IT BASED SOIL HEALTH MANAGEMENT-SOIL HEALTH CARD

Dr. N. C. Patel

India during the green revolution witnessed continuous increase in agricultural production and could reach self-sufficiency. However, injudicious and haphazard use of chemical fertilizers while farming has been a matter of serious concern. Secondly, according to reports there has also been stagnation in productivity of crops. In this context, it is important to promote adoption of scientific farming to ensure economic prosperity of the farmers.

Gujarat Experience

A basic soil audit is the first and sometimes the only monitoring tool used to assess changes in the soil. To avoid deterioration of soil in long run and visualizing the importance of balance nutrient in crop production, government of Gujarat decided to embark on a massive programme from 2003, in order to address crucial areas in agriculture sector, which requires immediate attention.

As many as 3 issues were identified. They are:-

i) Promoting optimum fertilizer use and fertilizer-use-efficiency through soil-test method, by analyzing soil of every farmer's field.

ii) Developing a crop planning for the rain fed areas which register low and uncertain productivity and remain major reason for poverty among the farmers, and

iii) More elaborate data base, their quick utilization and networking to enhance efficient extension services at various levels of Department of Agriculture and Cooperation viz. village, taluka, district and state level offices. The vast nature of the project immediately brought in information technology (IT) as appropriate tool to achieve the goal. When the programme was initiated to issue cards to farmers for soil-test based fertilizer use along with other useful information, it was referred to as "Soil Health Card".

In India, a number of scientifically proven and location-specific technologies are available. There is a need to transfer these technologies to the farmers with greater speed so that productivity and quality are enhanced. Further, these technologies need to be tailor-made for the agro-climatic conditions existing in individual farmer's field. Presently transfer of technology involves training of the extension personnel and their direct contact with the farmers. It has limitations in reaching the farmers individually. The mode of transmission is also tedious and time consuming – scientists to Agricultural Department and percolation down the lane from state level to

district level and then to taluka level and then to villages. It is true that extension work through radio and television has made a mass impact, but the recommendations can only be general and can't be specific to individual farmer.

Therefore, an e - agricultural extension technology was introduced in the 'Soil Health Card Programme'. Since the inputs have been provided as specifically as possible at farmer / village / taluka level by the scientists in various modules, **'Soil Health Card'** programme is able to automatically provide output of specific technologies to a farmer.

Thus, through the **'Soil Health Card'** programme, the Government of Gujarat (GoG) has attempted to promote scientific agricultural technologies by enabling the farmers to get required specific information through use of Information Technology with the following objectives:

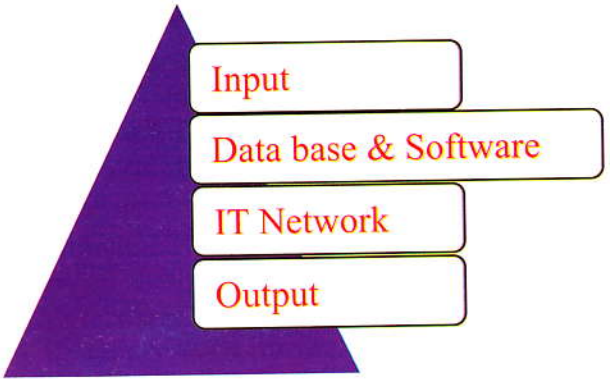
Objectives of the SHC project

- To analyze soil sample of farmers' fields across the state covering all the villages.
- To advocate soil-test based fertilizer rates for different crops grown by the farmer on the basis of the analytical results of soil of his farm
- To suggest possible new crops / cropping system that can give higher income based on Taluka level data on the available soil moisture, harvest and utilization of runoff water, suitability of crops and crop growth period based on moisture utilization of the crops.

Use of Information Technology (ICT) in agriculture

The information and better communication are critical requirements for sustainable agricultural development. Modern communication technologies when applied to conditions in rural areas can help to improve communication, increase participation, disseminate information and share knowledge and skills.

Government of Gujarat selected the Anand Agricultural University (AAU) to establish and implement the state wide programme of the **'Soil Health Card'**. Under this programme, AAU developed the web-based application software,



which generates and provides the fertilizer recommendations on the basis of soil analysis and the nutrient requirements of the crop for each field. This would increase the efficiency of the fertilizer use and reduction in use of the fertilizer.

Structure of SHC project (e-krishi kiran programme)

The architecture of the e-krishi kiran programme consists of four components viz., (1) Input, (2) Data base and Software, (3) Network and (4) Output. The details are as under.

(A) Input

To achieve the objectives of the programme, utilizing various applications, a number of basic information are required to be fed to the system. These information / data were collected from various government departments, agricultural universities, and NGOs in the state. Some of the important ones are given below.

- Information on individual farmer
- Soil-test values of individual farmer's field: values of EC, pH, organic carbon and available phosphorus and potassium.
- Soil characteristics
- Meteorological data
- Agro-climatic zone wise cultivation practices of all crops
- Data on economics (Taluka-wise and crop-wise)
- Recommended fertilizer dose
- Information for crop planning
- Agricultural Production Planning

(B) Database and Software

- The system can generate recommendation of the fertilizers needed for a particular crop based on a nutrition status of farmer's soil on the basis of low, medium, high soil fertility rating.
- The system can generate recommendation of the possible alternative crops to a farmer for better crop production based on his cropping practice and weather condition in his area considering the facts like moisture availability index, available water capacity, length of growing period, surplus water and supplementary irrigation.
- The system can generate recommendation of the alternative crops with a generic ranking of crops in terms of profitability, looking into the various costs involved for producing that crop.
- The system can generate statewise, districtwise, talukawise and individual farmerwise model action plans for crop production.
- The system can generate various FAQ's for farmers about agriculture and animal husbandry in a well classified manner.

(C) Network

The main server is maintained at the State capital and the replica server is at ITC, AAU, Anand. In case of any damage to one data base, the other will serve the purpose. Besides, there is a web server at the agricultural universities at Navsari, Dantiwada and Junagadh. The Programme is a plug-in network to the Gujarat State Wide Area Network.

(D) Output

(i) Soil Health Card

Soil health and its fertility play a key role in crop production. Soil analysis is the means to know the soil health. However, till recent past, fertilizer recommendations for different crops are made on the basis of agronomical practices and not on the soil test base. Soil test based recommendation for fertilizer use will not only increase the crop production with judicious investment on fertilizer use but will also help to keep the soil productivity sustainable.

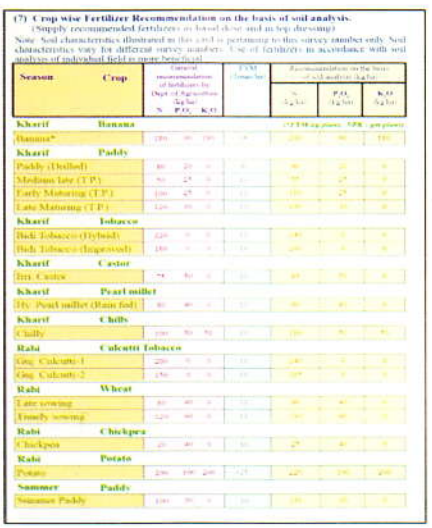
The English version of printed farmer's soil health card is given as under.

The General Information of farmer, Land Information, Soil analysis information, Crop-wise fertilizer recommendations and Ready Reckoner for calculating the quantity of fertilizer are the main information given in the Soil Health Card.

Soil health data and their use

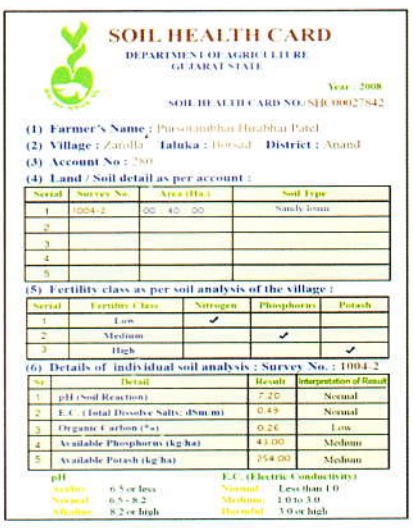
The SAUs (Gujarat), through field experiments, work out fertilizer requirement of each crop, But, this dose needs to be adjusted according to the actual nutrient status in farmer's field. When a nutrient status is low, the dose of that nutrient fertilizer is slightly increased, when the nutrient status is high, the fertilizer dose is reduced. Though, the government soil testing laboratories (STLs) have been doing this job, a need to revitalize this programme was taken up to accord top priority to soil health and promote optimum fertilizer use and its use efficiency.

The Government of Gujarat initiated the Soil Health Card related activities during the year 2003, Today, the data bank has more than 42 lakh soil data. The data are now available as individual farm value, means, range and percentage of low, medium and high groups. For any given set of data of any given farmer's field, the fertilizer requirement of crops can be obtained.



(7) Crop wise Fertilizer Recommendation on the basis of soil analysis.

Season	Crop
Kharif	Banana
Kharif	Paddy
Kharif	Tobacco
Kharif	Castor
Kharif	Pearl millet
Kharif	Chilli
Rabi	Calcutti Tobacco
Rabi	Wheat
Rabi	Chickpea
Rabi	Potato
Summer	Paddy



SOIL HEALTH CARD

DEPARTMENT OF AGRICULTURE
GUJARAT STATE

Year : 2008
SOIL HEALTH CARD NO./SHC100027842

(1) Farmer's Name : Parsottambhai Hirabhai Patel
(2) Village : Zarola Taluka : Borsad District : Anand
(3) Account No : 780
(4) Land / Soil detail as per account :

Serial	Survey No.	Area (Ha.)	Soil Type
1	1004-2	00 40 00	Sandy loam
2			
3			
4			
5			

(5) Fertility class as per soil analysis of the village :

Serial	Fertility Class	Nitrogen	Phosphorus	Potash
1	Low	✓		
2	Medium		✓	
3	High			✓

(6) Details of individual soil analysis : Survey No. : 1004-2

Sr.	Detail	Result	Interpretation of Result
1	pH (Soil Reaction)	7.20	Neutral
2	E.C. (Total Dissolve Salts: dSm/m)	0.49	Neutral
3	Organic Carbon (%)	0.26	Low
4	Available Phosphorus (kg/ha)	43.00	Medium
5	Available Potash (kg/ha)	254.00	Medium

pH
Acidic 6.5 or less
Normal 6.5 - 8.2
Alkaline 8.2 or high

E.C. (Electric Conductivity)
Normal Less than 1.0
Medium 1.0 to 3.0
Harmful 3.0 or high

Further as a part of this exercise, the guideline followed for the interpretation of the soil data to adjust the fertilizer requirement of the crops was updated to includ the current recommendations of the SAUs (Gujarat), which are specified to agro-climatic zone or its sub-unit (agro-ecological situations) in the state, specific crop varieties and even crop sequences and irrigated and rainfed conditions, the recommendations include those on integrated nutrient management and fertigation, the revision also incorporated.

(ii) Village soil health card

In general it is perceived that the land of different fields in a same village may have less variation in respect of the soil fertility. Hence, the fertility index is calculated from the available reports of the soil analysis of the fields of same village and on the basis of fertility index, the farmers who had not done the soil testing were also recommended for the requirement of the fertilization of each crop.

Access to Soil Health Card

The individuals soil health card or the village soil health card can be viewed / accessed through internet.

However, it is presumed that the farmers may not have easy access to the internet, hence, Govt. of Gujarat made provision to supply printed copy of the individual soil health card to all the farmers. Moreover, the printed color copy of the village soil health card is also supplied to each gram Panchayat during Krishi Mahotsav regularly during past several years.

(iii) Alternative Crop Planning

Crop planning for rainfed crops is based on LGP (length of growing period). The LGP is derived from MAI (moisture availability index), which in turn is obtained from AWC (available water content). In this exercise, soil type, bulk density, available water in soil, rainfall (average of 80 years), PEI etc. are taken into consideration. Surplus rain water available for recycling through farm pond is also obtained. The data have been worked out for all the Talukas of Gujarat. Farmers require the guidance on the best possible alternative crop which can be grown on his farm considering soil and meteorological parameters. Moisture availability index is the base for the suggestion of crop planning.

The availability of water in the soil during the course of crop growth determines largely its yield. Soil water availability depends on rainfall, PET, types of soil and crop water use. Though the availability in amount and distribution of rainfall and PET (across location) undoubtedly affect the duration & characteristics of growing season, the differences in soils, especially in respect of moisture storage and release characteristics strongly influence the agricultural importance of rainfall. Thus, a study of soil water balance is a pre-requisite in planning rain-fed farming for optimum rainfall use. Guideline developed for planning of un-irrigated crop based on LGP are given in **Table 1**.

(iii) Crop Cultivation Practices

The Farmer will require to know the scientific cultivation practices of the suggested alternative crop, therefore the detail package of practices for cultivation is also given as hyperlink with each name of the crop. Thus, existing crop and their economics V/S suggested alternative rain fed / irrigated crops with their economics and package of practices for cultivation of all the crops can be viewed by the farmers in detail through internet.

(iv) Model Action Plan

The function of the Action Plan Module is to capture all kinds of agricultural, demographic, geographic, climate and socio-economic data associated with a Taluka so that these inputs can further be used to decide about the effectiveness of the recommendations given to the farmer. This module can also produce different kinds of reports and analysis for the scientists / planners so as to enable them for better decision making.

(v) FAQ and Solution of Queries

The Question - Answer bank is maintained in a classified way for the frequently asked questions by the farmers. The answers of such questions are prepared by the concerned scientist, so that firsthand knowledge of research recommendations may be available to the farmers. If a farmer requires more details of technology or has any problem

Table 1: Chart prepared by AAU scientists showing suitability of different crops grown in Gujarat for various Leanth of Growing Period (LGP)

LGP (days)	Crop Name			
	Kharif		*Rabi* (based on conserved moisture)	Horticulture crop low lying area
< 60	Kidney bean			
69 - 90	Kidney bean Green fram Black gram Cowpea		Wheat (Durum) Barley Mustard After Rice Safflower Wheat Barley Musatrd Chickpea Oilseed Rajagira	Garlic Ginger Brinjal Arid fruit Drumstick Aonla Pomegrannate Lemon Jivanti Mango Guava Castard apple Ber
90-120	Pearl millet Minor millet Groundnut Indian bean Maize Sorghum Rice Forage pearlmillet	Green gram Clusterbean Udid bean Barley Seasamum Sunflower		
	Deep rooted crops Tobacco Pigeonpea Cotton Castor			
120-150	Seasamum Rice Pigeonpea Tobacco Cotton Castor			
150-180	Cotton Pigeonpea Sorghum Chilly	Tobacco Castor Indian bean		
180-210	Cotton Pigeonpea			
< 210	All *kharif* crops			
Crop which can be taken by supplementary irrigation				
Chickpea Wheat (Durum) Oilseed Safflower Mustard Barley		Cotton Garlic Cumin Cluster bean (Seed production) Sunhemmp (Seed production) Fenugreek		

he can send his problem through the query form available on the system.

Impact of Soil Health Card Programme (SHCP)

Pre-Deployment Scenario

- Soil analysis data were not available with farmers, so inadequate use of fertilizers being carried out leading to unnecessary use of fertilizers.
- Proper, efficient and maximum production of crops was not achieved.
- Alternate crops production was not known to the farmers in case of rain fed farming.

Post-Deployment Scenario

- Recommendation of appropriate rate of manure and fertilizer to each crop on the basis of analysis of soil sample obtained from the farmer's field.
- Farmers tend to use only N (urea) or N and P (urea and DAP) and ignore depletion of other nutrients. The soil test based recommendation helped in restoring balanced nutrition to crops.
- Because of tropical conditions, built up of soil organic matter is less in our soils. Further, in dry lands and economically constraint situations, very limited or no manure is added. This has led to depletion of organic carbon in soil so vital for many important physical, chemical and biological properties of soil, which ensure crop productivity. Inclusion of manure rates as a general management practice and through specific Integrated Nutrient Management (INM) practices will help in overcoming the depletion of organic carbon in soil.
- The present SHC programme helps in avoiding excess use of fertilizers and the excess expenditure that goes with it. Use of excess fertilizers can be detrimental for productivity and crop growth.
- The e-data bank will enable the administrators and experts to monitor the changes (depletion/ accumulation) of nutrients besides EC and pH. Salinity increases when excess use of canal water or poor quality water is used for irrigation. Similarly continuous use of acid forming fertilizers, occurrence of acid rain in industrial zone or use of acidic effluent water etc. can reduce the pH. The e data bank will help in monitoring such changes.
- The data bank can be used advantageously by the extension workers to locate suitable farm for fertilizer related demonstration programme.
- Attempt is also made to give specific recommendation for specific crop sequence. This will help in increasing fertilizer use efficiency

Lessons learnt from the Project

By the way of holistic approach of Soil Health Card Programme, millions of the farmers of Gujarat state have information available on:

- Soil Fertility
- Soil nutrient status and recommendation for fertilizer requirement
- Reclamation of saline or alkaline soil on the basis of soil analysis
- Integrated nutrient management to enhance productivity of crops
- More return by reducing cost of fertilizers

Spectacular awareness created among the farming community of the state for balance and judicious use of chemical fertilizer and also enhance the use of compost fertilizer, varmi composting and liquid bio-fertilizer which in long run improve the knowledge of farmers towards the plant nutrition as whole.

The programme of Soil health card has been taken on mission mode since 2009-10 involving various agencies/Govt dept like science colleges arranged by Department of Education, APMCs of Gujarat state Agriculture marketing Board and co operation of Government of Gujarat, Sugar co operatives etc.

This programme is the unique example of co-ordinated effort of various departments having different mandates but worked on a common platform to perform their roles individually. It has given wonderful result in the form of providing value added services to farmers. The Department of Agriculture managed over all implementation of programme, under take the task of collection of soil samples from the farmers field and send same to concerned soil testing lab and finally provide technical know how to end-user by the way of educating farmers through demonstration and farmer field school.

Other agencies like science colleges, Sugar co-operatives, Govt boards & co-operatives, Agriculture Produce Marketing Committees (APMC) extend their role by way of providing soil sample analysis facility in their lab, Govt of Gujarat having only 20 Soil Testing Laboratories having annual analysis capacity of 2.0 lakh soil samples. This programme brought the revolutionary change in soil samples analysis capacity, now a days Gujarat State having 13.40 lakhs Soil sample analysis capacity per annum as given in **Table 2.**

Table 2: The soil testing infrastructure in the state

Department / Agency	Total STLs	Annual analysis capacity (No of samples)
Agriculture Department	22	2,20,000
Agriculture Produce Marketing Committee (APMC)	62	6,20,000
Gujarat land development corporation (GLDC)	1	10,000
Gujarat state seed corporation (GSSC)	1	10,000
Sugar co-operatives	16	1,60,000
Science Colleges	32	3,20,000
TOTAL UNIT	**134**	**13,40,000**

Further, this Programme also brought few changes in nutrient analysis concept. Before 2009, soil samples were analysed only for five parameters like N, P, K (Major elements) as well as EC and PH. The state Government has added facilities for analysis of secondary nutrients (Ca, Mg, S) and micronutrients (Zn, Fe, Mn, Bo). Now the state is having a capacity to analyse 5.0 lakh soil samples for secondary and micronutrient per annum in 50 micronutrient soil testing laboratories (MSTLs) as shown in **Table 3.**

Table 3: Facility available for micronutrients analysis

Sr. No.	Department / Agency	Total STLS	Annual analysis capacity (No. of soil samples)
1	Agriculture Department	11	1,10,000
2	APMC	13	1,30,000
3	GLDC	1	10,000
4	GSSC	1	10,000
5	Sugar co-operatives	16	1,60,000
6	Science Colleges	8	80,000
TOTAL UNIT		**50**	**5,00,000**

This programme generate the employment opportunity at village level for deserving youth who join with activity of collection of soil samples from the farmers fields. These youth are selected on merit basis and they are given training for collection of soil samples, marking of samples and collection of miscellaneous information of farm imparted prior to engage them in this activity. Government of Gujarat has made a provision to outsource the activity of soil sample collection at village level and a provision of Rs. 15 made for collection of one soil sample. In this way this, programme provide immense experience to the department of Agriculture to provide quick, reliable services of soil testing and advisory for plant nutrition to the farmers of the state to increase the agriculture production in sustainable manner applying scientific agriculture practices evolved by state agriculture universities (SAUs) and institution working at national level.

Outcome of the programme on balanced use of fertilisers

The changes in fertilisers (NPK) consumption observed in Gujarat as an impact of Soil Health Card programme are indicated in **Table 5**.

Table 5: Total fertilisers (NPK) consumption and NPK ratio in Gujarat

Year	Nitrogen	Phospho-rous	Potash	Total	N : P : K Ratio
2006-07	9.27	3.61	1.20	14.09	7.72:3.01:1.00
2007-08	10.53	4.25	1.46	16.23	7.20:2.91:1.00
2008-09	10.69	4.65	1.82	17.17	5.87:2.55:1.00
2009-10	10.69	4.83	1.87	17.39	5.72:2.58:1.00

The ideal ratio for NPK consumption is 4:2:1. It has been noticed that the NPK consumption Ratio for the year 2006-07 was 7.72 : 3.01 : 1.00 and for year 2009 -10, it was 5.72 : 2.58 : 1.00. Thus, the NPK consumption Ratio is decreased in 2009-10 as compared to previous years. This trend of fertilizer consumption is more or less continuing in the state. Therefore, use of chemical fertilizer constantly heading towards ideal ratio in the state.

Future Road map of the project

This programme has created lot of awareness among farmers for balance and judicious use of fertilizers with the co-ordinated efforts of various Government agencies. Awareness created among farmers of the state through the largest agriculture extension campaign, i. e, krushimahotsav organized every year in the month of April –May where in various advisory on good agricultural practices given to farmers by technical experts and agricultural scientist.

Next phase of the project is to link each and every farmers with Government of Gujarat official web portal i-khedut portal where in farmers can collect (now voluntary) *khatar adhikar patra* (Fartilizer authorization letter) which authorize the farmers to receive precise quantity of fertilizers, from a particular dealer of fertilizer in area, calculated on the basis of soil testing report and scientific crop recommended practices. In this way, each and every farmers will be connected with Government portel and get the assured quantity of fertilizers in days to come. This future plan will ensure farmers for real time available fertilizers and also reduce the risk of unauthorized usage of fertilizer in industrial sector and also reduce the burden of subsidy on the Government of India in long run.

Utility of the programme in other states.

The application of Soil Health Card Programme can be successfully made for the remaining states of our country with a required modification in location specific technology and vernacular language of the respective state.

The Soil Health Card Programme (e-Krishi Kiran) of Anand Agricultural University bagged several awards and recognation during last 8 years from different organizations. The brief details are given below.

1. The e-Krishi Kiran Programme (Soil Health Card) of Information Technology Center, AAU has won the Special Mention Award for "Best Government to Citizens (G2C) Initiative of the Year" at the eMaharashtra Awards 2013, Mumbai.
2. EDGE 2011 Winner for Soil Health Card - Information Week honors organizations that use IT for maximizing business impact.
3. Bronze Icon Award - The 12th National Award was conferred on Anand Agricultural University for e-Governance (2008-09) by Department of Administrative Reforms and Public Grievances jointly with Department of Information Technology, Goverment of India, New Delhi, on 12 February 2009 at Goa for its contribution in the area of Outstanding performance in Citizen-Centric Service Delivery.

Conclusion

The IT based soil health management approach to provide balanced nutrition to the crops will greatly strengthen overall development of agriculture. Today, the information reaches to farmers through different sources but now farmers can get all necessary information through Kiosk. This will ultimately encourage scientific agriculture in each village and lead to increase in farmers' prosperity, sustainable production and eco-friendly environment.

(The author is Vice Chancellor Anand Agricultural University, Anand)