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Impact of soil health card scheme on improving soil health and quality: Synthesis of select cases and implications for sustainable agriculture

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Abstract
The present study attempted a synthesis of recently reported research results on the effectiveness Soil Health Card Scheme of Government of India. This scheme is a vital to achieving the goal of "Doubling Farmers Income". The ideal ratio of the three most common fertilizers that is, Nitrogen (N), Phosphorous (P) and Potassium (K) should be 4:2:1 whereas it had reached a threatening level of 8.2:3.2:1 in 2012-13 as per a report by Fertilizer Association of India. Excess application of fertilizers leads to wide range of nutrient deficiency symptoms in soils. Fertilizers are the main factors responsible for providing adequate food for the world's current population of over 7 billion people, fertilizers will be even more important in sustaining the over 9 billion people projected for 2050.While the primary impact of mineral fertilizers is on crop yields, they also have an indirect effect on the soil interms of its health and quality. There was a reduction in use of urea and DAP by 20 to 30% in paddy and cotton in some states resulted in decreased cost of cultivation. The reduction in cost of cultivation ranged between Rs.1000 and Rs.4000 per acre. In soybean, the total cost of cultivation decreased by 1.7 per cent from 10900 to 10714 per acre but net income increased by 67.7 per cent from 6696 to 11228 per acre. The return per rupee investment also increased from 1.60 to 2.00 after the farmers got their soil tested. In maize, the total cost of cultivation increased by 12.94 per cent from 8176 to 9234 per acre and net income increased by 139 per cent from 3379 to 8105 per acre. The return per rupee investment was also increased from 1.40 to 1.90 after soil testing by the farmers. So, the emerging challenge in present day agriculture is to protect and maintain the soil health which is being deteriorated every year by many of the factors either man made or natural.

Keywords: soil health cards, soil health, soil quality, sustainable agriculture

1. Introduction

Soil health can be defined as capacity of the soil to function as one of the vital living systems, by recognizing that it contains biological elements that are key to the functioning of the ecosystems within certain land-boundaries (Karlen *et al.*, 2001) [7]. The term "soil quality" is also often used synonymously with soil health, but the basic difference between these two terms are that soil quality is related to soil function (Karlen *et al*., 2003; Letey *et al*, 2003) [7], whereas soil health presents the soil as a finite non-renewable and dynamic living resource (Doran and Zeiss, 2000) [4].

"*SwasthDharaa. KhetHaraa.*" - Healthy Earth. Green Farm.

Soil Health Card (SHC) is a Government of India's scheme promoted by the Department of Agriculture & Co-operation under the Ministry of Agriculture and Farmers' Welfare. Soil Health Card scheme was launched by the Prime Minister of India. Shri Narendra Modi on 19 February 2015at Suratgarh in Rajasthan. It is being implemented through the Department of Agriculture of all the State and Union Territory Governments.

Soil Health Card Scheme is a very beneficial scheme for farmers. There are many farmers in India and they do not know which types of crops they should grow to get maximum yield. Basically, they do not know the quality and the type of their soil. They might know by experience what crops grow and what crops fail. But they don't know what they can do to improve the condition of the soil. National Soil Health Card scheme, which has completed its fifth year, has ushered in a new awareness about the importance of a green economy, says Dr P Balasubramanian, Head of the Department of Soil Sciences, Tamil Nadu Agricultural University, Trichy (source: News services Division) ALL INDIA RADIO. He said that the wide-spread use of these cards has helped in popularizing the optimal use of fertilizers. Talking to AIR, Dr Balasubramanian said that the health card was an excellent way of protecting the health of Mother Earth by accurately measuring the quality of soil and ensuring the use of proper fertilizers. He said that there is no doubt at all that the card system ensures accurate measuring of the character and constituents of the soil, and increases awareness about eco-friendly agriculture. SHC is a printed report that a farmer will be handed over for each of his holdings. It will contain the status of his soil with respect to 12 parameters, namely N,P,K (Macro-nutrients) ; S (Secondary- nutrient); Zn, Fe, Cu, Mn, Bo (Micro - nutrients) ; and pH, EC, OC (Physical parameters). Based on this, the SHC will also indicate fertilizer recommendations and soil amendment required for the farm. Sustainable agriculture is a way of farming that can be carried out for generations to come. This long-term approach to agriculture combines efficient production with the wise stewardship of the earth's resources. It is hoped that, over time, sustainable agriculture will do the following:

- meet human needs for food and fibre
- protect the natural resource base and prevent the degradation of soil and water quality
- use nonrenewable resources efficiently

- use natural biological cycles and controls
- assure the economic survival of farming and the well-being of farmers and their families.

Considering the importance of this scheme in ensuring optimum soil health for sustainable agriculture, we have attempted to analyze synthesize the primary research findings of select cases and present the synthesis in sustainability perspective.

2. Approach followed

Since the introduction of SHC Scheme by the Government of India, many studies have been conducted. However, keeping in view larger perspective, we attempted synthesis of five empirical research studies as cases. The selected studies are reported during 2017-18 with at least one state as study area. The areas include Andhra Pradesh, Assam, Madhya Pradesh, Punjab and all-India in different crops like *Kharif* paddy, maize, soybean.

3. Results and Discussion

3.1 Case study 1: Impact study on soil health card scheme (Amarender, 2017)

Under SHC scheme, cropped area was divided in to grids of 10 ha for rainfed and 2.5 ha for irrigated. One soil sample from each grid will be taken and test results will be distributed to all the farmers whose lands fall under the grid.

Level of utilization and Impact of the SHC scheme

- About 66% of the farmers are able to understand the content of the SHC, about 57% mentioned that the recommendations are suitable for their farms and about 53% are able to follow recommendations.
- The SHC scheme is inclusive in nature, small and marginal farmers are pro-active in adoption of recommendations based on SHC.
- There was a reduction in use of urea and DAP by 20 to 30% in paddy and cotton in some states resulted in decreased cost of cultivation. The reduction in cost of cultivation ranged between Rs.1000 and Rs.4000 per acre.
- The use of micro-nutrients (especially gypsum) was slightly increased after SHC distribution.
- There was a significant increase in yield for farmers who practiced recommended practices as per the SHC.
- With the decrease in cost of cultivation and increase in yields, netincomes of the farmers increased between 30 and 40% after the SHC scheme.

Constraints of SHC Scheme

- Some farmers complained that the soil test values are not representative of their fields and they also complained that the field staff are not collected soil samples in their presence. To build trust, samples to be collected in presence of GRID farmers.
- Uniform soil GRIDS of 10 ha for rainfed and 2.5 ha for irrigated should be reexamined. The grid size should be determined based on the soil variability index (soil variogram). If variability was high, GRID size should be less and vice versa.
- Soil variogram needs to be developed at each block level to determine the GRID size at block level.
- Many farmers are unable to understand the content, hence unable to follow the recommended practices.
- Only 44% of the farmers mentioned that the extension officers explained the content.
- SHC distribution and awareness campaigns needs to be arranged before sowing season, so that farmers will practice recommended crop choice and fertilizers.
- Awareness campaigns need to be organized the use of SHC in reduction in fertilizer use and costs and increase in yields.
- Many farmers feel that SHC should also mention one or two physical and micro-biological indicators (such as soil texture, water holding capacity, and water quality and bacterial content).
- There is a need to identify best practices in soil sample collection (predetermined DRID apps practiced in Punjab and TN) and testing for scale-up.
- Development of GIS based soil fertility maps at village/block level and wider publicity through wall-posters and display boards in village panchayats should be promoted.
- Government should ensure availability of recommended fertilizers and bio-fertilizers at village level at reasonable prices.

Table 1: Consumption of fertilizers in million tonnes in India

Million tonnes					NPK ratio		
Year	N	P	K	total	N	P	K
1956	0.1	0.0	0.0	0.1	10.4	1.3	1
1981	3.7	1.2	0.6	5.5	5.9	1.9	1
1991	8.0	3.2	1.3	12.5	6.0	2.4	1
2001	10.9	4.2	1.6	16.7	7.0	2.7	1
2011	16.6	8.0	3.5	28.1	4.7	2.3	1
2015	16.9	6.1	2.5	25.6	6.7	2.4	1

India is consuming about 25.6 million tonnes of fertilizers, mostly Nitrogen (17 million tonnes) followed by Phosphorous (6 million tonnes) and Potassium (2.5 million tonnes). The current NPK ratio is 6.7:2.4:1, which is highly skewed towards Nitrogen as against ideal ratio of 4:2:1 (Table 1). There are wide variations across the states, in terms of fertilizer use per acre and NPK ratios (Fig. 2). India is spending about Rs. One lakh crore on fertilizer subsidy. It is estimated that subsidy amount is about Rs.6500/ha of the net cropped area and about Rs.7000/farmer resulting in excessive use of fertilizers especially Nitrogen at the cost of micro-nutrients and manure (Figure 3). As a result of the excessive and unbalanced use of fertilizers, the amount of food grain produced per kg of fertilizer applied declined from 13 kg in the 1970s to just 4 kg by 2010. In order to promote balanced use of fertilizers, government of India introduced has Soil Health Card Scheme across India.

3.2 Case study 2: A study was conducted to know the impact of soil health card scheme on Farmer's income of *Kharif*crops in Madhya Pradesh (Chouhan *et al*., 2017).

In this study, data were collected from 30 soil tested farmers/beneficiaries before and after application of recommended doses of fertilizers (RDF) as an outcome of SHC Scheme. Thescheme was found highly beneficial to the farmers in terms of increasing their income. However, there is a need to generate awareness about the benefits of this scheme among the

farmers on one hand and strengthening of soil testing services / laboratories on the other hand for a wider adoption of RDF.The SHC scheme was launched in February 2015, and by July 2015, more than 34 lakh cards have been issued.

Table 2: Impact of soil testing on economics of cultivation of major kharif crop Madhya Pradesh (Rs/acre)

Variable	Before soil testing	After soil testing	Difference
Paddy			
Total cost	23639	26691	3052(12.91)
Gross income	34870	44076	9205(26.40)
Net income	11231	17385	6153(54.79)
B: C ratio	1.5	1.7	0.2(13.33)
Soybean			
Total cost	10900	10714	-186(-1.70)
Gross income	17596	21942	4346(24.70)
Net income	6696	11228	4532(67.70)
B: C ratio	1.6	2	0.4(25.00)
Maize			
Total cost	8176	9235	1058(12.94)
Gross income	11556	17340	5784(50.05)
Net income	3380	8105	4726(139.83)
B: C ratio	1.4	1.9	0.5(35.71)

Note: Figures within the parentheses show percentage difference after soil testing.

The impact of soil testing on the economics of cultivation of selected *kharif* crops was studied. In paddy the total cost of cultivation increased by 12.91 per cent, from 23639 to 26691 per acre, but net income also increases by 54.79 per cent from 11231 to 17385 per acre. The return per rupee investment also increased from 1.50 to 1.70 after the farmers got their soil tested. In soybean, the total cost of cultivation decreased by 1.7 per cent from 10900 to 10714 per acre but net income increased by 67.7 per cent from 6696 to 11228 per acre. The return per rupee investment also increased from 1.60 to 2.00 after the farmers got their soil tested. In maize, the total cost of cultivation increased by 12.94 per cent from 8176 to 9234 per acre and net income increased by 139 per cent from 3379 to 8105 per acre. The return per rupee investment was also increased from 1.40 to 1.90 after soil testing by the farmers.

3.3 Case study 3: A study to know the impact of soil health card scheme on production, productivity and soil health in Punjab (Singh *et al*., 2017)

Punjab has become the first state in India to issue Soil Health Cards (SHCs) during the year 2015. Keeping in view the importance of SHC scheme the present study was undertaken to examine the awareness, level of adoption and impact of application of recommended doses of fertilizers on soil test basis and its impact on income of major crops in Punjab, if any. Primary data were collected from 60 soil-tested and 60 control group farmers from four clusters of villages in Ludhiana and Patiala districts which were leading districts in distribution of SHC to the farmers in the state. The results of the study revealed that the farmers in soil-tested farmers category was younger having large family size, better educated and there were more number of OBC and SC in this category.

It was observed that farmers mostly preferred higher urea but lower DAP and MOP use in crops sown on their farms as compared to SHC recommendations. As far as application of organic fertilizers is concerned, only FYM was applied by some of the farmers in their fields. Major problems encountered by the respondents in implementing SHC scheme were; less organization of camps regarding soil testing, difficulty in understanding the SHC reports and delayed delivery of SHC reports. The respondent farmers suggested making aware the farmers about SHC scheme by organizing more camps and timely disbursement of SHC reports.

As far as impact of SHC scheme is concerned, in case of paddy and maize crops, there was slight decline in chemical fertilizer usage especially N and P and increase in K usage in case of paddy and increase in N usage in basmati on soil-tested farms which shows the balanced usage of chemical fertilizers as per recommendation. Also, there was slight increase in the yield in case of paddy, basmati and maize crops on soil-tested farms. The implication is that SHC scheme is a win-win situation for the farmers in terms of decline in fertilizer usage along with increase in crop productivity.

Table 3: Average recommended quantity of fertilisers based on soil test report (as mentioned in the SHC) and as per farmers opinion in Punjab, 2015-16 (kgs/acre)

Crops	FYM	Urea	DAP/SSP	MOP	MgSo4
As per soil test report					
Paddy	-	114	25/75	20	-
Basmati	-	30	-	-	-
Maize	-	123	50/140	20	-
As per the farmers opinion					
Paddy	1.29*	130	4	3	-
Basmati	-	81	-	-	-
Maize	-	103	42	-	-

3.4 Case study 4: Impact of Soil Health Card Schemeon Production, Productivity and Soil Health in Assam (Jotin Bordoloiand Anup Kumar Das, 2017).

Cost of cultivation and income of major crop (*Kharif* Paddy)

As the recommended dose of fertilizer (RDF) was not adopted by any of the sample farmers, the impact of application of recommended doses of fertilizer on yield and visible changes could not be found and incorporated in the report. In spite of that it was tried to work out the cost of cultivation and income of major crop (Kharif Paddy) for the sample farmers. The cost of cultivation and income of Kharif Paddy for the sample farmers have been presented in Table-5.1. From the table it is seen that the quantity and cost of most of the inputs (i.e. total labour, FYM, Fertilizers, etc.) are marginally in higher side for the soil tested farmers as compared to control group farmers except the rental value of the land. The rental value of land (Rs. 795/acre) for soil tested farmers was less than that of control group (Rs. 993/ acre) by Rs. 198, as the leased in area under control group was more than that of the soil tested group. The total costs of cultivation of Kharif paddy per acre of land were calculated at Rs. 12,868 and Rs. 12,993 for Soil tested and the control group farmers, respectively, with a marginal difference of Rs.125. On the return part, per acre yield (13.12 quintals) for soil tested farmers was marginally higher i.e. 0.50 quintal valued at Rs. 638 than the yield of the control farmers (12.62 quintals). There was a marginal difference of 0.17 quintal (valued at Rs. 41) in the yield of by-product also, and the net income difference between the two groups was worked out at Rs. 804 per acre. Although, the soil

tested farmers got slightly higher yield than the control group, it might not be due to judicious use of fertilizer as there was no such noticeable difference. It might have happened due to some other exogenous factors. Impact of any development programme can be assessed only when it goes to the field for execution. As the farmers in the sample area received the Soil Health Cards a bit late and could not go with the RDF as yet, proper evaluation of the scheme in Assam could not be undertaken in the true sense of the term. An assessment of this flagship programme can be carried out meaningfully in subsequent crop seasons if timely measures in the line are taken by the implementing agencies.

Table 4: Changes in cost of cultivation of *Kharif* paddy crop and income in Assam, 2015 (Per acre)

Variables	Unit	Soil tested farmers		Control group		Difference	
		Qty	Cost (Rs.)	Qty	Cost (Rs.)	Qty	Cost (Rs.)
Cost							
Total labour cost		45.38	10,222	44.62	10,207	0.76	15
Manure/FYM	Tonnes	0.09	175	0.08	169	0.01	6
Seed	No/kgs	18.63	466	18.60	465	0.03	1
Fertilisers N (Urea)	Kgs	9.08	82	8.80	79	0.28	3
P (DAP)	Kgs	8.15	635	17.42	610	0.73	26
K (MOP)	Kgs	15.13	303	14.30	287	0.83	16
Complex	Kgs	-		-		-	
Others	Kgs	-		-		-	
	Kgs	-		-		-	
PPC		-		-		-	
Irrigation*	Acre inch	-	14	-	6	-	8
Others		-		-		-	
Rental value of land		-	795	-	993	-	-198
Land revenue		-	176	-	176	-	0
Total cost			12,868		12,993		-125
Return							
Variables	Unit	Qty	Value (Rs.)	Qty	Value (Rs.)	Qty	Value (Rs.)
Main product yield	Quintals	13.12	16,072	12.62	15,434	0.50	638
By product yield	Quintals	2.04	509	1.87	468	0.17	41
Gross income			16,531		15,902		679
Net income			3,713		2,909		804

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

3.5 Case study 5: Soil health card Adoption behavior of Farmers in Andhra Pradesh state of India (Chowdary *et al.*, 2018).

The Government of Andhra Pradesh had launched the Bhoochetana Project (Soil Testing Project) in 2010-11 for distributing Soil Health Cards (SHCs) to farmers to encourage judicious application of fertilizers and to maintain soil fertility. Therefore, a study was undertaken to evaluate the project in terms of knowledge level on Soil Health Management (SHM) among beneficiary farmers, extent of adoption of SHC recommendations by beneficiary farmers, and factors that determined the adoption of SHC recommendations. 47 respondents had followed the SHC recommendations for all the five years. This is followed by nine respondents who had followed for four years, 21 respondents for three years, 14 respondents for two years, and the rest nine respondents for one year. Among adopters of SHC recommendations, cent per cent of the farmers had adopted the SHC recommendations as such without any deviation. Whereas, among non-Adopters of SHC recommendations, an overwhelming proportion (92.45%) of farmers fell under excess adoption category.

Table 5

S. No	Years of Adoption	No. of Adopters (n=100)
1	5 years	47
2.	4 years	9
3.	3 years	21
4.	2 years	14
4.	1 years	9
	Total	100

Table 6: A Snap shot of cases reviewed

S.NO	cases reviewed and source	Major findings
1	Impact study on soil health card scheme AMARENDER (2017)	1)There was a reduction in use of urea and DAP by 20 to 30% in paddy and cotton in some states resulted in decreased cost of cultivation. The reduction in cost of cultivation ranged between Rs.1000 and Rs.4000 per acre.

		2)SHC distribution and awareness campaigns needs to be arranged before sowing season, so that farmers will practice recommended crop choice and fertilizers. Only 44% of the farmers mentioned that the extension officers explained the content. 3)Balanced application of fertilizers across India. 4)Decrease in usage of urea and DAP in paddy 5)Decreased cost of cultivation 6)Increase in income of farmers.
2	A study was conducted to know the impact of soil health card scheme on Farmer's income of *Kharif*crops in Madhya Pradesh. Chouhan, R.S., Sharma, H.O., Rathi, D and Niranjan, H.K. (2017)	1) In paddy the total cost of cultivation increased by 12.91 per cent, from 23639 to 26691 per acre, but net income also increases by 54.79 per cent from 11231 to 17385 per acre. The return per rupee investment also increased from 1.50 to 1.70 after the farmers got their soil tested. 2)In soybean, the total cost of cultivation decreased by 1.7 per cent from 10900 to 10714 per acre but net income increased by 67.7 per cent from 6696 to 11228 per acre. The return per rupee investment also increased from 1.60 to 2.00 after the farmers got their soil tested. 3)In maize, the total cost of cultivation increased by 12.94 per cent from 8176 to 9234 per acre and net income increased by 139 per cent from 3379 to 8105 per acre. The return per rupee investment was also increased from 1.40 to 1.90 after soil testing by the farmers.
3	A study was conducted to know the impact of soil health card scheme on production, productivity and soil health in Punjab. Davinder, G., Singh, J.M and Sanjay, K. (2017)	1). It was seen that recommended quantity of fertilizers for paddy crop was 114 kg. urea, 25 kg. diammonium phosphate (DAP) or 75 Kg. single super phosphate (SSP) and 20kg. muriate of potash (MOP). Similarly, for basmati crop only 30 kg. urea was recommended per acre. In case of maize crop recommendation level of urea was 123 kg per acre besides 50 kg. DAP or 140 kg. SSP and 20 kg. MOP. Thus, recommendations about fertilizer use in SHC showed that these have been given only for macro-nutrients use in paddy, basmati and maize crops. 2) According to farmers opinion requirement of urea was higher for paddy and basmati and lower for maize crop as compared to SHC report. Also, as per farmers opinion, requirement of DAP and MOP in paddy and DAP in maize was also lower vis-a-vis based on SHC recommendations. Thus, farmers mostly preferred higher urea but lower DAP and MOP use in crops as compared to SHC recommendations.
4	Impact of soil health card scheme on production, productivity and soil health in Assam. Jotin Bordoloiand Anup K. Das. (2017)	1)The total costs of cultivation of Kharif paddy per acre of land were calculated at Rs. 12,868 and Rs. 12,993 for Soil tested and the control group farmers, respectively, with a marginal difference of Rs.125. On the return part, per acre yield (13.12 qtls.) for soil tested farmers was marginally higher *i.e*. 0.50 qtl. valued at Rs. 638 than the yield of the control farmers (12.62 qtl). There was a marginal difference of 0.17 qtl. (valued at Rs. 41) in the yield of by-product also, and the net income difference between the two groups was worked out at Rs. 804 per acre. Although, the soil tested farmers got slightly higher yield than the control group, it might not be due to judicious use of fertilizer as there was no such noticeable difference. 2)As the farmers in the sample area received the Soil Health Cards a bit late and could not go with the RDF as yet, proper evaluation of the scheme in Assam could not be undertaken in the true sense of the term. 3) Increase in yield of Kharif paddy per acre of land after adoption of SHC'S. 4) Decrease in cost of cultivation.
5	Soil health card Adoption behavior of Farmers in Andhra pradesh state of India. Chowdary, K.R., Babu, G.P and Ravi, K.T (2018)	1) Adoption of SHC'S in Andhra Pradesh for five span was taken. 2) 47 among 100 farmers were adopted and continued for five years.

3.6 Synthesis of cases reviewed

Analysis of the five select cases reviewed and presented in this article helped us to consolidate the evidences and synthesize the common elements. Overall, the impact of SHC was assessed in terms of the select indicators like edaphic, biological, socio-economic and cost-returns. The salient common findings of the reviewed cases are

1. Enabled balanced application of fertilizers across India.
2. Resulted in decreased usage of fertilizers.
3. Also led to decreased cost of cultivation.
4. Increased income levels of farmers.
5. Returns per rupee invested increased.
6. Adoption of SHC's increased.

3.7 Emerging issues

Global population is increasing and agriculture production is not adequate enough to support social need globally resulting in malnutrition, hunger, social instability, and death. Use of chemical fertilizer, insecticides, genetically modified organisms, and modern science and technology for agriculture increases production of agriculture products but there are big threat for ecosystems, risk for diseases, etc. systematic sustainable agriculture is not established in bigger scales. In many cases, farmers use fertilizers, insecticides, randomly without specification for specific crops which causes improper growth, heterogeneous crop production, and resistance to other crops. Use of bio fertilizer is not established properly yet. Sustainable agriculture is the key for survival of mankind in the future, which involves holistic management of crops, livestock, and fisheries to make the farming system self-sustaining for a long period. Applications of nanotechnology to such sustainable processes can enable improved plant growth, soils and microbial stabilization, targeted application of chemicals and better plant and farmyard animal management, food processing, and rural waste management. However, the environmental safety concerns of widespread nanoparticle use should be carefully examined before large-scale application of such technologies. Widespread nutrient deficiencies and deteriorating soil health care cause of

low nutrient use efficiency, productivity & profitability. The lack of adoption of soil test based recommendations among farmers has aggravated the problem of imbalanced fertiliser use. Sustainable production can be achieved through adoption of site-specific balanced and integrated nutrient management involving major, secondary and micro nutrients, organic manures, bio fertilizers and amendments. In the coming years, use of efficient information technologies will play an increasingly important role in crop production and natural resource management. In this context GIS has a significant role to play in the decision-making process in agriculture at various levels *i.e.*, field, regional, national and global levels. GIS is one of the important tool of Information Technology (I.T) highly relevant to agriculture. The application of modern Remote sensing technology coupled with GIS has opened the way for significant change in crop production management and agricultural decision-making process. This vision is reflected in site specific farming. Site specific farming aims to direct the application of seed, fertilizer, pesticides and water within fields in ways that optimize farm returns and minimize chemical inputs and environmental hazards.

Sensing soil health

Assessments of soil chemical properties normally rely on laboratory data with large numbers of samples required to adequately characterize spatial variability at farmscales (Sanchez *et al*., 2003) [10]. Shepherd and Walsh (2002) [13] have developed a promisingapproach that directly estimates several soil properties simultaneously from diffuse reflectance spectra in rapid nondestructive ways. The soil reflectance spectral datasuccessfully predicted crop yields of an 18-year field experiment in Kenya testingdifferent levels of fertilizer, manure and crop residue management (Shepherd and Walsh, 2002). Since spectral techniques allow large numbers of samples to be rapidly analyzed, resources can be directed towards thorough characterization of the soil and its spatialvariability within a target region.

4. Conclusion

With the use of soil health cards, the farmers are able to increase the crop yields by reducing the cost of cultivation, following the recommended dosage of fertilizers bringing the site specifics nutrient management. The SHC are to be supplied for every three years. The net income of the farmers increased between 30 and 40% after SHC scheme. It is indirectly helping in maintaining the soil health and fertility and bringing sustainable agriculture. however, there are some lacunae in soil health cards but they are highly useful to the farmers. Soil health and quality should be maintained by following integrated approach consisting of practices like reducing tillage, avoiding soil compaction, growing cover crops, better crop rotations, organic amendments and inorganic amendments.

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