Socio-economic impact of Soil Health Card scheme in the state of Andhra Pradesh

ANKHILA R H[1]*, ALKA SINGH[2], PRAMOD KUMAR[2], SURESH KUMAR[3], M C MEENA[2],
RASHMI SINGH[2], SUNIL KUMAR SUNANI[4], PARTHA PRATIM ADHIKARY[1],
DINESH KUMAR[2], SANATAN PRADHAN[1] and SUNIL B H[5]

ICAR-Indian Agricultural Research Institute, New Delhi 110 012, India

The recent scheme of soil health card (SHC) launched by the Government of India on 19th of February 2015 marking the International Year of Soil stands apart with the aim to correct the indiscriminate use of chemical nutrients at the farm sites by soil testing and giving crop wise recommendations for every three years (PIB 2021). The background of India's soil testing program began in 1955–1956 with the establishment of 16 soil testing laboratories under the Indo-US Operational Agreement for the Determination of Soil Fertility and Fertilizer Use. The program benefited from a substantial revival in the 11th five-year plan (2007–2012), when the National Project on Management of Soil Health and Fertility was launched with an outlay of ₹429.85 crores to set up new laboratories and strengthen existing laboratories with micronutrient testing facilities (Fishman *et al*. 2016). Later on, the program was expanded further in the 12th five-year plan (2012–2017), when all states adopted the system of preparing and issuing soil analysis-based Soil Health Cards (SHC) to farmers along with associated fertilizer use recommendations. Thus, the SHC scheme was launched across all the states of India since 2015 and Andhra Pradesh was one of the pioneering states to go for full adoption of the scheme with the active involvement of the state machinery. As on March 2020, the total SHC issued in the state of Andhra Pradesh is found to be 6967162. Thus from the SHC MIS portal, it is seen that the state meets 100% of its SHC target distribution for the cycle of 2018–20. With this background, study was carried out in 2020 to evaluate the effectiveness of soil health card in the state of Andhra Pradesh and the factors influencing the farmers to adopt the soil health card scheme.

The study has relied on secondary data to select the state of Andhra Pradesh based on the better performance of the state in terms of SHC distribution for the period 2018–20 cycle from SHC MIS portal. Primary survey was conducted in 2020 in Andhra Pradesh, with sample size of 180. Random sampling was used to select survey sites, Chittoor and Nellore were the selected districts. Chandragiri, Chittecherla and Allur, Nellore were the sampled blocks from Chittoor and Nellore districts respectively. 120 farmers were adopters of soil health card and 60 farmers were non-adopters of SHC among 180 sample. The village clusters were surveyed from the randomly selected blocks as the sampling units.

Logit model application to analyze the factors of adoption: Binary response models are suitable to explain the likelihood of farmer households opting for adoption of soil health card. Binary logistic regression is fitted to identify the factors influencing adoption of SHC. The dependent variable model captures the influence of several factors on adoption of SHC by the beneficiaries.

$$P_i = e(y=1/X_i) = 1/(1+e^{-z}) = e^z /(1+e^z)$$

Where, explanatory variables include level of income, education, head of the family, land holding of the beneficiary, access to institutions, contact with extension agents' access to market, farming experience, etc.

$$Z = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \dots + b_iX_i$$

$$\text{Odds ratio} = (p/1\text{-}p) = e^{b0+bixi+ui}$$

$$\text{Log odds} = L_i = Ln (p/1\text{-}p) = b_0 + b_iX_i + u_i$$

Methodology of regression adjustment to examine the impact of SHC: To quantify the impact of SHC on fertilizer consumption in the study area, regression adjustment (RA) tool of impact assessment is employed. Since the

[1]ICAR-Indian Institute of Water Management, Chandrasekharpur, Bhubaneswar, Odisha; [2]ICAR-Indian Agricultural Research Institute, New Delhi; [3]ICAR-Central Soil Salinity Research Institute, Karnal, Haryana; [4]ICAR-Indian Institute of Pulses, Research Regional Station, Bhubaneswar, Khordha; [5]ICAR- National Bureau of Soil Survey and Land Use Planning, Nagpur. *Corresponding author email: ankhila.handral@icar.gov.in

sample size chosen is 180, regression adjustment is found to be suitable method to know the impact of SHC in the study area. Regression adjustment uses the contrasts of the averages of treatment-specific predicted outcomes to estimate treatment effects.

RA is a two-step approach estimating treatment effects. In RA, the estimators estimate the average treatment effect (ATE), the average treatment effect on treated (ATET) and potential-outcome means (POMs). The steps involved in estimation are as follows:

1. Fitting separate regression models for the outcome on a set of covariates for each treatment level.

2. Computing the averages of the predicted outcomes for each subject and treatment level. The contrasts of these averages provide estimates of the ATEs.

The model specification for RA (regression adjustment):

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \mu$$

Where Y, Dependent variable (Fertilizer consumption (NPK and micro nutrients and yield); X_1, Farming experience; X_2, Education; X_3, Access to training; X_4, Input market distance; X_5, Access to credit; X_6, Number of trainings and; X_7, SHC dummy. In this model, SHC adopters are treatment group and non-adopters of SHC are control group.

Before the Govt of India in 2015, the SHC scheme was rolled out couple of years back in Andhra Pradesh with state machinery led soil testing scheme. It took 4–5 years from the year of inception for this scheme to reach out majority of its beneficiaries showing the time lag between the initiation of the scheme and availing the benefits of the scheme by the people. The study, throws light on the local factors influencing adoption of soil heath card and the changes in nutrient consumption in paddy after the adoption of SHC recommendations.

Factors affecting the adoption of soil health card in the study area: Using the logit model, the effect of various factors taken into consideration for adoption of soil health card is analyzed.

Table 1, shows that among the various factors considered, distance to input market and size of household

Table 1 Results of logit model for factors of adoption

Factors	Coefficient	P value
Distance to input market (km)	-1.06	0.020
Size of family	-3.33	0.012
Number of trainings attended	5.22	0.005
Output market distance (km)	0.12	0.343
Years of schooling	-0.42	0.181
Membership of farmers organization	5.85	0.037
Age in years	-0.33	0.051
Access to extension service	0.38	0.069
Landholding (acres)	0.43	0.149
Access to credit	-0.76	0.398
Constant	52.22	0.054

has significant negative relation with adoption of soil health card (SHC). It indicates that more is the distance of input market from the farmer lesser is the adoption of SHC. With easy accessibility to the inputs, the farmers can adopt SHC recommendations in better way and the interaction with input dealers also acts as the link for increased adoption of SHC by the farmers (Ankhila *et al.* 2020). Larger is the family lesser is the chances of adoption of SHC, which can be attributed to conventional agriculture practices followed in joint family. Number of trainings attended influenced the adoption of SHC significantly, and the farmer being the member of farmer organisation like FPO (farmer producer organisation) has significant positive effect on SHC adoption. The results are in consistent with Reddy (2017), where trainings given to farmers are found to influence adoption of SHC. Also, the satisfaction of the farmers from the trainings created enhanced awareness about the SHC (Chowdary and Theodore 2016). Age of the farmer had significant negative relationship with adoption of SHC, younger the farmer more was the adoption of SHC as innovative early adopter. The access to extension service influenced the adoption of SHC significantly as extension agents play bigger role in dissemination of such schemes in the village (Chowdary and Theodore 2016, Reddy 2017).

Study showed output market distance (km), education, landholding of farmer and access to credit had no significant effect on adoption of SHC by the sample households. Thus, no conclusions could be made on these variables. The results are in consistent with the study by Rajput and Chinchmalatpure (2016) and Patel *et al.* (2019).

Impact of soil health card (SHC) on consumption of nutrients and crop productivity: To see the impact of soil health card adoption on actual consumption of fertilizers, regression adjustment (RA) methodology of impact assessment is used as it suits best for the sample size, given the limited time frame and resource availability with the researcher. The expected mean differences in consumption of fertilizers representing the ATET (average treatment effect on the treated) for the adopters, and the non-adopters being the control group is calculated with RA.

Impact of SHC on paddy production is captured by means of changes in terms of nitrogen (N), phosphorous (P) and potash (K) application and finally the total macro

Table 2 Outcome of impact of SHC on fertilizer nutrients

Output variable (kg/ha)	ATET	ATE
Crop productivity	3.20***	3.17***
Nitrogen applied	-23.46***	-21.26***
Phosphorous applied	-19.20***	-18.89***
Potassium applied	1.91	2.11
Macro fertilizer	-41.7***	-42.05***
Micro fertilizer	9.15**	10.48**

*** =significant at 1%, **=significant at 5%, *=significant at 10%. ATET, Average treatment effect on the treated.

fertilizers and micro fertilizers application. It is evident from the Table 2, that there is moderate rise in productivity of paddy by 3.2 kg/ha with adoption of SHC recommendations by farmers and the rise is found to be significant in terms of ATE and ATET. Similar findings were made by Makadia (2012) in the state of Gujarat; and Bordoloi and Das (2017) in Assam in rice after usage of SHC by the farmers. Moderate increase in yield levels with SHC usage in Andhra Pradesh is perceived upon by 41% of farmers in a study by Ankhila *et al*. (2020) and Chouhan *et al*. (2017) in Madhya Pradesh. Nitrogen application has reduced significantly with adoption of soil health card. While there was significant decline in application of phosphorous also. It is seen that Potash application increased by around 2 kg/ha with no significant difference. Thus, adoption of soil health card had no significant change in usage of potash. The findings resonate with results of Reddy (2017), where there was reduced usage of fertilizers, especially nitrogen after the adoption of SHC.

In case of application of macronutrients (N, P and K) there is significant reduction in usage. In case of micronutrients, there is significant increase in application which is welcoming step with SHC adoption. It reflects the farmers awareness on micronutrients. The results are in agreement with Mukati *et al*. (2018) for Madhya Pradesh and Reddy (2017) for Andhra Pradesh. The findings are corroborated by the study, Gupta *et al*. (2020) in Andhra Pradesh. The study confirms increased micronutrients usage after SHC awareness combined with free supply of micronutrients to the farmers in case of deficient soils. With SHC scheme, the study affirms increased awareness level among the farmers regarding micronutrients use, for better soil health status in Andhra Pradesh.

The study estimated factors influencing the adoption of soil health card (SHC) in Andhra Pradesh. Among the factors, distance to input market, age and family size negatively affected the adoption of SHC. Factors such as number of trainings attended, membership of farmer organisations and timely extension service has positive impact on adoption of SHC. Factors such as output market distance (km), farmer education, landholding of farmer and access to credit had no significant effect on adoption of SHC in the area. Regression adjustment methodology of impact assessment revealed significant decline in use of nitrogen and phosphorus nutrients, while no significant increase in potash usage in paddy production was noticed due to SHC intervention. Results of the impact study also revealed significant increase in yield of paddy in case of SHC adopter. There was significant increase in micro fertilizer application by 9 kg/ha in case of SHC holders in comparison to the non-SHC holders.

Study revealed that SHC scheme has achieved its major objective of reducing the excess usage of fertilizers in cultivation in case of Andhra Pradesh. SHC scheme has created awareness among the farmers about the pros of using recommended doses of fertilizer in the given area. Study recommends these kinds of government programmes

to be promoted with better extension service to have impact on fertilizer savings and indirectly saves the input cost to farmer. It in turn encourages balanced nutrients application including micronutrients to correct the soil health assuring better yield and economic returns to the farmer community.

SUMMARY

The study is an attempt to evaluate the effectiveness of the soil health card (SHC) scheme in Andhra Pradesh (AP). Primary survey in the two selected districts of the AP state was carried out during 2020. Data set has 120 SHC adopters and 60 non-adopters of SHC from Chandragiri, Chittecherla blocks of Chittoor and Allur, Nellore blocks of Nellore district of Andhra Pradesh. The study evaluated the factors affecting the adoption of SHC in the selected districts of AP. Among them, number of trainings attended, membership of farmer organizations, the timely extension service availability has shown positive impact on adoption of SHC. However, distance to input market, age, and family size had significant negative impact on adoption of SHC. Impact of SHC showed significant decline in use of nitrogen and phosphorus nutrients by 20 kg/ha and 19 kg/ha, respectively, among the adopters. Micronutrient usage increased by 9.15 kg/ha among the adopters of SHC. The study implies SHC scheme has reduced the excess usage of fertilizers in paddy cultivation in the survey area. It also recommends timely extension service to improve fertilizer savings by farmers.

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