UTILIZATION OF SOIL HEALTH CARD BY THE FARMERS OF THRISSUR DISTRICT

By

RESHMI S.

(2017-11-107)

DEPARTMENT OF AGRICULTURAL EXTENSION

COLLEGE OF HORTICULTURE

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KERALA, INDIA

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THESIS

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KERALA, INDIA

2019

DECLARATION

I hereby declare that this thesis entitled **"Utilization of Soil Health Card by the farmers of Thrissur district"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, fellowship or other similar title, of any other university or society.

Vellanikkara **RESHMI S.**
(2017-11-107)

Date : 19/10/2019

CERTIFICATE

Certified that this thesis entitled **"Utilization of Soil Health Card by the farmers of Thrissur district"** is a bonafide record of research work done independently by **Ms. Reshmi S. (2017-11-107)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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We, the undersigned members of the advisory committee of **Ms. Reshmi S. (2017-11-107)**, a candidate for the degree of **Master of Science in Agriculture** with major field in Agricultural Extension, agree that this thesis entitled **"Utilization of Soil Health Card by the farmers of Thrissur district"** may be submitted by **Ms. Reshmi S.** in partial fulfillment of the requirement for the degree.

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Chapter 1

INTRODUCTION

"On world soil day we reaffirm, our commitment to making our soil healthier. When soil is in good health, our farmers get more wealth".

– Narendra Modi, Prime Minister of India (2015)

Agriculture is the lifeline of Indian society and economy as well. Around two third of the country's population depends on agriculture either directly or indirectly for their livelihood. The Green Revolution technologies in the 1960s helped in achieving self-sufficiency in food production and transformed a food deficit country into a food surplus one. This lead to agriculture renaissance based on adoption of intensive farming powered by high yielding varieties of seeds, application of fertilizers, manures, plant protection chemicals and assured irrigation. The high yielding varieties responded more to the use of chemical fertilizers and it gradually became an integral part of the Indian agriculture. However, the continued extensive use of chemical inputs in farming has resulted in problems of natural base deterioration and resurgence of pests and diseases. Soil which serves as the natural nutrient source for plant growth has been one of the critical resources that recorded continuous deterioration.

1.1. Fertilizer Consumption in India

Soil serves as a combination of minerals, organic matter, air, water and the countless microorganisms that together support life on earth. Continued degradation of soils has adversely affected crop productivity in the country. The soil health has been impaired due to emergence of multi nutrient deficiencies and falling carbon levels. The secondary and micronutrient levels removed by the crops are generally not replenished back into the soil. The wider fertilizer consumption ratios in many parts of the country resulted in nutrient imbalance in the soil. The existing NPK consumption ratio in the country has also been skewed at 8.2:3.2:1(2013-14) as against the preferred ratio of 4:2:1(Chand and Pavithra, 2015).

Thus, there exist high levels of imbalance between three major nutrient components viz. Nitrogen (N), Phosphorous (P) and Potassium (K) in soils. The imbalance is mostly attributed to problems of over use of N fertilizers and

comparatively lower use of P and K fertilizers. Moreover, the fertilizer consumption in India has been increasing over the years and currently India is the second largest consumer of fertilizers in the world after China with a consumption of 26.5 million tonnes (Sharma and Thaker, 2011). The data presented in Table 1 showed the fertilizer consumption during 2015- 2016 as 267.53 MT compared to 183.98 MT for the year 2004-2005 which accounted for an increase of approximately 45 per cent.

Table 1.1: Year wise consumption of fertilizers in India (thousand tonnes)

Year	**Consumption of fertilizers (in MT)**			
	N	**P_2O_5**	**K_2O**	**Total**
2004-05	117.14	46.23	20.60	183.98
2005-06	127.23	52.03	24.13	203.40
2006-07	137.73	55.43	23.34	216.51
2007-08	144.19	55.15	26.36	225.70
2008-09	150.90	65.06	33.13	249.09
2009-10	155.80	72.74	36.32	264.86
2010-11	165.58	80.50	35.14	281.22
2011-12	173.00	79.14	25.76	277.90
2012-13	168.21	66.53	20.62	255.34
2013-14	167.50	56.33	20.99	244.82
2014-15	169.46	60.98	25.32	255.76
2015-16	173.72	69.79	24.02	267.53

Source: Desai *et al*. (2017)

The trend in fertilizer consumption of the major states as presented in Table 1.2 also indicated that in almost all leading states consumption of fertilizers has been on an increase in recent years. Thus over dependence of chemical fertilizers to maximise the food grain production has become hazardous in the long run, deteriorating the soil health and quality of agriculture produce besides polluting the ecosystem dangerously. The excessive usage of chemical fertilizer's especially nitrogenous and phosphatic fertilizers has led to environmental problems like eutrophication, ground water pollution and soil fertility loss (Ayoub, 1999). These led to the recognition that though use of chemical fertilizers is indispensible in modern farming, an excessive use will adversely affect soil health, crop quality and farm profits.

Table 1.2: Consumption of fertilizers in major states of India

	2014- 15 (Kg/ha)				2015-16(Kg/ha)			
State	**N**	**P**	**K**	**Total**	**N**	**P**	**K**	**Total**
Kerala	20.23	8.35	11.97	40.55	21.25	7.87	14.65	43.78
Tamil Nadu	96.98	36.01	30.68	163.67	104.52	40.81	29.86	175.19
Telangana	162.52	52.71	16.20	231.43	179.23	66.97	22.71	268.91
Andhra Pradesh	146.88	60.52	29.83	237.23	135.96	65.09	24.65	225.70
Madhya Pradesh	48.68	26.35	3.14	78.17	52.45	27.66	3.49	83.59
Rajasthan	39.97	13.91	0.64	54.51	42.99	17.83	0.74	61.56
Uttar Pradesh	111.61	32.24	6.60	150.45	107.73	40.37	7.43	155.53
Punjab	179.03	43.46	4.97	227.46	185.10	53.55	9.94	248.60

(Source: GOI, 2017)

Deteriorating soil health leading to sub optimal utilization of farming inputs, injudicious application of fertilizers, low addition of organic matter and non-replacement of depleted micro and secondary nutrients over the years, has resulted in nutrient deficiencies and decrease in the soil fertility in many parts of the country.

Though this gave credentials to organic farming based on manures and botanicals as an alternative, there has been uncertainty about its ability to meet the productivity and food security needs. This invited the attention of scientists and extension functionaries to evolve suitable strategies that promote integrated and judicious use of manure-fertilizer – bio-fertilizer schedules for the sustainability of agriculture.

However, till recent past, the fertilizer recommendation for different crops was made on the basis of agronomic practices and not on the basis of soil tests. Fertility maps prepared using soil analysis, in general, are not able to provide specific information for the farm of each and every farmer. In order to enhance the soil health and increase the productivity it has become necessary to nurture the soil. It was in this context, the Government of India has launched the soil health card programme. This is aimed at the promotion of soil test based recommendation of fertilizer use which not only increases the crop production but will also help to maintain the soil productivity in a sustainable manner.

Soil testing programme was started in India during 1955-56 with the setting up of 16 soil testing laboratories in different states under the Indo United States agreement. The first soil testing laboratory of Kerala was started in the College of Agriculture, Vellayani in 1957. The department of Agriculture has at present 14 stationary and 9 mobile laboratories providing soil testing advisories in all the districts. The Government under the component of soil health management of National Mission for Sustainable Agriculture (NMSA) is also providing free soil testing services for the farming community. Various initiatives are also being organized by state governments and ICAR, its institutions and Krishi Vigyan Kendras (KVKs) to promote Soil testing in the district. Various private laboratories are also involved in soil testing services throughout the state.

1.2. Soil Health Card Scheme

The Soil Health Card scheme was launched by Government of India in 2015 and is endorsed by the Department of Agriculture and Co-operation under the Ministry of Agriculture and Farmers Welfare, Government of India. Under the scheme, government issues soil health cards (SHCs) to the farmers which contain crop wise recommendations of the fertilizers and nutrients required for the individual land

holding. This is aimed to help farmers to improve productivity through judicious use of inputs. Soil health card scheme provides qualitative assessment of soil health and reclamation measures needed for problematic soils.

Soil health card gives each farmer the soil nutrient status of his individual farm, and recommend on the dosage of fertilizers and the soil amendments the farmer is supposed to take in order to maintain the soil productivity and health in the long run. The scheme targets to issue soil health cards in every 3 years to around 14 crore farmers throughout the country. It is being implemented through the Department of Agriculture of all the State and Union Territory Governments.

The stated objectives of soil health card scheme are as follows:

1) To strengthen the proper functioning of soil testing laboratories through capacity building
2) To diagnose constraints related to soil fertility with standardized procedure for sampling uniformly across states and design taluk level fertilizer recommendation in targeted districts.
3) To develop and promote soil test based nutrient management throughout the districts for enhancing nutrient use efficiency
4) To build capacities of district and state level staff and farmers for promotion of nutrient management practices

Thus a detailed report is provided to each farmer under the scheme by monitoring the individual soil health status, which helps the farmers to choose the suitable crops for cultivation. Moreover, it enables the authorities to monitor the soil health on a regular basis. The main agenda behind the scheme is to find out the type of soil and then the appropriate measures to improve it. The programme is expected to bridge the gap between scientists, extension agents, farmers and input - output dealers effectively. It helps the transfer of technology to be more systematic, scientific, precise, easy and need based. Cost of the scheme is being shared by the central and state government in the ratio 75:25.

1.3. Soil Health Card (SHC)

The soil health card is a printed report that provides data on soil health for the optimum usage of fertilizers to cultivate crop based on soil health status. It is a field specific detailed report of soil fertility status and other important parameters that affect crop productivity. The card is also accompanied by advisory on the various fertilizers and other soil ameliorants the farmer is supposed to take. Thus provide an assessment about the major fertilizers and create a better understanding about the missing nutrients and those which could be affixed for a balanced soil. Such test-based recommendations will bring in rational and regulated use of fertilizers (Dwivedi and Dwivedi, 2007). It is made available once in a cycle of 3 years, which indicates the status of soil health of a farmer's holding for that particular period

The unique features of SHC scheme are:

- Collecting soil samples at a grid of 2.5 ha in irrigated area and 10 ha in un-irrigated areas.
- GPS enabled soil sampling to create a systematic database and allow monitoring of changes in the soil health over the years.
- Uniform approach in soil testing adopted for 12 parameters viz. primary nutrients (N,P,K); secondary nutrient (S); micronutrients (B, Zn, Mn, Fe & Cu); and other (pH, EC & OC) for comprehensiveness.
- It also provides crop wise fertiliser recommendations.
- It would also lead to crop diversification in the country.
- Government interventions to promote Soil Health Card includes extension activities like farmers training, demonstration on farmer's field, farmer's mela or camps, promotion of micronutrients and workshops are organized by State Governments.
- To enable quick soil sample testing and distribution of soil health cards, the soil test infrastructure has been upgraded and soil testing labs have been sanctioned to States.

1.4. Kerala scenario

There is an increasing concern about the sustainability of agriculture sector in Kerala in the recent times. The major problems observed were the deterioration of soil fertility due to the indiscriminate application of fertilizers and the ignorance of micronutrients. The overuse of phosphatic fertilizers over a long period had resulted in high levels of P in the soils of Kerala. There is also an acute and extensive deficiency of Ca and Mg and Boron which requires immediate intervention. Soil acidification has also reached an alarming proportion, impairing the productivity of most of the crop plants. About 90% of the soils suffer from acidity with 50% as strongly to extremely acid in reaction (Rajasekharan, *et al*., 2014).

Table 1.3: Farmers covered under SHC scheme in Kerala (2015-2016)

Sl. no.	District	Farmers covered under SHC scheme (no.)
1	Alappuzha	21013
2	Ernakulam	14512
3	Idukki	13059
4	Kannur	12480
5	Kasaragod	3693
6	Kollam	14166
7	Kottayam	10159
8	Kozhikode	13695
9	Malappuram	15521
10	Palakkad	13387
11	Pathanamthitta	6956
12	Thiruvananthapuram	21260
13	Thrissur	24766
14	Wayanad	12673
	Total	197,340

(GOI, 2017)

In this scenario, the scheme is considered as a holistic measure for soil health and farm economy. In Kerala the Soil Health Card scheme was implemented in 2015, covering, all the 14 districts. A total of 197,340 farmers were covered during the implementation of the scheme which is presented in Table 1.3

1.5. Soil Health Card Portal

The soil health card scheme portal was launched on 2015.This application software has been developed by the National Informatics Centre (NIC) with support from Integrated Nutrient Management (INM) division of Department of Agriculture and Cooperation & Farmers Welfare (DACF&W) and Natural Resource Management (NRM), division of Indian Council of Agricultural Research (Katyal *et al*., 2016).

The software has the following four modules:

a) Registration of soil samples.
b) Testing of samples in soil testing laboratories.
c) Fertilizer recommendation based on Soil Test Crop Response (STCR) equations
d) Management Information System (MIS) Report

1.6. Objectives

The study focussed on the following researchable objectives:

1. To analyse the spread and extent of use of soil health cards by the farmers of Thrissur district
2. To study the utility perception of farmers about soil health cards in crop production
3. To compare the soil management practices by different categories of soil health card users and nonusers
4. To delineate the challenges in effective implementation of soil health card scheme

1.7. Scope and importance of the study

The soil health card provides the necessary information to improve the soil health related aspects of farmers by the judicious application of both organic and inorganic fertilizers. Both central and state government has made a tremendous effort for improving soil health by launching the soil health card programme. This investigation

is of great significance in creating data based understanding of the factors responsible for utility perception, spread and the extent of use of soil health cards, and also the course of action to be taken in the future. Also, this study will suggest several implications to the farmers, implementing officers and change agents to boost the utilization of SHC by delimiting the injudicious usage of chemical fertilizers in agriculture.

1.8. Limitations of the study

The study was conducted as part of post graduate work and had the inherent limitations in time and resources. Moreover, it was based on the responses of farmers in Thrissur district of Kerala and generalizations need not be completely accurate. The common errors in social science surveys like bias in reporting the data, inadequacy of information, common limitations of statistical analysis *etc* might also have some effect on the study. In spite of these limitations, utmost care has been taken to make the study as systematic as far as possible.

1.9. Organization of the thesis

The study compiled into thesis is organized into six chapters. Chapters start with the introductory section, describing the objectives, scope, importance and limitations of the study. Review of literature in accordance with the objective is provided as second chapter. The third chapter deals with methodology followed by conducting the research. Results and discussion constitute the fourth chapter. The fifth chapter includes summary, conclusion and future line of the study and finally ends up with references, appendices and abstract of the study.

Review of literature

Chapter 2

REVIEW OF LITERATURE

Literature review, which is of paramount importance for any research is done to situate the topic under study theoretically. Here the most recent works on the concepts, methods, variables and policy implications related to the topic have been reviewed.

This chapter attempts to systematically compile existing information on important aspects of fertility status of Indian soil, trend in fertilizer consumption, soil testing scenario, soil health card and constraints in scheme implementation.Review of previous studies would help us understand the present status of research work on the topic and provide the back drop for interpreting results. Relevant studies in this area of research are presented chronologically under the following subheads.

2.1 Fertility status of Indian soils

2.2 Trend in fertilizer consumption

2.3 Soil testing scenario in India

2.4 Soil health card scheme

2.5 Constraints and suggestions in the implementation of soil health card scheme

2.1 Fertility status of Indian soils

Tiwari (2001) reported that 98 per cent of the districts in India face severe problem in Phosphorus deficiency. All indications represents that P removal will continue to exceed net P additions, and P deficiency will accentuate further with time. Phosphorus in fact, must play a much greater role in Indian agriculture than in the past. Profitable cropping by using N is a short-lived phenomenon. Sites initially well supplied with P become deficient with continuous cropping

using nitrogen alone. Increasing N application without P & K application would not be a sound proposition.

Hasan (2002) revealed that the fertility status of potassium in Indian soil can be categorized as low (21 per cent) medium (51 per cent) and high (28 per cent) and it was found that 72 per cent of India's agricultural area, requires immediate potassium fertilization.

Gupta (2005) revealed that deficiency of Zn, Fe, Cu and Mn were prominent in majority of Indian soils. Application of micronutrients can mitigate the deficiency of these nutrients. Integrated nutrient management is another step for meeting the deficiency of micronutrients in different cropping systems.

Asthana and Kumar (2008) stated that maintenance of proper soil fertility, through application of a balanced mix of various nutrients, is important for maintaining sustainable crop production levels. Soil testing is a crucial step in this direction. Results also indicates that project interventions had a significant and variable soil impact on farmers awareness of and likelihood of adopting soil testing in the studied districts.

Kibble-white *et al*. (2008) revealed that soil health is defined as an integrative property that reflects the level of ecosystem services, and the capacity of agricultural production Soil quality is considered as the main factor determining the total soil functions and health.

Pathak (2010) found that in some states such as Tamil Nadu, West Bengal and Gujarat nitrogen fertility status increased, while it declined in states such as Kerala and Orissa. In the remaining states the nitrogen status remained almost same from 1967 to 1997. In Assam, Kerala and Karnataka an increasing trend of phosphorus status was observed. In the rest of the states it remained unchanged. Available information indicated that the organic carbon content of the soil either remained static or increased in certain regions of India. Therefore, contrary to the

general perception, there has not been much depletion of fertility of agricultural soils of the country over the years.

Kinekar, 2011 reported that the Potash consumption in India during last five years (2004-05 to 2009-10) has increased by average growth rate of 10%. Average growth rate between 2001-02 and 2009-10 is 9%.

Vijayakumar *et al*. (2011) reported that soil properties pH, EC, OC and OM are the main characteristics in controlling the availability of micronutrients. These factors could be manipulated in order to combat any present or future deficiencies of micronutrients in the soils.

Deshmukh (2012) stated that the available nitrogen and phosphorus in the soils are in low category. However, higher content of K was observed in the soils. The high values of K in the soils are attributed to release of K from clays under high pH conditions besides the use of potassic fertilizers. The boron in the soil ranges from 0.02 to 14.42 ppm. Higher concentration of boron was recorded in salt afflicted soils. This is possibly the result of high soil PH, high EC, choked drainage, limited leaching and clay texture of the soil in the area. Fertilizer recommendations on the basis of soil test data can be done for maximum crop yield.

John *et al*. (2013) reported that the overall nutrient status of Pathanamthitta district indicated that the soil was strongly acidic with high content of organic C, available P, exchangeable Ca and S, medium to high K and Mg and 100% sufficiency with respect to Fe, Cu, Mn, and Zn. The small extent of Mg and B deficiency noticed in some blocks of the district can be rectified through the application of dolomitic limestone and borax respectively. As the practice of soil based application of manures and fertilizers including secondary and micronutrients in cassava undertaken both on station and on farm was found promising due to saving of N and K fertilizers to the extent of 50-90% and P to 100%, it can be recommended and validated not only for tuber crops but also for

other crops in the district of Pathanamthitta. This in turn can convince the farmers on the need based application of nutrients not only to enhance their income but also to sustain soil health.

Kumar *et al*. (2013) reported that the physico-chemical characteristics and nutrient status of soil in Muzaffarnagar district of Uttar Pradesh indicates that soil of study area were neutral to strongly alkaline in reaction and non-saline in nature. A positive and significant correlation of NPK and micronutrients was found with organic matter content while significant and negative correlations exist between micronutrients and soil pH.

Dinesh *et al.* (2014) revealed that high soil P levels would cause a cascading effect, wherein P loads would affect the availability of a nutrient which in turn would affect the cycling of another nutrient, thereby triggering a chain reaction which would predispose the crops to pests, diseases and other physiological disorders resulting in total crop failure.

Kumar *et al*. (2014) revealed that Vertisols of Kabeerdham district in Chattisgarh showed low levels of available N and P and high level in available K. Hence, the soil requires attention regarding integrated nutrients management (INM) approaches and regular monitoring for soil health for better productivity and sustainable agriculture.

Kavitha and Sujatha (2015) concluded that in Thrissur district, the soil fertility status of the soil varied between different agro ecosystems. Among the various cropping systems, status of Nitrogen, Phosphorus and Pottassium was higher in rubber plantations. An acute deficiency of pottassium was noticed in arecanut while the deficiency of Sulphur was noted in rubber, vegetables and pepper. High accumulation of Phosphorus, acute deficiency of Boron and relatively higher levels of Fe, Cu, Zn and Mn were observed in all the agro ecosystems. However, site and crop specific amendments are recommended for enhanced productivity in all the agro ecosystems.

Mini and Usha (2015) reported that the overall fertility status of Onattukkara region indicated that the soil was strongly acidic with high level of P and low organic carbon and K. Excess levels of P and wide spread deficiencies of Ca, Mg, B and Zn are the major limitations to crop production in the region. Management of soil acidity is needed for successful crop production in this region. Liming of acidic soils in accordance with soil test results is highly essential.

Patel *et al.* (2015) reported that in the Raipur area, all types of soils were found to be high in Fe, Mn, S and moderate levels of Cu and low level of Mo and Zn. The relative abundance of micronutrients in soils of this region is found in following decreasing order as S >> Mn > Mo > Cu >> Zn ≈ Fe. The adverse effects *i.e.* chlorosis of young leaves, premature fall of fruits, necrosis, stunted growth of crops of this region are frequently seen may be due to either Fe and Mn toxicities or Zn deficiency or their combination.

Srinivasarao *et al.* (2015) revealed that critical appraisal of soil fertility in India with changing time trends states that Indian soils do not have enough P to meet the demands of existing high yielding crops of this era. The phosphorus use efficiency can be improved by following '4R nutrient management approach' through selection of right fertiliser of right amount to be applied at right time to meet the crop demand by right application method.

Bandypadhyay *et al*. (2016) reported that soil health deterioration is at an alarming situation in the North eastern regions of India facilitated by severe soil erosion on hills by deforestation and shifting cultivation and flood hazards in Brahmaputra valley regions. The region is by and large rain-fed and mono-cropped in most of its parts, responsible for steady decline in soil fertility status. Strong soil acidity in hill regions coupled with depletion of soil nutrient status (mainly nitrogen, phosphorus and zinc) in valleys are the major soil health concerns. Periodic monitoring of soil health status should be regulated by soil resource inventory at large scales and site specific nutrient management.

Chandrakala *et al.* (2017) reported that continuous application of phosphorus results in buildup of this nutrient in the soil. The buildup of phosphorus depresses the availability of Zn and S. However, when nutrient additions are less than the requirement, the crop draws the soil nutrients. With such continuous withdrawals, the native resources diminish with time. Therefore, application of soil based rather than uniform rates of fertilizers is must.

Dey *et al*. (2017) found that phosphorus deficiency is widespread in the Indian as well as world soils and estimates forecast for no P-reserves by 2050; as such India does not have adequate reserves of rock phosphate posing threat to sustainable crop production. In case of K, total K as well as various forms of K are adequate in majority of the regions of India as well as worldwide

Kumar *et al*. (2017) reported that the current nutrient status of available N, P and K deficiency in soils of the Koriya district has been found as 93.00, 76.00 and 16.00 per cent respectively. A substantial share of soils which are characterized over the deficiency needs special attention because improper management of these soils may again result in deficient category.

Ramamurthy *et al.* (2017) revealed a declining trend of Potassium in majority of the soils in India. High crop potassium removal than potassium addition by farmers and imbalanced use of the NPK fertilizers contributed to large scale potassium deficiency in soils. Widespread K deficiency was observed in rice-wheat system of Indo-Gangetic plains, plantation, horticultural as well as ornamentals plants. The current fertilizer recommendations are obsolete, very much generalized without considering the soil types, hence need immediate revision and revalidation. Site-specific fertilizer recommendations, if followed can minimize the fertility potassium depletion and maintain productivity and sustainability to some extent.

Shyju and Kumaraswamy (2017) reported that availability of nitrogen and potassium is medium in the Talapilli taluk of Thrissur District among primary

nutrients and magnesium is low and sulphur is high among secondary nutrients and the micro nutrients are all high in the taluk except few places in minor proportion.

Gurav *et al*. (2018) reported that in Indian soils even in black soils the available potassium status showed gradual decline from medium to low level. These trends were due to low application of potassium fertilizers by the farmers, misapplication of potassium recommendation and imbalanced use of NPK fertilizers. The present fertilizer recommendation is very old and is still being used, which needs immediate revision and revalidation.

Prasad *et al*. (2018) reported that the coffee productivity in Idukki district of Kerala is facing severe problems due to the prolonged higher acidity (98 per cent) of soils with deficiencies of P (42 per cent), Ca (39 per cent), Mg (88 per cent), S (39 per cent) and B (39 per cent).The majority of area in coffee is strongly acidic (67 per cent) due the prolonged use of acidic fertilizers and low addition of lime to the soil.. Deficiency of Ca and Mg affects intake of other nutrients. In coffee, B deficiency will results in poor flowering and fruit set. Amelioration of soil acidity and optimal use of macro and micronutrients are must to enhance the productivity of the district.

2.2 Trend in fertilizer consumption

Devi *et al*. (1991) concluded that during the period from 1960 to 1987 the growth rate in the consumption of N, P_2O5 and K_2O in Kerala was of the order of 5.3, 5 and 7 per cent, respectively, with potassium consumption increasing at the fastest rate. The increase in nutrient consumption is more due to intensification of farming rather than an extension of area under cultivation.

Hossain and Singh (2000) concluded that the increase in fertilizer consumption is proportional to the growth in demand for staple food grains. In the developed countries, as the population has become stationary fertilizer consumption has started declining and consumers are substituting high-price

better quality food for staple grains but in case of developing countries, however, population growth is still rising and food needs of a large proportion of the people are yet to be fully met. As the demand for food grains increases with growing population and the increase in per capita consumption of cereals, fertilizer consumption is expected to increase further in the low income countries of Asia.

Ramasamy (2004) studied the fertilizer consumption pattern in India. The fertilizer consumption was 25.75 kg. per hectare during 1970s and it increased to 78.43 kg. per hectare during 1990s registering a growth rate of 3.94 per cent per annum between 1990-91 and 2000-2001. There was however a notable disparity in fertilizer use among the states during 1970s and 1980s and the variation has declined marginally during 1990s.

Bala *et al*. (2005) concluded that the growth rate for fertilizer production was 10.6% but the consumption of fertilizers increased at the rate of 11% over the time period. Among the factors affecting fertilizer consumption, subsidy was found to be the most important factor followed by area under high yielding varieties and gross irrigated area. Farmers should be exhorted to follow balanced use of fertilizers, increasing area under high yielding varieties and harnessing available irrigation potential

Prasad (2009) found that fertilizer consumption increased 322 times in India during the 1950–51 to 2007–08 period. However, fertilizer use efficiency has been very low in Indian agriculture. Large applications of fertilizer N not only impair groundwater quality but also have profound deleterious effects on the environment through gaseous emissions of NH3 and NOx.

Jaga and Patel (2012) found that the fertilizer use has generally been higher in northern (91.5 kg/ha average) and southern (85.3 kg/ha average) region and lower in the eastern (44.7kg/ha) and western region (40.7 kg/ha) of India

Shukla *et al*. (2012) reported that All India Coordinated Research Project on ‘Micro and Secondary Nutrients and Pollutant Elements in Soils and Plants’

nearly 49, 15, 6, 8, 11 and 33% samples were found to be deficient in zinc, iron, manganese, copper, molybdenum and boron, respectively, across the country and hence all contribute towards poor soil health

Mala (2013) revealed that the efficiency of fertilizer use could be improved through fertilization practices that include an application of macronutrients and micronutrients according to crop requirements. An adequate supply of credit for farmers and distributors is necessary to ensure the availability of fertilizers when and where they are required.

Chand and Pavithra (2015) reported that optimum and balanced use of fertiliser in India requires higher use of N, P and K in Chhattisgarh, Jammu and Kashmir, Kerala, Madhya Pradesh, Maharashtra, Uttarakhand, West Bengal; higher use of P and K in Bihar, Haryana, Jharkhand and Odisha; higher use of P in Assam, and higher use of K in all the states except Assam. Optimum use implies a reduction in the use of N in Punjab, Haryana, Bihar, Jharkhand, Andhra Pradesh and Assam, and a reduction in the use of P in Andhra Pradesh, Gujarat, Punjab and Tamil Nadu.

Karunakaran (2016) found that among six crops selected, rubber and banana cultivators used overdose of chemical fertilisers, lower use of organic manures and lime showing ineffective application of fertilisers compared to other four crops. The overuse of total NPK fertilisers in the rubber plantations compared to the suggested dose in contrast to very low NPK soil fertility status in the rubber cropping system is a paradox in the agrarian economy of Kerala.

Lenka *et al*. (2016) reported that the imbalance in fertilizer use is required to be corrected for minimising soil degradation. In this direction, technology on fertilizer recommendations based on soil test is to be propagated extensively to the farmers by demonstrations

Bhagyamma and Bhat (2017) found that NPK usage pattern in Dharwad district had negative growth rate (-5.77%) over the years (2004-2015). Amongst

all the three major nutrients, usage of phosphatic fertilizer showed highest negative growth (-7.70%) followed by nitrogen (-3.95%) and potassic fertilizer (-3.39%)

Kumar and Indira (2017) revealed that there is a long run relationship between fertilizer consumption and food grain production in India. Due to this, the fertilizer consumption increased at a higher rate in the early years. With the introduction of new agricultural policy where greater emphasis is given on promotion of organic cultivation, there is a considerable reduction in the growth rate of chemical fertilizer consumption after 2000-2001.

Ramamurthy *et al*. (2017) reported that the amount of N, P and K fertilizers applied over period in Indian agriculture indicated that K fertilizers were applied in much lower dose with wide ratios of N and P. The fertilizer consumption of N increased from 1.4 to 85 kg/ha from 1960 to 2010 whereas P consumption increased from 0.2 to 18 kg/ha during the same period. The K application was still below

Tewatia *et al*. (2017) reported that the inherent soil fertility seems to be poor and the nutrient input is low and also there is growing evidence of increasing deficiency of P and K, aggravated by the imbalance application of higher doses of N in relation to P and K

Bagal *et al.* (2018) concluded that farmers were irrational in both usage and purchase of fertilizers. The quantity of fertilizer applied per hectare dependent on the type of crops grown and almost all the farmers apply more dosage of fertilizer than recommended. The NPK ratio applied was not in accordance as compared to the recommended. While estimating the preference for purchase, the farmers stated the easy availability, brand and price irrespective of nutrient composition of fertilizers. It is therefore, imperative that farmers need to be trained to use fertilizers in the right proposition and timely information should be given about different forms and kinds of fertilizers that are available.

2.3 Soil testing scenario in India

Srivastava and Pandey (1999) reported that without knowing the fertility status of their fields, majority of the farmers are continuously applying larger quantities of chemical fertilizers in order to increase the crop production

Rao and Sanjay (2000) reported that nowadays, a rising trend in fertilizer usage is seen, which in turn increases the unit cost of cultivation. Mostly native soil fertility status and the prior estimation of the nutrient requirement of crops have been ignored. Soil test based fertilizer use is inevitable for sustainable agriculture

Ray *et al*. (2000) revealed that overuse of fertilizers by the farmers in the fields without adequate knowledge on the soil fertility status and nutrient requirement of the crop will adversely affect the soil and crop by causing nutrient toxicity or deficiency either by overuse or underuse.

Ahmed *et al*. (2002) reported that site specific fertilizer recommendations are needed for soils of varying fertility status, resource conditions of farmers and levels of targeted yield for similar soil classes.

Biswas (2002) reported that the soil testing is a proven scientific technique to evaluate the fertility of soil and recommending balanced application of nutrition to crops. However, in India, the soil testing programme has failed to make the desirable impact on the farming population due to extremely poor coverage and delay in the timely dissemination of fertilizer recommendation to the farming community.

Doran (2002) reported that the indicators of soil health and strategies for sustainable management must be connected to the development of management systems that foster reduction in the inputs of nonrenewable resources, maintain acceptable levels of productivity and minimize the impact on the ecology.

Yadav *et al*. (2006) reported that farmers had adequate knowledge regarding the importance of soil testing. But their attitude towards soil testing programmes was unfavourable. The efforts should be made jointly by the KVK and Agriculture department to encourage the farmers in adoption of soil testing practices by conducting training programmes and campaigns regarding soil testing. If possible, mobile soil testing laboratories should visit the villages to test the soil samples at their doorsteps in the villages itself. By doing this, the reliability of soil test results could be increased among the farmers widely in future for better farming.

Pagaria (2011) reported that farmers know the benefits of soil testing like they agree with the statements like soil testing is necessary for better crop production, impact of recommended material is always positive and expenditure of crop production decrease after soil testing, but simultaneously they told that it is a very long process; result of soil testing are not reliable; and results are not given timely. This study indicates that farmers have willingness to adopt soil testing method but they face some minor problems which can be solved if government and other agencies took some steps.

Dey, 2012 reported that the soil test based fertilizer application helped to obtain higher B:C ratios. It is evident that STCR based approach of nutrient application has definite benefits in terms of increasing nutrient use efficiency over commonly recommended dose of nutrient application.

Lalatendu *et al*. (2014) revealed that aggregate adoption s of farmers was found to be medium level. Use of compost (42.22%), application of soil amendment (38.88%) and soil testing and application of micronutrients (37.78%) were adopted by maximum number of farmers. On the other hand use of super phosphate in compost pit (80%), application of sulphur (67.78%) and use of bio-fertilizers (66.66%) were rejected by farmers. Major constraints in adoption include difficulty in understanding soil test recommendations, lack of awareness and non-availability of inputs.

Majumdar *et al*. (2014) reported that the GIS based fertility maps, based on soil sampling at 100 m^2 grid, helped to estimate fertilizer requirement in farmer's fields that resulted in comparable crop yield and profitability with soil-test based fertilizer recommendation for individual field.

Dwivedi and Meena, 2015 reported that of the total installed analysing capacity of 17.83 million samples, 13.52 million samples were analysed during 2014-15 indicating an average capacity utilization of 75.8% .Therefore, the target of 10 million samples set for the year, 2015-16 will have to be accomplished utilizing existing infrastructure. However, quality of soil testing and timeliness of reporting will be crucial for distribution of targeted number of soil health cards to the farmers.

Kumar *et al.* (2015) reported that application of recommended doses of fertilizers based on soil test results showed similar yields in paddy as that of farmers practice and there was a net savings in the cost of phosphorus fertilizers applied per hectare to the extent of Rupees.1448.

Saha *et al*. (2016) revealed that the main advantages of soil health card reported were to prevent the injudicious application of chemical fertilizers and to prevent the contamination of water bodies. It also ensures balanced nutrition to crops and helps in improving the productivity and reduces the cost of inputs for cultivation.

Ramamurthy *et al*. (2017) reported that the soils of agro climatic zones vary widely and their behaviour and response to management also differs. It was also observed that efficiency of fertilizer application varied within each zone and within the management units. These differences will results in the errors of both excess and insufficient applications. Besides in all farming situations there is a continuous removal of secondary and micronutrients by crops resulting in inappropriate management practices. All these suggest that soil test based fertilizer recommendations should be preferred to obtain precision in farming and

to maximise the crop productivity, and for the maintenance of soil health and to minimize the misapplication of fertilizers.

Beena *et al*. (2018) reported that the existing Package of Practices recommendations for cowpea in Kerala does not consider the fertility variations in the field and plant uptake from soil and fertilizer, as it does not take into account the fertility differences of the soil, resulting in injudicious application of fertilizer nutrients.

Bodake *et al*. (2018) reported that as the agricultural productivity is mainly dependent on soil condition which in turn depends upon nutrient status of the soil. So, there is need of soil testing system. Based on soil analysis fertilizer should be recommended to the farmers in order to increase crop productivity and in turn increase the financial status of the farmers.

2.4 Soil health card scheme

Yadav *et al.* (2006) found that majority of the farmers (82 %) had knowledge regarding the soil testing practices and 18 % of the respondents had no knowledge about the soil testing practices. The knowledge about soil testing practices had been found satisfactory. And the results also revealed that majority of the farmers did not know the locations of the soil testing laboratories.

Bhatt *et al*. (2009) revealed that all the SHC beneficiaries were aware about various aspects of soil health card like major nutrients (N, P & K), soil PH and soil EC, while 74.00 per cent were aware about irrigation water analysis and only 20.00 per cent were aware about analysis of sulphur.

Chouhan *et al.* (2012) reported that soil health card scheme was reported to be highly useful for the farming community in terms of increasing their net income. However, there is a need to create awareness regarding the benefits of this scheme among the farmers on one hand and strengthening of soil testing

services on the other hand for a wider adoption of the recommended dose of fertilizer.

Patel and Chauhan (2012) revealed that 35.00 per cent of farmers had neutral attitude towards soil health card scheme, while 20.00 per cent of the farmers had strongly favourable attitude and around 17.00 per cent of farmers had unfavourable attitude towards the programme. Rest of them (11.00) per cent had favourable attitude, respectively.

Patel (2013) revealed that majority (86.67) of the farmers had medium level of knowledge regarding soil health card programme, followed by 08.00 per cent,03.33 per cent and 1.33 per cent of them had low, very low and very high level of knowledge regarding the soil health card scheme respectively.

Chowdary (2015) in his study reported that annual income, scientific orientation, perception of soil health, interest to learn about SHM, satisfaction index and follow-up of SHC recommendations were some of the factors determine the use of soil health card recommendation by the farmers.

Sharma *et al*. (2015) reported that adequate field staff with trained personnel's should be kept at village level and method demonstrations as well as result demonstrations of these recommendations may be taken up in farmer's field for its wide adoption among the farming community.

Chowdary and Theodore (2016) reported that among adopters of SHC recommendations, cent percentage of the farmers had adopted the SHC recommendations as such, without any deviation. Whereas, among non-adopters, an overwhelming proportion (92.45%) of farmers fell under excess adoption category. Inadequate follow-up by extension agency was the foremost constraint expressed by majority of the respondents.

Pandya and Timbadia (2016) revealed that more than half (66.00 per cent) of the farmers had most favourable attitude towards soil health card scheme.

While, 22.00 per cent, 10.00 per cent, and 2.00 per cent, farmers had favourable, neutral, and unfavourable attitude towards the programme respectively.

Sali *et al.* (2016) found that the majority of respondents 48.00 per cent had high level of knowledge about soil test recommendations, only 34.00 and 18.00 per cent of the respondents having medium and low level of understanding about soil testing, respectively.

Chouhan *et al.* (2017) analysed the impact of soil health card programme on farmers income by analysing the economics of cultivation of three major crops paddy, soybean and maize in Madhya Pradesh. It was found that soil health card scheme showed a positive result in increasing their income.

Makadia *et al*. (2017) revealed that the extent of over utilization of nitrogenous fertilizer for sugarcane and kharif paddy crops found to be lower for farmers with soil health card as compared to farmers without card. The extent of under utilization of phosphatic and potasic fertilizers were less for farmers having soil health card as compared to farmers without soil health card for sugarcane and kharif paddy crops. The paired 't' test analysis showed positive and significant impact of Soil Health Card on per hectare yield of sugarcane and kharif paddy crops. Generally, the farmers with soil health card utilized the fertilizers judiciously as per the recommendations given in the card.

Patel *et al*. (2017) reported that 52 per cent of the respondent belonged to high to very high category with respect to knowledge of soil testing and perception to use soil health cards in advance agriculture system.

Reddy (2017) found that at the national level 82.20 per cent of the farmers were aware of SHC. Awareness level was found to be good in South, West, Central and Eastern zones, with about 80 to 90 per cent of awareness. The high awareness in some zones could be attributed to the proactive nature of the state in the SHC initiative.

Charel *et al*. (2018) found that majority (70.83 per cent) of the SHC holders had moderate level of perception regarding the programme followed by (15.00 per cent) and (14.17 per cent) possessed good and poor level of perception about Soil Health Card Scheme, respectively.

Jaiswal and Singh (2018) reported that the perception of farmers of the relevance of technologies i.e. SHC was not only affected by the basic characteristics of the farmers but also by the level of awareness.

Mukati (2018) reveals that, out of 81.19 per cent of soil health card holders, majority of the respondents i.e. 55.66 per cent received the information regarding soil health card from the RAEO (Regional Agriculture Extension Officer) followed by KVKs (21.36 %), friends or neighbours (12.83 %) and from other sources (10.25 %)

Naruka *et al*.(2018) found that maximum no. of respondents possess medium level of knowledge about soil health card (58 %) followed by 26 per cent of the respondents with low level of knowledge and only 16 per cent respondents had high knowledge regarding the soil health card

Padmaja and Angadi (2018) reported that mere distribution of soil health card will not serve the purpose of the scheme, sustained efforts are needed by the extension machinery to convince the farmers to use recommended doses for obtaining sustainable yields over a period of time.

Gupta *et al*. (2019) revealed that the efficacy of the SHC depends on a three-step process, namely (i) collection of representative soil samples and farmers' inputs about their fields, (ii) reliable chemical analysis of the soil samples in a timely manner, and (iii) development of soil test based recommendations. Any dislocation or delay in the three-step process could easily render the SHC service ineffective.

2.5 Challenges and suggestions in the implementation of SHC scheme

Chouhan *et al.* (2012) revealed that the challenges faced by the farmers in adoption of the soil health card scheme included high cost of fertilizers, low reliability of soil testing results, and long distance to soil testing laboratories.

Patel and Chauhan (2012) revealed that 91 per cent of farmers expressed difficulty in identifying micronutrient deficiency due to unavailability of micronutrient status of soil. 88 per cent of them expressed difficulty in calculating the dosage of fertilizer on the basis of nutrient status. 84 per cent of them expressed that soil health cards were issued after harvesting of crops. 82 per cent expressed that time taken between soil sampling and issuing cards to the farmers was too high, 65 per cent expressed problem of unavailability of internet facility at village level and 23 per cent of them expressed that collection of soil sample was not done in presence of farmers.

Patel (2013) reported that majority of the farmers had suggested that there should be crop wise recommended dose of fertilizer and micronutrient status displayed in soil heath card and the cards should be issued prior to crop season, farmer should be trained to take soil sample of their own soil, soil testing laboratory should be established at taluk level with highly qualified supporting staff , internet facility should be provided at village level and soil sampling procedure should be done in presence of farmer.

Chowdary and Theodore (2016) reported that farmers needed quick distribution of Soil Health Cards (96.0%), followed by follow-up by extension agency (84.0%), all farmers to be covered under the Bhoochetana project (71.0%), conduct of more number of demonstrations (28.0%), training on soil sampling and use of SHC results (13.0%), and weekly once visit by AEO to the farmer's fields (6.0%). He also found that majority of farmers discontinued adoption of soil health card recommendations during the five years, since inception of Bhoochetana project.

Sali *et al*. (2016) reported that due to the lack of knowledge about nutrient management, among farmers the soil test report was not clear to the respondents and this was found to be a major constraint of majority of the farmers.

Patel *et al.* (2017) reported that in the Petlad taluk region around one third respondents reported very low to low adoption of the recommended technology. These respondents reported that the challenges which limited the extent of their adoption of this technology were difficulty in understanding of soil testing , Delay in getting the test reports on time , Difficulty in following test based fertilizer recommendation ,No proper and scientific guidance *etc.*

Mukati *et al*. (2018) reported that 64.10 per cent of the farmers faced difficulty in calculating fertilizer dose on the basis of nutrient status of soil and 55.56per cent of the respondents responded that the task of collection of soil sample was not done in presence of farmers and 51.28 per cent revealed that the time lag between soil samples taken and issuing cards was too long.

Naruka *et al.* (2018) revealed that majority of farmers (70 percent) expressed difficulty in having knowledge about the importance of micronutrients. 68 percent of them expressed difficulty in the aspect that the prices of fertilizers are too high. While 58 percent farmers expressed their view on non-availability of organic manure.

Niranjan *et al*. (2018) revealed that the major problems reported by the majority of soil tested farmers were found to be difficulty in calculating the required quantity of fertilizers as per SHC (87 %)followed by high price of fertilizers (79 %), lack of training (74 %), recommended fertilizers not available in adequate quantity in the local market (63 %), lack of knowledge about method of collecting ideal soil sample(56 %), lack of technical guidance on method and time of fertilizers application (53 %), lack of capital to purchase fertilizers (34%), incredibility of soil test results (47 %), soil testing laboratories are located far away (45 %).

Research Methodology

Chapter 3

RESEARCH METHODOLOGY

Research methodology has been defined as the systematic and theoretical analysis of the procedures applied in the field of study. Methods and procedures followed in the study are described in this chapter. In order to accomplish the objectives of the study, appropriate data collection tools and analytical methods were employed and the details are presented under the following subheads.

3.1 Research design of the study

3. 2 Locale of the study

3.3 Sampling procedure

3.4 Selection of variables

3.5 Operationalization of variables

3.6 Measurement of variables

3.7 Tools for data collection

3.8 Statistical framework for analysis of data

3.1. Research design of the study

The overall framework in which the study is conceived and conducted is termed as research design. Research design as defined by Kerlinger (1964) is a plan which describes how, when and where data are to be collected and analysed, by which the foundation for conducting the research is laid.

As the major objective of the study is to analyse the spread and extent of use of soil health cards (SHCs) by the farmers, *ex-post facto* design of research was employed. *Ex-post facto* research is the systematic empirical enquiry in which the scientist does not have any direct control over the independent variables because they have already occurred or they are inherently not manipulative (Robinson, 1976).

3.2. Sampling Procedure

Thrissur district, which covered maximum number of farmers under the soil health card (SHC) scheme among the 14 districts of Kerala, was purposively selected for the study. Details of the SHC distribution recorded from the Department of Soil Survey given as Appendix IV.

3.2.1 Brief description of the study area

Thrissur district is situated in the southwestern India (10.52ºN 76.21ºE) and is the central part of the state of Kerala. It is bounded on the north by Malappuram district, on the northeast by Palakkad district, on the east by small parts of Coimbatore district of Tamil Nadu, on the south by Ernakulam and Idukki district and on the west by Arabian Sea. It accounts for 7.8% of the area of the state. Total area of the district is 3032 sq.km. The district has five taluks viz. Chavakkad, Talappilly, Thrissur, Kodungallur and Mukundapuram which comprises 17 blocks that spreads over a total of 97 panchayaths and 7 muncipalities. Demographically it has a population of 3,110,327 as per 2011 census and the male population is 1,474,665 while female population is 1,635,662. The literacy rate of the district is 95.32%. The district is traversed by five main rivers viz. Periyar, Chalakudy, Karuvannur, Kurumali and Ponnani. Major crops grown in the district are paddy, coconut, arecanut, vegetables banana and rubber.

Soil is mainly laterite in origin though sandy, alluvial and forest soils are also seen in certain belts. Sandy soil,which is deficient in almost all plant nutrients is mainly seen in coastal belts of Chavakkad and Kodungallur. Forest soil is confined to some parts of Thalappilly, Thrissur and Mukundapuram taluks. Alluvial soil which is rich in organic matter are generally found in the low lying areas of Thrissur and Mukundapuram taluks

Climate is tropical monsoon type with hot summer in the months of March to May. The average temperature is about 27.6º C. The hot season is followed by the South-West monsoon season from June to September. The period from

October to November is the north east monsoon season. About 3000 mm of precipitation is received annually. Relative humidity fluctuates highly in the district, ranging from 72 per cent to 95 per cent of maximum mean and 38 per cent to 80 per cent of minimum mean.

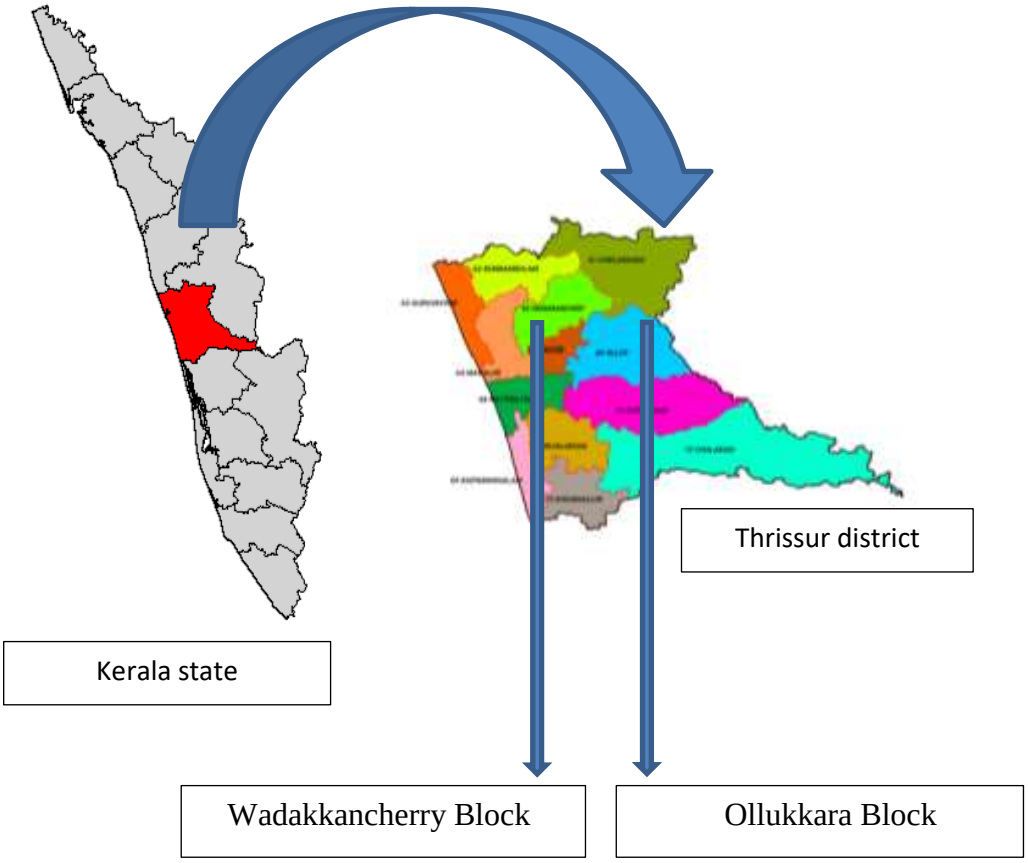


Figure 1 .Map of the study area

3.2.2 *Selection of Block:* Survey was conducted during the period 2019. Out of the 17 blocks in Thrissur district, two blocks namely Wadakkancherry and Ollukkara were purposively selected for the study as these blocks had the maximum number of soil health card holders during 2015-2016 as per the list provided by the Department of Soil Survey which was the implementing agency of the SHC

scheme in Thrissur. The details of SHC distribution among farmers are appended as Appendix V and the study area is given as Fig. 1.

3.2.3 *Selection of respondents*: The sample of respondents included 150 farmers and 30 SHC scheme implementing officers selected from the district following simple random sampling. Soil health card holders, 30 numbers each, were randomly selected from Wadakkancherry and Ollukkara blocks as per the list provided by Soil Survey Department. In order to have a comparative analysis, 30 farmers who had no enrolment in the SHC scheme were also chosen from the respective blocks. Another 30 paid soil health card users from Thrissur district but were not members of the SHC scheme were also randomly selected. List collected from Radio Tracer Laboratory (RTL) of Kerala Agricultural University which provided SHCs based on soil analysis on payment basis was used for the selection of paid SHC users. Constraint analysis of the SHC scheme implementation was based on the responses of 30 scheme implementing officers who were randomly selected from the Soil Survey and Soil Conservation Department working in the selected blocks. The sample plan followed in the selection of respondents is presented as Fig. 2.

3.2.4. *Categorization of farmers based on SHC use*: During data collection it was found that those farmers who were enrolled under the SHC scheme and from whom soil samples were collected, did not receive the SHC results on time. Therefore the respondents under the study were categorised based on SHC use into four classes viz, participant SHC scheme users (30), participant SHC scheme non-users (30), Paid SHC users (30) and Non-participant SHC non-users (60). Comparison of soil management practices by these different categories of soil health card users and non-users was also attempted in the study.

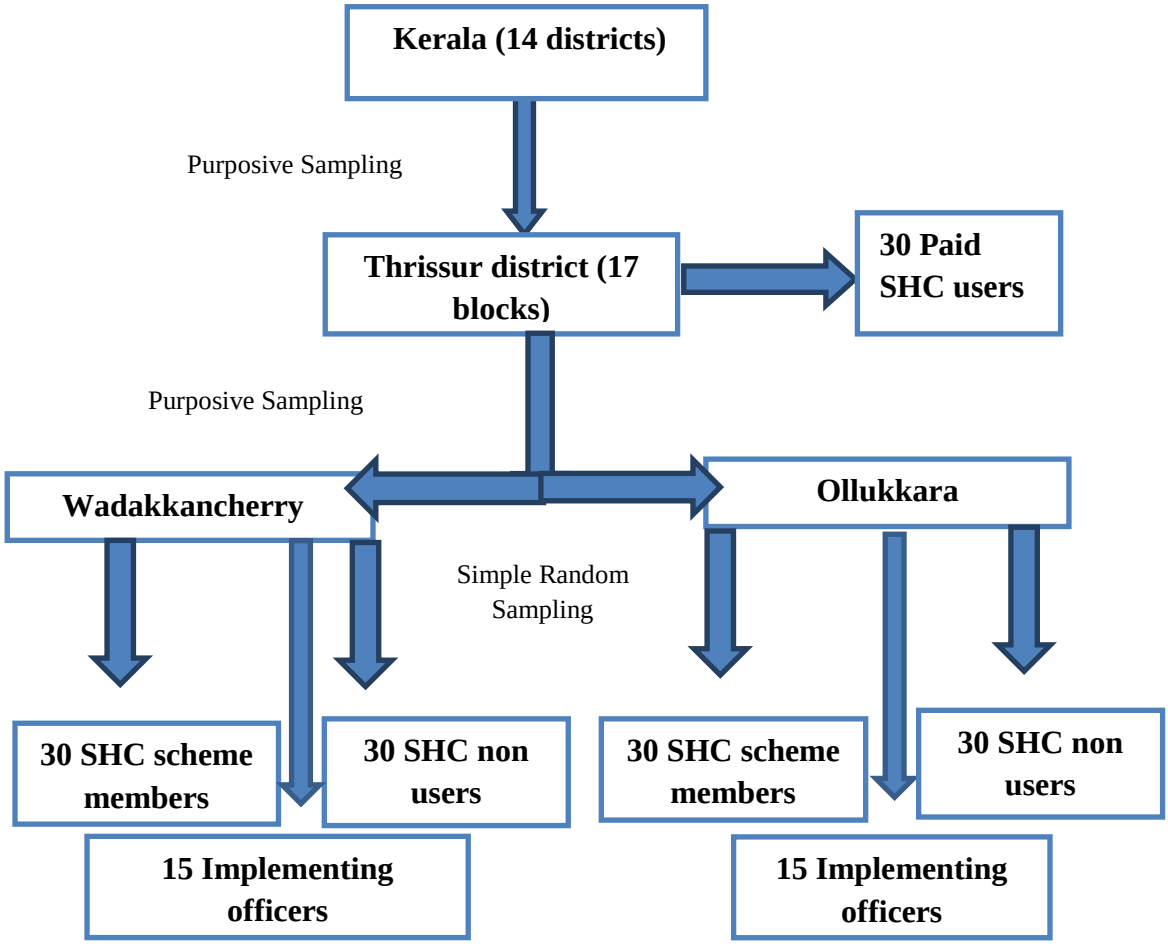


Figure 2. Sample plan showing selection of respondents

3.4 Selection of the variables

Based on the specific objectives of the study and review of literature, independent and dependent variables were selected for the study. The selected independent variables and the method of measurement adopted are presented as Table 3.1.

Table 3.1 Details of independent variables selected for the study and their measurement

Sl. no	Variable	Method of measurement
Independent variables		
1	Age	Number of years of completed life
2	Education	Scoring procedure followed by Anupama (2014)
3	Farm size	Scoring procedure followed by Jaganathan (2004)
4	Farming experience	Scoring procedure followed by Jayasree (2004) and modified
5	Annual income	Scoring procedure followed by Sivaprasad (1997) and modified
6	Exposure to training	Scoring procedure followed by Sasidharan (2015)
7	Social participation	Scoring procedure followed by Jasna (2015)
8	Scientific orientation	Scale followed by Supe (1969)
9	Irrigation facility	Scoring procedure used by Narbaria (2013)
10	Leadership	Scale used by Nandapurkar (1980) and modified

3.5 Operationalization of independent variables

An operational definition is a specification of the activities in measuring a variable or in manipulating it (Kerlinger, 1964). The operational definition and scoring method used to quantify and categorise the variables selected for the study are explained under the following sub heads.

3.5.1 Age

Age has been operationalized as the number of calendar years completed at the time of interview. The respondents were categorized into three groups by slightly modifying the method followed in the Census of India (Government of India, 2011). Each group was assigned scores as given in the table below for quantifying the relationship with dependent variables.

Sl. No.	Age category	Score
1	Younger (40 - 55 years)	1
2	Middle age (56-66 years)	2
3	Old (> 66 years)	3

3.5.3 Educational status

Education forms a critical variable that is instrumental in bringing desirable changes in the behaviour of an individual. Education status has been operationalized for the study as the years of formal education obtained by the respondents in terms of their level of schooling. The respondents were categorised into four classes and the scores are presented in the following table.

Sl. No.	Education level	Score
1	Primary (Up to 7^{th} standard)	1
2	High school(8^{th} to10^{th} standard)	2
3	Higher secondary (11^{th} and 12^{th})	3
4	College and above (graduate)	4

3.5.4 Farm size

Farm size has been operationally defined as the total area of cultivable land owned by the farmers. The categorization used by Jaganathan (2004) was adopted to classify the farmers based on farm size and scores were assigned as given in the table below.

Sl. No.	Farmer category	Farm size (ha)	Score
1	Marginal farmers	< 1.00	1
2	Small farmers	1.00 -2.00	2
3	Semi-medium farmers	2.00 -4.00	3
4	Medium farmers	4.00-10.00	4
5	Large farmers	> 10.00	5

3.5.5 Farming experience

Farming experience was operationally defined as the years of engagement in farming activities of farmers measured in terms of number of years at the time of investigation. Scoring procedure used by Jayasree (2004) was adopted and the farmers were classified into three categories based on their years of involvement as given in the table below.

Sl. No.	Farmer category	Experience	Score
1	Low farming experience	< 5 years	1
2	Medium farming experience	5-10 years	2
3	High farming experience	>10 years	3

3.5.6 Annual income

Annual income was operationally defined as the total income earned by the respondents in rupees and other family members from agriculture and other sources on a yearly basis. Scoring procedure followed by Sivaprasad (1997) was adopted with modification, as given below.

Sl. No.	Annual income (Rs.)	Score
1	Below 0.5 lakh	1
2	0.50 – 1.0 lakh	2
3	1.0 – 2.0 lakh	3
4	2.0 – 3.0 lakh	4

3.5.6 Exposure to training

Exposure to training was operationalized and measured as the frequency and number of training sessions on soil and other natural resource management attended by the farmers as recollected by them. This followed the adaptation of the scale used by Sasidharan (2015) and the scoring pattern adopted is presented in the table below.

Sl. No.	Number of exposure to trainings	Score
1	No training	0
2	Less than five training	1
3	Five or more than 5 training	2

3.5.7 Social participation

Social participation was operationalized as the extent of involvement of the respondents in any organizations like Grama Panchayat, co-operative society, SHG or any related farmer organization either as a member or as an office bearer. This signified their role in building community mobilization for rural development including agriculture. The scoring used by Jasna (2015) was used to categorize respondents as given in the following table.

Sl. No.	Level of social participation	Score
1	Non membership	0
2	Membership only	1
3	Office bearer	2

3.5.8 Scientific orientation

Scientific orientation has been defined under the study as the degree to which respondents are oriented to the use of scientific methods in soil health management as recommended in the soil health card (SHC). The scale developed by Supe (1969) was used with due modifications for its measurement in the study. The responses of the farmers were obtained against each item of the scale in terms of their degree of agreement or disagreement. The positive statements were scored 5, 4, 3, 2 and 1 for strongly agree, agree, undecided, disagree and strongly disagree respectively. Scoring system was reversed in case of negative items and the total score ranged from 10 to 50. On arbitrary basis, the respondents were grouped into five categories as given in the table below.

Sl. No.	Level of scientific orientation	Score
1	Very low	Up to 18
2	Low	18-26
3	Medium	26-34
4	High	34-42
5	Very high	Above 42

3.5. 9 Irrigation facility

Irrigation facility has been defined as the availability of irrigation water through various sources accessible to farmer for crop production. Scale used by Narbaria (2013) was used with suitable modification in the study. The following categorization as given in the table below was followed based on irrigation sources available to farmer.

Sl. No.	Irrigation facility available	Score
1	Rainfed	1
2	Canal	2
3	Well	3
4	Tube well	4
5	Pond	5

3. 5. 10. Leadership

Leadership is operationally defined in the study as the ability of a person to influence people to co-operate in achieving a goal. Scale developed by Nandapurkar (1980) with suitable modifications was used to measure leadership.

In the present study, leadership was measured along a three point rating scale Always, Sometimes and Never with decreasing score 3, 2 and 1 respectively. The total score was computed for each respondent by summing up the scores recorded. Based on the total scores obtained, the respondents were classified into 3 categories as low, medium and high keeping the mean and standard deviation as check as given in the table below.

Sl. No.	Leadership level	Score range
1	Low	< (Mean- SD)
2	Medium	(Mean $\pm$ SD)
3	High	> (Mean + SD)

3.6. Measurement of dependent variables

Dependent variables of the study were the extent of adoption of soil health card recommendations by farmers, utility perception of farmers about SHC use and awareness of farmers on benefits of soil health card. The methods used in the quantification of these variables are given as Table 3.2 and the details of

methodology adopted to measure each of them are explained under following subheads.

Table 3.2 Details of dependent variables selected for the study and their measurement

Sl. No.	Dependent variables	Method of measurement
1	Extent of adoption of soil health card recommendations	Adoption index (AI) developed by Narain *et al*. (1991)
2	Utility perception of farmers about SHC	Standardised schedule developed
3	Awareness of farmers on benefits of soil health card	Standardised schedule developed

3.6.1 Extent of adoption

According to Rogers (2003), adoption is a decision to make full use of an innovation as the best course of action available for a particular purpose. Extent of adoption of SHC recommendations was operationalized as the degree to which a respondent actually adopted the SHC based recommendations in soil health management.

Adoption index

Adoption Index (AI) has been measured as an aggregation of adoption of different dimensions of an agricultural technology. The approach used by Narain *et al.* (1991) has been followed in the study.

Farmers were represented by a set of n points (1, 2,…,n) and the groups of indicators by a set of k points. (1,2,…,k).

There are six indicators taken for the study which were quantity of fertilizers (N, P, K), organic manure, micronutrients, and soil ameliorants used by the farmers.

AI was represented by a matrix [Xij]; where i = 1, 2,…,n and j = 1, 2,…,k.

As the indicators were normally in different units of measurement and the objective was to compute the single composite index relating to dimension, there was a need of standardization of these indicators to give mean zero and variance one. For standardizing the data the data matrix [X_{ij}] is transformed to another data matrix of standardized indicators [Zij] by using the formula as follows

$$Z_{ij} = \frac{X_{ij-\bar{X}_j}}{S_j} \quad \text{----------(1)}$$

Where, $\bar{X}_J$ and S_j are the mean and standard deviation of j^{th} indicator.

Then [*Zij*] was presumed to denote the matrix of standardized indicators. From [*Zij*] the best value of each indicator was identified and was denoted as $Z_{0j.}$ Here mean of Z_{ij} was taken as the best value. For obtaining the pattern of adoption, C_i of the i_{th} farmer, P_{ij} was calculated as per equation (2) given below.

$$P_{ij} = \left(Z_{ij} - \overline{Z_j}\right)^2 \text{----------(2)}$$

Pattern of adoption is given by equation (3) below.

$$C_i = \left[\sum_{j=1}^{n} \frac{P_{ij}}{CV_j}\right]^{1/2} \quad \text{----------(3)}$$

where, n= 6 and $CV_j = \frac{S_J}{X_j} * 100$

Composite index of adoption is given by equation (4)

$$D_i = \frac{C_i}{C} \quad \text{----------(4)}$$

where, $C = \bar{C} + 3SD_{i;}\ and\ \bar{C} = \sum_{i=1}^{n} \frac{Ci}{n}$

SD_i =Standard deviation of C_i

The value of adoption index is non-negative and had values between 0 and 1. The value of Adoption Index closer to zero indicated the lower level of adoption, while that closer to 1 indicated the higher level of adoption.

3.6.2 Utility Perception score

Perception is the process of understanding sensation or attaching meanings based on past experiences. The utility perception of the farmers regarding use of soil health card recommendations was measured using a standardised interview schedule containing of statements related to the scheme. The items of measurement were prepared with the help of available literature, discussion with the subject experts, and implementing officers. The responses of the farmers were recorded on a dichotomous scale of agree or disagree and the frequency and percentage were calculated for each statement to derive the utility perception score.

3.6.3 Awareness of farmers

Awareness score of the farmers regarding soil health card scheme was quantified using an interview schedule containing 24 statements related to the scheme. It was prepared with the help of available literature, discussion with the subject experts, personal experience, and suggestions from field officers involved in the implementation. Awareness of respondents were quantified on a three point continuum as ‘fully aware’, ‘partially aware’ and ‘not aware ’ with corresponding scores of ‘3’, ‘2’ and ‘1’ respectively. Extent of awareness of a farmer on soil health card and its uses were obtained by summing the scores obtained for each item.

3.6.4. Constraint analysis

Constraint analysis was aimed at delineation of constraints faced by farmers in the use of SHC and challenges in the implementation of the scheme as perceived by implementing officers. These were quantified based on ranking of the items selected through expert consultancy and literature review.

3.7. Tools used for data collection

A structured interview schedule was prepared by reviewing previous research studies and through consultation with experts in the field of agricultural extension. A pilot study was conducted in order to check the validity of the interview schedule. The final interview schedule was prepared after making necessary modifications, additions and deletions based on the pilot study. Data on policies and role of agencies were also collected from primary and secondary sources. Secondary data were collected through published review reports, literature published by various government/non-government agencies and reference materials available on websites. The schedule of data collection has been included as Appendix I, II and III. Also photographs of field survey has been included as Plate 1(a) and Plate 1 (b).

3.8. Statistical methods used to analyse data

Suitable parametric and non-parametric statistical methods were used to analyze the data collected. Results have been presented as mean values, standard deviation, frequency, percentage, correlation etc. as required by the type of data, inferences drawn and context of interpretation.

3.8.1. Descriptive statistics

Descriptive statistics are brief descriptive coefficients that summarize a given data set, which can be either a representation of the entire or a sample of a population. Descriptive statistics include measures of central tendency like mean, median, and mode and measures of variability like standard deviation, variance, the minimum and maximum variables, and the kurtosis and skewness. Simple frequencies and percentages were also worked out to find the distribution of respondents based on the scores for different variables. Results of the independent variables selected for the study were interpreted using this analysis.

3.8.2. Mann Whitney U- test

Mann- Whitney U- test is used to determine whether two independent samples have been drawn from the same population (or from two different populations having the same distribution)

Let n_1 and n_2 be the size of the two samples.

The statistic U is defined as follows:

$$U = n_1 n_2 + \frac{n_{1(n_1+1)}}{2} - R_1$$

$$Mean = \frac{n_1 n_2}{2}$$

$$Standard\ deviation = \sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}$$

$$U = n_1 n_2 + \frac{n_2 (n_2 + 1)}{2} - R_2$$

where R_1 and R_2 are the sum of the ranks of the two samples.

3.8.3. Kruskal - Wallis one way analysis of variance by ranks

Kruskal-Wallis one way analysis of variance by ranks is used to determine whether k independent samples are from different populations for at least ordinal level of measurements. It tests the null hypothesis that the k samples come from the same population or from identical population with respect to averages.

$$H = \frac{12}{N(N+1)} \sum_{j=1}^{k} \frac{R_{j^2}}{N_j} - 3(N+1)$$

Where,

$k = number\ of\ samples$

$N_j = number\ of\ cases\ in\ the\ j^{th}\ sample$

$N = \sum n_j$ *the number of cases in all samples combined*

$R_j = sum\ of\ ranks\ in\ the\ j^{th}\ sample(coloumn)$

$\sum_{j=1}^{k} directs\ to\ sum\ over\ k\ samples\ (columns)$

3.8.4 Spearman's rank correlation coefficient

Spearman rank correlation was done to find out the factors that influenced the awareness and adoption among farmers and extension personnel

3.8.5 Binary logistic regression

Many social phenomena are qualitative rather than quantitative in nature. Binary logistic regression is used to predict the probability of SHC scheme membership based on multiple independent variables. Logistic regression analyses the relationship between a binary response variable and multiple independent variables. The response variable Y is a dichotomous variable with possible values 0 and 1. Let there be k independent variables. Then the prediction equation takes the form:

$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots \beta_k x_k$

where p is the probability of the event to occur (Y=1) given x_i, i=1,2,3……. k.

and $\beta_0, \beta_1, \beta_{2,\ldots}.\beta_k$ are the regression coefficients.

A positive β_i indicates that increase in x_i will be associated with increase in p. A negative β_i indicates that increase in x_i will be associated with decrease in p.

$\ln\left(\frac{p}{1-p}\right)$ is called logarithm of the odd, also known as log odd. The odds reflect the likelihood that the event will occur. It can be seen as the ratio of success to non-success. In the present study, success refers to soil health card user and non-success refers to non- user of soil health card.

The probability, p can be calculated from the odds as $p = \frac{Odds}{1+odds}$

When the odds ratio is greater than one, the probability for using soil health card will also be high (greater than 0.5).

3.8.6. Garrett ranking

To identify the constraints faced by both farmers and implementing officers in Soil Health Card programme, Garrett ranking technique was used. As the first step in constraint analysis, major problems faced by farmers and officers were identified. The respondents were then asked to rank the identified problems. Then, Garrett ranking technique was used to identify the major constraints.

In this method, the rank assigned to different constraints were transformed into percentage using the following formula described below.

Per cent position= $100(R_{ij} -0.5)/N_j$

Where, R_{ij} = Rank given for i^{th} factor by j^{th} individual

N_j = Number of factors ranked by j^{th} individual

Here 0.5 is subtracted from each rank because the rank is an interval on a scale and its midpoint best represents the interval. Then the percentage positions were transformed into scores on a scale of 100 points referring to the table given by Garett and Woodworth (1969). From the scores so obtained, the mean score level was derived and constraints were ranked based on the mean score level.

Plate 1(a) Survey of farmers in Thrissur district

Plate 1(b) Survey of farmers and implementing officers in Thrissur district

Result and discussion

Chapter 4

RESULTS AND DISCUSSION

The chapter deals with the findings of the study that have been derived after subjecting the data to statistical analysis and its interpretation in the light of the existing theories and literature. The results and interpretation have been presented under following subheads.

4.1 Socio-economic variables of farmers

4.2 Awareness of farmers on soil health card (SHC)

4.3 Spread and extend of use of soil health cards (SHCs) among the farmers

4.4 Utility perception of farmers about soil health cards (SHCs) in crop production

4.5 Comparison of soil management practices by soil health card users and nonusers

4.6 Challenges in effective implementation of soil health card scheme

4.1 Socio-economic variables of farmers

The socio-economic variables of the respondents studied were age, education, annual income, farming experience, farm size, social participation, exposure to training, scientific orientation, irrigation facility and leadership ability. Descriptive statistics was used to measure these variables.

4.1.1 Age

Farmers were categorized into groups *viz.* young (40-55 years), middle aged (56-66 years) and aged (>66 years). Age category and their respective frequency and percentage are given in Table 4.1. It showed that all the farmers under study belonged to age group of above 40 years. In case of participant SHC scheme users 56.60 per cent were of the age group of 40-55 years, 30.00 per cent were in the age group of 56-66 and the remaining 13.40 per cent belongs to above 66 years of age.

Table 4.1 Distribution of respondents based on age

Age category (years)	Participant Soil Health Card (SHC) scheme users (n=30)	Participant non-users (n=30)	Non-Participants (n=60)	Paid soil test users (n=30)
40 – 55	17 (56.60)	18 (60.00)	29 (48.30)	13 (43.30)
56 – 66	09 (30.00)	10 (33.33)	25 (41.70)	14 (46.60)
> 66	04 (13.40)	02 (06.67)	06 (10.00)	03 (10.10)

(Values inside the parenthesis indicates percentage)

In the case of participant non-users 60 per cent farmers belonged to the age group 40 to 55, 33.3 per cent in the age category of 56 to 66 and the remaining 6.67 per cent in the above 66 age group. In case of non-participant farmers, 48.30 per cent belonged to the age group 40-55 years, while 41.7 per cent were of age group 56-66 years and the remaining 10 per cent belonged to the age group of above 66 years. However, in the case of paid soil test users, 43.3 per cent of them belonged to the relatively younger age group of 40-55 years. 46.60 per cent and 10.10 per cent were of the age group of 56-66 years and above 66 years age group respectively. It can be inferred from the relatively higher age group of different adopter categories that there is few new entrants into farming from youngsters. These findings are consistent with the results found by Lamkane (2018), Jaiswal and Singh (2018).

4.1.2 Education

The results in Table 4.2 showed that majority of the farmers had acquired high school level of education. In case of participant SHC scheme users, 36.60 per cent of the farmers had primary education whereas 46.6 per cent had acquired high school education. Farmers with qualification above matriculation were only 16.8 per cent ie. (10.10 per cent with higher secondary and 6.70 per cent with collegiate education). In the case of participant nonusers, 63.3 per cent farmers had acquired high school education whereas 16.74 per cent farmers belonged to secondary, 13.3 per cent had primary level of education and the remaining 6.66 per cent had acquired collegiate

level of education. In case of non-participant farmers, 60 per cent belonged to high school level of education while 18.4 per cent had acquired primary education, 15 per cent belonged to secondary level of education and the remaining 6.6 per cent had college and above educational status. In case of paid soil test users 56.80 per cent had acquired high school level of education, 13.3 per cent of the farmers had primary education. Farmers with qualification above matriculation were only 29.9 per cent (26.6 per cent with higher secondary and 3.3 per cent with collegiate education). Results indicated that majority of the farmers had high school level of education *i.e.* 8th to 10th standard and the results are in conformity with the results of Chowdary and Theodore (2016).

Table 4.2 Distribution of respondents based on education

Category (years of schooling)	Participant SHC scheme users (n=30)	Participant non-users (n=30)	Non-Participants (n=60)	Paid soil test users (n=30)
Primary	11 (36.60)	04 (13.30)	11 (18.40)	04 (13.30)
High school	14 (46.60)	19 (63.30)	36 (60.00)	17 (56.80)
Secondary	03 (10.10)	05 (16.74)	09 (15.00)	08 (26.60)
College and above	02 (06.70)	02 (06.66)	04 (6.60)	01 (3.30)

4.1.3 Farm size

Classification of farmers based on the farm size as presented in Table 4.3 indicated that small farmers (46.6 per cent) with farm size 1-1.99 ha were found to be the most predominant category among the participant SHC users. The share of marginal farm category was 43.4 per cent and only 10 per cent had semi medium farm size holders. In the case of Participant non-user farmer, 63.4 per cent were

marginal farmers, 33.3 per cent belonged to small farmer category and only 3.3 per cent were semi medium farmers. In case of non-participant farmers, about 65 per cent were marginal farmers, 30 per cent belonged to small farmer category and the remaining 5 per cent were semi medium farmers. However in case of paid soil test users 83.37 per cent were marginal farmers, 13.3 per cent belonged to small farmer's category and the remaining 3.33 per cent were semi medium farmers. Results reinstate the predominance of marginal farmers among all categories of adopters and are consistent with the fragmentation of marginal and small farmer group persistent in the agricultural sector of Kerala. More interestingly, the paid SHC users were more prevalent among the marginal framers which are in consonance with the findings of Jaiswal and Singh (2018).

Table 4.3 Distribution of respondents based on their farm size

Category	Participant SHC scheme users (n=30)	Participant non-users (n=30)	Non-Participants (n=60)	Paid soil test users (n=30)
Marginal farmers (<1 ha)	13 (43.40)	19 (63.40)	39 (65.00)	25 (83.37)
Small farmers (1-1.99 ha)	14 (46.60)	10 (33.30)	18 (30.00)	04 (13.30)
Semi-medium farmers (2-3.99 ha)	03 (10.00)	01 (3.30)	03 (05.00)	01 (03.33)

4.1.4 Farming experience

Experience of farmers was measured in terms of the number of years of their engagement in farming. Distribution of respondents based on their experience is presented in Table 4.4. The overall distribution of respondents as indicated in the results showed that 33.3 per cent of participant SHC users were having 5 to 10 years' experience in farming, whereas 46.6 per cent had more than 10 years' experience and

only 20.10 per cent of the farmers showed farming experience below 10 years. In case of participant nonusers under the soil health card scheme, 50 per cent were having 5 to 10 years of experience, 36.6 per cent more than 10 years and 13.4 per cent had less than 10 years of experience in farming. In case of nonparticipant farmers, 48.4 per cent were having more than 10 years of experience, 35 per cent had 5 to 10 years of experience and 16.6 per cent were of less than 10 years' experience in farming. In case of paid soil test users, 53.4 per cent had 5 to 10 years of experience followed by 30 per cent with more than 10 years and 16.6 per cent with less than 10 years of experience in farming. Results indicated that majority of the farmers were having above 5 years of experience in farming.

Table 4.4 Distribution of respondents based on farming experience

Farming experience	Participant SHC users (n=30)	Participant non-users (n=30)	Non-Participants (n=60)	Paid soil test users(n=30)
<10 Years	06 (20.10)	04 (13.40)	10 (16.60)	05 (16.60)
05-10 Years	10 (33.30)	15 (50.00)	21 (35.00)	16 (53.40)
>10 years	14 (46.60)	11(36.60)	29 (48.40)	09 (30.00)

4.1.5 Annual income

Farmers with sound economic conditions, ultimately result in higher adoption of the technologies. Keeping this in view, the annual income of the respondents was studied.

Farmers were categorized in to different income categories based on their income from agriculture and other sources on yearly basis. The frequency and percentage of farmers under each category are listed below (Table 4.5)

As seen from the table, majority of the participant SHC users belonged to income categories with annual income of 1-2 lakh (43.3 per cent), 40 per cent of the farmers belonged to income category of 2-3 lakh per annum, 13.4 per cent farmers

were earning more than 3 lakhs, and 3.3 per cent of the farmers earned between 50,000 and one lakh of annual income. In case of participant non-users, 40 per cent belonged to income categories with 1-2 lakh, 46.6 per cent belonged to the income category of 2-3 lakh per annum, 10.00 per cent farmers were in the income category of 50,000-1 lakh and 3.4 per cent were earning more than 3 lakh of annual income. In case of non-participant farmers, majority of farmers belonged to income categories with 1-2 lakh (36.7 per cent), 25 per cent belonged to the income category of 2-3 lakh per annum, 23.3 per cent belonged to the income category of 50,000 to 1 lakh, and 15 per cent of farmers were earning greater than 3 lakh rupees per annum. In case of paid soil test users, majority of farmers belonged to income categories with 2-3 lakh (46.6 per cent), 40 per cent were in the income category of 1-2 lakh per annum, 13.4 per cent farmers were earning more than 3 lakhs per annum and none of the farmers earns between 50000- 1 lakh of annual income. Results implies that majority of the farmers had annual income between Rs.1 lakh and Rs.3 lakh.

Significant finding was that all the paid SHC users belonged to relatively higher income groups compared to others adopter categories. These findings are contradictory to the finding of Patel *et al*. (2017).

Table 4.5 Distribution of respondents based on annual income

Annual income	Participant SHC users (n=30)	Participant non-users (n=30)	Non-Participants (n=60)	Paid soil test users (n=30)
Rs.50,000 -1 lakh	01 (03.30)	03 (10.00)	14 (23.30)	0.00
Rs.1 lakh -2 lakh	13 (43.30)	12 (40.00)	22 (36.70)	12 (40.00)
Rs.2 lakh-3 lakh	12 (40.00)	14 (46.60)	15 (25.00)	14 (46.60)
> Rs. 3 lakh	04 (13.40)	01 (3.40)	09 (15.00)	04 (13.40)

4.1.6 Exposure to training

Distribution of farmers based on the frequency of exposure to various training programs that facilitated awareness and adoption of soil test based nutrient management practices are categorized below (Table 4.6). The results showed that majority (66.6 per cent) of the Participant SHC users had not attended any of the training programs on soil testing and 30 per cent of the farmers had attended less than five trainings and only 3.4 per cent of the farmers had attended more than 5 trainings. In case of participant non-users, 27 per cent had not attended any training programs related to soil testing or soil health and 40 per cent participated in less than five training programmes and 33 per cent attended more than five training programmes. In case of non-participant farmers 61.6 per cent had not attended any training programmes and 30 per cent of the respondents had attended less than five training programmes and 8.40 per cent of the farmers had attended more than 5 training programmes on soil testing. With respect to paid soil health card users, 76.6 per cent of the farmers had received training on soil testing and 20 per cent of the farmers had not attended any training and 3.4 per cent attended more than 5 training programmes. Results indicate that though awareness program were part of SHC scheme a majority of 66 per cent of participant SHC users has not received training on soil health management. However 40 and 33 per cent of participant non-users had attended training in soil management.

This could be explained by the fact that it is not the lack of awareness that made this farmers registered under the SHC scheme non-user but the timely unavailability of the cards. This could be inferred that the most critical component for the success of the program is not the enrolment of farmers but timely distribution of the cards.

Table 4.6 Distribution of respondents based on exposure to training

No of trainings attended	Participant SHC users (n=30)	Participant non-users (n=30)	Non-Participants (n=60)	Paid soil test users (n=30)
No training	20 (66.60)	8 (27)	37 (61.60)	06 (20)
Less than five training	09 (30.00)	12 (40)	18 (30.00)	23 (76.6)
Five or more than 5 training	01 (03.40)	10 (33)	05(08.40)	01 (3.4)

4.1.7. Social participation

The involvement of a respondent in organizations like Grama panchayats, cooperative society, SHG, farmer organization, samithies, Vegetable and Fruit Promotion Council Keralam (VFPCK) etc either as a member or as an office bearer, was assessed and the results obtained is given in Table 4.7.

The distribution revealed that in case of participant SHC users, 46.6 per cent of the respondents had no linkage with social organizations and 53.4 per cent of the farmers were involved in social activities either as a member (40 per cent) or as an office bearer (13.4 per cent). And in case of participant non-users, also 43.3 per cent were not any member in any of the organisations and 43.3 per cent were having membership and 13.4 per cent were officer bearers of any of these organisations. In case of non-participant farmers, more than half of the respondents, (61.6 per cent) were holding membership in any one of the group and 10 per cent were acting as office bearers and 28.4 were not linked to any of the social organisations. In case of paid soil test users, half (50 per cent) of the respondents holds membership in any one of the organisations and 36.6 per cent were not linked to any social organisations and 13.4 per cent were acting as office bearers of any of the social organisations. It could be inferred from the table that there existed an inverse relation between social

participation of farmers and their utilization of soil health card results which contradicted the existing theories of group dynamics. However, the results could further substantiate the importance of timely distribution of SHC for its adoption by farmers. These findings were in line with the finding of (Bunkar, 2018) and contradictory to the finding of Charel *et al*. (2018).

Table 4.7 Distribution of respondents based on social participation

Category	Participant SHC users (n=30)	Participant non-users (n=30)	Non-Participants (n=60)	Paid soil test users (n=30)
Non-member	14 (46.6)	13 (43.3)	17 (28.4)	11 (36.6)
Member	12 (40.0)	13 (43.3)	37 (61.6)	15 (50.0)
Office bearer	04 (13.4)	04 (13.4)	06 (10.0)	04 (13.4)

4.1.8. Scientific orientation

The results from the Table 4.8 shows that majority (66.6 per cent) of the participant SHC users were having medium level of scientific orientation, followed by 20 per cent were belonging to low level of scientific orientation and 13.4 per cent is having high level of scientific orientation. In case of participant non-users, 56.6 per cent were having medium level of scientific orientation, followed by 33.4 per cent belonging to low level of scientific orientation and 10 per cent is having high level of scientific orientation. In case of non-participant farmers, 60 per cent falls under medium category and 25 per cent were having low level of scientific orientation and 15 per cent were having high level of scientific orientation. In case of paid soil health card users, 83.4 per cent falls under medium level of scientific orientation and 10 per cent falls under low level and 6.60 per cent were having high scientific orientation. It could be inferred from the results that even the high scientific orientation of the farmers could not make any significant effect on the adoption of SHC results by the

farmers. This confirms that the non-availability of SHC results on time could even topple the best interests of the farmer in using it. The present finding gets support from the findings reported by Patel (2013).

Table 4.8 Distribution of respondents based on scientific orientation

Category	Participant SHC users (n=30)	Participant non-users (n=30)	Non-Participants (n=60)	Paid soil test users (n=30)
Low(18-26)	06 (20.00)	10 (33.40)	15 (25.00)	03 (10.00)
Medium(26-34)	20 (66.60)	17 (56.60)	36 60.00)	25 (83.40)
High(34-42)	04 (13.40)	03 (10.00)	09 (15.00)	02 (6.60)

4.1.9 Irrigation facility

It is apparent from the Table 4. 9 that majority of the participant SHC users (33.3) had well as the main source of irrigation. Followed by 23.3 per cent is having canal system as well as pond as source of irrigation. About 3.47 per cent is having tube well as irrigation source and 16.6 per cent of the farmers were rainfed. In case of participant non-users, 36.6 per cent were having pond as the main source of irrigation followed by 33.5 per cent were having well and 13.3 per cent were having canal as the main source of irrigation. None of the farmers depends on bore well as irrigation source and 16.6 per cent were rainfed. In case of non-participant farmers, 30 per cent were having well as the main source of irrigation followed by 25.01 per cent were having canal and 23.33 per cent were having pond as the main source of irrigation. About 8.33 per cent depends on bore well as irrigation source and 13.33 per cent of the farmers were rainfed. In case of paid soil test users, 36.71 per cent were having well as the main source of irrigation followed by 33.3 per cent were having pond and 20 per cent were having canal as the main source of irrigation. About 3.33 per cent of

the farmers depends on bore well as irrigation source and 06.66 per cent were rainfed. In all the four categories of farmers, well and pond were the main source of irrigation and only few farmers were using tube well.

Table 4.9 Distribution of respondents based on irrigation facility

Irrigation facility	Participant SHC users (n=30)	Participant non-users (n=30)	Non-Participants (n=60)	Paid soil test users(n=30)
Rainfed	05 (16.60)	05 (16.60)	8 (13.33)	2(06.66)
Canal	07 (23.30)	04 (13.30)	15 (25.01)	06 (20.00)
Well	10 (33.30)	10 (33.50)	18 (30.00)	11 (36.71)
Tube well	01 (3.47)	00.00	05 (8.33)	01 (3.33)
Pond	07 (23.33)	11 (36.60)	14 (23.33)	10 (33.30)

4.1.10 Leadership ability

The results from the Table 4.10 shows that 40 per cent of the participant SHC users had low level of leadership ability, followed by 36.6 per cent with medium level of leadership ability and 23.4 per cent of the farmers belonged to high level of leadership ability. In case of participant non-user farmers 40 per cent belonged to medium level of leadership ability, 30 per cent belonged to both high and low category. In case of non-participant farmers, 36.6 per cent belonged to low level of leadership ability, 33.4 per cent belonged to medium level and 30 per cent belonged to high level.

In case of paid soil test users 43.3 per cent belonged to medium level, 33.3 per cent to low level and 23.4 per cent to higher level of leadership ability. It could be

concluded that majority of the farmers fall in medium and high level of leadership abilities.

Table 4.10 Distribution of respondents based on leadership ability

Category	Participant soil health card scheme users (n=30)	Participant non-user farmer(n=30)	Non-participant farmers(n=60)	Paid soil test users(n=30)
High	07 (23.4)	09 (30.0)	18 (30.0)	07 (23.4)
Medium	11 (36.6)	12 (40.0)	20 (33.4)	13 (43.3)
Low	12 (40.0)	09 (30.0)	22(36.6)	10 (33.3)

4.1.11 Comparison of SHC users and non-users on socio-economic profile

Based on the receipt of SHC results, farmers enrolled under the scheme were categorised as Participant SHC users and Participant SHC nonusers in the study. Participant SHC users were those who received and used SHC results in time and Participant SHC non-users were those who participated in the scheme but did not receive the results for use. A comparison of the different categories of soil test data users and non-users were found out by Kruskal- Wallis test by taking the ten socio economic variables as the independent variable and the significant results are presented in Table 4.11. The results revealed that the different categories of SHC users and non-users differed significantly on farming experience, exposure to training and irrigation facility with p values 0.040, 0.016 and 0.001 respectively at 0.05 and 0.01 levels of significance. However there was no significant difference between the adopter categories on any other socioeconomic variables selected in the study.

Table 4.11 Comparison of farmer respondents based on relevant socioeconomic profile

Sl. No.	Group variability	Farming experience	Exposure to training	Irrigation facility
1	Participant SHC users (n=30)	84.03	76.05	55.00
2	Participant SHC non-users (n=30)	83.62	76.05	69.58
3	Non-participant farmers (n=60)	58.60	56.33	91.30
4	Paid soil test users (n=30)	75.62	84.53	80.81
	Chi-Square	1.28	5.09	5.60
	Asymp. Sig.	0.040*	0.016*	0.001**

* Significant at the 5% level (2 -tailed), ** Significant at the 1% level (2 - tailed)

4. 2. Awareness of farmers on components of soil health card (SHC) scheme

Awareness is an important concept which implies the perception or state of mind of an individual to a particular phenomenon. Awareness of the farmers about the soil health card scheme was judged by a schedule containing statements regarding the different SHC scheme domains. Responses of the farmers were recorded in a three point continuum of fully aware, partially aware and not aware scale with scores 3, 2 and 1 respectively. On the basis of the total score obtained by each respondent, the weighted mean score on overall awareness and mean of the scores on individual components of soil health card *viz*., Soil sampling procedures, general scheme information, card details interpretation, soil health card uses and soil health management practices were estimated. The awareness of participant soil health card users and paid soil test users with respect to these different components has been detailed in Table 4.12 and 4.13 respectively.

4.2.1. Awareness of Participant Soil Health Card users

Distribution of participant soil health card users based on their awareness on soil sampling depicted in Table 4.12 showed that only 58 per cent of the farmers were aware of the procedure for taking soil samples, time for soil collection and the suitable sites for taking samples and 57 per cent were aware about the time gap between collection of two samples for testing. This may be due to the reason that the soil sample is not collected directly by the farmers. The scheme is implemented through various farmer groups and samples are collected by these groups on behalf of farmers collectively. Members of various groups like Padasekharasamities, Kudumbasree and other related farmer groups are involved in the collection of soil samples and distribution of results.

However, majority of the participant soil health card users (66.66 per cent) were aware about the general aspects of the scheme. This is due to the reason that most of the soil health cards were distributed in connection with some programmes like soil day where general awareness about the scheme alone was given to the farmers by the implementing agencies. With respect to the interpretation of soil test results, only 57 per cent of the farmers were aware of parameters like micronutrients, pH (58 per cent) and EC (57 per cent). This can be attributed to the fact that the soil health card is distributed by the agency to fulfil their targets rather than the need of the farmer. Moreover, the results substantiate the fact that there were a large number of farmers enrolled under the scheme who did not get the test results in time.

Results implied that in general, the implementing agencies were neither involved in educating the farmers about the specific soil test details nor gave proper assistance to them as per the scheme guidelines which was ascribed to the lack of field level officers.

Table 4.12 Distribution of participant SHC users based on awareness score

Sl. No.	Different components of SHC	Awareness score (n=30)				
		Fully aware	Partially aware	Unaware	Weighted awareness score (%)	Composite weighted Mean
I.	**Soil sampling procedures**					
	Method of soil collection	6	10	14	58.00	57.5
	Time of soil collection	6	10	14	58.00	
	Suitable site to collect soil sample	6	10	14	58.00	
	Optimum weight of soil sample	6	10	14	58.00	
	Time gap for soil retesting	5	11	14	57.00	
II.	**General information about SHC scheme**					
	Slogan of SHC scheme	10	10	10	66.66	66.66
	Year of implementation	5	10	15	55.55	
	Details of SHC portal	10	15	5	72.22	
	Implementation agency	10	15	5	72.22	
III.	**Interpretation of SHC results**					
	Primary nutrients	25	05	0	94.44	70.88
	Secondary nutrients	20	10	0	89.00	
	Micronutrients	5	11	14	57.00	
	pH	6	10	14	58.00	
	EC	5	11	14	57.00	
IV.	**Advantages of soil health card use**					
	Helps in crop planning	14	12	04	78.00	69.62
	Save input cost	6	10	14	58.00	
	Taking corrective measures	6	10	14	58.00	
	Promote INM	5	11	14	57.00	
	Judicious use of fertilizers	16	12	02	82.22	
	Improve productivity	21	05	04	85.55	
V.	**Soil health management practices**					
	Green manuring	30	0	0	100.00	98.33
	Crop rotation	28	02	0	98.00	
	Cover cropping	28	02	0	98.00	
	Minimum tillage	28	02	0	98.00	
	Overall awareness score					**381.64**

With respect to the uses of the SHC, only 69.62 per cent of the farmers were aware about the benefits such as crop planning, savings in input cost, soil nutrition management, promotion of Integrated Nutrient Management, judicious use of fertilizers and improvement in productivity. This comparatively lower level of awareness on the uses of SHC among respondents indicates the need of proper training and awareness programmes to popularise the scheme objectives and its relevance in farm management. Moreover, as these cards were distributed free of costs, the farmers were not giving much importance to its use.

The results also revealed that majority (98.33 per cent) of the participant soil health card users were aware of the different components in general soil health management practices, such as green manuring, crop rotation, cover cropping and minimum tillage. The reason can be credited to the high experience of the majority of farmer respondents as these soil management practices were practiced by most of the farmers from the early times onwards. The findings of this study are supported by the results of Charel *et al.* (2018) and Patel *et al.* (2017).

4.2.2. Awareness of Paid Soil Health Card Users

The results from Table 4.13 indicated that the Paid Soil Health Card Users had an overall awareness score of 448.24 and on all selected awareness domains they had uniformly high scores except on general information on SHC scheme wherein the score was only 64.72 per cent. This was low compared to scores on the awareness domains of soil sampling procedures (94%), interpretation of the SHC results (97.5%), advantages of soil health card use (93.0%) and soil health management practices (99.0%). This was quite logical as they did not depend on the free SHC scheme for soil tests but were willing to use paid services which they perceived to be time bound and precise.

An attempt to analyse the domain wise results of awareness presented in Table 4.13 showed that majority (94%) of the Paid Soil Health Card Users were

aware of soil collection procedures related to soil sample collection. This can be ascribed to the fact that these farmers collected the soil samples themselves and took the guidance of the experts of soil testing laboratories in the process. They were convinced of the importance of soil test results in soil nutrition management and were using paid services voluntarily. They scored uniformly high awareness score on all the five parameters of soil collection procedures viz. method (100.00), time(97.77), suitable sites (97.77), optimum quantity(90.00) and time gap (83.33) for soil sample collection.

With regard to awareness of interpretation of the SHC results, all the paid users had high awareness on primary and secondary nutrients with cent person scores respectively. However with respect to micronutrients and pH interpretations the awareness score was 95.55 per cent. EC also recorded high awareness score of 96.66 per cent. The reason for high awareness score is derived from the fact that most of the respondents were regular users of soil test results and the current status of each parameter was indicated in easily interpretable terms of high, medium and low. Moreover, the necessary corrective measures to be followed by the farmers were clearly mentioned in the local language in the SHC, a sample of which is presented as Appendix 6.

With respect to the awareness on the advantages of soil health card use, all the respondents (99%) were convinced of the advantages of correcting nutritional deficiency observed in the farms and judicious use of fertilizers by using soil test results. Most of the farmers stated that their main intention to carry out the soil analysis was to know the current nutrient status of their farm so that fertilizer application can be limited as per the requirement of the soil. This helped to avoid excess consumption of fertilizers and to save input cost as reported by 98.88 per cent farmers.

Table 4.13 Distribution of Paid SHC users based on awareness score

Sl. No	Awareness Score (n=30)					
	Different components of SHC	**Fully aware**	**Partially aware**	**Unaware**	**Weighted awareness score (%)**	**Component wise weighted mean**
I.	**Soil sampling procedures**					
	Method of soil collection	30	0	0	100.00	94.00
	Time of soil collection	28	02	0	97.77	
	Suitable site to collect soil sample	28	02	0	97.77	
	Optimum quantity of soil sample	23	05	02	90.00	
	Time gap after which soil should be retested	20	05	05	83.33	
II.	**General information about SHC scheme**					
	Slogan of SHC scheme	6	10	14	57.7	64.72
	Year of implementation	8	8	14	60	
	Details of SHC portal	6	10	14	57.77	
	SHC agency	15	15	0	83.33	
III.	**Interpretation of SHC results**					
	Primary nutrients	30	0	0	100.00	97.52
	Secondary nutrients	30	0	0	100.00	
	Micronutrients	26	04	0	95.55	
	pH	26	04	0	95.55	
	EC	27	03	0	96.66	
IV.	**Advantages of soil health card use**					
	Helps in crop planning	20	05	05	83.33	93.00
	Save input cost	29	01	0	98.88	
	Taking corrective measures	30	0	0	100.00	
	Promote INM	25	05	0	94.44	
	Judicious use of fertilizers	30	0	0	100.00	
	Improve productivity	16	10	04	80.00	
V.	**Soil health management practices**					
	Green manuring	30	0	0	100.00	99.00
	Crop rotation	28	02	0	97.77	
	Cover cropping	30	0	0	100.00	
	Minimum tillage	28	02	0	97.77	
	Over all Awareness Score					**448.24**

Awareness score of the farmers on the use of soil test results for crop planning and improved productivity was 83.33 per cent and 80.00 per cent respectively. The results draws its strength from the fact that majority of the farmers were adequately educated (secondary passed), had more irrigated area, with good social participation and more exposure to training. These provide them with the advantage of having better knowledge and understanding about the benefits of soil testing and soil health card.

With regard to the general soil management practices, it was observed that 99.9 per cent of the farmers were fully aware of the different soil health management practices such as green manuring (100%), crop rotation (97.77%), cover cropping (100%) and minimum tillage (97.77%). The reason can be ascribed to the added experience of these farmers in farming practices and all these soil management practices were practiced by most of the farmers from the early times onwards. The awareness domain on which the Paid Soil Health Card Users recorded comparatively lower score of 64.72 per cent was on the general awareness on soil health card scheme. This is quite logical as none of them depended on the scheme, though free, for soil test result. Rather they preferred to use the paid services as they were not convinced of the timely availability of results. With respect to the specific features of the SHC scheme such as the main slogan of SHC scheme, year of implementation, details of SHC portal and SHC implementation agency the awareness scores were 57.7 %, 60.00%, 57.7% and 83.3% respectively. The scores were indicative of the interest of the farmers in the benefits of the scheme and the importance they place on soil test results in soil management. However, they needed timely support for which they were inclined to pay rather than depend on a free scheme. This warrants better implementation strategy for the SHC scheme that can convince farmers who depend on soil test results.

4.2.3. Overall awareness of SHC scheme among Participant SHC users and Paid SHC users

Overall awareness of SHC scheme among Participant SHC users and Paid SHC users was done by using Mann-Whitney U test and the results from the Figure 3 indicates that on all studied components of SHC, except general information details of scheme, the paid soil test users, showed a better awareness score. This was indicative of the fact that it was not the unawareness among the paid users that made them not to opt for free SHC scheme. Therefore it can be inferred that they were willing to pay to get the paid benefits which were considered more reliable and timely for better soil health management.

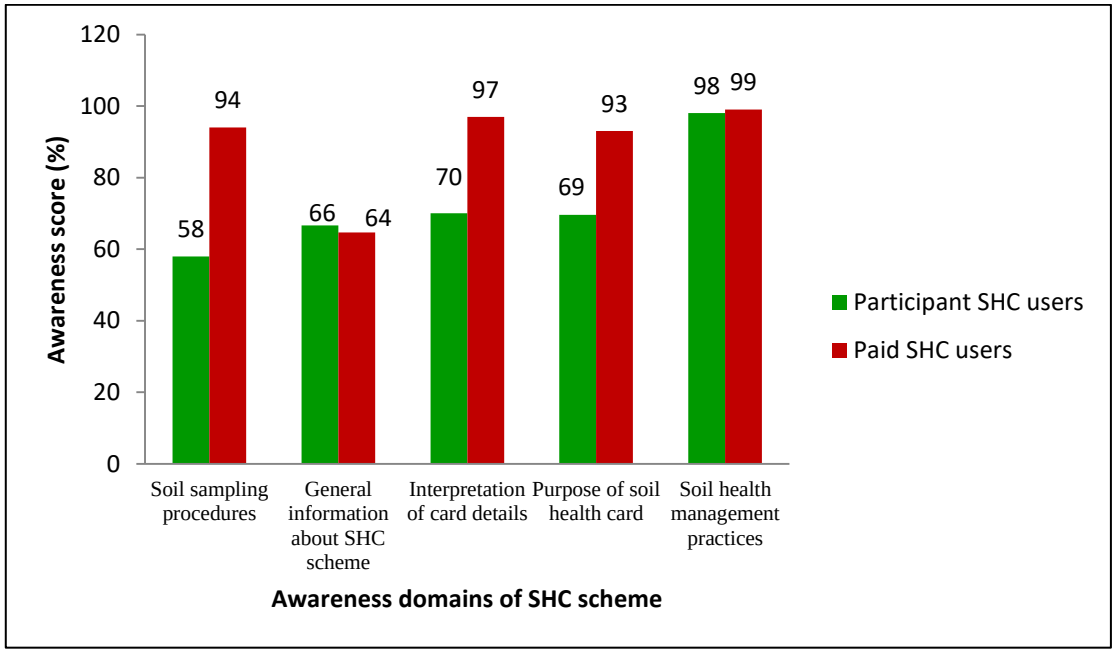


Figure 3: Overall awareness of SHC users on different domains of SHC scheme

Table 4.14 Comparison of Participant SHC users and Paid SHC Users on different domains of SHC scheme awareness score

Sl. No.	Awareness domain	Awareness score		Mann-Whitney U	Z value	Sig.
		Participant SHC User	Paid SHC User			
1	Soil sampling procedures	58.00	94.00	307.500	-2.703	0.008**
2	SHC scheme information	66.00	64.00	429.500	-0.290	0.886NS
3	Interpretation of card results	70.00	97.00	463.560	-3.460	0.008**
4	Advantages of SHC use	69.00	93.00	396.640	-2.410	0.015*
5	Soil health management	98.00	99.00	413.800	-0.306	0.886NS
	Overall Score	**362.11**	**448.24**	**210.000**	**-0.206**	**0.310NS**

**significance level 0.01, *significance level0.05

Table 4.14 indicates the comparative study between participant SHC users and paid SHC users on different domains of SHC scheme awareness score by using Mann-Whitney U test and the results indicated that even though there is no significant difference in the overall awareness score. There is significant difference in the individual components *viz.,* soil sampling procedures and interpretation of card details at 0.01 level of significance and advantages of SHC use at 0.05 level of significance respectively.

4.3. Spread of soil health card scheme in Thrissur district

Soil health card scheme was implemented in the year 2015, in order to understand the spread of SHC scheme in Thrissur district, secondary data was collected regarding the total number of farmers in each block and the total number of farmers covered in each block and calculated the percentage of farmers covered under the scheme (Table 4.15).

Table 4.15 Details of farmers covered under SHC scheme in Thrissur district (2017-2018)

Blocks	Total number of farmers	Farmers under SHC scheme	Percentage of farmers covered
Anthikkad	32494	5014	15.43
Chalakkudy	37440	10370	27.70
Chavakkad	24725	14097	57.02
Cherpu	22243	1822	8.19
Chowannur	50589	20134	39.80
Irinjalakuda	26031	9465	36.36
Kodakara	55364	11167	20.17
Mala	38150	9367	24.55
Mathilakam	52851	9886	18.71
Mullassery	20123	8818	43.82
Ollukkara	32573	11980	36.78
Pazhayannur	44000	13312	30.25
Puzhakkal	32845	6812	20.74
Thalikulam	32014	3845	12.01
Vellangallur	32110	7622	23.74
Wadakkancherry	26298	9383	35.68

Source: GOI, (2017)

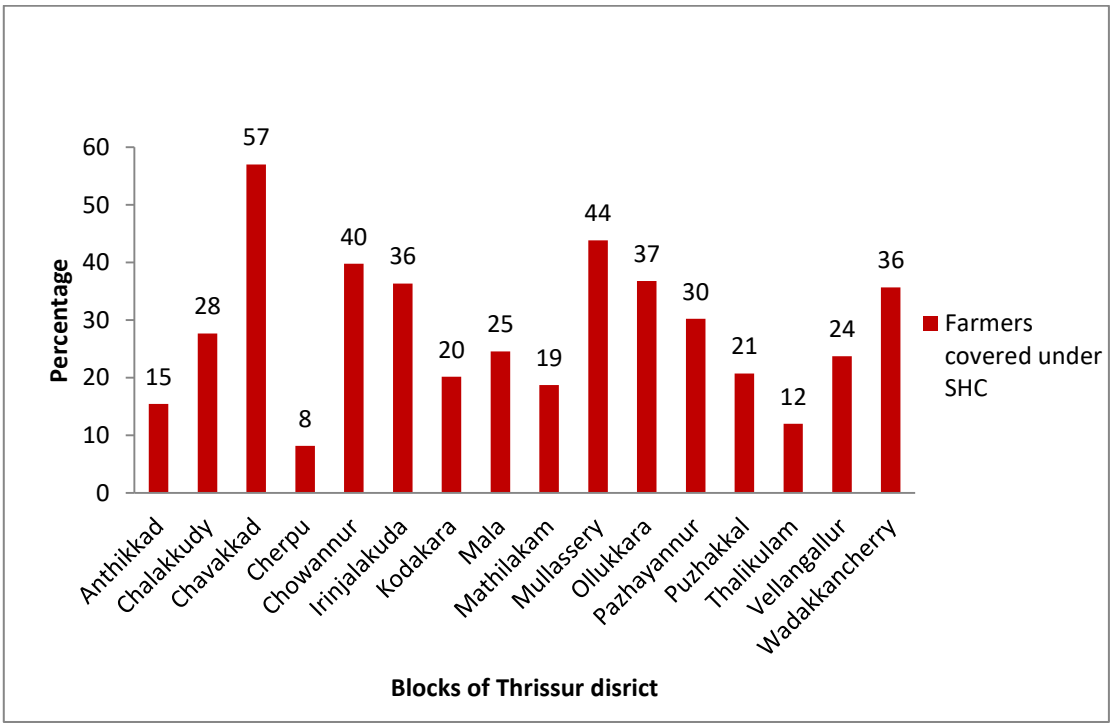


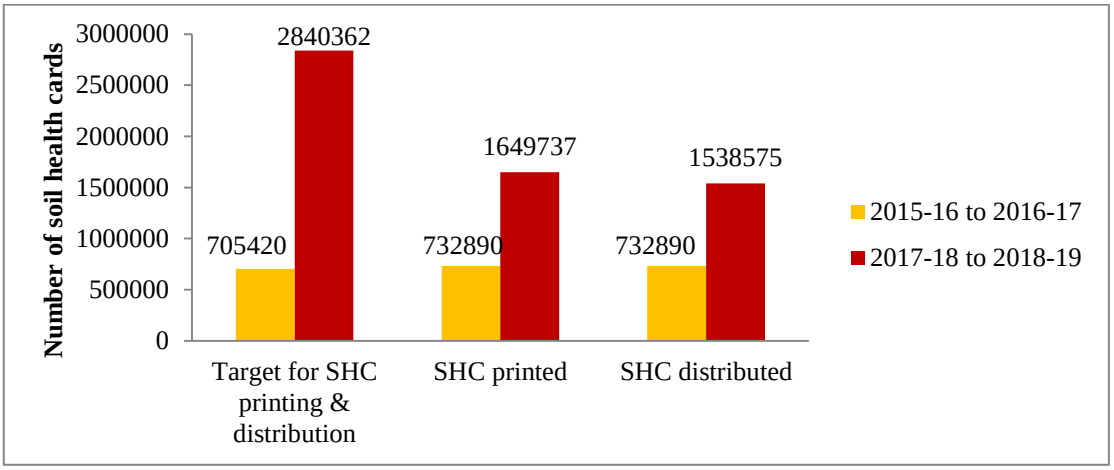
Figure 4: Spread of SHC scheme among farmers of Thrissur district (2017-18)

It is evident from Figure 4 that Chavakkad was the only block that covered more than 50 per cent of farmers. All other blocks, covered less than 50 per cent of farming community. The results implied that the scheme is yet to cover majority of farmers and efforts should be taken to increase the spread of SHC scheme. Thrissur being the district where the scheme was implemented in its early phase from 2015 itself, the relatively low spread warrants more effective strategies and time bound implementation. One of the mainly cause of the relatively poor spread of the scheme is that the scheme is major implemented through Soil Survey Department which is not the main stream extension agency. It neither has the back up of a local level office nor a regular field level officer and had to dependent on farmer group leaders for the collection of soil samples and distribution of the results. This caused delay in reaching the results to the farmers and loss of their faith in the scheme. Moreover, mere distribution of soil health cards could not serve the purpose of the scheme,

sustained efforts were needed by the extension agencies to convince the farmers to use the recommendations for obtaining sustainable yields over a period of time. This was quite lacking under the scheme and it was interesting to find that many farmers who used SHCs preferred for paid services for their timely delivery rather than the free services under SHC scheme.

4.3.1 Year-wise performance of target and achievement of SHC scheme in Kerala

The year wise performance of SHC scheme in Kerala was analysed. The figure 5 shows that in the year 2015-16 to 2016-17, the actual number of SHC printed and distributed were slightly more than the target. But in 2017-18 to 2018-19 the actual number of SHC printed and distributed were much lower than the target.



Source : (GOI, 2017)

Figure: 5 Year-wise performance of SHC scheme in Kerala

4.3.2 Time lag in Soil Health Card distribution

The time lag in SHC distribution among the farmers was studied and the results are presented as Figure 6. It revealed that half of the population sampled, that

is 50 per cent of the farmers had not received the soil health card at all. While, only 13 per cent had received it in less than 2 weeks. The results showed the inefficiency of the distribution channel of the implementation agency.

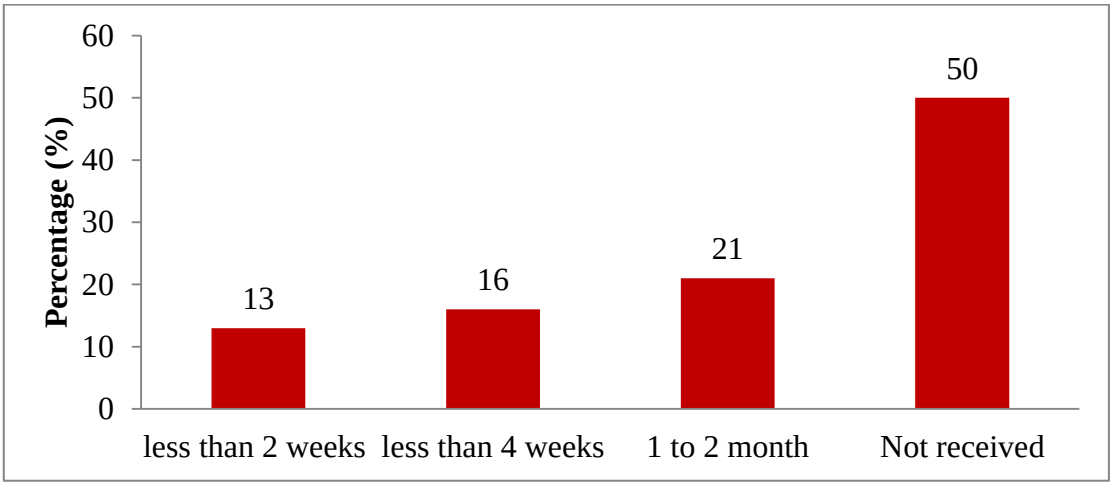


Figure 6: Trends in time lag in Soil Health Card distribution

4.3.3 Infrastructure facilities available in the Soil testing laboratories

The infrastructure facilities of the lab were also analysed. The figure 7 shows that majority of 68 per cent of officers stated that the facilities were average in condition and 18 per cent officers stated that the lab facilities needs improvement and only 14 per cent stated that facilities were good in condition. The officers stated that many of the equipment's in the soil test laboratories are old and non-functional and need immediate replacement. A number of labs are facing severe shortage of technical personnel for managing the soil testing laboratories, so government should focus on hiring employees for this program. Training of existing manpower is another area requiring immediate attention.

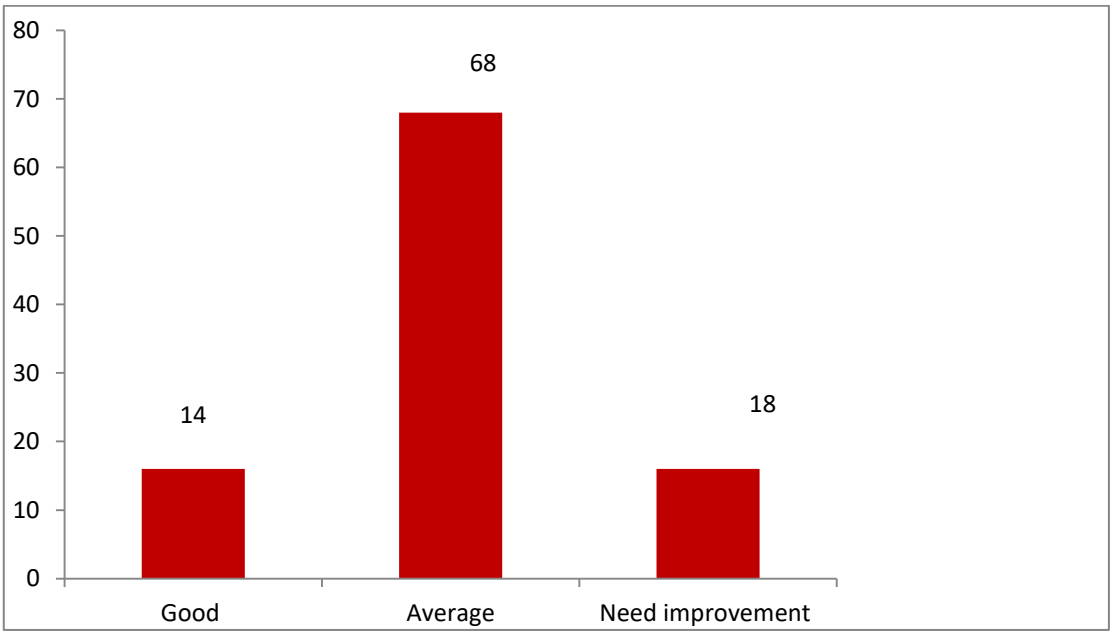


Figure 7: Rating of infrastructure facilities available in the Soil testing laboratories

4.3.4. Extent of adoption of SHC by farmers

Adoption of technology is the decision to make full use of a new idea as the best course of action available and involves a change in the orientation and behaviour of the farmer from the time he or she becomes aware of the technology to its adoption (Akubuilo *et al.*, 1982).Extent of adoption of soil health card by the participant Soil Health Card Scheme Users and Paid Soil Health Card Users was calculated using adoption index developed by Narain *et al.* (1991). The adoption index was adapted to suit the study. The six indicators selected for the index were the quantity of major fertilizers (N, P, K), organic manure, soil ameliorants and micronutrients applied by the farmers. The adoption index value is always nonnegative and lies between 0 and 1.The value of index closer to zero indicated low level of adoption and the value closer to one indicated high level of adoption.

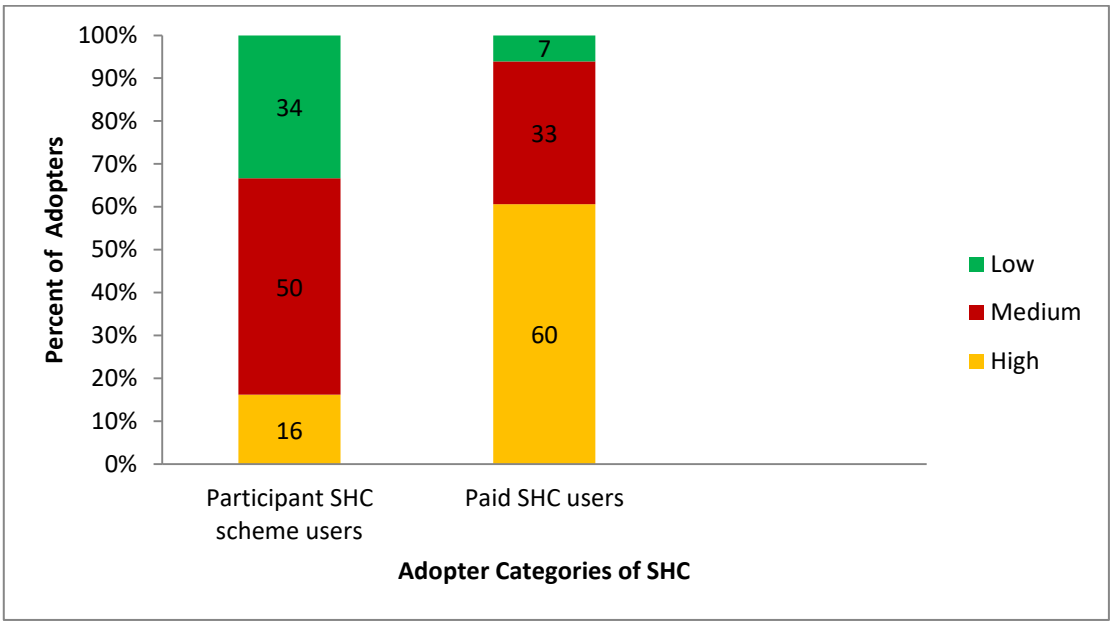


Figure 8. Distribution of SHC users on levels of adoption

It is evident from Figure 8 that 50 per cent of the participant SHC scheme users, were of medium adoption category, followed by 34 per cent low adopters and only 16 per cent belonged to the high adoption category. The main reason for the medium level adoption of soil health card by majority farmers can be related to the fact that most of farmers enrolled under the scheme were default beneficiaries and had limited knowledge about the importance of soil test based fertilizer recommendations and use. Proper guidance or follow up could not be ensured by the Soil Survey department that implemented the scheme as they lacked local level offices and field staff. They mostly depended on the farmer organizations and other field level farmer agencies for the collection of samples and distribution of results. In most of the cases the tests results reached the farmers late or in many cases even failed to reach the farmers from whom the samples were collected.

Chowdary and Theodore (2016) also observed with similar trend in their study in Andhra Pradesh where more than half of the SHC beneficiaries were not following the recommendation but used their own doses of fertilizers. However, in the case of

paid soil test users, it could be inferred that majority of the farmers (93 per cent), came under high and medium adoption category, and only 7.00 per cent belonged to low adoption category. The medium and low levels of adoption can be attributed to specific field level issues related to climate availability of water and inputs rather than with the SHC results. The results are in conformity with the theory of the importance of felt need of farmers in the adoption of technologies. Moreover, paid SHC users were convinced of the importance of soil test based fertilizer use as evident from their willingness to pay.

4.3.5. Adoption of SHC recommendations by different SHC users

The adoption index of Participant SHC scheme users and Paid SHC users were analysed to find out whether the two groups of respondents differed significantly on adoption of SHC recommendations by employing Mann Whitney U test. The results of the analysis are presented in Table 4.16

Table 4.16 Comparison of adoption of SHC recommendation by participant and paid SHC users

Sl. No.	SHC adopter category	Mean Adoption Index	Mann-Whitney U	Z	Sig.	Remarks
1	Participant SHC scheme user	0.47	306.500*	-2.142	0.032	Significant at 5% level
2	Paid SHC user	0.62				

Since the computed p-value (0.032) was less than p value at five per cent level of significance, (ie, p= 0.05), it could be inferred that the level of adoption of both categories of farmers were significantly different.

4.3.6. Comparative analysis of adoption of SHC recommendations by different adopter categories on their socio-economic characteristics

An attempt was made to analyse the relationship between socio-economic characteristics of different adopter categories and their adoption behaviour based on adoption index using Spearman's rank correlation. Results of Table 4.17 which indicate the correlation between the independent variables and adoption of SHC recommendations by Participant SHC scheme users and Paid SHC users revealed that, among selected variables age, farm size, annual income, leadership ability and social participation had no significant correlation with the adoption behaviour of both the adopter categories. However, irrigation facility and farming experience showed significant positive correlation with adoption for both the categories. It is also important to find that when scientific orientation recorded high significant positive correlation with adoption for both Participant SHC scheme users and Paid SHC users, whereas training and education showed significant correlation only for the Paid SHC users.

Table 4.17 Correlation of socio-economic variables with Adoption Index

Independent variables	Correlation coefficient (r)	
	Participant SHC User	Paid SHC User
Age	-0.104	0.002
Education	0.098	0.183**
Farm size	0.309	0.118
Farming experience	0.199**	0.299*
Annual income	0.283	0.090
Exposure to training	0.088	0.287**
Scientific orientation	0.368*	0.196*
Social participation	0.120	0.146
Irrigation facility	0.208**	0.396**
Leadership ability	0.304	0.050

* Significant at 5 % level, **Significant at 1% level.

4.4. Utility perception of soil health card

Perception is the process by which we receive information or stimuli from our environment and transform it into physiological awareness (Van den ban and Hawkins, 1996). Different statements related to perception were placed before the respondents and asked to give their opinion against each statement in form of agreement or disagreement. The results for Participant SHC scheme users and Paid SHC users are presented below.

4.4.1 Utility perception of Participant SHC scheme users

Results in Table 4.18 showed that the majority of SHC scheme users had favourable utility perception with respect to all aspects of the scheme except on the components of reliability of soil tests results and dependability on timely delivery of results. Most of them were enrolled on a group basis and had low awareness of the components of the scheme as evident from the results on awareness. With respect to the reliability of soil test results, only 40 per cent of the participant SHC scheme users displayed a favourable utility perception. The reason was attributed to the fact that the soil collection was done on a campaign mode under the local farmer groups wherein chances for mixing up of soil samples from different fields were high and in many cases farmers were not even informed of the results.

Only 40 per cent of the farmers indicated a favourable perception with respect to the dependability of the timely delivery of results. In fact, a major complaint from farmers about the scheme was that the soil health cards were not received on time and many a time after the crop season or never. This was mostly due to the lack of field level coordination in the implementation of the scheme. The results from Soil survey department was lying with the farmer group officials and ward members who could not deliver in time. However, with respect to the conviction of SHC use in crop production, 53 per cent of the farmers showed a favourable perception. This emerges from the fact that even before the implementation of the scheme many of them were

testing the soil under the guidance of the Krishi Bhavan and they were satisfied with the results also. This could have given an impetus to the scheme provided it had better reliable networks at the field level implementation.

Fertilizer application based on the need of the soil under SHC is perceived to reduce the cost of crop production. Majority of 57 per cent of the farmers under the study agreed that SHC use helped to reduce the cost of cultivation. Moreover, majority of the farmers (60 per cent) had the favourable perception that SHC helped in crop planning. The crop suitable for the individual field and their fertilizer recommendation was clearly displayed in the card, and this will helped the farmers in choosing the ideal crops for their fields. Regarding the complexity of information provided in the SHCs, only 33 per cent felt that there was information overload of which only few were of direct relevance to farmers.

Table 4.18 Distribution of participant SHC scheme users based on utility perception (n=30)

Sl. No.	Utility perception dimension	Favourable perception (%)	Unfavourable perception (%)
1	Reliability of soil test results	12 (40.00)	18 (60.00)
2	Conviction in the use of SHC for better crop yields	16 (53.33)	14 (47.00)
3	Reduced cost of production from SHC use	17 (57.00)	13 (43.00)
4	Use in systematic crop planning	18 (60.00)	12 (40.00)
5	Dependability of timely delivery of results	13 (40.00)	17 (60.00)
6	Complexity of SHC recommendations to interpret	10 (33.00)	20 (67.00)
7	SHC is effective only if supplemented with free inputs	15 (50.00)	15 (50.00)

The reason was revealed from the fact that many farmers felt that they only require the fertilizer recommendation for their crops and they were not concerned

about the nutritional status of the soil. However, it was significant to find that the majority of (67 %) famers did not find the information complex, rather they found it as useful for their soil health management.

There were 50 per cent of the farmers who perceived free supply of soil test based inputs as an essential prerequisite for the successful utilization of SHC results. They felt that the recommendations regarding the inputs alone will not serve the purpose. However, it was significant to note that an equal 50 per cent farmers were unfavourable to the free supply of inputs, they depended on the scheme just for the right recommendations for soil health management at the right time. Results of the study is in line with Mukati *et al.* (2018).

4.4.2 Utility perception of Paid SHC users

The results in Table 4.19 indicated that a high majority of respondents were having favourable perceptions on all the dimensions of SHC utility assessed. The results are in line with the fact that these farmers paid for soil testing even when there were free schemes just to ensure reliability and timely delivery.

Regarding the reliability of SHC, 90 per cent of the farmers were having favourable perception. This could be attributed to the fact that the soil samples were collected by themselves and could not find any chance of a mix up of the results.

With respect to the conviction in the use of soil testing in crop production, 83 per cent of the Paid SHC users were having favourable perception. The reason was that many of these farmers relied on these results to take corrective measures needed for their farms. They fixed nutritional deficiencies observed in the field based on the results and were convinced of the results it produced in the yield of crops.

Majority of 67 per cent of the Paid SHC users agreed that soil testing helped them to reduce the cost of cultivation and thus indicating a favourable perception towards the utility of SHC use in this. These farmers favoured application of only the

required amount of fertilizers to the soil, thereby avoiding the wastage of input and contamination of environment. This indirectly contributed to the reduced cost of cultivation.

Majority of the farmers (93 %) were having favourable perception that SHC helped in crop planning. As some farmers had difficulties in choosing the suitable crop for their field, they relied on SHC in selecting the ideal crop for their field. Also on the timely receipt of soil test results, majority 97 per cent of the farmers were having favourable perception. These farmers received the results on time which helped them in taking farm decisions without any delay.

Table 4.19 Distribution of Paid SHC users based on utility perception (n=30)

Sl. No.	Utility perceptions	Favourable perceptions (%)	Unfavourable perceptions (%)
1	Reliability of soil test results	27 (90.00)	03 (10.00)
2	Conviction in the use of SHC for better crop yields	25 (83.00)	05 (17)
3	Reduced cost of production from SHC use	20 (67.00)	10 (33.00)
4	Use in systematic crop planning	28 (93.00)	02 (7.00)
5	Dependability of timely delivery of results	29 (97.00)	01 (3.00)
6	Complexity of SHC recommendations to interpret	02 (07.00)	28 (93.00)
7	SHC is effective only if supplemented with free inputs	04 (13.00)	26 (87.00)

Regarding the information provided in the SHC cards, vast majority of 93 per cent of the Paid users found the information in the SHC adequate enough to understand the current nutritional status of the field. The details were indicative as to whether the nutrients were optimum, deficit or in toxic levels and also the crop wise fertilizer recommendations. Only a minority of seven per cent perceived the details

to be complex which could be attributed to their personal inability rather than the defect of the SHC.

Supplementing the SHC results with free inputs was not favoured by a large majority of 87 per cent of the paid SHC users. About 13 per cent of the farmers perceived favourably towards free government supply of necessary inputs.

4.5 Comparison of soil management practices by farmers

Soil health management is one of the important interventions under National Mission for Sustainable Agriculture. Soil management practice is an integral part of cultivation that aims at promoting site specific approaches which generally includes integrated nutrient management (INM), balanced and judicious use of chemical fertilizers, use of secondary and micronutrients in conjunction with organic manure and the addition of soil amendments in order to reclaim acidic or alkaline soil.

Table 4.20 represents the different components of soil management practices such as primary nutrient management of farmers, which includes exclusive use of either inorganic or organic manures or an integrated use of both, the number of application of fertilizers, (two, three or as multiple split doses), the quantity of fertilizer (Urea, SSP and MOP), micronutrients and soil ameliorants applied by the farmers.

Extent of use of the soil management practices of both SHC users and non-users is found out by using adoption index and comparison between users and non-users was done by using Mann-Whitney U test. Regarding the primary nutrient management of both SHC users and non-users, there is no significant difference between SHC users and non-users as p value=0.509.

Table 4.20 Comparison of soil management practices by SHC users and non users

Sl. No.	Soil management practice	Evaluation criterion	Extent of use (AI)		Mann-Whitney U	Z value	Sig.
			SHC user (60)	SHC non user (60)			
1	Primary nutrient management	Exclusive use of organics	0.40	0.50	806.4	-0.31	0.50
		Exclusive use of inorganic					
		Integrated use					
2	Number of applications	02 splits	0.60	0.58	563.2	-0.43	0.60
		03 splits					
		Multiple splits as recommended					
3	Urea, SSP and MOP	>recommended	0.50	0.41	680.1	-4.14	0.04 *
		< recommended					
		As recommended					
4	Micronutrients	>recommended	0.50	0.66	603.5	-3.13	0.01 *
		< recommended					
		As recommended					
5	Soil ameliorants	>recommended	0.40	0.50	403.3	-0.30	0.58
		< recommended					
		As recommended					

** Significant at 1 % level * Significant at 5 % level

Majority of the farmers were adopting integrated method of farming, comprising of both organic and inorganic fertilizers. In case of the number of application of fertilizers, also there is no significant difference as p value = 0.600. Majority of the farmers were applying fertilizers as multiple split doses.

With regard to the quantity of fertilizer (Urea, SSP, MOP) applied, there is significant difference between users and non-users as p value= 0.044.These findings are in concordance with Srivastava and Pandey (1999). In case of micronutrient use also there is significant difference between the users and non-users (p value=0.017*).

It was found that non-users were applying micronutrients in lower quantities and majority of them were not giving much importance to the micronutrient application. With regard to the soil ameliorant use there is not much difference between the users and non-users.

4.5.1 Results of binary logistic regression

Binary logistic regression is used to predict the odds of being a case based on the values of the independent variables. The odds are defined as the probability that a particular outcome is a case divided by the probability that it is a non-case. Table 4.21 shows the binary logistic regression of SHC users and non-users with socioeconomic variables and average crop yield taken as independent variables.

It could be observed from the Table 4.21 that, education, farming experience, irrigation and yield were the variables in which the changes could lead to a change in adoption behaviour. The calculated value of odds of improvement showed that a change in the level of education, farming experience, irrigation or yield could bring a corresponding chance of 64, 30, 31 and 67 per cent respectively for a non-user to become a user of SHC results.

Table 4.21 Binary logistic regression summary

Sl. No	Variable	B	Sig.	Exp. B	Odds of improvement (%)
1	Age (x_1)	-0.038	0.922	0.963	49
2	Education (x_2)	0.615	0.009**	1.849	64
3	Farm size(x_3)	0.283	0.391	1.327	57
4	Farming experience (x_4)	-0.82	0.022*	0.44	30
5	Annual income(x_5)	0.54	0.123	1.716	63
6	Training (x_6)	0.586	0.103	1.798	64
7	Social participation	0.11	0.753	1.116	52
8	Scientific orientation (x_8)	-0.522	0.163	0.593	37
9	Irrigation (x_9)	-0.786	0.001*	0.456	31
10	Leadership (x_{10})	-0.183	0.525	0.833	45
11	Yield (x_{11})	0.749	0.002**	2.116	67
12	Constant	-1.577	0.477	0.207	17

*significant at 5 % level, * *significant at 1 % level

Regression equation : $\ln\left(\frac{p}{1-p}\right)$ = -1.577- $0.038x_1$+$0.615x_2$+$0.283x_3$-$0.82x_4$+0.54 x_5+0.58 x_6+0.11 x_7-0.522 x_8-0.786 x_9-0.183 x_{10}+0.749 x_{11}.

4.5.2 Labour utilization for soil management practices

Labour is also one of the critical component of factors of production. Figure 9 represents the labour used for soil management practices used by different categories of farmers. It is apparent from the Table 4.22 that, there is no considerable difference among the different categories of farmers in labour use.

Majority of the farmers were employing both family and hired labour. A slight variation is observed in the participant SHC users where they utilise family labour more than hired labour in handling the different soil management practices.

Table 4.22 Labour use pattern in soil management

Labour used	Participant soil health card scheme users (n=30)	Participant non-user farmer(n=30)	Non-participant farmers(n=60)	Paid soil test users(n=30)
Family labour	12 (40)	08 (27)	09 (30)	13 (22)
Hired	11 (37)	10 (33)	10 (33)	21 (35)
Both	07 (23)	12 (40)	11 (37)	26 (43)

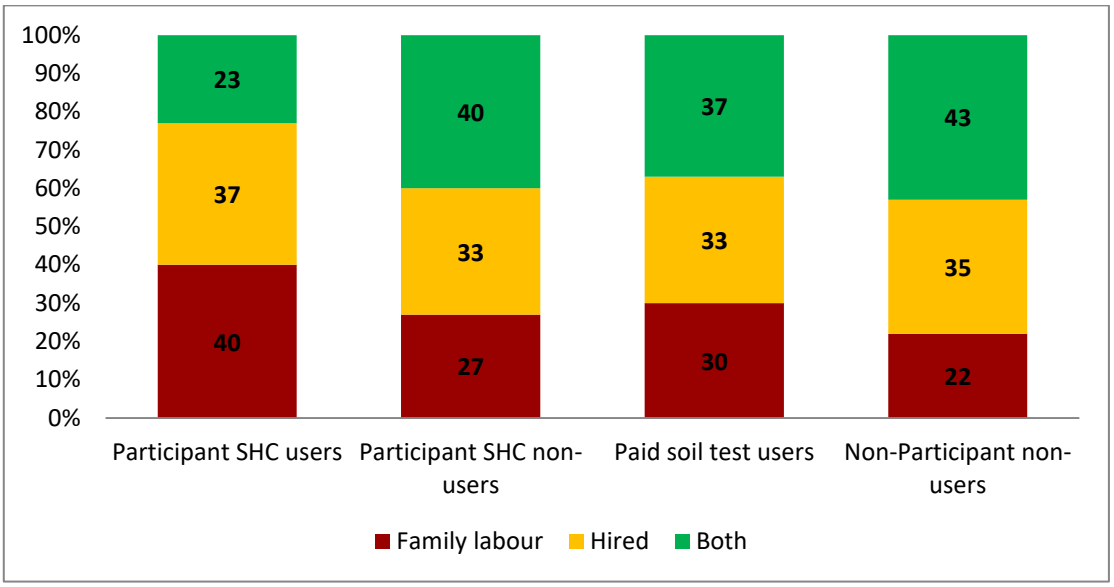


Figure 9. Labour utilization for soil management

4.5.3. Comparison of average yield of farmers

The result of the analysis for the productivity of three major crops grown in the farmland of participant SHC users and non-users are presented in Table 4.23. The result conveyed that the average yields of major crops such as Banana and Paddy were slightly higher for the participant SHC users and paid SHC users. Average yield of Banana in the fields of participant SHC users and paid SHC users were 26250 kg/ha and 27000 kg/ha respectively whereas that of non-users belonging to the

scheme and others were 25666 kg/ha and 23583 kg/ha respectively. Average yield of Paddy in the fields of participant SHC users and paid SHC users were 1400 kg/ha and 1463kg/ha respectively whereas that of non-users belonging to the scheme and others were 1313 kg/ha and 1296 kg/ha respectively.

Table 4.23 Average yield of major crops grown by the respondents

Major Crops	Participant SHC users (30)	Participant Non users (30)	Paid SHC users (30)	Non-users (60)
Coconut (Nuts/ha/year)	9468	9370	9457	9437
Banana (Kg/ha)	26250	25666	27000	23583
Paddy (Kg/ha)	1400	1313	1463	1296

Table 4.24 Comparison of crop yield by Kruskal -Wallis one way analysis of variance

	Coconut (Nuts/ha/year)	Banana (Kg/ha)	Paddy (Kg/ha)
Participant SHC users (30)	76.22	77.80	76.82
Participant SHC non-users (30)	73.55	84.83	71.82
Paid SHC users (30)	77.05	90.57	91.52
Non-users (60)	75.34	62.15	68.68
Chi-Square	0.110	11.625	6.013
Asymp. Sig.	0.991	0.009**	0.023*

** significance at 1% level ,*significance at 5% level

The results of p value in Table 4.24 showed that the participant SHC users and non-users differs significantly in productivity of banana at 0.01 level of significance

and productivity of paddy at 0.05 level of significance, although there was no significant difference found between SHC beneficiaries and non-beneficiaries for productivity of Coconut. As coconut being a perennial crop, in which the results is not immediately visible whereas in case of Banana and Paddy the results were immediately visible. The results are in agreement with Makadia *et al*. (2017), Bordoloi and Das (2017).

4.6. Constraints in SHC scheme

A constraint refers to situation or circumstances which impede or restrict the activity or performance of an individual. In the present study, it was operationalized as the items of difficulties faced by the farmers and the implementing officers in the effective implementation of SHC scheme. The information regarding constraints experienced by them were collected using a standardized interview schedule and ranked based on the severity of problems. The ranks given by the respondents were converted into mean score by using Garrett ranking method and the results are presented under the following sub heads.

4.6.1 Constraints faced by SHC scheme members

Soil health card was an ambitious scheme aimed to improve soil health of Indian farmers. Though the services are free under the scheme, farmers face a lot of impediments in getting full benefits of the scheme. The results of the constraints faced by the SHC scheme members from the study are presented in Table 4.25. The results from the table indicated that majority of farmers (68 Garett score) were concerned about the time gap between soil sample collection and issue of SHCs which was too long and seldom met time limits of crop seasons. The reason was that there were no proper field level staffs to supervise the collection of soil samples from the farmer's field and there was no proper channel for the distribution of SHCs. In certain cases they send the cards directly to the farmers through postal service. But the officers said that there was no provision under the scheme to meet the costs

involved. This made them to use the services of elected representatives such as Panchayath member, Padasekharasamiti representatives etc mostly for the distribution of SHC. However, most of these representatives failed in the timely dispersal of cards and the implementing agencies could not ensure the timely receipt of SHC to the farmers. Poor lab infrastructure was another reason that caused the time lag in the distribution of cards

Another major constraint as reported by farmers (62 Garett score) was the lack of knowledge among farmers in interpreting the SHC recommendations for use. It can be attributed to the inadequate guidance to the farmers from the implementing agencies. There were no training or soil collection campaigns organized under the scheme which could guide the farmers properly. The respondents also revealed that the soil sample collection was not done in the presence of farmers and this created doubts among the farmers about the authenticity of soil test results as they feared the soils were not collected from their fields.

Table 4.25 Constraints faced by soil health card scheme members (n=60)

Sl. no.	Constraints	Garret score	Rank
1	Time gap between soil sample collection and issue of SHC	68.23	1
2	Lack of knowledge among farmers for using soil health card	62.00	2
3	Collection of soil sample in the absence of farmers	59.00	3
4	Lack of training in use of soil health card	55.00	4
5	Lack of Extension advisory support in SHC use	53.00	5
6	Unreliable crop production results by following SHC recommendations	46.38	6
7	No awareness about method of taking soil sample	42.20	7

This too is attributed to the lack of proper field staff and the local people representatives chosen by the agencies were not paying much effort to do the task it in a scientific way as they were not trained properly. Lack of training in soil health management (55 Garett score) was another constraint expressed by the farmers. The implementing agency did not have field staff and as such much effort was not taken for the conduct of any training programmes for farmers regarding soil health management. Moreover, there were no training component under the scheme which limits farmers from obtaining full benefit of the scheme.

Lack of extension advisory support in SHC use was another constraint (53 Garett score) expressed by the farmers. Effective utilisation of the scheme warrants the presence of field level experts to clear doubts of farmers at the time of their need in a scientific way Another constraint expressed by farmers was the unreliability of crop production results by following SHC recommendations. Efforts should be taken by the implementing agency to make them aware about the results they obtain by practising farming in a scientific way. Some of the farmers reported (42.20 Garett score) that they were unaware of the method of taking soil samples. So proper training should be given by the experts to educate them about the sampling methods. This in turn will also increase the credibility of soil test results. The findings of this study support the findings of Patel *et al.* (2017), Mukati (2018) and Patel (2013).

4.6.2. Constraints of the officers in SHC scheme implementation

The major constraint observed in the effective implementation of the scheme as per the results from Table 4.26 was unavailability of field staffs for taking samples. It showed a high Garret score of 62.20. The very success of the programme depended on the effective collection of soil samples and needed to be done in a very scientific manner. Improper collection of soil samples often gave incorrect test values therefore many times farmers could not be convinced of the real benefits of soil testing in their fields. So there was a felt need among the officers that the sample collection should be done by properly trained experts of the implementing agency. Therefore, adequate

number of field officers should be ensured by the agency for effective implementation of the scheme.

Another major constraint reported by the officers was the difficulties involved in soil collection with Garret score of 60.40. Collection of soil samples from different localities was a difficult task which needed support and guidance of field officers, proper labelling to prevent mixing of samples and adequate transportation facilities. Coordination of all these in a time bound manner could not be managed by the implementing agencies involved as they lacked field staff and offices. Lack of farmer's interest in soil testing and lack of good infrastructure facilities in the lab shared a Garret score of 54.00. Effective implementation of any scheme was related to the interest of the beneficiaries and SHC scheme cannot be an exception

Table 4.26 Constraints faced by implementing officers of soil health card scheme

Sl. no.	Constraints	Garret score (n=30)	Rank
1	Unavailability of field staffs for taking samples	62.20	1
2	Soil collection is difficult	60.40	2
3	Farmers lack interest in soil testing	54.00	3
4	Poor lab infrastructure	53.00	4
5	No proper usage of budget	51.50	5
6	Lack of resource persons	50.40	6
7	Lack of mobile soil testing vans for soil collection	42.00	7
8	Number of soil testing labs is less	28.00	8

Implementing officers felt that many of the farmers were not convinced of the benefits of soil test use in farming and need to be educated of the importance of soil

testing. They perceived that more awareness campaigns and training programmes should be conducted by the implementing agencies in order to educate the farmers about the importance of soil test based fertilizer application. Moreover, the time bound distribution of soil test results depended on good infrastructural lab facilities which needs to be ensured by the implementing agency. Poor lab infrastructure is also one of the constraints faced by majority of the implementing officers.

Budget use was another constraint expressed by the officers which ranked fifth. Proper and effective functioning of any scheme depended on adequate budget provisions and its allocation by the government at the right time. Many a time delayed budget allotments and lack of flexibility of fund use as per field requirement has plagued the scheme. Lack of resource person (50.4 Garett score), lack of mobile soil testing vans for soil collection (42.0 Garett score), and the low number of soil testing labs (28.0 Garett score) also emerged as constraints lower ranked constraints by the officers. This finding is in conformity with the findings of Chaudhary (2018).

Summary and Conclusion

Chapter 5
SUMMARY AND CONCLUSION

5.1 Introduction

The Green Revolution was instrumental in transforming food deficit India into a food surplus country. Chemical fertilizers along with High Yielding Varieties and irrigation formed the critical components of the process. However, over the years there has been indiscriminate use of chemical fertilizers to boost crop production. This has resulted in the degradation of soil health and the quality of agricultural produce. Besides it has also lead to the contamination of the environment and natural resource base of agricultural systems. This has warranted judicious use of chemical fertilizer which forms an indispensable component in sustaining agricultural productivity. However, indiscriminate use of the same will have adverse effect on soil and plant health and also escalate the cost of cultivation. It is in this context the Government of India has launched the soil health card (SHC) scheme in 2015 to promote soil test based and balanced application of fertilizers. Soil health card is the printed report which recommends chemical fertilizers judiciously in combination with organic manures and bio fertilizers. Soil health card can be used as part of an overall integrated nutrient management (INM) program to reduce the environmental hazards from undiscerning chemical fertilizers. It was considered imperative to know the effectiveness of the scheme and the extent to which Soil Health Card recommendations are followed by the farmers. Keeping this view in mind, the present research study entailed "Utilization of soil health card by the farmers of Thrissur district" was undertaken with following specific objectives.

5.2 Specific objectives

1. To analyze the spread & extent of use of soil health cards (SHCs) by the farmers of Thrissur district
2. To study the utility perception of farmers about soil health cards in crop production

3. To compare the soil management practices by different categories of SHC users and non-users
4. To determine the challenges in the implementation of soil health card scheme

5.3. Research methodology

Ex-post-facto research design was used for the study. Thrissur district which covered maximum number of (13761) farmers among the 14 districts of Kerala, under the SHC scheme was purposively selected for the study. From the list of blocks which implemented SHC scheme in the district, two blocks (Ollukkara and Wadakkancherry) with maximum farmer coverage were also purposively selected. From each of these selected blocks, 30 farmers with and without SHCs were randomly selected for comparison. Comparison was also be made with another sample selected randomly from paid soil health card users in the district using the data from Radio Tracer Lab (RTL) of Kerala Agricultural University. Soil Survey Department officials who implemented the SHC scheme in the district were also surveyed taking a random sample of 15 officers each from the selected blocks. Thus the total sample size selected for the study was 180.

Primary data was collected through personnel interviews for which pretested structured schedules were used. Secondary data was collected from Soil Survey Department, soil testing labs, RTL and published sources of information on SHC scheme.

5.4 Major findings of research

5.4.1 Awareness of Participant SHC users on components of SHC scheme

- Only 58 per cent of the farmers were aware of the procedure for taking soil samples, time for soil collection, suitable sites for taking samples and 57 per cent were aware of the time gap between collection of two samples for testing.
- Majority of the participant soil health card users (66.66 per cent) were aware about the general aspects of the scheme.

- With respect to the interpretation of soil test results, only 57 per cent of the farmers were aware of parameters such as micronutrients, about pH (58 per cent) and EC (57 per cent).
- Regarding the use of soil health card, only 69.62 per cent of the farmers were aware about the benefits such as crop planning, savings in input cost, soil nutrition management, promotion of INM, judicious use of fertilizers and improvement in productivity.
- Majority (98 per cent) of the participant soil health card users were aware of the different components in general soil health management practices, such as green manuring, crop rotation, cover cropping and minimum tillage.

5.4.2 Awareness of Paid Soil Health Card Users on SHC scheme

- Paid Soil Health Card Users had an overall awareness score of 461.52 and on all selected awareness domains they had uniformly high scores except on general information on SHC scheme wherein they scored 64.72 per cent. This was low compared to scores on the awareness domains of soil sampling procedures (94.0%), interpretation of the SHC results (97.5%), advantages of soil health card use (93.0%) and soil health management practices (99.0%).
- Majority (94%) of the Paid Soil Health Card Users were aware of soil sampling procedures related to soil sample collection.
- They also showed uniformly high awareness score on all the five parameters of soil collection procedures viz. method (100.00), time (97.77), suitable sites (97.77), optimum quantity (90.00) and time gap (83.33) for soil sample collection.
- Even with respect to micronutrients and pH interpretations the awareness score was 95.55 per cent. EC also recorded high awareness score of 96.66 per cent.

- Awareness score of the farmers on the use of soil test results for crop planning and improved productivity was 83.33 per cent and 80.00 per cent respectively.
- With regard to the general soil management practices, it was observed that 99.9 per cent of the farmers were fully aware of the different soil health management practices such as green manuring (100.00%), crop rotation (97.77%), cover cropping (100%) and minimum tillage (97.77%).
- Regarding the specific features of the SHC scheme such as the main slogan of SHC scheme, year of implementation, details of SHC portal and SHC implementation agency the awareness scores were relatively low as 57.7 %, 60%, 57.77% and 83.33% respectively.

5.4.3 Extent of adoption of SHC by farmers

- With regard to the participant SHC scheme users, 50 per cent were of medium adoption category, followed by 34 per cent low adopters and only 16 per cent belonged to the high adoption category
- It could be inferred that majority of the Paid soil test users (60 per cent), came under high adoption category, followed by 33 per cent under medium level of adoption and only 7 per cent belonged to low adoption category.
- Irrigation facility and farming experience showed positively significant correlation with adoption at 0.05 level for both SHC scheme users and paid soil test users.
- Scientific orientation recorded positive and significant relation with adoption at 0.01 level for both Participant SHC scheme users and Paid SHC users, training and education showed significant relation only for the Paid SHC users at 0.01 and 0.05 levels of significance respectively.

5.4.4 Utility perception of Participant SHC scheme users

- With respect to the reliability of soil test results, only 40 per cent of the participant SHC scheme users displayed a favourable utility perception.
- Only 40 per cent of the farmers indicated a favourable perception with respect to the dependability of the timely delivery of results.
- However, with respect to the conviction of SHC use in crop production, 53 per cent of the farmers showed a favourable perception.
- Majority of 57 per cent of the farmers under the study agreed that SHC use helped to reduce the input cost.
- Majority of the farmers (60 %) had the favourable perception that SHC helped in crop planning
- Regarding the complexity of information provided in the SHCs, only 33 per cent felt that there was information overload of which only few were of direct relevance to farmers.
- There were 50 per cent of the farmers who perceived free supply of soil test based inputs as an essential prerequisite for the successful utilization of SHC results

5.4.5 Utility perception of Paid SHC users

- Regarding the reliability of SHC, 90 per cent of the farmers were having favourable perception.
- With respect to the conviction in the use of soil testing in crop production, 83 per cent of the Paid SHC users were having favourable perception.
- Majority of 67 per cent of the Paid SHC users agreed that soil testing helped them to reduce the cost of cultivation and thus indicating a favourable perception towards the utility of SHC use in this.
- Majority of the farmers (93 %) were having positive perception regarding the timely receipt of results
- Majority of the farmers (93 %) were having favourable perception that SHC helped in crop planning.

- Regarding the information provided in the SHC cards, vast majority of 93 per cent of the Paid users found the information in the SHC adequate enough to understand the current nutritional status of the field.
- Supplementing the SHC results with free inputs was not favoured by a large majority of 87 per cent of the paid SHC users. About 13 per cent of the farmers perceived favourably towards free government supply of necessary inputs.

5.4.6 Comparison of soil management practices by farmers

- With regard to the quantity of fertilizers (Urea, SSP, MOP) applied, there is significant difference between users and non-users at a p value of 0.44.
- In micronutrient use also there was significant difference between the users and non-users (p value=0.017*).
- Results of binary logistic regression revealed that among the different variables considered regression coefficients were positive for education, farm size, annual income, training, social participation and yield. The odds ratios were high for these variables (greater than one). High significance of the regression coefficients for yield and education show that these variables have more influence on the use of soil health card. The odds ratios were high (greater than one) for all the above variables and consequently, the corresponding probabilities were also high (greater than 0.5)

- The results of p value showed that the participant SHC users and non-users differed significantly in productivity of banana at 0.01 level of significance and productivity of paddy at 0.05 level of significance, although there was no significant difference found between SHC beneficiaries and non-beneficiaries for productivity of Coconut.

5.4.7 Constraints faced by SHC scheme members

- Majority of farmers (68 Garett score) were concerned about the time gap between soil sample collection and issue of SHCs which was too long and seldom met time limits of crop seasons.
- Another major constraint reported by (62.0 Garett score) of the farmers was the lack of knowledge among farmers in interpreting the SHC recommendations for use.
- Collection of soil samples in the absence of farmers is also a major constraint faced by the farmers (59.00 Garett score) which affects the reliability of the results.
- Lack of training in soil health management was another constraint expressed by (55 Garett score) the farmers.
- Lack of extension advisory support in SHC use was another constraint expressed by (53 Garett score) the farmers.
- Another constraint expressed by farmers (46.38 Garett score) was the unreliability of crop production results even under adoption of SHC recommendations.
- Some of the farmers (42.20 Garett score) reported that they were unaware about of the method of taking soil samples

5.4.8 Constraints of the officers in SHC scheme implementation

- The major constraint observed in the effective implementation of the scheme was unavailability of field staffs for taking samples (62.20) .
- Another major constraint reported by the officers was the chances of mix up of soils collected without proper supervision and control by officers with Garret score of 60.40.
- Lack of farmer's interest in soil testing and lack of good infrastructure facilities in the lab shared a Garret score of 54.00.

5.4.9 SUGGESTIONS FOR FUTURE RESEARCH

- The study was carried out under limitations of time and resources available with researcher, covering only Thrissur district of Kerala. It is true that a finding of single study is not adequate to make any generalized conclusion. Therefore, it is necessary to replicate the same study in other districts of the state and country where such conditions are prevailing.
- An impact study on Soil Health Card may be conducted to bring out the extent to which it has influenced the socio-economic and environmental domains of farming.
- The area of research may be extended further to cover the entire state and sufficiently large number of farmers should be studied to draw more valid and general conclusions.
- Existing constraints faced by the SHC users and implementing officers need to be addressed through solutions evolved through these investigations.

References

References

Ahmed, S., Riazuddin, M., and Reddy, K. P. V. 2002. Optimizing fertilizer doses for rice in alluvial soils through chemical fertilizers, farm yard manure and green manure using soil test values. *Agropedology* 12(2): 133-140.

Akubuilo, C. J. C. 1982. Adoption of innovations among farmers in Anambra State. M. Sc. (Ag.) thesis, University of Nigeria, Nsukka, 124p.

Anupama, S. 2014. Content development for an agricultural expert system on organic vegetable cultivation. M. Sc. (Ag.) thesis, Kerala Agricultural University, Thrissur, 134p.

Asthana, A. and Kumar, S. 2008. Soil health and sustainable crop production: Adoption and awareness of soil testing. *J. Sustain. Agric.* 32(2): 303-320.

Ayoub, A. T. 1999. Fertilizers and the environment. *Nutr. Cycl. Agroecosy.* 55(2): 117-121.

Bagal, Y. S., Sharma, L. K., Kaur, G. P., Singh, A., and Gupta, P. 2018. Trends and patterns in fertilizer consumption: A case study. *Int. J. Curr. Microbiol. App. Sci.* 7(4): 480-487.

Bala, B., Sharma, R. K., and Sharma, S. D. 2005. Factors influencing fertilizer production and consumption in India. *Indian J. Agric. Res.* 39(2): 146-149.

Bandypadhyay, S., Ray, P., and Ray, S. K. 2016. Present status and future strategies to maintain the soil health in the North East India In: *National Seminar on 'Bringing Second Green Revolution in North East India',* 11-12 Feb. 2016, India [on-line]. Available: https://www.researchgate.net/publication/322306853 [12Feb.2018].

Beena, V. I., Dey, P., and Rajimol, R. P. 2018. Soil test based fertilizer recommendations under integrated plant nutrition system for vegetable cowpea [*Vigna unguiculata* (L) Walp] in Ultisols of Kerala, India. *Int. J. Curr. Microbiol. App. Sci*. 7(1): 2420-2425.

Bhagyamma, S. and Bhat, A. R. S. 2017. An analysis of pattern and growth of fertilizer consumption in Karnataka state. *Int. J. Curr. Microbiol. App. Sci.* 6(12): 568-573.

Bhatt, P. M., Patel, H. B., and Patel B. M. 2009. A study on awareness about soil health card.

Gujarat J. Ext. Educ. 20(21): 53-54.

Biswas, P. P. 2002. Soil testing at farmer's door step. *Fertil. news* 47(10): 21-24.

Bodake, K., Ghate, R., Doshi, H., Jadhav, P., and Tarle, B. 2018. Soil based fertilizer recommendation system using internet of things. *MVP J. Eng. Sci.* 1(1): 13-19.

Bordoloi, J. and Das, A. K. 2017. Impact of soil health card scheme on production, productivity and soil health in Assam. Agro-Economic Research Centre for North-East India, Assam Agricultural University, Jorhat, [on-line].Available from:http://www.aau.ac.in/data/reports/Impact-of-Soil-Health-Card-Scheme.pdf

Chand, R. and Pavithra, S. 2015. Fertiliser use and imbalance in India. *Econ. Political Wkly.* 50(44): 99-101.

Bunkar, D. K. 2018. Awareness about Soil Health Card Scheme among the Farmers of Jaipur District (SKNAU). Ph.D. thesis, S. K. N. Agriculture university, Jobner, 123p.

Chand, R. and Pavithra, S. 2015. Fertilizer use and imbalance in India. *Econ. Political Wkly.* 50(44): 98-104.

Chandrakala, M., Srinivasamurthy, C.A., Kumar, S., Bhaskar, S., Parama, V. R. R., and Naveen, D. V. 2017. Phosphorus status in soils of eastern dry zone, Karnataka, India. *Int. J. Curr. Microbiol. App. Sci*. 6(11): 310-324.

Charel, J. M., Vejapara, V. P., Parmar V. S., and Baria, N. 2018. Perception of farmers about the soil health card. *Int. J. Curr. Microbiol. App. Sci.* 7(2): 3233-3236.

Chaudhary, A. 2018. Prospects and Challenges of Soil Health Card Scheme in Bikaner district of Rajasthan. Ph.D. thesis, Swami Keshwanand Rajasthan Agricultural University, Bikaner, 117p.

Chouhan, R. S., Kumar, D., and Sharma, H. O. 2012. Performance of soil testing service in Bhopal district of Madhya Pradesh. *Agric. Econ. Res. Rev.* 25(1): 544-546.

Chouhan, R. S., Sharma, H. O., Rathi, D., and Niranjan, H. K. 2017. Impact of soil health card scheme on farmers' income–a case study of kharif crops in Madhya Pradesh. *Agric. Econ. Res. Rev.* 30: 139-141.

Chowdary, K. R. and Theodore, R. K. 2016. Soil health card adoption behaviour among

beneficiaries of Bhoochetana project in Andhra Pradesh. *J. Ext. Educ.* 28(1): 5588-5597.

Chowdary, R. K. 2015. Factors determining the use of Soil Health Card (SHC) recommendations in Kurnool district of Andhra Pradesh. *Int. J. Pure App. Biosci.* 5 (6): 1689-1694.

Desai, P., Patil, A., and Veeresh, K. 2017. An overview of production and consumption of major chemical fertilizers in India. *J. Pharmacogn. Phytochem*. 6(6): 2353-2358.

Deshmukh, K. K. 2012. Evaluation of soil fertility status from Sangamner area, Ahmednagar district, Maharashtra, India. *Rasayan J. Chem.* 5(3): 398-406.

Devi, P. I., Radhakrishnan, V., and Thomas, E. K. 1991. Fertiliser consumption and agricultural productivity in Kerala. *Agric. Econ. Res. Rev.* 4(3): 119-128.

Dey, P., Santhi, R., Maragatham, S., and Sellamuthu, K. M. 2017. Status of phosphorus and potassium in the Indian soils vis-a-vis world soils. *Indian J. Fertil.* 13(4): 44-59.

Dey, P. 2012. December. Soil-test-based site-specific nutrient management for realizing sustainable agricultural productivity. In: *International Symposium on Food Security Dilemma: Plant Health and Climate Change Issues* (pp. 141-142).

Dinesh, R., Srinivasan, V., Hamza, S., and Anandaraj, M. 2014. Massive phosphorus accumulation in soils: Kerala's continuing conundrum. *Curr. Sci*. 106(3): 343-344.

Doran, J. W. 2002. Soil health and global sustainability: translating science into practice. *Agric. Ecosyst. Envir*. 88: 119-127.

Dwivedi, B. S. and Meena, M. C. 2015. Soil testing service–retrospect and prospects. *Indian J. Fertil.* 11(2): 110-122.

Dwivedi, B. S. and Dwivedi, V. 2007. Monitoring soil health for higher productivity. *Indian J. Fertil.* 3(1): 11-14.

Garret, H. E. and Woodworth, R. S. 1969. *Statistics In Psychology and Education*. Longmans, Green, Oxford, 370p.

GOI [Government of India] 2011. Census of India, Provisional Population Totals. Office of the Registrar and Census Commissioner, India, pp.144.

GOI [Government of India] 2017. *Agricultural Statistics at a glance 2017* [on-line].

Available: https://eands.dacnet.nic.in [28 June 2018].

Gupta, A. P. 2005. Micronutrient status and fertilizer use scenario in India. *J. Trace Elem. Med. Bio.* 18(4): 325-331.

Gupta, R., Sahoo, R. N., Abrol, I. 2019. Does soil testing for fertiliser recommendation fall short of a soil health card. *J. Agron. Res.* 1(3): 15-26.

Gurav, P. P., Ray, S. K., Choudhari, P. L., Biswas, A. K., and Shirale, A. O. 2018. A review on soil potassium scenario in vertisols of India. *J. Sci*. 2(1): 89-90.

Hasan, R. 2002. Potassium status of soils in India. *Better Crops Int.* 16(2): 3-5.

Hossain, M. and Singh, V. P. 2000. Fertilizer use in Asian agriculture: implications for sustaining food security and the environment. *Nutr. Cycl. Agroecosys.* 57(2): 155-169.

Jaganathan, D. 2004. Analysis of organic farming practices in vegetable cultivation in Thiruvananthapuram district. Ph. D. thesis, Kerala Agricultural University, Thrissur, 187p.

Jaga, P. K. and Patel, Y. 2012. An overview of fertilizers consumption in India: determinants and outlook for 2020-a review. *Int. J. Sci. Eng. Technol*. 1(6): 285-291.

Jaiswal, M. and Singh, A. 2018. Study on awareness & perception regarding soil health card. *J. Pharmacogn. Phytochem.* 1(4): 395-400.

Jasna, V. K. 2015. Impact of climate resilient technologies in rainfed agro-ecosystem. M. Sc. (Ag.) thesis, Indian Agricultural Research Institute, New Delhi, 97p.

Jayasree, R. 2004. Impact of Tanwa: training in farm women: Unpub. M. Sc. (Ag.) thesis, Tamil Nadu Agricultural University, Madurai, 110p.

John, K. S., Bharathan, R., Nair, M. M., and Suja, G. 2013. Soil based nutrient management plan for tuber crops in Pathanamthitta district of Kerala. *J. Root Crops,* 38(1): 51-54.

Karunakaran, N. 2016. Suggested and actual application of chemical fertilizers in the agricultural sector of Kerala. *J. Krishi Vigyan* 4(2): 94-98.

Kavitha, C. and Sujatha, M. P. 2015. Evaluation of soil fertility status in various agro ecosystems of Thrissur district, Kerala, India. *Int. J. Agric. Crop Sci.* 8(3): 328-338.

Katyal, J. C., Chaudhari, S. K., Dwivedi, B. S., Biswas, D. R., Rattan, R. K., and Majumdar, K. 2016. Soil Health. Health: Concept, Status and Monitoring. *Bull. Indian Soc. Soil Sci.* 30: 1-98.

Kerlinger, F. N. 1964. *Foundations of behavioural research* (Indian Reprint, 2014). Surjeet Publishers, New Delhi, 741p.

Kibblewhite, M. G., Ritz, K., and Swift, M. J. 2008. Soil health in agricultural systems. *Philos. Trans. R. Soc. B. Biol. Sci*. 363(1492): 685-701.

Kinekar, B. K. 2011. Potassium fertilizer situation in India: Current use and perspectives. *Karnataka J. Agric. Sci.* 24(1): 1-6.

Kumar, A., Mishra, V. N., Srivastav, L. K., and Banwasi, R. 2014. Evaluations of soil fertility status of available major nutrients (N, P & K) and micro nutrients (Fe, Mn, Cu & Zn) in vertisol of Kabeerdham district of Chhattisgarh, India. *Int. J. Interdiscip. Multidiscip. Stud*. 1(10): 72-79.

Kumar, A., Srivastava, L. K., Banvasi, R., and Mishra, V. N. 2017. Current status of major nutrients (Av. N, P and K) deficiencies in soils of Koriya district of Chhattisgarh. *J. Pharmacogn. Phytochem.* 6(6): 2583-2587.

Kumar, A. D. V. S. L. P., Rao, M. S., and Satyanarayana, M. 2015. Influence of soil test based application of phosphorous fertilizers on yield of paddy: A case study in Khammam district of Andhra Pradesh. *J. Rice Res*. 8(1): 48-50.

Kumar, L. P. and Indira, M. 2017. Trends in fertilizer consumption and food grain production in India: a co-integration analysis. *SDMIMD J. Manag.* 8(2): 45-50.

Kumar, P., Kumar, A., Dhyani, B. P., Kumar, P., Shahi, U. P., Singh, S. P., Kumar, R., Kumar, Y., Kumar, A., and Raizada, S. 2013. Soil fertility status in some soils of Muzaffarnagar District of Uttar Pradesh, India, along with Ganga canal command area. *Afr. J. Agric. Res.* 8(14): 1209-1217.

Lalatendu, M. and Kameswari, V. L. V. 2014. Knowledge level of soil management practices

and their adoption by farmers of Odisha. *Int. J. Farm Sci.* 4(4): 240-246.

Lamkane, Y. S. 2018. Attitude of farmers towards recommendation of soil health card. Ph.D. thesis, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, 99p.

Lenka, S., Rajendiran, C. M., Dotaniya, M. L., and Saha, J. K. 2016. Impacts of fertilizers use on environmental quality. In: *National seminar on 'environmental concern for fertilizer use in future',* 24-26 Feb. 2016, Kalyani [on-line]. Available: http://www.researchgate.net/publication/298388032 [24 June 2018].

Makadia, J. J., Mistry, H. H., and Kuthe, S. B. 2017. Impact of soil health card on fertilizer consumption and yield of sugarcane and kharif paddy in Gujarat state. *Econ. Affairs* 62(1): 61-66.

Majumdar, K., Dey, P., and Tewatia, R. K. 2014. Current nutrient management approaches. *Indian J. Fertil.* 10(5): 14-27.

MANAGE [National Institute of Agricultural Extension Management] 2017. *Impact Study of Soil Health Card Scheme 2017* [on-line]. Available: https:// www.manage.gov.in. [25 Nov.2018].

Mala, P. 2013. Fertilizer scenario in India. *Int. J. Soc. Sci. Interdiscipl. Res.* 2(1): 62-72.

Mini, V. and Usha, M. 2015. Soil based nutrient management plan for Onattukara sandy tract of Kerala. *Asian J. Soil Sci.* 10(1): 99-103.

Mukati, A., Bisht, K., Singh, S. P., and Raghuwanshi, S. 2018. Farmer's perception regarding soil health card. *Int. J. Chem. Stud.* 6(6): 307-310.

Nandapurkar, G. G. 1980. A study of the entrepreneurial behaviour of small farmers. M.Sc. (Ag.) thesis, University of Agricultural Sciences, Bangalore, 130p.

Narbaria, S. 2013. A study on adoption level of system of rice intensification (SRI) technology among farmers in Dhamtari district of Chhattisgarh. Ph. D. thesis, Indira Gandhi Krishi Vishwavidyalaya, Raipur, 125p.

Narain, P., Rai, S. C., and Shanti Sarup. 1991. Statistical evaluation of development on socio-economic front. *J. Indian Soc. Agric. Statist*. 43(3): 329-345.

Naruka, P. S., Verma, S., Pachauri, C. P., Sarangdevot, S. S., Kerketta, S., Bhadauria, S. S., and Singh, J. P. 2018. Study on knowledge, adoption and constraints faced by farmers about soil health card based fertilizer application in Neemuch district, India. *Int. J. Curr. Microbiol. App. Sci.* 7(7): 1833-1837.

Niranjan, H. K., Chouhan, R. S., Sharma, H.O., and Rathi, D. 2018. Awareness and performance of soil health card scheme in central India. *J. Crop Weed,* 14(1): 99-103.

Padmaja, B. and Angadi, J. G. 2018. Utilization of soil health card by farmers in nutrient management. *Int. J. Curr. Microbiol. App. Sci.* 7(12): 1583-1592.

Pagaria, P. 2011. Knowledge and attitude of small and marginal farmers towards soil testing. *J. Adv. Dev. Res.* 1(2): 171-173.

Pandya, A. M. and Timbadia, C. K. 2016. Attitude of farmers about soil health card programme. *Gujarat J. Ext. Educ*. 27(1): 102-104.

Pandya, C. D., Bhatt, S. T., and Chauhan, N. M. 2013. Knowledge and adoption level of farmers about scientific cultivation of okra in Tapi district. *Gujarat J. Ext. Educ.* 125(24): 102-104.

Patel, G. G., Lakum, Y. C., Mishra, A., and Bhatt, J. H. 2017. Awareness and knowledge regarding soil testing and utility perception of soil health card. *Int. J. Curr. Microbiol. App. Sci*. 6(10): 329-334.

Patel, J. K. and Chauhan, N. B. 2012. Attitude of farmers towards soil health card (SHC) programme. *Asian J. Soil Sci.* 7(1): 114-116.

Patel, K. S., Chikhlekar, S., Ramteke, S., and Sahu, B. L. 2015. Micronutrient status in soil of central India. *Am. J. Plant Sci.* 6: 3025-3037.

Patel, N. G. 2013. Attitude of the farmers towards soil health card programme. Ph.D. thesis, Anand Agriculture University, Anand, 99p.

Pathak, H. 2010. Trend of fertility status of Indian soils. *Curr. Adv. Agric. Sci.* 2(1): 10-12.

Prasad, R. 2009. Efficient fertilizer use: The key to food security and better environment. *J.*

Trop. Agric. 47(1): 1-17.

Prasad, S. P., Hariyappa, N., Pati, R., Nagaraja, J. S., Chandrashekar, N., Nadaf, S. A., Hareesh, S. B., Venkatesh, D.H., and Sujatha, K. 2018. Studies on soil fertility status of coffee growing regions in Idukki district. *Int. J. Agric. Sci*. 10(13): 6568-6572.

Rajasekharan, P., Nair, K. M., John, K. S., Kumar, P. S., Kutty, M. N., and Nair, A. R. 2014. Soil fertility related constraints to crop production in Kerala. *Indian J. Fertil.* 10(11): 56-62.

Ramamurthy, V., Naidu, L. G. K., Chary, G. R., Mamatha, D., and Singh, S. K. 2017. Potassium status of Indian soils: need for rethinking in research, recommendation and policy. *Int. J. Curr. Microbiol. App. Sci*. 6(12): 1529-1540.

Raman, V. Y. S. and Kumar, R. 2006. Knowledge and attitude of farmers towards soil testing practices. *Indian Res. J. Ext. Educ.* 6(3): 1-3.

Ramasamy, C. 2004. Constrains to growth in Indian agriculture: Needed technology, resource management and trade strategies. *Indian J. Agric. Econ*. 59(1): 1-41.

Rao, A. S. and Sanjay, S. 2000. Soil test based fertilizer use: a must for sustainable agriculture. *Fertil. news,* 45(2): 25-38.

Ray, P. K., Jana, A. K., Maitra, D. N., Saha, M. N., Chaudhury, J., Saha, S., and Saha, A. R. 2000. Fertilizer prescriptions on soil test basis for jute, rice and wheat in a typic ustochrept. *J. Indian Soc. Soil Sci.* 48(1): 79-84.

Reddy, A. A. 2017. Impact study of soil health card scheme, National Institute of Agricultural Extension Management (MANAGE), Hyderabad, 210p.

Robinson, P. W. 1976. *Fundamentals of experimental psychology: A comparative approach*. Prentice-Hall, New jersey, 432p.

Rogers, E. M. 2003. *Diffusion of innovations*. The free press, New York, 526p.

Saha, B., Basak, N., Saha, S., Singh, P. K., Hazra, G. C., and Mandal, B. 2016. Soil health card: A tool for better productivity. *Indian Farming*, 66(4): 2-4.

Sali, J. R., Mokhale, S. U., Padekar, D. G., and Rajput, H. K. 2016. Adoption of soil test

recommendations by the farmers. *Asian J. Soil Sci*. 11(2): 358-360.

Sasidharan, A. 2015. Adoption of organic farming technologies in banana and vegetable crops in Kasargod district. M. Sc. (Ag.) thesis, Kerala Agricultural University, Thrissur, 160p.

Sharma, H. O., Mishra, P. K., and Chouhan, R. S. 2015. Impact of soil testing in Madhya Pradesh. *JNKVV Res. J*. 49(2): 158-165.

Sharma, V. P. and Thaker, H. 2011. Demand for Fertilisers in India: Determinants and Outlook for 2020. *Indian J. Agric. Econ.* 66(4): 661-669.

Shukla, A. K. and Behera, S. K., Shivay, Y. S., Singh, Pooja and Singh, A. K. 2012. Micronutrient and field crop production in India: A review. *Indian J. Agron.* 57 (3): 123-130.

Shyju, K. and Kumaraswamy, K. 2017. Physicochemical characteristics of soils of Talapilli taluk, Thrissur, Kerala, India. *Saudi J. Humanities Soc. Sci*. 2(11): 1126-1135.

Sivaprasad, S. 1997. Problems and prospects of self-employment of trained rural youth in agriculture. Ph. D. thesis, Kerala Agricultural University, Thrissur, 208p.

Srinivasarao, C., Veni, G. V., Sharma, K. L., Raju, B. M. K., Pasricha, N. S., and Singh, R. 2015. Phosphorus fertility status and strategies to improve its use efficiency in Indian soils. *Indian J. Fertil.* 11(3): 22-36.

Srivastava, Y. C. and Pandey, A. P. 1999. Knowledge and attitude of small and marginal farmers towards soil testing. *Agric. Ext. Rev*. 11(6): 3-6.

Supe, S. V. 1969. Factors related to different degrees of rationality in decision making among farmers. Ph.D. thesis, IARI, New Delhi, 290p.

Tiwari, K. N. 2001. Phosphorus needs of Indian soils and crops. *Better Crops Int.* 15(2): 6-10.

Tewatia, R. K., Rattan, R. K., Bhende, S., and Kumar, L. 2017. Nutrient use and balances in India with special reference to phosphorus and potassium. *Indian J. Fertil*. 13(5): 20-29.

Van den Ban, A. W. and Hawkins, H. S. 1996. *Agricultural Extension.* Wiley-Blackwell, New Jersey, 304p.

Vijayakumar, R., Arokiaraj, A., and Prasath, P. M. D. 2011. Macronutrient and micronutrients status in relation to soil characteristics in South-East coast plain-riverine soils of India. *Orient. J. Chem.* 27(2): 567-571.

Yadav, V. P. S., Raman, R. S., and Kumar, R. 2006. Knowledge and attitude of farmers towards soil testing practices. *Indian Res. J. Ext. Educ.* 6(3): 1-3.

Appendices

APPENDIX- 1

KERALA AGRICULTURAL UNIVERSITY

COLLEGE OF HORTICULTURE, VELLANIKARA, THRISSUR

DEPARTMENT OF AGRICULTURAL EXTENSION

"Utilization of soil Health Card by the farmers of Thrissur district"

Interview schedule for SHC users

District: Thrissur Block: Panchayath:

Part 1

Questionnaire for soil health card users

1. Name of the farmer : ……

2. Address : ……

3. Phone no : ……..

4. Age: ……..

5. Years of experience in farming ……

6. Land holding ……

7. Educational qualification:

Sl.no.	Education	Tick
1	Primary education	
2	Secondary education	
3	Higher secondary education	
4	Graduate and above	

8. Annual income: (Rs.).…….

9. Social participation:

Are you a member in any of the organisation? If yes give details

Sl. no	Name of organisation	Member	Office bearer	No of years of association
1	Farmers associations			

2	PRI			
3	Watershed management community			
4	Agriculture co-operatives			
5	Farmers club			
6	Youth club			
7	NGO			
8	Any other (Mention)			

10.Leadership ability (Scale by Nandapurkar, 1978)

Sl.no	Situation	Always	Sometimes	Never
1	Did you participate in discussion on new farm practices in group meeting or in peer group?			
2	Whenever you see a new farm practices, did you intimate discussion about it with your colleagues			
3	Do village people regard you as a good source of information on new farm practices?			
4	Do you prefer to do farm works by yourself than to assign it to your family members			

11. Scientific orientation: (Scale developed by Patel, 2009)

Sl.no	Statements	Strongly Agree	Agree	Undecided	Disagree	Strongly disagree
1	Quality crop production is possible through use of science (+)					
2	I prefer scientific					

	techniques of crop production(+)					
3	Profitable agriculture production is possible through scientific techniques(+)					
4	Application of scientific techniques saves money for farming(+)					
5	Scientific techniques in agriculture increase crop production(+)					
6	Scientific methods of agriculture always confuse me(-)					
7	I believe in traditional method of farming(-)					
8	Application of scientific methods in farming is wastage of time (-)					
9	Scientific techniques require high infrastructural facility (-)					
10	Scientific techniques in agriculture damage the ecology (-)					

12. Soil management practices

Crop	Area (ha)	Soil type	Irrigation			Fertilizer use			
			Type	Yes	No	Type	Quantity		Frequency
							Recommended	Applied	

Soil ameliorants				Manure			
Type	Quantity		Frequency	Type	Quantity		Frequency
	Recommended	Applied			Recommended	Applied	

13. Economics of fertilizer use

Sl.no	Cost incurred for purchase			Labour involved		
	Fertilizer	Soil ameliorants	Manure	Family labour	Hired Labour	Cost

14. Have you ever tested your soil? (Yes/No)

15. If yes, duration of soil testing?

a) Regularly before start of crop ☐ b) After 6 months ☐ c) After 1 year ☐ d) After 2 years ☐ d) Not fixed ☐

16. From where do you test the soil sample?

a) KVK b) SAU c) Govt. soil testing laboratory d) Private agency

17. Number of soil tests done during last 5 years?

Number of soil tests done	Year	Purpose		Soil health card received (Year)
		Personal use	Under schemes	

18. Do you know about soil health card scheme (Yes /No)

19. Source of awareness about soil health card scheme?

a) Self ☐ b) Media ☐ c) Government officials ☐ d) Fellow farmers ☐

f) Private companies ☐ Any other mention ☐

20. Do you have soil health card : (Yes/No)

21. From where you got SHC a) Krishi bhavan b) SAU c) Private soil testing lab

22. Have you adopted SHCs (Yes/ No)

23. If yes reasons for adoption of SHC

a) For availing benefits under subsidy schemes

b) For increasing crop yield

c) Peer farmer's group pressure

d) Nutrient deficiency

e) To adopt new technological practices

f) Motivation from demonstration of best farming practices

24. Are you able to understand the information on soil health card? Yes/No

25. Are you using fertilizers and micronutrients as per the SHC? Yes/No

26. If you are not following recommendation, why …….

27. Have you got any financial assistance from government? Yes/No

28. How many of your plots covered for soil testing?

One/ none / some / all

29. How many soil samples are taken from your farm?

30. Do you think the samples represent all the soil types in your farm? Yes/No

31. If no, how many samples are required?

32. Number of trainings attended on soil testing.....

33. Is there any time lag between soil collection and distribution of soil health cards (Yes/ No)

34. Are the results provided in time? Yes/No

35. Whether agricultural extension worker explained the content of SHC? Yes/No

36. Who informed about SHC content?

a. KVK
b. Agricultural extension officer/Agricultural officer
c. Scientist of SAU/ICAR
d. NGOs

37. Are the recommendations practical? Yes/No

38. Are the recommended inputs easily available in the market? Yes/No

39. From how much time you are availing the benefits of SHC?

a) 1 year b) 2 years c) 3 years d) 4 years e) 5 years

40. Is SHC effective in :

Variable	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Increased productivity					
Increased fertilizer use efficiency					
Protecting environment by preventing overuse of fertilizers					
Checking contamination in soil					
Reducing fertilizer cost					

41. Do you face any difficulties in adopting the practices? Yes/ No

42. Are you planning for soil testing in future? (Yes/ No)

43. Did you recommend SHCs to your fellow farmers? (Yes/ No)

44. Do you suggest any improvement in the SHC system? (Yes/No)

If yes, provide details

45. Level of awareness (Guttmann scale)

a)Low b)Medium c)Low

Sl.no	Variable	Low	Medium	High
1	Do you know about SHC scheme			
2	Do you know the procedure for taking soil sample			
3	Are you aware of any govt soil testing lab			
4	Are you aware of any soil testing labs nearby your village?			
5	Do you know the benefits of SHC			
6	Do you follow the recommendations of SHC			
7	Are you aware about any financial help provided by govt			
8	Are you planning for soil testing in future?			
9	Do you recommend SHCs to your fellow farmer			

47. Utility perception about soil health card

Sl.no	Statements	Agree	Disagree
1	Soil fertility and productivity can be maintained on the basis of SHC information		
2	We can do systematic crop planning by using information given in SHC		
3	Economic achievement can be obtained by using SHC information		
4	Farming can be done in scientific way by the help of SHC		
5	Unnecessary expenditure can be reduced by using information given in SHC		
6	Soil degradation can be reduced		
7	On the basis of PH value given in SHC, we can know about acidity and alkalinity in the soil and we can take necessary action for improvement		
8	On the basis of information given in SHC about available organic carbon we can apply the necessary quantity into the soil		
9	We can know about the nitrogen in soil by information given in SHC		

10	On the basis of information given in SHC about available pottasium in soil, we can apply necessary quantity of phosphorus into the soil		

49. Constraints in the scheme implementation

(Please indicate ranks from most to least)

Sl.no.	Constraints	Rank
1	Collection of soil sample is not done in the presence of farmer	
2	No soil testing labs available, in nearby areas	
3	Time gap between soil samples taken and issuing cards is too high	
4	Received soil health card after the crop harvest	
5	Extension personnel is not available to give advice	
6	Difficulty in calculating fertilizer dose on the basis of nutrient status of soil given in soil health card	
7	No awareness about method of taking soil sample	
8	Danger of mixing up of soil samples of different fields	
9	No impact seen in the crop by using fertilizer as per dose	
10	Information provided in SHC is often incorrect	
11	Subsidy is not given to improve soil nutrient status	
12	Lack of mobile soil testing vans for soil collection	
13	Lack of training in use of soil health card	
14	Lack of knowledge among farmers for using soil health card	

50. Suggestions by farmers to overcome the constraints

Sl.no	Suggestions	
2	SHC should be issued prior to crop season	
3	Farmers should be trained to take soil samples of their own soil	
4	Soil testing lab should be established at taluk level with qualified supporting staff	
6	Soil sampling procedure should be done in presence of farmer	

APPENDIX- 11

KERALA AGRICULTURAL UNIVERSITY

COLLEGE OF HORTICULTURE, VELLANIKARA, THRISSUR

DEPARTMENT OF AGRICULTURAL EXTENSION

"Utilization of soil Health Card by the farmers of Thrissur district"

Interview schedule for SHC non-users

District: Thrissur Block: Panchayath:

Part 2

1.Name:……..

2.Address:…….

3.Phone number……

4.Age…….

5.Years of experience in farming…….

6.Land holding ……

7.Education

Sl.no.	Education	
1	Primary education	
2	Secondary education	
3	Higher secondary education	
4	Graduate and above	

8.Annual income (Rs): ……

9 Social participation

Are you a member in any of the organisation? If yes give details

Sl.no	Name of organisation	Member	Officer bearer	No.of years of association
1	Farmer associations			
2	PRI			
3	Watershed management community			

4	Agriculture co-operatives			
5	Farmers club			
6	Youth club			
7	NGO			
8	Any other (Mention)			

10. Leadership scale

Sl.no	Situation	Always	Sometimes	Never
1	Did you participate in discussion on new farm practices in group meeting or in peer group?			
2	Whenever you see a new farm practices, did you intimate discussion about it with your colleagues			
3	Do village people regard you as a good source of information on new farm practices?			
4	Do you prefer to do farm works by yourself than to assign it to your family members			

11. Scientific orientation (Patel, 2009)

Sl.no	Statements	Strongly Agree	Agree	Undecided	Disagree	Strongly disagree
1	Quality crop production is possible through use of science (+)					
2	I prefer scientific techniques of crop production(+)					
	Profitable agriculture production is possible through scientific techniques(+)					
3	Application of scientific techniques saves money for farming(+)					
4	Scientific techniques in agriculture increase crop production(+)					
5	Scientific methods of agriculture always confuse me(-)					

6	I believe in traditional method of farming(-)					
7	Application of scientific methods in farming is wastage of time (-)					
8	Scientific techniques require high infrastructural facility (-)					
9	Scientific techniques in agriculture damage the ecology (-)					

12. Soil management practices

Sl.no	Crop	Area (ha)	Soil type	Irrigation			Fertilizer use		
				Type	Yes	No	Type	Quantity	Frequency
1									
2									
3									
4									
5									
6									
7									

Soil ameliorants			Manure		
Type	Quantity applied	Frequency	Type	Quantity applied	Frequency

13. Economics of fertilizer use

Sl.no	Cost incurred for purchase			Labour involved		
	Fertilizer	Soil ameliorants	Manure	Family labour	Hired Labour	Cost

14. Have you ever tested the soil? (Yes/No)

15. If yes, duration of soil testing?

b) Regularly before start of crop ☐ b) After 6 months ☐ c) After 1 year ☐ d) After 2 years ☐ d) Not fixed ☐ e) Never ☐

16. From where do you test the soil samples?

a) Govt.soil testing labs b) KVK c) SAU d) Private agency

17. No of soil tests done during last 5 years?

Soil test done	Year	Purpose	
		Personal use	Under schemes

18. Do you know about soil health card scheme (Yes /No)

19. Source of awareness about soil health card scheme?

b) Self ☐ b) Media ☐ c) Government officials ☐ d) Fellow farmers ☐ e) ☐ KVK

f) Private companies ☐ g) Mention others ☐

20. Do you face any problems without soil testing (Yes/No)

a) Increased toxicity (Yes/No)

b) Increased soil contamination (Yes/No)

c) Reduction in yield (Yes/No)

d) Reduced availability of nutrients (Yes/No)

e) Waste of resources (Yes/No)

21. Level of Awareness

a)Low b)Medium c)Low

Sl.no	Variable			
1	Do you know about SHC scheme			
2	Do you know the procedure for taking soil sample			
3	Are you aware of any govt soil testing lab			
4	Are you aware of any soil testing labs nearby your village?			
5	Do you know the benefits of SHC			
6	Are you aware about any financial help provided by govt?			
7	Are you planning for soil testing in future?			
8	Did someone suggest you to take the advantage of soil health card?			

22. Constraints in adoption of SHCs

Sl.no	Constraints	Rank
1	Lack of interest	
2	Soil testing labs are located far away	
3	Do not know whom to contact for soil testing	
4	Soil testing is not required to my field	
5	Do not know how to take soil samples	
6	Mention (If any)	

APPENDIX- 111

KERALA AGRICULTURAL UNIVERSITY

COLLEGE OF HORTICULTURE, VELLANIKARA, THRISSUR

DEPARTMENT OF AGRICULTURAL EXTENSION

"Utilization of soil Health Card by the farmers of Thrissur district"

Interview schedule for scheme implementing officers

Part 3

1. Name of person/ agency……

2. Qualification…….

3. Designation

4. Address……

5. Status of SHC

a) Number of farmers covered under SHCs till date…….
b) No of soil samples collected……
c) No of cards issued……
d) No of cards distributed……..

6. Is there any time lapse in sample collection and distribution of cards Yes/No

7. Infrastructure facilities available for implementation of the scheme

a) Number of AEOs/TOTs trained under the scheme …….
b) Number of soil testing laboratories ……
c) Facilities available in the lab : a) Good b) Average c) Improvements needed

8. How many STLs equipped with soil test based crop response (STCR)……

9. Is there any time lags between release of funds to actual utilization?

10. Is there any difference in crops identified in SHC and actual crops sown by farmers? (Yes/No)

11. Is there any difference in recommended fertilizers based on SHC and actual application (Yes/No)

12. What roles soil testing labs are playing in awareness & publicity of SHCs

a) Number of trainings organized on soil testing …….

b) Display of posters Yes/No
c) Discuss the benefits of SHCs with farmers Yes/No
d) Handouts on soil testing like brochures and pamphlets given to farmers Yes/No

13. Reasons for time lag between soil collection and distribution of soil health cards?

a) Unavailability of field officers b) Poor lab facilities c) Lack of mobile soil testing vans for soil collection d) Mention any other

14. Constraints in scheme implementation

Rank	Constraints	Rank
1	Number of soil testing labs is less	
2	Unavailability of field staffs for taking samples	
3	Low awareness among farmers	
4	No proper usage of budget	
5	Lack of resource persons	
6	Poor lab infrastructure	
7	Lack of mobile soil testing vans for soil collection	
8	Farmers lack interest in soil testing	
9	Soil collection is difficult.	
10	Farmers fail to follow the recommended dose of fertilizers	

15. Suggestions by implementing officers

a) Increase availability of staff Yes /No

b) Increase number of soil testing labs Yes/No

c) Soil health card must be attached with subsidy Yes/No

Mention any other…….

APPENDIX- 1V

Number of farmers covered under SHC scheme in Kerala (2015-16)

District	Farmers covered under SHC scheme
Alappuzha	5481
Ernakulam	6334
Idukki	3376
Kannur	4752
Kasaragod	1801
Kollam	2653
Kottayam	4517
Kozhikode	11,154
Malappuram	8902
Palakkad	6184
Pathanamthitta	2709
Thiruvananthapuram	10,665
Thrissur	13,761
Wayanad	2,064

Source: Records of the Department of Soil Survey

APPENDIX- V

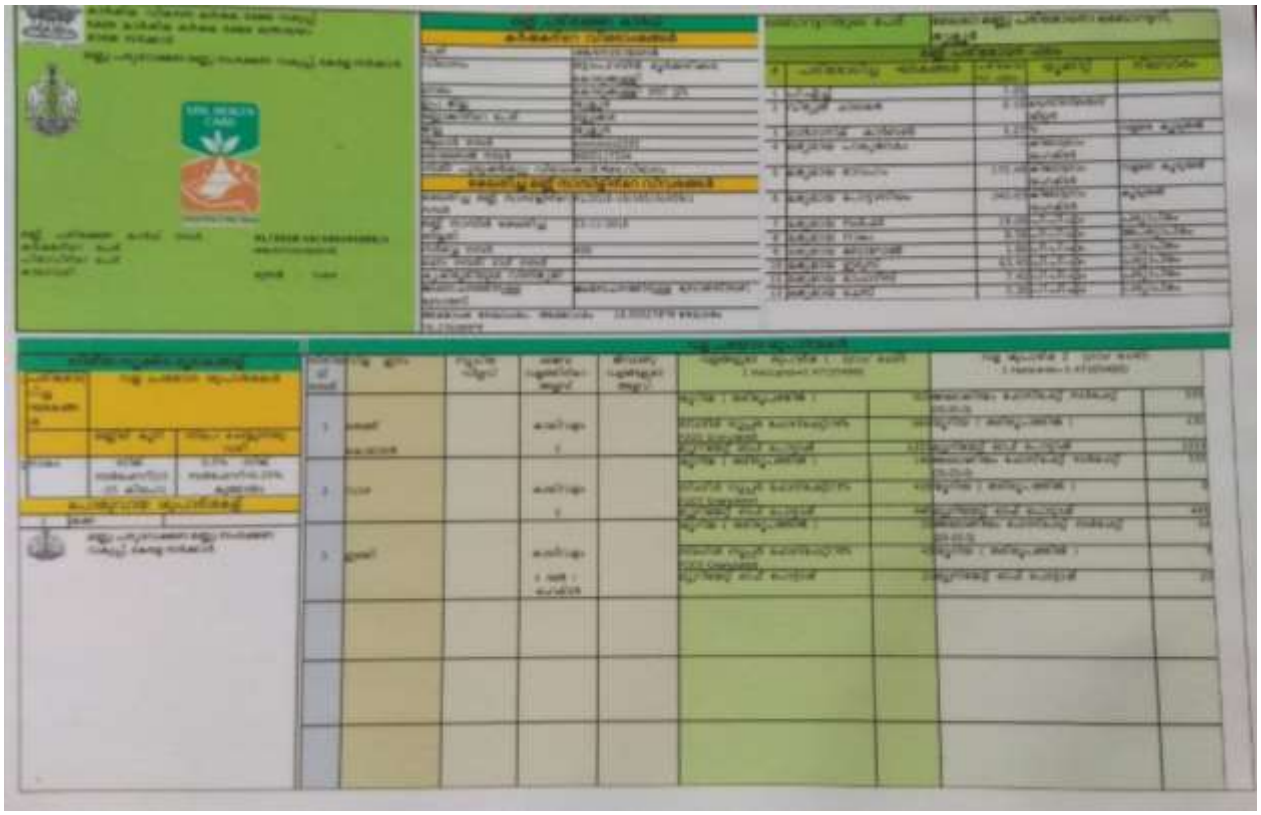
Number of farmers covered under SHC scheme in Thrissur district (2017-18)

Blocks	**No of farmers covered**
Anthikkad	171
Chalakkudy	226
Chavakkad	21
Cherpu	504
Chowannur	204
Irinjalakuda	271
Kodakara	1,260
Mala	264
Mathilakam	6
Mullassery	174
Ollukkara	1667
Pazhayannur	1298
Puzhakkal	1460
Thalikulam	0
Vellangallur	222
Wadakkancherry	1680

Source: Records of the Department of Soil Survey

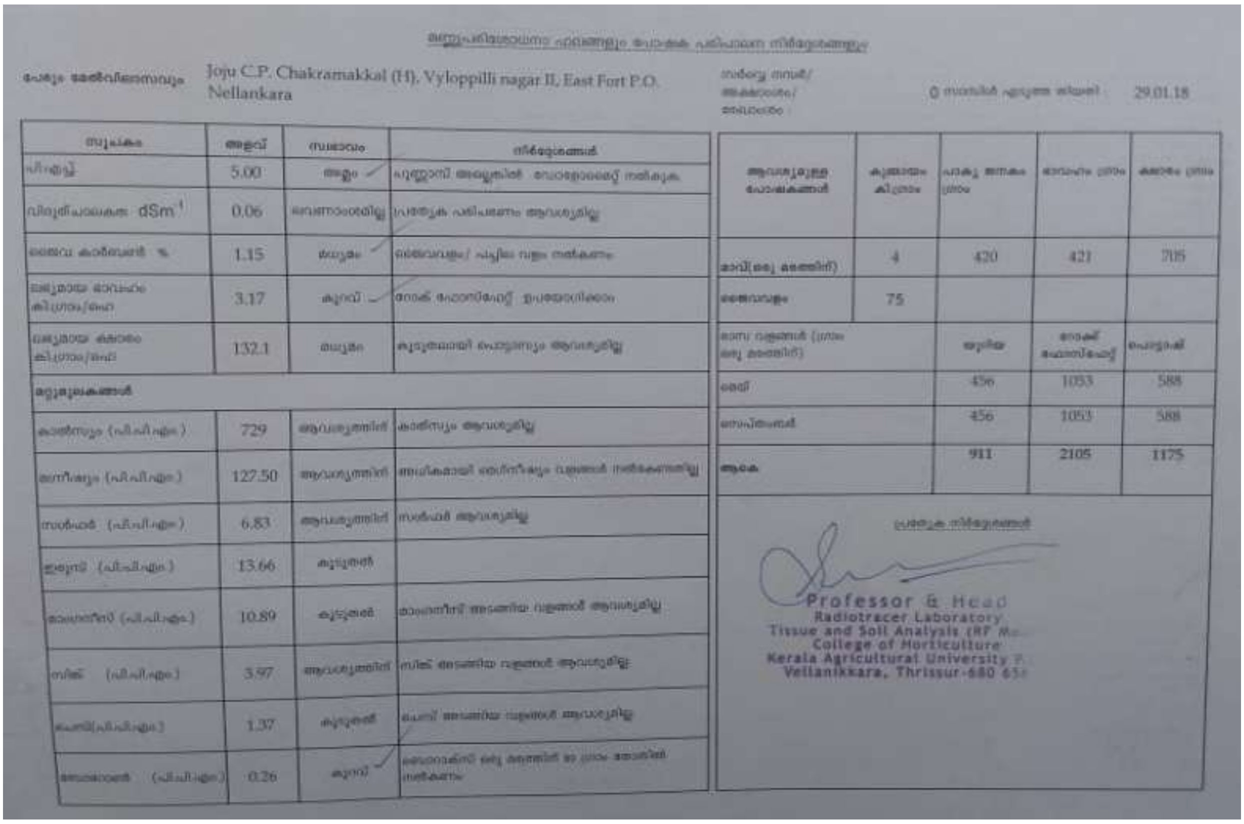
APPENDIX- VI

SPECIMEN OF SOIL HEALTH CARD (Under the scheme for free users)



APPENDIX- VII

SPECIMEN OF SOIL HEALTH CARD (KAU scheme for Paid Users)



[illegible]

Joju C.P. Chakramakkal (H), Vyloppilli nagar II, East Fort P.O. Nellankara

29.01.18

[illegible]	[illegible]	[illegible]	[illegible]
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[illegible] dSm^-1	0.06	[illegible]	[illegible]
[illegible] %	1.15	[illegible]	[illegible]
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[illegible]	132.1	[illegible]	[illegible]
[illegible]			
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[illegible]	6.83	[illegible]	[illegible]
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[illegible]	3.97	[illegible]	[illegible]
[illegible]	1.37	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	75			
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[illegible]		456	1053	588
[illegible]		456	1053	588
[illegible]		911	2105	1175

Professor & Head
Radiotracer Laboratory
Tissue and Soil Analysis (RF M...
College of Horticulture
Kerala Agricultural University P.
Vellanikkara, Thrissur-680 65...

APPENDIX- V1II

GARRETT RANKING CONVERSION TABLE

The conversion of orders of merits into units of amount of "socres"

Percent	Score	Percent	Score	Percent	Score
0.09	99	22.32	65	83.31	31
0.20	98	23.88	64	84.56	30
0.32	97	25.48	63	85.75	29
0.45	96	27.15	62	86.89	28
0.61	95	28.86	61	87.96	27
0.78	94	30.61	60	88.97	26
0.97	93	32.42	59	89.94	25
1.18	92	34.25	58	90.83	24
1.42	91	36.15	57	91.67	23
1.68	90	38.06	56	92.45	22
1.96	89	40.01	55	93.19	21
2.28	88	41.97	54	93.86	20
2.69	87	43.97	53	94.49	19
3.01	86	45.97	52	95.08	18
3.43	85	47.98	51	95.62	17
3.89	84	50.00	50	96.11	16
4.38	83	52.02	49	96.57	15
4.92	82	54.03	48	96.99	14
5.51	81	56.03	47	97.37	13
6.14	80	58.03	46	97.72	12
6.81	79	59.99	45	98.04	11
7.55	78	61.94	44	98.32	10
8.33	77	63.85	43	98.58	9
9.17	76	65.75	42	98.82	8
10.06	75	67.48	41	99.03	7
11.03	74	69.39	40	99.22	6
12.04	73	71.14	39	99.39	5
13.11	72	72.85	38	99.55	4
14.25	71	74.52	37	99.68	3
15.44	70	76.12	36	99.80	2
16.69	69	77.68	35	99.91	1
18.01	68	79.17	34	100.00	0
19.39	67	80.61	33		
20.93	66	81.99	32		

UTILIZATION OF SOIL HEALTH CARD BY THE FARMERS OF THRISSUR DISTRICT

by

Reshmi S.

(2017-11-107)

ABSTRACT

Submitted in partial fulfilment of the requirement for the degree of

Master of Science in Agriculture

Faculty of Agriculture

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2019

ABSTRACT

Injudicious and hazardous use of chemical fertilizer in agriculture is a matter of concern in recent times. In order to avoid deterioration of soil in the long run and visualizing the importance of balanced nutrition in crop production, Government of India launched the soil health (SHC) programme in 2015. The Soil Health Card provides appropriate guidance to the farmers for the efficient use of fertilizer for crops based on soil health analysis. The SHC is a printed document, which contains data on soil test based chemical analysis to describe soil health in terms of its nutrient availability and its physical and chemical properties.

The study was carried out in Thrissur district as it had the maximum number of SHC scheme beneficiaries in the State. A total of 180 respondents from the district formed the sample which constituted 150 farmers and 30 scheme implementing officers. Status of SHC use among farmers revealed the presence of four categories of SHC users *viz.* participant SHC scheme users, participant SHC scheme non-users, paid SHC users and non-participant non-users. Analysis of the socio-economic variables between the different categories of users and non-users of farmers revealed that the variables, farming experience, exposure to training and irrigation facility showed significant difference among the respondents at 0.05 and 0.01 levels with p values 0.040, 0.016 and 0.001 respectively.

With regard to awareness on SHC, Paid SHC users had an overall awareness score of 461.52. On all selected awareness domains they had uniformly high scores except on general information on SHC scheme wherein the score was only 78.00 per cent. Regarding the spread of SHC in Thrisssur district, Chavakkad was the only block that covered more than 50 per cent of farmers. Extent of adoption measured using adoption index, and the results indicated that 50 per cent of the participant SHC scheme users were of medium adoption category, followed by 34 per cent of low adopters and only 16 per cent belonged to the high adoption category. However, in

the case of paid soil test users, it could be inferred that majority of the farmers (60 per cent), came under high adoption category, followed by 33 per cent under medium level of adoption and only 7 per cent belonged to low adoption category. Correlation between the independent variables and adoption of SHC recommendations by participant SHC scheme users and paid SHC users revealed that, irrigation facility and farming experience showed positively significant correlation with adoption at 0.05 level for both the categories. It is also important to find that when scientific orientation recorded positive and significant relation with adoption at 0.01 level for both participant SHC scheme users and paid SHC users, training and education showed significant relation only for the paid SHC users at 0.01 and 0.05 levels of significance respectively. When 90 per cent of the paid SHC users showed favourable perception regarding the reliability of SHCs, only 40 per cent of the participant SHC scheme users displayed a favourable utility perception on the domain. With regard to the quantity of fertilizers (Urea, SSP, MOP) applied, and micronutrient use, there is significant difference between users and non-users with p values 0.44 and 0.017 respectively. Results of binary logistic regression of SHC users and non-users with socioeconomic variables and yield taken as independent variables revealed that a change in the level of education, farming experience, irrigation or yield could bring a corresponding chance of 64, 30, 31 and 67 per cent respectively for a non-user to become a user of SHC results. Majority of farmers (68 per cent) stated that the time gap between soil collection and distribution of cards was too long. The major constraint stated by officers was unavailability of field staffs for taking samples (68.23 per cent). Though the services were free under the scheme, farmers face a lot of impediments in getting full benefits of the scheme. It is suggested that the policy makers should conduct suitable awareness programs and trainings to promote the usage of soil health cards. Follow-up by extension agency, timely reporting of soil test results to farmers is crucial in whole programme. Effective utilization of the scheme also needs the presence of field level experts to clear doubts of farmers at the time of their need in a scientific way.