

# STCR

## The Indian Plant Nutrient Management Approach

Based on Resource Endowment Capacity of the Farmers' for

Increasing Crop Yield and Improving Soil Health

**Yield Targeting Made Possible**



**Developed by**

All India Coordinated Research Project on Soil Test Crop Response (AICRP-STCR)

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## **Preamble**

The major challenges in 21 century are food security, environmental quality and soil health. Besides, shrinking land holdings and increasing cost of inputs in India, merit adoption of scientific use of plant nutrient for higher crop productivity. The fertilizer recommendations based on qualitative/semi-quantitative approaches or methods do not give expected yield responses. The generalized recommendations of fertilizer use developed for the soil testing laboratory area were thought applicable to the medium category of soil testing estimates with an arbitrary adjustment (decrease or increase by 25-50 per cent) for high and low categories of soil test estimates. Therefore, inductive approach, a refined method of fertilizer recommendation for varying soil test values has been developed by All India Coordinated Research Project Soil Test Crop Response (AICRP-STCR) for different crops under different agro-ecological sub-regions. Soil Test Crop Response studies have used the targeted yield approach to develop relationship between crop yield on the one hand, and soil test estimates and fertilizer inputs, on the other. Considerable agronomic and economic benefits were accrued when farmers' applied fertilizer nutrient doses based on soil test. Lately, the calibrations are being developed under integrated supply of organics and fertilizers keeping into account the nutrient contribution of organics, soil and fertilizers.

## **Use of Targeted Yield Equation and Development of Prediction Equation for Cropping Sequence**

To apply soil test based fertilizer recommendations, the soils are to be tested after each crop, which is not practicable. Hence, it has become necessary to predict the soil test values after the harvest of the crop. It is done by developing post-harvest soil test value prediction equations making use of the initial soil test values, applied fertilizer doses and the yields obtained or uptake of nutrients. The post-harvest soil test values were taken as dependent variable and a function of the pre-sowing soil test values and the related parameters as yield/uptake and fertilizer nutrient doses. During last fifteen year, the different centres of AICRP on STCR developed prediction equation by using the targeted yield equation for different cropping sequence like rice-rice, rice-maize, rice-wheat, maize-tomato, maize-wheat, potato-yellow sarson, paddy-ragi, maize-Bt. Cotton, wheat-groundnut, okra-wheat, paddy-chick pea, soybean-wheat, rice-pumpkin, bajra-wheat, cotton-maize and soybean-onion. The predicted values can be utilized for recommending the fertilizer doses for succeeding crop thus eliminating the need of soil test after each crop. This provides the way for giving the fertilizer recommendations for whole cropping sequence based on initial soil test values.

## **Economic analysis of fertilizer doses associated with different yield targets**

An appraisal of the effect of nutrients (NPK) applied on crop yield and benefit: cost ratios (BCR), both under (NPK) alone and under integrated plant nutrition system (IPNS) for 15 agricultural and horticultural crops showed that out of 66 crop x target combinations, the BCR was between 1 and 2 in 35 % cases and between 2.1 and 3.0 in 62% cases. In 3% cases BCR was above 3. Irrespective of the crops, higher yield has been recorded at higher yield targets over lower target coupled with higher net return and BCR. As in the case of yield, wherever three targets (low, medium and high) were tried, the BCR was relatively higher between low and medium target levels than between medium and high target levels both under NPK alone and IPNS. Again, irrespective of the crops and yield targets, yield increase was higher with IPNS than under NPK applied through fertilizers alone. In this regard, farmers can choose the desired yield targets according to their investment capabilities and availability of organic manures but would generally benefit from adopting an appropriate IPNS package as apart from contributing nutrients, organic manures also improve soil physical conditions. At present, the soil test based recommendations are relatively on a stronger footing when these involve only fertilizers as compared to IPNS. This is because there are several issues concerning the nutrient which need to be sorted out as illustrated using STCR information from Andhra Pradesh. One of the outstanding problems is that while the composition of fertilizers is fairly standard, that of organic manures can vary several-fold even within the same location or from lot to lot.

## **Fertilizer recommendations for fixed cost of investment and allocation under resource constraints**

A new dimension to the value of the utility of soil testing has been added by the concept of fertilizer application for targeted yield demonstration in farmers' fields by choosing the yield target at such a level so that the cost of fertilizer

requirement becomes more or less same as what was being practiced by farmers' already. When fertilizer availability is limited or the resources of the farmers' are also limited, planning for moderate yield targets which are, at the same time, higher than the yield levels normally obtained by the farmer provides means, for covering more areas with the available fertilizers and ensuring increased total production also.

### Fertilizer recommendation through targeted yield approach for maintenance of soil health

Fertilizer recommendation for realizing in the short term higher crop yield on one hand, and maintenance of soil physical and biological properties besides chemical fertility in the long term on the other, seem to have two opposing dimensions. This twin objectives of high yields and maintenance of soil physical and biological fertility could be achieved through fertiliser application based on STCR prescription equations for achieving yield targets.

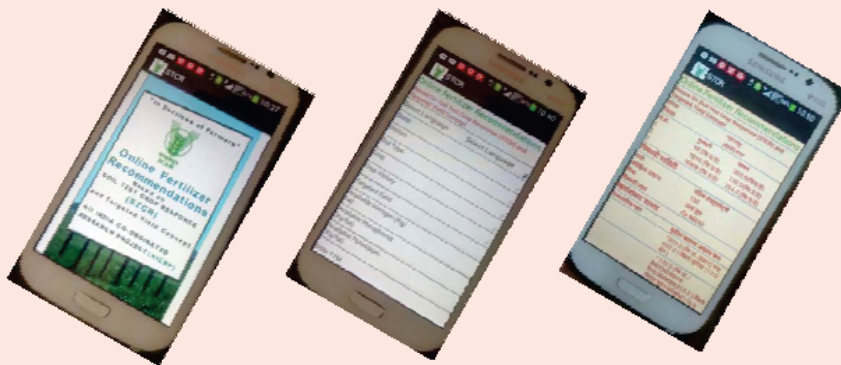
### Improving response ratio through STCR technology

Plant nutrient application based on fertiliser prescription equations under STCR-IPNS system for various crops in soils of different agro-ecological regions of India resulted better response ratio (RR) in terms of kg grain/kg nutrients applied in STCR vis-à-vis general recommended dose (GRD) under different agro-ecological regions as shown below:

Crop	Location/AER	Soil type	GRD		STCR	
			Fertilizer dose	RR	Fertilizer dose	RR
Rice	Pantnagar,Uttarakhand/ 14.5 WarmHumid/perhumid	Mollisol (tarai)	120-40-40	8.50	STCR Target: 4.0 Dose: 94-36-0	16.15
Wheat	Palampur,HP/14.3 Warm Humid-Per humid transitional	Hill Soil	120-60-30	3.52	STCR Target: 4.0 Dose:176-187-75	6.95
Chickpea	Durg,Chattisgarh/ 11 Hot/moist/Dry sub- humid transitional	Black	20-50-20	2.76	STCR Target: 1.2 Dose:20-0-0	7.90
Linseed	Jabalpur, MP/ 10 Hot sub-humid	Medium black	60-40-20	5.21	STCR Target: 2.0 Dose:89-51-19	8.29
Safflower	Bangalore,Karnataka/ 8.2 Hot moistSemi-arid	Black soil	38-50-25	5.78	STCR Target: 1.5 Dose: 54-0-13	10.9
Soybean	Jabalpur,MP/ 10 Hot sub-humid	Medium black	20-80-20	8.28	STCR Target: 2.5 Dose: 15-52-0	13.77

### STCR APP for delivering fertilizer recommendations directly to farmers' mobile

A mobile based bilingual (Marathi and English) STCR App for fertilisers recommendations of Maharashtra has been launched which was prepared in collaboration with National Informatics Centre (Govt. of India), Pune.





## DSSIFER

Decision Support System for Integrated Fertiliser Recommendation (DSSIFER) is a user friendly software and the updated version encompasses soil test and target based fertiliser recommendations through STCR-IPNS system developed by the AICRP-STCR centre at TNAU. Using this software, fertilizer doses can be prescribed for about 1645 situations and for 190 agricultural and horticultural crops along with fertilisation schedule. In addition, it also provides quality appraisal of irrigation water and reclamation measures for problem soil management. It is being used Agrilclinic cum Mini Soil Testing Laboratories at each block, Soil Testing and Technology Advisory Centre (SOTAC) of TNAU, Soil Testing Laboratories of KVKs, NGOs, Private entrepreneurs and progressive farmers'.



## STCR in Soil Health Card Portal

The soil health card portal (<http://www.soilhealth.dac.gov.in>), developed by Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Govt. of India in collaboration with NIC, New Delhi has used STCR prescription equations for generation of fertilizer recommendations.

(<http://soilhealth.dac.gov.in/Report/STCRReport/STCRReport>)



## On-line fertiliser recommendation system

AICRP on STCR in collaboration with National Informatics Centre (NIC), Pune has developed Decision Support System for on-line fertilizer recommendation to different crops grown in various states using the fertilizer prescription equation developed by different centres. On-line fertilizer recommendation system has been completed for 10 states namely; Maharashtra, Andhra Pradesh, Karnataka, Chhattisgarh, Kerala, Orissa, Himachal Pradesh, West Bengal, Jharkhand and Tamil Nadu. This on-line fertilizer recommendation system has been uploaded on STCR website (<http://www.stcr.gov.in>). Farmers' and other end users can get a STCR based fertilizer recommendations to different crops by feeding the soil test values and target yield.



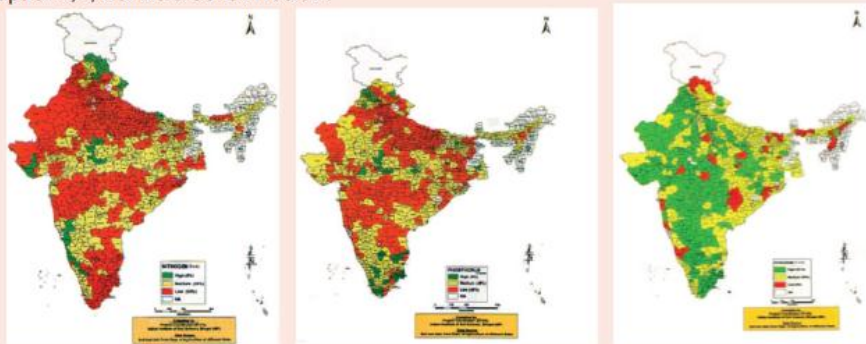
## Integration of STCR based fertilizer recommendations in Mridaparikshak Mini-Lab

STCR based fertilisers recommendations has been made an integral part of Mini Soil Lab – Mridaparikshak, which is an economic and rapid soil testing instrument developed to assess soil health parameters and prepare soil health cards for the large farming community of our country. It is a user friendly instrument which can be easily operated by a young educated farmer (11-12th Pass) with 2-3 days of training. Mridaparikshak is also capable of providing crop and soil specific (alluvial soils, red soils and black soils) fertilizer recommendations based on the targeted yield equations directly to farmers' mobile.

## Developed Nutrient Index based soil fertility maps

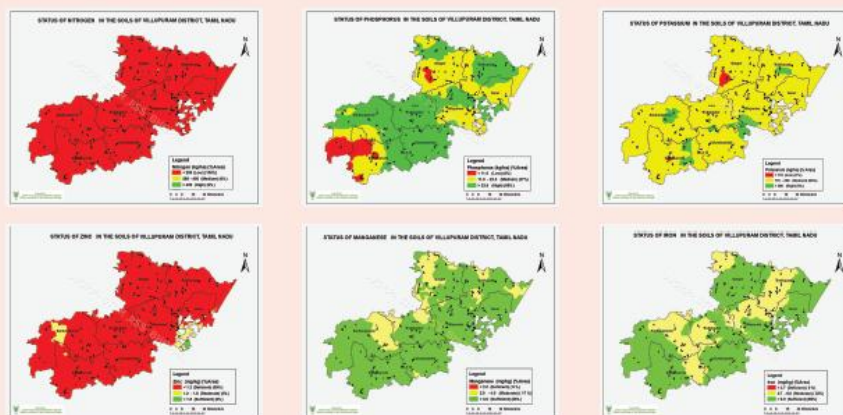
The soil fertility data on N, P and K index values at district level for the states of Andhra Pradesh, Maharashtra, Chhattisgarh, Madhya Pradesh, West Bengal, Haryana, Orissa, Himachal Pradesh, Karnataka, Punjab and Tamil Nadu has been developed in MS-Access. From the attribute database, the different thematic layers were reclassified to generate various thematic maps on N, P and K index values (IVs). The calculated soil test values were

incorporated into the developed soil fertility maps to prescribe nutrients for targeted yields. GIS-based nutrient index maps of N, P, K of India is shown below:



### Developed nutrient plan from GPS and GIS based Soil Fertility Maps of 173 districts of India

From the soil fertility maps of 173 districts of India, developed under DAC Sponsored project on "GPS and GIS Based Soil Fertility Maps for Precise Fertilizer Recommendations for farmers of the country", nutrient plan developed. The segregation of districts based on the soil fertility maps are being used to distribute/channelize fertilizers and more priority are being attached towards districts with poor fertility. In North Zone, majority of the soils are medium to high in available P and available K status. GPS and GIS-based soil fertility maps of Villupuram District of Tamil Nadu is shown below:



### Development of user friendly software for preparation of Soil Health Card

Developed user friendly software for the preparation of Soil Health Card as per Ministry of Agriculture & Farmers Welfare, Govt. of India guidelines for Madhya Pradesh, Odisha and Uttar Pradesh. The user needs to fill the desired values at respective cells provided in the soil health card which is self-explanatory. After furnishing the information the user needs to click on "generate soil health card" button and the software will analyze the furnished information, interpret it and provide customized prescription for different crops.



Front page of the software

Soil Health	Nutrient Status	Recommended Fertilizer
High	High	High
Medium	Medium	Medium
Low	Low	Low

Sample soil health card generated



## Use of STCR in development of customized fertilisers

The concept of balanced use of fertilizers to promote site specific nutrient management is also done through customised fertilisers. A number of fertiliser companies like Indo-Gulf Fertiliser, Nagarjuna Fertilisers and Chemicals Limited, Coromondal Fertilisers are using STCR prescription equations for developemnt of customised fertilisers. Two consultancy projects for providing advisory related to customised fertilisers have been sponsored by Indo-Gulf Fertiliser and Nagarjuna Fertilisers and Chemicals Limited.

## Impact: Metadata analysis

During the last five decades the STCR project has generated numerous fertilizer adjustment equations for achieving targeted yields of important crops on different soils in different agro-ecological regions of the country. These fertilizer adjustment equations have been tested in follow-up and frontline demonstrations conducted in different parts of the country. A metadata analysis of these trials showed that STCR-based fertilizer application helped to obtain higher response ratios (kg grain/kg nutrients) over a wide range of agro-ecological regions as compared to farmers' practice as evidenced by the following table:

Crop	No. of trials	Farmers' practice	STCR- IPNS practice
Rice	120	11.4	16.8
Wheat	150	10.3	14.2
Maize	35	12.7	17.7
Raya	25	4.8	7.6
Groundnut	50	5.1	6.8
Soybean	17	9.6	12.2
Chickpea	35	6.1	9.4

AICRP (STCR) has made efforts to reach the unreach and serve the unserved through Tribal Sub Plan (TSP) programme in some of the remotest corners of Assam, Bihar, Chhattisgarh, Himanchal Pradesh, Jammu & Kashmir, Jharkhand, Kerala, Madhya Pradesh, Maharashtra, Manipur, Odisha, Telangana, Tamil Nadu, Karnataka and West Bengal. The superiority of nutrient application based on STCR approach has been demonstrated through 1460 FLDs in tribal farmers' field during XII plan itself.



## Patent

Patent Application No. 201611014379 filed on April 25, 2016 for Portable Soil Testing Kit for Agricultural and Horticultural Crops developed by STCR centre at IGKV, Raipur; this was published on October 27, 2017.



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