Working Paper 2015/01

Adoption of Recommended Doses of Fertilisers on Soil Test basis by Farmers in Gujarat

Mrutyunjay Swain, S. S. Kalamkar and Kalpana Kapadia

May 2015

Agro-Economic Research Centre

For the States of Gujarat and Rajasthan

(Ministry of Agriculture, Govt. of India)

Sardar Patel University

Vallabh Vidyanagar, Dist. Anand, Gujarat

Working Paper 2015/01

Adoption of Recommended Doses of Fertilisers on Soil Test basis by Farmers in Gujarat

Mrutyunjay Swain
S. S. Kalamkar
Kalpana Kapadia

Agro-Economic Research Centre
For the States of Gujarat and Rajasthan
(Ministry of Agriculture, Govt. of India)

Sardar Patel University
Vallabh Vidyanagar, Dist. Anand, Gujarat

May 2015

AERC Working Paper 2015/01

About the Centre:

The Agro-Economic Research Centre (AERC) for the states of Gujarat and Rajasthan was established in July 1961 at the Sardar Patel University, Vallabh Vidyanagar by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi. AERC has been working as an associate institution of Sardar Patel University and enjoying autonomy status in its working. The Centre has completed 54 glorious years (1961-2015) of its journey marked by both achievements and challenges. During these years, the Centre has emerged as a strong policy feedback centre of the Ministry of Agriculture, Government of India due to hard work and strong commitment of the staff in the Centre. The focus of research effort in the initial stage was on comprehensive village surveys and resurveys in order to understand the process and direction of change at the village level. Subsequently, the emphasis of research has shifted to problem oriented studies. The Centre has by now completed 159 problem-oriented studies, 21 village surveys and 4 village resurveys. During its long journey, the Centre has brought remarkable improvement in every aspects of research including methodological base of the studies. The studies have come out with useful findings and policy implications for agricultural and rural development of the states of Gujarat and Rajasthan.

Working Paper Series:

The Working Paper Series provides an opportunity for AERC and CCS faculty/staff, invited guest speaker, visiting fellows and Ph.D. scholars to discuss their ideas and research work before publication and to get feedback from their peer group. Papers selected for publication in the series present empirical analyses and generally deal with wider issues of public policy at a sectoral, regional or national level. These working papers undergo review but typically do not present final research results, and constitute works in progress.

Adoption of Recommended Doses of Fertilisers on Soil Test basis by Farmers in Gujarat

Mrutyunjay Swain, S. S. Kalamkar & Kalpana Kapadia

ABSTRACT

The present study examines the level of adoption and constraints in the application of recommended doses of fertilisers based on soil test (through Soil Health Card Scheme) by the farmers in Gujarat, India. The impacts of adoption of recommended doses of fertilisers on crop productivity, income and relevant institutional problems have also been assessed for different farmer categories. The two major crops grown in the state (groundnut and cotton) were selected for the detailed study. The household survey was administered on 400 farmers from 8 talukas of four districts (Surendranagar and Rajkot for cotton and Jamnagar and Junagarh for groundnut) of Gujarat. The study was conducted following a cluster approach on a sample of160 control farmers (no soil test) and 240 soil test farmers. The study finds that the level of adoption of recommended doses by the soil test farmers was reasonably less (around 40 per cent for both cotton and groundnut groups) among the sample farmers. However, the adoption of recommended doses of fertiliser based on soil test has helped the farmers in increasing the agricultural productivity and income. The crop yield after soil tests has increased by 23.8 per cent and 22.9 per cent in case of groundnut and cotton respectively. The low adoption of recommended doses of fertilizers by the soil test farmers was due to various constraints, viz. difficulty in understanding and following application of recommended doses as stated in Soil Health Cards, unavailability of technical advice on method and time of fertiliser application, high prices of fertilisers and unavailability of required fertilisers in adequate quantity. The quality of implementation of the programme was unsatisfactory due to focus on target achievement ignoring quality norms, inadequate staff strength, unavailability of required number of soil test laboratories (STLs) and mobile STLs and lack of upgradation of skills of the personnel involved in the implementation of the programme.

Key words: Soil Test, Soil health card, Recommended doses of fertilizer, Technology adoption

1.Introduction

Fertilisers have been considered as an essential input to Indian agriculture for increasing agricultural production so as to meet the food grains requirements of growing population of the country. It is has been well established fact that chemical fertilisers bear a direct relationship with food grains production along with a number of supporting factors like High Yielding Variety seeds (HYVs), irrigation, access to credit, tenurial conditions, size of the product market and the prices they face in input and output markets, etc. A very close association is observed between growth in use of fertilisers and crop productivity in almost all the states of the country (Chand and Pandey, 2008). Therefore use of chemical fertiliser in India has tremendously grown since the advent of green revolution in late 1960s. With the improvement in production since green revolution period, India's position has turned from the state of net importer of agricultural products to exporter of certain agricultural commodities like rice, wheat and sugar (Krishnaji 1975; Vaidyanathan, 1988; Rao 1996). Further, the technology has also altered traditionally followed cropping pattern, which comprised growing multiple crops every season to mono-cropping, for example cultivation of only rice in some parts of south India. This practice put the land and other resources under severe strain resulting in depletion of soil nutrients, decline in water table, build up of pest and diseases, and micro-nutrient deficiency (Murgai et al 2001; Pingali and Shah 2001).

Chemical fertilisers are the important source of nutrients for plant growth. With the advent of fertiliser responsive crop varieties, total consumption of nitrogenous (N), phosphatic (P) potassic (K)

fertilisers have increased from about 1.1 million tonnes in 1966-67 to 24.48 million tonnes in 2013-14. It was estimated that urea accounts for 82 per cent of total nitrogen consumption and di-ammonium phosphate for 63 per cent of phosphate consumption (FAO, 2005). The all-India average consumption of fertilisers has increased from 6.9 kg per ha of gross cropped area to 125.39 kg per ha during corresponding period (FAI, 2013). However, the level of consumption of fertilisers varied widely within as well as between states, i.e. from 216.73 kg/ha in Punjab to 49.69 kg/ha in Rajasthan to 14.22 kg/ha in Meghalaya in 2013-14. The variability in consumption of fertilisers can be attributed to different cultivation methods, type of crops and subsidy on fertilisers. Further, the consumption of fertilisers has also varied across farm size groups with the highest amount of consumption recorded among group of small farmers.

The indiscriminate use of chemical fertilisers by farmers has led to deterioration of soil structure, wastage of nutrients, destruction of soil micro-organisms and scorching of plants at the extreme cases. The Government of India has undertaken many initiatives to encourage the farmers for balanced use of fertilisers. The Soil Health Card (SHC)[1] Scheme is one of them which has been implemented in various states. At national level, the scheme been launched in February 2015 that has targeted to cover about 14 crore farmers in next

1 A Soil Health Card (SHC) contains information on major nutrients like Organic carbon (N), P, K, Ec, pH; secondary nutrients (Mg, Ca, S) and micro nutrients (Cu, Fe, Zn, Mn and B etc) that helps farmers in judicious fertilizer application. Soil health card also contains the fertilizers recommendation for major Kharif, Rabi and Summer crops. These cards are being supplied to farmers specifically to reduce imbalances in fertiliser application.

three years (GOI, 2015). Among various states of India, Gujarat has been a leading state that implemented the SHC Scheme in much advance (since 2003-04). The state has covered about 53 lakh farmers by 2013-14. There have been efforts in other states to replicate the Gujarat Model of SHC implementation. However, there is no systematic study undertaken in the state so far for evaluating the effectiveness of the programme in promoting better soil health, raising crop productivity and farmers income. It is necessary to know the level of adoption of recommended doses of fertilizer based on soil tests done through SHC Scheme and its implications.

Therefore, the present study examines the level of adoption and constraints in the application of recommended doses of fertilisers by different categories of farmers in Gujarat, India. The study has also assessed the impacts of soil tests and adoption of recommended doses of fertilisers on crop productivity and income of the farmers.

2. Objectives of the Study

The major objectives of the study were as follows:

- To examine the level of adoption and its constraints in the application of ecommended doses of fertilisers based on soil test reports by the farmers in Gujarat.
- To analyse the impact of adoption of recommended doses of fertilisers on crop productivity and income of farmers in the state.

3. Data and Methodology

The present study is based on both secondary and primary level data. The secondary data (1980-81 to 2013-14) were collected from

Department of Agriculture, Government of Gujarat and some other sources. The primary data were collected from the four selected districts of Gujarat covering the reference year 2013-14. The farmers who got their soil tested during the last three years were included for the detailed analysis. The household survey was administered on 400 farmers from 8 talukas of four districts. The selected districts of Gujarat were Surendranagar and Rajkot for cotton and Jamnagar and Junagadh for groundnut. The two major crops grown in the state (groundnut and cotton) were selected for the detailed study. For each study crop, the study was conducted following a cluster approach on a sample of 80 control farmers (no soil test) and 120 soil test farmers. Thus, the total sample size of the study for two selected crops was 400 (Table 1).

The cluster approach was followed to ensure that adequate number of soil test farmers is available for the survey. The multistate sampling method was used to select the districts, blocks and farm households. At first stage, four districts (Surendranagar and Rajkot for cotton and Jamnagar and Junagadh for groundnut) of Gujarat were selected on the basis of the average area under crops during the last three years (TE 2012-13). At second stage, 16 villages from 8 blocks of four study districts were selected. At third stage, 400 sample households representing different farm categories (MF: Marginal farmers (0-2.5 Ac); SF: Small farmers (2.5-5.0 Ac); MDF: Medium farmers (5.0- 10 Ac); LF: Large farmers (>10 Ac)) were selected for the survey. The sample farmers were classified into different farm size groups post-survey as per the size of net operated area.

Table 1: District-wise Distribution of Sample Farmers

(Number of farmers)

Districts	MF	SF	MDF	LF	Total
Soil Test Farmers					
Surendranagar	3	7	17	33	60
	(5.0)	(11.7)	(28.3)	(55.0)	(100.0)
Rajkot	4	20	24	12	60
	(6.7)	(33.3)	(40.0)	(20.0)	(100.0)
Cotton total	7	27	41	45	120
	(5.8)	(22.5)	(34.2)	(83.3)	(100.0)
Junagadh	8	27	17	8	60
	(13.3)	(45.0)	(28.3)	(13.3)	(100.0)
Jamnagar	4	18	26	12	60
	(6.7)	(30.0)	(43.3)	(20.0)	(100.0)
Groundnut total	12	45	43	20	120
	(10.0)	(37.5)	(35.8)	(27.8)	(100.0)
Total (Soil Test)	19	72	84	65	240
	(7.9)	(30.0)	(35.0)	(55.6)	(100.0)
Non-Soil Test Farmers					
Surendranagar	0	6	9	25.0	40
	(0.0)	(15.0)	(22.5)	(62.5)	(100.0)
Rajkot	7	12	10	11.0	40
	17.50	30.00	25.00	27.5	(100.0)
Cotton total	7	18	19	36	80
	(8.8)	(22.5)	(23.8)	(123.1)	(100.0)
Junagadh	10	9	14	7.0	40
	(25.0)	(22.5)	(35.0)	(17.5)	(100.0)
Jamnagar	1	6	14	19.0	40
	(2.5)	(15.0)	(35.0)	(47.5)	(100.0)
Groundnut total	11	15	28	26	80
	(13.8)	(18.8)	(35.0)	(54.4)	(100.0)
Total (Non-Soil Test)	18	33	47	62	160
	(11.3)	(20.6)	(29.4)	(88.8)	(100.0)
Grand Total (Soil test+ Non soil test)	37	105	131	127	400
	(9.3)	(26.3)	(32.8)	(31.8)	(100.0)

Notes: Figures in parentheses are the percentages of total; MF: Marginal farmers (0-2.5 acre); SF: Small farmers (2.5 – 5.0 acre); MDF: Medium farmers (5.0 – 10.0 acre); LF: Large farmers (>10.0 acre).

Source: Field survey data.

4. Results and Discussion

4.1. Progress in Soil Test and Distribution of Soil Health Card in Gujarat

Gujarat has made spectacular progress in soil testing and distribution of Soil Health Cards. The SHC programme was implemented in the state in two phases. During the first phase (2004-05 to 2011-12), 38.43 lakhs farmers (out of total of 46.61 lakhs in Gujarat) were provided Soil Health Cards (SHCs), covering about 85.5 per cent of total farmers in Gujarat. The Second phase was started from 2012-13, aiming to cover 25% farm holding (11.50 Lakh) every year. During last two years (2012-13 and 2013-14), about 15.26 lakh farmers have been provided the SHCs. Thus, since the inception, a total of 53.69 lakh soil health cards have been given to farmers by the end of 2013-14 (Table 2). The programme has generated alternative crop planning and recommendations for 229 talukas and 24324 villages and generated all Taluka and Village Model Action Plans (GoG, 2013).

Along with increase in cumulative number of SHCs distributed to farmers from 2.27 lakh in 2004-05 to 53.69 lakh in 2013-14, the number of soil testing labs (STL) has also increased from 20 in 2004-05 to 134 in 2013-14 at the rate of 17.9 per cent per annum. Similarly, the annual soil sample analysing capacity has increased from 2.34 lakh in 2004-05 to 10.3 lakh in 2013-14. The actual soil sample analyzed has increased at the rate of 10.0 per cent per annum, i.e. from 3.23 lakh in 2004-05 to 7.64 lakh in 2013-14.

Table 2: Progress in Soil Health Card Programme in Gujarat, India

Year	Soil Testing Laboratories under	Number of soil testing laboratories			Annual analyzing capacity	No. of sample analyzed	Capacity Utilized (%)	No. of dist. having STL	No. of SHCs made available to farmers	
		Static	Mobile	Total					During the year	Cumulative Total
1	2	3	4	5	6	7	8	9	10	11
2004-05	(I) State Government	16	4	20	184000	184893	100.5	18	227425	
	(ii) Public Sector Undertaking	3	1	4	50000	138089	276.2	0		
	(iii) Private Sector	0	0	0	0	0	0.0	0		
	(iv) Total	19	5	24	234000	322982	138.0	18	227425	227425
2005-06	(I) State Government	16	4	20	184000	188596	102.5	18	492200	
	(ii) Public Sector Undertaking	3	1	4	60000	125583	209.3	0		
	(iii) Private Sector	0	0	0	0	0	0.0	0		
	(iv) Total	19	5	24	244000	314179	128.8	18	492200	719625
2006-07	(i) State Government	18	2	20	190000	211691	111.4	18	249186	
	(ii) Public Sector Undertaking	3	1	4	50000	99677	199.4	3		
	(iii) Private Sector						0.0			
	(iv) Total	21	3	24	240000	311368	129.7	21	249186	968811
2007-08	(I) State Government	18	2	20	190000	142692	75.1	18	219000	
	(ii) Public Sector Undertaking	3	1	4	50000	84789	169.6	3		
	(iii) Private Sector						0.0			
	(iv) Total	21	3	24	240000	227481	94.8	21	219000	1187811
2008-09	(i) State Government	18	2	20	190000	158224	83.3	18	568614	
	(ii) Public Sector Undertaking	3	1	4	50000	83819	167.6	3		
	(iii) Private Sector						0.0			
	(iv) Total	21	3	24	240000	242043	100.9	21	568614	1756425
2009-10	(i) State Government	18	2	20	190000	307348	161.8	19	100000	
	(ii) Public Sector Undertaking	3		3	50000	104733	209.5	3		
	(iii) Private Sector						0.0			
	(iv) Total	21	2	23	240000	412081	171.7	22	100000	1856425

Table 2 Continued...

1	2	3	4	5	6	7	8	9	10	11
2010-11	(i) State Government	18	2	20	210000	650000	309.5	19	1279968	
	(ii) Public Sector Undertaking	70	0	70	1430223	1401646	98.0	24		
	(iii) Private Sector	0	0	0	0	0	0.0	0		
	(iv) Total	88	2	90	1640223	2051646	125.1	26	1279968	3136393
2011-12	(i) State Government	20	2	22	220000	136408	62.0	21	706241	
	(ii) Public Sector Undertaking	81	0	81	810000	353625	43.7	24		
	(iii) Private Sector	0	0	0	0	0	0.0	0		
	(iv) Total	101	2	103	1030000	490033	47.6	24	706241	3842634
2012-13	(i) State Government	20	2	22	220000	278931	126.8	21	900095	
	(ii) Public Sector Undertaking	81	0	81	810000	607421	75.0	24		
	(iii) Private Sector	0	0	0	0	0	0.0	0		
	(iv) Total	101	2	103	1030000	886352	86.1	26	900095	4742729
2013-14	(i) State Government	20	2	22	220000	203725	92.6	21	626362	
	(ii) Public Sector Undertaking	112	0	112	810000	560099	69.1	24		
	(iii) Private Sector	0	0	0	0	0	0.0	0		
	(iv) Total	132	2	134	1030000	763824	74.2	26	626362	5369091
CAGR (2004-05 to 2013-14)	(i) State Government	2.5	-7.4	1.1	2.0	1.1	-0.9	1.7	11.9	
	(ii) Public Sector Undertaking	49.5	-100.0	44.8	36.3	16.8	-14.3			
	(iii) Private Sector									
	(iv) Total	24.0	-9.7	21.1	17.9	10.0	-6.7	4.2	11.9	42.1

Notes: *During 2010-11, other than 70 PSU, analysis work done in 55 science colleges to meet the Golden Goal 739431 samples were analysed by science colleges. Analysis work was outsourced to private agencies by State Government STLs to meet the Golden Goal and work was done in two shifts. Soil samples were analysed by Public Sector Undertakings such as APMCs, Govt. supported Corporation Labs, Govt supported Sugar cooperatives labs) and Science Colleges.

Source: Department of Agriculture, Government of Gujarat.

4.2. Socio-Economic Characteristics of Sample Households

Among the sample farmers, the marginal and small farmers together constitute about 37.9 per cent of total soil test farmers and 31.9 per cent of total control farmers. Thus, the majority of the sample households are the medium and large farmers. The age of respondent selected farmer household was 47.3 years with education of 7.1 years. The agriculture formed the main source of occupation for about 99.5 per cent of sample households. The average years of experience in farming were 26.8 years among soil test farmers and 23.5 years among control farmers. The majority of sample households belonged to general castes (60%) and other backward castes (36.5%).

The average size of land holding of all sample households was 8.7 acres per household, out of which about 70 per cent land was irrigated (6.0 acres) and remaining 30 per cent land (2.7 acres) was un-irrigated. In the case of soil test farmers, the average size of land holding was found to be 8.5 acres per household, out of which 5.9 acres was irrigated and 2.6 acres was un-irrigated. In the case of control farmers, the average size of land holding was 8.95 acres per household, out of which 6.3 acres was irrigated and 2.65 acres was un-irrigated. The gross cropped area for soil test farmers and control farmers was 12.20 acres and 12.18 acres respectively. The cropping intensity for soil test farmers and control farmers was estimated to be 143.78 per cent and 136.03 per cent respectively. Thus, cropping intensity for soil test farmer was slightly higher than control group.

The crop-wise data shows that the gross cropped area of cotton group of farmers was much higher (15.33 acre per HH) than the

groundnut group of farmers (9.18 acre per HH). Therefore cropping intensity was much higher (149.5%) for the cotton farmers compared to groundnut farmers (129.2%). Among the selected farmers, the land leased-in tendency was found significant in case of soil test farmers than control group farmers. Among the sources of irrigation, open wells and dug wells were the major sources for all categories of sample households, which constituted about 57.6 per cent followed by bore wells (38.6 per cent). Thus, groundwater was the main source of irrigation for the selected sample households.

4.3 Cropping Pattern and Area under HYV

Among the selected crops, the GCA of cotton group of farmers was almost one and half time higher than that of groundnut group of farmers. The proportion of area under more remunerative Rabi crops was also found to be higher (31.4% of GCA) in case of cotton growers as compared to groundnut farmers (20.7% of GCA). For cotton farmers, around 60 per cent cropped area was in kharif season and remaining area was covered under rabi crops. The area under kharif crop for groundnut farmers was much higher (76.7%). Among the Kharif crops grown by cotton farmers, cotton (41.7%), kharif oilseeds such as castor (5.1%) and groundnut (3.8%), jowar (3.5%) were the major crops. Among the Rabi crops grown by cotton farmers, wheat (11.7%), cumin (12.3%) were the major crops. Total summer crops contributed about 8.1 per cent of GCA of cotton growers. Among the Kharif crops grown by groundnut farmers, groundnut (56.8%) and cotton (16.8) were the major crops. Among the Rabi crops grown by groundnut farmers, wheat (5.7%), cumin (5.3%) and gram (4.1%) were the major crops. Total summer crops contributed only about 2.3 per cent of GCA of groundnut growers.

The area under HYV crops under both crops category was found to be much less. The HYV area under kharif groundnut, kharif cotton and wheat was relatively better for both soil test and control farmers. The HYV area under kharif groundnut, kharif cotton and wheat for soil test farmers was 36.3 per cent, 21.3 per cent and 10 per cent, respectively.

It is surprising to note that the control farmers under cotton crop category have received better returns per acre (Rs. 41006.2) over soil test farmers (Rs. 33122). However, the reverse is found to be true in the case of groundnut farmers. The value of output per acre for groundnut farmers was Rs. 30524.9 for soil test group and Rs. 24665.1 for control group. The cotton growers were more mechanized as compared to groundnut growers. That to soil test farmers in cotton crop were more mechanized than control group farmers. The tractor with trolley, diesel engine, drip and sprinkler systems of irrigation was found higher with significant than its counterpart. However, in case of groundnut growers, except number of sprinkler and diesel engines, the control group farmers dominate the moderation of agriculture than soil test farmers. Thus, totally opposite situation of cotton grower could be seen in case of groundnut growers.

4.4. Soil Testing and Recommended Doses of Fertilisers

The cost of soil test was nil for all soil test farmers since it was provided free of cost by the Government (Table 3). Some of the progressive farmers were also provided the detailed soil test analysis by the cooperatives. However, the average distance travelled to soil test lab (STL) by the groundnut farm households (129.3 km) was more

than doubled the distance travelled by cotton farm households (49.4 km). Among groundnut farmers, the distance to STL was highest (151.9 km) for the medium farmers.

Table 3: Details of Soil Testing by Sample Farmers

Particulars	Cotton	Groundnut
% of farmers tested their soil in the last three years	100.00	100.00
Average cost of soil testing (Rs/sample)	0.00	0.00
Average distance from field to soil testing lab (kms)	49.39	129.30
Average number of soil samples taken per plot	4.93	4.77
Average no. of plots considered for soil testing	1.27	1.14
Av area covered under soil test (Acre)	5.90	4.37
Area covered as % of net operated area	56.59	66.76
% of farmers who collected samples themselves	40.83	36.67
% of soil sample collected by the department officials	59.17	63.33

It is very surprising to note here is that about 40.8 per cent of cotton farmers and 36.7 per cent of groundnut farmers collected the soil samples by themselves. The collection of soil sample is scientific and systematic process which requires the training of same. Thus, the trained staff should have been collected the all soil sample to have correct results about soil health. The remaining around 60 per cent of total soil samples were taken by the department officials. The selected farmers opined that inadequate number of STLs has severely affected the quality of testing service provided to them by these agencies.

The farmers had shown keen interest in getting their soil tested for several reasons. The major motivating factors towards soil testing

were to increase crop yield, adoption of new technological practices, motivation from village demonstration/training/exposure visits to places with best farming practices. Thus both group farmers got motivated with the information they received about the benefit of testing of soil in crop production.

There are some farmers who had not tested their farm soil. It is because of the fact that spread of SHC programme was restricted and thus due to lack of awareness among the farmers, some farmers left out. Among non-soil test farmers, about 86.3 per cent farmers expressed that they are not aware about how to draw soil sample, about 79 per cent farmers mentioned that they do not know whom to contact for details on testing. Thus, lack of awareness, interest and low level of education has kept away around 81 per cent sample control farmers from soil test.

The results of soil test indicted that average soil quality of farm plots of sample farmers was very poor in terms of nitrogen and phosphorus content. Only about 1.7 per cent farms of cotton growers and 2.8 per cent of groundnut growers were found to have normal nitrogen level. Only about 6.3 per cent of farm plots of cotton growers and 2.1 per cent of groundnut growers were found to have normal Phosphorus level. About 11.4 per cent farm plots of cotton growers and 14.9 per cent of groundnut growers were found to have normal level of potassium. The pH value was found to be normal in sufficient number of cases (90.8% for cotton and 100% for groundnut). The poor soil health has been mainly due to unbalanced use/doses of fertiliser application. Thus, it is necessary to adopt the recommended doses of fertiliser for maintaining better soil health.

The average quantities of recommended dose of fertilisers given based on soil test (as reported in the farmers' SHC) for the two study crops indicated that, for cotton, the major fertilisers recommended were Urea and FYM. The quantity of Urea recommended for HYV irrigated cotton, HYV unirrigated cotton and local cotton were 153.7kg/acre, 69.8kg/acre and 34.9kg/acre, respectively (Table 4). The FYM recommended for all types of cotton was 4.0 tonne/acre. In the case of Groundnut, the major fertilisers recommended were Urea, DAP and FYM. The average quantities of Urea, DAP and FYM recommended for summer groundnut were much higher than that for kharif groundnut. The average quantities of Urea, DAP and FYM recommended for summer groundnut were 7.0kg/ha, 37.1kg/acre and 4.0 tonne/acre, respectively. On the other hand, the average quantities of Urea, DAP and FYM recommended for kharif groundnut were only 3.5kg/acre, 17.6kg/acre and 4.0 tonne/acre, respectively.

Table 4: Average Quantity of Recommended Dose of Fertilisers Based on Soil Test(as reported in the health card)-Soil Test Farmers

(Kg/acre)

Fertiliser	Cotton					Groundnut		
	HYV Irrigated	HYV Unirrigated	Local Unirrigated	Total unirrigated cotton	Total Cotton (Average)	Kharif Groundnut	Summer Groundnut	Total Groundnut (Avg)
Urea	153.7	69.8	34.9	52.3	86.1	3.5	7.0	5.3
DAP	0.0	0.0	0.0	0.0	0.0	17.6	37.1	27.1
MOP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FYM	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Source: Soil Health Cards of Sample Farmers (Field Survey).

4.5. Adoption of Recommended Doses of Fertilisers and Its Constraints

The level of adoption of recommended doses by the soil test farmers was found to be around 40 per cent for both cotton and groundnut farmers (Table 5). Among the Cotton growers, the maximum adoptability was found in the case of small farmers (45.7%) and minimum adoptability was observed in the case of marginal farmers (28.6%). In contrast, in the case of groundnut crop, the maximum adoptability was found in the case of large farmers (45.0%) and minimum adoptability was observed in the case of small farmers (37.8%). Among soil test farmers, about 50.0 per cent of cotton farmers and 72.5 per cent of groundnut farmers have expressed their willingness to continue the same practices to maintain the better soil health and to get the better yields.

A Copy of Soil Health Card used in Gujarat

Table 5: Application of Recommended Doses of Fertilisers on Reference Crops- Soil Test Farmers

Particulars	Marginal	Small	Medium	Large	Total
			Cotton		
% of farmers applied recommended doses of fertilisers	28.6	45.7	35.8	42.2	40.0
Average area (acre)	1.8	2.4	3.0	6.4	4.1
Area covered as % of net operated area	14.7	5.6	7.0	16.6	3.5
Average number of seasons applied	2.0	2.0	2.0	2.0	2.0
% of farmers willing to continue applying recommended doses of fertilizers	42.9	55.6	36.6	60.0	50.0
			Groundnut		
% of farmers applied recommended doses of fertilisers	41.7	37.8	40.3	45.0	40.3
Average area (acre)	1.1	2.4	5.2	8.2	4.3
Area covered as % of net operated area	38.4	19.6	42.2	187.8	13.8
Average number of seasons applied	1.0	1.0	1.0	1.0	1.0
% of farmers willing to continue applying recommended doses of fertilisers	66.7	73.3	72.1	75.0	72.5

Source: Field Survey data.

The data on actual quantity of fertilisers applied by the sample farmers during the reference year shows that, in case of cotton, the selected soil test farmers have applied more quantity of Urea and Potash than control group farmers. On the other hand, DAP use was much higher by the control farmers than the soil test farmers. The average actual quantity of fertilisers applied by the soil test farmers was more close to the recommended doses compared to that by the control farmers. For example, the average recommended dose of Urea (the major fertiliser applied) for total cotton was 86.1 kg/acre. The soil test farmers growing cotton have applied about 83.1 kg/acre compared to 71.2 kg/acre by the control farmers (Table 6).

Table 6: Actual Quantity of Fertilisers Applied by the Sample Farmers during the Reference Year (Cotton farmers)

(Kg/Acre)

Fertilisers	Marginal	Small	Medium	Large	Total
		Soil Test Farmers			
Urea	75.8	103.2	101.4	55.6	83.1
DAP	41.9	35.5	31.2	25.8	30.8
MOP	2.8	7.2	9.9	1.6	5.8
SSP	7.1	2.2	5.4	0.0	2.8
NPK Mixture	0.0	1.2	11.0	1.5	4.6
Others	0.0	6.6	14.7	14.2	11.8
		Control Farmers			
Urea	77.00	100.6	66.8	57.8	71.2
DAP	45.2	79.3	37.9	33.1	45.7
MOP	0.0	2.8	4.3	3.4	3.2
SSP	6.5	1.4	4.5	0.9	2.4
NPK Mixture	6.0	4.9	1.8	0.7	2.4
Others	3.6	0.1	0.1	1.2	0.9

Source: Field survey data.

In case of groundnut, use of DAP was the highest in both categories since this was the key fertiliser recommended for the crop (Table 7). The recommended dose of DAP for total groundnut was 27.1kg/acre. The quantity of DAP applied by the soil test farmers (29.9 kg/acre) was more close to the recommended dose compared to that applied by the control farmers (35.5 kg/acre). The control farmers of groundnut was found to apply excess quantity of DAP than the soil test farmers which is harmful to the overall health of soils.

Table 7: Actual Quantity of Fertilisers Applied by the Sample Farmers during the Reference Year (Groundnut farmers)

(Kg/Acre)

Fertilisers	Marginal	Small	Medium	Large	Total
Soil Test Farmers					
Urea	0.0	9.0	5.4	4.5	6.1
DAP	52.6	32.7	24.0	22.7	29.9
MOP	0.0	2.1	3.5	0.6	2.1
SSP	17.3	29.9	7.5	0.0	15.6
NPK Mixture	5.8	19.1	16.3	20.4	17.0
Others	6.3	7.8	2.1	1.5	4.6
Control Farmers					
Urea	58.5	22.5	13.4	6.5	19.1
DAP	56.2	39.6	36.9	23.0	35.5
MOP	5.7	0.0	0.4	7.2	3.3
SSP	6.5	10.8	8.2	5.8	7.7
NPK Mixture	0.0	4.1	3.6	6.0	4.0
Others	0.0	0.0	3.9	3.2	2.4

Source: Field survey data.

The use of organic fertilizers by sample farmers indicates that as expected most of cotton as well as groundnut growers had used farm yard manure. About 84.2 per cent of soil test farmers and 93.8 per cent of control farmers applied FYM on their soil. Among groundnut farmers, about 80.8 per cent of soil test farmers and 85.0 per cent of control farmers applied FYM on their soil. The use of other organic fertilisers was found very meager in total in both the crops.

4.6 Constraints in Application of Recommended Doses of Fertilisers

The soil test farmers have faced several difficulties in applying the recommended doses of fertiliser as well. Among these constraints, difficulty in understanding and following application of recommended doses as stated in Soil Health Cards, unavailability of technical advice on method and time of fertiliser application, high prices of fertilisers and unavailability of required fertilisers in adequate quantity were the major ones (Table 8).

Table 8: Constraints in Applying Recommended Doses of Fertilisers

(% of soil test farmers)

Reasons	Cotton				Groundnut			
	Most Important	Important	Least Important	Total	Most Important	Important	Least Important	Total
Adequate quantity of fertilisers not available	3.3	7.5	3.3	14.2	9.2	4.2	2.5	15.8
Prices of fertilisers are high	3.3	6.7	3.3	13.3	5.0	8.3	1.7	15.0
Lack of money to purchase fertilisers	0.8	2.5	5.0	8.3	5.0	4.2	5.0	14.2
No technical advice on method and time of fertiliser application	10.8	2.5	2.5	15.8	10.8	5.0	0.0	15.8
Difficult to understand and follow the recommended doses	18.3	0.8	0.0	19.2	13.3	1.7	0.0	15.0
Any Other	2.5	0.0	0.0	2.5	2.5	0.0	0.0	2.5

Source: Field survey data.

In case of control farmers, around 66.7 per cent cotton farmers and around 58.3 per cent groundnut farmers mentioned that they are aware about the recommended doses. Around 65 per cent of farmers had received information on recommended doses of fertiliser from the officials of department of agriculture of the state. The other sources were fellow farmer and private input dealer. About one fourth cotton growers received information from fellow farmers whereas more than one fifth groundnut growers were advised by input dealers. Importantly in both crop growers, two third farmers had received information from authentic sources of state agriculture department since this was linked with a flagship programme like Krishi Mahotsav.

4.7. Impacts of Adoption of Recommended Doses of Fertilisers

The adoption of recommended doses is believed to benefit the farmers in terms of improvement in yield, net returns and better soil health. The soil test farmers were found to realize better yield over the control farmers. The average yield of groundnut was found to be more in the case of soil test farmers by 13.3 per cent over control farmers (Table 9). Similarly, the soil test group of cotton farmers realized better average yield by 9.6 per cent compared to the control group. Thus, overall yield impact was better in case of groundnut farmers compared to cotton farmers. However, the increase in yield may not exclusively for adoption of recommended doses of fertiliser. It may be due to some other favorable factors like better seeds, better availability of irrigation water, among others.

As far as increase in average value of output per acre is concerned, cotton farmers recorded better increase, i.e., by about 25.4 per cent increase mainly because of the better price the realized;

whereas the groundnut farmers have recorded an increase in average value of output by 13.5 per cent. Thus, overall returns on crop output realised was better in case of cotton farmers compared to groundnut farmers. It would be important to see the impact of application of recommended doses of fertiliser on yield of particular crop, i.e. change in crop yield after application of recommended doses of fertilizers. It may be noted that, among the marginal cotton farmers, increase in yield level was lowest (9.3%) compared to other farmers (Table 10). However, among groundnut farmers, the marginal and small farmers had realized better yield level over other categories of farmers. They have realized about 20.4 per cent and 41.8 per cent increase in yield, respectively, after the adoption of recommended doses of fertiliser.

Table 9: Productivity Impacts of Soil Test on the Sample Crops (soil test vs control)

Particulars	Average Yield (Quintal/Acre)			Average value of output (Rs/Acre)		
	Soil test Farmers	Control farmers	% difference in yield	Soil test Farmers	Control farmers	% difference in yield
			Cotton			
Marginal	7.9	9.5	-16.4	38805.1	45355.0	-14.4
Small	10.0	8.6	15.9	49601.1	43251.7	14.7
Medium	8.6	8.0	7.5	40986.2	31361.1	30.7
Large	7.8	7.0	11.2	33458.4	23827.3	40.4
Total	8.6	7.8	9.6	39974.4	31870.7	25.4
			Groundnut			
Marginal	8.8	4.3	103.3	28188.0	13555.9	107.9
Small	8.7	7.2	20.7	28630.2	23135.6	23.7
Medium	7.7	7.8	-2.2	23677.5	24762.8	-4.4
Large	8.1	8.0	2.2	25173.5	25384.4	-0.8
Total	8.2	7.3	13.3	26235.2	23118.8	13.5

Source: Field Survey data.

In addition to increase in crop yield, several other changes have been observed after the application of recommended doses of fertilisers on reference crops by the sample farmers. Improvement in soil texture, improvement in crop growth, improvement in grain filling, decrease in application of other inputs like seed, labour, pesticide etc. and fewer incidences of pest and diseases were the major benefits experienced by the sample farmers.

Table 10: Impact of Application of Recommended Doses of Fertilizers on Crop Yield (Before and after soil test)

Particulars	Average yield (Quintal/Acre)		% change in yield
	Before	After	
	Cotton		
Marginal	7.3	7.9	9.3
Small	7.6	10.0	32.6
Medium	6.6	8.6	31.5
Large	6.6	7.8	18.3
Total	7.0	8.6	22.9
	Groundnut		
Marginal	7.3	8.8	20.4
Small	6.1	8.7	41.8
Medium	6.6	7.7	15.4
Large	6.9	8.1	17.5
Total	6.7	8.2	23.8

Source: Field survey data.

5. Policy Implications

The major impression which has emerged from the study is that the Soil Health Card (SHC) programme is an important and beneficial programme to the farmer. However, it was not implemented in proper manner in the State. In view to achieve the quantity targets fixed for some period/s, quality norms were not given proper attention which defeated the main purpose of the programme. In majority of cases, it was found that the SHCs were not with farmer. Those were kept together somewhere with some official/s. Thus, it was no use to the farmer/s. Depending on nutrient availability in soils, the recommended doses of fertiliser are expected to vary from region to region and from agro-climatic zone to zone. However, the same was not reflected in the SHCs provided to the farmers. Also, the recommended doses of fertilisers given on SHC were found to be invariant across eight study talukas covering four different districts. Though huge amount of money has been spent on implementation of the scheme, the main objective of the programme was overlooked.

The qualitative improvements need to be made in implementation of SHC programme so as to improve the confidence of farmers on recommendations of SHC. It was observed that many farmers even failed to understand the content of the card. They failed to calculate the recommended doses of various fertilisers required for their pieces of lands. Thus, the information on SHC should be provided in simple format and understandable language and special Gram Sabha or training programmes should be organized to train/educate farmers or to raise the awareness level regarding importance of soil test, scientific method of collection of soil sample, how to read and understand SHC and what are the benefits of applying recommended doses of fertiliser.

The level of adoption of recommended doses by the soil test farmers was reasonably less due to various constraints, viz. difficulty in understanding and following application of recommended doses as stated in Soil Health Cards, unavailability of technical advice on method and time of fertiliser application, high prices of fertilisers and unavailability of required fertilisers in adequate quantity. Adequate efforts should be made to eliminate such constraints in order to increase the adoption level of recommended doses of fertilizers.

The inadequate number of Soil Testing Lab (STLs) in the state has severely affected the quality of service provided to the farmers, as opined by the most of the sample farmers. Therefore, adequate STL facility should be created/made available in nearby areas, at least at the Taluka level. Since there were only two mobile STLs operating in the state and it was reported that both were virtually dysfunctional, thus benefit of Mobile Soil Testing Lab (STL) did not reach to most of the farmers in the state as well as farmers in selected study area. Therefore, State Government should increase the number of mobile STLs with effective plans of action, since these mobile labs can provide services at door steps and can help in increasing the awareness level in villages.

Looking at existing situation of inadequate staff in implementation of scheme, the involvement of non-governmental organizations and public private partnership (PPP) mode of operation may be promoted for the benefits of the farmers. Alternatively, establishment of private STLs should be encouraged/ promoted with some government incentives/support.

The inadequate staff strength along with inadequate infrastructures and equipments has severely affected the quality performance of this programme. More number of Gram Sevaks/Gram Mitras should be hired so as to complete the soil testing in time with assured quality and to hand over of SHC to farmers within a reasonable time limit. The Gram Sevaks/Gram Mitras should be provided regular training on accurate implementation of schemes/programmes.

The actual procedures followed for soil samples collection need to be monitored properly since it was found that near about 40 per cent of soil samples were collected by the farmers themselves which cannot be technically sound. Unless there is a systematic effort to address the bureaucratic lethargy and political interference in implementation of such a wonderful programme, achievement of desired outcomes and the set objectives of the programme would be difficult/delayed. Collection of Soil Samples may be organised in a particular village in campaign mode. All stakeholders [such as farmers, farmer friends (Gram Mitras), village level workers (VLWs), Block level officers fertilizer industries, Co-op Society, SAU students (as part of their internship of farmer's field /village for technical exposure), people representatives] should be brought to common platforms on some occasions so as to bring qualitative improvements and to raise the level of awareness in the villages.

Drawing soil sample in field is a laborious job. Time required to draw one soil sample may take at least one hour or so (after reaching on the field). For obtaining better results, proper sampling implements need to be provided to the farmers' friend (Gram Mitras) and their

remuneration may be increased. At present they get Rs 15 per sample which happens to be very less for the required job (since this token amount also includes collection charges, primary requirement like sample bag, woven bag, forms, marker pen as well as transportation charges of samples). Since the compensation rate is seems to be very low, it may have forced them adopting the wrong methods to achieve the targets, which may affect the success of entire programme in future.

Furthermore, it was reported that not only the selection of Gram Mitras was biased due to political interference but also they were not been imparted proper training to perform their duty accurately. Besides, their work was not properly monitored on a regular basis, which resulted in collection of poor quality of soil samples and non-submission of soil samples in time. Thus, appropriate care should be taken in appointing as well as necessary training should be provided to gram mitras. Some of the farmers during discussion reported that samples had been collected from a single plot but had been shown for a large number of plots. Therefore collected soil samples need to be handled more carefully so as to ensure that farmer get his SHC for his plot/s only.

At present, different institutions such as Agriculture Department of the state government, Public Sector Undertakings (such as APMCs, Government supported Corporation Labs, Government supported Sugar cooperatives labs) and Science Colleges are involved in testing the soil samples and generating the soil health cards. For instance, the tests on major nutrients like N, P, K, Ph etc are done at all 134 STLs. However, the tests on micronutrients are done at only at designated 50

STLs and Agricultural Universities. The test results are transferred to another organization Silver Touch Pvt. Ltd for generating SHCs. Anand Agricultural University was given the responsibility for uploading all these SHCs on its website through e-Krishi Kiran Programme. Proper coordination among all these institutions is necessary for delivering reliable results and matching data sets. Collection of soil samples in the field, analysis of soil samples in the laboratory and delivery of SHC to the farmers must be performed in perfect harmony and entire process should be completed prior to sowing season.

One way to raise the level of confidence of the farmers is to demonstrate the usefulness of the recommendations by applying recommended doses of fertiliser on experimental plots at every village or at least at Gram Panchayat level. If the better results can be demonstrated on the experimental plots compared to farmers' field, farmers will be self-motivated to have SHCs.

Adoption level of organic fertiliser and green manure was found to be very low among sample farmers. It may be because of less production, consequent high prices and lack of availability of these manures at local levels. In order to lower down the excessive use of chemical fertilisers and to boost the health of soil, organic and green manure use needs to be promoted. Therefore, effective measures needs to be adopted to increase supply and use of organic manures. It is also necessary to reduce subsidy on chemical fertilisers and instead, subsidize more organic fertilisers so as to increase their adoption level.

References

Chand, Ramesh and L. M. Pandey (2008), "Fertiliser Growth, Imbalances and Subsides: Trends and Implications", Discussion Paper (NPP 02/2008), *National Centre for Agricultural Economics and Policy Research* (Indian Council of Agricultural Research), New Delhi.

FAO (2005), *Fertiliser Use by Crop in India*, Land and Plan Nutrition Management Service, Land and Water Development Division, Food and Agriculture Organization of the United Nation, Rome.

FAI (Fertiliser Association of India) (1974), *A Study on Fertiliser Demand and Marketing, Volume III,* All India Summary Report, Fertiliser Association of India, New Delhi.

FAI (2013), *Fertiliser Statistics of India 2012-13*, Fertiliser Association of India, New Delhi.

Government of Gujarat (2013), *Soil Health Card Project in Gujarat,* http://agri.gujarat.gov.in/soil-health-card-project.htm, Accessed on 13th April, 2013.

Government of India (2008), *Eleventh Five Year Plan Volume III Agriculture, Rural Development, Industry, Services, and Physical Infrastructure*, New Delhi: Oxford University Press.

Government of India (2013), *State of Indian Agriculture, 2012-13*, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi.

Government of India (2015), *PM launches 'Soil Health Card Scheme'*, http://pmindia.gov.in/en/news_updates/pm-launches-soil-health-card-scheme-presents-krishi-karman-awards-from-suratgarh-rajasthan, Accessed on 5th April, 2015.

Kanwar, J.S. (1997), 'Balanced Fertiliser Use and Food Security – Overview of Indian Scenario', *Fertiliser News*, 42 (7), 63, 65 & 67.

Krishnaji. N., (1975), 'Inter-Regional Disparities in Per Capita Production and Productivity of Food Grains: A Preliminary Note on Trends', *Economic and Political Weekly*, 10 (33/35): 1377-85.

McGuirk and Mundlak (1991), 'McGuirk, A. and Y. Mundlak (1991), 'Incentives and Constraints in the Transformation of Punjab Agriculture', *IFPRI Research Report 87*, Washington, D.C.

Menon, K.N.N. and H.K. Lakshman Rao (1983). "Is ECA Allocation Conducive to Stimulate Fertiliser Consumption", *Fertiliser News*, July 1983, 1-69.

Murgai, R., M. Ali and D. Byerlee (2001), 'Productivity and Sustainability in Post-Green Revolution Agriculture: the Case of Indian and Pakistan Punjab', The World Bank Research Observer, 16(2):199-218.

Pathak, Mahesh, V.D. Shah and M.L. Jhala (1993), "Impacts of Fertiliser Price Hike on Gujarat Agriculture ", AERC Report No. 89, *Agro-Economic Research Centre, Vallabh Vidyanagar*, Gujarat.

Pingali, P.L. and M. Shah, (2001), 'Policy Re-directions for Sustainable Resource Use: The Rice-Wheat Cropping System of The Indo-Gangetic Plains', In *The Rice-Wheat Cropping System of South Asia: Trends, Constraints, Productivity and Policy*, ed. P.K. Kataki, 103-18. New York: Food Products Press.

Pingali, Venugopal (2004), 'Input Management', *State of Indian Farmers: A Millennium Study (Volume 8)*, Academic Foundation, New Delhi.

Prasad R (2000), '*Nutrient Management Strategies for the Next Decade: Challenges Ahead*', www.cabdirect.org/abstracts /20001914969.html.

Randhawa, M.S. ((1992), *Green Revolution in Punjab*, Punjab Agricultural University, Ludhiana, India.

Rao, Hanumantha and K. Jayasree, (2000), 'Subsidies and Fertiliser Use Efficiency under the New Economic Policy Regime', Rural Prosperity and Agriculture Policies and Strategies, 197-239.

Rao, V. M., (1996), 'Agricultural Development with A Human Face: Experiences and Prospects', Economic and Political Weekly, 31(26): A50-A62.

Rastogi, B.K., V. Annamalai (1981), *A Study on the Adoption and Diffusion of Recommended Technology in Dryland Agriculture*, AICRPDA, Hyderabad.

Sevak, R.D. (1982), 'Soil Testing Services in Rajasthan', *AERC Report No. 60*, Agro-Economic Research Centre, Vallabh Vidyanagar, Gujarat.

Shah, V.D. (1989), "Fertiliser Consumption in Gujarat", *AERC Report No. 80*, Agro-Economic Research Centre, Vallabh Vidyanagar, Gujarat.

Singh, M.V. (2001), 'Evaluation of Current Micronutrient Stocks in Different Agro-Ecological Zones of India for Sustainable Crop Production', *Fertiliser News*, Vol. 46. Issue No.2. February, pp. 25-42.

Swain, M (2013), Problems and Prospects of Oilseeds Production in Gujarat', *AERC Report 148*, Agro-Economic Research Centre, S.P. University, Vallabh Vidyanagar.

Swain, M., S .S. Kalamkar and Kalpana Kapadia (2012), 'State of Gujarat Agriculture 2011-12', AERC Report No. 146, Agro-Economic Research Centre, S. P. University Vallabh Vidyanagar.

Vaidyanathan, A. (1988), '*India's Agricultural Development in a Regional Perspective*', Orient Longman, Hyderabad.

Annexure I: Fertilizer Consumption in Gujarat (1980-81 to 2015-16)									
Sr. No	Year	Fertiliser consumption in Gujarat (000' tonnes)					NPK Ratio		
		Nitrogenous (N)	Phosphate (P2O5)	Potassic (K2O)	Total NPK	Per Ha Consumption of NPK (Kg/Ha)	N	P	K
1	1980-81	204.12	117.22	0.00	356.86	32.58	NA	NA	NA
2	1981-82	245.40	114.64	41.42	401.46	36.50	5.9	2.8	1.0
3	1982-83	236.39	115.73	34.31	386.43	34.66	6.9	3.4	1.0
4	1983-84	317.04	147.35	37.96	502.35	45.60	8.4	3.9	1.0
5	1984-85	320.31	148.78	35.47	504.56	48.33	9.0	4.2	1.0
6	1985-86	286.51	109.30	25.50	421.31	42.23	11.2	4.3	1.0
7	1986-87	255.61	111.77	34.91	402.29	50.05	7.3	3.2	1.0
8	1987-88	290.15	120.30	31.83	442.28	41.32	9.1	3.8	1.0
9	1988-89	434.74	164.46	44.27	643.47	60.23	9.8	3.7	1.0
10	1989-90	434.40	213.86	47.12	695.38	65.72	9.2	4.5	1.0
11	1990-91	430.75	217.15	58.49	706.39	67.26	7.4	3.7	1.0
12	1991-92	456.59	216.98	59.68	733.26	66.64	7.7	3.6	1.0
13	1992-93	496.17	181.14	39.29	716.60	66.79	12.6	4.6	1.0
14	1993-94	472.89	157.01	39.17	669.08	59.50	12.1	4.0	1.0
15	1994-95	572.27	195.64	50.38	818.29	74.42	11.4	3.9	1.0
16	1995-96	551.92	160.16	41.41	753.49	68.15	13.3	3.9	1.0
17	1996-97	596.65	175.62	41.27	813.54	72.55	14.5	4.3	1.0
18	1997-98	702.77	264.83	60.29	1027.89	91.78	11.7	4.4	1.0
19	1998-99	690.73	267.57	61.36	1019.66	95.28	11.3	4.4	1.0
20	1999-00	632.13	264.73	68.75	965.61	91.99	9.2	3.9	1.0
21	2000-01	498.96	195.67	56.01	750.64	69.56	8.9	3.5	1.0
22	2001-02	605.64	240.23	69.36	915.23	86.09	8.7	3.5	1.0
23	2002-03	510.80	207.04	71.59	789.43	69.12	7.1	2.9	1.0
24	2003-04	687.55	255.28	73.50	1016.33	92.32	9.4	3.5	1.0
25	2004-05	754.00	296.26	96.22	1146.48	101.42	7.8	3.1	1.0
26	2005-06	834.73	328.46	116.73	1279.92	114.99	7.2	2.8	1.0
27	2006-07	927.57	361.13	120.09	1408.79	106.78	7.7	3.0	1.0
28	2007-08	1052.63	424.52	146.11	1623.26	119.78	7.2	2.9	1.0
29	2008-09	1068.83	465.17	182.98	1716.98	135.09	5.8	2.5	1.0
30	2009-10	1101.60	491.67	206.45	1799.72	205.86	5.3	2.4	1.0
31	2010-11	1241.22	518.00	179.94	1939.16	138.08	6.9	2.9	1.0
32	2011-12	1183.30	417.02	132.74	1733.06	132.59	8.9	3.1	1.0
33	2012-13	1007.70	257.82	76.46	1341.97	108.99	13.2	3.4	1.0
34	2013-14	1158.93	315.37	90.60	156.90	127.65	12.8	3.5	1.0
35	2014-15	1217.51	351.99	114.51	1684.00	NA	10.6	3.1	1.0
36	2015-16	1088.61	328.14	109.26	1526.01	NA	10.0	3.0	1.0

Note: NA- Not Available

Sources: Statistical Outline of Gujarat (1980-81 to 1990-91) and Statistical Abstract 2009, Directorate of Economics and Statistics, Department of Gujarat, Gandhinagar.

Annexure II: District-wise Per Hectare Consumption of Fertilisers (2013-14)

(in Kg / ha.)

Sl. No.	District	N	P	K	NPK
1	Ahmedabad	82.29	20.26	4.62	107.17
2	Amreli	82.62	40.40	5.31	128.33
3	Anand	170.74	25.19	11.53	207.46
4	Banaskantha	63.41	18.08	3.66	85.14
5	Bharuch	106.81	28.78	15.10	150.69
6	Bhavnagar	104.76	51.01	7.48	163.25
7	Dahod	41.35	12.62	3.07	57.04
8	Gandhinagar	101.54	25.18	9.51	136.23
9	Jamnagar	78.94	35.22	5.76	119.92
10	Junagadh	95.20	41.49	6.59	143.28
11	Kheda	129.46	21.51	6.64	157.61
12	Kutch	53.75	15.52	0.84	70.12
13	Mehsana	75.27	19.95	2.83	98.05
14	Narmada	89.28	20.78	13.52	123.58
15	Navsari	169.89	66.14	51.79	287.83
16	Panchmahal	102.73	18.19	3.20	124.13
17	Patan	48.55	12.70	0.73	61.98
18	Porbandar	55.49	29.92	4.29	89.70
19	Rajkot	145.11	59.03	14.36	218.50
20	Sabarkantha	86.64	27.32	12.07	126.04
21	Surat	167.64	81.74	51.18	300.57
22	Surendranagar	63.82	19.67	1.60	85.09
23	Tapi	74.48	26.29	18.51	119.28
24	Dang	3.44	0.67	0.80	4.91
25	Vadodara	102.69	22.54	15.63	140.86
26	Valsad	88.42	34.41	22.46	145.29
27	Gujarat state	89.91	29.36	8.37	127.65

Source: GOG (2016)

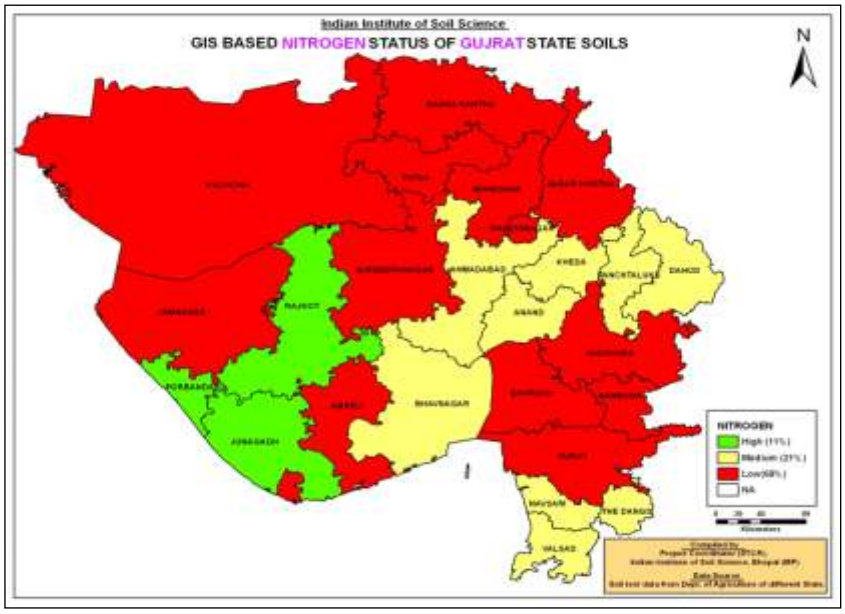
Annexure III: District wise Progress in Soil Health Card Programme in Gujarat (2015-16)

District	Target (No. of samples)			Samples Entered	Samples Collected	Sample Tested	SHCs Printed	SHCs Distributed
	Kharif	Rabi	Total					
Ahemdabad	489,709	0	489,709	0	400,671	0	0	0
Amrelli	565,994	52,272	618,266	0	463,086	0	0	0
Anand	396000	246026	642026	0	234000	0	0	0
Banaskantha	598,583	149,258	747,841	9	454,977	0	0	0
Bharuch	236,985	189,541	426,526	882	421,146	0	0	0
Bhavnagar	527417	109472	636889	0	462726	0	0	0
Dang	26,694	0	26,694	2,644	9,180	0	0	0
Dahod	26,694	0	26,694	2,644	9,180	0	0	0
Gandhinagar	275,495	0	275,495	198	246,393	40,500	0	0
Jamnagar	234,540	0	234,540	3,015	234,540	0	0	0
Kutch	526,042	0	526,042	0	426,042	0	0	0
Junagadh	718,204	0	718,204	9	945,882	0	0	0
Kheda	688,215	125,961	814,176	0	475,137	27,000	0	0
Mehsana	416,299	0	416,299	1,422	410,632	0	0	0
Narmada	60,319	0	60,319	558	60,057	18,774	0	0
Navsari	234,540	0	234,540	3,015	234,540	0	0	0
Panchmahal	440,231	89,441	529,672	0	308,529	37,710	0	0
Patan	471,306	0	471,306	0	385,614	36,000	0	0
Porbandar	110,000	81,290	191,290	0	79,299	0	0	0
Rajkot	868,131	119,218	987,349	0	586,971	0	0	0
Sabarkantha	710,289	257,795	968,084	63	462,663	0	0	0
Surat	195,243	0	195,243	1,521	178,335	18,000	0	0
Surendranagar	589,424	88,341	677,765	0	446,976	0	0	0
Tapi	123,140	0	123,140	252	114,786	36,000	0	0
Vadodara	915,729	86,504	1,002,233	9	748,908	7,416	0	0
Valsad	231,443	106,403	337,846	477	66,825	0	0	0
Gujarat Total	10,676,666	1,701,522	12,378,188	16,718	8,867,095	221,400	0	0

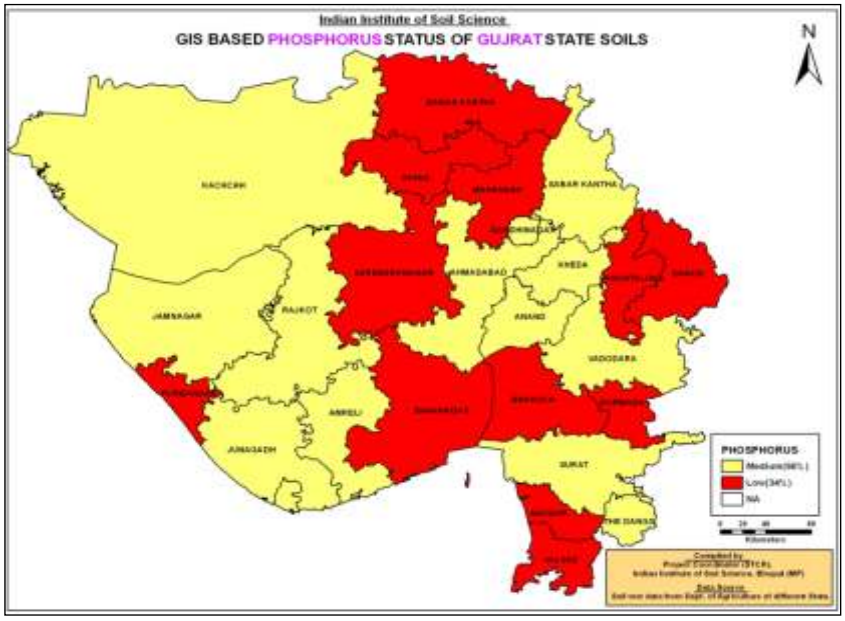
Source: http://www.soilhealth.dac.gov.in/

Annexure IV: Selected Maps/Photographs.

Map 1: Nitrogen Status of Soils in Gujarat



Map 2: Phosphorous Status of Soils in Gujarat



Map 3: Potassium Status of Soils in Gujarat

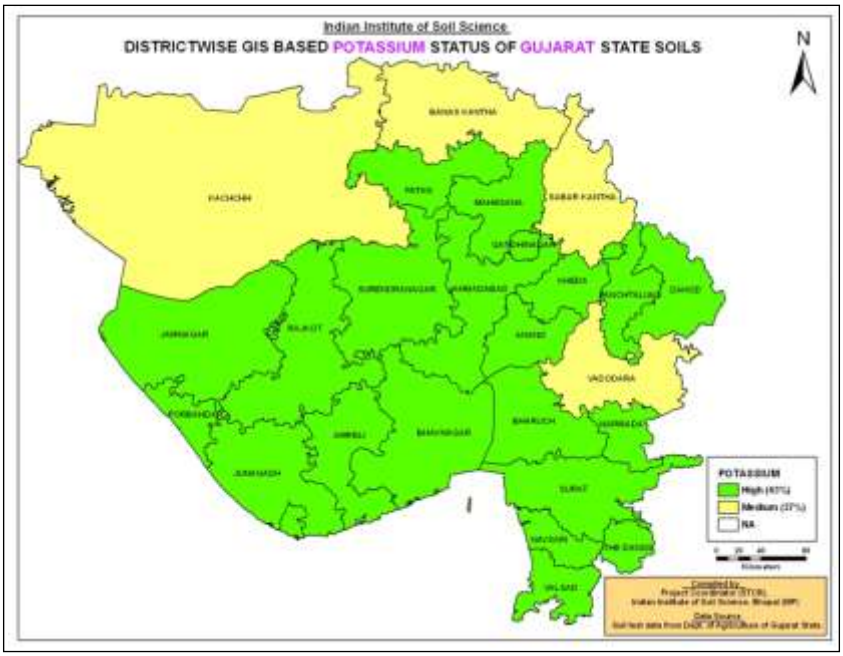
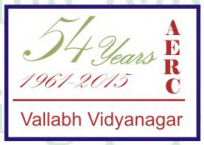


Photo 1: Training on Soil Sample Collection to Field Staff

Photo 2: Soil Sample Processing at Soil Test Laboratory, Borsad, Anand

Photo 3: Soil Sample Processing at Soil Test Laboratory, Borsad, Anand



Agro-Economic Research Centre
For the States of Gujarat and Rajasthan
(Ministry of Agriculture, Govt. of India)
H.M. Patel Institute of Rural Development
Opp. Nanadalaya Temple, Post Box No. 24
Sardar Patel University
Vallabh Vidyanagar 388120, Dist. Anand, Gujarat
Ph. No. +91-2692-230106, 230799; Fax- +91-2692-233106
Email: director.aerc@gmail.com; directoraercgujarat@gmail.com
Websites: www.aercspu.ac.in; www.spuvvn.edu

Lajja Publication - (02692) 233864