all India progress of SHC scheme during Cycle II in terms of soil samples collected is found to be 93 per cent, while the proportion is 70 per cent with respect to soil samples tested. However, SHCs have reached to just 20 to 26 per cent of the farmers as on 13th March 2018. These delays in the achievement of targets could be attributed to a poor implementation of the scheme in a few states and specifically due to lack of infrastructure and staff in the soil testing laboratories.

- A majority of the states have achieved a good progress in terms of soil sample collection, but the situation is worst in the case of soil samples testing, printing and distribution of SHCs. Overall, Maharashtra, Gujarat, Tamil Nadu, Chhattisgarh, Himachal Pradesh and Puducherry are the leading states in terms of the overall implementation of the SHC scheme, followed by Uttar Pradesh, Madhya Pradesh, Karnataka, Andhra Pradesh, Telangana, Odisha, Uttarakhand and Jharkhand. States like Punjab, Kerala, Arunachal Pradesh, Sikkim and Dadar Nagar & Haveli are lagging behind in the implementation.

- For a majority (>95%) of the soil-tested and control farmers across the sample states, agriculture is the main occupation with more than 25 years of experience in farming. A higher proportion of the soil-tested farmers have undergone seven years of schooling as against five years of schooling by control farmers. However, the educational attainment is up to high school level in the case of Punjab and Maharashtra control farmers in contrast to primary school level in states like Bihar, Madhya Pradesh, Assam and Karnataka. The average family size comprises six members. Interestingly, one third of the soil-tested family members and half of the control farmers are engaged in farming only.

- The net operational holding per household of the sample farmers is much higher among Punjab sample farmers both in the case of soil-tested (13.55 acres/ household) and control (11.55 acres/household) categories followed by Karnataka (7.20 acres/household & 7.35 acres/ household). In the rest of the states, the average land holding is less than 6.5 acres/household. Similarly, leased land, average rental values and the irrigated land are highest in respect of Punjab only both in the case of soil-tested and control farmers.

- The major sources of irrigation are bore wells (98%) in the sample areas, followed by dug wells (38%) and canals (16%). Both the soil-tested and control farmers have grown crops like paddy, maize, tur, jowar, soybean, vegetables and other crops (which include pulses and vegetables) in the study states with their proportions being relatively the same in respect of both (control and soil-tested farmers) the cases.

- Overall, Soil-tested farmers sold 41 quintals of agricultural produce at a unit price of Rs. 1429/-, which amounts to a gross income of Rs. 59105/- per season in contrast to an average of 33 quintals of agricultural produce at the price of Rs. 1432/ quintal in respect of control farmers. It is interesting to note that soil-tested farmers have achieved a better return as compared to control farmers, which might be due to the adoption of soil-testing technology and RDFs.

Awareness regarding soil testing

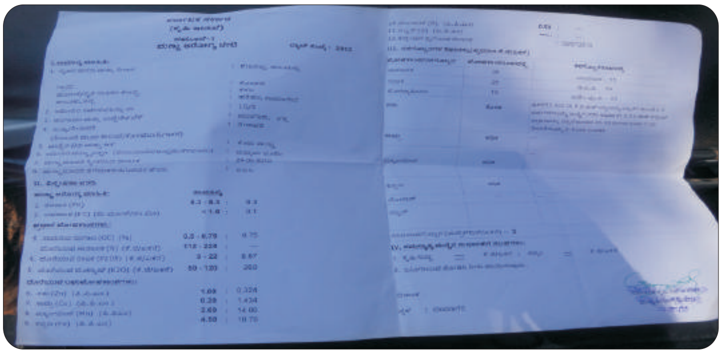
- Overall, a majority of the soil-tested farmers are aware of soil health cards (98%), followed by the ongoing programmes under soil health mission (57%) and imbalanced application of fertilizers and their adverse effects (48%). The awareness regarding INM and a reduction in the consumption of chemical fertilizers due to INM are limited to less than 20 per cent of the soil-tested farmers.

- Across all the sample states, excepting Assam, more than 55 per cent of the soil-tested farmers are familiar with the ongoing programmes under soil health mission besides being aware of an imbalanced application of fertilizers and their harmful effects.
- With regard to control farmers, a majority (>50%) of them are unaware of soil health management and related ongoing government schemes. Across the sample states, the situation is slightly better in the states of Bihar, Assam and Punjab, with a majority of the control farmers being aware of soil health card (>53%) and the adverse effects of an imbalanced application of fertilizers (>47%).
- More interestingly, less than half of the soil-tested farmers have experienced a reduction in consumption of chemical fertilizers due to INM in almost all the sample states.
- It is fairly disappointing to note that a negligible proportion (<10%) of the farmers is aware of the grid system meant for soil sample selection followed under the SHC scheme, which reiterates that there is a necessity of awareness component being part of the SHC scheme and that the implementation authorities need to pay more attention to the same so as to make the programme successful.
- State Department of Agriculture (SDA) is the major source (in the case of Maharashtra, Karnataka and Bihar) of information on soil testing and its related aspects, followed by State Agriculture Universities (SAUs) (17%) and neighbours (10%). However, in the case of Punjab, SAUs are the major source of information as against Private companies in respect of Assam.
- Although SDA and KVKs conduct training programmes related to the various aspects of soil-nutrient management, on a regular basis, less than 20 per cent of the farmers (both soil-tested and control) are found to have attended these trainings.
- A majority of the farmers in all the states are found to have applied all the fertilizers, following broadcasting method. However, a minor proportion of the farmers have applied micronutrients, using spraying and drilling methods.
- Interestingly, about 90 per cent of the Assam farmers are found to have applied micro-nutrients through spraying method.
- On an average, three samples had been collected from two plots over an area of around four acres for soil testing under the SHC scheme.

- Across the sample states, a majority of the soil-tested farmers had purchased Urea from private fertilizer shops/ dealers, excepting Punjab (90%) and Madhya Pradesh (57%), where a majority of the farmers had purchased fertilizers from Co-operative societies. Whereas, DAP, Potash and complex fertilizers had been purchased from both private fertilizer shops/ dealers and Co-operative societies in all the states.
- On the contrary, micro nutrients (58%) and bio fertilizers (50%) had been purchased from government agencies in Karnataka and Madhya Pradesh, respectively, due to subsidized prices.
- Farmer facilitators are the major source of soil sample collection (33%), followed by SDA (24%) and SAUs (9%). Interestingly, one third of the sample farmers also had collected soil samples on their own.

Adoption of recommended doses of fertilizers

- Generally, educated farmers follow the package of practices (POP) published by the State Agricultural Universities (SAUs) for the application of inputs and operations to be undertaken in the cultivation of crops.



- POP also suggests the farmers to undertake soil testing at least once in three years, as each farm varies in terms of nutrient status and other soil parameters. However, it is observed that a majority farmer neither follow POP nor RDFs as prescribed in SHCs.
- On an average, excepting DAP, all other fertilizers had been applied less than the recommended levels in the case of paddy crop. Across states, Madhya Pradesh farmers are found to have applied higher quantities than the RDFs in respect of DAP (9 kg/acre) alone, but the rest of the fertilizers such as SSP, MOP, urea and FYM had been applied in lesser quantities to the extent of 152 kg/acre, 27 kg/acre, 65 kg/acre and 7.7 tons/acre correspondingly, and the variance is found substantial.
- As regards red gram, the average quantities of fertilizers applied are found more than the recommended doses in the case of nutrients such as DAP (44kg/acre) and MOP (4 kg/acre), while relatively less than the recommended quantities in respect of urea (7 kg/acre), SSP (2 kg/acre) and FYM (1.4 tons/acre). However, Karnataka farmers had applied slightly less quantities of urea, MOP and FYM, while DAP had been applied in excess of the recommended levels.
- The average quantities of fertilizers applied by jowar farmers are found relatively on par

with the RDFs in terms of NPK chemical fertilizers, whereas, FYM application is found substantially low (4.4 tons/acre). The difference between the recommended and applied quantity of FYM is found to be negative and huge in respect of Karnataka while urea usage is more.

- With respect to wheat crop, excepting DAP, the average quantity of applied fertilizers applied is found to be less than the recommended doses in terms of all nutrients (NPK) as well as FYM. However, DAP application is found more than the recommended level in the case of Bihar while all the fertilizers applied are less than the recommended levels in respect of Maharashtra.
- In the case of Ragi crop in Karnataka, all the fertilizers applied are found more than the recommended levels (11 kgs of Urea/ acre, 5 kgs of DAP/ acre and 9 kgs of MOP/ acre), while the application of FYM is slightly less (0.36 tons/acre).
- The application of almost all the fertilizers is slightly lesser than the recommended levels in respect of soybean farmers in Madhya Pradesh, while the variation is substantially high in terms of FYM (7.6 tons/acre).
- Excepting urea, the application all the other fertilizers is relatively less for Bihar in relation to lentil/gram crop, while the urea application is moderately higher (30 kg/acre) than the recommended quantity.
- There are no recommendations made of DAP, MOP, SSP and FYM for basmati crop in the case of Punjab, excepting urea, but the use of urea by soil-tested farmers exceeds the recommended doses.
- In terms of organic manure usage, a majority (69%) of the farmers are found to have applied FYM to all the reference crops, followed by biogas (0.18 tons) and green manure (0.67 tons). Among all the organic fertilizers, the prices of bio-fertilizers are found to be high as compared to FYM and bio-gas.
- A few of the soil -tested farmers (<27%) have noticed some problems in the implementation of SHC scheme in their respective states. These problems include 'Not aware of the technique of taking samples' as the major problem, followed by 'No training campaigns', 'SHCs are not distributed on time', 'Lack of information on soil test technology', 'Lack of involvement of farmers while taking samples', 'Soil testing laboratories are far away' etc.
- Based on the problems noticed, a majority of them also have made suggestions for overcoming these problems such as undertaking campaigns for creating awareness regarding SHC scheme and its importance, conducting trainings on soil sampling, timely distribution of SHCs and creation of infrastructure for soil testing on a priority

basis.

Impact of Soil Health Card scheme

- Both before and after situations & with and without approaches have been used for assessing the impact of the soil health card scheme and the results reveal that a comparatively better yields are observed after the intervention of soil testing and adoption of RDFs (kharif 2015) as against the before situation (kharif 2014) in respect of almost all the sample crops chosen across states.

- The percent change in yield is highest to the extent of 44 per cent in respect of Bengal gram, followed by wheat (43%) in Karnataka, correspondingly maize (30%) in Madhya Pradesh and red gram (22%) in Maharashtra.

- The change in paddy yield (as per the before and after situations) is highest to the tune of 19 per cent in respect of Madhya Pradesh and lowest (<1%) in the case of Punjab. Interestingly, out of all the sample states, the lowest increase in yield is less than three per cent in respect of Punjab and Bihar.

- A majority of the farmers consider an increase in yield levels (45%) as the most important change post application of RDFs, followed by improvement in soil texture (12%). Whereas, improvement in crop growth and grain filling are considered as an important visible change by 38 per cent and 35 per cent of the sample farmers.

- On the contrary, a majority of the farmers consider less incidence of pest and diseases (46%) and changes in the application of other inputs like seed, labour, pesticide etc. (28%), as the least important changes noticed post adoption of RDFs.

- Following with and without approaches, there is a minor decline observed in the usage of all chemical fertilizers such as NPK, micronutrients and plant protection chemicals by paddy farmers. On the other hand, an increase in the yield levels of both the main & by-products to the extent of 1.49 quintal/acre (Rs. 2889/-/ acre) and 4.47 quintal/acre (Rs. 831/ acre), respectively, is also observed. The total increase in net returns from paddy is found to be Rs. 3720/ acre as compared to control farmers post adoption of RDFs.

- Whereas, in the case of Wheat, there is a drastic decline observed in the usage of chemical fertilizers such as Phosphorus (DAP) (41%), Potassium (MOP) (27%), Plant Protection Chemicals (PPC) (56%) and nitrogen (N) (7%) as compared to control farmers. But, there has been a slight increase in the main product yield (0.11 quintals/acre), while a decrease in the by-product yield levels (1.39 quintals/ acre).

- In respect of Red gram, there is a minor decline observed in the usage of chemical fertilizers such as nitrogen (N) by 8.46 kg/acre and DAP (P) by 7.58 kg/acre by soil-tested farmers, while, an increase in the main product yield (0.56 quintal/acre) and returns (Rs. 6976/acre), indicating that there is an increase in the net income to the extent of Rs. 7891/acre.
- A contrasting result is revealed with regard to maize crop in terms of a higher use of NPK fertilizers by control farmers. In addition, there are also higher expenses incurred on labour and seed on the part of soil-tested farmers as compared to control farmers. In spite of increased costs, maize yield shows an increase by 0.23 quintals per acre valued at Rs.578 for soil-tested farmers as compared to control farmers. However, the net income is found negative for both the farm categories.
- With respect to Jowar crop, a minor decline is observed in the use of nitrogen (N) (9.98 kg/acre) and phosphorus (P) (4.7 kg/acre) by soil-tested farmers, while labour costs show a decline to the extent of Rs.517/ acre in respect of control farmers. However, due to a slightly higher yield levels of both the main product and by-products, soil-tested farmers have realized a little better gross income of Rs. 1456/ acre.
- There are no significant changes observed in the use of chemical fertilizers by both the soil-tested and control farmers for ragi crop in Karnataka during kharif 2015. However, due to a decrease in the labour costs and a slight increase in yield levels observed (0.36 quintal/acre) by soil-tested farmers, the difference in net income over control farmers works out to Rs.1243 per acre.
- Similarly, at the aggregate, there is a decrease witnessed in the paid-out costs (7%) and an increase in net returns (5%) by soil-tested farmers as compared to control farmers with respect to Lentil crop, whereas, in the case of Soybean, the cost of cultivation shows a marginal decrease (2%) with better yield both in terms of the main and by-products to the extent of 26 per cent and 13 per cent, respectively, post adoption of RDFs.
- In the case of Basmati crop, there is a slightly higher (0.53 kg.) use of nitrogen (N) fertilizer on the part of soil-tested farmers as compared to control farmers. In spite of that there is a higher basmati yield to the extent of 0.18 quintal per acre valued at Rs.499f or soil-tested farmers and hence, the net income is higher by Rs. 430 as compared to control farmers.

POLICY SUGGESTIONS

Based on the results, observations from the field and discussions held with the farmers and state government officials, we have come up with some of the following policy suggestions for a better implementation of the programme:

- Special training programmes/ camps/ demonstrations should be organised by the various stakeholders (SAUs, KVKs, SDAs, Private Companies) in the agricultural sector as part of educating the farmers regarding soil sampling, benefits of soil testing, balanced use of chemical fertilizers, INM and knowledge of SHC recommendations.
- For a successful implementation of the SHC scheme, there is a need for capacity building of the field level staff along with the required facilities and equipment such as Soil Test Laboratories (STLs), manpower, high quality instruments/devices, etc., as these are the main reasons for undue delays in soil test analysis and distribution of SHCs.

- Field level staff are not provided with GPS devices and hence, a majority of the field level staff use their mobiles to trace the sample points across the grids. Generally, these mobiles do not work properly due to network and visibility problems during day-time. Therefore, it becomes difficult for the field staff to collect samples as per the procedure and targets set. Therefore, the SDA should supply suitable GPS devices to all the field level staff across the states.
- A majority of the states have reported undue delays in the distribution of soil test reports SHCs (Soil Health Cards) as the major problem facing all the soil testing

programmes, including the SHC Scheme. As a result, farmers are more likely to lose their confidence in these programmes. Therefore, a timely distribution of SHCs (preferably before sowing season) in hard copy and educating of farmers about the information provided in SHCs may promote, to a large extent, the adoption of recommended doses of fertilizers on the basis of soil test reports.

- It is noticed from among the soil-tested farmers that a majority have not treated SHC as an important document for protecting their soil systems (like our blood test reports). Hence, there is a need for educating the farming community regarding the importance of soil health, benefits of soil testing, SHCs/ report, and the information on SHCs, knowledge about SHC recommendations etc., as part of encouraging the farmers towards a judicious/ balanced use of chemical fertilizers and thereby optimizing the crop yield levels.
- Gram panchayats should be involved in soil-test campaigns on a priority basis alongside the SDA officials for a proper and better implementation of the soil health card scheme.
- Special care may be taken for the collection of representative soil samples. Validity of samples is to be ensured at all levels-starting from collection stage to storage in labs even after analysis.
- The Department of Agriculture is expected to ensure an effective and live linkage between the field and the laboratory. Hence, there is a need for creating Soil Testing Labs (STLs), at least one in each taluka. Each lab can take up one village on a mission basis to spread the utility of the SHC scheme and identify the shortcomings so that the whole SHC scheme can be improved on the basis of such direct observation / study. In addition, accreditation of such labs to National/international standard institutes should be initiated.
- There is an urgent need for making the SHC related information available to the farmers on their fingertips with the help the existing information technology through internet and mobile apps. Efforts should also be made towards integrating all the stakeholders such as farmers, government officials, fertilizer industries etc., through the web and mobile applications for assessing, producing, distributing and applying fertilizers scientifically for sustainable agriculture. Adoption of villages by industrialists may help promote the development at a faster rate.
- Some incentives/awards for farmers, Gram Panchayats, Agriculture Officers/ Assistant Director of Agriculture need to be devised as part of promoting the soil test technology, encouraging the adoption of RDFs, undertaking production of green manure, vermi-compost and increasing soil fertility in their areas over the years.

CHAPTER I

INTRODUCTION

1.1 Background of the Study

In an apparently disturbing trend, most of India's soil-based production systems have been showing signs of fatigue since the green revolution, while on the other side, the demand for food grains is increasing in view of an ever-increasing population of the country. Going by the conservative estimates, the demand for food grains will increase to 355 MT by 2030 as against the present level of 270 MT ***(Dey, 2016)***. In stark contrast to the increasing food demand, the factor productivity and the rate of crop to fertilizers applied under intensive cropping systems are declining year after year.

Frequent soil testing of the farmer's field is an integral part of the fertilizer management policy as part of understanding the nutrient status and health conditions. It is a well-known fact that the Indian soils have become deficient over time in major nutrients such as N (nitrogen), Phosphorous (P) and Potassium (K), as also secondary and micro nutrients. Deficiency in micronutrients during the last three decades has grown in terms of both the magnitude and extent because of increased use of inorganic fertilizers, use of high yielding crop varieties and increase in the cropping intensity, which has adversely affected the production and productivity of crops. Therefore, it is extremely essential to arrest the declining soil health through a judicious application of various nutrients.

Currently, the use of improved varieties along with an extensive use of fertilizers has resulted in the depletion of soil fertility, decline in water table, decrease in organic matter

content and deterioration of soil health. These disturbing developments may lead to an inter and intra-specific variations in plant growth and mineral nutrient use efficiency (NUE). It is also found that NUE is higher at reduced levels of crop production, when the use of N fertilization is much lower. Presently, the nutrients use efficiency (NUE) is quite low in Indian soils, with the deficiency being 30-50 per cent with N (Nitrogen), 15-20 per cent with P (Phosphorus), 8-12 per cent with S (Sulphur), 2-5 per cent with Zn (Zinc), 1-2 per cent with Cu (Copper) and 1-2 per cent with Fe (Iron), as estimated by ***Dey (2016)***. Low NEU results in the deterioration of physical, chemical and biological health of soils.

Due to lack of knowledge, unscientific application of synthetic fertilizers (either more or less) and low addition of organic matters, the soil health is deteriorating at a much faster rate. Hence, it is becoming a cause for concern in the recent years. Testing of soil reveals various characteristics and nutrient deficiencies of soil systems. Depending upon the extent of deficiencies revealed through testing, if soil is supplemented with nutrients required for a particular cropping pattern, the productivity of the soil could be enhanced. Therefore, a soil test-based application of fertilizers is extremely important for increasing efficiency of fertilizer usage and increasing the crop yield.

Recognizing this fact, the Indian government has tried to implement various schemes and programmes from time - to - time related to soil health as part of creating awareness among the farming community regarding the importance of soil health and its management based on soil test technology. For the first time, during 1955-56, a Soil Testing drive was implemented in the country with 16 soil testing laboratories being set up under 'Determination of Soil Fertility and Fertility Use' programme. Both the State and Central governments have been encouraging farmers, through various subsidy programmes, to go in for a free testing of soil health and soil health cards (SHCs).

Over the period, realizing the issues and challenges involved in the implementation of the soil health programmes and also with a view to reaching out to the entire farming community across the country, the governments have adopted a sampling framework for assessing the soil health status at the lowest block levels based on general fertilizer use recommendations depending on their highest area under major crops across the targeted districts. As observed by the scientists, soil test values vary over a period of three years and hence, it has been recommended to the farmers to test their soils at least once in three years.

To make it a grand success and also to popularize soil testing among the farming community, the Government of India relaunched a Soil Health Card Scheme on 19th February, 2015 with a focused attention on soil health in agricultural areas across the country as part of enhancing productivity through a judicious use of inputs, especially fertilizers. Under this scheme, soil testing is done for its main characteristics such as organic carbon, PH, electrical conductivity, macro and micro nutrients, degradation type, colour, texture and so on before reports are given in the form of a SHC, which contains crop-wise recommendations for fertilizer use. It is to be noted that this scheme has helped farmers identify the health of soil systems and a judicious use of soil nutrients through a proper monitoring. In this study, an attempt has been made to understand and document the issues related to awareness, adoption and impact of the SHC scheme on farmers of India.

1.2 Review of Literature

In this section, various research studies dealing with the importance of soil health technology, adoption and its impact on soil health, productivity and farmer's income have been reviewed and discussed in a chronological order as under. Fertilizer use on the basis of SHC is a scientific way of maintaining a good soil health and increasing crop yields. Keeping this in view, a review of various studies related to macro and micro-nutrients replenishment of soils has been carried out as part of highlighting the importance of soil testing for increasing crop productivity.

Soil testing is an important scientific tool in evaluating the fertilizer use status of the soil systems, as it helps to determine the required quantity of plant nutrients for achieving an optimum crop production. It helps address the problematic soils through a better nutrient management so as to realize higher crop productivity (**Dhyan Singh. 1996**). Similarly, **Trivedi and Patel** (**1994**) have concluded, based on their study, that soil testing is a basic tool required for improving Fertilizer Use Efficiency (FUE) and reducing the adverse effects of an excessive fertilizer consumption.

In the context of the absence of an external application of either manures or inorganic fertilizers continuously for six years, **Prasad and Sinha** (**1995**) noticed a decline of 23, 44 and 16 per cent in available N, P and K, respectively. Going further, they observe that the application of graded doses of fertilizers (50, 100 and 150% NPK) either in the presence or absence of FYM showed an average increase of about 10 per cent in available nitrogen over 21 years of continuous rice-wheat cropping.

The mean increase in the uptake of N over control with a 50 per cent recommended treatment, a 50 per cent recommended treatment with green manuring and FYM, and a 100 per cent recommended treatment was 39.3, 78.1 and 77.3 kg per ha in respect of rice and 36.8, 47.2 and 76.4 kg per ha in respect of wheat, respectively. It was also observed that N uptake by rice from green manuring or FYM, or FYM with a 50 per cent recommended treatment was similar to that from a 100 per cent recommended treatment. In addition, the uptake of P and K also increased significantly with the application of NPK and its combined use with green manuring and FYM. Hence, **Yaduvanshi** (**2001**) concluded that the 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. Similar are the results of a study conducted by **Sharma and Sharma (2002)**, in that the application of different combinations of N, P and K did not show any significant effect on the available N content in soils, whereas, the application of NPK+FYM significantly increased the available N content in soils vis-a-vis all the combinations of FYM in respect of rice -wheat cropping systems.

Sankaram, Ayala and Prakash Rao (2002) argue, based on their study, that the promotion of soil health, plant and environment system should be free of economic exploitation in terms of an overuse and abuse of inputs and as consider it the prime requisite for India in the 21st century as part of increasing the productivity of land under cultivation with reduced costs of production and a higher use efficiency of inputs with no harm to the environmental quality.

Tiwari and Nagendra Rao (2005) emphasize, in their study, the significance of improving fertilizer use efficiency in terms of productivity, profitability, sustainability in addition to following eco-friendly models of integrated nutrient management for different well-defined agro-ecological zones and cropping systems. The study argues that networking arrangements are necessary for monitoring and forecasting the changing scenario of nutrient deficiency and toxicity. Going further, the study suggests an elaborate program of monitoring changes in soil fertility so as to periodically revise the nutrient application rates for achieving a maximum possible fertilizer efficiency, so that today's maximum yield could be transformed into tomorrow's average yield.

Subba Rao and Damodar Reddy (2005) express that the approach to soil quality maintenance/ improvement for sustainable agriculture should essentially be an integrated one with a due focus on: (i) removal of various kinds of limitations inherent in soils; (ii) building carbon stocks in soils; (iii) harnessing benefits of positive interactions between nutrients and other inputs such as soil moisture; and (iv) economizing the fertilizer use through a balanced fertilization and integrated plant nutrient supply from organic and inorganic nutrient sources.

Singh *et al* (2006) studied the impact of integrated management of fertilizers, FYM and green manuring on the productivity of rice for a period of two years and found that the application of recommended doses of fertilizers along with FYM at the rate of five tons per ha and green manuring at the rate of 2.1 tons per ha had resulted in a higher yield of rice as compared to the application of chemical fertilizers only. Similarly, **Kumar *et al* (2008)** conducted a long-term field experiment on integrated management of FYM, green manuring and crop residues with the application of inorganic fertilizers in rice-wheat system. It was reported that a long-term application of crop residues and organic manures had increased the organic carbon content of soils. Further, it was found that a combined use of crop residues, organic amendments and chemical fertilizers had significantly increased the availability of N, P, K, S and micronutrients in soils vis-a-vis 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 and 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. The study brought out that there existed a number of gaps in the adoption of recommended production technologies for wheat crop, which needed to be properly plugged for enhancing productivity as well as net returns to wheat producers in the Punjab state.

A study conducted by **J. K. Patel and N. B. Chauhan (2012)** in five villages of Anand district of Gujarat state as part of assessing the attitude of farmers towards the Soil Health Card programme implemented by the State, revealed that more than one third (35 per cent) of the farmers had shown a neutral attitude towards the Soil Health Card programme, while 20 per cent of the farmers had shown a strongly favourable attitude. An equal number (17 per cent) of farmers had shown an unfavorable and a strongly unfavorable attitude towards the Soil Health Card programme. While the rest of them (11 per cent) had shown a favourable attitude towards the Soil Health Card programme. A scale developed by Department of Extension Education for assessing the attitude of farmers towards the Soil Health Card programme had been used in assessing the attitude of these farmers.

Chauhan and Bharti Mittu (2015) found the widespread nutrient deficiencies and deteriorating soil health as being responsible for a poor state of soil health, reduced productivity & profitability. The study observes that adoption of site-specific balanced and integrated nutrient management systems involving primary, secondary and micro nutrients, organic manures, bio-fertilizers and amendments can improve the present state of soil health. Simultaneously, a conducive policy on environmental safety, investments in the fertilizer sector for sustained supplies of fertilizers, utilizing indigenously available nutrient sources to reduce dependence on imports, development of new efficient fertilizer products and approaches through research & development applications, an effective soil testing service to back up a precise fertilizer use, promotion of awareness amongst farmers regarding the potential benefits of a balanced fertilizer use can bring about a significant improvement in soil health for a safe environment and better agricultural productivity, observes the study. Although, many indicators and indices of soil quality and soil health have been proposed, a globally acceptable and applicable definition and methodology for a scientific assessment of soil quality or soil health are still missing. While an analysis of physical, chemical and biological characteristics of soil systems simultaneously is required for evaluating sustainability or unsustainability of different management practices, most studies in the context of developing countries have looked at the physical and chemical characteristics only, that needs to be changed.

The study on 'adoption of recommended doses of fertilizers on soil test basis by the farmers of Karnataka' reveals that an increase in crop yield was the major reason for soil testing in the case of paddy (92%) and maize (89%) farmers in the state. Accordingly, the soil-tested farmers achieved an 8.35 per cent higher yield as compared to control farmers in the case of paddy and a 3.84 per cent higher yield in the case of maize farmers. However, out of the soil-tested farmers, only 23 per cent of paddy and 11 per cent of maize farmers found to have had adopted the recommended doses of fertilizers. However, a majority (94%) of them had expressed their willingness to continue to apply the recommended doses of fertilizers. The study also found that no technical advice on method and time of fertilizer application, difficult to understand and follow the recommended doses and high prices of chemical fertilizers were the major constraints involved in the adoption of recommended doses of fertilizers by the farmers in Karnataka **(Ramappa *et al*, 2015)**.

Chaudhari S.K (2016) observes that the major reasons for soil fertility deterioration include a wide gap between nutrient demand and supply, high nutrient turnover in soil-plant system coupled with a low and imbalanced fertilizer use, emerging deficiencies of secondary and micronutrients, rise in soil acidity and nutrient immobilization in red, lateritic and clayey soils and that a faulty management of irrigation water leads to leaching of nutrients, water logging, salinization and alkalization.

Grover *et al* (2016) reveal, based on their study, that only 40.83 per cent of soil-tested farmers had applied recommended doses of fertilizers in the case of paddy and wheat crops in Punjab. The most important constraint revealed by about 69 per cent of soil-tested farmers with respect to applying recommended doses of fertilizers was the difficulty in understanding the soil test reports. Interestingly, in respect of both paddy and wheat crops, the average yield and value of output were higher for soil-tested farmers as compared to control farmers. The positive impact of application of recommended doses of fertilizers by soil-tested farmers based on the soil health card recommendations was reflected in an increase in yield by 3.70 per cent in the case of paddy and 6.16 per cent in wheat crop. Also, there was a decline observed in the fertilizer consumption by soil-tested farmers for both paddy and wheat crops along with an increase in yield.

It is clear from the above studies that Soil Health Management is very important for sustainable agricultural growth. Hence, the technology of soil testing and adoption of recommended doses of fertilizers are very much crucial to the farmers, at least once in three years as part of assessing site-specific nutrient deficiencies and soil-plant system's capacity to supply/absorb nutrients for better crop yields. The reviews also include farmer's attitude towards Soil Health Card programmes and their impact on crop productivity which in turn, actually help the present study incorporate and improve upon the evaluation process further.

1.3 Need for the Study

An over use of chemical fertilizers by the farming community in most parts of India for nutrient management of farming practices in the last few decades has led to several problems, affecting soil health, nutrient flow and natural environment. Hence, there is a need for promoting, among others, a balanced use of fertilizers for increasing the productivity of crops and a better absorption of nutrients by soil-plant system from fertilizers applied. Table 1.1 illustrate that the ratio of NPK consumption is against norm of balance use of N, P, and K which is recommended to be in the ratio of 4:2:1. However, the ratio is far away from the recommended level. The overall trend in imbalance at country level shows a decline over time but it is still far away from the ratio considered optimum for the country. The deviation in actual use of N, P and K from the recommended proportion are found in all directions i.e. higher level of N and P relative to K, lower level of N and P relative to K and higher or lower level of N relative to P as against the norm.

Table 1.1: NPK Consumption Ratio Since 2007-08 to 2016-17

Sl. No.	*Year*	*NPK Ratio*
1	2007-08	5.5:2.1:1
2	2008-09	5.6:2.0:1
3	2009-10	4.3:2.0:1
4	2010-11	4.7:2.3:1
5	2011-12	6.7:3.1:1
6	2012-13	8.2:3.2:1
7	2013-14	9.7:2.7:1
8	2014-15	6.7:2.4:1
9	2015-16	7.2:2.9:1
10	2016-17	6.7:2.7:1

***Source:* 1.** *Department of Agriculture and Cooperation;* **2.** *Outlook for 2017-18, Indian Journal of Fertilizers, October 2017*

Against this backdrop, it is suggested that farmers opt for a regular soil testing (at least once in three years) and use recommended doses of fertilizers as prescribed in the Soil Health Cards (SHCs), as also the guidance of agricultural scientists. Over time, several states have implemented various programmes related to soil testing at free of cost in their states, however, still a majority of the farmers are not aware of these programmes, nor are they opting for soil testing on their own due to various reasons.

Realizing the importance of SHCs and of supporting the state government efforts, a Task Force on Balanced Use of Fertilizer recommended the formulation of a Centrally Sponsored Scheme called "Soil Health Card scheme" on February 2015, as part of implementing a mega programme on soil testing and distributing soil health cards to each and every farmer in the country at free of cost. For a successful implementation of the programme, the Task Force incorporated the strengthening of soil testing laboratories (STLs), promoting use of integrated nutrient management and strengthening of fertilizer quality control laboratories in the scheme. In view of the programme being implemented relatively recently, the Integrated Nutrient Management (INM) Division of the Ministry of Agriculture and Farmers Welfare (MOA&FW), was interested in understanding the status and issues involved in the implementation of this progarmme across the country. Hence, the study was entrusted to Agricultural Development and Rural Transformation Centre (ADRTC), Institute for Social and Economic Change (ISEC), Bengaluru. Accordingly, with the help of six Agro-Economic Research Centres, this study was undertaken across the country. Further, there is no systematic study undertaken so far with respect to evaluating the effectiveness of the soil test technology on crop productivity, extent of soil testing for nutrient deficiency and adoption of recommended doses of fertilizers by farmers based on soil tests. Therefore, the present study examines the status of implementation of SHC scheme, awareness regarding the programme and their level of adoption, constraints involved in the application of recommended doses of fertilizers, impact on crop productivity and relevant institutional problems.

1.4 Specific objectives of the study

The objectives of the study are as follows:

1. To examine the status and implementation of the Soil Health Card Scheme in the country.
2. To examine the level of adoption of soil health card scheme and constraints involved in the distribution of the soil health card to farmers.
3. To analyze the impact of adoption of recommended doses of fertilizers on crop productivity and income of soil health card- holding farmers.

1.5. Limitations of the study

The study was undertaken on a short notice post the policy implementation of SHC Scheme (since, February 2015) with the reference period of the study being Kharif 2015. At that point of time, a majority of the farmers hadn't received SHCs in six states. Hence, it was difficult to assess the impact of SHC on crop production, productivity and farmer's income within this limited period. However, the study tried to understand the status of the scheme and issues involved in the implementation of the programme. Besides, the study also tried to find out the impact of SHCs with the help of those farmers who had received SHCs before Kharif 2015

1.6 Data and Methodology

The present study relied on both the primary and secondary data collected from selected states in India. The selected states under the study included Karnataka, Maharashtra, Punjab, Madhya Pradesh, Bihar and Assam. The primary data were drawn from the list of farmers who had got tested their soil systems under the SHC Scheme through their respective State Department of Agriculture/ Horticulture. The sampling framework included, two districts from each state based on the number of farmers who had got tested their soil systems under the SHC Scheme through the respective State Department of Agriculture/ Horticulture. Similarly, from each district, two taluks/tehsils were selected. From among the selected taluks, two clusters of villages comprising 3-4 villages per cluster were selected for conducting the survey. A total of 30 farmers, who had tested their soil-systems under the SHC scheme are selected randomly from each district. The relevant information related to the objectives under study such as farmer's awareness regarding the SHC programme, sources of information about the SHC scheme, soil testing, benefits of soil testing, reasons for soil testing or not testing, adoption of recommended doses of fertilizers, problems involved in the implementation of the SHC programme, suggestions for improvement in the implementation of the programme etc., was collected from the sample farmers using a pre-tested questionnaire. The secondary information related to the number of soil samples collected, samples tested, SHCs printed and dispatched across the country was collected from the website of MoA & FW. The cluster approach was followed to ensure that adequate numbers of soil health card farmers were available for the survey. Further, an adequate care was taken to ensure that the selected villages shared certain common characteristics with respect to soil type, irrigation and crop variety.

The survey also included 30 control (not soil-tested) farmers from each state and district, selected randomly from the chosen cluster for differentiating the effect of the application of recommended doses of fertilizers on crop productivity and income. Thus, the study covered a total of 120 sample farmers per state, representing 60 Soil-tested farmers (under SHC Scheme) and 60 control farmers. Thus, the total sample for in India represented 720 farmers. An adequate representation was given to different farm size groups based on operational land holding.

1.7. Organization of the Report

The present report is divided into the following seven chapters. First chapter relates to the background information related to soil testing, a brief review of literature, specific objectives, scope of the study, data and methodology along with limitations of the study.

Second chapter discusses the status of Soil Health Card Scheme in India using secondary data. Third chapter presents the socio-economic characteristics of the sample households. Fourth chapter explores the awareness levels of selected respondents regarding the SHC scheme, while Fifth chapter examines the adoption of Recommended Doses of Fertilizers (RDF) as per soil health cards by the respondent farmers. The impact of SHC Scheme has been dealt with in Chapter Sixth, followed by represents Summary and policy Suggestions in chapter seventh.

CHAPTER II

STATUS OF SOIL HEALTH CARD SCHEME

2.1 Background

The increased degradation of cultivable land due to intensive cultivation and injudicious use of chemical fertilizers has led to several problems affecting soil health, nutrient flow and natural environment. The situation is further worsening in the recent days, as farmers hardly apply the recommended quantities of organic manure to the soil. Intensive crop production creates nutrient deficiencies and hence a regular replacement of depleted nutrients becomes necessary. Several government schemes and policies have tried to address these issues in the last two decades by way of encouraging farmers to apply a balanced mix of fertilizers through regular soil testing and to adopt recommended doses of fertilizers so as to increase the productivity of crops and also to facilitate better absorption of nutrients from fertilizers applied, but the results, do not seems to be satisfactory. In continuation of these efforts, the Government of India launched a Soil Health Card Scheme on 19th February, 2015 focusing attention on soil health in agricultural areas across the country as part of enhancing productivity through a judicious use of inputs, especially fertilizers. An attempt has been made in this chapter to understand the status and progress of the scheme.

The main objective of this program/scheme is to issue Soil Health Cards (SHCs) to all farmers within three years. Under this mission, many Soil Health Centres (SHCs), Fertilizer Control Laboratories, and Micro Nutrient Laboratory have been established for analysing soil samples for pH, EC, major nutrients like N, P, K, secondary nutrients like Sulphur and magnesium, and micro nutrients such as Zn, Fe, Mn, Cu and Boron. The field-specific detailed reports of soil health, fertility status and other important soil parameters that affect crop productivity are given in the form of a card called SHC. The soil health card provides an advisory on a soil test-based use of fertilizers and amendments. It is a Central Government scheme promoted by the Department of Agriculture & Co-operation under the Ministry of Agriculture and Farmers' Welfare. It is being implemented through the Department of Agriculture of all the State and Union Territory Governments.

2.2 Status of Soil Health Card Scheme

SHC Scheme is being implemented in the country over a two-period Cycles. Cycle-I covers the period from 2015-16 to 2016-17, whereas, Cycle-II represents the period from 2017-18 to 2018-19. The state-wise status and progress of SHC Scheme implemented in Cycle I and Cycle II as on 13th March 2018 are presented in Tables 2.1 and 2.2, respectively.

It is observed from Table 2.1 that the achievement of targets set under Cycle I in terms of soil sample collection, soil samples tested, SHCs printing and distribution have been met cent per cent by almost all the states by March 2018, excepting Punjab, West Bengal and Assam, which otherwise would have been met before March 2017. The progress of soil sample testing is very much slow in the case of Punjab (<60%), whereas, West Bengal and Assam have failed in printing and distributing the SHCs. These delays in Punjab, West Bengal and Assam may be attributed to a poor implementation of the scheme, specifically due to lack of infrastructure and staff in the soil testing laboratories. However, they have to make concerted efforts to achieve their set targets at the earliest without hampering the progress of Cycle II, which is already in progress since 2017-18 across all states.

Table 2.1: State-wise Status of Soil Health Card Scheme in Cycle-I as on 13.03.2018

Group - I					
1	Uttar Pradesh	100.00	100.00	98.04	100.00
2	**Maharashtra**	**100.00**	**100.00**	**100.00**	**100.00**
3	**Madhya Pradesh**	**100.00**	**100.00**	**100.00**	**100.00**
4	Rajasthan	100.00	100.00	100.00	100.00
Group - II					
1	**Karnataka**	**100.00**	**100.00**	**100.00**	**100.00**
2	Gujarat	100.00	100.00	100.00	100.00
3	Andhra Pradesh	100.00	100.00	100.00	100.00
4	**Bihar**	**100.00**	**100.00**	**100.00**	**100.00**
5	West Bengal	100.00	100.00	100.00	82.11
6	Tamil Nadu	100.00	100.00	100.00	100.00
7	Telangana	100.00	100.00	100.00	100.00
Group - III					
1	**Punjab**	**100.00**	**59.12**	**90.26**	**95.66**
2	Haryana	100.00	100.00	100.00	100.00
3	Chhattisgarh	100.00	100.00	100.00	100.00
4	Odisha	100.00	100.00	100.00	100.00

Group - IV					
1	Kerala	100.00	100.00	100.00	100.00
2	Goa	100.00	100.00	100.00	100.00
3	Uttarakhand	100.00	100.00	100.00	100.00
4	Himachal Pradesh	100.00	100.00	100.00	100.00
5	J & K	100.00	100.00	100.00	100.00
6	Jharkhand	100.00	100.00	100.00	100.00
7	Arunachal Pradesh	100.00	100.00	100.00	100.00
8	**Assam**	**100.00**	**100.00**	**51.16**	**87.55**
9	Manipur	100.00	100.00	100.00	100.00
10	Meghalaya	100.00	100.00	100.00	100.00
11	Mizoram	100.00	100.00	100.00	100.00
12	Nagaland	100.00	100.00	100.00	100.00
13	Sikkim	100.00	100.00	100.00	100.00
14	Tripura	100.00	100.00	100.00	100.00
Union Territories					
1	Andaman & Nicobar	100.00	100.00	100.00	100.00
2	Dadar Nagar & Haveli	100.00	100.00	100.00	100.00
3	Puducherry	100.00	100.00	100.00	100.00
	Total	**100.00**	**98.65**	**98.89**	**99.02**

At the national level, out of the target set (2.53 lakhs) during Cycle I, the achievement is found to be cent per cent in terms of sample collection, 99 per cent in respect of sample testing and printing SHCs, but the distribution is found limited to 98 per cent as on 13th March 2018.

Table 2.2 represents the progress of SHC Scheme during Cycle II. Similar to Cycle I, the progress in terms of soil sample collection is cent per cent or more in respect of states like Maharashtra, Gujarat, Tamil Nadu, Haryana, Chhattisgarh, Uttarakhand, Himachal Pradesh and Puducherry (UT) by the end of 13th March 2018. However, the soil sample collection progress is more than 90 per cent with respect to Uttar Pradesh, Madhya Pradesh, Karnataka, Andhra Pradesh, Bihar and Telangana states. Similarly, the progress of sample collection is more than 50 per cent and less than 90 per cent with regard to states such as Rajasthan, West Bengal, Punjab, Odisha, Goa, Jharkhand, Meghalaya, Tripura and Andaman & Nicobar. Unfortunately, the pace of sample collection is found to be less than 50 per cent in respect of the rest of the states. The situation is much worse when it comes to soil samples tested, SHCs printed and distributed in Cycle II. A very few states have completed soil samples testing and have been very active from the time of implementation (both cycles) of the scheme to as of now. These leading states include Maharashtra, Gujarat, Tamil Nadu, Chhattisgarh, Himachal Pradesh and Puducherry, followed by Uttar Pradesh, Madhya Pradesh, Karnataka, Andhra Pradesh, Telangana, Odisha, Uttarakhand and Jharkhand, with a soil testing proportion being more than 50 per cent in terms of soil samples collected as compared to samples tested. Many states/Union Territories such as Punjab, Kerala, Arunachal Pradesh, Sikkim and Dadar Nagar & Haveli have not yet begun soil testing in Cycle II for the samples collected, while the ratio is less than 10 per cent in the case of Sikkim and Nagaland. Consequently, the printing and distribution of SHCs is slightly better in the leading states.

Table 2.2: State-wise Status of Soil Health Card Scheme in Cycle-II as on 13.03.2018

Group - I							
1	Uttar Pradesh	2385200	92.54	75.39	11662730	4.84	4.84
2	Maharashtra	1173561	>100	>100	6488616	45.04	38.94
3	Madhya Pradesh	1156989	96.98	80.76	4436189	55.53	55.52
4	Rajasthan	1154007	58.93	41.16	3443000	37.73	30.03
Group - II							
1	Karnataka	832883	92.56	72.39	3916095	38.89	25.37
2	Gujarat	794618	>100	>100	2554462	0.00	0.00
3	Andhra Pradesh	674191	90.79	58.59	3727602	27.15	27.15
4	Bihar	654389	91.72	45.91	3618117	30.00	26.52
5	West Bengal	650175	61.52	30.45	2520255	34.16	0.00
6	Tamil Nadu	637268	>100	>100	3500000	34.88	20.08
7	Telangana	517339	94.26	81.90	2860369	20.26	14.04

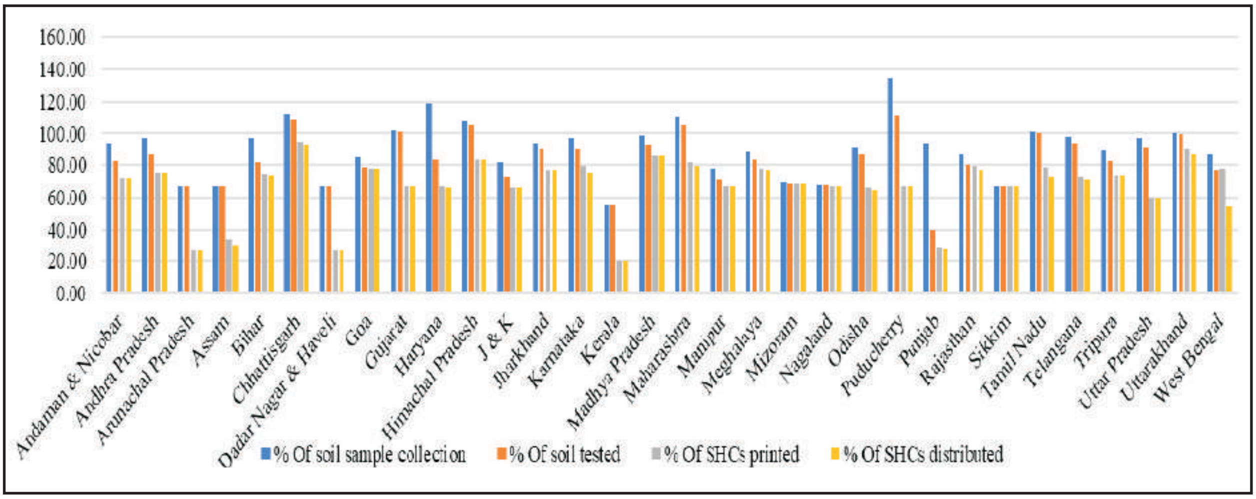
Group - III							
1	Punjab	417763	81.36	0.00	2309811	0.00	0.00
2	Haryana	394335	>100	48.60	2180278	2.35	1.26
3	Chhattisgarh	351846	>100	>100	1945355	84.35	80.45
4	Odisha	334318	75.28	58.55	1848441	22.80	19.58
Group - IV							
1	Kerala	103392	0.00	0.00	2852208	0.00	0.00
2	Goa	12500	54.06	35.62	12500	33.78	33.78
3	Uttarakhand	67869	>100	97.51	375247	71.73	61.99
4	Himachal Pradesh	50000	>100	>100	480383	69.46	69.46
5	J & K	82659	46.41	20.78	457022	15.60	15.60
6	Jharkhand	57651	82.19	73.53	318754	30.23	30.23
7	Arunachal Pradesh	10266	0.00	0.00	56762	0.00	0.00
8	Assam	139354	0.00	0.00	770484	0.00	0.00
9	Manipur	10357	34.20	14.15	57261	0.00	0.00
10	Meghalaya	19686	65.89	49.55	104781	34.27	31.99
11	Mizoram	5993	8.18	5.82	5993	5.54	5.54
12	Nagaland	16712	3.59	2.99	92399	0.00	0.00
13	Sikkim	6609	0.00	0.00	23000	0.00	0.00
14	Tripura	16368	71.29	47.62	58862	20.97	20.97
Union Territories							
1	Andaman & Nicobar	703	81.14	47.40	3900	0.00	0.00
2	Dadar Nagar & Haveli	1081	0.00	0.00	6000	0.00	0.00
3	Puducherry	1765	>100	>100	9797	0.00	0.00
	Total	**12731841**	**93.06**	**70.47**	**62696665**	**26.27**	**21.37**

Overall, all India progress of SHC scheme during Cycle II in terms of soil samples collected is found to be 93 per cent, while the proportion being 70 per cent with respect to soil samples tested. However, the distribution of SHCs, to farmers amounts to just 20 to 26 per cent as on 13th March 2018.

For a better understanding of the status of SHC scheme implementation, a bar diagram is shown in Figure 2.1. The figure clearly depicts a downward trend in terms of samples collected, samples tested, SHCs printed and distributed across all the states. The blue bar (% of soil samples collected) is much higher for majority of states, followed by red bar (% of soil samples tested), ash bar (% SHCs printed) and yellow bar (% SHCs disturbed) across all the states. From the secondary data, it is very clear that SHCs were not at all distributed-on time to the farming community even as this delayed distribution of SHCs fails to be accounted for. Although, the targets had been set in consultation with the state representatives, the states were unable to execute the program as expected and hence, a poor achievement.

In the present context of land degradation and declining agricultural productivity, such kind of programs are very much essential and hence, concerted efforts should be made by all the states towards addressing the loose ends in the implementation of the programme. As is evident from the guidelines of the programme, it has already covered all the dimensions of its implementation, however, the states haven't realized the same.

Figure 2.1 : Status of SHC Scheme as on 12-03-2018- % of Samples collected, Tested, SHC Printed and Distribued



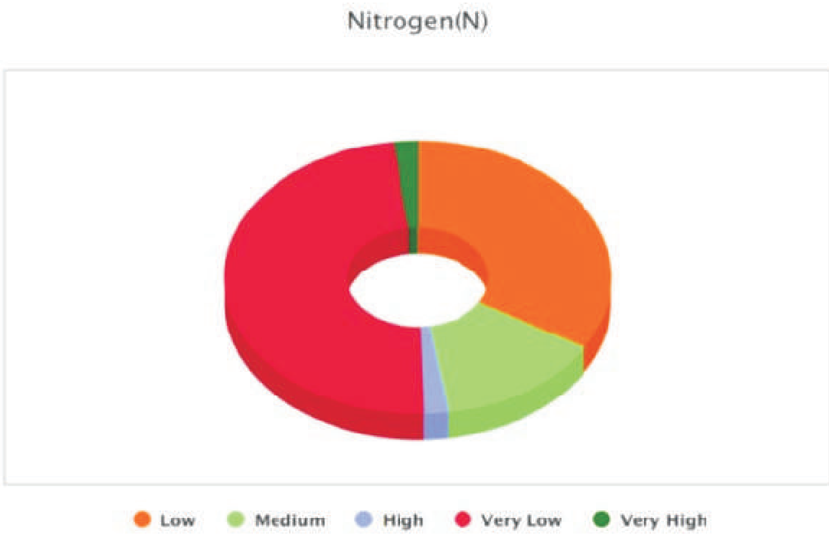
The focus of the SHCs should be on making it as a habit among the farming community in following soil testing as a tool for application of fertilizers to crops (as per their physiological requirements /recommended doses) and what is more important is that they should continue the same even after the scheme is over. Soil testing should be done at least once in three years as per the University of Agricultural Sciences, along with the scientific advisory in soil health management.

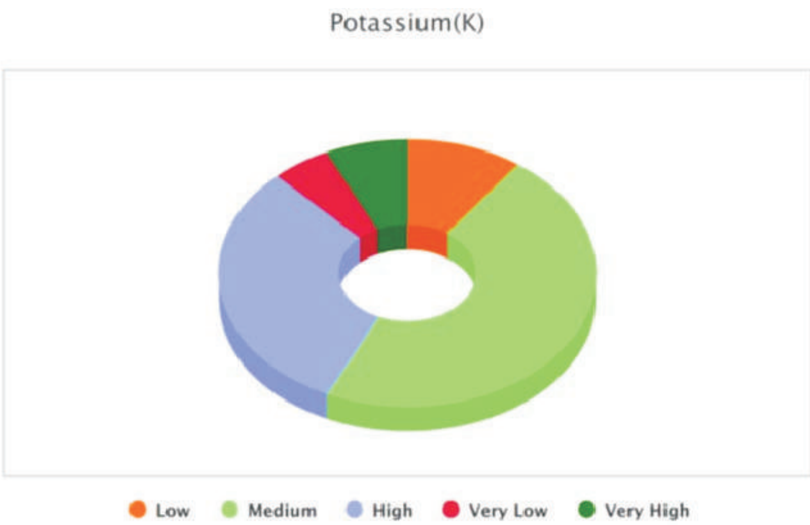
2.3 Nutrient Status of Indian Soil Systems based on the SHC Scheme

One of the objectives of the SHC Scheme is to develop and promote a soil-test based nutrient management in the farmer's fields for enhancing nutrient use efficiency. It is also envisaged to promote a balanced and judicious use of plant nutrients through this programme. From among the samples tested, an overview of the status of N, P and K nutrients, pH and micro-nutrients across Indian soil systems is presented in Figures 2.2 and 2.3.

The fertility status of Indian soils in terms of N, P and K nutrients, based on the samples collected under the SHC scheme, is presented in Figure 2.2. It is evident from the figure that Indian soil systems are very low with respect to N, medium with regard to P and K at the aggregate. However, the variations in the nutrient status may be subject to changes in the type of soils, Agro Economic Zones, climatic factors, soil health management practices followed, cropping pattern, irrigation availability etc.

Figure 2.2: All India SHC based Status of N, P and K Nutrients





Phosphorus(P)

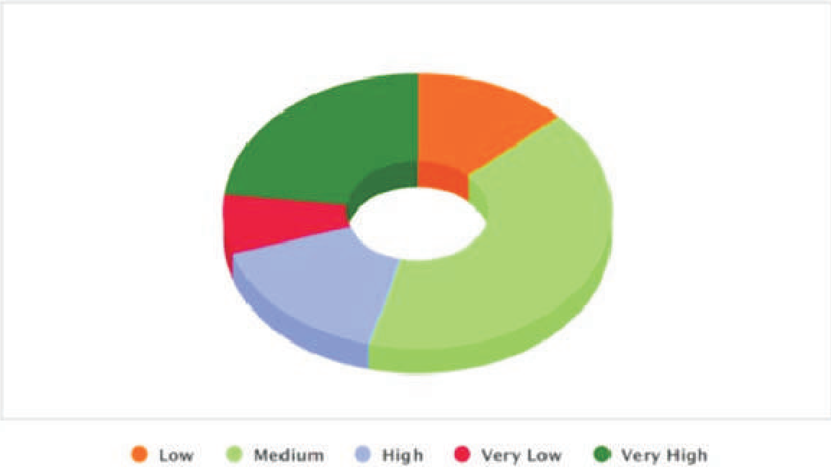
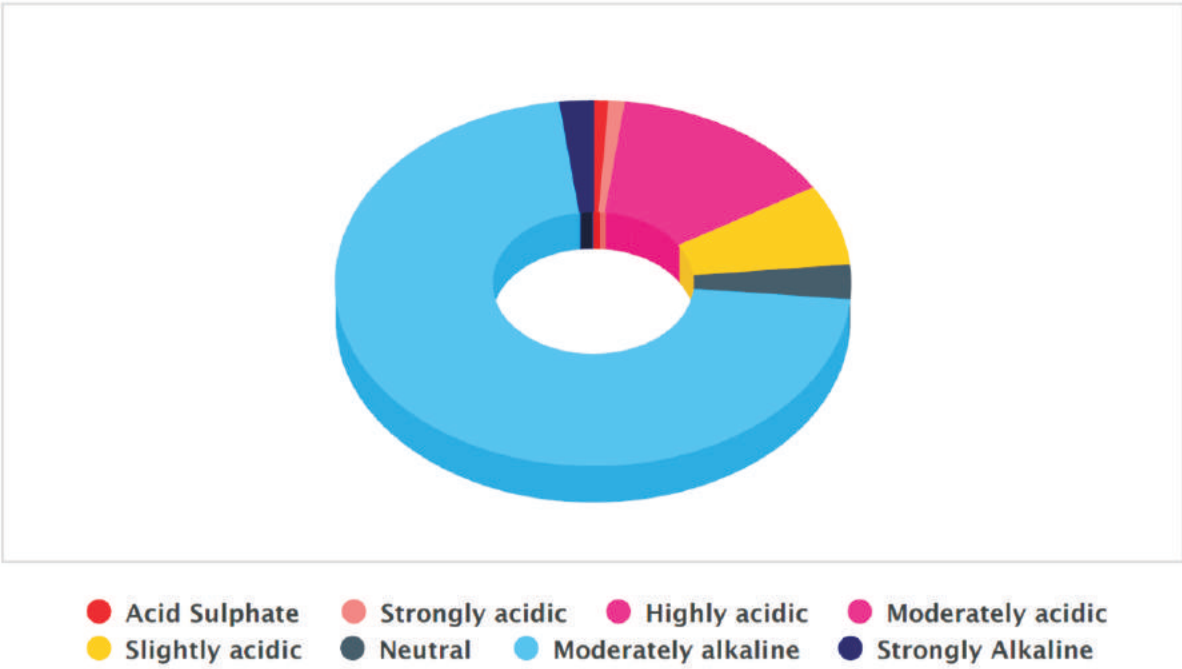
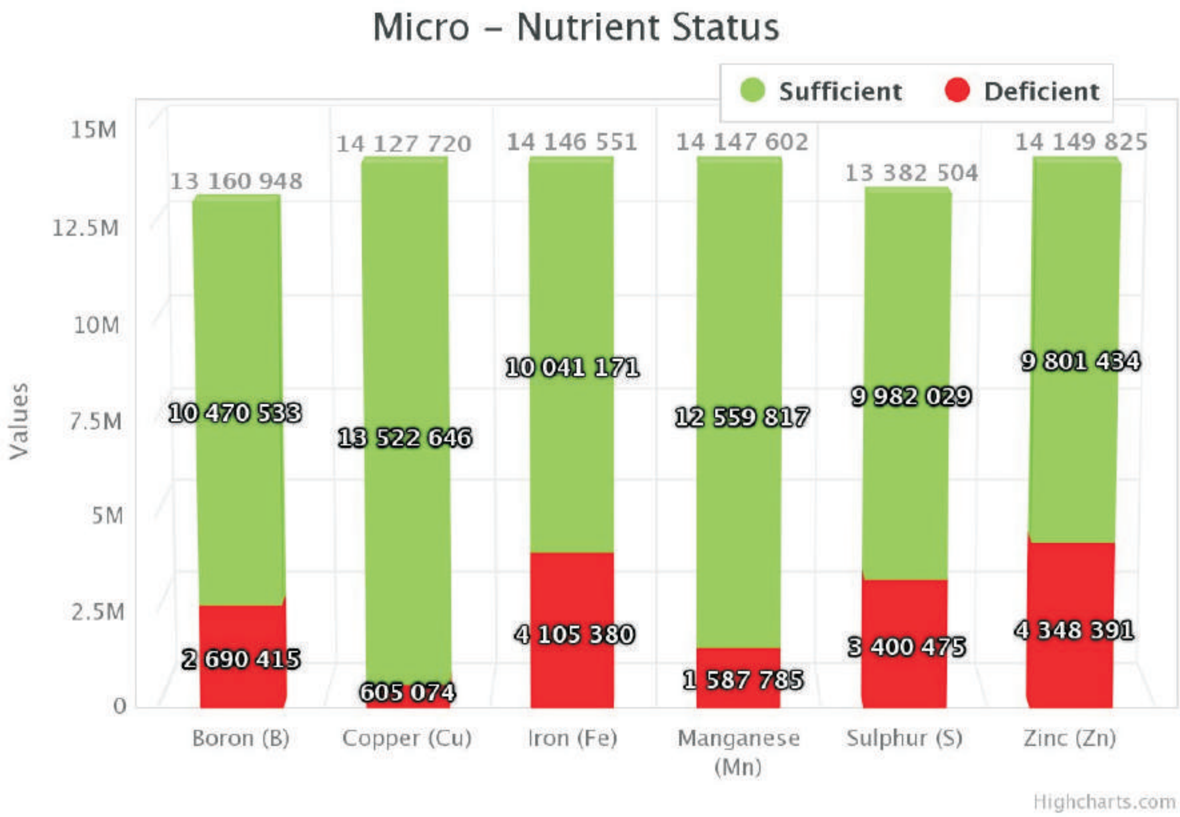


Figure 2.3: All India SHC based Status of pH of the Indian Soil-Systems



Soil pH is a measure of the acidity or basicity of a soil. Based on the samples collected across states, a high proportion of the Indian soils is moderately alkaline in nature (Figure 2.3). Alkalinity in soil occurs when there is insufficient water flowing through the soils to leach soluble salts. This may be due to arid conditions, or poor internal soil drainage; in these situations, most of the water that enters the soil is transpired (taken up by plants) or evaporates, rather than flowing through the soil. Hence, there is a need for the farming community to balance their soil pH within the optimal range of 5.5 to 7 for a better absorption of nutrients to enhance productivity. Very interestingly, the status of micro-nutrients (Figure 2.4) is found to be sufficient in respect of almost all major micro-nutrients such as boron, copper, iron, manganese, Sulphur and zinc.

Figure 2.4: All India SHC based Status of Micro-Nutrients



CHAPTER III

GENERAL CHARACTERISTICS OF THE SAMPLE HOUSEHOLDS

To understand the socio-economic status of the sample farmers, the information relating to age, family size, its composition, literacy status, caste, land use pattern, operational holdings, cropping pattern, sources of irrigation and income from production has been collected, analyzed and discussed in detail in this chapter. These characteristics of the respondents play an important role in the process of adoption of any technology in the agricultural sector.

3.1. General characteristics of the sample households

The general characteristics of the soil-tested farmers and control farmers are shown in Table 3.1. It is evident from the table that the overall age of soil-tested farmers is 47 years with seven years of schooling and about 97 per cent of them following agriculture as their main occupation. A majority (94%) of them are male respondents with 25 years of farming experience. The average family size comprises six members, out of which two are engaged in farming. With regard to social class, a majority of soil-tested farmers belong to Other Backward Classes (OBCs 47%), followed by general category (45%) and the rest constitute SC & STs.

Across states, excepting educational levels, all other characteristics such as age, major occupation, agricultural experience and proportion of gender remain relatively the same. However, the average educational attainment of the Karnataka and Assam respondents is limited to primary school, whereas, others have studied up to high school level. With regard to the family size, the average is slightly higher in the case of Karnataka, Punjab and Madhya Pradesh, while lower in respect of Assam and Bihar. Interestingly, the average number of family members engaged in agriculture is restricted to one only in the case of Punjab, but it is three in Karnataka, Maharashtra, Madhya Pradesh and Assam. Regarding social classes, a majority of the respondents belong to the general category in Madhya Pradesh, Karnataka and Punjab, while it is OBC in Assam and Bihar. SC and ST proportion remains low in almost all the states.

As regards control farmers, the average age of the respondents is 46 years with 5 years of schooling. However, the age varies within 45 to 48 years across the sample states, with Punjab and Maharashtra farmers having studied up to high school level, while the educational level is up to primary school in states such as Bihar, Madhya Pradesh, Assam and Karnataka. A majority of these respondents constitute males (>95%) and follow agriculture as their main occupation across all states. The average family size works out to

Table 3.1: General characteristics of soil-tested and control farmers

Particulars		Karnataka		Punjab		M.H.		M.P.		Assam		Bihar		Overall	
		ST	Control	ST	Control	ST	Control	ST	Control	ST	Control	ST	Control	ST	Control
Average age of respondents		53	47	44	45	48	46	47	48	49	47	41	46	47	46
Average years of respondent education		3	3	9	8	10	8	7	4	4	4	7	6	7	5.5
Agriculture as a major occupation (% of respondents)		100.00	100.00	100.00	100.00	100.00	100.00	97.00	93.00	83.00	85.00	100.00	100.00	96.66	96.33
Gender (% of respondents)	Male	88.33	95.00	100.00	100.00	95.00	100.00	100.00	100.00	90.00	100.00	91.67	98.33	94.16	98.88
	Female	11.67	5.00	-	-	5.00	-	-	-	10.00	-	8.33	1.67	5.84	1.12
Average family size		7	6	7	6	6	7	7	7	5	5	5	5	6	6
Average number of people engaged in farming		3	3	1	1	3	3	3	4	3	3	2	2	2	3
Average years of experience in farming		29	27	23	23	25	25	28	26	29	27	18	20	25	25
Caste (% of respondents)	SC	8.33	6.67	2.00	-	13.3	5.00	-	3.00	1.67	6.67	6.67	6.67	5.32	4.66
	ST	11.67	5.00	-	-	0.00	0.00	-	-	-	-	1.67	-	2.24	0.83
	OBC	20.00	30.00	41.00	35.00	3.30	5.00	80.00	70.00	71.67	71.67	68.33	78.33	47.38	48.33
	General	60.00	58.33	57.00	65	83.4	90.00	20.00	27.00	26.67	21.67	23.33	15.00	45.06	46.18

Note: ST – Soil-tested farmers & Control – Control farmers be six members with half of them being engaged in farming only. More interestingly, similar to soil-tested farmers, only one person in the family is engaged in agriculture in the state of Punjab, whereas it is four in the case of Madhya Pradesh with 25 years of farming experience, on an average. As for the social status of these respondents, a majority of them belong to the category of either OBC or General with an almost equal proportion (46-48%). However, SCs constitute five percent only, while the STs are very, few in number. Across states, a majority of OBCs are found in Bihar (78%), Assam (72%) and Madhya Pradesh (70%) in contrast to General categories in Maharashtra (90%), Punjab (65%) and Karnataka (58%).

3.2 Operational landholdings

3.2. Operational landholdings of soil-tested and control farmers

The details of operational landholdings of the soil-tested and control farmers are shown in Table 3.2. A perusal of the table reveals that the overall net operated land in the study area works out 6.6 acres with reference to the soil-tested farmers. However, there exist wide variations in the landholdings across states and sample farmers. The net operational landholding is as high as 13.55 acres in the state of Punjab, whereas it is almost half of it in Karnataka (7.20 acres), followed by Maharashtra (6.20 acres) and Madhya Pradesh (6.03 acres). Contrastingly, the landholding is less than the overall average for Assam (2.84 acres) and Bihar (3.81 acres). On an average, the leased in land constitutes 1.37 acres and is highest (4.80 acres) in respect of Punjab, while the rest of the places account for less than 2 acres. On the other hand, leased-out land is observed to be less than an acre/household. Of the net operated land, a major proportion (59%) falls under the category of irrigated condition and rest is rainfed (40%). At the aggregate, the average rental value for leased-in land works out to almost Rs. 18000/ acre in respect of irrigated condition, while Rs. 6000/acre for rain fed condition. As usual, the rental values of land are observed highest in Punjab (Rs. 40731/ acre) alone which might be due to an assured irrigation.

Coming to control farmers, the overall net operated land at the aggregate works out to around six acres in the study area. Similar to the soil-tested farmers, there seem to be wider variations in the landholding size across states with the highest net operated land found in the state of Punjab (11.55 acres), followed by Karnataka (7.35 acres), Madhya Pradesh (5.55 acres) and Maharashtra (5.20 acres), while lowest in Assam (2.74 acres) and Bihar (3.47 acres). Relatively, the land-leasing is similar to that of soil-tested farmers in the case of control farmers. Out of the total operated area, nearly 59 per cent is irrigated and the rest un-irrigated. At the aggregate, the average rental value for leased-in land is highest with regard to Punjab (Rs. 39, 362/- acre) and lowest in Bihar (Rs. 2964/- per acre) in respect of irrigated land, while it is less than six thousand rupees per acre for un-irrigated land.

Table 3.2: Operational landholdings of soil-tested and control farmers

Particulars		Karnataka		Punjab		M.H.		M.P.		Assam		Bihar		Overall	
		ST	Control	ST	Control	ST	Control	ST	Control	ST	Control	ST	Control	ST	Control
Avg Owned land (acres)		7.08	6.00	8.75	8.23	7.10	5.40	5.68	4.72	2.82	2.55	3.02	2.74	5.74	4.94
Avg Leased in (acres)		1.65	2.44	4.80	4.01	0.00	0.20	0.35	0.83	0.42	0.34	1.04	0.91	1.37	1.45
Avg Leased out (acres)		1.35	1.09	-	0.69	0.00	0.00	-	-	0.25	0.10	0.15	0.13	0.3	0.33
Avg Uncultivated land (acres)		0.18	-	-	-	0.80	0.40	-	-	0.15	0.05	0.10	0.05	0.20	0.08
Total irrigated land (%)		19.46	24.05	100.00	100.00	53.23	53.85	92.20	91.71	12.38	4.74	79	80.11	59.38	59.07
Total un-irrigated land (%)		80.54	75.95	-	-	46.77	46.15	7.80	8.29	87.62	95.26	21	19.89	40.62	40.93
Net operated land (acres)		7.20	7.35	13.55	11.55	6.20	5.20	6.03	5.55	2.84	2.74	3.81	3.47	6.60	5.98
Avg Rental value of leased in land (Rs/acre)	Irrigated	-	6000	40731	39362	-	-	9375	10333	-	-	3672	2694	17926	14597
	Un-irrigated	4500	5625	-	-	-	4560	-	-	7743	7340	-	-	6122	5842
Avg Rental value of leased out land (Rs/acre)	Irrigated	-	-	-	40000	-	-	-	-	-	-	2751	2500	2751	21250
	Un-irrigated	-	-	-	-	-	-	-	-	8167	7188	-	-	8167	7188

Note: ST – Soil-tested farmers & Control – Control farmers

3.3. Sources of irrigation

The details of sources of irrigation for the soil-tested and control farmers are shown in Table 3.3. Irrigation is considered as one of the foremost inputs in agriculture. Crop failures in many parts of India occur due to lack of sufficient irrigation water. Hence, an attempt was made through this study to collect information related to various sources of irrigation in the study area.

It is clearly noticed from Table 3.3 that bore-wells form the major source of irrigation for both soil-tested (52% of GCA) and control farmers (46% of GCA) in the overall sample area, followed by dug wells (23% of GCA in respect of soil-tested farmers and 15% of GCA in the case of control farmers) and canal (around 16% of GCA in both the cases). Tank irrigation accounts for a very negligible proportion of the GCA. However, a combination of different sources of irrigation accounts for 18 to 20 per cent of the GCA, which is represented under other sources of irrigation.

Table 3.3: Sources of irrigation for soil-tested farmers (%GCA)

Particulars	Karnataka	Punjab	M.H.	M.P.	Assam	Bihar	Overall
Soil-tested farmers							
Dug well	26.66	-	21.67	20.00	-	19.34	23.33
Bore well	70.00	100.00	66.67	60.00	-	13.33	52.33
Canal	-	-	-	13.33	-	67.33	16.66
Tank	3.33	-	3.33	6.67	-	-	2.22
Others *	-	-	8.31	-	100.00	-	18.05
Control farmers							
Dug well	10.00	-	25.00	70.00	-	11.07	15.44
Bore well	90.00	100.00	43.00	23.30	-	15.00	46.33
Canal	-	-	-	6.70	-	74.00	16.11
Tank	-	-	12.30	-	-	-	2.21
Others *	-	-	20.00	-	100.00	-	20.00

Others* - represents a combination of different sources of irrigations

Across sample states, the irrigation sources are found to be different. Among soil-tested farmers, the aggregate values in respect of irrigation sources match with those in states such as Karnataka, Maharashtra and Madhya Pradesh wherein bore-wells account for a substantial proportion of the GCA (>60%), whereas, with regard to Punjab, cent per cent of the GCA is irrigated by bore wells alone. However, in respect of Bihar, a very large proportion of GCA (67%) is covered by canal irrigation, followed by dug wells (19%) and bore-wells (13%). The irrigation situation is relatively the same when it comes to control farmers across states with a slight variation in proportions.

3.4. Cropping pattern

Cropping patterns being followed by the soil-tested and control farmers in the study area (for kharif 2015) are shown in Table 3.4. It is observed from the table that both the soil-tested and control farmers have grown crops like paddy, maize, tur, jowar, soybean, vegetables and other crops (which include pulses and vegetables) in the study area with their proportions being relatively the same in respect of both the cases. In fact, a majority of them have grown paddy as their major crop, which accounts for 47 to 48 per cent of the GCA in the case of both soil-tested and control farmers. Similarly, soybean is found to be the second major crop in terms its GCA to the extent of 20 per cent and 17 per cent, respectively, with regard to soil-tested and control farmers, followed by other crops (15% and 16% of the GCA), tur (7% of the GCA in both the cases), jowar (5% and 7% of the GCA), maize and vegetables (2-3% of the GCA).

Across sample states and farmers (both soil-tested and control), paddy crop constitutes the major crop in Punjab (80-82% of the GCA), Assam (83-90% of the GCA) and Bihar (93-94% of the GCA), whereas, soybean constitutes the major crop in the case of Maharashtra (54-59% of the GCA) and Madhya Pradesh (46-61% of the GCA). With reference to Karnataka, others (crops) constitute a major proportion of GCA, followed by tur (31-33%), jowar (15-24%) and maize (7-13%) in Karnataka (39 per cent of the GCA). Vegetables (11-18% of GCA) form the other alternative crop in respect of Assam, while others (6-7% of GCA) form the next alternative crops in Bihar. In Karnataka and Maharashtra, Jowar is the crop grown among the sample states over an area that makes up around 15-24 per cent of GCA. Although crops grown remain the same across sample states, the importance given to the cultivation of particular crops shows a slight variation depending upon their food habits and irrigation availability across different agro-climatic zones of the sample areas selected for the study.

Table 3.4: Cropping pattern followed by soil-tested farmers (% GCA)

Sample	Crops Farmers	States						
		Karnataka	Punjab	M.H.	M.P.	Assam	Bihar	Overall
Soil - tested farmers	Paddy	-	82.11	-	24.71	82.94	94.02	47.29
	Maize	12.58	2.77	-	2.51	-	-	2.97
	Tur	33.49	-	7.9	0.16	-	-	6.92
	Jowar	14.69	-	16.5	-	-	-	5.19
	Soybean	-	-	59.2	61.08	-	-	20.04
	vegetables	-	0.15	-	-	17.56	-	2.95
	others	39.24	14.97	16.4	11.54	-	5.98	14.68
Control farmers	Paddy	-	79.62	-	25.25	89.34	93.39	47.93
	Maize	7.54	2.16	-	4.38	-	-	2.34
	Tur	31.47	-	12.9	0.67	-	-	7.5
	Jowar	23.97	-	19.6	-	-	-	7.26
	Soybean	-	-	54.4	46.13	-	-	16.75
	vegetables	-	-	-	-	10.66	-	1.77
	Others	37.02	18.22	13.1	23.57	-	6.61	16.42

3.5. Gross income from agricultural production

The gross income realized from agricultural production by the soil-tested and control farmers during kharif 2015 across sample states is presented in Table 3.5. A perusal of the table reveals that the overall control farmers have sold an average of 33 quintals of agricultural produce at the price of Rs. 1432/ quintal, which, amounts to a gross income of Rs. 47336 per season (kharif 2015). Correspondingly, soil-tested farmers have sold 41 quintals of agricultural produce at a unit price of Rs. 1429/-, amounts to a gross income of Rs. 59105/- per season. It is interesting to note that the soil-tested farmers have achieved a better return as compared to control farmers, which might be due to the adoption of soil-testing technology and follow-up of RDF.

Across sample states, the gross income obtained by both the soil-tested and control farmers consecutively is found to be highest in the case of Punjab (3.24lakh and Rs. 2.92 lakhs), followed by Bihar (64.43 thousand and Rs. 61.09 thousand), Karnataka (61.68 thousand and Rs. 56.60 thousand), Maharashtra (Rs. 35.28 thousand and Rs. 28.50

thousand) and Madhya Pradesh (Rs. 15.46 thousand and Rs. 30.20 thousand). The gross income realized by Assam farmers happens to be the least income from agriculture among sample farmers, in the range of 9.92 thousand to Rs. 10.50 thousand per season. Interestingly, the income earned by the soil-tested farmers is relatively better than the control farmers across all sample states. The details of the gross income from agriculture for the sample states are provided in the Appendices section (Appendix I to Appendix VI).

Table 3.5: Gross income realized by the sample households from agricultural production during kharif 2015

States	Control farmers			Soil-tested farmers		
	Avg. qty sold (Qtls)	Avg. price (Rs/Qtl)	Gross income obtained	Avg. qty sold (Qtls) (Rs)	Avg. price (Rs/Qtl)	Gross income obtained
Assam	8.18	1213	9923	8.66	1209	10471
Bihar	56.91	1074	61093	60.35	1068	64434
Karnataka	25.24	2242	56600	25.45	2423	61680
Maharashtra	8.25	3469	28621	9.88	3569	35289
Madhya Pradesh	8.08	1913	15459	13.73	2200	30204
Punjab	210.20	1391	292437	241.0	1343	323818
Overall	33.06	1432	47336	41.36	1429	59105

CHAPTER IV

AWARENESS OF SOIL HEALTH CARD SCHEME

While understanding the status of any programme/ technology, it is a pre-requisite to understand the level of awareness among the sample households regarding the technology/ programme. This Chapter focuses on the awareness level of soil-tested farmers regarding soil-test technology, sources of information, training programs attended by the respondent farmers related to the application of chemical fertilizers, method of application of fertilizers, details of soil sampling and source(s) of fertilizer purchase.

4.1. Awareness on soil testing

The details of awareness regarding soil-testing among the soil-tested and control farmers in the study area are presented in Table 4.1. It is noticed from the table that a majority (98%) of the overall soil-tested farmers are aware of soil health card, followed by knowledge about the ongoing programmes under soil health mission (57%) and imbalanced application of fertilizers and their effects (48%). However, a smaller proportion of around 32 and 29 per cent are also aware of INM and a reduction in the consumption of chemical fertilizers due to INM, respectively. However, only 10 per cent of them are aware of the grid system followed for the selection of soil samples under SHC scheme. Across sample states, relatively a majority of the soil-tested farmers are aware of soil health card in all the states, while more than 58 per cent of the soil-tested farmers across all the sample states, excepting Assam, do have knowledge about the ongoing programmes under soil health mission. Whereas in the case of Assam, cent per cent of the soil-tested farmers are aware of the Soil Health Cards, but are ignorant about any aspect of soil testing and INM. Similarly, more than 55 per cent of the soil-tested farmers in the case of Punjab, Maharashtra, Madhya Pradesh and Bihar are in the know of an imbalanced application of fertilizers and their adverse effects. However, the knowledge about INM is to be seen only in the case of half of the Punjab and Maharashtra soil-tested farmers, while less than half of the farmers have experienced a reduction in the consumption of chemical fertilizers due to INM in almost all the sample states. Regrettably, a maximum of 20 per cent of the soil-tested farmers in Maharashtra and a minimum of four per cent of farmers in Madhya Pradesh are aware of the grid system under the SHC scheme. This shows that there is a need for creating awareness regarding the procedure of sample selection and soil testing under the SHC scheme, which is creating a rift among farming community.

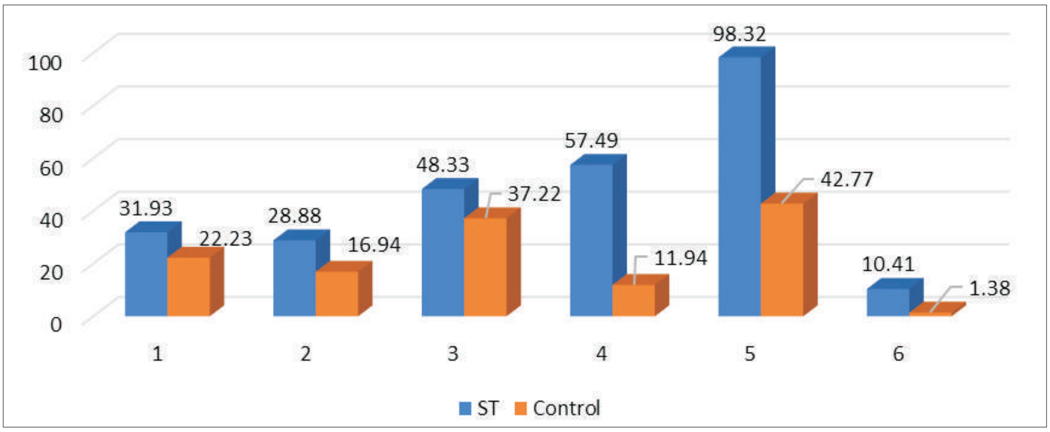
With regard to control farmers, less than half of the overall farmers are aware of soil health card (43%), followed by imbalanced application of fertilizers and its effects (37%), INM (22%), reduction in the consumption of chemical fertilizers due to INM (17%), ongoing programmes under Soil Health Mission (12%) and the grid system followed under the SHC Scheme for soil sample collection (1%). In other words, a majority of the control farmers are unaware of soil health management and the related ongoing government schemes. Across the sample states, the situation is slightly better in the case of Bihar, Assam and Punjab, where, according to a majority of the control farmers, they are aware of soil health card (>53%) and the adverse effects of an imbalanced application of fertilizers (>47%). The awareness level is very low (5%) among the control farmers of Karnataka regarding all aspects of soil health management. Similarly, the awareness level is less than 20 per cent among Madhya Pradesh and Maharashtra farmers especially concerning INM and an imbalanced application of fertilizers and their adverse effects. It is very important to note that a negligible proportion of the farmers is aware about the grid system of soil sample selection followed under the SHC scheme, which reiterates that there is a necessity of awareness component in the SHC scheme and that the implementation authorities need to pay much attention to the same so as to make the programme successful. Awareness creation can be more effective through frequent demonstrations of the soil-test technology at the grassroots level.

Table 4.1: Awareness regarding soil testing among soil-tested and control farmers (% of farmers)

Particulars	Karnataka		Punjab		M.H.		M.P.		Assam		Bihar		Overall	
	ST	Control	ST	Control	ST	Control	ST	Control	ST	Control	ST	Control	ST	Control
Households knowing about INM	28.33	5.00	51.67	46.67	55.00	16.70	23.30	23.30	-	-	33.33	41.67	31.93	22.23
Households experiencing a reduction in the consumption of chemical fertilizers due to INM	25.00	5.00	48.33	46.67	33.30	-	16.70	13.30	-	-	25.00	36.67	28.88	16.94
Households aware of an imbalanced application of fertilizers and their effects	21.67	5.00	80.00	46.67	55.00	15.00	70.00	20.00	-	78.33	63.33	58.33	48.33	37.22
Households knowledgeable about the ongoing programs under Soil Health Mission	58.33	5.00	68.33	-	95.00	36.67	65.00	30.00	-	-	58.33	-	57.49	11.94
Households aware of Soil Health Card	98.33	5.00	100.00	53.33	98.30	41.70	93.30	33.30	100.00	58.33	100.00	65.00	98.32	42.77
Households aware of grid system under SHC scheme	5.00	5.00	11.67	-	20.00	-	3.97	3.30	-	-	21.87	-	10.41	1.38

Note: ST – Soil-tested farmers & Control – Control farmers; Overall - represents weighted average of all states

Table 4.1: Overall awareness regarding soil testing among soil-tested and control farmers (% of farmers)



Note: 1. Knowing about INM; **2.** Experienced a reduction in the consumption of chemical fertilizers due to INM; **3.** Aware of an imbalanced application of fertilizers and their effects; **4.** Knowledge about the ongoing programs under Soil Health Mission; **5.** Aware of Soil Health Card; **6.** Aware of grid system under SHC scheme

4.2. Sources of information on soil testing

It is observed from Table 4.2 that, although there exist many sources of information available on soil testing and its related aspects, overall, a majority (57%) of the farmers are found to have got the information from the State Department of Agriculture (SDA), followed by State Agriculture Universities (SAUs) (17%) and neighbors (10%). On the contrary, a few of the farmers got information about soil testing from private companies (9%) and KVKs (4%). Interestingly, less than two per cent of the farmers also got information on soil testing from friends; in fact, this was a primary source of information related to agriculture earlier. However, across the states, State Department of Agriculture (SDA) and SAUs happens to be the major sources of information on soil testing in the case of Maharashtra, Karnataka and Bihar, as revealed by more than 86 per cent of the sample farmers. Similarly, as per more than 46 per cent of the Madhya Pradesh farmers, Agriculture Department is one of the major sources of information for them on soil testing. However, in the case of Punjab, SAUs are the major source of information, while it is the Private companies that dominate as the major source in Assam. On the contrary, a negligible number of farmers got information on soil testing from KVKs, friends and neighbors.

Table 4.2: Sources of information on soil testing (% of farmers)

Sources	Karnataka	Punjab	M.H.	M.P.	Assam	Bihar	Overall
SAUs	-	96.67	-	6.70	-	-	17.23
KVKs	10.00	-	5.00	10.00	-	-	4.56
Private companies	-	-	-	6.70	48.33	-	9.17
Agriculture department	86.67	3.33	96.70	46.30	23.33	86.67	57.16
Friends	-	-	3.3	2.30	-	-	1.93
Neighbors	3.30	-	5.00	10.10	28.34	13.33	10.01

4.3. Training programs attended in respect of the application of chemical fertilizers

Efforts were also made to collect information on various capacity building activities organized by various institutions and farmer's participation. Many farmers were silent on these questions across all the sample states, excepting Karnataka. Hence, the details of the training programmes attended on the application of chemical fertilizers with respect to Karnataka state are presented in Table 4.3. It is revealed from the state that the State Department of Agriculture (SDA), State Agricultural Universities (SAUs) and KVKs used to conduct training programmes related to the various aspects of agriculture. It is found that a very negligible proportion of the farmers attended training programmes related to the application of chemical fertilizers, while about 21 per cent of the soil-tested farmers and 15 per cent of the control farmers had attended the trainings for an average duration of one day.

Table 4.3: Training programs attended on the application of chemical fertilizers

Particulars	Soil-tested farmers	Control farmers
% of farmers attended	20.75	15.44
Average number of days	1	1

4.4. Method of application of fertilizers followed by the soil-tested farmers

The details of application method of fertilizers followed by soil-tested farmers in the study area are presented in Table 4.4. As, the table reveals, overall, a majority of the farmers had applied Urea (95%), DAP (75%), SSP (67%), Potash (55%) and complex fertilizers (28%) using broadcasting method, while, 35 per cent and 17 per cent of the farmers had applied micro nutrients and other fertilizers, following spraying and drilling method, respectively. Similarly, across the sample states, a majority of the farmers had applied Urea, DAP, SSP, Potash, complex fertilizers, micro nutrients and other fertilizers, adopting broadcasting method. In contrast, a majority of the farmers in Maharashtra had applied Potash, micro nutrients and DAP by fertigation, spraying and drilling methods, respectively. Interestingly, about 90 per cent of the Assam farmers had applied micro-nutrients, using spraying method. However, a negligible proportion of the farmers also had applied fertilizers following by spraying, fertigation and drilling methods. It was also noticed during the study that a majority of the farmers had used drilling method for fertilizer application in the case of closely spaced row planted crops.

4.5. Details of soil sampling

The details of soil testing by soil-tested farmers under the SHC scheme are shown in Table 4.5. It is evident from the table that overall, although the soil health card scheme costs nothing for the farming community on an average, farmers have been incurring a cost of Rs.51/ with sample the average distance from the field to soil-testing laboratory being 21 kms. The cost incurred by farmers is mainly on transport for getting SHCs from the soil-testing laboratories. On an average, three samples were collected from two plots over an area of around four acres for soil testing under the SHC scheme. However, across the sample states, a high cost of soil-testing (Rs.250/ sample.) was seen in the case of Karnataka, whereas, a longer distance from the field to soil-testing laboratories was observed in Madhya Pradesh (27 Kms), followed by Madhya Pradesh and Assam (25 kms each). Similarly, the average number of samples collected and area covered under soil-testing were higher in Bihar (6) and Maharashtra (7 acres), respectively. Interestingly, the average no. of plots considered for soil-testing was relatively the same in all states (2-3).

Table 4.4: Method of application of fertilizers by the soil-tested farmers (%)

States	Method of fertilizer application	Urea	DAP	SSP	Potash	Micro nutrients	Complex fertilizers	Other fertilizers
Karnataka	Broadcasting	80.00	11.67	-	1.67	3.33	28.33	-
	Spraying	-	-	-	-	1.67	3.33	-
	Fertigation	-	-	-	-	-	1.67	-
	Drilling	21.67	45.00	-	-	5.00	25.00	-
Punjab	Broadcasting	100	100	5.00	28.33	60.00	-	-
	Spraying	-	-	-	-	16.67	-	-
	Fertigation	-	-	-	-	-	-	-
	Drilling	-	-	-	-	-	-	-
M.H.	Broadcasting	93.50	37.00	100	-	-	37.00	-
	Spraying	1.60	3.70	-	-	100	13.00	-
	Fertigation	1.60	-	-	100	-	4.30	-
	Drilling	3.20	59.60	-	-	-	46.00	100
M.P.	Broadcasting	100	100	100	100	-	100	10.00
	Spraying	20.00	-	-	-	-	-	-
	Fertigation	-	-	-	-	-	-	-
	Drilling	-	-	-	-	-	-	-
Assam	Broadcasting	100	100	100	100	-	-	-
	Spraying	-	-	-	-	90.29	-	-
	Fertigation	-	-	-	-	-	-	-
	Drilling	-	-	-	-	9.71	-	-
Bihar	Broadcasting	100	100	100	100	100	-	-
	Spraying	-	-	-	-	-	-	-
	Fertigation	-	-	-	-	-	-	-
	Drilling	-	-	-	-	-	-	-
Overall	Broadcasting	95.58	74.77	67.50	55.00	27.21	27.55	1.66
	Spraying	3.60	0.62	-	-	34.77	2.72	-
	Fertigation	0.26	-	-	16.66	-	1.00	-
	Drilling	4.14	17.43	-	-	2.45	11.83	16.66

Table 4.5: Details of soil sampling

Sl no.	Particulars	Karnataka	Punjab	M.H.	M.P.	Assam	Bihar	Overall
1	Average cost of soil testing (Rs/sample)	250.00	20.00	-	35.00	-	-	50.83
2	Average distance from filed to soil testing lab (kms)	16.24	18.80	25.50	27.00	25.35	14.57	21.25
3	Average samples taken for soil testing	4	2	3	2	-	6	3
4	Average no. of plots considered for soil testing	3	2	3	3	-	3	2
5	Average area covered under soil testing	3.80	5.83	6.70	5	-	1.56	3.81

4.6. Sources of fertilizer purchase for soil-tested farmers

The sources of fertilizer purchase among soil-tested farmers in the study area are shown in Table 4.6. It is noticed from the table that, overall, a majority of the soil-tested farmers had purchased Urea (64%), DAP (59%), SSP (33%), potash (43%) and micro nutrients (43%) from private fertilizer shops/ dealers, respectively, while, complex fertilizers (21%) and bio-fertilizers (10%) were purchased from Co-operative societies, respectively. Across sample states, a majority of the soil-tested farmers had purchased Urea from private fertilizer shops/ dealers, excepting Punjab (90%) and Madhya Pradesh (57%), where a majority of the farmers had purchased fertilizers from Co-operative societies. Whereas, DAP, Potash and complex fertilizers were purchased from both private fertilizer shops/ dealers and Co-operative societies in all the states. Interestingly, SSP was purchased from only private fertilizer shops/ dealers by a majority of the farmers in all the states. In contrast, micro nutrients (58%) and bio fertilizers (50%) were purchased from government agencies in Karnataka and Madhya Pradesh, respectively, due to subsidized prices. It is concluded that a majority of the farmers depended upon private dealers for the purchase of fertilizers on credit basis; unfortunately, they were to return this amount after-the harvest with a mammoth interest.

4.7. Sources of soil sample collection

The sample collection is very important before the process of soil-testing begins, as the indicators of soil sample represent the characteristics of the soil, on the basis of which fertilizer use recommendations are made for a particular crop. There is a scientific way of collecting soil samples. To educate the farming community on soil sample collection, various institutions have been conducting demonstrations, training programmes and awareness campaigns across the states. Therefore, it was felt necessary to understand the various sources available to the farmers in the study area and accordingly, the sources collected are presented in Table 4.7.

It is noticed from Table 4.7 that overall, farmer facilitators were the major source for soil

Table 4.6: Sources for fertilizer purchase among soil-tested farmers (% of farmers)

States	Sources	Urea	DAP	SSP	Potash	Complex	Micro nutrient	Bio-fertilizers
Karnataka	53.30	28.33	1.67	-	35.00	-	-	
	2	5.00	8.33	-	1.67	1.67	3.33	-
	3	38.33	38.33	1.67	5.00	6.67	-	-
	4	-	-	-	1.67	-	23.33	6.67
Punjab	1	36.67	36.67	3.33	25.00	-	58.33	-
	3	90.00	90.00	1.67	5.00	-	18.33	-
M.H.	1	61.40	66.10	63.60	50.00	43.30	-	-
	3	38.60	33.90	36.40	50.00	56.70	-	-
M.P.	1	43.30	40.00	30.00	11.80	40.00	80.00	30.00
	2	-	3.30	-	-	-	-	-
	3	56.70	56.70	70.00	88.20	60.00	-	50.00
	4	-	-	-	-	-	20.00	20.00
Assam	1	100.00	100.00	100.00	100.00	-	100.00	-
Bihar	1	87.50	80.00	-	72.50	-	22.50	16.67
	3	12.50	20.00	-	14.17	-	-	-
	4	-	-	-	-	-	-	27.50
	5	-	-	-	-	-	-	24.16
Overall	1	63.70	58.51	33.10	43.21	19.71	43.47	7.77
	2	0.83	1.93	-	0.83	0.27	0.55	-
	3	39.35	39.82	18.30	27.06	20.56	3.05	9.50
	4	-	-	-	0.83	-	7.22	7.90
	5	-	-	-	-	-	-	4.02

Note: 1. Private fertilizer shops/dealers; 2. Company authorized dealers; 3. Co-operative societies; 4. Government agency; 5. Others – includes DoA and other Departments on a subsidized basis.

sample collection (33%), followed by SDA (24%) and SAUs (9%). Interestingly, one third of the sample farmers also expressed that they themselves had collected soil samples in view of their previous experience. A less than one per cent of soil sample collection was done by KVKs. However, across the sample states, SDA (60%) was the major source for soil sample collection in Karnataka and Assam, respectively, whereas, a majority of the farmers had collected soil samples on their own in Maharashtra (73%) and Madhya Pradesh (83%). In contrast, SAUs (55%) were the major source of soil sample collection in Punjab and cent per cent of the samples were collected from farmer facilitators in Bihar.

Table 4.7: Sources of soil sample collection (% of farmers)

Particulars	Karnataka	Punjab	M.H.	M.P.	Assam	Bihar	Overall
Self	-	42.00	73.30	83.00	-	-	33.10
RSK officials	60.00	-	18.40	5.00	60.00	-	23.90
SAUs	-	55.0	-	-	-	-	9.16
KVKs	3.33	-	-	1.00	-	-	0.72
Farmer facilitator	36.37	3.00	8.30	11.00	40.00	100	33.12

CHAPTER V

USE AND ADOPTION OF RECOMMENDED DOSES OF FERTILIZERS

A balanced and timely application of chemical fertilizers is very essential, to ensure sustained productivity levels, as part of an appropriate management of the overall crop nutrients. Soil Health Card is an important agricultural tool in this regard, which provides information to the farmer on soil characteristics such as available nutrient status, soil health condition, recommended doses of fertilizers to be applied to particular crop/s and other parameters that impact crop productivity. It also helps guide the farmer/s in improving the quality of soil systems. This Chapter presents the results of the actual quantities of chemical fertilizers applied, recommended quantities of fertilizers based on soil test results, application of organic fertilizer to crops, problems encountered in the implementation of the SHC scheme and suggestions for further improvements.

5.1. Average Recommended Doses of Fertilizers (RDFs) based on soil test results (as mentioned in the SHC)

Generally, educated farmers follow the package of practices (POP) published by the State Agricultural Universities (SAUs) with respect to the application of inputs and operations to be undertaken for the cultivation of crops. POP also suggests the farmers to undertake soil testing, at least once in three years, as each farmer-field varies in terms of nutrient status and other soil parameters. However, in reality, a majority of the farmers neither follow POP nor RDFs as prescribed in the SHCs. Understanding the difficulties of farmers, the governments have come up with various programmes with a view to creating awareness regarding the technological innovations in agriculture and trying to disseminate information to the farming community to the extent possible through extension staff. Similarly, for spreading awareness and making use of the soil test technology, the GOI has laid down a procedure and introduced a Grid System under the SHC scheme for soil testing at free of cost and distributing SHCs to all the farmers coming under the respective grids. Under the grid system, soil samples are drawn from a grid of 2.5 ha under irrigated area and 10 ha under rain-fed area with the help of GPS tools and revenue maps. The scheme also ensures that the crop-specific recommendations are passed on to the farmers.

The study has gone through the soil-test reports received by the sample farmers and recorded the RDFs in the report (SHCs) (Table 5.1) and also the actual application of fertilizers (Table 5.2). A comparison of the two has been carried out as part of understanding the implications of fertilizer application for crop productivity and the results are shown in Table 5.3.

Table 5.1: Average RDFs based on Soil Test Results (As mentioned in SHC)

(Kgs/ha)

Crops	State	FYM	Urea	DAP	MOP	SSP
Paddy	Madhya Pradesh	20000	220	155	67.5	380
	Punjab	-	285	62.5	50	187.5
	Bihar	7573	243	52.5	92.5	-
	Assam	10000	27.5	-	45	170
	Average	**12525**	**195**	**90**	**65**	**245**
Red gram	Maharashtra	8940	100	95	87.5	97.5
	Karnataka	13000	293	50	128	-
	Average	**10970**	**196**	**72.5**	**108**	**97.5**
Jowar	Maharashtra	10640	158	133	97.5	112.5
	Karnataka	25000	158	313	-	-
	Average	**17820**	**158**	**223**	**97.5**	**112.5**
Wheat	Bihar	6598	190	92.5	95	-
	Maharashtra	13948	168	118	118	137.5
	Average	**10273**	**179**	**105**	**106**	**137.5**
Maize	Madhya Pradesh	20000	263	130	50	317.5
	Punjab		308	125	50	350
	Average	**20000**	**285**	**128**	**50**	**333.75**
Ragi	Karnataka	9400	135	198	42.5	-
Soybean	Madhya Pradesh	20000	45	155	35	380
Horse gram	Bihar	1350	35	32.5	52.5	-
Potato	Bihar	17348	453	333	193	-
Basmati	Punjab	-	75	-	-	

***Note:** Excepting Karnataka, no other state has tested for micronutrients and hence there are no recommendations made in the SHCs and no farmers applied the same.

Table 5.1 reveals that the RDFs for a particular crop differ from state to state, depending upon the nutrient status of the soil, type of soil, irrigation, physical properties of the soil, crops grown and management practices followed by farmers in their respective areas. Similarly, for different crops, the physiological nutrient requirements are different and hence, the RDFs also differ. For instance, the (weighted) average quantity of RDFs for paddy crop, as per the SHCs, is to the tune of 78 kg/acre of urea, 36 kg/acre of DAP, 26 kg/acre of MOP and 98 kg/acre of SSP. In relation to the average quantity of RDFs for paddy crop, Madhya Pradesh is the only state which signifies higher requirements of macronutrients and FYM, whereas, the rest of the states either denote more or less of one or the other nutrient. Unfortunately, Punjab scientists have not at all recommended FYM for paddy crop.

n respect of red gram, the average RDFs are higher for Karnataka as compared to Maharashtra, while, the average RDFs are 79 kg/acre of urea, 29 kg/acre of DAP, 43 kg/acre of MOP and 39 kg/acre of SSP. Only Maharashtra scientists have recommended SSP. In addition to these macronutrients, 4.3 tons/acre of FYM is also recommended for red gram at the average level, while the quantity recommended is higher in the case of Karnataka. With regard to jowar, the SHCs have recommendation made for urea, DAP and FYM only in the case of Karnataka state, while all other nutrients are found recommended in Maharashtra. Looking into the average values, Karnataka has more than twice the quantity of DAP recommended as compared to Maharashtra. Similarly, the quantity recommendations (RDFs) for wheat crop are higher in the case of Maharashtra as compared to Bihar, excepting urea. The average quantity recommended for wheat is 179 kg/ha of urea, 105 kg/ha of DAP, 106 kg/ha of MOP and 137.5kg/ha of SSP. No SSP recommendation is observed in the case of Bihar. When it comes to maize crop, the average recommendations are 285 kg/ha of urea, 128 kg/ha of DAP, 50kg/ha of MOP and 333.75 kg/ha of SSP. Here, excepting urea (307.5kg/ha) and SSP (350kg/ha), all other nutrient recommendations are higher in respect of Madhya Pradesh. Again, FYM is not found in the list of RDFs in the case of Punjab state.

Ragi is one of the dryland crops, which may not require much of fertilizers. However, the average RDFs for Karnataka, as per the SHCs, are 54:79:17, along with 3.7 tons of FYM. In the same way, RDFs for soybean crop in Madhya Pradesh are 45 kg/ha of urea, 155 kg/ha of DAP, 35 kg/ha of MO and 380 kg/ha of SSP along with 20 tons/ha of FYM. The recommendations (RDFs) for horse gram involve 14:13:21 kg/acre of urea, DAP and MOP respectively. In respect of potato, Bihar soil test reports suggest 452 kg/ha of urea, 333 kg/ha of DAP and 193 kg/ha of MOP; it appears from the results that the RDFs are much higher than for any other field crop. Interestingly, only 30 kg/acre of urea is found recommended for basmati rice for Punjab.

Remarkably, there are no recommendations for micronutrients noticed in any other state, excepting Karnataka, which may be due to the absence of micro-nutrients soil testing laboratories in these states. Therefore, a comparison of micro-nutrients is not represented in Table 5.1.

As against RDFs, the actual application of fertilizers is presented in Table 5.2 for the sample crops in the study area. Overall, it is noticed that the actual usage of fertilizers is very much less than the RDFs for almost all the crops and nutrients, including the usage of FYM. The average actual application of fertilizers in respect of paddy crop is 155 kg/ha of urea, 97.5 kg/ha of DAP and 25 kg/ha of MOP, in addition to two ton of FYM. However, the average values do not match each other in terms of any of the nutrients across the sample states. Farmers of Punjab and Bihar are found to have applied higher quantities than the average values in terms of all nutrients, while Madhya Pradesh farmers have applied less than the average values, excepting DAP nutrient. The average quantity of fertilizers applied to red gram crop amounts to 7455 kgs/ha of FYM, 180 kg/ha of urea, 183 kg/ha of Dap, 117.5 kg/ha of MOP and SSP at the rate of 93 kg/ha only in the case of Maharashtra. The average quantities of nutrients applied are comparatively higher in respect of FYM, urea and DAP for Karnataka state as compared to Maharashtra and is exactly the opposite when it comes to other nutrients.

Jowar farmers of Karnataka have applied only urea (170 kg/ha), DAP (313 kg/ha) and three tons of FYM which exceed the average quantities of fertilizers applied by the Maharashtra farmers. However, in addition to urea, DAP and FYM, they are also found to have applied MOP and SSP at the rate of 105 kg/ha and 63 kg/ha, respectively. Similarly, there is no matching observed in terms of the actual application of fertilizers by the wheat farmers of Bihar and Maharashtra. Comparatively, higher quantities of fertilizers are observed to have been applied by the Maharashtra farmers as compared to Bihar. Similar is the case with maize crop producers in respect of Madhya Pradesh and Punjab, with Punjab farmers applying almost twice the quantity of urea and DAP. However, it is noticed that none of them has applied MOP, barring 45 kg/ha of SSP applied by the Madhya Pradesh farmers.

Regarding ragi crop, Karnataka farmers have used 162.5 kg/ha of urea, 210 kg/ha of DAP and 65 kg/ha of MOP, along with 8.5 tons of FYM. On the contrary, the actual application of fertilizers by soybean farmers amounts to less than a ton of FYM/ha, 10kg/ha of urea, 125 kg/ha of DAP and 315 kg/ha of SSP in Madhya Pradesh. Only urea (110 kg/ha) and DAP (22.5 kg/ha) are found applied by lentil/gram producers of Bihar, while only urea (92.5 kg/ha) by Basmati producers of Punjab.

For a better understanding of the adoption of RDFs, the actual quantities of fertilizers applied by the soil-tested farmers vis-a-vis the RDFs in respect of each crop across states have been compared in Table 5.3. Overall, as the table reveals, the soil-tested farmers have applied lesser quantities/ doses of many nutrients as compared to the recommended levels, as prescribed in the Soil Health Cards for almost all the sample crops across states. However, the crop-wise details are discussed in detail in the following section.

Table 5.2: Average Quantity of Fertilizers Applied by Soil-Tested Farmers

(Kgs/ha)

Crops	State	FYM	Urea	DAP	MOP	SSP
Paddy	Madhya Pradesh	600	57.5	177.5	-	-
	Punjab	3000	152.5	5	5	-
	Bihar	3575	257.5	107.5	42.5	-
	Average	2392.5	155	97.5	25	0
Red gram	Maharashtra	4907.5	112.5	112.5	125	92.5
	Karnataka	10000	247.5	250	107.5	-
	Average	7455	180	182.5	117.5	92.5
Jowar	Maharashtra	5792.5	130	117.5	105	62.5
	Karnataka	7500	170	312.5	-	-
	Average	6647.5	150	215	105	62.5
Wheat	Bihar	3750	92.5	110	35	-
	Maharashtra	6617.5	102.5	105	62.5	-
	Average	5185	97.5	107.5	50	-
Maize	Madhya Pradesh	587.5	55	90	-	45
	Punjab	-	137.5	47.5	-	-
	Average	587.5	97.5	70	-	45
Ragi	Karnataka	8500	162.5	210	65	-
Soybean	Madhya Pradesh	915	10	125	-	315
Lentil/Gram	Bihar	-	110	22.5	-	-
Basmati	Punjab	-	92.5	-	-	-

***Note:** Excepting Karnataka, no other state has tested for micronutrients and hence there are no recommendations made in the SHCs and no farmers applied the same.

Table 5.3: Difference between the Average RDFs and the Actual Application by the Soil-tested Farmers in respect of Major Crops in India

(Kgs/ha)

Crops	State	FYM	Urea	DAP	MOP	SSP
Paddy	Madhya Pradesh	-19400	-162.5	22.5	-67.5	-380
	Punjab	3000	-132.5	-57.5	-45	-187.5
	Bihar	-3997.5	15	55	-50	NA
	Average	-6800	-92.5	7.5	-55	-285
Red gram	Maharashtra	-4032.5	12.5	17.5	37.5	-5
	Karnataka	-3000	-45	200	-20	0
	Average	-3517.5	-17.5	110	10	-5
Jowar	Maharashtra	-4847.5	-27.5	-15	7.5	-50
	Karnataka	-17500	12.5	NA	NA	NA
	Average	-11175	-7.5	-15	7.5	-50
Wheat	Bihar	-2847.5	-97.5	17.5	-60	NA
	Maharashtra	-7330	-65	-12.5	-55	-137.5
	Average	-5090	-82.5	2.5	-57.5	-137.5
Maize	Madhya Pradesh	-19412.5	-207.5	-40	-50	-272.5
	Punjab	NA	-170	-77.5	-50	-350
	Average	-19412.5	-190	-60	-50	-312.5
Ragi	Karnataka	-900	27.5	12.5	22.5	NA
Soybean	Madhya Pradesh	-19085	-35	-30	-35	-65
Lentil/Gram	Bihar	-1350	75	-10	-52.5	NA
Basmati	Punjab	NA	17.5	NA	NA	NA

*Note: RDFs - Recommended doses of fertilizers; NA – Neither Applied nor recommended; Excepting Karnataka, no other state has tested for micronutrients and hence there are no recommendations mentioned in the SHCs and no farmers applied the same.

In the case of paddy, farmers have either applied less or more than the RDFs in almost all the sample states. On an average, excepting DAP, all the fertilizers are found applied much below the recommended levels. A comparison across states, shows that Madhya Pradesh farmers have applied higher quantities than the RDFs in respect of DAP (22.5 kg/ha) alone, but the rest of the fertilizers such as SSP, MOP, urea and FYM are found applied in lesser quantities i.e., to the extent of 380 kg/ha, 67.5 kg/ha, 162.5 kg/ha and the difference is substantial. Both DAP (55 kg/ha) and Urea (15 kg/ha) are found applied in higher quantities than the recommended doses by Bihar paddy farmers, while MOP and FYM in comparatively lower quantities. Although recommendations for FYM are nil in respect of Punjab, farmers have applied 1.2 tons/ acre, whereas, all other macronutrients are found applied less than the recommended doses i.e., which is to the extent of 187.5 kg/ha of SSP, 132.5 kg/ha of urea, 57.5 kg/ha of DAP and 45 kg/ha of MOP.

With regard to red gram, the average quantities of fertilizers applied are more than the RDs in the case of nutrients such as DAP (110kg/ha) and MOP (10 kg/ha), while relatively less than the recommended quantities in respect of urea (17.5 kg/ha), SSP (5 kg/ha) and FYM (3.5 tons/ha). Interestingly, excepting FYM (-4 tons/acre), almost all the nutrients (NPK) applied are found slightly more than the RDs in Maharashtra. Conversely, Karnataka farmers have applied slightly less quantities of urea (45 kg/ha), MOP (20 kg/ha) and FYM (3 tons/ha), while DAP is observed applied substantially (200 kg/ha) more than the recommendations.

Similar to red gram, the average quantities of fertilizers applied by jowar farmers are relatively on par with the RDs in terms of NPK chemical fertilizers, whereas, FYM application is substantially low (4.4 tons/acre). It is important to note that, excepting urea and FYM, there are no recommendations observed for DAP, MOP and SSP fertilizers in the case of Karnataka. Unfortunately, the difference in the recommended and applied quantity of FYM is found to be negative and huge (17.5 tons/ ha) for Karnataka, while the urea usage is more than the recommended level (12.5 kg/ ha). This variation might be due to the successive droughts prevailing in the red gram and jowar growing areas of Karnataka during that period. On the contrary, Maharashtra farmers are found to have applied slightly less than the RDFs in respect of urea, DAP and SSP, while more of MOP (7.5 kg/ha). Like in the case of Karnataka, Maharashtra farmers also have not applied FYM, as per the recommendations, and the variation is found substantial (two tons/acre).

With respect to wheat crop, excepting DAP, the average quantity of fertilizers applied is less than the recommended doses in terms of all nutrients (NPK) as well as FYM. In contrast to the average figures, the DAP application is more than the recommended level (17.5 kg/ha) with all the other nutrients applied being less in the case of Bihar state. On the other hand, all the fertilizers applied are found less than the recommended levels in respect of Maharashtra with the difference appearing moderate in terms of urea (65 kg/ha), DAP

(12.5 kg/ha) and MOP (55 kg/ha), while slightly large with reference to SSP (137.5 kg/ha) and FYM (7.25 tons/ha).

Coming to the case of Ragi crop in Karnataka, all the fertilizers applied are found more than the recommended levels (27.5 kgs of Urea/ ha, 12.5 kgs of DAP/ ha and 22.5 kgs of MOP/ ha), while the application of FYM is slightly less (0.9 tons/ha). The difference between the adoption of RDs and their actual application by soybean farmers of Madhya Pradesh reveals that the actual application is slightly lesser than the recommended levels in respect of almost all the fertilizers and that the difference is substantially high with regard to FYM (19 tons/ha). Excepting urea, the application of all other fertilizers to lentil/gram crop is relatively less for Bihar, while urea application is moderately higher (75 kg/ha) than the recommended quantity. Interestingly, there are no recommendations noticed for DAP, MOP, SSP and FYM for basmati crop in Punjab, excepting urea, but the soil-tested farmers have applied seven kg/acre more of urea than the recommended level.

By tradition, farmers are not used to the application of chemical fertilizers to pulses and millets, more so in the case of almost all the dryland crops. However, in view of the increased awareness level among the farming community regarding the adverse impact of chemical fertilizers, many farmers have started applying NPK fertilizers recently, especially under irrigated conditions.

5.2. Application of organic fertilizers to reference crops

Traditionally, the farming community produced food grains using organic fertilizers, especially cow dung/ slurry, decomposed organic matters etc. Unfortunately, these traditional practices are vanishing these days. At the same time, various new methods have come up in the place of traditional organic fertilizers such as biogas, bio-fertilizer and green manure. The details of organic fertilizers applied to reference crops are presented in Table 5.4. The table reveals that overall, a majority (69%) of the farmers have applied FYM to all the reference crops, followed by a combination of FYM (1.85 tons), biogas (0.18 tons) and green manure (0.67 tons). Among all organic fertilizers, the prices of bio-fertilizers are found very high (93 Rs/kg) as compared to FYM (2 Rs/kg) and bio-gas (1.2 Rs/kg). On the other hand, the area covered under these organic fertilizers appears to be highest with regard to FYM (two acres) followed by biogas and bio-fertilizers (one acre each). However, across sample states, a majority (93%) of the farmers are found to have applied FYM to the reference crops in Bihar followed by Karnataka (90%), Madhya Pradesh (74%), Maharashtra (63%) and Punjab (52%). Whereas, in terms of the quantity of FYM applied, Karnataka is found at the top (five tons), followed by Maharashtra (two tons), Bihar (1.6 tons), Punjab (1.28 tons), Madhya Pradesh (0.76 tons) and Assam (0.39 tons). Among all the organic fertilizers, the prices of bio-fertilizers (270 Rs/kg) are found high in respect of Madhya Pradesh. The area covered under these organic fertilizers appears to be highest with regard to biogas, bio-fertilizers and green manure (four acres each) for Karnataka. In the present context of degradation of land, there is a need for the promotion of these organic fertilizers towards improving the quality of soil for sustainable agriculture.

5.3. Major problems encountered in the implementation of the SHC scheme

The major problems faced by sample farmers in opting for soil testing under the SHC scheme are listed in Table 5.5. The table shows that about 27 per cent of the farmers have pointed to a few problems in the implementation of SHC scheme in the sample states. Out of these problems, 'Not aware of the technique of taking samples' is the major problem (as reported by 27 per cent of the farmers), followed by 'No training campaigns', 'SHCs are not distributed on time' (21%), 'Lack of information on soil test technology' (15%),' Lack of involvement of farmers in taking samples' (14%), 'Soil testing laboratories are far away' (13%), 'Don't know whom to contact' (9%) and 'Samples of soils are not collected from individual fields '(8%) are the major ones according to their relative importance. In addition to these problems, about 22 per cent of the farmers also have reported other problems such as 'Not taken samples from everyone's field', 'problem in understanding the information provided in the SHCs', 'Do not know the benefits of soil testing' etc.

Table 5.4: Application of organic fertilizers to reference crops (% of farmers)

States	Particulars	FYM	VC/ Biogas	Bio-fertilizer	Green manure
Karnataka	Average Quantity applied (tons)	5.00	1.00	0.02	0.40
	Price (Rs/kg)	2.17	5.00	1.67	-
	Average area (Acres)	3.19	4.00	4.00	4.00
	Percent of farmers applied	90.00	1.67	5.00	1.67
Punjab	Average Quantity applied (tons)	1.28	-	-	-
	Price (Rs/kg)	0.27	-	-	-
	Average area (Acres)	3.34	-	-	-
	Percent of farmers applied	52.00	-	-	-
. M.H.	Average Quantity applied (tons)	2.00	-	-	-
	Price (Rs/kg)	2.90	-	-	-
	Average area (Acres)	2.20	-	-	-
	Percent of farmers applied	63.30	-	-	-
M.P.	Average Quantity applied (tons)	0.76	-	0.02	-
	Price (Rs/kg)	1.50	-	270	-
	Average area (Acres)	2.39	-	1.20	-
	Percent of farmers applied	74.00	-	46.00	-
Assam	Average Quantity applied (tons)	0.39	-	-	-
	Price (Rs/kg)	2.00	-	-	-
	Average area (Acres)	1.23	-	-	-
	Percent of farmers applied	41.67	-	-	-
Bihar	Average Quantity applied (tons)	1.67	0.09	0.08	-
	Price (Rs/kg)	3.78	2.69	6.63	-
	Average area (Acres)	3.11	2.19	0.22	-
	Percent of farmers applied	93.33	42.50	18.33	-
Overall	Average Quantity applied (tons)	1.85	0.18	0.02	0.07
	Price (Rs/kg)	2.10	1.28	92.76	-
	Average area (Acres)	2.35	1.03	1.00	0.27
	Percent of farmers applied	69.05	7.36	11.55	0.27

Note: RDFs - None of the farmers has applied any other organic manure, excepting the ones mentioned in the Table.

Table 5.5: Major problems encountered in the implementation of the SHC scheme

Sl. No	Problems	(% of farmers)
1	Samples of soils are not collected from individual fields	7.90
2	Soil testing laboratories are far away	13.72
3	SHCs are not distributed on time	21.34
4	Lack of information on soil test technology	15.02
5	Do not know the benefits of soil testing	13.40
6	Don’t know whom to contact	8.82
7	No training campaigns	22.32
8	Not aware of the technique of taking samples	26.60
9	Lack of involvement of farmers in taking samples	14.50
10	Others	22.06

* Multiple responses

5.4. Major suggestions for improving the SHC scheme

Studying the SHC scheme related problems apart, an attempt was also made to collect suggestions for improvements in the SHC scheme and its implementation. Accordingly, the major suggestions received from the sample respondents are listed in Table 5.6. As per the suggestions provided by the sample farmers, ‘Need to create awareness regarding SHC scheme’ is emerged as the major suggestion, as reported by a majority (37%) of the sample farmers, followed by ‘Need to organize trainings related to soil sampling’ (24%), ‘access to free and timely SHC distribution’ (23%), ‘establish soil test laboratories at each taluk level’ (18%), ‘information regarding SHC needs to be given’ (15%) and ‘soil samples should be collected from individual fields’ (12%). Interestingly, as per seven per cent of the farmers, the SHC programme is good and is being implemented properly and hence, no suggestions.

Table 5.6: Major suggestions for improving the SHC scheme

Sl. No	Suggestions	(% of farmers)
1	Establish soil test laboratories at each taluk level	18.12
2	Need to create awareness regarding SHC scheme	37.04
3	Access to free and timely SHC distribution	23.70
4	Soil samples should be collected from individual fields	11.52
5	Information regarding SHC needs to be given	15.00
6	Need to organize trainings related to soil sampling	24.02
7	No suggestions	7.00

* Multiple responses

CHAPTER VI

IMPACT OF SOIL HEALTH CARD SCHEME

Both the State and Central Governments have implemented many schemes for the welfare of the farming community as a whole, but it is more important to investigate the extent of out-reach of such schemes. Impact evaluation is an assessment of how the intervention being evaluated affects the outcomes and whether these effects are intended or unintended. This chapter brings out the impact of application of recommended doses of fertilizers on yield levels, visible changes in crops along with their cost of cultivation and income from major crops under the SHC scheme in India.

6.1. Impact of application of recommended doses of fertilizers (RDFs) on crop yields

The impact of application of recommended doses of fertilizers on yields of the sample crops is shown in Table 6.1. Before and after situations have been considered for assessing the impact of the soil health card scheme. The results reveal comparatively better yields after the intervention (kharif 2015) as against the before situation (kharif 2014) in respect of almost all the sample crops chosen across states. The percent change in yield is highest to the tune of 44 per cent in respect of Bengal gram followed by wheat (43%) in Karnataka, consecutively maize (30%) in Madhya Pradesh and red gram (22%) in Maharashtra. The change in paddy yield is highest to the extent of 19 per cent in Madhya Pradesh and lowest (<1%) in the case of Punjab. Interestingly, out of all the sample states, the increase in yield is less than three per cent for Punjab and Bihar. However, the increase in yield levels may not be directly attributed to the application of recommended doses of fertilizers alone, as various other factors could have also impacted crop yields in general. Overall, we can conclude that there is an increase in crop yield levels after the adoption of RDFs.

Table 6.1: Impact of application of recommended doses of fertilizers on Yield levels

States	Crops	Average Yield (Quintal/acre)		% Change
		Before	After	
Karnataka	Bengal gram	9.00	13.00	44.44
	Jowar	19.00	20.02	5.37
	Ragi	11.03	11.77	6.71
	Red Gram	11.33	13.38	18.09
	Tomato	210.00	216.00	2.86
	Wheat	21.00	30.00	42.86
M.H	Jowar	4.44	4.76	7.10
	Red Gram	2.84	3.48	22.30
	Wheat	5.98	6.92	15.70
Punjab.	Paddy	29.07	29.21	0.48
	Basmati	19.23	19.41	0.94
	Maize	17.33	17.56	1.33
M.P.	Paddy	20.06	24.60	19.42
	Soybean	5.80	6.60	13.79
	Maize	6.30	9.30	30.00
Assam	-	-	-	-
Bihar	Paddy	18.70	19.07	1.98
	Wheat	13.08	13.19	0.84
	Lentil	4.49	4.59	2.23

6.2: Visible changes found after the application of RDFs

In addition to an increase in crop yield levels, there are other visible changes also observed post application of RDFs and are presented in Table 6.2. The table reveals that overall, there is a mixed response among the sample farmers with respect to visible changes such as increase in crop yield; improvement in crop growth; improvement in grain filling; less incidence of pest and diseases; changes in the application of other inputs like seed, labour, pesticide etc.; and improvement in soil textures. A majority of the farmers have found the increase in yield levels (45%) as the most important change post the application of RDFs, followed by improvement in soil texture (12%), whereas, improvement in crop growth and grain filling are an important visible change as observed by 38 per cent and 35 per cent of the sample farmers. On the contrary, a majority of the farmers consider less incidence of pest and diseases (46%) and changes in the application of other inputs like seed, labour, pesticide etc. (28%), as the least important changes post adoption of RDFs.

However, across sample states, excepting Bihar farmers (28%), a majority of the farmers from Karnataka (57%), Punjab (32%), Maharashtra (74%) and Madhya Pradesh (56%) observe 'increase in crop yield levels' as the most important visible change after the adoption of RDFs, while Bihar farmers find it as the least visible change. In terms of 'improvement in crop growth', a large proportion of farmers from Maharashtra (50%), Madhya Pradesh (70%) and Bihar (28%) consider it as an important change noticed post application of RDFs. At the same time, 42 per cent of Karnataka and 27 per cent of Maharashtra farmers also state it as the least important change noticed after the adoption of RDFs. A mixed response is seen with regard to 'improvement in grain filling' post adoption of RDFs in that 65 per cent of Karnataka farmers, 40 per cent of Maharashtra farmers and 15 per cent each of Punjab and Bihar farmers consider it as least important, while about 61 per cent of Madhya Pradesh, 35 per cent of Bihar, 32 per cent of Maharashtra and 30 per cent of Karnataka farmers think it as an important visible change found after the application of RDFs. On the other side, the mainstream sample farmer of Karnataka (79%), Maharashtra (71%) and Madhya Pradesh (67%) evaluate 'less incidence of pest and diseases' as the least important change noticed after the adoption of SHC recommendations. Excepting 67 per cent of Madhya Pradesh and 77 per cent of Maharashtra farmers, a majority have not observed any 'changes (either increase or decrease) in the application of other inputs like seed, labour, pesticide etc.'., and hence treat it as the least important visible change. Only Madhya Pradesh farmers (60%) have noticed 'improvement in soil texture' after the application of RDFs, while the rest of the sample farmers (all other states) have not reacted to the same.

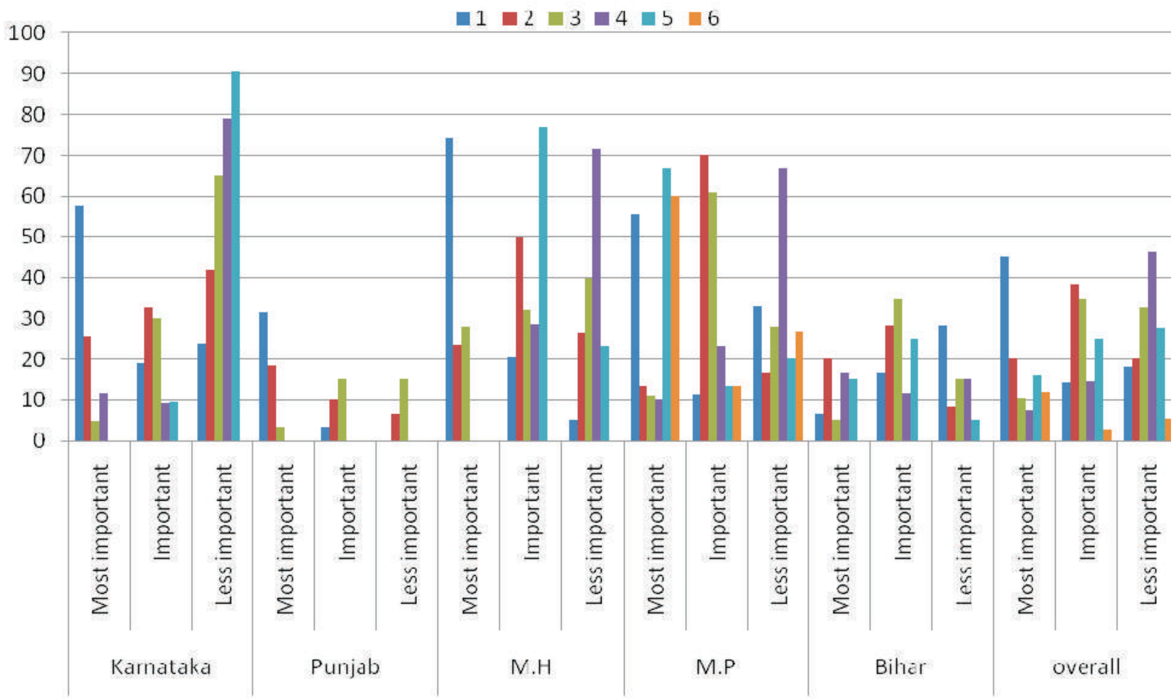
Table 6.2: Visible changes found after the application of recommended doses of fertilizers by soil-tested farmers (% of farmers)

(N=300)

States	Reasons/ Category	1	2	3	4	5	6
Karnataka	Most important	57.42	25.83	4.65	11.63	-	-
	Important	19.04	32.55	30.23	9.30	9.52	-
	Least important	23.80	41.86	65.12	79.07	90.47	-
Punjab	Most important	31.67	18.33	3.33	-	-	-
	Important	3.33	10.00	15.00	-	-	-
	Least important	-	6.67	15.00	-	-	-
M.H.	Most important	74.40	23.50	28.00	-	-	-
	Important	20.50	50	32.00	28.60	76.90	-
	Least important	5.10	26.50	40.00	71.40	23.10	-
M.P.	Most important	55.60	13.33	11.10	10.00	66.70	60.00
	Important	11.40	70.00	61.00	23.30	13.30	13.30
	Least important	33.00	16.67	27.90	66.70	20.00	26.70
Bihar	Most important	6.67	20.00	5.00	16.67	15.00	-
	Important	16.67	28.33	35.00	11.67	25.00	-
	Least important	28.33	8.33	15.00	15.00	5.00	-
Overall	Most important	45.15	20.19	10.41	7.66	16.34	12.00
	Important	14.18	38.17	34.64	14.57	24.94	2.66
	Least important	18.04	20.00	32.60	46.43	27.71	5.34

Note: 1. Increase in crop yield; 2. Improvement in crop growth; 3. Improvement in grain filling; 4. Less incidence of pest and diseases; 5. Changes in the application of other inputs like seed, labour, pesticide etc. (increase/decrease); 6. Improvement in soil texture.

fig .6.2 Visible changes found after the application of recommended doses of fertilizers by soil-tested farmers (% of farmers)



6.3. Changes in the cost of cultivation of major crops and income

6.3.1. Changes in the cost of cultivation and income from Paddy

Aggregate change in yield levels and other input costs observed post soil-testing and adoption of RDFs have been worked out in comparison to the control group and the results are illustrated in Table 6.3.1. However, the supporting tables with respect to individual sample states for paddy crop are listed in Appendix VII to X in the Appendices section of this report.

Table 6.3.1: Changes in the cost of cultivation and income from Paddy

(N= 720)

Variables	Unit	Soil-tested farmers		Control farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labor cost		-	8473	-	8897	-	-424
Manure/ FYM	Tons	0.98	484	0.90	445	0.08	39
Seedlings	No/Kgs	16.33	1203	18.68	1275	-2.35	-72
Fertilizers - N	Kgs	62.30	551	62.74	569	-0.44	-18
P	Kgs	38.86	1056	41.10	1097	-2.24	-41
K	Kgs	6.30	79.20	7.90	97.88	-1.60	-18.68
Complex	Kgs	-	-	-	-	-	-
Others*	Kgs	-	-	0.92	23.12	-.92	-23.12
Micronutrients	Kgs	2.35	129	2.76	140.30	-0.41	-11.30
PPC	Liters	1.31	1021	1.49	1082	-0.18	-61
Irrigation	Acre inch	-	480.50	-	419.50	-	61
Others	-	-	-	-	-	-	-
Rental value of land	Rs	-	10061	-	9258	-	803
Land revenue	-	-	37	-	35	-	2
Main product yield	Qtls	24.29	33256.21	22.80	30367	1.49	2889.21
By- product	Qtls	26.81	4517.20	22.37	3686	4.47	831.20
Gross Income	-		14683		10715		3968
Total cost			23090		23338		-248
Net income			37773		34053		3720

A perusal of the table reveals an interesting fact post adoption of RDFs for paddy crop. There is a minor decline in the usage of all chemical fertilizers such as nitrogen (N), DAP (P) and Potash (K), micronutrients and plant protection chemicals vis-a-vis control farmers. On the other hand, there is also an increase in yield levels of both main & by-products to the extent of 1.49 quintal/acre (Rs. 2889/-/ acre) and 4.47 quintal/acre (Rs. 831/ acre) respectively. Overall, the total increase in net returns from paddy amounts to Rs. 3720/ acre as compared to control farmers post adoption of RDFs. However, across sample states, there is an increase in chemical fertilizer usage by paddy farmers of Punjab and Bihar, but the difference is insignificant (less than Rs. 1000/- acre) as compared to their counterparts.

6.3.2. Changes in the cost of cultivation and income of Wheat

Table 6.3.2. shows the impact of soil testing on the cost of cultivation and income from wheat crop. Although two states, Bihar & Maharashtra (Appendices XI & XII) have been considered for the study, only Bihar results are explained in this chapter due to incompatibility with the Maharashtra data. Bihar state is explained here, as it provides the results of the soil testing in terms of with (soil-tested farmers) and without approach (control group) and the other method before and after is explained in Table 6.1.

It is very clear from Table 6.3.2 that there is a drastic decline in the usage of chemical fertilizers such as nitrogen (N) (7%), Phosphorus (DAP) (41%), Potassium (MOP) (27%) and Plant Protection Chemicals (PPC) (56%) vis-a-vis control farmers. In fact, soil-tested farmers started applying bio-fertilizers as per the guidelines. However, due to various factors, the cost of Irrigation (27%) and rental value of land (13%) have increased in the case of the soil-tested farmers. As regards output, there has been a slight increase observed in the main product yield (0.11 quintals/acre), but a decrease in the by-product yield levels (1.39 quintals/ acre). However, in value terms, there is an increase in the output levels to the extent of three and seven per cent, respectively. Overall, there is an increase in the net income for the wheat soil-tested farmers to the extent of 11 per cent vis-a-vis control group. The per rupee net return is found to have increased from 1.94 to 2.32, i.e., a nine per cent increase. The above analysis reveals that the impact of SHC scheme on the cultivation of wheat is positive and encouraging.

6.3.3. Changes in the cost of cultivation and income of Red gram

Change in yield levels, input costs and income observed after the adoption of RDFs have been worked out using the cost of cultivation variables and the results are illustrated in Table 6.3.3. Although, two states, Karnataka and Maharashtra (Appendices XIII & XIV), have been considered for the study, only Karnataka results are presented in this chapter due to incompatibility with the Maharashtra data. Karnataka results are discussed here, as it provides the results of the soil testing in terms of with (soil-test farmers) and without approach (control group) and the other method 'before and after' is explained in Table 6.1.

A perusal of the Table (6.3.3) reveals that there is a minor decline in the usage of chemical fertilizers such as nitrogen (N) by 8.46 kg/acre and DAP (P) by 7.58 kg/acre in the case of red gram soil-tested farmers, and at the same time, an increase in the main product yield (0.56 quintal/acre) and returns (Rs. 6976/acre), indicating thereby that the net income has increased to the extent of Rs. 7891/acre. Thus, in view of the use of recommended doses of

Table 6.3.2: Changes in the cost of cultivation and income of Wheat post the adoption of RDFs

(Rs/Acre) (N=720)

Variables	Unit	Soil-tested farmers		Control farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labour cost	H+B+M	—-	2532.52	—-	3057.08	—-	524.56 *(-9.38)*
Manure/ FYM	Tons	0.15	155.05	0.28	284.11	(-) 0.13	-129.06 *(-29.39)*
Seeds	Kgs	46.98	1368.39	46.51	1339.26	1.47	29.13 1.08
Fertilizers - Urea	Kgs	36.44	293.35	46.89	340.33	(-) 10.45	-46.98 *(-7.41)*
DAP	Kgs	43.79	1211.97	74.64	2906	(-) 30.85	-1694.03 *(-41.14)*
MOP	Kgs	14.1	173	26.92	303.3	(-) 12.82	-130.3 *(-27.36)*
Bio-Fertilizers	Kgs.	50.13	213.5	—-	—-	—-	213.5
Others	Kgs	—-	—-	—-	—-	—-	—-
PPC	Liters	2.42	76.67	4.22	269	(-) 1.80	-192.33 *(-55.64)*
Irrigation	—-	—-	1483.7	—-	845.47	—-	638.23 27.4
Rental value of land	—-	—-	2585.13	—-	2000	—-	585.13 12.76
Land revenue	—-	—-	—-	—-	—-	—-	—-
Total paid out costs	—-	—-	10093.28	—-	11344.55	—-	-1251.27 *(-5.84)*
Main product yield	Qtls	13.19	20554.76	13.08	19497.61	0.11	1057.15 2.64
By-product yield	Qtls	11.36	2833.29	12.75	2532.44	(-) 1.39	300.85 5.61
Gross return	—-	—-	23388.05	—-	22030.05	—-	1358 *2.99*
Net Income	—-	—-	13294.77	—-	10685.55	—-	2609.22 10.88
Per Rupee Return	—-		2.32		1.94		0.38 8.92

Source: Primary Survey; **Note:** Figures in parentheses indicate percentage differences of STFs over CFs fertilizers, a slightly higher yield is observed in the case of red gram sample soil-tested farmers as well as a minor decline in the fertilizer use. Moreover, the benefit-cost ratio works out to 0.86, implying that for every one rupee of investment, there has been a rise in returns to the extent of Rs. 0.86. Because of the successive droughts, the last year yield levels of red gram might be very low and hence, the results of Karnataka state cannot be generalized.

Similarly, soil-tested farmers of Maharashtra (Appendix XIII) have witnessed a slight increase in the yield levels of both the main product and by-products of red gram post the adoption of soil-test technology and RDFs with the net returns realized amounting to Rs. 1682/ acre.

6.3.4. Changes in the cost of cultivation and income of Maize

With regard to maize crop, although Punjab and Madhya Pradesh (Appendices XV& XVI) were selected as the sample states for the study, only the changes in the cost of cultivation and income from maize crop of the sample households of Punjab state have been presented in Table 6.3.4 due to compatibility issues with the Madhya Pradesh data. A perusal of the table reveals that there is a higher use of nitrogen (N) and phosphorus (P) fertilizers by control farmers. In addition, there is also a higher cost incurred on labour and seed by soil-tested farmers as compared to control farmers. It is seen that maize yield is higher by 0.23 quintals valued at Rs.578 per acre for soil-tested farmers as compared to control farmers and that the net income is negative for both the farm categories due to a higher total cost. On the contrary, a substantial increase in the yield levels of maize has been observed by soil-tested farmers after the adoption of RDFs (soil testing) with the net income realized amounting to Rs. 4725/- per acre in the case of Madhya Pradesh (Appendix XVI).

6.3.5. Changes in the cost of cultivation and income of Jowar

Like other crops, changes in the cost of cultivation and income from jowar crop for the sample households have been worked out and presented in Table 6.3.5. Although Karnataka and Maharashtra (Appendices XVII & XVIII) were considered for this study, only Karnataka results are discussed in this section due to data incompatibility issues.

A perusal of the table reveals that there is a minor decline in the use of nitrogen (N) (9.98 kg/acer) and phosphorus (P) (4.7 kg/acre) by soil-tested farmers, whereas, labour costs show a decline to the extent of Rs.517/ acre for control farmers. However, due to slightly higher yield levels of both the main product and by-products, soil-tested farmers have managed to realize a little better gross income (Rs. 1456/ acre). Overall, the soil-tested farmers could achieve a net income of Rs. 2117/ acre with the BC ratio work out to 0.85. Although the results have not been aggregated, they show that jowar growing farmers of

Maharashtra (Appendix XVII) have noticed a slight increase in the yield levels of both the main and by-product with the net income realized after the adoption of RDFs working out to Rs. 3193/ acre vis-a-vis the control group.

Table 6.3.3: Changes in the cost of cultivation and income of Red gram

(Rs/Acre) (N=720)

Variables	Unit	Soil-tested farmers		Control farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labor cost		13	3167	14	3269	1	102
Manure/ FYM	Tons	1.04	1510	1.08	1281	0.04	-229
Seedlings	No/Kgs	3.06	482	3.22	513	0.16	31
Fertilizers- N	Kgs	26.95	186	35.41	247	8.46	61
P	Kgs	29.98	695	37.56	979	7.58	284
K	Kgs	-	-	-	-	-	-
Complex	Kgs	5.65	161	20.02	424	14.37	263
Others*	Kgs	1.00	15	-	-	1	-15
Micronutrients	Kgs	8.74	184	2.02	44	6.72	-140
PPC	Liters	0.78	1919	7.20	2117	6.42	198
Irrigation	Acre inch	-	-	-	-	-	-
Others	-	-	-	-	-	-	-
Rental value of land	Rs	1	1214	1	1214	-	-
Land revenue	-	-	-	-	-	-	-
Main product yield	Q	2.91	23957	2.35	16621	0.56	7336
By- product	(Rs/Qtls)	-	-	-	-	-	
Gross return	Rs	-	23957	-	16621	-	6976
Total cost	Rs	-	9553	-	10088	-	-535
Net Income	Rs	-	14404	-	6533	-	7891
BC Ratio	-	1.50	0.64	0.86			

Source: primary data * Others – include 20:20:20; 17:17:17; 20:20:0 etc.

Table 6.3.4: Changes in the cost of cultivation and income of Maize post the adoption of RDFs

(Rs/Acre) (N=720)

Variables	Unit	Soil-tested farmers		Control farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labour cost	-	-	7833	-	7800	-	33
Manure/ FYM	Tons	-	-	-	-	-	-
Seed	Kgs	8	1308	8	1267	-	41
Fertilizers- N	Kgs	55.03	877	67.67	1051	-12.64	-174
P	Kgs	19.17	720	21.08	792	-1.91	-72
K	Kgs	-	-	-	-	-	-
Complex	Kgs	-	-	-	-	-	-
Micro Nutrients	Kgs	-	-	-	-	-	-
Plant protection chemicals	Liters	-	592	-	608	-	-16
Irrigation	No.	3	-	3	-	-	-
Rental value of land	-	-	16900	-	16250	-	-650
Land revenue	-	-	-	-	-	-	-
Total cost	-	-	28230	-	27768	-	462
Main product yield		17.56	22968	17.33	22390	0.23	578
By- product yield	(RS/Qtls)	-19.80	1996	19.30	1872	0.50	124
Net income	-	-	-3266	-	-3506	-	240

Table 6.3.5: Changes in the cost of cultivation and income of Jowar post the adoption of RDFs

(Rs/Acre) (N=720)

Variables	Unit	Soil-tested farmers		Control farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labor cost		6	1220	8	1737	2	517
Manure/ FYM	Tons	0.75	754	0.75	754	0	0
Seedlings	No/Kgs	3.38	176	3.38	175	0	1
Fertilizers- N	Kgs	25.23	183	35.21	229	9.98	46
P	Kgs	28.16	704	32.86	826	4.7	122
K	Kgs	-	-	-	-	-	-
Complex	Kgs	-	-	-	-	-	-
Others*	Kgs	0.28	28	-	-	-	-
Micronutrients	Kgs	-	-	-	-	-	-
PPC	Liters	-	-	-	-	-	-
Irrigation	Acre inch	-	-	-	-	-	-
Others	-	-	-	-	-	-	-
Rental value of land	Rs	-	-	-	-	-	-
Land revenue	-	-	-	-	-	-	-
Main product yield	Q	3.47	7315	2.91	6103		1212
By- product (Rs/Qtl)	-	10.32	1061	8.07	812		249
Gross returns	Rs	-	8376	-	6920		1456
Total cost	Rs	-	3065	-	3721		-656
Net Income	Rs	-	5311	-	3199	-	2117
BC Ratio	-	1.70	0.85	0.85			

Source: primary data * Others – include 20:20:20; 17:17:17; 20:20:0 etc.

6.3.6. Changes in the cost of cultivation and income of Ragi

Ragi is a staple food of southern India with Karnataka being one of the major producers. Ragi is cultivated mainly under dryland areas. Therefore, ragi was one of the sample crops selected for the study. The changes in the cost of cultivation and income from ragi crop with regard to sample households have been presented in Table 6.3.6. A perusal of the table reveals that there are no significant changes observed in the use of chemical fertilizers by both the soil-tested and control farmers during kharif 2015. However, due to a decrease in labour costs and a slight increase in yield from ragi (0.36 quintal/acre) in respect of soil-tested farmers, the difference in net income over control farmers works out to Rs.1243 per acre. Thus, by using the recommended doses of fertilizers, soil- tested farmers have observed a slightly higher ragi yield as well as a minor decline in the fertilizer use. In fact, a majority of the small and marginal farmers under dryland conditions do not generally use any chemical fertilizers, while the case is reverse with respect to irrigated farmers

6.3.7. Changes in the cost of cultivation and income of Lentil

The impact of soil testing on the cost of cultivation of lentil pulse in respect of Bihar state is presented in Table 6.3.7. It is noticed from the table that the total cost of cultivation per acre has decreased in the case of soil-tested farmers as against their counterparts (control farmers). The decrease in cost amounts to three per cent in the case of seeds, five per cent in respect of nitrogen fertilizers, 13 per cent in respect of DAP and one per cent in respect of PPCs. In totality, the decrease in paid-out costs amounts to accounted for seven per cent. On the other hand, the net returns also have increased by five per cent as compared to control farmers. The increase in per rupee contribution has increased by 11 per cent (i.e., from Rs. 1.55 in respect of control farmers to Rs. 1.95 in the case of soil-tested farmers). It clearly indicates that there is a positive impact of SHC scheme on the cultivation of lentil and income there from.

6.3.8. Changes in the cost of cultivation and income of Soybean

The impact of soil testing on the economics of cultivation of soybean shown in Table 6.3.8. Since the study has not carried out a carried out a comparison of both the groups, only the results of before and after situations are presented in the table. It is understood from the table that the cost of cultivation of soybean has decreased marginally (2%) post adoption of RDFs. Of all the input costs, farmers have completely stopped the application of MOP, while reducing the usage of FYM (29%), other miscellaneous costs (26%), Zinc (21%), labors, seeds, urea (11% each), SSP (7%) and so on. Fortunately, they have also got a better yield both in terms of the main and by-product to the extent of 26 per cent and 13 per cent, respectively. Therefore, the net income realized after soil testing amounts to Rs. 4532/ acre and the return per rupee investment has increased from Rs.1.60 to 2.00 in the case of Madhya Pradesh.

Table 6.3.6: Changes in the cost of cultivation and income of Ragi post the adoption of RDFs

(N=720)

Variables	Unit	Soil-tested farmers		Control farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labor cost		17	3270	18	3537	1	267
Manure/ FYM	Tons	1.34	2538	1.64	3267	0.30	729
Seedlings	No/Kgs	10.05	227	10.09	229	0.04	2
Fertilizers- N	Kgs	40.58	323	43.13	341	-2.55	18
P	Kgs	41.66	1078	41.66	1078	0	0
K	Kgs	-	-	-	-	-	-
Complex	Kgs	34.95	826	36.65	849	1.7	23
Others*	Kgs	196	392	-	-	-	-
Micronutrients	Kgs	-	-	-	-	-	-
PPC	Liters	-	-	-	-	-	-
Irrigation	Acre inch	-	-	-	-	-	-
Others	-	-	-	-	-	-	
Rental value of land	Rs	-	-	-	-	-	-
Land revenue	-						
Main product yield	Q	5.77	8607	5.41	8062	0.36	545
By- product (Rs/Qtl)	-	10.56	505	10.00	454	0.56	52
Gross return	Rs	-	9112	-	8516		596
Total cost	Rs	-	8654	-	9301		-647
Net Income	Rs	-	458	-	-785	-	1243

Table 6.3.7: Changes in the cost of cultivation and income of Lentil post the adoption of RDFs

(Rs/Acre) (N=720)

Variables	Unit	Soil-tested farmers		Control farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labour cost	H+B+M	—-	2290.07	—-	2273.54	—-	16.53 0.36
Seeds	Kgs	37.6	2298.83	37.72	2438.12	(-) 0.12	-139.29 (-2.94)
Fertilizers- Urea	Kgs	45.49	333.43	46.12	368.96	(-) 0.63	-35.53 *(-5.05)*
DAP	Kgs	8.1	218.84	10.05	282.48	(-) 1.95	-63.64 *(-12.69)*
PPC	Liters	0.4	400	0.41	408	(-) 0.01	-8 *(-0.99)*
Rental value of land	—-	—-	346.84	—-	1006.69	—-	-659.85 *(-48.75)*
Total paid out costs	—-	—-	5888.01	—-	6779.79	—-	-891.78 *(-7.03)*
Main product yield	Qtls	4.59	17397.82	4.49	17275.76	0.1	122.06 *0.35*
By- product yield	Qtls	—-	—-	—-	—-	—-	—-
Gross return	—-	—-	17397.82	—-	17275.76	—-	122.06 *0.35*
Net Income	—‘	—-	11509.81	—-	10495.97	—-	1013.84 *4.6*
Per Rupee Return	—-		1.95		1.55		0.4 *11.43*

Source: Primary Survey; **Note:** Figures in parentheses indicate percentage differences of STFs over CFs

Table 6.3.8: Changes in the cost of cultivation and income of soybean post the adoption of RDFs (Rs/Acre)

Variables	Unit	After Soil-testing		Before Soil-testing		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labour cost			2187		2450	0.0	-263.3 (-10.8)
Manure/ FYM	Kg/acre	366.6	627	506.6	882	-140.1	-255.4 (-29.0)
Seed	Kgs	34.4	1652	39.9	1861	-5.5	-209.6 (-11.3)
Urea	Kgs	3.9	23	4.8	26	-0.9	-3.1 (-11.6)
DAP	Kgs	50.0	1389	50.0	1325	0.0	64.0 (4.8)
MOP	Kgs	0.0	0.00	0.0	0.43	0.0	-0.4 (100.0)
SSP	Kgs	126.8	761	147.0	821	-20.2	-59.9 (-7.3)
Zinc	Kgs	0.8	73	0.9	92	-0.1	-19.7 (-21.3)
PPC	Liters	0.8	532	0.97	588	-0.2	-55.8 (-9.4)
Others miscellaneous charges			183		247		-64.0 (-25.9)
Rental value of land			3272		2590		681.6 (26.3)
Land revenue			15		15		0.0 (0.00)
Total Cost			10714		10900		-185.6 (-1.7)
Main product yield		6.7	19632	5.8	15542	0.9	4089.6 (26.3)
By- product yield (RS/Qtl)		6.6	2310	5.9	2054	0.7	256.7 (12.5)
Gross Income			21942		17596	0.0	4346.3 (24.7)
Net Income			11228		6696	0.0	4531.9 (67.7)
B:C Ratio			**2.0**		**1.6**	**0.0**	

Note: Figure in parentheses show percentage difference after soil testing

6.3.9. Changes in the cost of cultivation and income of Basmati

The changes in the cost of cultivation and income of basmati crop with regard to the sample households of Punjab are presented in Table 6.3.9. A perusal of the table reveals that there is a slightly higher (0.53 kg.) use of nitrogen (N) fertilizer by soil-tested farmers as compared to control farmers. Whereas, there is a marginal decline in the expenses incurred on seed, micro-nutrients and plant protection chemicals by soil-tested farmers. FYM application is completely nil in respect of both soil-tested and control farmers. In spite of that, there is a higher basmati yield observed by soil-tested farmers to the extent of 0.18 quintal per acre (Rs. 499) and hence, the net income is higher by Rs. 430 as compared to control farmers.

From the above results, it can be concluded that soil-tested farmers have achieved slightly better results as compared to control farmers mainly in view of the adoption of RDFs. It is also pertinent to mention here that there are numerous factors that might influence the productivity of crops with fertilizer use being one of them. But the results need to be verified over a long period in order to be able to confirm the real impact of RDFs on production and productivity of agricultural crops. It is also imported to be noted that the mandatory production and distribution of Neem-Coated Urea (NCU) was introduced at the same period, which also might have played a positive role in reducing the cost of cultivation, while increasing agricultural production.

Table 6.3.9: Changes in the cost of cultivation and income of Basmati rice post the adoption of RDFs (Rs/Acre)

Variables	Unit	Soil-tested farmers		Control farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty(Kgs)	Cost (Rs)
Total labour cost	-	-	8838	-	8780	-	58
Seed	Kgs	4.12	803	4.05	805	0.07	-2
Fertilizers- N	Kgs	37.33	467	36.80	460	0.53	7
Micro nutrients	Kgs	1.15	35	3.00	90	-1.85	-55
Plant protection chemicals	Liters	-	1254	-	1300	-	-46
Irrigation	No.	18	-	18	-	-	-
Rental value of land	Rs.	-	20222	-	20063	-	159
Land revenue	-	-	-	-	-	-	-
Total cost	-	-	31619	-	31498	-	121
Main product yield	-	19.41	39305	19.23	38806	0.18	499
By- product yield							
(RS/Qila)	-	22.38	1618	21.90	1566	0.48	52
Net income	-	-	9304	-	8874	-	430

CHAPTER VII

SUMMARY, CONCLUSIONS AND POLICY SUGGESTIONS

7.1 BACKGROUND

Soil testing of the farmer's field, an integral part of the fertilizer management policy, helps understand the nutrient status and health conditions of crops being grown. It is a well-known fact that the Indian soils have become deficient over time in terms of major nutrients (NPK), as also secondary (Calcium, Magnesium, Sulphur) and micro nutrients (Boron, Chlorine, Copper, Iron, Zinc etc.). Deficiency in micronutrients during the last three decades has become more pounced both in terms of magnitude and extent, in view because of the increased use of inorganic fertilizers, use of high yielding crop varieties and increase in the cropping intensity which, in turn, have adversely affected the production and productivity of crops besides damaging soil properties. Therefore, it is extremely essential to arrest the declining trend soil nutrients and soil health through a judicious application of various required nutrients.

Due to lack of knowledge, unscientific application of synthetic fertilizers (either more or less) and low addition of organic matters to the soil systems, the soil health is deteriorating at a much faster rate than before. Hence, it is becoming a cause for concern in the recent years. Therefore, a soil test-based application of fertilizers is extremely important for ensuring an optimum fertilizer usage efficiency and better crop yield levels. In this direction, both the state and central governments have started paying a greater attention towards understanding and assessing the nutrient deficiencies facing the agricultural lands through preparation of district and block-wise soil fertility maps. Simultaneously, they have focused their efforts on expanding the testing facilities, popularizing the soil-test technology as part of a larger campaigns, using the information technology to deliver the soil nutrient status and appropriate recommendations to farmers. Among the different programmes undertaken by the central government, soil-testing programmes, implemented through National Mission for Sustainable Agriculture (NMSA) and Rashtriya Krishi Vikas Yojana (RKVY), are of greater importance.

Over the period, realizing the issues and challenges involved in the implementation of soil health programmes and also with a view to reaching out to the entire farming community across the country, the governments have adopted a grid-based sampling framework for assessing the soil health status at the lowest block levels. As part of this, the Government of India launched a Soil Health Card Scheme on 19th February, 2015 with a focused attention on soil health of agricultural areas across the country with the main objective of enhancing agricultural productivity through a judicious use of inputs, especially fertilizers. Under the SHC scheme, the cropped area is divided into grids of 10 ha for rain fed conditions and 2.5 ha for irrigated conditions and only one soil sample is taken from each grid and the test results are made known to all the farmers coming under either of the grids. The reports are given in the form of a SHC, which contains crop-wise recommendations of fertilizer use. The SHC has been designed to help farmers identify the health of soil systems and a judicious use of soil nutrients through proper monitoring. In this study, an attempt has been made to understand and document the issues related to implementation, awareness, adoption and impact of the SHC scheme on the farming community across India.

The specific objectives of the study are as follows:

1. To examine the status and implementation of the Soil Health Card Scheme in the country.

2. To examine the level of adoption of the soil health card scheme and constraints involved in the distribution of the soil health card to farmers.

3. To analyze the impact of adoption of recommended doses of fertilizers on crop productivity and the income of soil-tested farmers.

The study relied on both the primary and secondary data. A multi-stage sampling procedure was adopted for the sampling framework. In the first stage, Karnataka, Maharashtra, Punjab, Madhya Pradesh, Bihar and Assam states f were included or the study. In the second stage, depending upon the progress and implementation status of the SHC scheme, two districts from each state were selected for the study. The primary data were drawn from a list of farmers who had got tested their soil systems under the SHC Scheme through their respective State Department of Agriculture/ Horticulture. Similarly, from each district, two taluks/tehsils were selected in the third stage. Lastly, from among the selected taluks, two clusters of villages comprising 3-4 villages per cluster were selected for conducting the primary survey. A total of 30 farmers, who had tested their soil-systems under the SHC scheme, were selected randomly from each district. Both qualitative and quantitative information related to the objectives under the study such as farmers awareness regarding the SHC programme, sources of information about the SHC scheme, soil testing, benefits of soil testing, reasons for soil testing or not testing, adoption of recommended doses of fertilizers, problems involved in the implementation of the SHC programme, suggestions for improvement in the implementation of the programme etc., was collected from the sample farmers using a pre-tested questionnaire. The secondary information related to the number of soil samples collected, samples tested, SHCs printed and dispatched across the country was collected from the website of MoA&FW. The cluster approach was followed to ensure that adequate numbers of with-soil-health card farmers were available for the survey. Further, an adequate care was taken to ensure that the selected villages shared certain common characteristics with respect to soil type, irrigation and crop variety.

The survey also included 30 control (not soil-tested) farmers from each state and district, selected randomly from the chosen clusters for differentiating the effect of the application of recommended doses of fertilizers on crop productivity and income. Thus, the study covered a total of 120 sample farmers per state, representing 60 soil-tested farmers (under SHC Scheme) and 60 control farmers. Thus, the total sample for India represented 720 farmers. An adequate representation was given to different farm size groups based on operational land holding. Three major crops from each state were considered for analyzing the impact of the SHC scheme.

7.2 SUMMARY OF FINDINGS

7.2.1. Status of Soil Health Card (SHC) programme in India

SHC Scheme is being implemented in the country over a two-period Cycles. Although targets in terms of soil sample collection, soil sample testing, SHCs printing and distribution had been set at 253 lakhs for the period from 2015-16 to 2016-17, the achievement is found to be cent per cent in terms of sample collection, 99 per cent in respect of sample testing and printing of SHCs, but the distribution is found limited to 98 per cent as on 13th March 2018. The progress of soil sample testing is very much slow in the case of Punjab (<60%), whereas, West Bengal and Assam have failed in printing and distributing of SHCs. These delays in Punjab, West Bengal and Assam may attributed to poor an implementation of the scheme in these states, specifically due to lack of infrastructure and staff in the soil testing laboratories.

All India progress of SHC scheme during Cycle II (from 2017-18 to 2018-19), in terms of soil samples collected, is found to be 93 per cent while the proportion is 70 per cent with respect to soil samples tested. However, SHCs have reached to just 20 to 26 per cent of the farmers as on 13th March 2018. The progress in terms of soil sample collection is cent per cent or more in respect of states like Maharashtra, Gujarat, Tamil Nadu, Haryana, Chhattisgarh, Uttarakhand, Himachal Pradesh and Puducherry (UT). However, the soil sample collection progress is more than 90 per cent in Uttar Pradesh, Madhya Pradesh, Karnataka, Andhra Pradesh, Bihar and Telangana states. Similarly, the progress of sample collection is more than 50 per cent and less than 90 per cent in states such as Rajasthan, West Bengal, Punjab, Odisha, Goa, Jharkhand, Meghalaya, Tripura and Andaman & Nicobar. Unfortunately, the pace of sample collection is found to be less than 50 per cent the rest of the states. The situation is much worse when it comes to soil samples tested, SHCs printed and distributed in Cycle II across all the selected states.

7.2.2. General characteristics of the sample households

For the majority (97%) of the sample soil-tested farmers across the sample states agriculture is the main occupation with 25 years of farming experience & seven years of schooling. The average family size comprises six members, out of which two are engaged in farming. Coming to the social status/composition, a majority of the soil-tested farmers belong to Other Backward Classes (OBCs: 47%), followed by general category (45%) and the rest constitute SC & STs.

Similarly, for a majority of the control farmers (>95%), agriculture is the main occupation across all the states, with 25 years of farming experience and 5 years of schooling. As far as schooling is concerned, it is up to high school level in the case of Punjab and Maharashtra control farmers in contrast to primary school level in respect of those in states like Bihar, Madhya Pradesh, Assam and Karnataka. The average family size comprises six members with half of them being engaged in farming only.

The net operational landholding per household of soil-tested farmers is as high as 13.55 acres in the state of Punjab, while it is almost half of it in Karnataka (7.20 acres), followed by Maharashtra (6.20 acres) and Madhya Pradesh (6.03 acres). On an average, the leased-in land constitutes 1.37 acres and again it is highest (4.80 acres) in respect of Punjab, while the rest of the states, account for less than two acres. On the other hand, leased-out land constitutes less than an acre/household. Of the net operated land, a major proportion (59%) falls under the category of irrigated land and the rest under rainfed (40%). At the aggregate, the average rental value for leased-in land works out to almost Rs. 18000/ acre under irrigated conditions, while Rs. 6000/acre under rain fed conditions. As usual, the rental values of land are observed highest in respect of Punjab (Rs. 40731/ acre) alone, which might be due to an assured irrigation.

Coming to control farmers, there seem to be wider variations in the landholding size across states with the highest net operated land found in the state of Punjab (11.55 acres), followed by Karnataka (7.35 acres), Madhya Pradesh (5.55 acres) and Maharashtra (5.20 acres. Relatively, the land-leasing status is similar to that of soil-tested farmers. Out of the total operated area, nearly 59 per cent is irrigated and the rest un-irrigated. At the aggregate, the average rental value for leased-in land is highest with regard to Punjab (Rs. 39362/- acre) and lowest in Bihar (Rs. 2964/- per acre) for irrigated land, while it is less than six thousand rupees per acre for the un-irrigated land.

The major sources of irrigation are bore wells (98%) in the sample areas, followed by dug wells (38%) and canals (16%). Both the soil-tested and control farmers have grown crops like paddy, maize, tur, jowar, soybean, vegetables and other crops (which include pulses and vegetables) in the study states with their proportions being relatively the same in respect of both (control and soil-tested farmers) the cases. Overall, control farmers have sold an average of 33 quintals of agricultural produce at the price of Rs. 1432/ quintal, which amounts to a gross income of Rs. 47336 per season (kharif 2015). Correspondingly, soil-tested farmers have sold 41 quintals of agricultural produce at a unit price of Rs. 1429/-, which amounts to a gross income of Rs. 59105/- per season. It is interesting to note that soil-tested farmers have achieved a better return as compared to control farmers, which might be due to the adoption of soil-test technology-based RDFs.

7.2.3. Awareness regarding soil testing

The study results reveal that, overall, a majority of the soil-tested farmers are aware of soil health card (98%), followed by the ongoing programmes under soil health mission (57%) and an imbalanced application of fertilizers and their adverse effects (48%). Further, about 29-30 per cent of them are also aware of INM and a reduction in the consumption of chemical fertilizers due to INM, respectively. Across sample states, excepting Assam, more than 58 per cent of the soil-tested farmers are had knowledgeable about the ongoing programmes under soil health mission. Similarly, more than 55 per cent of the soil-tested farmers of Punjab, Maharashtra, Madhya Pradesh and Bihar are knowledge about the imbalanced application of fertilizers and their harmful effects. Less than half of the farmers have experienced a reduction in consumption of chemical fertilizers due to INM in almost all the sample states. However, less than 20 per cent of the soil-tested farmers are aware of the grid system under SHC scheme.

With regard to control farmers, less than half of them are aware of soil health card (43%), followed by the imbalanced application of fertilizers and their harmful effects (37%). However, only 10 per cent of the soil-tested farmers are aware of the grid system followed for the selection of soil samples under the SHC scheme. Across sample states, the situation

is slightly better in Bihar, Assam and Punjab, with a majority of the control farmers being aware of soil health card (>53%) and the effects of an imbalanced application of fertilizers (>47%). The awareness level is very low (5%) among the control farmers of Karnataka regarding all the aspects of soil health management.

Although there exist many sources of information available on soil testing and its related aspects, overall, a majority (57%) of the farmers are found to have got the information from the State Department of Agriculture (SDA),followed by State Agriculture Universities (SAUs) (17%) and neighbours (10%).Interestingly, less than two per cent of the farmers also are found to have got information on soil testing from friends; in fact, this was a primary source of information related to agriculture earlier.

State Department of Agriculture (SDA), State Agricultural Universities (SAUs) and KVKs conduct training programmes related to the various aspects of agriculture. It is found that a very negligible proportion of the farmers attended training programmes related to the application of chemical fertilizers, while about 21 per cent of the soil-tested farmers and 15 per cent of the control farmers had attended trainings for an average duration of one day.

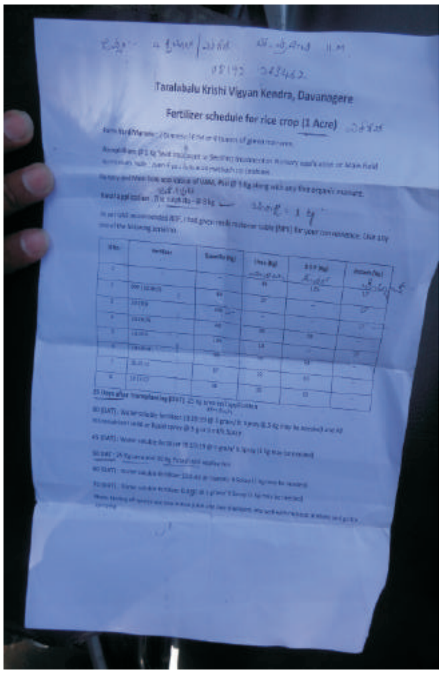
Overall, a majority of the farmers had applied Urea (95%), DAP (75%), SSP (67%), Potash (55%) and complex fertilizers (28%), using broadcasting method, while 35 per cent and 17 per cent of the farmers had applied micro nutrients and other fertilizers, following spraying and drilling methods, respectively. Although the soil health card scheme costs nothing for the farming community, on an average, farmers have been incurring a cost of Rs.51/ sample with the average distance from the field to soil-testing laboratory being 21 kms. On an average, three samples were collected from two plots over an area of around four acres for soil testing under the SHC scheme.

At the aggregate, a majority of the soil-tested farmers had purchased Urea (64%), DAP (59%), SSP (33%), potash (43%) and micro nutrients (43%) from private fertilizer shops/ dealers, while complex fertilizers (21%) and bio-fertilizers (10%) were purchased from Co-operative societies.

Farmer facilitators were the major source for soil sample collection (33%), followed by SDA (24%) and SAUs (9%). Interestingly, one third of the sample farmers also expressed that they themselves had collected soil samples in view of their previous experience. While a less than one per cent of the soil sample collection was done by KVKs.

7.2.4. Adoption of recommended doses of fertilizers

Generally, educated farmers follow the package of practices (POP) published by the State Agricultural Universities (SAUs) for the application of inputs and operations to be undertaken in the cultivation of crops. POP also suggests the farmers to undertake soil testing at least once in three years, as each farm varies in terms of nutrient status and other soil parameters. However, it is observed that a majority of the farmers neither follow POP nor RDFs prescribed in the SHCs.



The (weighted) average quantity of RDFs for paddy crop, as per the SHC, is to the tune of 78 kg/acre of urea, 36 kg/acre of DAP, 26 kg/acre of MOP and 98 kg/acre of SSP. When it comes to the average quantity of RDFs for paddy crop, Madhya Pradesh is the only state to have signified higher requirements of macronutrients and FYM, whereas, the rest of the states either denote more or less of one or the other nutrients. The average RDFs for red gram include 79 kg/acre of urea, 29 kg/acre of DAP, 43 kg/acre of MOP and 39 kg/acre of SSP. However, the recommendations are higher for Karnataka as compared to Maharashtra. The aggregate recommended doses of fertilizers for jowar include seven tons of FYM/acre, 63 kg/acre of urea, 89 kg/acre of DAP, 39 kg/acre of MOP and 45 kg/acre of SSP, but the recommendations are more than twice the quantity of DAP for Karnataka as compared to Maharashtra.

Similarly, the quantity recommendations (RDFs) for wheat crop are higher for Maharashtra in contrast to Bihar, excepting urea nutrient. The average quantity recommended for wheat is 71 kg/acre of urea, 42 kg/acre of DAP, 43kg/acre of MOP and 55kg/acre of SSP. The average recommendations comprise 8 tons/acre of FYM, 114 kg/acre of urea, 51 kg/acre of DAP, 20kg/acre of MOP and 133 kg/acre of SSP. Here, excepting urea (123kg/acre) and SSP (140kg/acre), all other nutrient recommendations are higher in respect of Madhya Pradesh.

With respect to ragi crop in Karnataka, the average RDFs, as per the SHC include 54, 79 and 17 kg/acre of nitrogen, phosphorous and potassium fertilizers respectively, along with 3.7 tons of FYM. In the same way, RDFs for soybean crop in Madhya Pradesh stand at 18 kg/acre of urea, 62 kg/acre of DAP, 14 kg/acre of MO and 152 kg/acre of SSP, along with 8 tons/acre of FYM. The recommendations (RDFs) for horse gram involve 14:13:21 kg/acre of urea, DAP and MOP respectively. In respect of potato vegetable, Bihar soil test reports suggest 181 kg/acre of urea, 133 kg/acre of DAP and 77 kg/acre of MOP. It appears from the results that the RDFs are much higher than for any other field crop. Interestingly, only 30 kg/acre of urea is recommended for basmati rice in Punjab.

In the case of paddy, farmers have either applied less or more than the RDFs in almost all the sample states. On an average, excepting DAP, all other fertilizers are found applied less than the recommended level. Across states, Madhya Pradesh farmers are found to have applied higher quantities than the RDFs when it comes to DAP (9 kg/acre) alone, but the rest of the fertilizers such as SSP, MOP, urea and FYM are found applied in lesser quantities to the extent of 152 kg/acre, 27 kg/acre, 65 kg/acre and 7.7 tons/acre correspondingly, and the difference is substantial. Both DAP (22 kg/acre) and Urea (6 kg/acre) fertilizers are found applied in higher quantities than the recommended doses by Bihar paddy farmers, while the application of MOP and FYM is found comparatively low.

As regards red gram, the average quantities of fertilizers applied far exceed the recommended doses in the respect of nutrients such as DAP (44kg/acre) and MOP (4 kg/acre), while relatively less than the recommended quantities in respect of urea (7 kg/acre), SSP (2 kg/acre) and FYM (1.4 tons/acre). However, Karnataka farmers have applied slightly lower quantities of urea (18 kg/acre), MOP (8 kg/acre) and FYM (1.2 tons/acre) while substantially (80 kg/acre) higher quantities of DAP, that exceed the recommended levels. Similar to red gram, the average quantities of fertilizers applied by the jowar farmers are found relatively on par with the RDFs in terms of NPK chemical fertilizers, whereas, FYM application is substantially low (4.4 tons/acre). Unfortunately, the difference between the recommended and applied quantity of FYM is found to be negative and huge (seven tons/ acre) in respect of Karnataka, while urea usage is more than the recommended level (five kg/ acre). This variation might be due to successive droughts prevailing in the red gram and jowar growing areas of Karnataka during that period.

With respect to wheat crop, excepting DAP, the average quantity of fertilizers applied is found to be less than the recommended doses in terms of all nutrients (NPK) as well as FYM. In contrast to the average figures, the DAP application is found more than the recommended level (seven kg/acre) in the case of Bihar state, while all the other nutrients applied are found to be less. On the other hand, all the fertilizers applied are less than the recommended levels in respect of Maharashtra and the difference appears to be moderate in terms of urea (26 kg/acre), DAP (5 kg/acre) and MOP (22 kg/acre), while slightly large with reference to SSP (55 kg/acre) and FYM (2.9 tons/acre).

In the case of Ragi crop in Karnataka, all the fertilizers applied are more than the recommended levels (11 kgs of Urea/ acre, 5 kgs of DAP/ acre and 9 kgs of MOP/ acre), while the application of FYM is found slightly less (0.36 tons/acre). The difference in terms of application of RDFs to their actual application in respect of soybean farmers in Madhya Pradesh reveals that the application is slightly lesser than the recommended level in respect of almost all the fertilizers, but the difference is substantially high in terms of FYM use (7.6 tons/acre). Excepting urea, the application of all other fertilizers is relatively less in the case of relative to their lentil/gram crop, while the urea application is moderately higher (30 kg/acre) than the recommended quantity. Interestingly, there are no recommendations made of DAP, MOP, SSP and FYM for basmati crop in Punjab, excepting urea, but the soil-tested farmers have applied seven kg/acre more of urea than the recommended level.

Overall, a majority (69%) of the farmers have applied FYM to all the reference crops. A majority of the farmers have applied FYM (1.85 tons), followed by biogas (0.18 tons) and green manure (0.67 tons). Among all organic fertilizers, the prices of bio-fertilizers are found to be high (93 Rs/kg) as compared to FYM (2 Rs/kg) and bio-gas (1.2 Rs/kg). On the other hand, the area covered under these organic fertilizers appears to be highest with regard to FYM (two acres), followed by biogas and bio-fertilizers (one acre each).

Less than 27 per cent of the farmers have experienced a few problems in the implementation of SHC scheme across the sample states. Out of these problems, 'Not aware of the technique of taking samples 'is the major problem (as reported by 27 per cent of the farmers) followed by 'No training campaigns', 'SHCs are not distributed on time' (21%), 'Lack of information on soil test technology' (15%),' Lack of involvement of farmers while taking samples' (14%), 'Soil testing laboratories are far away' (13%), 'Don't know whom to contact' (9%) and 'Samples of soils are not collected from individual fields'(8%), according to their relative importance.

Based on the problems facing them, 'Need to create awareness regarding SHC scheme' has emerged as the major suggestion made by a majority (37%) of the sample farmers, followed by 'Need to organize trainings related to soil sampling' (24%), 'access to free and timely SHC distribution' (23%), 'establish soil test laboratories at each taluk level' (18%), 'information regarding SHC needs to be given' (15%) and 'soil samples should be collected from individual fields' (12%).

7.2.5. Impact of Soil Health Card scheme

Both before and after situations & with and without approaches have been used for assessing the impact of the soil health card scheme and the results reveal that a comparatively better yields are observed after the intervention of soil testing and adoption of RDFs (kharif 2015) as against the before situation (kharif 2014) in respect of almost all the sample crops chosen across states. However, the increase/ decrease in yield levels may not be directly attributed to the application of recommended doses of fertilizers alone, as there might be various other factors which could have also impacted crop yield in general.

The percent change in yield is highest to the extent of 44 per cent in respect of Bengal gram, followed by wheat (43%) in Karnataka, correspondingly maize (30%) in Madhya Pradesh and red gram (22%) in Maharashtra. The change in paddy yield is highest to the tune of 19 per cent in Madhya Pradesh and lowest (<1%) in the case of Punjab. Interestingly, out of all the sample states, the increase in yield levels is less than three per cent in respect of Punjab and Bihar.

A majority of the farmers have observed an increase in yield levels (45%) as the most important change post application of RDFs, followed by improvement in soil texture (12%), whereas, an improvement in crop growth and grain filling are considered as an important visible change by 38 per cent and 35 per cent of the sample farmers. On the contrary, for a majority of the farmers, less incidence of pest and diseases (46%) and changes in the application of other inputs like seed, labour, pesticide etc. (28%), are the least important changes noticed post adoption of RDFs.

In the case of Paddy, there is a minor decline observed in the usage of all chemical fertilizers such as nitrogen (N), DAP (P) and Potash (K), micronutrients and plant protection chemicals vis-a-vis control farmers. On the other hand, there is also an increase observed in the yield levels of both the main & by-products to the extent of 1.49 quintal/acre (Rs. 2889/-/ acre) and 4.47 quintal/acre (Rs. 831/ acre) respectively. Overall, the total increase in net returns from paddy is found to be to the extent of Rs. 3720/ acre as compared to control farmers post adoption of RDFs.

With regard to Wheat, there is a drastic decline observed in the usage of chemical fertilizers such as nitrogen (N) (7%), Phosphorus (DAP) (41%), Potassium (MOP) (27%) and Plant Protection Chemicals (PPC) (56%), as compared to control farmers. However, there has been a slight increase in the main product yield (0.11 quintals/acre), while a decrease in the by-product yield levels (1.39 quintals/ acre). Nevertheless, in value terms, there is an increase in the output levels to the extent of three and seven per cent, respectively.

In respect of Red gram, there is a minor decline observed in the usage of chemical fertilizers such as nitrogen (N) by 8.46 kg/acre and DAP (P) by 7.58 kg/acre by soil-tested farmers. At the same time, there is also an increase in the main product yield (0.56 quintal/acre) and returns (Rs. 6976/acre), indicating that there is an increase in the net income of farmers to the extent of Rs. 7891/acre.

As regards maize crop, there is a higher use of nitrogen (N) and phosphorus (P) fertilizers by control farms. In addition, there are also higher expenses incurred on variables such as labour and seed by soil-tested farmers as compared to control farmers. On the other hand, it is seen that maize yield is higher by 0.23 quintals valued at Rs.578 per acre for soil-tested farmers as compared to control farmers and hence, the net income is negative for both the farm categories due to the higher total cost.

In the case of Jowar crop, a minor decline is observed in the use of nitrogen (N) (9.98 kg/acre) and phosphorus (P) (4.7 kg/acre) by soil-tested farmers, while labour costs show a decline to the extent of Rs.517/ acre for control farmers. However, due to a slightly higher yield levels of both the main product and by-products, soil-tested farmers have managed to realize a little better gross income of Rs. 1456/ acre.

With reference to Ragi, there are no significant changes observed in the use of chemical fertilizers by both the soil-tested and control farmers during kharif 2015. However, due to a decrease in the labour costs and a slight increase in yield from ragi (0.36 quintal/acre) in respect of soil-tested farmers, the difference in net income over control farmers works out to be Rs.1243 per acre.

In the case of Lentil crop, at the aggregate, there is a decrease observed in the paid-out costs (7%) and an increase in net returns (5%) as compared to control farmers, whereas in respect of Soybean, the cost of cultivation shows a marginal decrease (2%) post adoption of RDFs with a better yield both in terms of the main and by-products to the extent of 26 per cent and 13 per cent, respectively. Finally, in the case of Basmati crop, a slightly higher (0.53 kg.) use of nitrogen (N) fertilizer is observed on the part of soil-tested farmers as compared to control farmers. In spite of that, soil-tested farmers have witnessed a higher basmati yield to the extent of 0.18 quintal per acre (Rs. 499) and hence, the net income is higher by Rs. 430 for them as compared to control farmers.

7.3. CONCLUSIONS

A balanced nutrition is critical to a satisfactory crop growth and production. Soil analysis is a valuable tool for farm practice, as it determines scientifically the required doses of inputs for an efficient and economic production. To overcome the adverse impacts of chemical fertilizers on soil health and environment, the Government of India has introduced various schemes and one of such schemes implemented during February, 2015, is popularly known as 'Soil Health Card Scheme'. Under the scheme a grid system has been introduced wherein the cropped area is divided into grids of 10 ha for rainfed and 2.5 ha for irrigated with only one soil sample taken from each grid and the test results are made known to all the farmers falling under either of the grids. The ultimate aim of the scheme is to encourage each and every farmer to make use of the soil testing technology and the associated benefits as part of a broader strategy of ensuring sustainable agriculture.

As per the records, the SHC scheme has been progressing satisfactorily in terms of soil sample collection, while the progress is slow in terms of testing, printing and distribution of SHCs due to poor infrastructure facilities, shortage of staff in the department and inadequate capacity building activities. Although the scheme is being implemented across states in the country, awareness regarding the programme is limited to 57 per cent of the soil-tested farmers. Out of these farmers, a very negligible proportion has adopted partially the soil testing technology and RDFs.

It is very interesting to note that, although soil-tested farmers have adopted soil test technology partially, a majority of them have experienced a decrease in costs, especially of macronutrient fertilizers (NPK), an increase in crop yield levels and a reduction in plant protection chemicals and an increase in income and improvement in soil health thereof.

Following before and after approaches, there is an increase in the yield levels of sample crops to as high as 44 per cent in respect of certain crops with no decrease in crop yields reported from the state. However, a majority of them have followed a sub-optimal usage of fertilizers/ recommendations. Hence, there is a need for the governments to make concerted efforts towards the promotion of soil test technology through massive campaign programmes, demonstrations, capacity building activities and better infrastructure facilities.

7.4. POLICY SUGGESTIONS

Based on the results, observations from the field and discussions held with the farmers and state government officials, we have come up with some policy suggestions for a better implementation of the programme. These include:

- Special training programmes/ camps/ demonstrations should be organised by the various stakeholders (SAUs, KVKs, SDAs, Private Companies) in the agricultural sector as part of educating the farmers regarding soil sampling, benefits of soil testing, balanced use of chemical fertilizers, INM and knowledge of SHC recommendations.
- For a successful implementation of the SHC scheme, there is a need for capacity building of the field-level staff along with the required facilities and equipment such as Soil Test Laboratories (STLs), manpower, high quality instruments/devices, etc., as these are the main reasons for undue delays in soil test analysis and distribution of SHCs.
- Field-level staff are not provided with GPS devices and hence, a majority of the field-level staff use their mobiles for tracing the sample points across the grids. Generally, these mobiles do not work properly due to network and visibility problems during day-time, making it difficult for the field staff to collect samples as per the procedure and targets set. Thus, the SDA should supply suitable GPS devices to all the field-level staff across the state.
- A majority of the states have reported delays in the distribution of soil test reports SHCs (Soil Health Cards) as the major problem facing all the soil testing programmes, including the SHC Scheme. As a result, farmers are more likely to lose their confidence in these programmes. Therefore, a timely distribution of SHCs (before sowing season) in hard copy and sensitizing farmers to the information provided in SHCs may promote, to a large extent, the adoption of recommended doses of fertilizers on the basis of soil test reports.
- It is noticed from among the soil-tested farmers that a majority have not treated SHC as an important document for protecting their soil systems (like our blood test reports).

Hence, there is a need for educating the farming community regarding the importance of soil health, benefits of soil testing, SHCs/ report, and the information on SHCs, knowledge about SHC recommendations etc., as part of encouraging the farmers towards a judicious/ balanced use of chemical fertilizers and thereby optimizing the crop yield levels.

- Gram panchayats should be involved in soil test campaigns on a priority basis alongside the SDA officials for a proper and better implementation of the soil health card scheme.
- Special care may be taken in the collection of representative soil samples. Validity of samples is to be ensured at all levels-starting from the collection stage to storage in labs even after analysis.
- The Department of Agriculture is expected to ensure an effective and live linkage between the field and the laboratory. Hence, there is a need for creating Soil Testing Labs (STLs), at least one in each taluka. Each lab can take up one village as a mission to see the utility of the SHC scheme by itself and find out shortcomings so that the whole SHC scheme can be improved on the basis of such direct observation / study. In addition, accreditation of such labs to National/international standard institutes should be initiated.
- There is an urgent need for making the SHC related information available to the farmers on their fingertips with the help of the available information technology through internet and mobile apps. Efforts should be made to integrate all the stakeholders such as farmers, government officials, fertilizer industries etc., through the web and mobile applications for assessing, producing, distributing and applying fertilizers scientifically as part of ensuring sustainable agriculture. Adoption of villages by industrialists may help to promote the development at a faster rate.
- There should be some incentives/awards put in place for farmers, Gram Panchayats, Agriculture Officers/ Assistant Director of Agriculture for the promotion of soil test technology, encouraging adoption of RDFs, undertaking production of green manure, vermi-compost and an increase in soil fertility in their areas over the years.

REFERENCES

Anonymous (2000). Relevance of soil testing of agriculture and the environment. Issue Paper Council for Agricultural Science and Technology, (15): 12.

Anonymous, (2008a). Factors affecting fertilizers consumption in India. *Agricultural Situation in India*, 65 (5): 353-356.

Anonymous, (2008b). Factors affecting fertilizers consumption in Haryana. *Agricultural Situation in India*, 65 (4): 227-231.

Biswas, P.P. (2002). Soil testing at farmers door step. Fertilizer News, 47 (10): 21-24.

Chanda, T. K. (2005). Need for higher use of plant nutrients for sustainable growth in agriculture. *Indian Journal of Fertilizer*, 1 (2) :13-18.

Chouhan R.S, Sharma H.O., and Rathi Deepak (2016), Extent of Adoption of Recommended Doses of Fertilizer in Soybean; Indian Ecological Society: International Conference, Natural Resource Management Ecological Prospective, 2 (Conference Number): 711.

Chouhan R.S, Sharma H.O., and Rathi Deepak (2015), Extent of Adoption of Recommended Doses of Fertilizer in Madhya Pradesh; *Agriculture Economics Research Review,* 28 (Conference Number): 320.

Desai, G. M.; Sagar V. and Sagar V. (1993). Fertilizer policies: A perspective on price and subsidy issues, International Food Policy Research Unit, Washington, DC, USA. *Fertilizer pricing issues related to subsidies*. 29-41 pp.

Dhyan Singh (1996). Planning and establishment of soil testing laboratory. *Fertilizer News*, 41 (3): 19-21.

Jha, D. and Sarin, R. (1980). Fertilizer consumption and growth in Semi-Arid Tropical India,*progress report, ICRISAT, Patancheru, A.P.*, NO. 10-24.

Keith Reid; Ontario. (2006). Soil sampling and analysis for managing crop nutrients, Ministry of Agriculture, Food and Rural Affairs, 2006.

Krishnamacharyulu, T. V. and Murlidhar, V. (1981). Interstate variations in trends of fertilizer use - A time series analysis. *Fertilizer Marketing News,* 12 (12): 3-6.

Leela, P. (1985). Fertilizer consumption in Andhra Pradesh- A district wise analysis. *Agriculture Situation in India,* 40 (8): 677-682.

Mohanam, T. C. (1989). Growth rate of fertilizer consumption: A distric wise analysis in Tamil Nadu. *Agricultural Situation in India*, 43 (11): 951-956.

Prasad, G. R. and Rao K. N. (2002). Thrust area of fertilizer promotional activities in NFCL. *Fertilizer News,* 47 (7): 31-36.

Shah, D. C. and Shah, Amita (1992). Efficiency of fertilizer use: Demand for soil testing services in Gujarat. *Indian Journal of Agricultural Economics,* 47 (3): 459-467.

Sharma H.O., Mishra P.K. and Chouhan R.S. (2015), Impact of Soil Testing in Madhya Pradesh; JNKVV Research Journal, 49 (2): 158-165.Singh, A. (1983). Regional disparity in fertilizer consumption in India. *Fertilizer Marketing News*, 14 (9): 1-6.

Kanwar L. Sahrawat and Suhas P. Wani (2013) Soil Testing as a Tool for On-Farm Fertility Management: Experience from the Semi-arid Zone of India., *Communications in Soil Science and Plant Analysis* Vol. 44, Iss. 6,2013

Sharma H.O., Yadav Rajeev, and Nahatkar S.B. (2005). Adoption Pattern and Constrains of Soybean Production Technology in Malawa Platues of M.P. *Agril. Situation in India,* 61 (4): 3 – 17.

Trivedi, H. P. and Patel N. M. (1994). Use of fertilizer in Indian agriculture- some environmental issues. *Artha Vikas*, 30 :17-22.

APPENDICIES

Appendix-I: Gross income realized by the sample households by agricultural production in Assam

Crops	Control farmers			Soil-tested farmers		
	Avg. qty sold (Qtls)	Avg. price (Rs/Qtl)	Gross income obtained (Rs)	Avg. qty sold (Qtls)	Avg. price price (Rs/Qtl)	Avg. income obtained (Rs)
KharifPaddy	13.18	1,223	2,274,214	12.98	1,225	2,260,113
KharifVegetables	2.30	1,145	228,519	3.68	1,143	378,870
Average	8.18	1212	9923	8.66	1208	10471

Appendix-II: Gross Income realized by the Sample Households by Agricultural Production in Bihar

Crops	Control farmers			Soil-tested farmers		
	Avg. qty sold (Qtls)	Avg. price (Rs/Qtl)	Gross income obtained (Rs)	Avg. qty sold (Qtls)	Avg. price price (Rs/Qtl)	Avg. income obtained (Rs)
Paddy	56.91	1073.50	61092.88	60.35	1067.67	64433.88

Appendix-III: Gross income realized by the sample households from agricultural production in Karnataka

Crops	Control farmers			Soil-tested farmers		
	Avg. qty sold (Qtls)	Avg. price (Rs/Qtl)	Gross income obtained (Rs)	Avg. qty sold (Qtls)	Avg. price price (Rs/Qtl)	Avg. income obtained (Rs)
Red gram	13.79	7671	105809	16.61	6430	106801
Jowar	17.84	3308	59029	13.75	2171	29849
Ragi	9.23	1607	14847	11.32	1495	16921
Chickpea	14.00	4183	58566	10.80	3840	41472
Maize	52.71	1147	60470	108.25	1321	143025
Tomato	152.50	525	80062	112.50	650	73125
Average	25.24	2242	56600	25.45	2423	61680

Appendix-IV: Gross Income Realized by the Sample Households by Agricultural Production in Maharashtra

Crops	Control farmers			Soil-tested farmers		
	Avg. qty sold (Qtls)	Avg. price (Rs/Qtl)	Gross income obtained (Rs)	Avg. qty sold (Qtls)	Avg. price price (Rs/Qtl)	Avg. income obtained (Rs)
Jowar	5.5	1602	10036	5.9	2030	9338
Moong	1.1	3655	5025	1.8	5553	10813
Soybean	13.2	3302	14984	18.2	3325	15630
Tur	2	7953	14016	3.4	7641	19632
Groundnut	0	0	0	3	5167	17300
Urd	6.9	5761	25184	3.8	5520	16115
Average	8.25	3470	28620	9.88	3568	35290

Appendix-V: Gross income realized by the sample HHs through agricultural production in Madhya Pradesh

Crops	Control farmers			Soil-tested farmers		
	Avg. qty sold (Qtls)	Avg. price (Rs/Qtl)	Gross income obtained (Rs)	Avg. qty sold (Qtls)	Avg. price price (Rs/Qtl)	Avg. income obtained (Rs)
Soybean	5.7	2970	17028	18.9	2835	53676
Paddy	17.5	1359	23785	20.1	1403	28160
Maize	5.5	1574	8657	6.3	1485	9281
Tur	4.1	4200	17220	4.3	4130	17759
Other (Urd)	2.2	2800	6160	2.6	3900	10101
Average	8.08	1912	15458	13.73	2200	30204

Appendix-VI: Gross income realized by the sample households by agricultural production in Punjab

Crops	Control farmers			Soil-tested farmers		
	Avg. qty sold (Qtls)	Avg. price (Rs/Qtl)	Gross income obtained (Rs)	Avg. qty sold (Qtls)	Avg. price price (Rs/Qtl)	Avg. income obtained (Rs)
Paddy	266.52	1450	386454	324.68	1450	470786
Basmati	14.77	2018	29806	9.60	2025	19440
Maize	4.27	1292	5517	6.35	1308	8306
Sugarcane	184.55	285	52597	227.43	285	64818
Vegetables	-	-	-	1.23	1800	2214
Average	210.2	1390	292440	241.0	1345	323817

Appendix-VII: Changes in cost of cultivation of Kharif paddy crop and income in Assam (Kharif 2015)

(Rs/Acre)

Variables	Unit	Soil-tested farmers		Control farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labor cost		45.38	10222	44.62	10207	0.76	15
Manure/ FYM	Tons	0.09	175	0.08	169	0.01	6
Seedlings	No/Kgs	18.63	466	18.6	465	0.03	1
Fertilizers- N	Kgs	9.08	82	8.8	79	0.28	3
P	Kgs	18.15	635	17.42	610	0.73	26
K	Kgs	15.13	303	14.3	287	0.83	16
Complex	Kgs	-	-	-	-	-	-
Others	Kgs	-	-				
Micronutrients	Kgs						
PPC	Liters						
Irrigation*	Acre inch	-	14	-	6	-	8
Others	-	-	-	-	-	-	-
Rental value of land	Rs	-	795	-	993	-	-198
Land revenue	-	-	176	-	176	-	0
Total Cost			12868		12993		-125
Return							
Main product yield	Qtls	13.12	16072	12.62	15434	0.5	638
By- product (Rs/Qtl)	-	2.04	509	1.87	468	0.17	41
Gross Income	-		**16581**		**15902**		**679**
Net income			**3713**		**2909**		**804**

Note: *Out of total paddy areas 140.65 acres (for soil-tested group) and 147.32 acres (for control group), only 10.76 acre and 4.84-acre areas are irrigated respectively.

Appendix-VIII: Changes in cost of cultivation of Kharif paddy crop and income in Bihar (Kharif 2015)

(Rs/Acre)

Variables	Unit	Control farmers		Soil-tested farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labour cost	H+B+M	—-	4131.73	—-	4720.47	—-	588.74 *(14.25)*
Manure/ FYM	Tonnes	0.63	568.21	1.43	789.81	0.80	221.60 *(39.00)*
Seeds	Kgs	20.53	1724.47	16.21	1476.80	(-) 4.32	(-) 247.67 *(-14.36)*
Fertilizers- Urea	Kgs	93.42	706.00	103.04	749.77	9.62	43.77 *(6.20)*
DAP	Kgs	29.94	834.55	43.38	1194.71	13.44	360.16 *(43.16)*
MOP	Kgs	22.45	257.64	16.87	181.58	(-) 5.58	(-) 76.06 *(-29.52)*
Bio-Fertilizers	Kgs.	—-	—-	88.18	191.36	—-	—-
Others	Kgs	—-	—-	2.76	69.36	—-	—-
PPC	Liters	1.11	467.60	0.92	413.32	(-) 0.19	(-) 54.28 *(-11.61)*
Irrigation	—-	—-	544.18	—-	698.77	—-	154.59 *(28.40)*
Rental value of land	—-	—-	3191.25	—-	3630.20	—-	438.95 *(13.75)*
Land revenue	—-	—-	54.73	—-	59.18	—-	4.45 *(8.13)*
Total paid out costs	—	—-	12480.36	—-	14175.33	—-	1694.97 *(13.58)*
Main product yield	Qtls	18.70	19539.67	19.07	20295.65	0.37	755.98 *(3.87)*
By- product yield	Qtls	1945	1912	1893	2070.40	(-) 52	158.40 *(8.28)*
Gross return	—-	—-	21451.67	—-	22366.05	—-	914.38 *(4.26)*
Net Income	—-	—-	8971.31	—-	8190.72	—-	(-) 780.59 *(-8.81)*
Per Rupee Return		—	1.71		1.58		(-) 0.13 *(-7.60)*

Source: Primary Survey; **Note:** Figures in parenthesis indicates percentage differences for STFs over CFs

Appendix-IX: Changes in cost of cultivation of Kharif paddy crop and income in Punjab (Kharif 2015)

(Rs/Acre)

Variables	Unit	Soil-tested farmers		Control farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labour cost	-	-	7697	-	7544	-	153
Manure/ FYM	Tonnes	1.29	354	1.89	520	-0.60	-166
Seed	Kgs	4.20	691	4.13	670	0.07	21
Fertilizers- N	Kgs	60.63	777	64.92	846	-4.29	-69
P	Kgs	2.00	79	3.51	132	-1.51	-53
K	Kgs	2.00	56	1.27	36	0.73	20
Complex	Kgs	-	-	-	-	-	-
Micro nutrients	Kgs	3.35	157	4.39	169	-1.04	-12
Plant protection chemicals	Liters	-	1574	-	1559	-	15
Irrigation	No.	30	263*	30	295	-	-32
Rental value of land	Rs.	-	20366	-	19681	-	685
Land revenue	-	-	-	-	-	-	-
Total cost	-	-	32014	-	31452	-	562
Main product yield	-	29.21	42355	29.07	42152	0.14	203
By- product yield	(Rs/Qtl)	-	-	-	-	-	-
Net income	-	-	10341	-	10700	-	-359

* Expenses on diesel for irrigation

Appendix-X: Changes in cost of cultivation of Kharif paddy crop and income in Madhya Pradesh (Kharif 2015)

(Rs/Acre)

Variables	Unit	After Soil Testing		Before Soil Testing		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labour cost			13002		15015	0.0	2013.1 (15.48)
Manure/ FYM	Kg/acre	240.7	310	194.7	248	46.0	61.6 (24.84)
Seed	Kgs	28.6	1442	31.4	1432	-2.7	10.4 (0.73)
Urea	Kgs	23.2	127	29.9	156	-6.8	-28.4 (-18.22)
DAP	Kgs	71.3	1894	89.9	2325	-18.6	-430.7 (-18.53)
MOP	Kgs	0.0	0	0.0	0	0.0	0.0 (0.00)
SSP	Kgs	0.0	0	0.0	0	0.0	0.0 (0.00)
Zinc	Kgs	3.7	230	3.9	252	-0.2	-21.9 (-8.71)
PPC	Liters	1.7	1260	1.87	1039	-0.2	221.2 (21.29)
Irrigation	Acre inch		0		0		0.0 (0.00)
Others miscell-aneous charges			211		269		-58.0 (-21.56)
Rental value of land			6186		4902		1284.7 (26.21)
Land revenue			15		15		0.0 (0.00)
Total Cost			26691		23639		3052.0 (12.91)
Main product yield		24.6	37118	20.6	29410	4.0	7708.1 (26.21)
By- product yield	(RS/Qtl)	34.7	6958	25.3	5460	9.3	1497.3 (27.42)
Gross Income			44076		34870	0.0	9205.5 (26.40)
Net Income			17385		11231	0.0	6153.5 (54.79)
B:C Ratio			1.7		1.5	0.0	

Note: Figure in the parenthesis shows percentage difference after soil testing

Appendix XI: Changes in cost of cultivation and income of Wheat in Maharashtra

(Rs/Acre)

Variables	Unit	After Soil Testing		Before Soil Testing		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labor cost		3	3492	3	3160	0	332
Manure/ FYM	Tones	2.3	2683	2.6	2433	-0.3	250
Seedlings	No/Kgs	29.4	1636	29.2	1379	0.2	257
Fertilizers- Urea	Kgs	48.9	305	46.6	284	2.3	21
DAP	Kgs	40.6	993	40.3	970	0.3	23
Potash	Kgs	25	435	0	0	25	435
SSP	Kgs	41.7	703	43.8	518	-2.1	186
Complex (10.26.26)	Kgs	43.8	911	50	1067	-6.3	-156
Others	Kgs	0	0	0	0	0	0
PPC	Liters	1	746	1.3	875	-0.3	-129
Irrigation	Acre inch	7.2	1638	6.8	1529	0.4	108
Others		8.5	2219	6.5	1943	2	276
Rental value of land	Rs	0	0	0	0	0	0
Land revenue	Rs	0	0	0	0	0	0
Total Cost	**Rs**		**15761**		**14158**		**1603**
Main product yield	Rs	8.5	2171	7.8	1997	0.7	174
By- product yield	Rs	4	360	3.9	317	0.1	43
Main Product Gross Income	Rs		18454		15577		2877
By-Product Gross Income	Rs		1440		1236		204
Gross Income	**Rs**		**19894**		**16813**		**3081**
Net Income	**Rs**		**4133**		**2655**		**1478**

Note: * indicates price per unit.

Appendix XII: Changes in cost of cultivation and income of Wheat in Bihar

(Rs/Acre)

Variables	Unit	Controle Farmers		Soil Testing Farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labour cost	**H+B+M**	—-	3057.08	—-	2532.52	—-	(-) 524.56 (-17.16)
Manure/ FYM	Tonnes	0.28	284.11	0.15	155.05	(-) 0.13	(-) 129.06 (-45.42)
Seeds	Kgs	46.51	1339.26	46.98	1368.39	1.47	29.13 (-2.17)
Fertilizers - Urea	Kgs	46.89	340.33	36.44	293.35	(-) 10.45	(-) 46.98 (-13.8)
DAP	Kgs	74.64	2906	43.79	1211.97	(-) 30.85	(-)1694.03 (-58.29)
MOP	Kgs	26.92	303.3	14.1	173	(-) 12.82	(-) 130.30 (-42.96)
Bio-Fertilizers	Kgs.	—-	—-	50.13	213.5	—-	—-
Others	Kgs	—-	—-	—-	—-	—-	—-
PPC	Liters	4.22	269	2.42	76.67	(-) 1.80	(-) 192.33 (-71.50)
Irrigation	—-	—-	845.47	—-	1483.7	—-	638.23 (-75.49)
Rental value of land	—-	—-	2000	—-	2585.13	—-	585.13 (-29.25)
Land revenue	—-	—-	—-	—-	—-	—-	—-
Total paid out costs	—-	—-	11344.55	—-	10093.28	—-	(-) 1251.27 (-11.03)
Main product yield	Qtls	13.08	19497.61	13.19	20554.76	0.11	1057.15 (-5.42)
By- product yield	Qtls	12.75	2532.44	11.36	2833.29	(-) 1.39	300.85 (-11.88)
Gross return	—-	—-	22030.05	—-	23388.05	—-	1358 (-6.16)
Net Income	—-	—-	10685.55	—-	13294.77	—-	2609.27 (-24.42)
Per Rupee Return	—-	1.94		2.32		0.38 (-19.58)	

Source: Primary Survey; **Note:** Figures in parenthesis indicates percentage differences for STFs over CFs

Appendix XIII: Changes in cost of cultivation and income of Red gram in Maharashtra

(Rs/Acre)

Variables	Unit	After Soil Testing		Before Soil Testing		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labor cost		3	3264	3	3098	0	166
Manure/ FYM	Tones	2.4	2681	2.6	2606	-0.2	75
Seedlings	No/Kgs	19.5	1160	19.7	1062	-0.2	97
Fertilizers- Urea	Kgs	46.4	295	47.1	287	-0.7	8
DAP	Kgs	39.2	990	31.9	808	7.3	183
Potash	Kgs	25	420	25	420	0	0
SSP	Kgs	37.5	275	33.3	323	4.2	-48
Complex (10.26.26)	Kgs	39.8	799	42.4	857	-2.6	-58
Others	Kgs	0	0	0	0	0	0
PPC	Liters	1.3	775	1.2	841	0.1	-66
Irrigation	Acre inch	3.1	1146	3.2	1057	-0.1	89
Others		4.4	1591	3.1	1410	1.3	181
Rental value of land	Rs	0	0	0	0	0	0
Land revenue	Rs	0	0	0	0	0	0
Total Cost	**Rs**		**13397**		**12770**		**627**
Main product yield	Rs	4.5	4881*	4	4961*	0.5	-80
By- product yield	Rs	2.4	390	2.3	325	0.1	65
Main Product Gross Income	Rs		21965		19844		2121
By- Product Gross Income	Rs		936		748		189
Gross Income	Rs		22901		20592		2309
Net Income	**Rs**		**9504**		**7821**		**1682**

Note: * indicates price per unit.

Appendix XIV: Changes in cost of cultivation and income of Red gram in Karnataka

(Rs/Acre)

Variables	Unit	Soil Tested Farmers		Controle Farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labor cost		13	3167	14	3269	1	102
Manure/ FYM	Tons	1.04	1510	1.08	1281	0.04	-229
Seedlings	No/Kgs	3.06	482	3.22	513	0.16	31
Fertilizers- N	Kgs	26.95	186	35.41	247	8.46	61
P	Kgs	29.98	695	37.56	979	7.58	284
K	Kgs	-	-	-	-	-	-
Complex	Kgs	5.65	161	20.02	424	14.37	263
Others*	Kgs	1.00	15	-	-	1	-15
Micronutrients	Kgs	8.74	184	2.02	44	6.72	-140
PPC	Liters	0.78	1919	7.20	2117	6.42	198
Irrigation	Acre inch	-	-	-	-	-	-
Others	-	-	-	-	-	-	-
Rental value of land	Rs	1	1214	1	1214	-	-
Land revenue	-	-	-	-	-	-	-
Main product yield	Q	2.91	23957	2.35	16621	0.56	7336
By- product (Rs/Qtl)	-	-	-	-	-	-	
Gross return	Rs	-	23957	-	16621	-	6976
Total cost	Rs	-	9553	-	10088	-	-535
Net Income	Rs	-	14404	-	6533	-	7891
BC Ratio	-	1.50	0.64	0.86			

Source: primary data * Others – include 20:20:20; 17:17:17; 20:20:0 etc.

Appendix XV: Changes in cost of cultivation and income of Maize in Punjab

(Rs/Acre)

Variables	Unit	Soil Tested Farmers		Controle Farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labour cost	-	-	7833	-	7800	-	33
Manure/ FYM	Tonnes	-	-	-	-	-	-
Seed	Kgs	8	1308	8	1267	-	41
Fertilizers- N	Kgs	55.03	877	67.67	1051	-12.64	-174
P	Kgs	19.17	720	21.08	792	-1.91	-72
K	Kgs	-	-	-	-	-	-
Complex	Kgs	-	-	-	-	-	-
Micro Nutrients	Kgs	-	-	-	-	-	-
Plant protection chemicals	Liters	-	592	-	608	-	-16
Irrigation	No.	3	-	3	-	-	-
Rental value of land	-	-	16900	-	16250	-	-650
Land revenue	-	-	-	-	-	-	-
Total cost	-	-	28230	-	27768	-	462
Main product yield		17.56	22968	17.33	22390	0.23	578
By- product yield (RS/Qtl)	-	19.80	1996	19.30	1872	0.50	124
Net income	-	-	-3266	-	-3506	-	240

Appendix XVI: Changes in cost of cultivation and income of Maize in Madhya Pradesh

(Rs/Acre)

Variables	Unit	After Soil Testing		Before Soil Testing		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labour cost			2932		3212	0.0	280.0 (-8.72)
Manure/ FYM	Kg/acre	235.0	540.5	231.0	531.3	4.0	9.2 (1.73)
Seed	Kgs	4.5	135.0	5.4	162.0	-0.9	-27.0 (-16.67)
Urea	Kgs	21.8	109.0	25.6	128.0	-3.8	-19.0 (-14.84)
DAP	Kgs	36.9	959.4	37.5	975.0	-0.6	-15.6 (-1.60)
MOP	Kgs	0.0	0.0	0.0	0.0	0.0	0.0 (0.00)
SSP	Kgs	18.2	109.2	21.1	126.6	-2.9	-17.4 (-13.74)
Zinc	Kgs	1.3	58.5	0.9	40.5	0.4	18.0 (44.44)
PPC	Liters	1.7	765.0	1.9	889.0	-0.2	-124.0 (-13.95)
Irrigation	Acre inch		0.0		0.0		0.0 (0.00)
Others miscellaneous charges			143.0		171.0		-28.0 (-16.37)
Rental value of land			3468.0		1926.0		1542.0 (80.06)
Land revenue			15.0		15.0		0.0 (0.00)
Total Cost			9234.6		8176.4		1058.2 (12.94)
Main product yield		9.3	13020.0	6.3	8820.0	3.0	4200.0 (47.62)
By- product yield	(RS/Qtl)	24.0	4320.0	15.2	2736.0	8.8	1584.0 (57.89)
Gross Income			17340.0		11556.0		5784.0 (50.05)
Net Income			8105.4		3379.6		4725.8 (139.83)
B:C Ratio			1.9		1.4		0.5

Appendix XVII: Changes in cost of cultivation and income of Jowar in Maharashtra

(Rs/Acre)

Variables	Unit	After Soil Testing		Before Soil Testing		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labor cost		3	3540	3	3310	0	230
Manure/ FYM	Tones	1.9	3039	2.1	2980	-0.2	59
Seedlings	No/Kgs	4.8	245	4.9	221	-0.1	23
Fertilizers- Urea	Kgs	46.6	348	46.1	285	0.5	63
DAP	Kgs	39.3	999	41.4	1072	-2.1	-74
Potash	Kgs	25	430	37.5	535	-12.5	-105
SSP	Kgs	35	262	25	190	10	72
Complex (10.26.26)	Kgs	42.5	863	41.3	843	1.3	20
Others	Kgs	0	0	0	0	0	0
PPC	Liters	1.3	875	1	500	0.3	375
Irrigation	Acre inch	3.1	1273	3.4	1310	-0.3	-38
Others		5	1915	3.0	1814	1.6	101
Rental value of land	Rs	0	0	0	0	0.0	0
Land revenue	Rs	7	1300	5	1200	2.0	100
Total Cost	**Rs**		**15088**		**14260**		**828**
Main product yield	Rs	7.1	1870*	6.7	1746*	0.4	124
By- product yield	Rs	12.8	836	11.1	744	1.7	92
Main Product Gross Income	Rs		13277		11698		1579
By-Product Gross Income	Rs		10701		8258		2442
Gross Income	Rs		23978		19957		4021
Net Income	**Rs**		**8890**		**5697**		**3193**

Note: * indicates price per unit.

Appendix XVIII: Changes in cost of cultivation and income of Jowar in Karnataka

(Rs/Acre)

Variables	Unit	Soil Tested Farmers		Controle Farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labor cost		6	1220	8	1737	2	517
Manure/ FYM	Tons	0.75	754	0.75	754	0	0
Seedlings	No/Kgs	3.38	176	3.38	175	0	1
Fertilizers- N	Kgs	25.23	183	35.21	229	9.98	46
P	Kgs	28.16	704	32.86	826	4.7	122
K	Kgs	-	-	-	-	-	-
Complex	Kgs	-	-	-	-	-	-
Others*	Kgs	0.28	28	-	-	-	-
Micronutrients	Kgs	-	-	-	-	-	-
PPC	Liters	-	-	-	-	-	-
Irrigation	Acre inch	-	-	-	-	-	-
Others	-	-	-	-	-	-	-
Rental value of land	Rs	-	-	-	-	-	-
Land revenue	-	-	-	-	-	-	-
Main product yield	Q	3.47	7315	2.91	6103		1212
By- product (Rs/Qtl)	-	10.32	1061	8.07	812		249
Gross returns	Rs	-	8376	-	6920		1456
Total cost	Rs	-	3065	-	3721		-656
Net Income	Rs	-	5311	-	3199	-	2117
BC Ratio	-	1.70	0.85	0.85			

Source: primary data * Others – include 20:20:20; 17:17:17; 20:20:0 etc.

Review of the Report & Comments included in the Report

I. Title of the Draft Study Report Examined:

Impact of Soil Health Card Scheme on Production, Productivity and Soil Health in Karnataka

II. Date of Receipt of the Draft Report:

September 28, 2017

III. Date of Dispatch of Comments:

October 31, 2017

IV. General Comments

1. This is an important study as indicated by the title and the objectives. Fertilizer is a highly subsidized input, and with substantial & increasing fertilizer use, a huge amount of expenditure is incurred by the government towards fertilizer subsidies. It is reported that the fertilizer use by farmers often exceeds the recommended doses and is frequently inconsistent with the real requirement of the crops and the soils. The results are not only wasteful/ inefficient use of fertilizers but also a large subsidy burden on the government. If the fertilizers were to be applied in accordance with the soil test reports and the doses recommended accordingly, not only would the fertilizer use be reduced but the crop yields may be even higher.

2. In this context, the study with the given objectives is of considerable usefulness through examining the level of adoption of soil health cards and its impact on crop productivity and income.

3. The objective of the study is to examine the status of soil health card scheme in Karnataka and its social-economic characteristics. The study has examined the awareness of SHC scheme, its adoption among the farmers and impact of SHC in crop productivity and income, also touching upon the constraints faced by farmers in using SHC's.

Comments on the Methodology and Analysis

1. Chapter I (1.3- Need for the Study) - It would be good to show some data/charts on why there is a need for the study such as fertilizers use trends, changes in NPK ratios - **need for the study is explained with the data on NPK Consumption Ratio Since 2007-08 to 2016-17.**

2. Chapter II: In table 2.1, for the cycle-II, target set for sample collection and actual samples collected have a huge gap. What are the possible reasons for this gap? – **No**

much difference in targets set & actual sample collection in both the period (Cycle I & II). The actual target set for sample collection in Cycle I was 2.53 lakhs and the actual samples collected were 2.53 lakhs (100%) while the target set for sample collection in Cycle II was 2.74 lakhs and the actual samples collected were 2.54 lakhs as on November, 2018.

3. Chapter III - V: The Chapters extensively give statistics of the profile of the sample farmers on socio-economic or other characteristics, separately for Soil Test farmers and Control Farmers, often in separate Tables. The comparison is often difficult, and are all characteristics meaningful? Some consolidated Tables giving the comparison on some meaningful characteristics where differences are expected might be useful. These could appear at least towards the end section. Also, if these characteristics are related to the adoption of soil health cards, the adoption of recommended doses, and the impact – then more meaningful conclusions can be derived. Such analysis could appear in Chapters V & VI - **Consolidated Tables are prepared as suggested in Chapter III & the other Tables seems to be already consolidated and hence, kept them as it is in Chapter IV & V. Further, analysis could not include in this report due to insufficient data during consolidation.**

4. Chapter IV: In Table 4.1, what is the meaning of "overall" column? It must be clearly mentioned in the text. Is it an average? – **Overall column in the Table 4.1 depicts the weighted average of all states.**

5. Tables where there is a comparison between control farmers and soil tested farmers, a column chart or bar chart would be very useful to show the difference. For, e.g. in Table 4.1. – **Based on the suggestion and suitability, Figure 4.1 is formed to represent the comparison between control farmers and soil tested farmers.**

6. Table 4.4 and 4.4.1 shows the difference in methods of applying fertilizers by soil-tested and control farmers. Column or description showing the differences would be helpful and make it easier to see the difference. – **Table 4.4 deals with the methods of fertilizer application by the soil-tested farmers only and hence comparison is not made.**

7. Chapter V: It would be useful to show overall sample "N" in the top right of the tables. – **As suggested 'N' is shown in the top right of the tables.**

8. The fertilizer doses are given in kg/acre. The standard/ usual way to give fertilizer doses or use levels is kg of nutrient (N, P or K) per hectare. Even if it is given in terms of urea or DAP it should typically be in kg/hectare. – **Incorporated the suggestions.**

9. Chapter VI: It would be useful to show overall sample size "N" on the top right of the tables. - **As suggested 'N' is shown in the top right of the tables.**

10. Table 6.1 only states full adoption of RDFs has had a positive impact. But this is not clear. Other factors also play an important role. Simple averages show that the percentage difference is positive but quite small both for yield and value. A dummy variable regression would give an estimate of the difference and show the statistical significance of the difference. - **analysis could not include in this report due to insufficient data during consolidation.**

11. Table 6.1: The after to before difference again appears positive but quite small. Numbers for the overall sample at the bottom of the Table would help give a clearer conclusion. Exploring the reasons for the variation in this across the sample in relation to some socio-economic characteristics from Chapter 3 would be interesting. A column of the N for each may be given. A dummy variable regression on the lines discussed above would give the statistical significance and the estimate. - **analysis could not include in this report due to insufficient data during consolidation.**

12. Table 6.2 may need some restructuring. A bar graph can be added – **As suggested a bar graph is included.**

13. If the variation is related to some of the socio-economic characteristics given in Chapter 3, it may reveal some interesting patterns or reasons – such as with farm size, age, irrigation or crop. This could be done through Tables, correlation or regression analysis. - **analysis could not include in this report due to insufficient data during consolidation.**

14. Chapter VII: The changes and findings from the above points may be reflected in this concluding chapter as well as in the Executive Summary. – **All changes are included in the Chapter VII.**

V. Comments on the Presentation, Get up etc.

A. Comments on Table presentation:

As suggested comments included in the Table presentations

B. Comments on other issues:

Typographic matters are corrected as suggested by the reviewer.

VI. Overall View on Acceptability of the Report

The report has valuable and useful content and is quite acceptable. If some of the suggestions and comments given above can be addressed/ included, it will help to make this a better report.