



Impact of Soil Health Card on Determinants of Fertilizer Consumption and Fertilizer Use Efficiency in Gujarat, India

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Paper No.: 265

Received: 2 January 2015

Accepted: 2 November 2015

Abstract

The present study was undertaken with a view to assess the impact of soil health card to identify the factors affect on fertilizer consumption and fertilizer use efficiency in sugarcane and kharif paddy crops in South Gujarat region of Gujarat State. The multistage random sampling technique comprised of 224 farmers was taken for the study. The production function analysis employed for determinants of fertilizer use indicated that annual total income of farmers, short term credit, one year lagged price and educational level were found the major influencing factors for determining fertilizers consumption in sugarcane and kharif paddy in general, for with and without Soil Health Card farmers. The production function analysis employed for fertilizer use efficiency indicated that there existed a variation in the production elasticities of resource inputs between the crops and groups of farmers under study. In general, area under the crop, human labours, phosphorus and other working capital were the important resource variables positively and significantly influencing the crop output in general for with and without Soil Health Card farmers. The nitrogen and manure showed the negative and significant effect on crops output when farmers used these resources excessively.

Keywords: Soil health card, determinants, fertilizer consumption, fertilizer use efficiency, sugarcane, kharif paddy, gujarat

In India, agricultural sector still occupies a predominant position in the country's economy, accounting for about 14 per cent of gross domestic product and one-fifth of foreign exchange. This sector provides employment to about 58.2 per cent (www.indiancensus, 2001) of the total labour force in the country. With the 2 per cent world's geographical area, India has the responsibility to feed 18 per cent of world population. Since independence, our country is constantly increasing food grains production which has reached to 244.78 million tonnes in 2010-11, more than about five times the 50.8 million tonnes in 1950-51. With the success of green, white and blue revolution, India is now in the position of self reliance in food grains production. It is expected that the total food grains demand by 2020 and 2025 is estimated to be 294 and

322 million tonnes, respectively (Kumar, 1998; Malavia, *et al.*, 2000). Thus by 2025, we need to produce about 118 million tonnes additional food grains per year from the same or even less area. The most challenging problem which India faces today is the growth rate of food grains production which is lower than the population growth rate during last two decades. Growing population puts enormous pressure on the available natural resources and infrastructure, which become more and more fragile. Thus, in developing countries like India, reeling under population pressure, the efficient use of fertilizer must go hand-in-hand for a better tomorrow.

As a key element of the food grains production cycle, fertilizer usage contributed to about 50 per cent of increased food grains production in the world (Hegde and Sudhakarbabu, 2004; Tanwar and Bisvas, 2005). In

India, fertilizer consumption is concentrated in about one-third of the cultivated area. It is key element to increase sustainable production of agriculture (Painuly and Dev, 1998). The average yield per hectare of crops in India is very low due to exhausted soils which have been over cropped from centuries without adequate replenishment for plant nutrients through fertilizers. Such heavy removal of plant nutrients from soil leads to depletion of soil fertility, which shows up in crop yield decline and lowered factor productivity (Yadav *et al.*, 1998). Therefore, application of fertilizers is essential to prevent soil degradation, keeping agriculture land productive and economically viable.

The fertilizer consumption in India has increased many folds from 65.6 thousand tonnes in 1951-52 to 281.22 lakh tonnes in 2010-11. The corresponding figures for total consumption of N_2 , P_2O_5 and K_2O during 2010-11 were 165.58, 80.50 and 35.14 lakh tonnes, respectively. The fertilizer consumption in India has grown considerably in the last five decades however; it is still low in comparison to other countries. The fertilizer consumption was 25.75 kg per hectare during 1970 and it increased to 75.43 kg per hectare during 1990s registering a growth rate of 3.94 per cent between 1990-91 and 2000-01 (Ramasamy, 2004). The average fertilizer consumption per hectare of cropped area in India rose from mere 0.55 kg in 1950-51 to 144.14 kg in 2010-11. It is disheartening to note that in spite of this impressive growth over the last five decades, per hectare fertilizer consumption in India is still very low as compared to that of many other countries.

A great deal of variability was observed in fertilizer consumption during 2009-10 among the states. Amongst states in the country, per hectare consumption was quite high in Punjab, Haryana and Andhra Pradesh. It was quite low in case of Rajasthan, Orissa and Madhya Pradesh. The all India average consumption of fertilizer was 135.3 kg per hectare in 2009-10. Gujarat occupied eighth position on the basis of per hectare consumption of total NPK (154.96 kg) in the country. It is still far below the levels of consumption of some of the progressive states. In 2005, the then Hon. Chief Minister of Gujarat, Mr. Narendra Modiji has launched Soil Health Card Scheme in which Soil Health Card are issued for farmers containing the information on soil type, cropping pattern, crop sequence, fertilizer dose on the basis of soil analysis etc. The farmers are advised to use chemical fertilizers on the basis of information provided in soil health card, which resulted into optimum yield response and thereby increase in net income. No systemic study to examine the impact of Soil Health Card has been conducted. Hence, it is necessary to identify the

determinants of fertilizer consumption and fertilizer use efficiency for sugarcane and paddy for with and without Soil Health Card in South Gujarat region of Gujarat.

Database and Methodology

The study was conducted in the South Gujarat region of Gujarat state. A multistage sampling technique was used for the selection of sample. Two districts of South Gujarat namely Surat and Navsari were selected purposively as they rank in the use of fertilizers per hectare; and two major crops like kharif paddy and sugarcane were selected as they acquired highest area in these Districts. At the first stage, two talukas were selected randomly from each district. In the second stage, four villages were selected from each taluka randomly and at final stage, 14 farmers (7 without soil health card + 7 with soil health card) were selected randomly from each village for the study. Thus, total sample comprised of 224 farmers from sixteen villages. The primary data for the study at micro level were collected by survey method adopting personal interview of the selected respondents with the help of well-structured and pre-tested questionnaire. The survey work was carried out for the agricultural year 2010-11.

The following type of multiple linear regression model was best fitted to identify the determinants of fertilizer consumption for both crops under study:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + u$$

Where, Y = Total fertilizer (N, P, K) consumption for selected crops (Kg/ha), a = Intercept, X_1 = Irrigated area under the crop in ha, X_2 = Annual total income of the farmer in Rs, X_3 = Cropping intensity in percentage, X_4 = Operational holding of farmers in ha, X_5 = Educational level of the farmers, X_6 = Short term credit per farmer in Rs, X_7 = One year lagged average price of the crops output in Rs. per quintal, X_8 = Manures (cartload), X_9 = Number of irrigations, U = Error term and b_i = Regression coefficients of the variables.

Irrigation is considered as the major factor to determine the extent of fertilizer consumption. So, this variable is included in the set of independent variable. But in kharif season there was no need to apply irrigation to kharif paddy in this heavy rainfall region. Hence, number of irrigation was omitted in analysis for kharif paddy.

The fertilizer use efficiency for the selected crops was estimated by using production function as given below.

$$Y = a X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} X_7^{b_7} X_8^{b_8} e^u$$

The Cobb-Douglas production function is the most appropriate for studying fertilizer use efficiency. In this functional form, 'Y' is dependent variable, 'Xi' are the independent input variables, 'a' is constant representing intercept of production function and 'bi' are the regression coefficients of the respective input variables. The regression co-efficient obtained from this function directly give the elasticities of production, which remain constant throughout the relevant range of inputs. The sum of coefficients indicates the nature of returns to scale. When the function is expressed in logarithmic term, it becomes a linear function of the following type.

$$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + b_7 \log X_7 + b_8 \log X_8 + u$$

Where, Y = Output of crop in qtl/ha, a = Intercept, X_1 = Area under crop in hectares, X_2 = Human labour in man days/ha, X_3 = Bullock labour in pair days/ha, X_4 = Manures in cartloads/ha, X_5 = Nitrogen in kg/ha, X_6 = Phosphorus in kg/ha, X_7 = Potash in kg/ha, X_8 = Other working capital in rupees/ha, b = Regression coefficients of inputs and e = Error term.

Results and Discussions

The determinants of fertilizer use for sugarcane crop are presented in Table 1. The value of R^2 was found 36.40 per cent and 61.20 per cent for without Soil Health Card in Surat and Navsari districts, respectively. It is revealed from the table that for with Soil Health Card farmers in Navsari district, all the variables except, operational holding and manure were positive but non-significant. The operational holding (X_4) and manure (X_8) showed negative sign but non-significant. It indicated that farmers of this district judiciously used the fertilizers when they used more manures with their limited financial resources, whereas educational level (X_5) was found positive and significant at 1 per cent for Soil Health Card holders. In Navsari district, educational level showed the positive and statistically significant effect on consumption of fertilizers. For without Soil Health Card farmers of Navsari district, all variables except manure were found positive but statistically non-significant. Manure (X_8) showed the similar trend in with Soil Health Card and without Soil Health Card farmers.

It is seen from the Table 1 that in Surat district, for with Soil Health Card farmers, operational holding (X_4) and manure (X_8) were found negative but statistically non-significant. For manure, the similar trend was also observed in Surat district. It indicated that this is the general tendency of the farmers of this region. The short

Table 1: Determinants of fertilizers consumption in sugarcane crop

Particulars	Navsari		Surat		South Gujarat	
	With SHC	Without SHC	With SHC	Without SHC	With SHC	Without SHC
Constant	60.80	644.75	1329.35	583.59	314.37	457.97
Irrigated area under the crop (X_1) (ha)	38.7244 (26.79)	0.0510 (0.0411)	0.0137 (0.1085)	0.0371 (0.9412)	59.0447 (54.6490)	0.5610 (0.4108)
Annual total income Per farmer (X_2) (₹)	0.0011 (0.001)	0.2630 (0.3632)	0.1997 (0.2931)	0.1610 (0.1923)	0.3274 (0.3912)	0.2527 (0.3542)
Cropping intensity (X_3) (%)	0.0525 (0.3215)	0.0076 (0.4680)	0.2963 (0.9319)	0.1642 (0.2556)	0.0918 (0.4472)	0.1499 (0.2631)
Operational holding (X_4) (Ha)	-31.3222 (27.0064)	1.6863 (35.4201)	-11.78 (24.0740)	5.0372 (10.3531)	-55.5784 (54.5362)	-12.2242 (10.4431)
Educational level (X_5)	6.3416** (2.4530)	0.4731 (19.0653)	2.2212 (26.7560)	7.7351 (10.3561)	6.6275 (14.5698)	18.1052 (11.5364)
Short term credit (X_6) (₹)	0.0003 (2.4530)	0.0012 (0.0008)	0.0127* (0.0057)	0.0115 (0.0112)	0.1617 (0.0178)	0.0012 (0.0002)
One year lagged average price (X_7) (₹/t)	0.1434 (0.1128)	0.0378 (0.0223)	0.0256 (0.0212)	0.0276 (0.0844)	0.0599 (0.0898)	0.0532** (0.0179)
Manure (X_8) (cartload)	-0.2759 (0.5915)	-1.8842 (1.7960)	-0.2192 (0.3906)	-0.1685 (0.1590)	-0.0782 (0.2176)	-0.2881 (0.2162)
Number of irrigation (X_9)	4.0130 (4.0881)	16.3807 (13.0385)	13.9207 (14.9290)	4.2487 (5.9773)	2.6360 (6.3217)	5.4559 (6.4678)
R^2	54.71	61.20	60.00	36.40	40.86	49.83

Figures in parentheses are the standard errors, *Indicates 5 per cent level of significance

**Indicates 1 per cent level of significance

term credit (X_6) means crop loan showed the positive significant effect at one per cent level. It indicated that one per cent increased in short term credit increased the consumption of fertilizer by 0.01 Kg per hectare. This result is in conformity with the results obtained by Singh (1983), Singh and Gupta (1991) and Singh and Nasir (2003). All other variables were found positive but non-significant. For without Soil Health Card farmers of Surat district, all variables except, manure (X_8) were found positive but non-significant. The manure reflected the similar trend as per with Soil Health Card farmers.

As a whole for South Gujarat, all variables except operational holding and manure were found to be positive but non-significant in case of farmers having with and without soil health card. The operational holding (X_4) and manure (X_8) were found negative but non-significant. Only one variable one year lagged price (X_7) was found statistically significant at one per cent for without soil health card farmers. The similar results were obtained by Ardesna and Khunt (2011). The number of irrigations (X_1) did not show the significant positive effect on fertilizer consumption in this region might be due to highly assured canal irrigation facilities and tendency of farmers to grow cash crop like sugarcane.

The determinants of fertilizer use for kharif paddy crop are presented in Table 2. The value of R^2 was found

40.29 per cent and 79.41 per cent in case of with Soil Health Card in Navsari and Surat districts, respectively. It is revealed from the table that for with Soil Health Card farmers in Navsari district, all the variables were found positive but non-significant. The annual total income of the farmers (X_2) was only the variable showed significant positive effect at five per cent level. It indicated that one per cent increase in total annual income of the farmers leads to increase fertilizer consumption by 0.50 Kg per hectare. For without Soil Health Card farmers of Navsari district, all variables except, manure were found positive but statistically non-significant. The manure (X_8) was found negative and non-significant. The short term credit (X_6) and one year lagged price (X_7) exhibited the positive and statistically significant effect at one per cent level. These results are in conformity with the results obtained by Ardesna and Khunt (2011). The negative sign of farm yard manure showed that farmers used lesser quantity of fertilizers when they used higher quantity of manures due to their financial limitations.

A look to Surat district with Soil Health Card farmers revealed that operational holding (X_4) and manure (X_8) were found negative but statistically non-significant. For manure, the similar trend was also observed in Surat district as per Navsari district. It indicated that this is the general tendency of the farmers of this region. The short-term credit (X_6) showed the positive and significant

Table 2: Determinants of fertilizers consumption in kharif paddy crop

Particulars	Navsari		Surat		South Gujar at	
	With SHC	Without SHC	With SHC	Without SHC	With SHC	Without SHC
Constant	63.64	817.99	647.31	134.63	45.85	134.63
Irrigated area under the crop (X_1) (ha)	0.1821 (0.2630)	3.4535 (447.33)	0.2845 (0.3441)	0.1142 (0.1048)	0.2731 (0.3715)	0.1710 (0.3762)
Annual total income Per farmer (X_2) (₹.)	0.5047* (0.2452)	0.1273 (0.0976)	0.3841 (0.1440)	0.0914 (0.0826)	0.0249 (0.0223)	0.1315 (0.2336)
Cropping intensity (X_3) (%)	0.3091 (0.8042)	0.1459 (0.4601)	0.2021 (0.5053)	0.0411 (0.0437)	0.0287 (0.1945)	0.0411 (0.0437)
Operational holding (X_4) (Ha.)	2.0930 (2.6409)	4.4618 (6.6407)	-7.8773 (32.8933)	0.8553 (1.7139)	-5.9151 (7.1812)	-0.8535 (1.7140)
Educational level (X_5)	5.4214 (6.5362)	0.6079 (0.2056)	1.8773 (32.8933)	1.3919 (1.8639)	8.0762 (11.9317)	1.3923 (1.8634)
Short term credit (X_6) (₹)	0.0341 (0.0424)	0.1864** (0.0719)	0.1030** (0.0447)	0.0814 (0.0723)	0.0286 (0.1820)	0.1010 (0.2115)
One year lagged average price (X_7) (₹/qtl.)	0.2994 (0.5857)	2.7542** (1.662)	2.4306 (2.8056)	0.0316 (0.1908)	0.4492 (0.7504)	0.0031 (0.1901)
Manure (X_8) (cartload)	0.0103 (0.2754)	-1.2154 (5.8114)	-1.3288 (0.6037)	0.0175 (0.1143)	-0.3204 (0.2994)	-0.0175 (0.1143)
R^2	40.29	59.71	79.41	45.83	42.67	45.83

Figures in parentheses are the standard errors,

*Indicates 5 per cent level of significance,

**Indicates 1 per cent level of significance

effect at one per cent level. It indicated that one per cent increased in short term credit increased the consumption of fertilizer by 0.10 Kg per hectare. This result is in conformity with the results obtained by Singh (1983), Singh and Gupta (1991) and Singh and Nasir (2003). The rest of the variables were found positive but non-significant. For without Soil Health Card farmers of Surat district, all variables were found positive but non-significant.

For south Gujarat as a whole for with Soil Health Card farmers all the variables except, operational holding and manure were found positive but statistically non-significant. The operational holding (X_4) and manure (X_5) were found negative but non-significant. The similar trend was also observed in without Soil Health Card farmers. An overview of production function analysis applied to determine the factors responsible for fertilizer use for sugarcane and kharif paddy revealed that annual total income of the farmers, one year lagged price, short term credit and educational level were found the major factors for fertilizer use in this region.

The data on regression coefficients, standard errors and coefficients of multiple determinations are presented in Table 3. It is revealed from the table that value of coefficients of multiple determinations was found 48.18 per cent and 65.53 per cent in case of with Soil Health Card in Surat and Navsari district, respectively. In Navsari district for with Soil Health Card farmers, the regression coefficients of the entire resource

variables were found positive and non-significant except, nitrogen (X_5). The nitrogen (X_5) was found statistically significant at 1 per cent. The highly significant regression coefficient observed in case of nitrogen indicated that the one per cent change in its use level would increase the output of sugarcane by 0.25 per cent keeping the use levels of the other variable constant. It is due to the fact that with Soil Health Card farmers of Navsari district applied the nitrogen as per recommended dose of Soil Health Card. These results corroborated the results obtained by Singh and Srinivas (1989). For without Soil Health Card farmers of Navsari district, the entire resource variables were found positive and non-significant except nitrogen and manure. The manure reflected negative effect on sugarcane yield due to excess utilization of the said variable. But it was non-significant. The nitrogen (X_5) was found negative and significant at 5 per cent level. It is clearly indicated that over utilization of nitrogen would decrease the sugarcane yield and also decrease its fertilizer use efficiency. It might be due to the fact that without Soil Health Card farmer of Navsari district applied 8 per cent higher dose of nitrogen than recommended dose. These results are in conformity with results obtained by Hossain *et al.* (1987).

In Surat district for with Soil Health Card farmers, all the included resource variables were found positive and non-significant except, manure (X_4). The manure (X_4) was found negative but non-significant. It indicated

Table 3: Fertilizer use efficiency for sugarcane

Particulars	Navsari		Surat		South Gujarat	
	With SHC	Without SHC	With SHC	Without SHC	With SHC	Without SHC
Constant	2.4552	4.0357	5.8992	7.4516	2.5521	3.7640
Area under crop (X_1) (ha)	0.0561 (0.0679)	0.0912 (0.0814)	0.2719 (0.2224)	0.2628* (0.1216)	0.1714 (0.2426)	0.0815 (0.0296)
Human labour (X_2) (man day/ha)	0.0598 (0.0366)	0.0611 (0.0435)	0.1044 (0.0780)	0.2087** (0.0684)	0.0321 (0.0422)	0.0033 (0.0482)
Bullock labour (X_3) (Pair day/ha)	0.0378 (0.0205)	0.0083 (0.0069)	0.0035 (0.0039)	0.0019 (0.0038)	0.0426 (0.0417)	0.0014 (0.0041)
Manures (X_4) (Cartload/ha)	0.1014 (0.4995)	-0.0038 (0.0032)	-0.0050 (0.0048)	0.0017 (0.0039)	-0.0045 (0.0036)	-0.0012 (0.0032)
Nitrogen (X_5) (Kg./ha)	0.2535** (0.0701)	-0.1165* (0.0523)	0.0357 (0.2427)	-0.4410** (0.1128)	0.3591** (0.1041)	0.0432 (0.0683)
Phosphorus (X_6) (Kg./ha)	0.0011 (0.0702)	0.0979 (0.0937)	0.0188 (0.0416)	0.1356 (0.1664)	0.0328 (0.0366)	0.0309 (0.1154)
Potash (X_7) (Kg./ha)	0.0288 (0.0395)	0.0149 (0.0646)	0.1007 (0.0612)	0.1175 (0.2393)	0.0735 (0.0434)	0.0813 (0.0951)
Other working	0.0486	0.0047	0.0296	0.1411	0.0651	0.0293
Capital (X_8) (₹)	(0.0322)	(0.0340)	(0.0770)	(0.0881)	(0.0387)	(0.0502)
R ²	65.53	55.40	48.18	58.71	53.62	42.56

Figures in parentheses are the standard errors,

*Indicates 5 per cent level of significance,

** Indicates 1 per cent level of significance

the over utilization of manure by the farmers. The resource variables like area under the crop (X_1) and human labour (X_2) were found statistically significant at 5 per cent and 1 per cent level, respectively for without Soil Health Card farmers. The nitrogen (X_5) was found negative and significant at 1 per cent indicating over utilization of the said variable in the production process. These results corroborate the results obtained by Shah *et al.* (1995).

In south Gujarat as a whole for with Soil Health Card farmers, the only one resource variable nitrogen (X_5) was found positive and significant at 1 per cent. The manure (X_4) exhibited negative effect but non-significant. The rest of the variables were found positive but non-significant. It indicated that with Soil Health Card farmers applied the nitrogenous fertilizer in sugarcane crop near about same quantity recommended by Soil Health Card. These results are in conformity with the results obtained by Sagwal and Kumar (1994). For without Soil Health Card farmers, all the resource variables were found positive but non-significant except, manure (X_4). The manure (X_4) was found negative but non-significant. An overview of production function analysis of sugarcane crop, nitrogen (X_5) was over utilized by the without Soil Health Card farmers in both the districts. The with Soil Health Card farmers used nitrogen judiciously as per recommendation of Soil Health Card resulted into better fertilizer use efficiency.

The data on regression coefficients, standard errors and coefficients of multiple determinations are given in Table 4. It is observed from the table that value of coefficients of multiple determinations was found 49.93 per cent and 61.69 per cent for with Soil Health Card farmers in Surat and Navsari district, respectively. In Navsari district for with Soil Health Card farmers, the regression coefficients of all the resource variables except, manure (X_4) were found positive but non-significant. The only variable found statistically significant at 5 per cent was area under the crop (X_1). The resource variable manure (X_4) showed the negative and non-significant effect on crop output. It indicated the excess use of the said variable in production process. The resource variables like human labour (X_2) and phosphorus (X_6) were found positive and statistically significant at 1 per cent and 5 per cent, respectively for without Soil Health Card farmers in Navsari district. The positive significant effect of phosphorus (X_6) might be due to lower dose of phosphorus applied by the without Soil Health Card farmers as compared to recommended dose. The resource variables like manure (X_4) and nitrogen (X_5) were found negative but non-significant. It indicated the over utilization of the said variables in the production process. The higher dose of nitrogen enhanced vegetative growth and the problem of lodging would occur. These results are in conformity with the results obtained by Kumar and Grower (2007).

Table 4: Fertilizer use efficiency for kharif paddy

Particulars	Navsari		Surat		South Gujarat	
	With SHC	Without SHC	With SHC	Without SHC	With SHC	Without SHC
Constant	4.9875	5.7032	8.8192	-0.5643	7.3674	6.6312
Area under crop (X_1) (ha)	0.2024* (0.1015)	0.1241 (0.1517)	0.1917* (0.0827)	0.1415 (0.1720)	0.0781 (0.1047)	0.1247* (0.0611)
Human labour (X_2) (man day/ha)	0.0542 (0.1492)	0.6185** (0.0963)	0.2578 (0.8455)	0.1984* (0.1033)	0.0690 (0.0911)	0.3573 (0.0651)
Bullock labour (X_3) (Pair day/ha)	0.0202 (0.0162)	0.0054 (0.0071)	0.0632 (0.0512)	0.0133 (0.0113)	0.0082 (0.0074)	0.0069 (0.0064)
Manures (X_4) (Cartload/ha)	-0.0128 (0.0136)	-0.0040 (0.0037)	0.0195 (0.0416)	-0.0489** (0.0179)	0.0040 (0.0052)	-0.0124 (0.0058)
Nitrogen (X_5) (Kg./ha)	0.2172 (0.3127)	-0.1752 (0.0597)	0.1432 (0.1843)	0.6482 (1.0146)	0.2298 (0.1995)	-0.2369 (0.1032)
Phosphorus (X_6) (Kg./ha)	0.2032 (0.1863)	0.1013* (0.0444)	0.1961** (0.0410)	0.1188 (0.4916)	0.0389 (0.0839)	0.1350 (0.0896)
Potash (X_7) (Kg./ha)	0.1054 (0.0445)	0.0001 (0.0147)	0.0351 (0.0385)	0.1558 (0.1750)	0.0704 (0.0711)	0.0368 (0.0228)
Other working Capital (X_8) (₹)	0.2418 (0.1651)	0.0219 (0.0403)	0.0309 (0.0307)	0.3948* (0.1878)	0.0006 (0.0433)	0.1005 (0.0696)
R ²	61.69	83.78	49.93	81.98	50.47	69.73

Figures in parentheses are the standard errors,

*Indicates 5 per cent level of significance,

** Indicates 1 per cent level of significance

In Surat district for with Soil Health Card farmers, all the resource variables exhibited positive effect but non-significant except, area under the crop (X_1) and phosphorus (X_6). The area under the crop (X_1) showed positive significant effect at 5 per cent, while phosphorus (X_6) exhibited positive significant effect at 1 per cent. It might be due to the fact that with Soil Health Card farmers of Surat district utilized near about quantity of phosphorus as recommended by Soil Health card.

For without Soil Health Card farmers in Surat district, human labour (X_2) and other working capital (X_8) were found positive and significant at 5 per cent and 1 per cent, respectively. The manure (X_4) was found negative and significant at 5 per cent indicating over utilization of this input. These results are in conformity with the results obtained by Patel (1986) and Hossain *et al.* (1987).

In South Gujarat as a whole for with Soil Health Card farmers, all the resource variables were found positive but non-significant. For without Soil Health Card farmers, area under the crop (X_1) was found statistically significant at 5 per cent. The manure (X_4) and nitrogen (X_5) were found negative but non-significant. On the examination of the production function analysis of Kharif paddy crop, manure (X_4) and nitrogen (X_5) were over utilized by the without Soil Health Card farmers in this region. These two variables should be judiciously used for bringing out the positive change in the Kharif paddy output.

Conclusion

An overview of the factors responsible for fertilizer use for sugarcane and kharif paddy revealed that annual total income of the farmers, one year lagged price, short term credit and educational level were found the major factors for fertilizer use in this region, whereas, for sugarcane crop, nitrogen was over utilized by the without Soil Health Card farmers in both the districts. The with Soil Health Card farmers used nitrogen judiciously as per recommendation of Soil Health Card resulted into better fertilizer use efficiency. As far as the fertilizer use efficiency is concerned for kharif paddy crop, manure and nitrogen were over utilized by the without Soil Health Card farmers in this region. These two variables should be judiciously used for bringing out the positive change in the kharif paddy output.

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