Report No. 42

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

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Foreword

Green Revolution Technologies have substantially increased crop yields. But it has indirectly impacted on the soil in terms of quality or health or its fertility because of injudicious and imbalanced application of chemical fertilizers. Since soil is fundamental to life on earth so, as in many other areas of science, there needs to be a more concerted efforts on synergy between fertilizers in relation to crop yields and health of the soil. The compatible goals should be sustainable agricultural intensification and a healthy environment. Perhaps with this view, the Government of India had launched a centrally sponsored Soil Health Card (SHC) Scheme in 2015. Its monitoring and evaluation are also the priorities of the Government to make the scheme successful at the field level. I am happy to hear that the scheme has been evaluated in Bihar along with other states by the respective AERCs/Units. The result of the study relating to the status of awareness, adoption of recommended doses of fertilizers and its effects on farm yields and income etc., in Bihar are, no doubt, useful. It is hoped that the policy managers and implementation functionaries of the Governments of India & Bihar and other research professionals and practitioners will be benefitted from the findings of the study.

I thank all the members of the Project Team, particularly Dr. Ranjan Kumar Sinha, Principal Investigator of the study, for its meaningful completion.

08/09/17

(Nalini Kant Jha)

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Preface

Soil health is an assemblage of chemical, physical and biological parameters that closely relate to native or acquired production capacity and sustenance of ecologically important regulatory role. A soil is said to be suffering from ill health when it is unable to perform either of these functions. It happens when a soil is employed for a purpose for which it is not suitable or is managed poorly. In fact, soil health decline has been there since time immemorial. But several on-station and on-farm studies have clearly shown that soil health could be restored and improved through soil test based balanced and integrated use of chemical fertilizers and plant nutrients. The Government has made huge investments for improving the declining status of soil fertility through several agricultural development schemes in the country. With the intent of improving the soil health, a centrally sponsored scheme on Soil Health Card was launched by the Hon'ble Prime Minister in February, 2015 for soil test based health management practices.

The study on **"Impact of Soil Health Card Scheme on Production, Productivity and Soil Health in Bihar"** was assigned to this Centre by the Directorate of Economics & Statistics, Ministry of Agriculture & Farmers Welfare, Government of India for the work-plan year 2016-17 under the Co-ordination of ADRTC, ISEC, Bengaluru. Accordingly, this study was undertaken for the reference period of kharif, 2015 in two sample districts viz., Saran and Banka with 120 sample farm households, consisting of 60 soil tested farmers and 60 control farmers on three major crops viz., paddy, wheat and Lentil. The study found a positive impact of SHC scheme on yield of these crops by 1.98 per cent for paddy, 0.84 per cent for wheat and 2.23 per cent for Lentil after the application RDF. Besides, a number of constraints were also observed, which are required to be removed for realizing the greater benefits of the programme. We hope that the findings of the study would be useful to policy makers, implementation functionaries, research professionals and other stakeholders.

We record our deep sense of gratitude to the Hon'ble Vice-Chancellor, Prof. (Dr.) Nalini Kant Jha for his kind endeavour in completion of this study. It is our privilege to express our deep admiration to Dr. K B Ramappa, Associate Professor, ADRTC, ISEC, Bengaluru for designing and successfully co-ordinating the study and his valuable comments on the draft report. We are also grateful to Mr. Ram Prakash Sahni, Joint Director (Chemistry) and Mr. Sanjay Kumar, Dy. Director (Chemistry), CSTL, Government of Bihar, Patna for providing us all necessary data and information. We express our sincere thanks to Mr. Sudama Mahto, DAO-Cum-Assistant Director, DSTL, Banka and Mr. Binay Kumar Pandey, Assistant Director, DSTL, Saran for extending their kind co-operation in collection of data and information.

We wish to express our sincere thanks to all the members of the Project Team for involving themselves in pursuing the study. We will be failing in our duty, if we do not thank the respondents for sparing their valuable time and providing required information and data.

Basant Kumar Jha
Ranjan Kumar Sinha

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EXECUTIVE SUMMARY

Soil health is synonymously used in terms of soil fertility or nutrient status. Its deterioration in considered as one of the major second generation problems, occurred due to use or abuse of Green Revolution Technologies. According to latest estimates of ICAR (2010), around 120 mha (104 mha arable land) of the country is subjected to land degradation due to soil erosion caused by water and wind, chemical degradation (salinity, alkalinity, acidity) and physical degradation (water logging). As per the NAAS (2010) data, Nagaland (93.48%) has the highest in terms of area affected by various kind of land degradation followed by Manipur (79.17%), Meghalaya (77.21%), Tripura (77.02%), Kerala (67.13%), Uttar Pradesh (60.38%), Rajasthan (59.68%), Assam (58.27%), Mizoram (55.17%), Jharkhand (49.46%) and in Bihar, it is only 14.56 per cent.

Soil health management is a widely studied area in soil science across the country, but most of the researchers have remained confined to soil fertility and nutrient management. So soil health and quality have remained matters of great concern for the Government of India. Government has made huge investments in arresting soil degradation and improving the declining status of soil fertility in the country. For this purpose several developmental schemes have been implemented from time to time. On 19th February, 2015 National Mission on Soil Health Card (SHC) has been launched as a centrally sponsored scheme by the Hon'ble Prime Minister to provide soil test based fertilizer recommendations to all the farmers across the country. It aims at issuing SHC to each of the 140 million farmers once in a cycle of 3 years on a continuous basis. Though each cycle would be of 3 years, the maiden cycle is being squeezed to 2 years to facilitate quick soil test based health management practices.

In Bihar, the State Department of Agriculture have been issuing SHCs to farmers since Xth Five Year Plan (2002-07) and till 2014-15, it had issued 15.7 lakh SHCs. This new SHC scheme is implemented in all the 38 districts of Bihar with a target of 13.09 lakh soil samples to be collected during 2015-16 and 2016-17. Till 14th March 2017, 9.23 lakh samples (70.51%) were collected and 8.28 lakh samples (63.25%) were tested. A total of 28.67 lakh SHCs were printed and the average SHCs printed per tested sample was 3.46. All the printed SHCs were reported to be distributed. Considering all the facts, the INM Division of the Ministry of Agriculture & Farmers Welfare, Government of India felt the need of examining the impact of SHC scheme on production, productivity and soil health in selected six states including Bihar and thus, this study was entrusted to six AERCs/Us in their respective states under the Co-ordination of ADRTC, ISEC, Bengaluru with following specific objectives:

i. *To document the status and implementation of soil health card scheme.*
ii. *To analyse the impact of soil testing technology and recommended doses of fertilizers on the bases of SHCs, on crop production, productivity and soil health.*

The present study is based on primary data collected from two sample districts viz., Saran and Banka. From each selected district, two blocks and from each of the selected blocks, two clusters of villages were selected. A sample of 15 soil tested farmers and an equal number of control farmers were selected from each block. Taking together 30 soil tested farmers and 30 control farmers were selected from each of the selected districts. This way from two sample districts, the sample forms 120 farm households comprising 60 soils tested and 60 control farmers. The study was undertaken by survey research method for the reference period of kharif, 2015.

Major Findings

- *An average sample household was of 43.65 years of age, in which he/she spent only 6.52 years in education and have 5.3 persons in his/her family, out of which 2.20 persons were found to be engaged in farming. All the sample households were engaged in agriculture as main occupation and 95 per cent of them were males and were found to have 19.26 years of experience in farming. The social composition of the respondents was dominated by other backward castes (68.33%) followed by general (23.33%), scheduled castes (6.67%) and scheduled tribes (1.67%). Almost similar findings were observed in control and soil tested farmers both with a very little variation. Except in case of control farmers, there were no scheduled tribe respondents.*

- *The average land owned by a sample farmer on overall basis was found to be 2.88 acres, 0.98 acres of leased-in and 0.14 acres of leased-out. The average net-operated area was found to be 3.64 acres. Of the net operated area, nearly 80 per cent is irrigated and 20 per cent is un-irrigated. The rental value of irrigated leased-in land as reported by the sample household was Rs. 3218.12 per acre and the irrigated leased-out at Rs. 2636.10 per acre. It is interesting to note here that the rental value of irrigated leased out land was quite low as compared to irrigated leased-in land. Moreover, no remarkable difference between the control and soil tested farmers was found in the study area.*

- *At overall level, canal (88.33%) was found to be the major source of irrigation among the sample households followed by dug-well (32.50%) and bore-well (22.50%). In case of control and soil tested farmers, no significant differences were found in respect of sources of irrigation.*

- *During kharif 2015, the sample households grew only paddy. Of the total net operated area, about 95 per cent area was covered under paddy. Across the control and soil tested farmers about 94 and 96 per cent respectively of the net operated area were devoted to paddy crop. The average gross income realized by the soil tested farmers (Rs. 64433.88) was found to be higher as compared to control farmers (Rs. 61092.88).*

- *Awareness relating to imbalanced application of fertilizers and its effects, soil health cards and knowledge about on-going programmes on Soil Health Mission were found to be higher in regard to soil tested farmers as compared to control farmers. But in case of households' knowledge about Integrated Nutrient Management (INM) and experience of reduction in consumption of chemical fertilizers due to INM were found to be higher in case of control farmers as compared to soil tested farmers. On overall level, majority of the households were aware of SHCs (82.50%) but only a few households were aware on grid system under SHC scheme (10.83%). The analysis of awareness on soil testing reveals that the knowledge and awareness of the sample households on different parameters are good irrespective of soil tested or not.*

- *Major sources of information amongst the soil tested farmers were the Agriculture Department (86.67%) followed by neighbours (13.33%) whereas in case of control farmers the sources, which remained instrumental, were neighbours (30.00%), friends/relatives (23.33%) and Agriculture Department (11.67%).*

- *There was no specific training programme organised in the study area on application of fertilizers and thus, none of the sample households could availed such training programme. Broadcasting method of application of fertilizers was the only method for all the sample households.*

- *An average soil tested farmer covered a distance of 14.57 kilometres from the field to soil testing lab i.e., DSTL for getting his/her soil tested. It is done free of cost. On an average, 6.25 samples were taken for soil testing with 3.02 average number of plots and 1.56 acres of average area.*

- *The major source of purchase of fertilizers such as urea, DAP, and MoP, was reported to be private fertilizer shops/license dealers and co-operative societies, while the micro-nutrients was found to have been purchased only from private fertilizer shops/license dealers and bio-fertilizers largely from the government source (in-terms of subsidy or with rabi/kharif kit) followed by private shops and units operating in the village/nearby areas.*

- *All the soil tested farmers reported that their soil samples were collected by Kisan Salahkar/Co-ordinator of the State Agriculture Department.*

- *On an average 97.13 kg of urea, 20.90 kg of DAP and 37 kg of MoP were recommended for per acre cultivation of paddy by respective DSTLs. In cultivation of per acre of wheat, 76.57 kg of urea, 37.18 kg of DAP and 37.98 kg of MoP were recommended, while 14.14 kg of urea, 12.9 kg of DAP and 20.86 kg of MoP for cultivation of per acre of horse gram/chickpea. Apart from these RDF, DSTLs also recommended per acre of 3029 kg FYM for paddy, 2639 kg for wheat and 539.8 kg for horse gram/chickpea. As far as the farmer's opinion is concerned, the average quantity of fertilizers in cultivation of paddy was found higher for urea and DAP, whereas in case of MoP it was found lower. In case of wheat, farmer's opinion was found lower for urea and MoP but higher for DAP. Similarly, the farmer's opinion in case of lentil/gram was found higher for urea and lower for DAP. The average quantity of FYM required to be applied across the selected crops was also found to be lower than the recommend quantity based on soil test results.*

- *Majority of the households used to apply organic fertilizer in the form of FYM (99.33%), vermin compost (42.50%) and bio-fertilizer (18.33%) in average quantity of 1672.04 kg/acre, 92.42 kg/acre and 86.34 kg/acre respectively with average prices of Rs. 3.78/kg, Rs. 2.69/kg and Rs. 6.63/kg respectively. The average area covered under organic fertilizers in the form FYM, vermi-compost and bio-fertilizer were found to be 3.11 acres, 2.19 acres and 0.22 acre respectively.*

- *Major problems reported by majority of the soil tested farmers were printing of SHC reports in a mix script/language of English and Hindi and recommendations made on acre basis, was hardly understood by them (81.67%) followed by SHC programme is merely a fulfilment of targets of sample collection and distribution of SHC reports, its findings are not explained or dealt to the farmers by the functionaries of the State Agriculture Department (75%), less awareness about the grid system of soil sample collection (65%), SHC reports are not delivered in time (53.33%), soil test is not done in farms of farmers' choice (31.67%), ploughing of fields have made the fields undulated in such cases one sample for having different beds does not provide results for the field as a whole (28.33%) and lack of farmers' participation in the programme (25%).*

- *SHC report may be printed in Hindi and the recommendations may also be made in local units for measurement of land, such as katha or bigha (71.67%), making aware of simple method of collection of soil samples and get the same tested preferably at soil testing mobile van (STMV) and reports should be delivered immediately (53.33%), the recommendations should be explained by organising camps at panchayat/village level (46.67%), collection of soil samples should be made from different beds of a field and the*

reports should be prepared separately for each bed (28.33%) and the scheme may be implemented in one grid-one sample-one beneficiary mode for enhancing the faith in SHC reports (26.67%) were the major suggestions reported by the sample households for improving the SHC scheme in the study area.

- *A positive change in yield of three major crops was observed. Per acre yields of paddy, wheat and lentil were found to have increased by just 1.98 per cent, 0.84 per cent and 2.23 per cent respectively after application of RDF.*

- *The most important changes which were observed by the sample households were improvement in crop growth, less incidence of pest and disease, decrease in application of inputs like seed, labour, pesticides etc. Important changes, which were observed by the sample households, were improvement in grain filling, improvement in crop growth, decrease in application of other inputs like seed, labour, pesticides etc. Increase in crops yield, less incidence of pest and disease, improvement in grain filling etc. were observed as least important ones.*

- *In cultivation of paddy, per acre expenditure for soil tested farmers was found to have decreased for seeds (14.36%), MoP (29.52%) and PPC (11.61%), while the expenditure on labour, manure/FYM, urea, DAP, irrigation, etc. were found to have increased by 14.25 per cent, 39.00 per cent, 6.20 per cent, 43.16 per cent, 28.40 per cent respectively for soil testing farmers. The total cost of cultivation for paddy was found to have increased from Rs. 12480.36 to Rs. 14175.33 per acre registering an increase of 13.58 per cent with decrease in net income from Rs. 8971.31 to Rs. 8190.72 per acre (- 8.81%). Per rupee return was also found to have decreased by 7.60 per cent i.e., from 1.71 to 1.58 for soil tested farmers. So in case of cultivation of paddy, the impact of SHC scheme is far from the satisfactory level.*

- *In cultivation of wheat, per acre expenditures on seeds (2.17%), irrigation (75.49%) and rental value of land (29.25%) had increased on soil tested farmers while labour (- 17.16%), manure/FYM (-45.42), urea (-13.80), DAP (-58.29%), MoP (-42.96%), and plant protection chemicals (-71.50%) were found to have decreased on soil tested farmers. The total paid-out cost was also found to have reduced by 11.03 per cent with an increase in net income of about 24.42 per cent on soil tested farmers. Per rupee net return was found to have increased from 1.94 to 2.32 i.e., an increase of 19.58 per cent. Analysis reveals that the impact of SHC scheme on cultivation of wheat was positive and encouraging.*

- *In cultivation of lentil pulse, per acre expenditures on soil tested farmers were found to have decreased in almost all inputs except labour, which recorded an increase of only 0.72 per cent. Decrease in costs were seen in seeds by 5.71 per cent, urea by 9.63 per cent, DAP by 22.53 per cent, plant protection chemicals by 1.96 per cent and rental value of land by 65.55 per cent. The total paid-out cost was found to have decreased by 13.15 per cent i.e., from Rs. 6779.79 per acre to Rs. 5888.01 per acre. The net return was found to have increased by 9.66 per cent i.e., from Rs. 10495.97 per acre to Rs. 11509.81 per acre (an additional return of Rs. 1013.84 per acre). Per rupee return was also found to have increased by 25.81 per cent (from Rs. 1.55 to Rs. 1.95). It indicates that there was positive impact of SHC scheme on cultivation of lentil and income there from.*

Policy Suggestions

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

i. *Soil testing is not a priority for farmers in general. So the farmers are required to be sensitized and there is need to make them partners of the programme for greater benefits of soil tests in a massive campaign mode. Wall writings, audio-visual clips (films/songs), TV advertisements, distribution of leaflets and pumplets, door-to-door campaign, trainings/meetings at Block/Panchayat/Village level etc. may be the instruments for the same. Scientists and faculties of Krishi Vigyan Kendras (KVKs), State Agricultural Universities (SAUs), Agro-Economic Research Centres (AERCs) etc. may be involved with the nodal agency for implementation of such programme.*

ii. *All DSTLs are required to be optimally strengthened in terms of laboratory designed buildings, adequate technical personnel and their capacity building, quality instruments, availability of adequate and in time contingent funds for day to day expenses, laboratory cadre staff, updating of software/app, headed by full time Chemists, liberal support of the state government etc. to make the DSTLs more efficient and vibrant ones.*

iii. *Adoption of RDF and nutrient use by majority of the farmers should be the target. This will require regular interaction with all concerned and a mission mode implementation, monitoring and evaluation of the scheme.*

iv. *Reliability of soil samples and its results should be ensured at all levels with careful efforts.*

v. *Printing of SHC report may be made exclusively in Hindi (Deonagri script) particularly in Bihar and the recommendations be made for at least five local major crops and units of land measurement in local units also like; bigha or katha.*

vi. *Secondary and micro-nutrient analysis at the DSTLs may also be included.*

vii. *Since DSTLs are literally cut-off from the fields, so for each year, at least one revenue village may be adopted by the DSTLs for implementation of best practices in the light of soil test results and its documentation may be made for dissemination to other villages as well.*

CHAPTER – I

INTRODUCTION

1.1 Background

Soil is the essence of life on the planet Earth. It has sustained humanity and human civilizations through five functions *(Karlen et.al, 1997)* viz., (i) sustaining biological activity, diversity and productivity; (ii) regulating and partitioning water and solute flow; (iii) filtering, buffering, degrading, immobilizing and detoxifying organic and inorganic materials; (iv) storing and cycling nutrients and other elements within the earth's biosphere; and (v) providing support to socio-economic structures and protection for archaeological treasures associated with human habitation.

Notwithstanding the significant growth in agriculture during the last six and half decades, most of India's soil-based production systems are showing signs of fatigue. The conservative estimates show that the demand for food grains would be 355 MT by 2030 against the present level of 270 MT. Contrary to increasing food demand, the factor productivity and rate of response of crops to applied fertilizers under intensive cropping systems are declining year after year. Currently, the nutrients use efficiency (NUE) is quite low. It is 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). Low NEU results in deterioration of physical, chemical and biological health of soils *(Dey, 2016).*

Soil health is the capacity of a soil to function as a living system, with ecosystem and land use boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health (www.fao.org/agriculture/crops/thematic...../soil;..... of soil/healthy-soil/en). The Soil Science of America defines soil health 'as the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality and support human health and habitation. Several other researchers *(Doran & Parkin, 1994; Karlen et.al 1997)* have proposed near similar concept of soil health. It is linked to the status of various nutrients, useful biota and physical parameters. Hence, the need for nurturing the soil health for sustaining agriculture is of paramount importance. Its well being is thus, essential for the very existence of mankind.

In mid 1960s, with the advent of Green Revolution, the technology driven farming started, which engendered significant changes in food production and livelihood

security of farmers, traders and other stakeholders. Green Revolution was principally based on high responsiveness of plant varieties to intensive use of agro-chemicals and water. However, its indiscriminate use led to several problems, often termed as second generation problems, challenging the sustainability of production and productivity gains achieved earlier. Soil health deterioration is considered as one of the major second generation problems. Depletion in soil organic carbon levels, emergence and spread of micronutrient deficiencies, and sub-soil compaction have been frequently documented. Inadequate and imbalanced use of plant nutrients lead to excessive mining of finite nutrient reserves in the soil rendering the latter progressively poorer over the years. Such nutrient mining has serious implications, viz.; more acute and widespread nutrient deficiencies, declining fertilizer use efficiency and returns from money spent on these and falling response ratio of other inputs, a weakened function for high yielding sustainable farming and escalating remedial costs for rebuilding depleted soils *(Dalwai & Dwivedi, 2016).*

In India, out of total geographical area (328.73 mh), 163 mh (49.58%) was affected by various kinds of soil degradation (NCA, 1976). *Sehgal & Abrol (1994)* estimated the extent of land degradation to 187.8 mh (57.13%) in 1994 and 202 mh (61.45%) in 1997. However, the ICAR (2010) harmonised land degradation data and reported that 120.40 mh (36.63%) suffers from different forms of soil degradation. This includes water and wind erosion (79.79%), water logging (0.75%), soil alkalinity (3.08%), soil acidity (14.89%), soil salinity (2.26%) and mining and industrial waste (0.21%). The extent and severity of such degradation, however, varies *(Bhattacharya et al. 2015).* Nagaland (93.48%) has the highest in terms of area affected by various kinds of land degradation to total geographical area followed by Manipur (79.17%), Meghalaya (77.21%), Tripura (77.02%), Kerala (67.13%), Uttar Pradesh (60.38%), Rajasthan (59.68%), Assam (58.27%), Mizoram (55.17%), Jharkhand (49.46%) etc. The extent of land degradation in Bihar is only 14.56 per cent (NAAS, 2010).

1.2 Review of Literature

There exists a wide range of studies on soil health or quality or fertility. First systematic soil fertility map of Indian soils was published in 1967 by *Ramamurthy & Bajaj (1969).* At that time around 4 per cent samples were high in available P. Recently prepared GIS based district wise soil fertility maps of India *(Muralidharudu et al. 2011)* showed that soils of about 57 districts were low in available N, 36 per cent medium and 7 per cent were high. Similarly, soils of about 51 districts were low, 40 per cent were medium and 9 per cent were high in available P. Available K status showed that the soils of about 9 per cent districts were low, 42 per cent were medium and 49 per cent were high in available K status. The high P status in some soils is due to non-judicious use of phosphatic fertilizers by the farmers. This

suggests that the considerable proportion of soil in the country may have become rich in available P as the farmers continue to use the phosphatic fertilizers. The deficiency of nitrogen might continue to remain same in Indian soils, as they are low to medium in organic matter content. The three estimates *(Ramamurthy & Bajaj, 1969; Ghosh & Hasan, 1980; Motsara, 2002)* of soil fertility for K indicate an increase in the percentage of samples testing high over the year.

By now, it has become amply clear that it is a management mediated interaction of user community with soils that is primarily responsible for enhancing or upsetting quality of soil in the recent times, of all the organisms dependent on soils for their survival, humans and their animal support system assert maximum pressure on soil health. Soil has a finite space to accommodate a certain number of needy mortals i.e., carrying capacity of the soils. If the carrying capacity is transgressed consistently, soil quality declines due to overburdening. Since population has already hit the wall, it is more urgent now then even before to save soils from ongoing deterioration in soil health. Business as usual approach will only heighten environmental crisis costing 5-25% drop in crop yields *(Nellemann et al. 2009).*

Transfer of ecological secure lands to cropped area by removal and or burning escalates incidence of adverse effects on soil's health and its climate regulatory function. Ongoing transfer of prime agricultural land in the vicinity of urban areas to fill the needs of industrial and infrastructural projects is another source worsening soil and environmental crisis. Conversion of this kind has been happening swiftly across China and India over the last 50 years *(Bongaarts, 1998).* FAO (1976) observed that land use changes that are at odds with sustaining vegetative cover or utilising unsuitable soils for farming spur incidence of land degradation process.

While fertilizers have been harbinger of Green Revolution, they also are alleged to cause fall in soil health and climate change. Available information does not prove if fertilizer use has any direct link to the ongoing mess up in soil health or global warming. What emerges is their continuing inefficient use that provokes rise of multi-nutrient deficiencies, contamination of ground waters, etc. *(Katyal, 2015).*

Like fertilizers, irrigation is necessary to realise the productivity potential of HYVs. However, continuing poor water use efficiency (<50%) of canal water affects soil health due to rise in salinity and water logging. *Qadir et al. (2014)* observed that every day for more than 20 years, an average of 2000 hectares of irrigated land in arid and semi-arid areas across 75 countries have been degraded by salts. Then, overdevelopment of underground water is common across length and breadth of the world *(Frankelo, 2015).*

With the increased farm intensification, agriculture has become more and more industrialised. Its reliance on fossil fuel energy for powering machinery and manufacture of agro-chemicals has replaced manual labour and draft animals. With that allocation of fossil fuel energy for use of agriculture has increased faster in the core of Green Revolution regions of the world e.g., like India. India and USA employ 25 per cent and 6 per cent respectively of the total energy for agriculture. Heavy subsidy on power to Indian farmers is not the core issue, but it is that free energy that instigates its misuse, it is a matter of grave concern. According to *Jha et al. (2012),* 50 per cent of the energy allocated for agriculture is consumed by 23 million electric/diesel pump sets having energy use efficiency of no more than 30 per cent. Likewise of 30 per cent energy appropriated for manufacture of fertilizers, at least one-half of that stands unutilised. Calculations of *Pimentel & Pimemtel (2012)* confirm inefficiency of energy use by highly mechanised industrial agriculture compared to traditional or sustainable modern system of farming. Antecent waste in energy is released into the atmosphere as Co and Co_2. Resultant global warming influences soil health due to accelerated breakdown of active pool of SOC--- nucleus of good soil health.

The Soil Health Index (SHI) is worked out for soils under different treatment and cropping system in a large number of long term fertility experiments in India by different researchers *(Mandal et al. 2005; Chaudhury et al. 2005; Sharma et al, 2005, 2008; Mohanty et al 2007; Masto et al 2007, 2008; Bhaduri & Purakayastha 2014; Bhaduri et al 2014; Kundu 2014; Basak et al 2016 a, b, c).* Most of them found higher SHI values in soil cultivated with balanced use of NPK than those cultivated with the imbalanced ones. Again, values of such SHI were always higher with than without organics/FYM.

It is quite clear from above reviews that soil health management is very important for sustained agricultural growth. It is perhaps due to this the Department of Agriculture, Co-peration and Farmers Welfare, Government of India has accorded its priorities on it. It has initiated several central sector schemes during different five year plans to sustain high productivity and enhance farmers' income through soil health improvement and judicious use of plant nutrients and soil ameliorants. These were Balanced and Integrated use of Fertilizers in 1991-92; Macro Management Scheme, which included distribution of SHCs to the farmers during 10th Five Year Plan (2002-07), National Project on organic family during 11th Five Year Plan (2007-12), National Project on Management of Soil Health and Fertility (NPMSH & F) during the 11th Five Year Plan (2007-12). Besides, NPMMSH & F, a few components of other two national flagships scheme/mission namely RKVY and NFSM also partly address soil health related issues. So, the past initiatives have helped to an

extent in promoting balanced and integrated use of plants nutrients by raising farmers' awareness and also by strengthening relevant infrastructure. However, the desired objectives remained only partially fulfilled. With lack of information on soil health, there is always likelihood of neglect of nature and extent of certain nutrients deficiencies and excessive use of N. Irrational consumption of N skewed fertilizer consumption ratio in favour of N *(Dwivedi, 2012)*. Further, the usage of secondary and micronutrients remained neglected. These developments signalled failure of interventions in right tracking yield to the desired levels.

In fact, State Department of Agriculture have been issuing SHCs to the farmers, since 10th Five Year Plan. Soil health management (SHM) is one of the sub-missions of National Mission for Sustainable Management (NMSM). It aims at strengthening of soil test infrastructure in the states including building their manpower capacity. It is operated as a centrally sponsored scheme and the pattern of assistance was 75:25 till the year 2014-15, which is now 60:40 w.e.f., 2015-16. This paved way for launch of a comprehensive scheme for soil analysis across the country in a time bound and on a continuous basis and recommendation for suitable treatment of soils. Thus, a new initiative--- Soil Health Card (SHC) scheme was launched as a centrally sponsored scheme by the Hon'ble Prime Minister on 19th February, 2015. INM (Integrated Nutrient Management) Division of the DACF & W has been mandated to implement this scheme. It aims at issuing SHCs to each one of the 140 million farmers of the country once in a cycle of 3 years on a continuous basis. This will facilitate building up of the soil database of the country and monitor the changes in the soil health status periodically. It lays down a grid of 10 hectare in rain fed and 2.5 hectare in irrigated areas for collection of soil samples. Based on the soil test results of a grid generated composite sample, each farm will get a SHC. This translates into a total of about 25.3 million soil samples to be tested in the laboratories. Though each cycle would be of three years, the maiden cycle is being squeezed to 2 years to facilitate quick soil test based health management practices. Accordingly, the target has been split into 10 million in 2015-16 ad 15.3 million in 2016-17 to generate 140 million SHCs over these two years. The subsequent cycle will, however, run over a period of 3 years each.

In Bihar, the State Department of Agriculture has been issuing SHCs to farmers since Xth Five Year Plan and cumulatively the department have issued 15.7 lakh SHCs till 2014-15. This new SHC scheme is being implemented in all the 38 districts of Bihar. But, the soil testing laboratories infrastructure is found to be weak in the state. The details of its infrastructure may be seen from table 1.1:

Box – 1

Objectives of SHCs Scheme

- *To issue soil health cards every 3 years to all farmers of the country, so as to provide a basis to include deficient nutrients in fertilizer practices.*
- *To diagnose soil fertility related constraints with standardized procedures for sampling uniformly across states and analysis; and design Taluka/Block level fertilizer recommendations in targeted districts.*
- *To develop and promote soil test-based nutrient management in the districts for enhancing nutrient use efficiency.*
- *To build capacities of district and state level staff and of progressive farmers for promotion of nutrient management practices.*
- *To strengthen functioning of Soil Testing Laboratories (STLs) through capacity building, involvement of students agricultural and science colleges and effective linkage with Indian Council of Agricultural Research (ICAR)/State Agricultural Universities (SAUs).*

Table No. 1.1: Infrastructural Details of Soil Testing Laboratories

SN	Particulars	Numbers
i.	Total Number of Static STL	38
ii.	Total Number of Mobile STL	09
iii.	Total Number of CSTL	01
iv.	Total area coverage per STL (In ha)	2,46,304
v.	Net Sown Area Coverage per STL (In ha)	1,38,217
vi.	Total Number of Cultivators (Census, 2011) per STL	1,89,374
vii.	Total Number of Agril. Hhs (2012-13) per STL	1,86,692
viii.	Head Available at STLs & CSTL (38 + 1)	12 + 1
ix.	Technical Manpower Sanctioned (In Nos.)	366
x.	Technical Manpower Available (In Nos.)	91 (24.86% of the sanctioned strength)
xi	Non-technical Manpower Sanctioned (In Nos)	49
xii.	Non-technical Manpower Available (In Nos.)	37 (75.51% of the sanctioned strength)

Source: Compiled by the author on the basis of data available in Economic Survey--- Bihar (2016-17) and collected from CSTL, Patna.

Table 1.1 reveals that there is one each static STL and one mobile STL at district and Commissionery/Divisional levels respectively. A soil testing lab was found to cover a total geographical area of 2.46 thousand hectares and 1.38 thousand hectares of net sown area. About 1.89 thousand farmers are covered under each STL. The data further indicate that there is only 24.86 per cent technical manpower available against its sanctioned strength. So there is dearth of technical manpower in the STLs. Out of 38 DSTLs in the state, 2 (31.58%) DSTLs were headed by their full time heads and the remaining was being looked after by the respective DAOs.

It is observed that 70.51 per cent soil samples were collected against the target of 13.09 lakh. The percentage of samples tested was 63.25 and the average SHCs

printed per tested sample were 3.46. It further reveals that all the printed SHCs were distributed to the farmers (table 1.2).

Table No. 1.2: Status of Soil Health Card (SHC) Scheme in Bihar *(As on 14/03/2017)*

SN	Particulars	Numbers
i.	Target of soil samples to be collected during 2015-16 & 2016-17 (In lakh)	13.09
ii.	Samples collected (In lakh)	9.23
iii.	Samples collected (In %)	70.51
iv.	Samples tested (In lakh)	8.28
v.	Samples tested (In %)	63.25
vi.	Total SHCs printed (In lakh)	28.67
vii.	Avg. SHCs printed per tested sample	3.46
viii.	Total SHCs distributed (In lakh)	28.67
ix.	SHCs distributed (In %)	100.00

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

Considering all the facts in mind, the INM Division of the Ministry of Agricultural & Farmers Welfare, Government of India felt the need of examining the impact of SHC scheme on production, productivity and soil health in selected six states including Bihar, and thus, this study was entrusted to six AERCs/Us in their respective states under the co-ordination of ADRTC, ISEC, Bengaluru.

1.3 Major Objectives and Scope of the Study

The specific objectives of the study are as follows:

i. *To document the status and implementation of soil health card scheme.*
ii. *To analyse the impact of adoption of soil testing technology and recommended doses of fertilizers on the basis of SHCs, on crop production, productivity and soil health.*

It is known that agricultural intensification have negatively affected our natural resources. So, their sustainable management holds the key for ensuring sustainable food production. Indian population, which was 1210 million in 2011, is estimated to reach 1412 million in 2025 and 1475 million in 2030. To feed the projected population of 1.48 billion by 2030, India needs to produce 350 MT of food grains. The expanded food needs of future must be met through intensive agriculture without much expansion in the arable land. On the other hand, the per capita arable land decreased from 0.34 ha in 1950-51 to 0.15 ha in 2000-01 and is expected to shrink to 0.08 ha in 2025 and 0.07 ha in 2030. So the current food grain production of 270 MT (2016-17) is produced from the net arable land of 141 million ha. Lack of awareness, imbalance use of chemical fertilizers, mismanagement of water resources etc. have led to several problems affecting soil health, nutrient flow and natural environment. There is a need for promoting, among others, balanced use of fertilizers for increasing agricultural productivity of crops and for better absorption

of nutrients from the applied fertilizers. It is in this perspectives, the present study will dispense greater scope in the times to come from the baseline information and the documentation on the status and implementation of SHC scheme and its impact on production, productivity and soil health.

1.4 Data and Methodology

In Bihar, the SHC scheme was implemented since its initial year 2015-16 in all the 38 districts simultaneously. The present study is based on primary data collected from two sample districts viz., Saran and Banka. The selection of districts was made in consultation with the officials of the office of the Joint Director (Chemistry), Soil Testing Laboratory, Government of Bihar. From each selected district, two blocks/taluks were selected again based on the same criterion. From the selected blocks, two clusters of villages were selected for conducting the survey. A sample of 15 soil tested farmers and 15 control farmers were selected from each block. Adding together 30 soil tested farmers and 30 control farmers were selected from each of the sample districts, thus, totalling to 60 soil-tested farmers and 60 control farmers from the state. This way the sample forms 120 farmers. The selection of soil tested farmers (STFs) was made randomly from the list of SHC beneficiaries and from the SHC beneficiaries' villages, the selection of control farmers (CFs) was made randomly. Adequate care was given for proper social and farm wise representation in the sample. The reference period for the study was kharif 2015.

Since the scheme is not specific to any crop, three major crops viz., paddy, wheat and lentil (pulse) grown by the farmers were taken into account for analysing the results of the study. The details of sample and its distribution are presented in table 1.3.

Table No. 1.3: Sample Details

Districts	Blocks/Taluks	Villages	STFs	CFs	Total
Saran	Nagra	Aphaur, Banni, Chainpur	15	15	30
	Chapra Sadar	Sherpur, Mala	15	15	30
Banka	Dhoriya	Bhelai, Jagatpur, Tilondha	15	15	30
	Rajoun	Dhoni, Baamdeo	15	15	30
02	**04**	**---**	**60**	**60**	**120**

1.5 Limitations of the Study

The study suffered with following limitations:

i. The results of the study were based on sample districts, so the findings can be hardly generalized.

ii. Some of the SHC reports for the initial year i.e., 2015-16 was distributed in 2016 and the application of RDF were translated into practices since kharif 2016, so the study came across with problem of overlapping of reference periods.

iii. Some of the qualitative questions of the survey schedule required long term scientific analysis, so the finding drawn on the basis of such questions was limited to only perceptions of sample farmers.

1.6 Chapter Stream

The present report is drafted into six chapters. Chapter – I covers the introductory part of the study. Socio-economic characteristics of the sample households have been dealt in Chapter – II. Chapter – III discusses the awareness of SHC scheme. Adoption of RDF as per SHC scheme has been deliberated in Chapter – IV. Chapter – V deals with the Impact of SHC scheme. VIth and final Chapter focus on summary and policy suggestions.

CHAPTER – II

SOCIO-ECONOMIC CHARACTERISTICS OF THE SAMPLE HOUSEHOLDS

This chapter is an attempt to cover different aspects, which directly or indirectly concerned with socio-economic characteristics of sample households. These are general characteristics of the sample households, operational land holdings, cropping pattern sources of irrigation and gross income realized by the sample households out of agricultural production.

2.1 General Characteristics

As discussed earlier, a total number of 60 soil-tested farmers under SHC scheme and 60 non-soil tested farmers were interviewed for primary investigation. The data relating to their general features are depicted in table 2.1. It is observed from the table that at overall level, an average the age of respondents was 43.65 years, in which he/she spent only 6.52 years of schooling. Of the sample households, 95 per cent (114 hhs) were male and 5 per cent (6 hhs) female. The main occupation of all sample households was agriculture. Average family size on total farms was 5.30 persons. There was not much difference in it in case of control farmers and soil tested farmers (5.20 persons and 5.40 persons respectively). The average number of family members, who were fully engaged in farming activities was 2.20 at total households level, which slightly varied in case of control farmers (2.15 persons) and soil tested farmers (2.25 persons). The farming experience of sample households was 19.26 years at total farmers whereas it was a little higher at control farmers (20.23 years) than soil tested farmers (18.28 years). Further, caste composition was found to be dominated by OBC (68.33%) followed by General (23.33%), Scheduled Castes (6.67%) and Scheduled Tribes (1.67%) at total farms. Almost same composition was indicated in case of control and soil tested farmers.

Table 2.1: General Characteristics of Sample Households

Particulars	Control Farmers	Soil tested farmers	Total
Average age of respondents (yrs.)	46.0	41.3	43.65
Average years of respondent education	6.38	6.65	6.52
Agriculture as main occupation	100.00	100.00	100.00
Gender (% of respondents)			
Male	98.33	91.67	95.00
Female	1.67	8.33	5.00
Average family size (persons)	5.20	5.40	5.30
Average number of people engaged in farming	2.15	2.25	2.20
Average years of experience in farming	20.23	18.28	19.26
Caste (% of respondents)			
SC	6.67	6.67	6.67
ST	---	3.33	1.67
OBC	78.33	58.33	68.33
General	15.00	31.67	23.33

Source: Primary Survey

2.2 Landholdings

The details of average operational land holdings of the sample farmers have been depicted in table 2.2. It is observed from the data that the land owned by an average sample household at overall farms level was 2.88 acres, 0.98 acres leased-in land, 0.14 acres leased-out land and 0.08 acres uncultivable land, which constituting net operated area of 3.64 acres. Among the soil tested farmers, the net operated area was found to be 3.81 acres. In case of control farmers, it was 3.47 acres. Nearly 80 per cent of the net operated area was found to be irrigated. The rental value of irrigated leased-in land was reported to be Rs. 3218 per acre at overall farms level. However, it was as high as Rs. 3672 per acre on soil tested farmers and Rs. 2694 per acre in regard to control farmers. The rental value of irrigated leased-out land was lower than that of leased-in land across the households.

Table 2.2: Average Operational Landholdings of Sample Households *(In Acres)*

Particulars	Control Farmers	Soil tested farmers	Overall
Owned land	2.74	3.02	2.88
Leased in	0.91	1.04	0.98
Leased out	0.13	0.15	0.14
Uncultivated land	0.05	0.10	0.08
Rental value of irrigated leased in land (Rs/acre)	2694.28	3672.49	3218.12
Rental value of un-irrigated leased in land (Rs/acre)	0.00	0.00	0.00
Rental value of irrigated leased out land (Rs/acre)	2500.00	2751.32	2636.10
Rental value ofun- irrigated leased out land (Rs/acre)	0.00	0.00	0.00
Total irrigated land	2.78 (80.11%)	3.01 (79.00%)	2.90 (79.67%)
Total un-irrigated land	0.68 (19.59%)	0.80 (21.00%)	0.74 (20.33%)
Net operated land	3.47 (100.00%)	3.81 (100.00%)	3.64 (100.00%)

Source: Primary Survey

2.3 Sources of Irrigation

Different sources of irrigation viz., dug well, bore well, canal, etc. Across control and soil tested farmers and at overall level are shown in table No. 2.3. It is quite clear from the data given in table that canal (88.33%) was the major source of irrigation followed by dug well (32.50%) and bore well (22.50%) at overall farms level. Across the soil tested farmers and control farmers, canal was the major source followed by dug well and bore well in the study area. But canal irrigation is dependent on the vagaries of monsoon. If sufficient water was found in the dams then only water is left from the upper end of the canal for irrigation of fields. In case of deficient rain, irrigation through canal was not possible. During the last 2-3 years, irrigation through canal miserably failed particularly in Banka district of the study area.

Table 2.3: Sources of Irrigation of Sample Households *(In %)*

Particulars	Control Farmers	Soil tested farmers	Overall
Dug well	31.67	33.33	32.50
Bore well	25.00	20.00	22.50
Canal	90.00	86.67	88.33
Tank	---	---	---
Others *	---	---	---

Source: Primary Survey

2.4 Cropping Pattern

It is to clear here that all sample households grew only paddy during kharif, 2015. Of the total operated area (436.11 acres) at the overall level, about 94.77 per cent (413.28 acres) area was covered under paddy crop. Across the control and soil tested farmers, 93.39 per cent (193.98 acres) and 96.02 per cent (219.30 acres) respectively of the gross operated areas were under paddy crop. There was no remarkable difference in the cropping pattern of an average control and soil tested farmer (table 2.4).

Table 2.4: Cropping Pattern of the Sample Households

Season	Crops	Control Farmers		Soil Tested Farmers		Overall	
		Area (Acres)	*% of GCA*	*Area (Acres)*	*% of GCA*	*Area (Acres)*	*% of GCA*
Kharif 2015	Paddy	193.98	93.39	219.30	96.02	413.28	94.77

Source: Primary Survey

2.5 Gross Income by Agricultural Production

Table 2.5 presents data on gross income realized by the sample households out of their agricultural production during kharif, 2015. It reveals that all the sample households cultivated paddy during the kharif season. An average control farmer sold 56.91 quintals of paddy at an average price of Rs. 1073.50 per quintal and out of it, received a gross income of Rs. 61092.88. In case of soil tested farmers, the volume of sale was 60.35 quintals at an average price of Rs. 1067.67 per quintal and received a gross income of Rs. 64433.88. It seems that soil tested farmers received higher income than control farmers.

Table 2. 5: Gross Income realized by the Sample Households by Agricultural Production

Crops	Control farmers				Soil tested farmers			
	% of farmers	Avg. qty sold (Qtls)	Avg. price (Rs/Qtl)	Gross income obtained (Rs)	% of farmers	Avg. qty sold (Qtls)	Avg. price (Rs/Qtl)	Avg. income obtained (Rs)
Paddy	100.00	56.91	1073.50	61092.88	100.00	60.35	1067.67	64433.88

Source: Primary Survey

On the basis of above analysis, it can be concluded that there is almost no difference in the socio-economic characteristics of the control and soil tested farmers in the area under study.

CHAPTER – III

STATUS OF AWARENESS ON SHC SCHEME

The participation of farmer in any of the programme either new or old one is determined by their awareness about the same. In course of our field survey, attempt was made to record the awareness of farmers on soil testing, sources of information about soil testing, training programme attended on application of chemical fertilizers, method of application of fertilizers, details of soil sampling, sources of fertilizer purchase and sources of soil sample collection.

3.1 Awareness on Soil Testing

The awareness on soil testing was examined in regard to knowledge about Integrated Nutrient Management (INM), experience of reduction in consumption of chemical fertilizers due to INM, imbalanced application of fertilizers and its effects, knowledge about on-going Soil Health Mission Programme, awareness on Soil Health Cards and grid system under SHC scheme for control and soil tested farmers. The relevant data are given in table 3.1.

Table 3.1: Awareness on Soil-testing among Sample Households *(% of farmers)*

Particulars	Control farmers	Soil tested farmers	Total
Households know about INM	41.67	33.33	37.50
Households experienced the reduction in consumption of chemical fertilizers due to INM	36.67	25.00	30.83
Households awareness on imbalanced application of fertilizers and its effects	58.33	63.33	60.83
Households knowledge about ongoing programmes on Soil Health Mission	---	58.33	29.16
Households aware of Soil Health Cards	65.00	100.00	82.50
Households awareness on grid system under SHC scheme	---	21.87	10.83

Source: Primary Survey

It is observed from the data that majority of the overall farmers were aware of soil health cards (82.50%), imbalanced application of fertilizers and its effects (60.83%), knowledge about Integrated Nutrient Management (37.50%), experience of reduction in consumption of chemical fertilizers due to INM (30.83%), knowledge about on-going programme on soil health mission (29.16%) etc. But only 10.83 per cent households were aware in regard to grid system of SHC scheme. It may be due to application of soil app and other technical skills and knowledge. Across the

sample households, 100 per cent soil tested farmers were aware of SHCs, 58.33 per cent about on-going soil health mission, 63.33 per cent on imbalanced application of fertilizers and its effects, knowledge about INM (33.33%), experience of reduction in consumption of chemical fertilizers due to INM (25.00%) and only 21.27 per cent were aware of grid system of SHC scheme. In case of control farmers 65.00 per cent were aware of SHC scheme, knowledge about INM (41.67%), imbalanced application of fertilizers and its effects (58.33%) etc. It reveals that the knowledge and awareness of the sample households on different parameters are good irrespective of soil tested or not tested.

3.2 Sources of Information about Soil Testing

The study has also tried to find out the sources of information about soil testing. In response to this query, 86.67 per cent of the soil tested farmers reported that they have got the information from the state department of Agriculture. About 13.33 per cent of the soil tested households got the information from neighbours also. Among the control farmers, 30 per cent households got the information from neighbours followed by 23.33 per cent friends/relatives and 11.67 per cent from the State Department of Agriculture (table 3.2).

Table 3.2: Sources of Information about Soil-testing *(% of farmers)*

Sources	Soil tested farmers	Control farmers
SAUs	---	---
KVKs	---	---
Private companies	---	---
Agriculture department	86.67	11.67
Friends/Relatives	---	23.33
Neighbours	13.33	30.00

Source: Primary Survey

3.3 Training Programmes Attended on Application of Chemical Fertilizers

No specific training programme was organized on fertilizer application in the study area, so none of the sample households could avail any such training programmes. However, on different occasions, such as International Soil Day (5th December), Kharif Mahotasava, Rabi Mahotasava, Kisan Mela etc. wherein resource persons use to come from the Department of Agriculture, KVK Scientists and others advised the farmers in regard to different agricultural operations including fertilizer application and soil health etc.

3.4 Method of Application of Fertilizers

While asking about method of application of fertilizers during the reference period, it is noticed by having a glance on table 3.3 that full quantity of all the fertilizers and nutrients was applied through broadcasting method by both the groups of farmer

viz., soil tested and control. None of the farmer was found to have applied fertilizer through spraying, fertigation and drilling methods (table 3.3).

Table 3.3: Method of application of Fertilizers *(% of farmers)*

Method of fertilizer application	Urea	DAP	SSP	Potash	Micro nutrients	Complex fertilizers	Other fertilizers
Soil tested Farmers							
Broadcasting	100.00	100.00	100.00	100.00	100.00	---	---
Spraying	---	---	---	---	---	---	---
Fertigation	---	---	---	---	---	---	---
Drilling	---	---	---	---	---	---	---
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Control Farmers							
Broadcasting	100.00	100.00	100.00	100.00	100.00	---	---
Spraying	---	---	---	---	---	---	---
Fertigation	---	---	---	---	---	---	---
Drilling	---	---	---	---	---	---	---
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: Primary Survey

3.5 Details of Soil Sampling

With a view to understand the details of soil testing done by the sample households, the relevant data are presented in table 3.4. It is observed from the table that no cost was borne on account of testing of soils by any of the soil tested farmers. It is done free of cost by the DSTLs. The average distance from the farmer's field to DSTL was found to be 14.57 kilometres. On an average, about 6.25 acres and 3.02 as average number of plots were considered for soil testing. In fact long distance hinders them to go for soil testing besides, their apathy or sluggishness for the same.

Table 3.4: Details of Soil Sampling

Sl No.	Particulars	Soil tested farmers
1	Average cost of soil testing (Rs/sample)	0.00
2	Average distance from field to soil testing lab (kms)	14.57
3	Average samples taken for soil testing	6.25
4	Average no. of plots considered for soil testing	3.02
5	Average area covered under soil testing (acre)	1.56

Source: Primary Survey

3.6 Sources for Fertilizer Purchase

Data presented in table 3.5 shows that sample households of both the groups of farmer viz., soil tested and control used to purchase fertilizers from different sources. But fertilizers like urea, DAP, SSP and MoP were largely purchased from license dealers/pvt. fertilizer shops, while the bio-fertilizers were found to be purchased from government and other agencies like; govt. Sponsored manufacturing units at village level. Co-operative societies outlets i.e., PACS were

not contributing much in fertilizer purchase. More than 80 per cent of the fertilizers were bought from private fertilizers shops. It is revealed that the access of the sample farmers of both groups viz., soil tested and control, for all chemical fertilizers was more for private shops than that of PACS. In fact PACSs are mainly located at Panchayat headquarters, which covered sometimes 5-6 villages under its operational area.

Table 3.5: Sources for Fertilizers Purchase *(% of farmers)*

Sources	Urea	DAP	SSP	MOP	Complex	Micro-nutrient	Bio-fertilizers
Soil-tested Farmers							
Private fertilizer shops/dealers	88.33	78.33	---	80.00	---	45.00	11.67
Company authorized dealers	---	---	---	---	---	---	---
Co-operative societies	11.67	21.67	---	8.33	---	---	---
Government agency	---	---	---	---	---	---	40.00
Others	---	---	---	---	---	---	48.33
Control Farmers							
Private fertilizer shops/dealers	86.67	81.67	---	65.00	---	---	21.67
Company authorized dealers	---	---	---	---	---	---	---
Co-operative societies	13.33	18.33	---	20.00	---	---	---
Government agency	---	---	---	---	---	---	15.00
Others	---	---	---	---	---	---	---
Overall							
Private fertilizer shops/dealers	87.50	80.00	---	72.50	---	22.50	16.67
Company authorized dealers	---	---	---	---	---	---	---
Co-operative societies	12.50	20.00	---	14.17	---	---	---
Government agency	---	---	---	---	---	---	27.50
Others	---	---	---	---	---	---	24.16

Source: Primary Survey

3.7 Soil Sampling

The accuracy and utility of soil test results and fertilizer recommendations are the function of the quality of soil sampling. In fact, a poor soil sample is the biggest error in the soil testing programme. In order to collect representative soil samples, uniform sampling norms have been prescribed. SHC envisages GPS enabled soil sampling from a grid of 2.5 ha in irrigated areas and 10 ha in rainfed areas. The samples are drawn from a depth of 0-15 cm. following due collection protocols. In case of the present study, all the soil samples were collected by Kisan Salahkars/Co-ordinators of the State Department of Agriculture, who were trained and have skill for operating soil health app. in regard to formation of sampling grid. The farmers were also not acquainted with techniques of soil sampling. Besides Co-ordinators/Kisan Salahkars, no other sources were found collecting the soil sample in the study area.

Table 3.6: Sources of Soil Sample Collection *(% of farmers)*

Particulars	Soil tested farmers
Self	---
RSK officials	---
SAUs	---
KVKs	---
Kisan Salahkar/Co-ordinator	100.00

Source: Primary Survey

CHAPTER – IV

ADOPTION OF RDF AS PER SHC SCHEME

This chapter deals with the adoption of recommended doses of fertilizer as per SHC report, application of organic fertilizers, problems encountered while implementing of SHC scheme and suggestions for improvement of SHC as reported by the sample households.

4.1 Recommended Quantity of Fertilizers

Soil health card (SHC) report consists of five sections. First two sections are related to identifications of farmer and soil sample. Section third deals with the results of tested soil sample into 12 parameters such as; P^H, Ec, Organic Carbon (OC), Nitrogen (N), Phosphate (P), Potassium (K), Sulphur (S), Zinc (Zn), Boron (B), Iron (Fe) Mangnese (Mn) and Copper (Cu). Per acre need of micro-nutrients/fertilizers based on test results is shown in section four and in fifth and final recommendations of reference crops are given. Table 4.1 presents the average recommended dose of fertilizers (RDF) based on the soil health results as mentioned in the fifth section of SHC report, as well as, farmers' opinion obtained from the sample households.

Table 4.1: Average Recommended Quantity of Fertilizers based on Soil Test results *(as mentioned in the SHC)* **and as per Farmer's Opinion**

(Kgs/acre)

Crops	FYM	Urea	DAP	MOP	MgSo4	Potash	Any other, specify
Soil test Results							
Paddy	3029	97.13	20.90	37.00	---	---	---
Wheat	2639	76.57	37.18	37.98	---	---	---
Horse Gram/Chick Pea	539.8	14.14	12.9	20.86	---	---	---
Potato	6939	181.03	133.06	76.63	---	---	---
Farmer's Opinion							
Paddy	1430	103.00	43.00	17.00	---	---	---
Wheat	1500	37.00	44.00	14.00	---	---	---
Lentil/Gram	---	44.00	9.00	---	---	---	---

Source: Primary Survey

It is observed from the data that on an average 3029 kg/acre of farm yard manure, 97.13 kg/acre of urea, 20.90 kg/acre of DAP and 37 kg/acre of MoP was recommended in the SHC report for cultivation of paddy @ expected yield of 40 quintal/hectare. In cultivation of wheat with same expectation of yield, on an average 2639 kg/acre of farm yard manure, 76.57 kg/acre of urea, 37.18 kg/acre of DAP and 37.98 kg/acre of MoP, while 539.8 kg/acre of FYM, 14.14 kg/acre of urea, 12.9 kg/acre of DAP and 20.86 kg/acre of MoP for cultivation of gram/pea were

recommended in the SHC report. It is to be made clear here that the recommendations in the SHC report are made on four counts only viz., compost, DAP, urea and MoP.

As far as the farmer's opinion is concerned, the average quantity of urea and DAP in cultivation of paddy was found to be more as compared to the average quantity based on soil test results. In case of wheat, the farmer's opinion for DAP was found to be more than the soil test results. As per the farmer's opinion, the average quantity of urea for cultivation of lentil/gram was found to be higher than recommendations of SHC report. As per farmer's opinion, the average quantity of FYM required to be applied across selected crops, which was found to be less than the average recommended quantity based on soil test results.

4.2 Organic Fertilizer for Reference Crops

As regards the application of organic fertilizers for reference crops, the data are presented in table 4.2. It is observed from the data that a majority of households used to apply organic fertilizer in the form of FYM (93.33%), vermin compost (42.50%) and bio-fertilizer (18.33%) in average quantities of 1672.04 kg/acre, 92.42 kg/acre and 86.34 kg/acre respectively with average price of Rs. 3.78/kg, Rs. 2.69/kg and Rs. 6.63 /kg respectively. The average areas covered under organic fertilizers were found to be 3.11 acres, 2.19 acres and 0.22 acre respectively.

Table 4.2: Applied Organic Fertilizers for Reference Crops

Particulars	FYM	VC/ Biogas	Bio-fertilizer
% of farmers applied organic fertilizers	93.33	42.50	18.33
Average area covered under organic fertilizers (Acres)	3.11	2.19	0.22
Average quantity applied (Kgs/acre)	1672.04	92.42	86.34
Price (Rs/kg)	3.78	2.69	6.63

Source: Primary Survey

4.3 Problems Encountered while Implementation of the SHC Scheme

In course of field survey, the sample households were also canvassed for a number of problems which they observed in implementation of SHC scheme. Those problems are presented in table 4.3. The major problems reported by majority of soil tested farmers were printing of SHC reports in a mix script/language of English and Hindi and recommendations are made on acre basis, which was hardly understood by them (81.67%) followed by SHC programme is merely a fulfilment of targets of sample collection and distribution of SHC reports, its findings are not explained or dealt to the farmers by the functionaries of state agriculture department (75%), less awareness about the grid system of soil sample collection (65%), SHC reports are not

delivered in time (53.33%); soil test is not done in farms of farmers' choice (31.67%); ploughing of fields have made the fields undulated in such cases one sample for having different beds does not provide reliable results for the field as a whole (28.33%) and lack of farmers' participation in the programme (25%).

Table No. 4.3: Problems Encountered while Implementation of SHC Scheme *(% of farmers)*

SN	Problems	Responses
i.	Soil test is not done in farms of farmers' choice	31.67
ii.	SHC reports are not delivered in time	53.33
iii.	Less awareness about the Grid system of soil sample collection	65.00
iv.	Soil testing programme is only fulfilment of targets of sample collection and distribution of SHC reports, its findings and recommendations are not dealt to the farmers by the agriculture dept. functionaries	75.00
v.	Lack of farmers' participation in the programme	25.00
vi.	SHC reports are printed in a mix script/language of English and Hindi and recommendations are made on acre basis, which is hardly understood by farmers	81.67
vii.	Ploughing of fields is generally made by tractors resulting in creation of undulated bed in fields. In such cases, one sample for fields having different beds does not provide reliable results for the field as a whole	28.33

Source: Primary Survey.

Box - 2

Discussion and Observation based Constraints at Lab. Level

- *Lack of staff for undertaking the time- bound lab work.*
- *Frequent deployment of staff in law and order duties hinders fulfilment of the targets set under the scheme.*
- *Funds are not made available in time.*
- *Non-existent laboratory cadres' employees at DSTLs.*
- *Problems in software for formation of grid. This causes repetition of the grid at the same place.*
- *Some of the laboratories are established in Joint Building of Divisional/District Agriculture Offices, which are not in accordance with the laboratories' specifications and structures.*
- *There are only 5-6 Chemists in the department and thus, DAOs have been given additional charge of DSTLs. It hampers smooth working and functioning of the DSTLs .*
- *Targets are not set as per the lab. Efficiency (25 tests/day). For example, Banka (one of the sample districts) is largely un-irrigated, but targets are set considering the district to be largely irrigated.*
- *Revised rate of honorarium for collection of soil samples to distribution of SHC Cards has not been implemented so far.*
- *Large/High targets are set mainly with the objective of obtaining large volume of grants from the Government of India.*
- *Equipments supplied to the DSTLs are not technically okay. Frequent errors are occurred.*
- *Sampling of soil is not made correctly. It is revealed from the texture of soil, while testing the samples.*
- *Frequent occurrence of mite, particularly in pulses (Gram & Masoor), is largely found. This is due to lack of facilities at DSTLs for testing of micro-nutrient.*
- *Sometimes virus in Soil App is found.*

4.4 Suggestions for Improvement of SHC Scheme

Major suggestions given by the sample households for improving the SHC scheme are presented in table 4.4. It is observed from the table that SHC report may be printed in Hindi and the recommendations may be made in local units for measurement of land such as katha or bigha (71.67%) followed by making aware of simple method of collection of soil samples and get the same tested preferably at soil testing mobile van (STMV) and reports should be delivered immediately (53.33%), the recommendations should be explained by organising the camps at panchayat/village level (46.67%), collection of soil samples should be made from different beds of a field and the reports should be prepared separately for each bed (28.33%) and the scheme may be implemented in one grid-one sample-one beneficiary mode for enhancing the faith of farmers' in SHC reports (26.67%).

Table 4.4: Suggestions for Improvement of SHC Scheme *(% of Farmers)*

SN	Problems	Responses
i.	Due to complications in grid system of taking soil sample, farmers should be made aware of simple method for collection of soil samples and get the same tested preferably at Soil Testing Mobile Van and reports should be immediately made available by the concerned.	53.33
ii.	The scheme may be implemented in *one grid-one sample-one beneficiary* mode. This will enhance faith of farmers' in SHC reports.	26.67
iii.	SHC reports may be printed in Hindi and the recommendations may be made in local unit of measurement also, such as '*katha'* or '*bigha.'*	71.67
iv.	Soil samples should be collected from different beds of a field and the reports should be prepared separately for each bed of the field.	28.33
v.	The recommendations suggested in SHC reports should also be explained by organising camps at village/panchayat level or at any other suitable places.	46.67

Source: Primary Survey.

CHAPTER – V

IMAPACT OF SHC SCHEME

This chapter analyses the impact of application of recommended doses of fertilizers on crop yield, visible changes found after the application of recommended doses of fertilizers and cost of cultivation and income of major crops viz., paddy, wheat and lentil for control and soil tested farmers in the area under study.

5.1 Impact of Application of RDF on Yield

The impact of RDF was observed on the yield of three major selected crops, presented in table 5.1 It is revealed from the data that average yields of paddy, wheat and lentil increased by 1.98 per cent, 0.84 per cent and 2.23 per cent respectively after the application of RDF on soil tested farmers over control farmers. So, there were positive impacts on the yield of all the selected crops.

Table 5.1: Impact of Application of Recommended Doses of Fertilizers on Yield

Crop	Season	Average Yield (Quintal/acre)		% Change
		Control farmers	Soil tested farmers	
Paddy	Kharif-2015	18.70	19.07	1.98
Wheat	Rabi – 2016	13.08	13.19	0.84
Lentil	Rabi – 2016	4.49	4.59	2.23

Source: Primary Survey

5.2 Visible Changes found after the Application of RDF

Besides positive impact on yield of all three major selected crops, some visible changes were also found after the application of RDF. These changes were to the extent of most important, important and least important. The relevant data are presented in table 5.2. It is clear from the table that the most important changes, which were observed by the sample households were improvement in crop growth (20.00%), less incidence of pest and disease (16.67%), decrease in application of other inputs like seed, labour, pesticide etc. (15.00%), increase in crop yield (6.67%) and improvement in grain filling (5.00%). The important changes, which were found by the sample households, were improvement in grain filling (35.00%), improvement in crop growth (28.33%), decrease in application of other inputs like seed, labour, pesticide etc. (25.00%), increase in crop yield (16.67%) and less incidence of pest and diseases (11.67%). Increase in crop yield (28.33%), improvement in grain filling (15.00%) and less incidence of pest and disease (15.00%) etc. were the least important impacts as reported by the sample households.

Table 5.2: Visible Changes found after the Application of Recommended Doses of Fertilizers

(% of farmers)

Reasons	Most important	Important	Least important	Overall
Increase in crop yield	6.67	16.67	28.33	51.67
Improvement in soil texture	---	---	---	11.67
Improvement in crop growth	20.00	28.33	8.33	56.67
Improvement in grain filling	5.00	35.00	15.00	55.00
Less incidence of pest and diseases	16.67	11.67	15.00	43.33
Decrease in application of other inputs like seed, labour, pesticide etc.	15.00	25.00	5.00	45.00

Source: Primary Survey

5.3 Cost of Cultivation and Income of Major Crop

5.3.1 Paddy

The data presented in table 5.3 shows the impact of soil testing on cost of cultivation of paddy and income. It is revealed from the table that in cultivation of paddy per acre expenditure for soil tested farmers decreased for seeds (14.36%), MoP (29.52%) and PPC (11.61%) while the expenditure on labour, manure/FYM, urea, DAP, irrigation, etc. were found to have increased by 14.25 per cent, 39.00 per cent, 6.20 per cent, 43.16 per cent, 28.40 per cent respectively for soil testing farmers. The total cost of cultivation for paddy was found to have increased from Rs. 12480.36 to Rs. 14175.33 per acre registering an increase of 13.58 per cent with decrease in net income from Rs. 8971.31 to Rs. 8190.72 per acre (- 8.81%). Per rupee return was also found to have decreased by 7.60 per cent i.e., from 1.71 to 1.58 for soil tested farmers. So in case of cultivation of paddy, the impact of SHC scheme is far from the satisfactory level.

Table 5.3: Changes in Per Acre Cost of Cultivation of Paddy and Income

variables	Unit	Control Farmers		Soil Testing 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	Litres	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	Atia	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
In parenthesis percentage differences are shown for STFs over CFs

5.3.2 *Wheat*

The data presented in table 5.4 shows the impact of soil testing on cost of cultivation of wheat and income. It is clear from the table that in cultivation of wheat, per acre expenditure on seeds (2.17%), irrigation (75.49%) and rental value of land (29.25%) had increased on soil tested farmers while labour (- 17.16%), manure/FYM (-45.42), urea (-13.80), DAP (-58.29%), MoP (-42.96%), and plant protection chemicals (-71.50%) were found to have decreased on soil tested farmers. The total paid-out cost was also found to have reduced by 11.03 per cent with an increase in net income of about 24.42 per cent on soil tested farmers. Per rupee net return was found to have increased from 1.94 to 2.32 i.e., an increase of 19.58 per cent. Above analysis

reveals that the impact of SHC scheme on cultivation of wheat was positive and encouraging.

Table 5.4: Changes in Per Acre Cost of Cultivation of Wheat and Income

variables	Unit	Control 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 *(13.80)*
DAP	Kgs	74.64	2906.00	43.79	1211.97	(-) 30.85	(-) 1694.03 *(-58.29)*
MOP	Kgs	26.92	303.30	14.10	173.00	(-) 12.82	(-) 130.30 *(-42.96)*
Bio-Fertilizers	Kgs.	---	---	50.13	213.50	---	---
Others	Kgs	---	---	---	---	---	---
PPC	Litres	4.22	269.00	2.42	76.67	(-) 1.80	(-) 192.33 *(-71.50)*
Irrigation	---	---	845.47	---	1483.70	---	638.23 *(75.49)*
Rental value of land	**---**	---	2000.00	---	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	---	1358.00 *(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
In parenthesis percentage differences are shown for STFs over CFs

5.3.2 Lentil

The impact of soil testing on cost of cultivation of lentil pulse was analysed and presented in table 5.5. It is observed from the tale that in cultivation of lentil pulse, per acre expenditures on soil tested farmers were found to have decreased in almost all inputs except labour, which recorded an increase of only 0.72 per cent. Decrease in costs were seen in seeds by 5.71 per cent, urea by 9.63 per cent, DAP by 22.53 per cent, plant protection chemicals by 1.96 per cent and rental value of land by 65.55 per cent. The total paid-out cost was found to have decreased by 13.15 per cent i.e., from

Rs. 6779.79 per acre to Rs. 5888.01 per acre. The net return was found to have increased by 9.66 per cent i.e., from Rs. 10495.97 per acre to Rs. 11509.81 per acre (an additional return of Rs. 1013.84 per acre). Per rupee return was also found to have increased by 25.81 per cent (from Rs. 1.55 to Rs. 1.95). It clearly indicates that there was positive impact of SHC scheme on cultivation of lentil and income there from.

Table 5.5: Changes in Per Acre Cost of Cultivation of Lentil and Income

variables	Unit	Control Farmers		Soil Testing Farmers		Difference	
		Qty	Cost (Rs)	Qty	Cost (Rs)	Qty	Cost (Rs)
Total labour cost	**H+B+M**	---	2273.54	---	2290.07	---	16.53 *(0.72)*
Manure/ FYM	Tonnes	---	---	---	---	---	---
Seeds	Kgs	37.72	2438.12	37.60	2298.83	(-) 0.12	(-) 139.29 *(-5.71)*
Fertilizers- Urea	Kgs	46.12	368.96	45.49	333.43	(-) 0.63	(-) 35.53 *(-9.63)*
DAP	Kgs	10.05	282.48	8.10	218.84	(-) 1.95	(-) 63.64 *(-22.53)*
MOP	Kgs	---	---	---	---	---	---
Bio-Fertilizers	Kgs.	---	---	---	---	---	---
Others	Kgs	---	---	---	---	---	---
PPC	Litres	0.41	408.00	0.40	400.00	(-) 0.01	(-) 8.00 *(-1.96)*
Irrigation	---	---	---	---	---	---	---
Rental value of land	**---**	---	1006.69	---	346.84	---	(-) 659.85 *(-65.55)*
Land revenue	**---**	---	---	---	---	---	---
Total paid out costs	**---**	---	6779.79	---	5888.01	---	(-) 891.78 *(-13.15)*
Main product yield	Qtls	4.49	17275.76	4.59	17397.82	0.10	122.06 *(0.71)*
By- product yield	Qtls	---	---	---	---	---	---
Gross return	---	---	17275.76	---	17397.82	---	122.06 *(0.71)*
Net Income	**---`**	---	10495.97	---	11509.81	---	1013.84 *(9.66)*
Per Rupee Return	**---**	1.55		1.95		0.40 *(25.81)*	

Source: Primary Survey

In parenthesis percentage differences are shown for STFs over CFs

CHAPTER – VI

SUMMARY AND POLICY SUGGESTIONS

6.1 Background

Green Revolution technologies brought revolutionary changes and significant growth in food production turning India from a country living on ship to mouth situation to over flowing granaries during the last five decades. So extensive has been the over exploitation of soil resources. The most of our soil based production system have started showing the signs of fatigue. Contrary to increasing food demands, the factor productivity and rate of response of crops to applied fertilizers under intensive cropping systems have been showing progressive decline year after year. Current status of nutrient use efficiency (NUE) is quite low due to deterioration in physical, chemical and biological health of soils. In India, soil health is synonymously used in terms of soil fertility or nutrient status and soil physical and biological health is often ignored. Unfavourable soil physical conditions lead to poor crop yields and fertilizer use efficiency in irrigated as well as rainfed agriculture. About 59 per cent of Indian soils are low in available N, 36 per cent medium and only 5 per cent high. Similarly, soils of about 49 per cent, 45 per cent and 6 per cent are low, medium and high in available P respectively and 9, 36 and 52 per cent are low, medium and high in respect of available K respectively. Land degradation is the manifestation of poor soil health or in other words, unhealthy soils are highly prone to further degradation. According to latest estimates of ICAR (2010), around 120 mha (104 mha arable land) of the country is subjected to land degradation due to soil erosion caused by water and wind, chemical degradation (salinity, alkalinity, acidity) and physical degradation (water logging). As per the NAAS (2010) data, Nagaland (93.48%) has the highest in terms of area affected by various kind of land degradation followed by Manipur (79.17%), Meghalaya (77.21%), Tripura (77.02%), Kerala (67.13%), Uttar Pradesh (60.38%), Rajasthan (59.68%), Assam (58.27%), Mizoram (55.17%), Jharkhand (49.46%) and in Bihar, it is only 14.56 per cent.

Soil health management is a widely studied area in soil science across the country, but most of the researchers have remained confined to soil fertility and nutrient management. So soil health and quality have remained matters of great concern for the Government of India. Government has made huge investments in arresting soil degradation and improving the declining status of soil fertility in the country. For this purpose several developmental schemes have been implemented from time to

time. On 19th February, 2015 National Mission on Soil Health Card (SHC) has been launched as a centrally sponsored scheme by the Hon'ble Prime Minister to provide soil test based fertilizer recommendations to all the farmers across the country. It aims at issuing SHC to each of the 140 million farmers once in a cycle of 3 years on a continuous basis. Though each cycle would be of 3 years, the maiden cycle is being squeezed to 2 years to facilitate quick soil test based health management practices.

In Bihar, the State Department of Agriculture have been issuing SHCs to farmers since Xth Five Year Plan (2002-07) and till 2014-15, it had issued 15.7 lakh SHCs. This new SHC scheme is implemented in all the 38 districts of Bihar with a target of 13.09 lakh soil samples to be collected during 2015-16 and 2016-17. Till 14th March 2017, 9.23 lakh samples (70.51%) were collected and 8.28 lakh samples (63.25%) were tested. A total of 28.67 lakh SHCs were printed and the average SHCs printed per tested sample was 3.46. All the printed SHCs were reported to be distributed. Considering all the facts, the INM Division of the Ministry of Agriculture & Farmers Welfare, Government of India felt the need of examining the impact of SHC scheme on production, productivity and soil health in selected six states including Bihar and thus, this study was entrusted to six AERCs/Us in their respective states under the Co-ordination of ADRTC, ISEC, Bengaluru with following specific objectives:

iii. *To document the status and implementation of soil health card scheme.*
iv. *To analyse the impact of soil testing technology and recommended doses of fertilizers on the bases of SHCs, on crop production, productivity and soil health.*

The present study is based on primary data collected from two sample districts viz., Saran and Banka. From each selected district, two blocks and from each of the selected blocks, two clusters of villages were selected. A sample of 15 soil tested farmers and an equal number of control farmers were selected from each block. Taking together 30 soil tested farmers and 30 control farmers were selected from each of the selected districts. This way from two sample districts, the sample forms 120 farm households comprising 60 soils tested and 60 control farmers. The study was undertaken by survey research method for the reference period of kharif, 2015.

6.2 Socio-Economic Characteristics of Sample Households

On overall basis, an average household was of 43.65 years of age, in which he/she spent only 6.52 years in education and have 5.3 persons in his/her family, out of which 2.20 persons were found to be engaged in farming. All the sample households were engaged in agriculture as main occupation and 95 per cent of them were males and were found to have 19.26 years of experience in farming. The social composition of the respondents was dominated by other backward castes (68.33%)

followed by general (23.33%), scheduled castes (6.67%) and scheduled tribes (1.67%). Almost similar findings were observed in control and soil tested farmers both with a very little variation. Except in case of control farmers, there were no scheduled tribe respondents.

The average land owned by a sample farmer on overall basis was found to be 2.88 acres, 0.98 acres of leased-in and 0.14 acres of leased-out. The average net-operated area was found to be 3.64 acres. Of the net operated area, nearly 80 per cent is irrigated and 20 per cent is un-irrigated. The rental value of irrigated leased-in land as reported by the sample household was Rs. 3218.12 per acre and the irrigated leased-out at Rs. 2636.10 per acre. It is interesting to note here that the rental value of irrigated leased out land was quite low as compared to irrigated leased-in land. Moreover, no remarkable difference between the control and soil tested farmers was found in the study area.

At overall level, canal (88.33%) was found to be the major source of irrigation among the sample households followed by dug-well (32.50%) and bore-well (22.50%). In case of control and soil tested farmers, no significant differences were found in respect of sources of irrigation.

During kharif 2015, the sample households grew only paddy. Of the total net operated area, about 95 per cent area was covered under paddy. Across the control and soil tested farmers about 94 and 96 per cent respectively of the net operated area were devoted to paddy crop. The average gross income realized by the soil tested farmers (Rs. 64433.88) was found to be higher as compared to control farmers (Rs. 61092.88).

6.3 Status of Awareness on SHC Scheme

Awareness relating to imbalanced application of fertilizers and its effects, soil health cards and knowledge about on-going programmes on Soil Health Mission were found to be higher in regard to soil tested farmers as compared to control farmers. But in case of households' knowledge about Integrated Nutrient Management (INM) and experience of reduction in consumption of chemical fertilizers due to INM were found to be higher in case of control farmers as compared to soil tested farmers. On overall level, majority of the households were aware of SHCs (82.50%) but only a few households were aware on grid system under SHC scheme (10.83%). The analysis of awareness on soil testing reveals that the knowledge and awareness of the sample households on different parameters are good irrespective of soil tested or not.

Major sources of information amongst the soil tested farmers were the Agriculture Department (86.67%) followed by neighbours (13.33%) whereas in case of control farmers the sources, which remained instrumental, were neighbours (30.00%), friends/relatives (23.33%) and Agriculture Department (11.67%).

There was no specific training programme organised in the study area on application of fertilizers and thus, none of the sample households could availed such training programme. Broadcasting method of application of fertilizers was the only method for all the sample households.

An average soil tested farmer covered a distance of 14.57 kilometres from the field to soil testing lab i.e., DSTL for getting his/her soil tested. It is done free of cost. On an average, 6.25 samples were taken for soil testing with 3.02 average number of plots and 1.56 acres of average area.

The major source of purchase of fertilizers such as urea, DAP, and MoP, was reported to be private fertilizer shops/license dealers and co-operative societies, while the micro-nutrients was found to have been purchased only from private fertilizer shops/license dealers and bio-fertilizers largely from the government source (in-terms of subsidy or with rabi/kharif kit) followed by private shops and units operating in the village/nearby areas.

All the soil tested farmers reported that their soil samples were collected by Kisan Salahkar/Co-ordinator of the State Agriculture Department.

6.4 Adoption of RDF on Soil Test Basis

On an average 97.13 kg of urea, 20.90 kg of DAP and 37 kg of MoP were recommended for per acre cultivation of paddy by respective DSTLs. In cultivation of per acre of wheat, 76.57 kg of urea, 37.18 kg of DAP and 37.98 kg of MoP were recommended, while 14.14 kg of urea, 12.9 kg of DAP and 20.86 kg of MoP for cultivation of per acre of horse gram/chickpea. Apart from these RDF, DSTLs also recommended per acre of 3029 kg FYM for paddy, 2639 kg for wheat and 539.8 kg for horse gram/chickpea. As far as the farmer's opinion is concerned, the average quantity of fertilizers in cultivation of paddy was found higher for urea and DAP, whereas in case of MoP it was found lower. In case of wheat, farmer's opinion was found lower for urea and MoP but higher for DAP. Similarly, the farmer's opinion in case of lentil/gram was found higher for urea and lower for DAP. The average quantity of FYM required to be applied across the selected crops was also found to be lower than the recommend quantity based on soil test results.

Majority of the households used to apply organic fertilizer in the form of FYM (99.33%), vermin compost (42.50%) and bio-fertilizer (18.33%) in average quantity of 1672.04 kg/acre, 92.42 kg/acre and 86.34 kg/acre respectively with average prices of Rs. 3.78/kg, Rs. 2.69/kg and Rs. 6.63/kg respectively. The average area covered under organic fertilizers in the form FYM, vermi-compost and bio-fertilizer were found to be 3.11 acres, 2.19 acres and 0.22 acre respectively.

Major problems reported by majority of the soil tested farmers were printing of SHC reports in a mix script/language of English and Hindi and recommendations made on acre basis, was hardly understood by them (81.67%) followed by SHC programme is merely a fulfilment of targets of sample collection and distribution of SHC reports, its findings are not explained or dealt to the farmers by the functionaries of the State Agriculture Department (75%), less awareness about the grid system of soil sample collection (65%), SHC reports are not delivered in time (53.33%), soil test is not done in farms of farmers' choice (31.67%), ploughing of fields have made the fields undulated in such cases one sample for having different beds does not provide results for the field as a whole (28.33%) and lack of farmers' participation in the programme (25%).

SHC report may be printed in Hindi and the recommendations may also be made in local units for measurement of land, such as *katha or bigha* (71.67%), making aware of simple method of collection of soil samples and get the same tested preferably at soil testing mobile van (STMV) and reports should be delivered immediately (53.33%), the recommendations should be explained by organising camps at panchayat/village level (46.67%), collection of soil samples should be made from different beds of a field and the reports should be prepared separately for each bed (28.33%) and the scheme may be implemented in *one grid-one sample-one beneficiary* mode for enhancing the faith in SHC reports (26.67%) were the major suggestions reported by the sample households for improving the SHC scheme in the study area.

6.5 Impact of SHC Scheme

A positive change in yield of three major crops was observed. Per acre yields of paddy, wheat and lentil were found to have increased by just 1.98 per cent, 0.84 per cent and 2.23 per cent respectively after application of RDF.

The most important changes which were observed by the sample households were improvement in crop growth, less incidence of pest and disease, decrease in application of inputs like seed, labour, pesticides etc. Important changes, which were observed by the sample households, were improvement in grain filling, improvement in crop growth, decrease in application of other inputs like seed,

labour, pesticides etc. Increase in crops yield, less incidence of pest and disease, improvement in grain filling etc. were observed as least important ones.

In cultivation of paddy, per acre expenditure for soil tested farmers was found to have decreased for seeds (14.36%), MoP (29.52%) and PPC (11.61%), while the expenditure on labour, manure/FYM, urea, DAP, irrigation, etc. were found to have increased by 14.25 per cent, 39.00 per cent, 6.20 per cent, 43.16 per cent, 28.40 per cent respectively for soil testing farmers. The total cost of cultivation for paddy was found to have increased from Rs. 12480.36 to Rs. 14175.33 per acre registering an increase of 13.58 per cent with decrease in net income from Rs. 8971.31 to Rs. 8190.72 per acre (- 8.81%). Per rupee return was also found to have decreased by 7.60 per cent i.e., from 1.71 to 1.58 for soil tested farmers. So in case of cultivation of paddy, the impact of SHC scheme is far from the satisfactory level.

In cultivation of wheat, per acre expenditures on seeds (2.17%), irrigation (75.49%) and rental value of land (29.25%) had increased on soil tested farmers while labour (-17.16%), manure/FYM (-45.42), urea (-13.80), DAP (-58.29%), MoP (-42.96%), and plant protection chemicals (-71.50%) were found to have decreased on soil tested farmers. The total paid-out cost was also found to have reduced by 11.03 per cent with an increase in net income of about 24.42 per cent on soil tested farmers. Per rupee net return was found to have increased from 1.94 to 2.32 i.e., an increase of 19.58 per cent. Analysis reveals that the impact of SHC scheme on cultivation of wheat was positive and encouraging.

In cultivation of lentil pulse, per acre expenditures on soil tested farmers were found to have decreased in almost all inputs except labour, which recorded an increase of only 0.72 per cent. Decrease in costs were seen in seeds by 5.71 per cent, urea by 9.63 per cent, DAP by 22.53 per cent, plant protection chemicals by 1.96 per cent and rental value of land by 65.55 per cent. The total paid-out cost was found to have decreased by 13.15 per cent i.e., from Rs. 6779.79 per acre to Rs. 5888.01 per acre. The net return was found to have increased by 9.66 per cent i.e., from Rs. 10495.97 per acre to Rs. 11509.81 per acre (an additional return of Rs. 1013.84 per acre). Per rupee return was also found to have increased by 25.81 per cent (from Rs. 1.55 to Rs. 1.95). It indicates that there was positive impact of SHC scheme on cultivation of lentil and income there from.

6.6 Policy Suggestions

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

i. Soil testing is not a priority for farmers in general. So the farmers are required to be sensitized and there is need to make them partners of the programme for greater benefits of soil tests in a massive campaign mode. Wall writings, audio-visual clips (films/songs), TV advertisements, distribution of leaflets and pumplets, door-to-door campaign, trainings/meetings at Block/Panchayat/Village level etc. may be the instruments for the same. Scientists and faculties of Krishi Vigyan Kendras (KVKs), State Agricultural Universities (SAUs), Agro-Economic Research Centres (AERCs) etc. may be involved with the nodal agency for implementation of such programme.

ii. All DSTLs are required to be optimally strengthened in terms of laboratory designed buildings, adequate technical personnel and their capacity building, quality instruments, availability of adequate and in time contingent funds for day to day expenses, laboratory cadre staff, updating of software/app, headed by full time Chemists, liberal support of the state government etc. to make the DSTLs more efficient and vibrant ones.

iii. Adoption of RDF and nutrient use by majority of the farmers should be the target. This will require regular interaction with all concerned and a mission mode implementation, monitoring and evaluation of the scheme.

iv. Reliability of soil samples and its results should be ensured at all levels with careful efforts.

v. Printing of SHC report may be made exclusively in Hindi (Deonagri script) particularly in Bihar and the recommendations be made for at least five local major crops and units of land measurement in local units also like; *bigha or katha.*

vi. Secondary and micro-nutrient analysis at the DSTLs may also be included.

vii. Since DSTLs are literally cut-off from the fields, so for each year, at least one revenue village may be adopted by the DSTLs for implementation of best practices in the light of soil test results and its documentation may be made for dissemination to other villages as well.

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Annexure – I

COMMENTS

on the report

"IMPACT OF SOIL HEALTH CARD SCHEME (SHCS) ON PRODUCTION, PRODUCTIVITY AND SOIL HEALTH IN BIHAR"

submitted by

AERC, Bhagalpur, Bihar

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

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

2. **Date of receipt of the Draft report:** 22nd July, 2017

3. **Date of dispatch of the comments:** 8th August, 2017

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

   The objectives of the study need to be revised as per the proposal.

5. **Comments on the methodology**

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

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

(i) In Table 2.1, the rental value of leased-in and leased-out land for irrigated and un-irrigated conditions may be given separately as there will be an huge difference between these two.

(ii) In Table 2.4 - Cropping pattern of sample households have to be mentioned both in quantity as well as in % GCA.

(iii) In the case of method of application and sources for fertilizers purchase, the information should be bifurcated for soil-tested and control farmers separately in tables.

(iv) The average recommended quantity of fertilizers based on soil-test results and the quantity as per farmer's opinion should be mentioned for all the crops for better understanding the knowledge of the farmers on soil testing and its usefulness.

(v) Throughout the report, the units mentioned in Tables should be in two digits for better clarity on the information provided.

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

7. Overall view on acceptability of report

Authors are requested to incorporate all the comments and submit the final report along with soft copy of the data for consolidation.

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Annexure – I

Action Taken Report (ATR)

1.	Title of the Study	:	**IMPACT OF SOIL HEALTH CARD SCHEME ON PRODUCTION, PRODUCTIVITY AND SOIL HEALTH IN BIHAR**
2.	Date of Despatch of the Draft Report	:	22nd July, 2017
3.	Date of Receipt of the Comments	:	11th August, 2017
4.	Date of Dispatch of the Final Report	:	11th September, 2017
5.	Comments on the Objectives of the Study	:	No action is required

6. Comments on Analysis, Organization, Presentation etc *(as given at SN-6 of Annexure- I)*

i. Needful has been done.

ii. Done as per comments.

iii. Done as per comments.

iv. In SHC report, the recommendations are given for four crops only and thus, the study dealt about the same in case of STFs. In case of CFs, the opinion has been obtained only for three major crops, as per the circulated methodology.

v. Done as per comments.

vi. The report has been copy edited.

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