ADOPTION OF RECOMMENDED DOSES OF FERTILISERS ON SOIL TEST BASIS BY FARMERS IN KARNATAKA

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PREFACE

India's foodgrains production has increased tremendously from 51 million tonnes in 1950-51 to 255 million tonnes in 2012-13. At the same time, fertilizer consumption in terms of NPK nutrients has increased from 0.69 million tonnes in 1950-51 to 27.8 million tonnes in 2011-12. There is a significant correlation between use of yielding improving inputs like fertilisers and foodgrains production. Notwithstanding, average intensity of fertilizer use in India is much lower than in other developing countries. Further, there is disparity in fertilizer consumption pattern within and across states. The variability in consumption of fertilisers can be attributed to different cultivation methods, type of crops and subsidy on fertilisers. The consumption of fertilisers has also varied across farm size groups with the highest amount of consumption recorded among small farmers.

There are concerns about the indiscriminate use of chemical fertilisers by farmers with a view to increase the crop yield. This has led to deterioration of soil structure, wastage of nutrients, destruction of soil microorganisms and scorching of plants at the extreme cases. Soil test based nutrient management is important for maintaining soil productivity. The Integrated Nutrient Management (INM) Division of the Ministry of Agriculture, Government of India entrusted this study to Agro-Economic Research Centres/Units to analyse the constraints in the adoption of soil testing and application of recommended doses of fertilisers through farmers' survey. The present report discusses issues related to adoption of soil testing and recommended doses of fertilizes for paddy and maize in Karnataka.

During the course of the study, we received excellent support from the officials of the Department of Agriculture, Government of Karnataka. We sincerely thank all of them for their kind cooperation in conducting field survey. We express our sincere thanks to the officials of the INM Division and DES, Government of India for their intellectual contribution at different stages of the study. We would also like to thank the Director, ISEC and Dr. Parmod Kumar, Professor and Head, ADRTC for constant encouragement and support for carrying out this study.

Authors

CHAPTER I

INTRODUCTION

1.1 Background

Food security remains a worldwide concern for the next 50 years and beyond. According to the World Bank projections, world's population will reach 7.5 billion by 2020. The consequences of population increase are well known to us since we are living in a country where there is high absolute increase in the number of people. Since there is no much scope for expansion of agricultural land, all the necessary increase in food has to come from the area already under cultivation which can only happen through introducing agricultural system and improved technologies to increase productivity contributing not only to more food but also to more income to farm family.

In India, the Green Revolution took place in the 1960's has tremendously increased crop output and farmer's income mainly through the introduction of High Yielding Varieties (HYVs) along with irrigation and chemical fertilizer applications. Owing to the change in preferences in crop production techniques over a period of time, several new challenges draw attention to food security. One such improved technology is Integrated Nutrient Management which refers to the maintenance of soil fertility and of plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic and biological components in an integrated manner.

It is important for all crops to have all the nutrients to produce optimum yield. Lack of one or more nutrients in soil may cause reduction in the crop yield even though an adequate amount of other nutrients are available. So it is very important to supply all the nutrients required by the crop in right stage to increase the productivity. Chemical fertilisers are the important source of nutrients for plant growth. With the advent of fertiliser responsive crop varieties, total consumption of nitrogenous (N), phosphatic (P) potassic (K) fertilisers increased from about 1.1 million tonnes in 1966-67 to 27.8 million tonnes in 2011-12. The all-India average consumption of fertilizers increased from 6.9 kg per ha of gross cropped area to 139.7 kg per ha between the same period (Fertiliser Statistics 2013). However, the level of consumption of fertilisers is highly varied within as well as between states. The consumption is varied from 243 Kg/ha in Punjab to 54 Kg/ha in Himachal Pradesh during 2011-12. The variability in consumption of fertilisers can be attributed to different cultivation methods, type of crops and subsidy on fertilisers. Further, the consumption of fertilisers has also varied across farm size groups with the highest amount of consumption recorded among small farmers.

India is the third largest producer and consumer of fertilizer in the world, after China and USA. Though there is significant increase in the foodgrain production in the post green revolution period due to impressive growth in the fertilizer consumption, this has led to the consequences like deterioration of soil structure, wastage of nutrients, destruction of soil microorganisms and scorching of plants at the extreme cases. A combination of factors such as intensive cultivation of crops, differential pricing of fertilisers and subsidy, might have contributed to excessive use of fertilisers by the farmers. At the same time, it is reported that many parts of India shown deficiency of not only primary nutrients (N,P,K) but also secondary (Sulphur, Calcium and Magnesium) and micro nutrients (Boron, Zinc, Copper and Iron). Government of India had undertaken initiatives to ameliorate the situation and encourage the farmers for balanced use of fertilisers. These initiatives among others, included decontrol of phosphatic and potassic fertilisers, promotion of integrated nutrient management, production and promotion of organic manures and bio-fertilisers, National Project on Management of Soil Health and Fertility (NPMSF), and nutrient based subsidy (NBS) policy. Attempts have also been made to strengthen and revamp soil testing laboratories in various districts under NPMSF. Farmers are encouraged to test their soil periodically and apply fertilisers based on the deficiency of nutrients in soil. This is intended to ensure balanced supply of nutrients for maintaining soil health and improving crop productivity.

The challenge in the crop nutrient management is to balance the nutrients required by the crop with the soil nutrient reserves and external application of nutrients. And soil test is the tool which analyse the soil sample to determine nutrients content, composition and other characteristics such as acidity or pH level. The report issued by any such soil testing laboratories is called as Soil Health Card. A proper soil test will help the application of enough fertilizer to meet the requirement of the crop while taking advantage of the nutrients already present in the soil. It will also determine lime requirement and help diagnosis of problematic soils.

The general fertilizer recommendation for crops are given as a range taking into consideration crop to be sown, crop variety, previous crop, soil texture, organic manure that will be applied, source of irrigation and management level. The State Department of Agriculture usually follow the recommendations provided by the State Agricultural Universities (SAUs) in their of package of practices and disseminate to the farming community. But the use of site specific recommendations by farmers is negligible. Farmers apply fertilizers according to their financial resources, the availability of water, the types of fertilizers available and the expected financial returns.

1.2 Review of Literature

This section presents a compendium of the literature available in the field of usage of fertiliser and soil testing methods, leading to unearth the findings of various authors from different perspectives and also to locate the research gap for the proposed study. The usage of fertilisers is for enhancing crop productivity based on the recommendations of soil laboratory officials. Farmers are encouraged to go for soil test in order to find out the nutrient content and the suitability of the land for a particular crop. Vast literature is present on the same lines carving the importance of fertilisers to enhance the soil health and thereby productivity.

Mukherjee (1968) discussed some of the problems of multiplication and distribution of new varieties of seeds, deciding on correct fertiliser dosages for different soil conditions, adapting an essentially protective irrigation system to the requirements of scientific agriculture that have been encountered in the course of implementation of the high-yielding varieties programme. He concluded that agriculture today is not starved of physical inputs; what it needs is better application of these inputs, which will be achieved once the necessary scientific knowledge is made available to the cultivator. According to his study, by and large, the comparatively enlightened and progressive farmers were following a policy of trial and error in the matter of application of fertilisers mainly because (a) the extension agency was not equipped with knowledge of the doses of fertilisers required in the homogeneous soil regions of the State; and (b) there were no adequate facilities for soil testing in different parts of the State. Unless sufficient experimental trials and demonstrations were held in small sub-research stations located preferably in each homogeneous soil climate area and facilities for soil testing on a large scale were provided, it would not be possible to achieve the optimum results out of the intensive application of a very large amount of resources leading to the wastage of scarce national resources and sometimes reducing individual farmers to penury when the crops fail because of poor trials and no soil testing at the initial stage. The main hurdle was in the group of institutional problems, which was the link between research and field action.

A study by Roy (1970) concluded that the application of chemical fertilisers was confined only to one or two major foodgrain crops and a few commercial crops that rose mainly under irrigation. The reasons were partly economic and partly sociological. The earlier varieties of crops were not very responsive to fertiliser application, and the crop-fertiliser price ratios were generally unfavourable making returns on fertiliser applications not very attractive. At the same time, the tradition-bound farmers were not enthusiastic about applying new inputs, the potentials of which were not fully known to them, and the preference was for time-honoured organic manures. There were also social prejudices against the use of chemical fertilisers on food crops. The article focussed a few selected wheat growing areas, whether the actual fertiliser use on HYV wheat has been above or below the recommended doses, and in the case of a lower dose to discover, what factors were responsible and what corrective measures were taken up. He highlighted the two main determinants of "returns" from fertiliser use, which affects the rate of fertiliser applicability viz., fertiliser-crop price ratio and fertiliser-crop production ratio; and stressed that fertiliser application can be stepped up either by lowering the former or by raising the latter, or both. He concluded that greater reliance, therefore, should be placed on an augmented internal supply rather than on the element of subsidy in bringing down the prices of fertilisers.

Parikh (1978) stated that in a given zone the cultivators who on their own grow a given high yielding variety for a given level of fertilisers get a lower yield than the yield obtained by the cultivators under the Simple Fertiliser Trials (SFTs) programme growing the same variety for the same level of fertilisers. This was the major research gap as there was no basis for clarification. The paper also analysed the results of the Simple Fertiliser Trials (SFTs) conducted by the Indian Council of Agricultural Research on cultivators' fields to argue that, contrary to conventional wisdom', fertiliser need not necessarily be concentrated either on irrigated land or on HYV's. Fertilised allocation ought to be based on an analysis of local conditions and responses of the available varieties. It should not be guided by general principles of synergy or intensive agricultural development.

Nagaraj (1983) developed a framework for the analysis of factors affecting fertiliser use in Indian Agriculture. Existing studies were unable to explain the deceleration in fertiliser use and the divergence between targets and actual levels of consumption. The paper has tried to explain the variations in fertiliser use over regions and over time in terms of a set of physical/technological factors and of relative prices, using regression and correlation analysis. It suggested that irrigation was uniformly a dominant influence especially the groundwater. The author came out with the conclusion that more disaggregated data would perhaps enable one to capture the relationship between rainfall and fertiliser use in a better way. The findings of the paper were: Spread of HYVs and fertiliser-intensive crops (notably those under irrigated area) were found to have a positive effect on fertiliser consumption. Use of fertilisers and relative price, as expected, were inversely related in a number of cases but the relation was weak. While the potential for absorption of nutrients had increased considerably as a result of rapid growth of irrigation facilities and qualitative improvements in it (due to the phenomenal growth of energised wells and rise in the share of groundwater) as well as a sharp increase in the proportion of cropped area under HYVs and fertiliser intensive crops, the growth of fertiliser use consumption had decelerated.

Shrivastava (1983) came up with the study that comparisons are often made with developed countries to show that agricultural production can be increased in developing countries by enhancing the quantity of fertiliser application. Most of the fertiliser promotion campaigns in developing countries are designed to make the message reach the farmers, that the present level of application of fertilisers in their fields is only a small fraction of the optimum level or is very insignificant compared to the levels on Japanese and Korean farms. But the real issue in the developing countries is not 'how much' fertiliser has been applied to the soil, as how efficiently even the existing level of fertiliser is being used. The paper has analysed this problem with respect to Indian context, which may be relevant to many other developing countries also. Since a larger proportion of fertilisers is used on food crops such as rice, wheat, etc, the analysis at the macro level has been attempted for foodgrains output. The study revealed that, NN application of fertilisers in India has shown consistent and significant increases, but the crop production had not reflected the expected results. It is quite likely that fertiliser might be substituting poor management, but other requirements such as appropriate seed variety, timely irrigation and water management practices, plant protection measures, and weeding operations, etc, were not adequately met.

Raut and Sitaula (2012) assessed the origins of and changes in fertilizer policy in Nepal over a period of time. It assessed farmers’ awareness of the recent changes to the subsidy policy and examined their perceptions of the extension services. The paper looked at the environmental implications of the concentrated application of chemical fertilizer, particularly as far as food security was concerned. The study found that in spite of decades of government policies prioritizing fertilizer as the leading driver of increased agricultural output; Nepal was yet to see the benefits in terms of higher yields. The development of effective and convenient policy with regard to the distribution and use of fertilizer has always been a challenge for the government. The paper concluded that the importation and distribution of fertilizer to farmers remained a challenge along with lack of awareness of policy changes with regard to fertilizer, and most farmers regarded the extension services provided by NGOs at the field level to be more efficient. It was also found from the study that agriculture development of Nepal should be addressed with a three-tier approach: efficient distribution of quality fertilizers, strengthened Extension services and involvement of private sector. The schemes must target the small and marginal farmers who should benefit most from the subsidy, and stressed on the effective provision of extension services

A study by Raju (1990) highlighted that future growth of fertiliser use in India depends much on the development of institutional infrastructure and hence marked that a shift in the focus of attention from the conventional 'demand' oriented agro-economic variables to complementary agricultural institutions is essential for understanding the dynamics of fertiliser use. The paper argued that without a proper understanding of these processes and accompanying policy measures, the task of attaining optimum levels of fertiliser use would be formidable.

Further, farmers' demand for fertilisers or prices is unimportant and strengthening of institutional facilities like extension, credit, distribution and marketing (for both inputs and output) is of greater importance such that farmers' potential demand for fertilisers can be made effective. However, in reality, farmers compromise with myriad bottlenecks that depend on two factors – one, their resource position and two, the level of agricultural development of a given region. The former relates to rural institutions and the benefits accrued there from and the latter indicates the importance of the regional factors in the development of such institutional infrastructure. A brief analysis that could be outlined from the paper is that the non-availability of credit seemed to be one of the important factors hindering the adoption of the new production techniques along with unpopularity of Co-operative societies, need for the extension and improving of the efficiency of the T and V system especially in the underdeveloped areas of the state. And finally there is a need to encourage substitution among different types of fertiliser and to bring about efficiency in the working of the co-operatives especially in the under-developed regions. Special efforts should be made to cater to the needs of small farmers. Thus, there is a need for production-oriented rather than input-oriented price policies.

Singh (2012) conducted a study to find out the farmer’s attitude towards adoption of recommended technology to increase productivity under selected dry land area. Total of 150 farmers were randomly selected from C. D. Block Chaka in Allahabad district of Uttar Pradesh. Results revealed that the reasons for non adoption of recommended technology under dry land farming are lack of crop rotation technique, lack of mulching technique, lack of adequate information, and lack of technical know-how followed by irrigation and drainage, risk bearing capacity and lack of enthusiasm.

FAO (2006), of The Republic of the Sudan explained that despite increasing oil exports, the agricultural and livestock sectors continued to make a major contribution towards gross domestic product. Mineral fertility of most soils were rated from moderate to poor, which showed that fertilizer consumption was very low, averaging about 4 kg of total nutrients per cultivated hectare. Farmers in the rainfed sector applied very little fertilizer. The price of fertilizers had risen steadily in the past decade. Until 1992, the Government controlled the marketing of agricultural inputs and outputs. However, as part of the economic reforms in the 1990s, it removed most of the controls on private traders. However, parastatal organizations still dominate the fertilizer supply system. There have been a number of cooperative programmes concerning the use of fertilizers, notably the FAO Fertilizer Programme, a fertilizer programme funded by the European Economic Community, Sasakawa Global 2000, and assistance from various bodies, e.g. the German development agency and the Arab Authority for Agricultural Investment and Development. Recent programmes concerning the use of non-traditional fertilizers have yielded promising results in terms of response and the economics of application. In the context of a 25-year plan, the Government is taking a number of measures to promote the development of agriculture and to improve rural services.

According to Government of India (2012), much importance had been given now to the use of fertilisers in order to enhance the productivity. Certain aspects related to use of organic manures and recycling of biomass need to be promoted, mixed/intercrops of pulses in all major cropping system should be encouraged, N-fixing and other useful trees/bushes as hedges on bounds for in-situ production of biomass should also be encouraged, green manure must be promoted, chemical nutrients should be used only on the basis of soil test recommendations. The usage of mineral nutrient resources such as rock phosphate along with composts – PROM (Phosphate rich organic manure) should also be encouraged. Lime, gypsum, basic slag and other soil amendments in problem soils are used so that Soil pH is brought to near neutrality to improve nutrient up take and fertilizer use efficiency. Bio-fertilisers need to be promoted on massive scale similar to chemical fertilizers but at the same time it needs to be ensured that bio-fertilisers of standard quality are supplied to the farmers so that they remain active till their use/ application. It is generally agreed that combined application of both nitrogenous and phosphatic bio-fertilizers can supply 25 kg N and 10 kg P_2O_5 per hectare. Some of the important reasons for limited use of bio-fertilizers are: Farmers are un-aware about bio-fertilizers, Inconsistent results on their use, Timely non-availability of standard quality bio-fertilizers which can withstand high temperatures, Supply of spurious products in the market, Dealers are not keen to store and supply bio-fertilizers to the farmers.

The study by Quasem and Hussain (Autumn 1979) was based on the pattern of utilisation of fertilisers on farms of different sizes and tenurial categories of the two villages of Bangladesh. They came out with the finding that although small farmers were late adopters they were not using less fertiliser per acre compared to large farmers in comparable crops. Total fertiliser use per acre was, however, higher on large farms mainly because of differences in crop-mix, i.e., the small farmers devoted a smaller proportion of the area to high-yielding crops which were fertiliser-intensive. Tenurial status of a farm did not have a negative impact on fertiliser use. The study attempted to analyse the pattern of utilisation of fertilisers in various crops and among different groups of cultivators which may throw some light on (i) the nature of constraint to agricultural growth through diffusion of fertilisers, and (ii) the impact of the diffusion on the distribution of income (Example -Fertilizer was used heavily in crops where the yield response seems to be high (e.g., HYVs and mustard grown on irrigated land) but was not used at all for the crops which were grown on water-logged land (iii) The tenurial status of a farm does not seem to have a negative impact on fertiliser use except in the case of large holdings. They concluded that the larger farmers were no doubt getting the lion's share of the fertiliser subsidy and cited that the inequality in the distribution of land, better financial position of the surplus farmers, and their access to financial institutions to be the reasons for getting the major share. The findings indicated that the small size of a farm or the share-cropping system may not be a constraint to agricultural growth through intensive use of fertilisers, provided credit at reasonable terms extended to the small farmers and tenants.

Tunney (1990) found that average available phosphorus in soils of the Republic of Ireland showed a steady and almost linear eightfold increase between 1950 and the present. A balance sheet study of phosphorus inputs and outputs indicated that inputs were more than double the outputs. These large inputs were related to the use of phosphorus fertiliser that had not increased over the past ten years, and was lower than the average for the European Community. The author also found that a positive P balance undoubtedly had important implications for both agricultural production and for water quality. A high P status, on the positive side ensured that agricultural production was not limited by P deficiency and ensured reserves against increase in price or shortage in the future. However, on the other hand, a high P status could contribute to nutrient imbalance with induced deficiencies or increased requirements for nutrients such as zinc and sulphur. Higher usage of P than necessary would lead to an increased cost to agricultural production. Finally, it was evident from the study that the results of soil analyses and advice to farmers should ensure that P should not be applied to soils that already had high levels.

1.3 Need for the Study

In the light of increased degradation of natural resources due to intensive cultivation and injudicious use, their sustainable management holds the key for ensuring sustainable food production. Due to lack of awareness among the farmers, there are wide spread problems related to the use of chemical fertilisers, mismanagement of surface water and over exploitation of ground water. The over use of chemical fertilisers in most parts of India for nutrient management in farming in the last few decades led to several problems affecting soil health, nutrient flow and natural environment. There is a need for promoting, among others, balanced use of fertilisers for increasing productivity of crops and for better absorption of nutrients from the applied fertilisers.

It is suggested that farmers should go for regular soil testing and use recommended doses of fertilisers as advised by the agricultural scientists. In this connection, Task Force on Balanced Use of Fertilizer recommended formulating a Centrally Sponsored Scheme entitled "National

Project on Management of Soil Health and Fertility (NPMSF)". Accordingly, this scheme has been implemented since 2008-09 and it encompasses three components viz., strengthening of soil testing laboratories (STLs), promoting use of integrated nutrient management and strengthening of fertiliser quality control laboratories. In addition, many states and institutions have made their efforts in educating, and promoting balanced use of fertilizers (recommended doses of fertilizers in particular) among farmers based on the soil test reports (Soil Health Cards). But there is no systematic study was undertaken so far for evaluating the effectiveness of these efforts / programmes on crop productivity, extent of soil testing for nutrient deficiency and adoption of recommended doses of fertilisers by farmers based on the soil tests. Therefore, the present study examined the adoption and constraints in the application of recommended doses of fertilisers, impact on crop productivity and other institutional problems in Karnataka for the selected crops such as paddy and maize.

1.4 Objectives

The specific objectives of the study are as follows:

1. To examine the level of adoption and its constraints in the application of recommended doses of fertilizers based on soil test reports by the farmers.
2. To analyse the impact of adoption of recommended doses of fertilisers on crop productivity and income of farmers

1.5 Data and Methodology

The present study relied on the primary data collected from the sample farmers grown two major crops such as paddy and maize (in terms of area) in the Karnataka state for the reference period of 2012-13. For each crop, two districts were selected based on their area share in the state. Sample of 150 farmers were selected for each crop for assessing the application of recommended dose of fertilisers and its impact on crop production. The list of farmers who got their soil tested was collected from the state Department of Agriculture. The number of taluks and villages were chosen based on the size of beneficiary list and the proposed sample size. The survey also involved control group of 100 farmers for each crop for assessing the effect of the application of the recommended dose of fertilisers on crop productivity and income.

1.6 Organisation of the Report

The present report has been organised in seven chapters. First chapter discussed the need for the study, objectives and methodology undertaken. Second chapter is concentrated on the trends in fertilizer consumption in the state. Third chapter focuses on the socio economic characters of the respondent farmers, cropping pattern, farm assets and details of credit availed. Fourth chapter deals with soil testing and recommended doses of fertilizers on soil test basis while fifth chapter deals with the adoption of recommended doses of fertilizers, constraints in following recommendations and training programmes attended by respondent farmers. The impact of adoption of recommended doses of fertilizers has been dealt in the sixth chapter. Final chapter contains summary and conclusions.

CHAPTER II

TREND IN FERTILIZER CONSUMPTION IN THE STATE

2.1 Trends in Fertilizer Consumption by Nutrients

Fertilizer is one of the strategic inputs for enhancing productivity which enables to meet the growing demand for food in the country. The Indian green revolution of 1960s has given more impetus on the use of fertilizers with fertilizer responsive hybrids and high yielding varieties and expansion of irrigation facility which resulted in quantum jump in food production. There has been a steady increase in the consumption of fertilizers (NPK) over the years across the country. The use of chemical fertilizers in India in the last 50 years has grown nearly 170 times. For instances, states like Punjab, Andhra Pradesh, Haryana, Karnataka, Tamil Nadu, West Bengal and Uttar Pradesh have very high average fertilizer consumption per hectare in comparison to the states like Rajasthan, Madhya Pradesh, Himachal Pradesh, Orissa, Goa and other north eastern states (FAO, 2006). The role of Government of India has been significant as the Government has been consistently pursuing policies conducive to increased availability and consumption of fertilizers at affordable prices in the country. However, the average intensity of fertilizer use in India at national level is much lower than in other developing countries but there are many disparities in fertilizer consumption patterns both between and within regions of India.

According to the Ministry of Agriculture, Government of India (2012-13), Karnataka is the seventh largest fertilizer consuming states in India in terms of NPK nutrients. As Suma (2007) pointed out, there was a substantial growth in production and consumption of chemical fertilizers in the state across the districts over the years. The production of complex fertilizer showed an increasing trend. The state has witnessed an increase in the consumption of NPK. The consumption of fertilizer during kharif and rabi showed a positive and significant growth. Similarly, it may be noted from the Table 2.1 and Figure 2.1 that consumption of NPK in Karnataka state has increased from 9.1 lakh tonnes in 1991-92 to 23.4 lakh tonnes in 2011-12, implying an increase by almost 2.5 times. The increased rate of consumption was much noticed during recent years (Table 2.1).

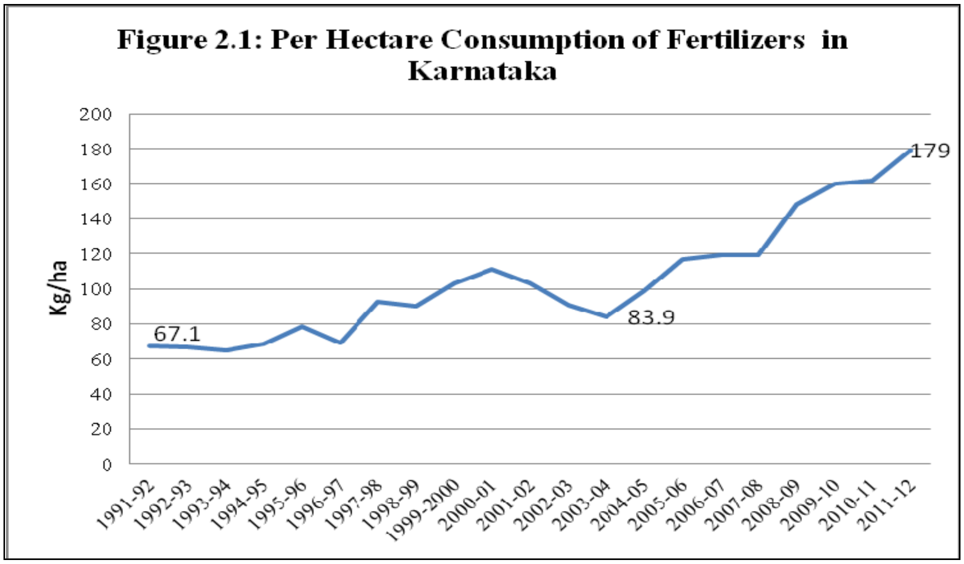
Table 2.1: Nutrient-wise Fertilizer Consumption in Karnataka (Lakh tonnes)

Year	N	P	K	TOTAL
1991-92	4.5	2.9	1.7	9.1
1992-93	4.3	2.6	1.2	8.1
1993-94	4.7	2.2	1.2	8.1
1994-95	5	2	1.3	8.2
1995-96	5.4	2.5	1.6	9.4
1996-97	5.2	1.9	1.2	8.3
1997-98	6.1	3.2	1.9	11.1
1998-99	6.4	3.4	1.7	11.5
1999-2000	6.8	3.7	2.2	12.7
2000-01	7.3	3.8	2.3	13.5
2001-02	6.7	3.6	2.2	12.5
2002-03	6	3	2	11
2003-04	5.3	2.8	2	10.2
2004-05	6.6	3.6	2.7	12.9
2005-06	7.5	4.4	3.4	15.3
2006-07	7.6	4.4	2.9	14.9
2007-08	7.9	3.9	3.4	15.3
2008-09	8.6	5.6	4.1	18.3
2009-10	9.6	6.3	4.7	20.6
2010-11	10.2	7	4	21.1
2011-12	12.2	7.9	3.3	23.4

Source: www.indiastat.com

The all India average consumption of fertilizers has increased from 95 kg/ha in 2004-05 to 144 kg/ha in 2010-11. Very high availability has however, been observed among states. While per hectare consumption is 237.1 kg in Punjab and 22.7 kg in Andhra Pradesh, it is comparatively low in MP (81kg/ha), Orissa (58 kg/ha), Rajasthan (48.3 kg/ha) and Himachal Pradesh (54.8 kg/ha), and below 5kg/ ha in some of the North Eastern States (State of Indian Agriculture, 2011-12). At the same time, the consumption was 179 kg/ha in Karnataka (Figure 2.1). The consumption has grown from 67.1 kg/ha in 1991-92 to 179 kg/ha within a span of two decades, which was almost 2.7 times. Moreover, the fertilizer consumption per hectare in Karnataka was higher than all-India average along with some of the south Indian states like Andhra Pradesh and Tamil Nadu.

The total fertilizer consumption is not a good indicator as there are large differences in total cropped area across states. Therefore, consumption of plant nutrients per unit of gross cropped area (GCA) is presented in Table 2.2. It is found from the table that the NPK consumption per hectare of GCA has also increased over the years in Karnataka. The NPK consumption per hectare of GCA was almost 160 in the state during 2009-10, which was more than the all-India average of 135 at the same period.



Source: www.indiastat.com

Table 2.2: Consumption of Plant Nutrients Per Unit of Gross Cropped Area in Karnataka (2008-2009 and 2009-2010) (Kg./Hectare)

Year	Nutrients	Karnataka	India
2008-2009	N	67	77.1
	P2O5	43.3	33.2
	K2O	31.7	16.9
	Total	142.1	127.2
2009-2010	N	74.7	79.6
	P2O5	48.9	37.1
	K2O	36.1	18.5
	Total	159.7	135.2

Source: State of Indian Agriculture 2012-13

The district-wise analysis of fertilizer consumption by nutrients has been is presented in Table 2.3. A wide variation is observed across districts with respect to total NPK fertilizer consumption during 2012-13. The top five districts with high consumption of fertilizers were Belgaum (1.47 lakh tonnes), Bellary (1.41 lakh tonnes), Raichur (1.40 lakh tonnes), Koppal (0.83 lakh tonnes) and Bagalkote (0.77 lakh tonnes), which seems to the availability of irrigation facilities and cropping pattern in the area might be the reason behind this high level of consumption in these districts. But, the lowest consumption of fertilizer districts in the state includes Udupi (0.06 lakh tonnes), Ramanagar (0.10 lakh tonnes) and Uttara Kannada (0.11 lakh tonnes). The state recorded an increase in the consumption of NPK over the years. As Suma (2007) reported the consumption of fertilizer during both kharif and rabi had a positive significant growth. Some of the districts such as Mysore, Gulbarga, Chikkamagalore, Kodagu, Dakshina Kannada and Udupi showed more consumption of potash fertilizer during 2012-13, most of these districts belong to hilly zones of the state.

2.2 Consumption of Fertilizers by Products in Karnataka

Like any other states in the country, Karnataka state uses many types of fertilizers, urea accounts for most of the consumption of N and DAP for most of that of $P_2O_{5.}$ Urea accounts for about 65 percent of the total consumption of straight N fertilizers. Other straight N fertilisers such as AS, CAN and ammonium chloride accounts for less than one percent. DAP accounts for 51 percent of total P_2O_5 consumption and other complex fertilizers for 37 percent. Single Super Phosphate (SSP) accounts for nine percent of total P_2O_5 consumption. Figure 2.2 shows the share of various fertilizers in total N and P_2O_5 consumption in 2012-13.

2.3 Soil Fertility Status in Karnataka

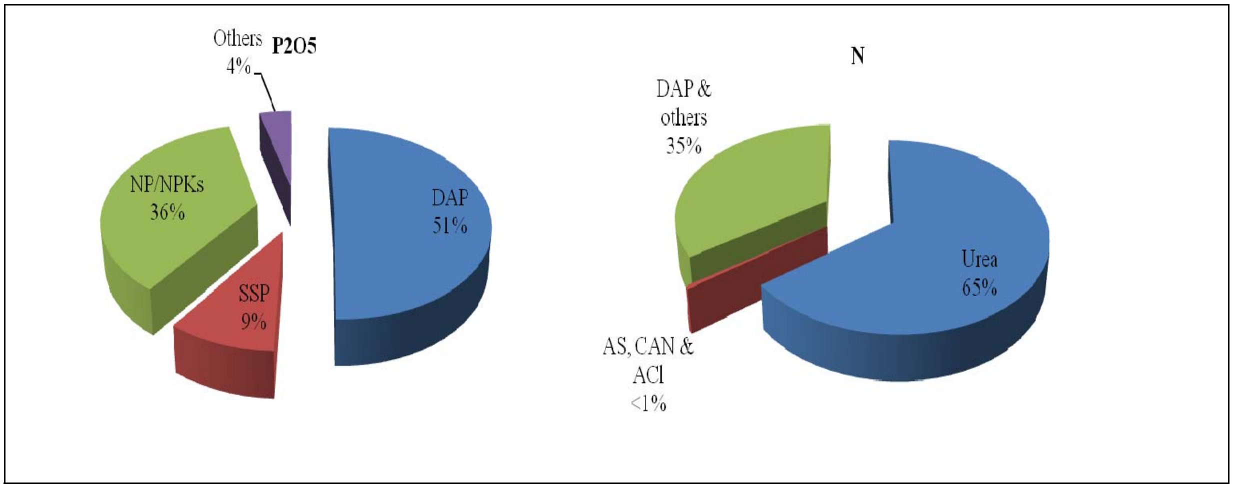
The trend in increasing the yield by adopting high yielding varieties has resulted in deficiencies in soils and has reflected as deficiency symptoms in plants. Therefore, the state has conducted a study to understand the fertility (NPK) status of the soilsfor applying required dosage of fertilizers and planning the regional distribution of fertilizers by collecting the soil samples from grid points (1906 grids) all over the state and analysed for pH, Ec., organic carbon, available phosphorus and potassium. The results of the analysis were given in Table 2.4 to 2.6.

Table 2.3: District wise consumption of plant nutrients in Karnataka 2012-13

S. No.	Districts	N	P2O5	K2O	Total
1	Belgaum	86336	32350	28451	147137
2	Bellary	85611	36507	18846	140964
3	Raichur	88337	36570	14909	139816
4	Koppal	51353	17944	13664	82961
5	Bagalkote	44906	17072	14768	76746
6	Davanagere	46581	19190	8369	74140
7	Mandya	50020	13403	10603	74026
8	Hassan	32041	14451	13442	59934
9	Shimoga	33134	14244	10678	58056
10	Bijapur	31890	16273	8620	56783
11	Gulbarga	28001	22720	5972	56693
12	Mysore	30378	11560	13702	55640
13	Haveri	33364	14527	4571	52462
14	Chickmagalur	22944	12239	15564	50747
15	Yadgiri	28062	11818	5139	45019
16	Tumkur	24537	8362	3583	36482
17	Dharwad	18005	11408	7056	36469
18	Kodagu	14257	7733	12043	34033
19	Bangalore Urban	19164	9790	4057	33011
20	Chikkaballapur	17984	10398	4174	32556
21	Bidar	14379	11800	3936	30115
22	Kolar	15361	8945	3152	27458
23	Chamarajanagar	13783	5000	5006	23789
24	Chitradurga	14419	5547	3291	23257
25	Gadag	13090	5703	3206	21999
26	Bangalore Rural	9392	5236	3643	18271
27	Dakshina Kannada	7549	3278	4908	15735
28	Uttar Kannada	6021	2789	2163	10973
29	Ramanagaram	7692	1600	826	10118
30	Udupi	3105	1184	1528	5817
	Total	891696	383641	249870	1531207

Source: Fertilizer Statistics 2012-13

Figure 2.2: Consumption of Total Fertilizer Products in Karnataka (% Share) During 2012-13



Source: The Fertilizer Association of India (2015)

2.3.1 Available Nitrogen Status

The available nitrogen status presented in Table 2.4 show that about 10.3 per cent of the soils in the state fall under the low category, 35.8 per cent under medium and 53.9 per cent under high category. The areas covering Western ghats, coastal plains and Malnad areas of the State, under forest and plantations, are high in nitrogen. Apart from this areas under irrigation and hilly regions of the plateau are high to medium in nitrogen. Rest of the area of the state is low in nitrogen.

Table 2.4: Available Nitrogen Status of Soils in Karnataka

Class	Available N (Kg/ha)	Area (000 ha)	Per Cent
Low	< 280	1963.8	10.31
Medium	280 - 560	6827.8	35.84
High	> 560	10258.2	53.85

Source: Adapted from http://raitamitra.kar.nic.in/agriprofile/fertility.htm

2.3.2 Available Phosphorous Status

The available phosphorus status in the soils of Karnataka from Table 2.5 reveals that about 83 per cent of the soils in the state are low in phosphorus. About 17 per cent area is under medium category implying thereby that most of the soils need to be fertilised through phosphorus for sustained production.

Table 2.5: Available Phosphorous Status of Soils in Karnataka

Class	Available P (Kg/ha)	Area (000 ha)	Per Cent
Low	< 280	1963.8	10.31
Medium	280 - 560	6827.8	35.84
High	> 560	10258.2	53.85

Source: Adapted from http://raitamitra.kar.nic.in/agriprofile/fertility.htm

2.3.2 Available Potash Status

The potassium status in the soil of the State presented in Table 2.6 shows that potassium is medium to high in most of the soils of the state except in lateritic soils of Coastal Plains and Western Ghats and in shallow red and black soils, where it is low.

Table 2.6: Available Potash Status of Soils in Karnataka

Class	Available P (Kg/ha)	Area (000 ha)	Per Cent
Low	< 280	1963.8	10.31
Medium	280 - 560	6827.8	35.84
High	> 560	10258.2	53.85

Source: Adapted from http://raitamitra.kar.nic.in/agriprofile/fertility.htm

2.4 New Initiatives of Government of Karnataka on Soil Heath

The extensive use of fertilisers and use of improved varieties has resulted in greater mining of soil nutrients which intern resulted in depleting soil fertility, decline in water table, decrease in organic matter content and deterioration in soil health. Indian soils not only deficiency of primary nutrients (NPK) but also of secondary nutrients (Sulphur, Calcium, Magnesium) and micronutrients (Boron, Zinc, Copper and Iron etc.) in most parts of the country. The same issues were noticed in the state of Karnataka. To overcome from these issues, the state has taken various steps in addition to the centrally available schemes. The two important mission mode schemes initiated by the state are 'Bhoochetana' from the year 2009-10 and 'Soil Health Mission-Karnataka' during 2014-15. In both the programmes soil test was made compulsory as it a part of the discipline of Fertilizer Use and Management.

2.5.1 Bhoochetana

The programme was initiated with the mission goal of increasing average productivity of selected rainfed crops by 20 per cent. The consortium partners of the programme include Karnataka State Department of Agriculture, Watershed Development Department, all the Universities of Agriculture in the State and ICRISAT, Hyderabad as the technical consultants. The soil test based nutrient management with major thrust on micronutrients was the main strategy behind the programme. In which, inputs (micronutrients) were distributed at 50 per cent subsidy at cluster village level under the services of new provisional post farmer facilitators created for the purpose. Extensive promotion and publicity was made through formation of Farmer Field School (FFS) and effective project monitoring and feedback system.

As per the available sources, the programme was successfully implemented across 26000 villages and covered 42 lakh farmers. The programme was extended to 50 lakh ha of dryland area and 5 lakh ha of irrigated area during 2012-13. An enhancement in yields of 11-37 percent is observed in the treated areas. With this success, Bhoochetana phase 2 was approved for the next five years (2013-14 to 2017-18).

2.5.2 Soil Health Mission

At present, there are 29 Soil Testing Laboratories (STLs) functioning in Karnataka with the analyzing capacity of 2 lakh soil samples per annum. The soil samples are analyzed for major nutrients, secondary nutrients and micro nutrients. After the analysis of the soil samples, farmers are given Soil Health Cards (SHCs) which include suitable recommendations of fertilizers in order to get better yields besides maintaining soil fertility. After analysing and reviewing the functioning of these STLs and delay in distribution of SHCs, the department has realized that the present pace is not sufficient to analyse the samples and distribute SHCs in time. It is also important to understand that soil test values remain varied for a period of three years and hence soil testing has to be done at least once in three years. Realizing these difficulties, it was proposed to implement the soil testing programme on a mission mode for three years in the form of Soil Health Mission with the main objective of analyzing the soil samples from all the farm holdings and issue SHCs by the end of 2016-17.

To sum up, the intensive agriculture lead to increase in chemical fertilizer usage that has changed the complexion of agriculture since green revolution in the country. The adoption of fertilizer responsive hybrids, high yielding varieties and expansion of irrigation facilities have supported by increased application of fertilizers which in turn resulted in quantum jump in food production across the country. Like other states, Karnataka has also experienced the substantial increase in fertilizer use during post green revolution. The consumption of NPK in Karnataka has increased from 9.1 lakh tonnes in 1991-92 to 23.4 lakh tonnes in 2011-12, implying an increase by almost 2.5 times. The NPK consumption per hectare of GCA was almost 160 in the state during 2009-10, which was more than the all-India average of 135 at the same period.

A wide variation is observed across districts with respect to total NPK fertilizer consumption during 2012-13. The top five districts with high consumption of fertilizers were Belgaum (1.47 lakh tonnes), Bellary (1.41 lakh tonnes), Raichur (1.40 lakh tonnes), Koppal (0.83 lakh tonnes) and Bagalkote (0.77 lakh tonnes) while the lowest consumption of fertilizer districts in the state include Udupi (0.06 lakh tonnes), Ramanagar (0.10 lakh tonnes) and Uttara Kannada (0.11 lakh tonnes). Some of the districts such as Mysore, Gulbarga, Chikkamagalore, Kodagu, Dakshina Kannada and Udupi showed more consumption of potash fertilizer during 2012-13, most of these districts belong to hilly zones of the state.

Among the various types of fertilizer products, urea accounts for about 65 percent of the total consumption of straight N fertilizers, whereas DAP accounts for 51 per cent of total P_2O_5

consumption. Other complex fertilizers accounts for 37 per cent of share among different fertilizer products.

The trend in increasing the yield by adopting high yielding varieties has resulted in deficiencies in soils and has reflected as deficiency symptoms in plants. A study conducted by the Government of Karnataka to understand the fertility (NPK) status of the soils for applying required dosage of fertilizers and planning the regional distribution of fertilizers shows that majority of the soils in the state were rich in nitrogen, low in phosphorous, and medium to high in terms of potassium.

Karnataka has taken foremost steps in protecting their soil from the issues arising out of imbalanced use of fertilizers and deterioration in soil health, in addition to the centrally sponsored schemes. The two important mission mode schemes initiated by the state are 'Bhoochetana' from the year 2009-10 and 'Soil Health Mission- Karnataka' during 2014-15. Bhoochetana has given major thrust on micronutrients application whereas Soil Health Mission aims at analyzing the soil samples from all the farm holdings across the state and issue SHCs by the end of 2016-17.

CHAPTER III

SOCIO-ECONOMIC CHARACTERISTICS OF SAMPLE HOUSEHOLDS

In any socioeconomic study it is very important to understand the farmer's household characteristics as they explain one's position in the social hierarchy, its structure, and social relations in influencing the adoption of agricultural technology. Also indicates one's access to collectively desired resources like material goods, natural resources, money, power, friendship networks, healthcare, leisure and educational opportunities. And it is the access to such resources that enable individuals to prosper in the social world.

3.1 Socio-economic Characteristics of the Sample Households

3.1.1 Distribution of Sample Households by Farm Size

Table 3.1.1 describes the demographic profile of the selected households. It can be observed from the table that among total paddy farmers, majority were small farmers (31.03%) followed by large farmers (27.59%), marginal farmers (23.36%) and medium farmers (19.63%). However, in case of paddy control farmers, the third largest group formed by marginal farmers (23.36%), and medium famers occupied fourth place with their least population (19.63%), whereas large farmers and marginal farmer's occupied third and fourth position in terms of their population of 29.72 per cent and 12.99 per cent respectively in case of paddy soil test farmers.

Among the maize farmers, control farmers group constitutes majority of small farmers (42.20%), followed by medium, large and marginal farmers with 22.90 per cent, 20.10 per cent and 14.60 per cent respectively. While in case of soil test farmers, the order remain same with majority belonged to small farmers (37.40%) followed by medium (28.30%), large (21.20%) and marginal farmers (12.90%). Hence, the total maize sample farmers constitute 39.39 per cent of small farmers, 26.14 percent of medium farmers, 20.83 per cent of large farmers and 13.64 per cent of marginal farmers.

Table: 3.1 Distributions of Sample Households by Farm Size Category (% of HHs)

Farm size group	Paddy			Maize		
	Control Farmers	Soil Test Farmers	Total	Control Farmers	Soil Test Farmers	Total
Marginal	23.36	12.99	17.24	14.6	12.9	13.64
Small	29.91	31.82	31.03	42.2	37.4	39.39
Medium	19.63	27.27	24.14	22.9	28.3	26.14
Large	27.10	27.92	27.59	20.1	21.2	20.83
Total	100.00	100.00	100.00	100	100	100

3.1.2 Socio-economic Characteristics of Households

Table 3.1 describes the socio economic characteristics of sample household of paddy farmers. A sample of 261 farmers was selected under paddy crop for assessing the extent of adoption of recommended doses of fertilizers and their impact on crop production and productivity. Out of which 107 were control farmers and the rest 154 were soil test farmers. Average age of total sample farmers was 46.58 years, while the age was more or less same in both control and soil test farmers. There was not much difference in the education status between the control and soil test farmers, secondary education being the common among the total sample. Cent percent of the control farmers were dependent on agriculture as their main occupation whereas it was 94.81 per cent in soil test farmers; hence on the whole 96.93 per cent of paddy farmer's main occupation was agriculture. Among the total paddy respondents’ cent per cent of control farmers and 94.81 percent of soil test farmer respondents were males. Family size, number of people engaged in agriculture, and average years of experience in agriculture among the two groups was also almost similar. Wherein the average family size was six, three persons were engaged in agriculture, and had an agriculture experience of 26 years. About 21.50 per cent of control farmers and 31.17 per cent of soil test farmers were members in one or more associations; however, the percentage was 27.20 in the total sample farmers. Out of the total selected farmers 48.66 per cent were belonged to general, 26.44 per cent from OBC, 17.24 per cent fit into ST and 7.66 per cent SC category.

Table: 3. 2 Socio-economic characteristics of sample households-Paddy

Particulars	Control Farmers	Soil Test Farmers	Total
No. of Sample Farmer HH	107	154	261
Average age of Respondents	46.81	46.42	46.58
Average years of respondent education	8.30	8.95	8.70
Agriculture as main occupation (% of respondent)	100	94.81	96.93
Gender (% of respondents)			
Male	100.00	94.16	96.55
Female	0.00	5.84	3.45
Average family size	7.00	6.00	6.00
Average number of people engaged in agriculture	3.00	3.00	3.00
Average years of experience in farming	27.00	26.00	26.00
% of farmers being a member of any association	21.50	31.17	27.20
Caste (% of households)			
SC	5.6	9.09	7.66
ST	16.82	17.53	17.24
OBC	24.29	27.92	26.44
General	53.27	45.45	48.66

Table 3.2 describes the socio-economic characteristics of maize sample households. It is clear from the table that out of total sample, 109 farmers were control and 155 were soil test farmers. Average age of respondents from control farmers was 46 years whereas soil test farmers was 44 years, therefore total sample respondents' average age was almost 45 years. Secondary education was the average education status among the total sample and not much difference observed between groups. About 99 per cent farmer's core occupation was agriculture in the total maize sample, which is almost same in both control and soil test farmers. Around 98 per cent respondents were males with an average family size of 8 persons in their family, out of which on an average 3 persons were engaged in agricultural activity. These persons had an average experience of around 25 years; interestingly soil test farmers had two years less experience than the control farmers. There was considerable difference in the percentage of farmers' being member in any associations, it was 27 per cent among control farmers and 18 percent in soil test farmers. Out of total selected sample, majority farmers were belonged to OBC category (49%) followed by general (28%), ST (15%) and SC (7%) categories.

Table: 3.3 Socio-economic Characteristics of Sample Households- Maize

Particulars	Control Farmers	Soil Test Farmers	Total
No. of Sample Farmer HH	109	155	264
Average age of Respondents	46.01	43.47	44.52
Average years of respondent education	7.03	9.31	8.98
Agriculture as main occupation (% of respondent)	99.08	98.06	98.57
Gender (% of respondents)			
Male	98.17	98.71	98.43
Female	1.83	1.29	1.56
Average family size	8.17	7.03	7.50
Average number of people engaged in agriculture	3.40	3.18	3.28
Average years of experience in farming	26.32	23.68	24.72
% of farmers being a member of any association	26.60	18.18	21.39
Caste (% of households)			
SC	11.01	2.58	6.79
ST	18.35	12.26	15.30
OBC	44.04	54.84	49.44
General	26.61	30.32	28.46

3.2 Details of Operational Land Holdings

Table 3.4 represents the landholding details of paddy farmers. It can be seen from the table that control farmers own on average of 8.21acres, in addition 0.94 acre of leased-in, 0.05 acre leased-out and 0.08 acre uncultivated land, therefore the net operational area of control farmers turned out to be almost nine acres; in which about seven acre was irrigated and two acres un-irrigated. On the other side, soil test farmers owned 9.68 acres of land, 0.48 acre leased-in, and 0.86 acre leased-out land, hence the total operational area accounts to 9.29 acres; out of which 7.85 acres was irrigated and 1.44 acres un-irrigated. There is not much difference in the gross cropped area between control and soil test farmers, which was about 13.35 acres in an average out of the total sample. However, cropping intensity of control farmers was slightly lower than the soil test farmers, and the average cropping intensity of total sample was 146 per cent.

Table: 3.4 Operational holding of the Sample Households Paddy (acres/HH)

Particulars	Control Farmers	Soil Test Farmers	Overall
Owned Land	8.21	9.68	9.08
Leased-in	0.94	0.48	0.67
Leased-out	0.05	0.86	0.52
Uncultivated/Fallow	0.08	0.01	0.04
Net operated area	8.99	9.29	9.17
Net irrigated area	6.96	7.85	7.60
Net un-irrigated area	2.10	1.44	1.73
Gross cropped area	12.89	13.64	13.35
Cropping intensity (%)	143.38	146.82	145.58

Table: 3.5 Operational holding of the Sample Households Maize (acres/HH)

Particulars	Control Farmers	Soil Test Farmers	Overall
Owned Land	7.47	8.02	7.79
Leased-in	0.32	0.28	0.30
Leased-out	0.05	0.04	0.05
Uncultivated/Fallow	0.24	0.04	0.14
Net operated area	7.49	8.22	7.92
Net irrigated area	4.18	4.94	4.56
Net un-irrigated area	3.31	3.27	3.29
Gross cropped area	8.60	9.81	9.21
Cropping intensity (%)	114.82	119.34	116.29

Table 3.5 gives the information on the landholding of maize farmers. The total land owned by control farmers was 7.41 acres whereas for soil test farmers it was eight acres. Control farmers had leased-in of 0.32 acre, leased-out of 0.05 acre, and the rest 0.24 acre was fallow land. Therefore, on an average control farmers had net operated area of about 7.5 acres, out of which 4.18 acres was irrigated and 3.31 acres was un-irrigated. In case of soil test farmers, leased-in was 0.3 acre, leased out was 0.05 acre and uncultivated was negligible (0.04 acres). But the owned land was 8 acres, consequently the net operational area was 8.22 acres. The overall gross cropped area of total maize sample was 9.21 acres with the cropping intensity of 121 per cent. There was not much difference in cropping intensity between soil test farmers and control farmers.

3.3 Sources of Irrigation

Among the sources of irrigation, canal forms the major source of irrigation for the paddy sample households in the study area followed by river/ponds and bore wells. The reason behind canal as a major source of irrigation might be the presence of rivers such as Tungabhdara and Surekerehalla in selected taluk's of Davangere district, and Krishna and Tungabhadra in selected taluk's of Raichur district. Table 3.6 describes the irrigation sources pattern of Paddy farmers. There was not much difference observed between the control and soil test farmers in irrigation source pattern. The major source of irrigation for the total sample was from canal, which constituted more than half (53.52%) of the net irrigated area followed by river or ponds (19.65%), bore wells (18.83%) and open or dug wells (4.69%). Streams accounts for meagre share (3.01%) among all sources of irrigation to paddy farmers in the study area.

Table: 3.6 Source of Irrigation in Paddy (% of Net Irrigated Area)

Particulars	Control Farmers	Soil Test Farmers	Overall
Open/dug well	4.68	4.71	4.69
Bore well	18.22	19.45	18.83
Canal	53.38	53.66	53.52
River/Ponds	21.00	18.31	19.65
Tank	0.00	0.56	0.30
Others*	2.72	3.32	3.01
Total	100.00	100.00	100.00

The sources of irrigation for maize was completely different from paddy, wherein the major sources of irrigation was bore well among both control and soil test farmers, which altogether accounted for 46 per cent of the net irrigated area. Open/dug well forms the second major category representing 26.15 percent of the net irrigated area, followed by canal (14.75%) and river/ponds (13.19%). Much difference was noticed in terms of second major source of irrigation between control farmers and soil test farmers, it was 33.51 percent of net irrigated area in case of control farmers, while 18.79 per cent of the net irrigated area in case of soil tests farmers. Subsequently, the third largest source of irrigation for control farmers (13.45% of net irrigated area) was canal, but it was river/ponds (18.21% of the net irrigated area) in case of soil test farmers. The sources of irrigation in maize crop were illustrated in Table 3.7.

Table: 3.7Source of Irrigation in Maize (% of Net Irrigated Area)

Particulars	Control Farmers	Soil Test Farmers	Overall
Open/dug well	33.51	18.79	26.15
Bore well	44.87	46.95	45.91
Canal	13.45	16.04	14.75
River/Ponds	8.17	18.21	13.19
Tanks	0.00	0.00	0
Others	0.00	0.00	0
Total	100.00	100.00	100

3.4 Cropping Pattern, Area under HYVs and Value of Output

Cropping pattern explains the sequence and spatial arrangement of crops in a particular farm. The cropping pattern in the particular area depends upon some of the factors like availability of irrigation, soil type, climatic conditions and market availability. Table 3.8 describes the cropping pattern of sample paddy farmers. Paddy was the predominant crop grown in the study area in all three seasons, which constituted about 59 per cent of total GCA because of the availability of canal irrigation in the study area. Other major crops grown in kharif were maize and cotton which accounts for around 46 per cent and 4 per cent of GCA respectively. In rabi season, considerable area was under cotton after paddy among soil test farmers because of assured irrigation from bore wells. In summer, soil test farmers cultivated sunflower in very small area (0.43 % of GCA) after paddy because of limited water availability from canal during this period. In addition, some perennial crops like areca nut, betel leave, coconut and sugarcane also had considerable share of 6.14 percent in the total GCA. Nevertheless, compared to control farmers, soil test farmers had more area under arecanut (4.10% of GCA), whereas control farmers had higher area under betel leaves (2.14 % of GCA) followed by sugarcane and coconut.

Similarly, the cropping pattern of maize sample farmers is presented in Table 3.9. Maize was the dominating crop in existing cropping pattern among both control and soil test farmers in the study area, which constituted an overall area of 58 percent of the total GCA in Kharif. This crop can also be grown in all the three seasons in the state. The percentage of maize area was little higher amongst control farmers in kharif, and soil test farmers in rabi. Cotton and paddy were the other important crops grown during kharif with both the categories. In rabi and summer, other crops like ground nut, jowar, pulses and vegetables were grown after maize, which represents a tiny share of GCA. Besides, sugarcane was the main annual crop grown in these districts because of canal accessibility from the rivers like Krishna, Malaprabha, Ghataprabha in Belgaum district, and Tungabhdara and Surekerehalla in Davangere district. Other perennial crops grown in the study area includes areca nut, pomegranate, betel leave and banana.

Table: 3.8 Cropping Pattern of the Sample Paddy Households (% of GCA)

Season/crop	Control Farmers	Soil Test Farmers	Overall
Kharif			
Paddy	45.09	45.04	45.03
Cotton	5.09	3.67	4.22
Jowar	1.84	0.27	0.89
Ragi	0.59	0.05	0.26
Sunflower	0.74	0.33	0.49
Maize	10.73	8.18	9.16
Vegetables	0.62	0.26	0.59
Rabi			
Paddy	15.12	14.51	14.72
Cotton	0.74	3.37	2.68
Maize		0.45	0.27
Others*	0.74	0.10	0.35
Summer			
Paddy	12.56	15.40	14.40
Sunflower		0.43	0.26
Annual/Perennial			
Arecanut	2.14	4.10	3.37
Betel leaves	2.14	0.25	0.25
Coconut	0.96	0.49	0.67
Sugarcane	1.62	2.00	1.85
GCA	**100.00**	**100.00**	**100.00**

Table: 3.9 Cropping Pattern of the Sample Maize Households (% of GCA)

Season/crop	Control Farmers	Soil Test Farmers	Overall
Kharif			
Cotton	3.12	1.64	2.19
Jowar	0.39	1.32	0.97
Ragi	0.33	0.79	0.62
Maize	66.29	52.44	57.78
Sunflower	0.11	0.33	0.24
Paddy	0.74	1.02	1.86
Pulses	0.44	0.16	0.26
Vegetables	0.69	0.53	0.58
Others*	0.23	0.33	0.28
Rabi			
Cotton	1.33	0.20	0.62
Groundnut	0.56	0.03	0.23
Jowar	0.89	0.33	0.54
Maize	6.18	8.47	7.62
Others*	0.28	1.48	1.02
Summer			
Groundnut		0.13	0.08
Jowar	0.22	0.86	0.62
Others*	0.00	1.61	1.01
Annual/Perennial			
Arecanut	0.56	0.00	2.17
Sugarcane	14.93	16.00	15.60
Others*	0.99	0.26	0.55
GCA	100.00	100.00	100.00

In recent years, Indian agriculture has experienced technological breakthrough with the introduction of High Yielding Varieties (HYVs) which have the ability to yield three to four times more than ingenious varieties and diverse claims have been done in success of high yielding variety programmes. There is a strong belief that the growth in fertilizer use underscored by the dependence of proven yield increasing technologies on fertilizers. The association between HYVs and fertilizer is clear whenever suitable varieties were available on both irrigated and un-irrigated land. Therefore, an attempt was made with this study to understand the diffusion of HYV technology among the crops grown by the farmers.

The diffusion of HYVs in particular crops among paddy and maize farmers have been presented in Table 3.10. Almost cent percent diffusion was found in case of maize, cotton and jowar among both control and soil test groups of paddy and maize sample farmers. Further, more than 90 per cent diffusion was observed in case of paddy and more than 40 per cent in case of sugarcane.

Table: 3.10 Area under HYVs of Major Crops (% of Cropped Area)

Crop	Paddy Sample Households	Maize Sample Households
Control Farmers		
Paddy	88.65	90.67
Maize	100.00	100.00
Cotton	100.00	100.00
Jowar	100.00	100.00
Sugarcane	44.56	40.49
Soil Test Farmers		
Paddy	98.94	97.67
Maize	100.00	100.00
Cotton	100.00	100.00
Jowar	100.00	100.00
Sugarcane	51.45	42.11

Improving farm income is the ultimate aim of any technology or any new practices that is introduced into the farming. Many farmers are mired in poverty and most of their livelihood depends on on-farm income. Since on-farm income is playing an important role in the rural livelihood, it is important to comprehend the influential factors determining on-farm income of the farmers and find solutions to improve their income level and enhance future agricultural developments. Farmer’s income is influenced by factors like size of holding, crops grown, technologies adopted, and diversification in cropping pattern etc,.

Table 3.11 presents the aggregate value of output of paddy farmers in the study area. It is interesting to note from the table that the soil test farmers under paddy crop category have received better returns per acre (Rs. 48,433) over control farmers (Rs. 46,755). The average per acre value of output was highest (Rs. 50,676) among large farmers followed by marginal farmers (Rs. 49,785) category under soil test farmers whereas it was marginal farmers (Rs. 48,586) in case of control farmers. Surprisingly, medium farmers in case of control farmers group achieved better returns (Rs. 47,526/acre) than their counterpart (Rs. 46,720/acre). The reason behind the highest per acre income among marginal farmers can be attributed to factors like intensive use of fertilizers, pesticides, irrigation and efficient management of the existing (small) area of operation. The large farmers have highest value of output per acre among soil test farmers may be because of high income from annual or perennial crops like arecanut and sugarcane grown by them. The value of output sold per acre seems to be more in case of soil test farmers compare to control farmers may be due to the balanced nutrient management according to the recommendations suggested in soil health card at the time of soil test.

Table: 3.11 Aggregate Value of Output –Paddy

Particulars	Value of Output		Value of Output Sold	
	Rs/HH	Rs/Acre	Rs/HH	Rs/Acre
Control Farmers				
Marginal	74823	48586	65663	42638
Small	170819	44484	165775	43171
Medium	373557	47526	303138	38567
Large	826111	37826	776590	35558
Total	595943	46755	329004	36678
Soil Test Farmers				
Marginal	93198	49785	89249	47676
Small	186001	47245	169348	43015
Medium	344004	46720	308236	41862
Large	1050643	50676	841246	40576
Total	459374	48433	360483	38791

The information on aggregate value of output of maize farmers is presented in Table 3.12. The cropping pattern of maize sample farmers mainly constituted of more than 50 per cent of GCA of maize, cotton, ground nut, jowar and sugarcane; their major source of irrigation was bore well. Similar to the paddy farmers, the average aggregate value of output per acre was much more (Rs. 41,564) in case of soil test farmers than control farmers (Rs. 33,183). On the other hand, value of output sold was less (Rs. 38,723/acre) among soil test farmers compared to control farmers (Rs. 40,053/acre). Interestingly, even the value of output across farm size groups was better among soil test farmers in contrast to their counterparts (control farmers). Among both the groups, large farmers had higher per acre income compared to other categories because of their commercial cropping pattern and huge landholding than other categories.

Table: 3.12 Aggregate Value of Output – Maize

Particulars	Value of Output		Value of Output Sold	
	Rs/HH	Rs/Acre	Rs/HH	Rs/Acre
Control Farmers				
Marginal	47136	25872	45636	25049
Small	147626	37889	145514	37347
Medium	279526	33800	274006	33133
Large	642602	35173	607448	33248
Total	424522	33183	407240	40053
Soil Test Farmers				
Marginal	56100	28836	54234	27876
Small	166486	41702	150422	37679
Medium	339986	45024	307826	40766
Large	1031125	50694	987965	48573
Total	401254	41564	366380	38723

3.5 Details of Farm Assets Holding

Table 3.13 and Table 3.14 depict details on distribution of farm assets by paddy and maize growers. The ownership of farm machineries and implements indicate the degree of mechanization in agricultural operations. Much difference was not found in terms of mechanization between control and soil test farmers in both paddy and maize crop sample households irrespective of soil test done or not. Almost half of the paddy respondents owned tractors, whereas only 20 to 22 per cent of the maize respondents had tractors. Similarly, more than 40 per cent of the total respondents possesses animal shed/pump houses. Interestingly, more of harrows and cultivators, drip/sprinkler systems, and bullock carts were found in maize farmers compared to paddy farmers. More or less equal manual/ power sprayers were owned by all the households. Looking into the possession of modern and heavy equipments in all the sample households, it is clear that farmers are coming out of the traditional practices and mechanizing faster to overcome the problem of labour shortages.

From the tables, it was also noticed that the current financial stock of paddy farmers worth more (> Rs. 2.49 lakh/household) than maize farmers (> Rs.1.04 lakh/household). And across different groups, soil test farmers hold more assets worth than control farmers in both the cases (maize & paddy), which indicates that the level of mechanization in soil test farmers' field was more than control farmers.

Table 3.13: Distribution of Farm Assets - Paddy

Particulars	Control Farmers		Soil test Farmers	
	Number/ Household	Value/ Household	Number/ Household	Value/ Household
Tractor, trailer/trolley	0.46	197000	0.45	158959
Harrow and cultivator	0.36	11141	0.37	10450
Electric motor/ Diesel Engine	0.31	10592	0.45	23357
Thresher	0.01	5607	0.01	9090
Planker	0.02	285	0.02	106
Manual/ power sprayer	0.31	632	0.49	1493
Fodder chopper	0.01	93	0.03	265
Bullock cart	0.13	4295	0.19	5238
Drip/ sprinkler system	0.05	7827	0.13	15796
Animal shed/ pump house	0.41	19327	0.43	24777
Total	2.07	256799	2.57	249531

Table 3.14: Distribution of Farm Assets - Maize

Particulars	Control Farmers		Soil test Farmers	
	Number/ Household	Value/ Household	Number/ Household	Value/ Household
Tractor, trailer/trolley	0.22	65091	0.20	78193
Harrow and cultivator	0.39	10277	0.57	12780
Electric motor/ Diesel Engine	0.35	10788	0.36	8587
Thresher	0.04	1926	0.02	10644
Planker	0.05	495	0.05	245
Manual/ power sprayer	0.34	494	0.48	1295
Fodder chopper	0.01	64	0.04	690
Bullock cart	0.39	9940	0.36	11987
Drip/ sprinkler system	0.25	5215	0.26	11745
Animal shed/ pump house	0.48	14724	0.44	21403
Total	2.52	104290	2.78	136166

3.6 Details of Agricultural Credit Availed

Credit plays an important role in increasing agricultural production. Availability and access to adequate, timely and low cost credit from institutional sources is of great important to the farming community. Because of lack of credit availability from the institutional sources, most farmers depend on non-institutional sources mainly continue to be in agricultural activities. The details of agricultural credit availed, present outstanding position and the purpose of loan availed etc., of the sample households were presented in Table 3.15 to 3.16.

Table 3.15: Agricultural Credit Outstanding by the Sample Household (Rs/Household): Paddy

Sources	Control Farmers		Soil Test Farmers	
	% farmers availed	Rs/Household	% of farmers availed	Rs/Household
Co-operative Credit Societies	46.73	70551	55.07	70473
Land Development Banks (PCARDB)	3.74	122500	5.80	98375
Commercial Banks	26.17	122429	34.78	222041
RRBs	11.21	46308	16.67	151434
Money Lenders	9.35	115000	4.35	181666
Friends/Relatives	0.93	30000	0.72	60000
Traders/Commission Agents	1.87	55000	2.17	150000
Total		561787		933991

Note: Soil Test Farmers- 89.61 availed the credit from different sources among total sample
Control Farmers-85.04 availed the credit from different sources among total sample

It can be observed from Table 3.61and Table 3.62 that cooperative credit societies, commercial banks and Regional Rural Banks (RRBs) were the major institutional sources of finance for the farming community in the study area. More than 80 percent of the sample household’s availed loan for different agricultural purposes from the total households selected for the study. As shown in the tables, co-operative credit societies were the major source of credit for more than 47 per cent of the farmers from both control and soil test groups followed by commercial banks and RRBs. But, the amount of money borrowed was more from commercial banks compared to other sources, which shows that even though there is good accessibility of credit from co-operative societies with lower interest rates, it was not sufficient to meet the credit requirement of the farmers. Therefore, farmers chose commercial bank for large borrowings even though their interest rates were high.

Interestingly, the credit outstanding amount was found higher (>Rs. 9.21 lakh/household) for soil test farmers than the control farmers (<Rs. 8.74 lakh/household) amongst both paddy and maize growers. And about 4 to 17 per cent of the farmers also availed loan from moneylenders even though they charge huge interest rates. About 2 per cent of the farmers depended on their friends & relatives for the credit.

Table 3.16: Agricultural Credit Outstanding by the Sample Household (Rs/Household) – Maize

Sources	Control Farmers		Soil Test Farmers	
	% of farmers availed	Rs/Household	% of farmers availed	Rs/Household
Co-operative Credit Societies	59.09	71413	59.54	90820
Land Development Banks (PCARDB)	5.68	226000	9.16	125166
Commercial Banks	29.55	228269	39.69	249384
RRBs	11.36	146500	11.45	52400
Money Lenders	17.05	82333	5.34	178571
Friends/Relatives	1.14	20000	1.53	112500
Traders/Commission Agents	1.14	100000	1.53	112500
Total		874516		921343

Note: Soil Test Farmers- 80.73 percent availed the credit from different sources among total sample; Control Farmers-84.41 percent availed the credit from different sources among total sample

The details on purpose of agricultural loan availed by farmers is presented in the Table 3.17 and 3.18. It can be seen from the Table 3.17 that over 95 per cent of paddy famers availed loan for meeting cultivation expenses. Some famers also availed loan for purchase of tractor and implements, and for land development purpose. In case of maize farmers, about 85 percent of the farmers availed loan for seasonal crop cultivation. Purchase of tractor and other implements followed by land development were the next immediate reasons for availing loan from all available sources. As compared to paddy farmers, maize farmers had taken credit probably from non-institutional sources for conducting marriage and social ceremonies. Interestingly, some farmers also took loan for certain non-agricultural activities.

Table 3.17: Purpose of Agricultural Loan Availed (% of farmers) - Paddy

Purpose	Control Farmers	Soil Test Farmers
Seasonal Crop Cultivation	97.78	95.45
Purchase of Tractor and Other Implements	4.44	4.55
Purchase of livestock	1.11	0.65
Land development	1.11	5.84
Consumption Expenditure	0.00	0.00
Marriage and Social ceremonies	0.00	0.65
Nonfarm activities	0.00	0.00
Other expenditures	0.00	10.39

Table 3.18: Purpose of Agricultural Loan Availed (% of farmers) - Maize

Purpose	Control Farmers	Soil Test Farmers
Seasonal Crop Cultivation	85.32	89.68
Purchase of Tractor and Other Implements	4.59	9.03
Purchase of livestock	0.92	0.65
Land development	3.67	3.23
Consumption Expenditure	0.92	0.65
Marriage and Social ceremonies	1.83	1.94
Nonfarm activities	0.00	1.29
Other expenditures	0.92	0.65

3.7 Training Programmes Attended

Training programme is one of the important communication methods for transfer of technologies to the farming community. Through training programmes, farmers will be provided full information about the technology, and motivated towards adoption of that technology. Therefore training programmes are proven to be the most influential tool to spread the technology. Information on training programmes attended on application of chemical fertilizers by the sample farmers are presented in Table 3.19.

It can be observed from the table that none of the control farmers of paddy and maize crops attended any training programme related to application of chemical fertilizers. In case of soil test farmers, 33 per cent of paddy farmers and 31 per cent of maize farmers reported to have attended training programme. The average number of training attended during the reference period was reported one day with the duration of 2 to 3 days.

Table 3.19: Training Programmes Attended on Application of Chemical Fertilizers by Sample Farmers

Particulars	Paddy	Maize
Control Farmers		
Average number of trainings attended	0	0
% of farmers attended	0	0
Average number of days	0	0
Soil Test Farmers		
Average number of trainings attended	1	1
% of farmers attended	32.46	30.96
Average number of days	2.79	2.06

Overall, small farmers accounted for a high proportion of total soil test paddy farmers. A similar pattern was observed for maize also. Average density of farm asset holding was worked out to be higher for soil test farmers of paddy and maize. In fact, paddy farmers had more number of tractors than that of maize farmers. However, no large variation was observed between soil test farmers and control farmers with respect to level of mechanisation. Analysis of credit taken by the sample farmers revealed that still average amount of loan taken from non-institutional sources was comparatively high.

CHAPTER IV

SOIL TESTING AND RECOMMENDED DOSES OF FERTILISERS

4.1 Background

Proper nutrition is essential for satisfactory crop growth and production. Soil analysis is a valuable tool for farm as it determines the inputs required for efficient and economic production. The success of the soil analysis depends on how scientifically the soil samples were drawn because the results are only as good as the sample you take. A proper soil test will help ensure the application of enough fertilizer to meet the requirements of the crop while taking advantages of the nutrients already present in the soil. It is observed from various studies across the country that indiscriminate use of chemical fertilizers by farmers with a view to increase the crop yield is a common problem, which has led to deterioration of soil structure, wastage of nutrients, destruction of soil micro-organisms, and scorching of plants at the extreme cases. In this regard, Government of India had undertaken initiatives to ameliorate the situation and encourage the farmers for balanced use of fertilizers. Therefore, an effort was made with this study to understand the level of awareness on soil testing, and the use of recommended doses of fertilizers by the farmers in Karnataka.

Among various agricultural schemes in Karnataka, many Soil Health Centres (SHCs), Fertilizer Control Laboratories, and Micro Nutrient Laboratory were established and analyzed about 16 lakhs soil samples (Soil Health Mission, 2014-15). The soil samples were analyzed for pH, EC, Major nutrients like N, P, K, secondary nutrients like Sulphur and magnesium, and micro nutrients such as Zn, Fe, Mn, Cu and Boron. This field-specific detailed report of soil health fertility status and other important soil parameters that affect crop productivity were given in the form of a card called as 'Soil Health Card'. These soil health cards provide an advisory on soil test based use of fertilizers and amendments. This chapter provides the status, awareness and the level of adoption of the technology of soil testing by the producers of paddy and maize in Karnataka.

4.2 Details of Soil Testing

Different categories of farmers possess diverse behaviour according to their land holding position, affordability and interest in farming. About the details on the soil testing and related parameters are presented in Table 4.1 and 4.2. It was observed from the tables that majority (about 50%) of the small and medium farmers (producers of both paddy and maize) followed by large farmers (27% in case of paddy and 21% in case of maize) and marginal farmers (23% of the paddy and 13% of the maize producers) tested their soil in the last three years. More importantly, it was also noticed at the time of field survey that majority of them tested their soil at free of cost as it was undertaken by the government itself through various schemes like RKVY, Bhoochetana, National Project on Management of Soil Health and Fertility (NPMSHF) and Macro Management of Agriculture (MMA). As the officials stated, even though it was at free of cost, farmers were not willing to come forward for soil testing because of their lack of awareness. Very few progressive farmers have also tested their soil through private soil testing labs. The majority participation of small and medium farmers indicates that they are highly involved, innovative and early adopters of new technologies among all the categories.

The average distance from field to soil test laboratories was 35 km among all the categories, since the samples were selected from the same locality. The average number of soil samples taken per plot and average number of plots considered for soil testing was two and three respectively without much difference among the different categories. The area covered as percentage to the net operated area and percentage of farmers who collected samples themselves is highest among the small farmers with 87 per cent and 43 per cent, respectively, which again prove that small farmers are the major adopters of soil testing among all other categories. The second major category in terms of area covered was marginal farmers (76%) followed by medium (59%) and large farmers (43%).

Table 4.1: Distribution of Sample Soil Test Farmers: Paddy

Particulars	Marginal	Small	Medium	Large	Total
% of farmers tested their soil in the last three years	23.36	29.90	19.62	27.10	100
Average distance from field to soil testing lab (kms)	33.35	34.59	28.41	42.24	34.82
Average number of soil samples taken per plot	2.00	2.00	2.00	3.00	2.00
Average no. of plots considered for soil testing	2.00	2.00	3.00	3.00	3.00
Average area covered under soil test (acre)	1.65	3.41	4.39	8.77	4.97
Area covered as % of net operated area	75.72	86.66	59.00	42.54	49.14
% of farmers who collected samples themselves	25.00	42.85	14.28	30.23	37.01
% of soil sample collected by the department officials	75.00	57.15	85.71	69.76	62.98

Table 4.2: Distribution of Sample Soil Test Farmers: Maize

Particulars	Marginal	Small	Medium	Large	Total
% of farmers tested their soil in the last three years	12.9	37.41	28.38	21.29	100
Average distance from field to soil testing lab (kms)	35.36	38.12	32.00	28.06	33.89
Average number of soil samples taken per plot	1.88	2.31	1.99	2.29	2.00
Average no. of plots considered for soil testing	1.75	2.06	2.43	3.15	2.00
Average area covered under soil test (acre)	1.76	3.41	5.72	12.66	5.84
Area covered as % of net operated area	90.46	85.41	75.75	62.21	71.04
% of farmers who collected samples themselves	15.00	25.86	34.09	42.42	30.32
% of soil sample collected by the department officials	85.00	74.13	65.91	57.57	69.67

The characteristics of maize soil test farmers across different categories are presented in Table 4.2. Among total soil test sample majority were small farmers (37%) followed by medium (28%), large (21%) and marginal farmers (13%). The average distance of farmer's field from soil testing laboratory in the particular locality was 34 km. And the average number of soil samples taken per plot and number of plots considered for soil testing is two. Though the percentage share of marginal farmers in the total soil test sample was least among all the category, the area covered as percentage of net operated area was highest (90%), followed by small (85%), medium (76%) and large farmers (62%), which indicates that as the net operated area increases the percentage of area covered under soil test decreases showing that the larger extent of technology adoption is found in farmers with marginal and small holding categories. With support to the previous statement the assistance from department officials to farmers in taking soil sample is found higher in marginal and small farmer's categories which could also be the reason for larger extent of technology adoption by respective categories.

4.3 Source of Information about Soil Testing by Soil Test Farmers

Soil testing is one among those important technologies in agriculture and farmers need to be educated about the importance and usefulness of this technology. And there is wide range of sources like State Agricultural Universities (SAUs), KVKs, private companies, friends, neighbours and agricultural departments from which farmer can avail information on soil testing. The details on different sources of information on soil test which are available to farmers are presented in the Table 4.3.

Table 4.3: Sources of Information about Soil Testing by Sample Households (% of farmers)- Soil Test Farmers

Sources	Marginal	Small	Medium	Large	Total
Paddy					
SAUs	0	0	0	0	0
KVKs	0	2.63	0	2.70	1.63
Private companies	8.33	0	0	5.41	4.07
Friends	0	0	0	2.70	0.81
Neighbours	25.00	10.53	2.78	10.81	8.13
Agriculture Department	66.67	86.84	97.22	78.38	85.37
Total	100	100	100	100	100
Maize					
SAUs	0	0.73	0.00	0.00	0.27
KVKs	0	0.00	0.00	0.00	0.00
Private companies	0	1.46	0.00	0.00	0.53
Friends	3.61	2.92	1.80	2.84	2.94
Neighbours	3.64	4.38	6.31	4.23	4.55
Agriculture Department	92.73	90.51	91.89	92.96	91.71
Total	100	100	100	100	100

Among soil test farmers agriculture department remained the major source (85% in paddy and 92% in maize) and neighbours (8% in paddy and 5 % in maize) were secondary source of information across different categories under both the crops. Whereas with respect to paddy marginal farmer's tertiary source was private companies, small farmer's was KVK's and large farmer's was private companies. With respect to maize crop tertiary source was friends across all the categories. So this table shows agriculture department is the major source of information regarding new technologies to the farmers.

4.4 Reasons for Soil Testing by Soil Test Farmers

Table 4.4: Reasons for Soil Testing by Sample Households (% of farmers) - Soil Test Farmers

Reasons	Paddy				Maize			
	Most Important	Important	Least Important	Total	Most Important	Important	Least Important	Total
For availing benefits under subsidy schemes	4.54	4.54	0.64	9.74	1.94	4.54	0	6.49
For increasing crop yield	85.06	6.49	0	91.56	77.92	7.14	3.24	88.96
Motivation from demonstration/training /exposure visits to places with best farming practices	4.54	17.53	25.97	48.05	5.84	16.88	21.43	44.16
Peer farmers' group pressure	11.68	43.50	12.33	68.83	16.23	33.12	11.68	61.04
Adopt new technological practices	5.84	20.12	22.07	48.05	3.89	22.07	12.33	38.31

As stated before soil test is an important technology in farming with many advantages which influences farmers to go for soil testing. Reasons for soil testing by sample households are presented in the table 22. In Paddy crop, around 92 per cent of farmers stated increase in crop yield was the reason behind soil testing and among them 85 per cent farmers stated it as most important one other 7 per cent said it was important reason for soil testing. Second major reason was peer farmers' group pressure (68 per cent), where 43 per cent farmers among them considered it has important reason. The next important reasons stated were motivation from village demonstration/training/exposure visits to places with best farming practices and adopt of new technological practices with 48 per cent each. Among maize sample farmers also the ranking order of reasons was same with for increasing crop yield (89 per cent) being the first among them and 78 per cent farmers among them opined that it is a most important reason. The second ranked reason was peer farmers' group pressure with 61 per cent and 33 per cent farmers opined that it is important reason to go for soil test followed by reasons like motivation from village demonstration/training/exposure visits to places with best farming practices (44 per cent) and adopt new technological practices (38 per cent). Therefore it was clear from the opinion of the farmers that they were interested in soil test for increasing their crop yield and they were also influenced by peer farmers group.

4.5 Reasons for Not Testing Soil by Control Farmers

As it was shown in the previous Table (Table 4.4), where soil test farmers had their own reasons and motivations to go for soil testing in their field, control farmers who have not gone for soil test also have their own reasons behind it. Table 4.5 depicts the reasons for not testing soil during the last three years by control farmers. Among the paddy sample farmers, 71 per cent farmers opined that they did not go for testing their soil because they did not know whom to contact for details on testing and around 38 per cent farmers among them stated it as a most important reason. Second majorly opined reason was that they did not know how to take soil sample (70 per cent) with 33 per cent farmers among them stating it as most important reason. Location of soil test laboratories far from farmers place was next most opined reason which accounts 51 per followed by soil test not required for my field as crop yield is good which accounts for 22 per cent. Lack of interest, lack of awareness and other reasons were accounted for 2, 4 and 1 per cent respectively.

The order of ranking of reasons was slightly different in case of maize farmers, where not knowing to take soil sample was ranked first among other reasons (72 per cent) with 41 per cent farmers among them stating it as most important one. Not knowing whom to contact for details on testing was ranked second (64 per cent) with 35 per cent farmers stating it as important reason among them followed by location of soil test laboratories far from farmers place (50 per cent) and soil testing not required for my field as crop yield is good (16 per cent). Lack of interest and lack of awareness accounts for 16 and 11 per cent respectively.

Table 4.5: Reasons for Not Testing Soil during the Last Three Years (% of Farmers)-Control Farmers

Reasons	Paddy				Maize			
	Most Important	Important	Least Important	Total	Most Important	Important	Least Important	Total
Do not know how to take soil samples	32.71	21.50	15.90	70.09	41.28	26.60	4.58	72.48
Do not know whom to contact for details on testing	38.32	28.03	4.67	71.03	21.10	34.86	8.25	64.22
Soil testing laboratories are located far away	6.54	16.82	27.10	50.47	3.67	16.51	29.35	49.54
Soil testing not required for my field as crop yield is good	11.22	8.41	1.87	21.50	10.09	3.67	1.83	15.60
Lack of interest	1.18	0.3	0	1.57	4.5	1.22	0.4	6.14
Lack of awareness	3.93	0	0	3.93	6.55	2.86	1.63	11.06
Others	0.6	0.3	0.3	1.2	0	0	0	0

4.6 Status of Soil Health on the Sample Soil Test Farms

Soil Health Cards list the vital components of a particular patch of land. They provide detailed information on various minerals present on the land, suitable crops, fertilisers to be used, and also whether the land is acidic or alkaline. Based on the soil test results the farmer’s reported status of nutrients on the sample soil test farms (Table 4.6). Among paddy sample farmers with respect to nitrogen status, majority of farmer’s fields were in normal range (36 per cent), equal percentage of farmers field were in medium and high range (23 per cent) and 18 per cent farmer’s fields were in low range. Whereas in phosphorus status 41 per cent farmers fields were in medium range, 27 per cent in high range, 18 per cent in normal and 14 per cent in low range. With respect to potassium, the per cent farmer’s field in normal and low range was similar with 27 per cent and high and medium with 23 per cent. Therefore in total the nutrient status of majority of the farmer’s fields among paddy sample farmers group was normal in nitrogen, medium in phosphorus and low to normal in potassium.

Table 4.6: Status of Soil Health in terms of Nutrients on the Sample Soil Test Farms (As reported by the farmers)- Soil Test Farmers (% of farmers)

Fertilizer type	Normal	High	Medium	Low
Paddy				
Nitrogen	36.36	22.73	22.73	18.18
Phosphorus	18.18	27.27	40.91	13.64
Potassium	27.27	22.73	22.73	27.27
Maize				
Nitrogen	54.55	9.09	18.18	18.18
Phosphorus	36.36	9.09	45.45	9.09
Potassium	27.27	63.64	9.09	0.00

4.7 Recommended Doses of Fertilisers on Soil Test Basis

After testing the farmer's soil, fertilisers will be recommended to farmer's field taking into consideration the nutrient requirement of the crop and the nutrient already present in the soil. In Table 4.7, the average quantity of recommended dose of fertilizers based on soil test report is given. For Paddy farmers on an average of 63Kg of urea, 53kg of DAP, 51kg of single super phosphate and 34 kg of potash was recommended for one acre of paddy crop, which provides around 39 kg of nitrogen, 33 kg of phosphorus and 21 kg of potash. And for maize farmers field 83kg of urea, 59 kg of DAP, 35 kg of single super phosphate and 38kg of potash was recommended per acre in other terms 49 kg of nitrogen, 32 kg of phosphorus and 23 kg of potash was recommended.

Table 4.7: Average Quantity of Recommended Dose of Fertilisers Given Based on Soil Test (As reported in the health card)-Soil Test Farmers (Kg/acre)

Crop	Paddy	Maize
Urea	63.32	83.23
DAP	53.16	59.6
Single Super Phosphate	51.42	35
Potash	34.25	38.09

To sum up, a high proportion of small and medium farmers of paddy and maize tested their soil in the last three years. Small farmers registered the highest proportion of area covered under soil test followed by marginal farmers, medium farmers and large farmers. Most of the soil samples were reportedly collected by the officials of the Department of Agriculture. Most soil test farmers indicated that the major reasons for soil testing were to increase crop yield. A relatively high proportion of farmers also indicated peer farmer pressure and village demonstrations as the reasons behind soil testing. In case of control farmers of paddy and maize, reasons for not going for soil testing was that they did not know whom to contact for details on soil testing and even if they knew many farmers indicated that they were not taught how to take soil sample. Further, soil test laboratories were reportedly located far away from villages, which desist them from taking soil and then go for testing it.

CHAPTER V

ADOPTION OF RECOMMENDED DOSES OF FERTILISERS AND ITS CONSTRAINTS

5.1 Background

Government of Karnataka attempted to promote Integrated Nutrient Management (INM) through various developmental schemes for judicious use of chemical fertilizers, including primary, secondary and micro nutrients in conjunction with organic manures and bio-fertilizers. Bhoochetana was one of such mega programmes initiated by the Government of Karnataka under the technical support/consultancy services and training being provided by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) with a major thrust on micronutrients mainly to boost productivity under rain-fed agriculture. The primary strategy of Bhoochetana is soil testing based nutrient management implemented from 2009-10, under which inputs were distributed at 50 percent subsidy at village level through timely positioning and effective publicity. Even then majority of the farmers have not understood the importance of soil test and application of recommended doses of fertilizers in crop production. The increase in adoptability will surely help in improving soil health and its productivity. However, there are many farmers who got tested and obtained the soil health cards (SHCs) but didn't apply the recommended doses of fertilizers on field. In this chapter an attempt has been made to understand the constraints in adoption of recommended doses and other issues related to fertilizer applications in detail.

5.2 Application of Recommended Doses of Fertilizers by Soil Test farmers

Fertilizer use is crucial for sustainable intensification and for raising farm productivity under increasing land constraints and declining soil fertility. Fertilizers for particular crop and field depend on the details obtained from the soil test report, the recommendations will be given on the SHC itself. The application of recommended fertilizers is influenced by many factors like, awareness of farmers about advantages in applying recommended doses of fertilizers, availability of fertilizers, convenience, sources of purchase of fertilizers, weather condition and time of fertilizer application etc.

Though many farmers tested their soil, only a few farmers applied recommended quantity of fertilizers on their field. Table 5.1 presents some of the characteristics of farmers who applied recommended quantity of fertilizers. It may be noted from the table that the level of adoption of recommended doses of fertilizers by the soil test farmers was around 23 per cent in case of paddy growers and 11 per cent only in case of maize growers. On an average about 94 per cent of farmers of paddy and 59 per cent of maize farmers have expressed their willingness to continue the same practices to maintain better soil health and to get better yields. Among the paddy growers' maximum adoptability (100%) was found in the case of small and marginal farmers. However, more than 91 percent of the medium and large farmers also showed their adoptability of application of recommended doses of fertilizers in paddy crop. On the contrary, in maize maximum (>67%) adoptability was found large and small farmers and minimum adoptability of nil was found in marginal categories of farmers. On the whole, more than 61 per cent of the area was covered as percent of net operated area under recommended doses of fertilizer use. In fact, medium and large farmers in case of paddy and marginal and medium farmers in case of maize applied recommended doses of fertilizers more than one season and the rest stopped at the first season only.

It was observed during the survey that the results mentioned in some of the SHCs were awkward, the range of fertility status of different parameters seems to be more than the ranges listed in the card. It may be due to error in the analysis or simply mentioned the ranges in the card without analyzing the soil samples. The recommendations given in the card were also found to be un-scientific. Therefore, farmers were not able to reap the real benefits of application of recommended doses of fertilizers and hence they could not continue the same. This was also true that the State has only one Soil Test Laboratory (STL) at the district level, which is understaffed many times, and hence they could not analyze all the samples received from different taluks and send the reports in time.

Table 5.1: Application of Recommended Doses of Fertilisers on Reference Crops-Soil Test Farmers

Particulars	Marginal	Small	Medium	Large	Total
Paddy					
% of farmers applied recommended doses of fertilisers	5.00	22.45	30.95	25.58	23.38
Average area (acre)	1.15	2.53	3.8	11	5.62
Area covered as % of net operated area	61.50	64.38	51.63	53.06	60.50
Average number of seasons applied	1.00	1.00	1.46	1.45	1.22
% of farmers willing to continue applying recommended doses of fertilizers	100	100	92.30	90.90	94.44
Maize					
% of farmers applied recommended doses of fertilisers	10.00	5.17	4.55	30.30	10.97
Average area (acre)	1.5	3	2	11.77	7.68
Area covered as % of net operated area	77.32	75.19	26.49	57.87	62.22
Average number of seasons applied	1.5	1.00	1.5	1.00	1.00
% of farmers willing to continue applying recommended doses of fertilisers	0.00	66.67	50.00	70.00	58.82

5.3 Constraints in Application of Recommended Doses of fertilizers (Soil Test Farmers)

During the survey it was noticed that most of the soil test farmers were also not aware of the recommended doses of fertilizer application as the SHCs were distributed to them very late and majority were not explained about the information provided in the SHCs. Unfortunately, this is the reason majority of the farmers not even kept/ maintained these cards with them. Nevertheless, among the soil test farmers only few farmers adopted recommended doses of fertilizers and not all were willing to continue because of some constraints faced in applying recommended doses of fertilizers. Those constraints are presented in Table 5.2.

Table 5.2: Constraints in Applying Recommended Doses of Fertilizers (% of farmers)-Soil Test Farmers

Reasons	Paddy				Maize			
	Most Important	Important	Least Important	Total	Most Important	Important	Least Important	Total
Adequate quantity of fertilisers not available	10.84	0.00	1.20	12.05	8.57	2.85	14.28	28.57
Prices of fertilisers are high	4.64	4.64	12.39	21.69	11.42	5.71	11.42	28.57
Lack of money to purchase fertilisers	0.00	4.81	9.64	14.46	0.52	2.62	3.15	6.30
No technical advice on method and time of fertiliser application	20.48	0	0	20.48	19.04	0	9.52	28.57
Difficult to understand and follow the recommended doses	24.1	0	0	24.10	14.29	0	0	14.29
Other	0	0	0	7.23	8.57	2.85	14.28	0.00

The soil test farmers have faced several difficulties in applying recommended doses of fertilizers. Among these constraints, difficult to understand and follow the recommended doses followed by prices of fertilizers are high, no technical advice on method and time of fertilizer application were the major reasons as expressed by paddy farmers and majority of them ranked these reasons as most important as per the level of importance. Similarly, 28.57 percent each of the maize farmers reported that adequate quantity of fertilizers not available, prices of fertilizers are high and no technical advice on method and time of fertilizer application were the major constraints for application of recommended doses of fertilizers. In the order of importance, majority ranked no technical advice on method and time of fertilizer application as most important, but the constraints such as no technical advice on method and time of fertilizer application and prices of fertilizers are high were ranked as least important.

5.4 Sources of Information about the Recommended Doses of Fertilizers by Control Farmers

Adoption of any technology by farmers is largely dependent on awareness level and source of information. The soil test farmers had come to know about recommended doses of fertilizers from various reliable sources as discussed earlier. Therefore, it is important to understand the sources for control group farmers. The awareness level and information sources about recommended doses of fertilizers by sample households of control farmers are presented in the Table 5.3.

Table 5.3: Awareness and Sources of Information about Recommended Doses of Fertilisers by Sample Households (% of farmers)- Control Farmers

Sources	Marginal	Small	Medium	Large	Total
Paddy					
% farmers aware	28.00	15.63	14.29	27.59	21.50
Source of information					
Department of agriculture	8.00	3.13	4.76	6.90	5.61
Agricultural University	0.00	0.00	0.00	0.00	0.00
Cooperatives/Growers' Association	0.00	3.13	0.00	6.90	2.80
Private input dealers	4.00	0.00	0.00	3.45	1.87
Fellow farmers	8.00	6.25	4.76	0.00	4.67
NGO	4.00	0.00	0.00	0.00	0.93
Others	4.00	3.13	4.76	10.34	5.61
Maize					
% farmers aware	6.25	15.22	12.00	45.45	19.27
Source of information					
Department of agriculture	0.00	0.00	0.00	9.09	1.83
Agricultural University	0.00	0.00	0.00	0.00	0.00
Cooperatives/Growers' Association	0.00	0.00	4.00	0.00	0.92
Private input dealers	0.00	4.35	0.00	0.00	1.83
Fellow farmers	0.00	10.87	8.00	13.64	1.83
NGO	0.00	0.00	0.00	0.00	0.00
Others	6.25	0.00	0.00	22.73	5.50

It can be seen from the table that only about 22 per cent of the paddy control farmers and 19 per cent of the maize control farmers aware of recommended doses of fertilizers in the study area. Across the categories of farmers, majority of them were from marginal and large categories in case of paddy, while the majority (45%) rests with large farmers in case of maize. Around 15 per cent of the small and medium categories know about the recommended doses of fertilizers in both the cases. Out of those who aware, around 6 per cent of paddy growers and 2 per cent of maize growers received information from the officials of agriculture department. About 6 per cent each also revealed that they got information from other sources such as exhibitions, magazines, leaflets etc,. The other important sources of information for the rest of the growers of paddy and maize were private input dealers and fellow farmers.

5.5 Application of Actual Quantity of Fertilizers

As many have not applied recommended dose of fertilizers, it is important to understand their actual quantity of application of fertilizers for making comparison with the recommended doses of fertilizers. Usually, farmers follow the fellow farmers in the application of fertilizers. We noticed that if any of the farmers got more yield by applying more fertilizer, the neighbour will follow the same in the next cycle. The details on actual quantity of fertilizers applied by the sample farmers during the reference year are presented in Table 5.4 and Table 5.5.

It can be observed from the Table 5.4 that in case of paddy farmers, control group applied more quantity of fertilizers such as urea, DAP, potash and complex fertilisers than the soil test group. On an average, they applied 140 kg of urea, 94 kg of DAP, 50 kg of potash and 152 kg of complex fertilizers per acre. Whereas soil test farmers applied 85 kg of urea, 58 kg of DAP, 25 kg of potash and 67 kg of complex fertilizers per acre. Across categories, more of urea, potash and complex fertilizers were applied by small and marginal farmers, while more of DAP was applied by large and small categories of farmers in both control and soil test group. None of the paddy farmers used single super phosphate. Overall, looking into the quantity and combinations of fertilizers applied by the control farmers, the doses applied by them seems to be more than the recommended doses of fertilizers (100:50:50) as prescribed by the Package of Practices of

Agricultural Universities in the State. On the other hand, soil test farmers were more close to the recommended doses for paddy crop.

Table 5.4: Actual Quantity of Fertilisers Applied by the Sample Farmers during the Reference Year (Kg/acre)- Paddy

Crop	Marginal	Small	Medium	Large	Total
Control Farmers					
Urea	169	172	142	160	140
DAP	58	98	59	131	94
Single Super Phosphate	0.00	0.00	0.00	0.00	0.00
Potash	64	60	40	41	50
Complex fertilisers	226	161	113	107	152
Soil Test Farmers					
Urea	111	93	83	80	85
DAP	38	53	35	66	57.50
Single Super Phosphate	0.00	0.00	0.00	0.00	0.00
Potash	43	33	24	9.5	25
Complex fertilisers	149	88	66	54	67

In case of maize, on an average control farmers applied 69 kg of urea, 28 kg of DAP, 13 kg of potash and 67 kg of complex fertilizers per acre whereas soil test farmers applied 63 kg of urea, 36 kg of DAP, 18 kg of potash and 28 kg of complex fertilizers per acre (Table 5.5). Except complex fertilizers, other fertilizers applied by both the categories were more or less same in case of maize, which is relatively on par with the recommended doses of fertilizer requirement of maize crop as suggested in the package of practices. Across categories of farmers (both control and soil test), more of urea, DAP and potash were applied by marginal, small and medium farmers while more of complex fertilizers were applied by the large farmers. None of the maize farmers also used single super phosphate. Farmers apply fertilizers in split doses by different stages of crop growth. It was found that majority applied DAP and potash as a basal application with very smaller quantity whereas urea, potash and complex fertilizers were mostly applied after intercultural operations for better vegetative growth and flowering of the plant.

Table 5.5: Actual Quantity of Fertilisers Applied by the Sample Farmers during the Reference Year (Kg/acre)- Maize

Crop	Marginal	Small	Medium	Large	Total
Control Farmers					
Urea	95	73	81	59	69
DAP	38	25	37	23	28
Single Super Phosphate	0.00	0.00	0.00	0.00	0.00
Potash	21.50	10	15	12	13
Complex	41	45	35	92	67
Soil Test Famers					
Urea	55	70	73	52	63
DAP	37	54	31	30	35.50
Single Super Phosphate	0.00	0.00	0.00	0.00	0.00
Potash	23	26	21	11	18
Complex	23	23	34	29	28

5.6 Method of Application of Fertilizers by Sample farmers

The efficiency of fertilizer utilization by crops is mainly influenced by method of application of fertilizers. The application of fertilizer causes many changes in the soil, including chemical changes that can positively or negatively influence it productiveness. Only fraction of the fertilizer applied to the soil is taken by the crop, the rest either remains in the soil or release to the atmosphere through chemical and microbiological processes. The critical information on the relative merits of different method of fertilizer placement is essential. The method of application of fertilizer adopted by the sample farmers is presented in Table 5.6 and 5.7. It can be seen from the table 5.6 that broadcasting was the only common method of application of fertilizers in paddy. Both control and soil test paddy farmers applied all kind of fertilizers by broadcasting method.

Table 5.7 presents the methods of application of chemical fertilizers in maize crop. It is revealed from the table that majority of both control and soil test farmers adopted line method of application for almost all fertilizers. Very few farmers also used broadcasting and dibbling methods. Some farmers sprayed urea in vegetative stage to avoid yellowing of leaves.

Interestingly, it was also noticed that around a percent of soil test farmers used fertigation method for applying urea, DAP and potash fertilizers in maize crop.

Table 5.6: Method of Application of Chemical Fertilizers (% of farmers)-Paddy

Method	Urea	DAP	SSP	Potash	Complex
Control Farmers					
Broadcasting	100.00	100.00		100.00	100.00
Dibbling	0.00	0.00		0.00	0.00
Fertigation	0.00	0.00		0.00	0.00
Line application	0.00	0.00		0.00	0.00
Spraying	0.00	0.00		0.00	0.00
Total	100	100	-	100	100
Soil Test Farmers					
Broadcasting	100.00	100.00		100.00	100.00
Dibbling	0.00	0.00		0.00	0.00
Fertigation	0.00	0.00		0.00	0.00
Line application	0.00	0.00		0.00	0.00
Spraying	0.00	0.00		0.00	0.00
Total	100	100	-	100	100

Table 5.7: Method of Application of Chemical Fertilizers (% of farmers)-Maize

Method	Urea	DAP	SSP	Potash	Complex
Control Farmers					
Broadcasting	0.92	1.59		3.13	1.25
Dibbling	1.83	1.59		3.13	2.50
Fertigation	0.00	0.00		0.00	1.25
Line application	96.33	96.83		93.75	95.00
Spraying	0.92	0.00		0.00	0.00
Total	100.00	100.00	-	100.00	100.00
Soil Test Farmers					
Broadcasting	3.27	2.73		3.66	2.33
Dibbling	1.96	2.73		2.44	16.28
Fertigation	0.65	0.91		1.22	0.00
Line application	94.12	92.73		91.46	80.23
Spraying	1.31	0.00		1.22	1.16
Total	100	100	-	100	100

5.7 Use of Organic Fertilizers

The use of organic fertilizer is very important from the point of maintaining soil fertility and sustaining soil texture and structure. Recently, soil treated only with synthetic chemical fertilizers loses organic matter and the all important living organisms that help to build quality soil. As soil structure declines and water-holding capacity diminishes, more and more of the chemical fertilizer applied will leach through the soil. In turn, it will take ever increasing amounts of chemicals to stimulate plant growth. The use of organic fertilizer will avoid throwing our soil into this kind of crisis condition. Some of the past studies also suggested that use of organic fertilizers along with chemical fertilizers will give encouraging results in terms of crop yields.

Table 5.8: Use of Organic Fertilizers by the Sample Farmers- Paddy

Particulars	Farm yard manure	Vermi-compost/Biogas waste	Bio-fertilizer	Green manure	Other organic manure	Total
Control Farmers						
% farmers applied	48.62	3.33	0.00	3.33	5.00	55.07
Quantity applied (Kg/acre)	3505.38	120.00	0.00	1360.00	161.66	2814
Area covered (% of net cropped area)	42.45	26.20	0.00	31.00	45.38	48.00
Soil Test Farmers						
% farmers applied	73.08	13.46	1.92	0.96	8.65	67
Quantity applied (Kg/acre)	3063.92	745.83	35.71	2000	633.81	2562
Area covered (% of net cropped area)	60.84	65.94	24.14	14.29	36.71	55.00

In the study area, different kinds of organic manures like farm yard manure, vermi-compost/ bio gas waste, bio-fertilizer, green manure and manures like city compost were used by the paddy sample farmers in cultivation practices (Table 5.8). It was observed from the table that about 55 per cent of the control farmers and 67 per cent of the soil test farmers used organic manures in case of paddy. Majority (73%) of the soil test farmers and 49 per cent of the control farmers in paddy applied on an average of 3 tons per acre and 3.5 tons per acre of farm yard manure to 61 per cent and 42 per cent correspondingly of their net cropped area. Along with that around 13 per cent of the soil test farmers applied vermi-compost at the rate of 746 kg/acre to a 66 per cent of their net cropped area whereas only 3 per cent of control farmers used the same at the rate of 120 kg/acre to 26 per cent of the net cropped area. In addition, around nine percent of soil test farmers and five percent of control farmers also applied city compost at the rate of 634 kg/acre and 161 kg/acre to an area of 37 per cent and 45 per cent respectively of their net operated area. Moreover, around 2 per cent of the soil test farmers applied bio-fertilizers at the rate of 36kgs/acre to 24 per cent of the net cropped area but none of the control farmers used bio-fertilizers. However, both (3% of the control farmers and 1% of the soil test farmer) grown green manures in their field to enrich organic content in their soil. Overall, the percent farmers applying organic manures to their field were higher among soil test farmers, which may be the result of adoption of practice of soil test technology.

Table 5.9: Use of Organic Fertilizers by the Sample Farmers- Maize

Particulars	Farm yard manure	Vermi-compost/Biogas waste	Bio-fertilizer	Green manure	Other organic manure	Total
Control Farmers						
% farmers applied	98.16		0.91			100
Quantity applied (Kg/acre)	3355		0.00			4322
Area covered (% of net cropped area)	50.72		80.1			
Price (Rs/kg)	1.38		2.00			2.96
Soil Test Farmers						
% farmers applied	95.55	3.70	0.00			97.00
Quantity applied (Kg/acre)	2866	113.75	0.00			2657
Area covered (% of net cropped area)	56.63	76.92	0.00			58.61
Price (Rs/kg)						

Use of organic fertilizers by the sample maize farmers is represented in Table 5.9. Farm yard manure was the most commonly used organic fertilizer among both control and soil test farmers of maize. More than 95 per cent of the farmers used farm yard manure in more than half of their net cropped area but the rate was little higher (3.35 tons/acre) among control farmers compared to soil test farmers (2.87 tons/acre). In addition, around 4 per cent of the soil test farmers applied vermi-compost at the rate of 114 kg/acre to an 77 per cent of the net cropped area whereas one percent of the control farmers applied a minute quantity of bio-fertilizers to 80 per cent of their net cropped area. No other organic manures were found applied by the maize producers in the study area.

5.8 Details of Fertilisers Purchased by the Sample Households

Marketing of fertilizer was highly controlled by Govt. regulations in India. Both Essential Commodities Act (ECA) and Fertilizer Control Order (FCO) govern fertilizers. In distribution government policies dictate the type, quantum and the area for distribution for each manufacturer. Traditionally, the cooperatives and Agro-Industries Corporations played significant role but from 1990's onward private trade has taken to the fertilizer distribution in a big way because of attractive margins. A few manufacturers have their own retail outlets also.

In Karnataka, there are many sources from where farmers can purchase fertilizers. Government also has taken some initiatives by establishing Raitha Samparka Kendras (RSKs) and cluster godowns for selling agricultural inputs such as fertilizers, pesticides, bio-fertilizers, vermi-compost, agricultural implements etc., to make available to farmers easily. The analysis on source-wise purchases of various fertilizers across different categories of farmers is presented in Table 5.10 and Table 5.11.

The tables reveal that the major source of purchase of fertilizers was private fertilizer shops/dealers for both paddy and maize growers of both control and soil test groups. More than 77 per cent of the control farmers and 73 per cent of the soil test farmers purchased from this source. The second major source was co-operative societies, wherein about 28 per cent of the paddy farmers and 21 to 25 per cent of the maize farmers purchased fertilizers. Very few (up to 2%) farmers were also opted company authorized dealers and government agencies (around one percent) for the purchase of fertilizers from both the crops and groups.

Table 5.10: Sources of Purchase of Fertilizers (% of farmers) – Paddy

Sources	Marginal	Small	Medium	Large	Total
Control Farmers					
Private fertilizer shops/dealers	72.00	84.38	90.48	62.07	76.64
Company authorized dealers	0	3.13	0.00	0.00	0.93
Co-operative societies	36.00	15.63	14.29	48.28	28.97
Government agency	0	3.13	0.00	0.00	0.93
Others	0	0	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00
Soil Test Farmers					
Private fertilizer shops/dealers	52.63	74.47	76.19	79.07	73.51
Company authorized dealers	0.00	0.00	4.76	0.00	1.32
Co-operative societies	42.11	27.66	21.43	27.91	27.81
Government agency	5.26	0.00	0.00	0.00	0.66
Others	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00

Across the categories of farmers, majority from all the categories preferred private fertilizer shops because of their easy accessibility, availability of option of future payment and convenience to the farmers. Fascinatingly, majority of cent percent of the marginal farmers of maize and 90 per cent of the medium farmers of paddy from control group depended on private fertilizers shops. Usually, farmers value relationships who understand his needs. Co-operative societies were preferred by 48 per cent of the large farmers and 36 per cent of the medium farmers of paddy control group, whereas 42 per cent of marginal farmers and 28 per cent each of small and large farmers of paddy from soil test group also purchased from private dealers. Likewise, 28 per cent each of the small and medium categories of control farmers and 35 per cent of small farmers and 27 per cent of medium farmers in case of maize soil test group purchased fertilizers from cooperative societies. None of the maize farmers visited government agencies for the purchase of fertilizers.

Table 5.11: Sources of Purchase of Fertilizers (% of farmers) - Maize

Sources	Marginal	Small	Medium	Large	Total
Control Farmers					
Private fertilizer shops/dealers	100	73.91	76.00	86.36	80.73
Company authorized dealers	0	0	0.00	0.00	0.00
Co-operative societies	0	28.26	28.00	13.64	21.10
Government agency	0	0	0.00	0.00	0.00
Others	0	0	0.00	0.00	0.00
Total	100	100	100.00	100.00	100.00
Soil Test Farmers					
Private fertilizer shops/dealers	75.00	64.91	75.00	84.38	72.55
Company authorized dealers	10.00	0.00	0.00	3.13	1.96
Co-operative societies	15.00	35.09	27.27	12.50	25.49
Government agency	0.00	0.00	0.00	0.00	0.00
Others	0.00	0.00	0.00	0.00	0.00
Total	100	100	100.00	100.00	100.00

When there are different sources for purchase of fertilizers, definitely there are chances of purchase of different quantities from all these sources according to the quantity and quality of fertilizer availability and convenience for the purchase. The quantity of fertilizer purchased from different sources by both paddy and maize farmers is presented in Table 5.12 and Table 5.13. Similar to the sources, major quantity (>72% in case paddy farmers and >66% in case of maize farmers) of fertilizers were purchased from private fertilizers shops/ dealers only, across all categories of farmers. Around 17 per cent to 35 per cent of quantities of fertilizers were purchased from co-operative societies in case of paddy farmers, whereas the proportion varies from 18 percent to 41 per cent in case maize farmers. Most (57%) of the bio-fertilizer products were purchased by the paddy soil test farmers again through private dealers/ shops followed by co-operative societies and other sources (14% each), company authorized dealers and government agencies (7% each).

Table 5.12: Quantity of Fertilizer Purchased by the Sample Farmers (Per cent) - Paddy

Sources	Urea	DAP	SSP	Potash	Complex	Bio-fert
Control Farmers						
Private fertilizer shops/dealers	76.64	72.73	0.00	83.33	73.91	0.00
Company authorized dealers	0.93	0.00	0.00	0.00	0.00	0.00
Co-operative societies	28.97	27.27	0.00	16.67	34.78	0.00
Government agency	0.93	0.00	0.00	0.00	0.00	0.00
Others	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	0.00
Soil Test Farmers						
Private fertilizer shops/dealers	73.51	77.50	0.00	74.51	72.06	57.14
Company authorized dealers	1.32	0.00	0.00	1.96	1.47	7.14
Co-operative societies	27.15	23.75	0.00	27.45	27.21	14.29
Government agency	0.66	0.00	0.00	0.00	0.74	7.14
Others	0.66	1.25	0.00	0.00	0.74	14.29
Total	100.00	100.00	100.00	100.00	100.00	100.00

For sustained agricultural growth and to promote balanced nutrient application, it is imperative that fertilizers are made available to farmers at affordable prices. With this objective, urea being the only controlled fertilizer, is sold at statutory notified uniform sale price, and decontrolled Phosphatic and Potassic fertilizes are sold at indicative maximum retail prices (MRPs). As of now prices of fertilizers depends upon the Nutrient Based Subsidy (NBS) revised time to time in operation. Under which a fixed rate of subsidy (in Rs. per Kg basis) is announced on nutrients namely nitrogen (N), phosphate (P), potash (K) and Sulphur (S) by the government on annual basis. Accordingly the manufacturers allowed to fix the MRP at reasonable rates for P&K fertilizers. In addition to NBS, freight for the movement and distribution of the decontrolled fertilizers by rail or road were also provided to enable wider availability of fertilizers. Therefore, different fertilizers have different prices based on their nutrient content, availability, subsidy on that particular fertilizer.

Table 5.13: Quantity of Fertilizer Purchased by the Sample Farmers (Per cent)- Maize

Sources	Urea	DAP	SSP	Potash	Complex	Bio-fert
Control Farmers						
Private fertilizer shops/dealers	80.73	76.67	0.00	81.08	83.33	0.00
Company authorized dealers	0.00	0.00	0.00	0.00	0.00	0.00
Co-operative societies	21.10	25.00	0.00	24.32	18.06	0.00
Government agency	0.00	0.00	0.00	0.00	0.00	0.00
Others	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	0.00
Soil Test Farmers						
Private fertilizer shops/dealers	72.55	65.71	0.00	86.76	77.79	0.00
Company authorized dealers	1.96	2.86	0.00	1.47	1.30	0.00
Co-operative societies	25.49	32.38	0.00	41.18	20.78	0.00
Government agency	0.00	0.00	0.00	0.00	0.00	0.00
Others	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	0.00

Average price of fertilizer and transport cost incurred are provided in Table 5.14. It was revealed from the table that there was not much difference between the price paid by control and soil test farmers, as the source of purchase was almost same among both categories. The average price paid for fertilizers as reported by the farmers were 7 Rs/kg for urea, 20 Rs/kg for DAP, 18 Rs/kg for potash, 21 Rs/kg for complex and 2 Rs/ kg for bio-fertilizers. In addition, farmer also incurred a cost around 20 Rs/100 kg of fertilizer for transportation of fertilizers (except bio-fertilizers) from the source of purchase to his farm.

Table 5.14: Average Price of Fertilisers and Transport Cost Incurred (Rs/kg)

Fertilizer type	Control Farmers		Soil Test Farmers	
	Average Price	Transport cost	Average Price	Transport cost
Urea	6.9	0.20	7	0.19
DAP	20.5	0.20	19.79	0.20
SSP				
Potash	18.42	0.21	17.68	0.22
Complex fertilisers	20.52	0.19	21.49	0.18
Bio-fertilisers	2.50	0.59	2.00	0.16

Overall, the level of adoption of recommended doses of fertilizers by the soil test farmers varied by crops and farm size categories. About 23 per cent of paddy growers and 11 per cent of maize farmers applied recommended dose of fertilisers based on soil test results. A significant proportion of soil test farmers expressed interest to continue to apply recommended dose of fertilisers. Among farm size groups, relatively a high proportion medium farmers in case of paddy and large farmers in case of maize expressed willingness to follow the soil test based fertiliser application in future. However, there were constraints expressed by farmers in adopting the recommended doses of fertilisers.

With respect to actual quantity of fertilisers applied, control farmers of paddy and maize applied more than the quantity applied by soil test farmers. The sample farmers also applied organic inputs along with chemical fertilisers. A high proportion of soil test paddy farmers applied organic manures as compared to control farmers. However, use of organic manure in maize was limited. Most sample farmers purchased chemical fertilisers from private input dealers. About a quarter of sample farmers also purchased fertilisers from cooperative credit societies.

CHAPTER VI

IMPACT OF ADOPTION OF RECOMMENDED DOSES OF FERTILISERS

6.1 Background

Adoption and usefulness of any technology is reflected in terms of crop productivity and most of the technologies developed are expected to bring positive change in productivity for the farmers. The adoption of recommended doses is believed to benefit the farmers in terms of improvement in yield, net returns and better soil health. The use of recommended doses of fertilizers is also found effective in mobilizing macro and micronutrients in soil and in improving soil fertility. In this chapter, an attempt has been made to examine these aspects. The changes observed after the application of recommended doses of fertilizers on reference crops have been analyzed in detail.

6.2 Productivity of Reference Crops among the Sample Households

The adoption of recommended doses fertilisers can be seen in terms of increase in crop yield in both the crops. The productivity realized by the sample crops during the study reference year is presented in Table 6.1 and Table 6.2. It can be seen from the Table 6.1 that the average yield of paddy was found to be more in case of soil test farmers by 8.35 per cent over control farmers. The productivity was 23.38 quintal/acre in case of control farmers whereas 24.63 quintals/acre in soil test farmers. Similarly, the soil test group of maize farmers realized better yield by 3.84 per cent compared to their counterpart. The yield was 18.53 quintal/acre in case of maize control farmers while it was19.24 quintals/acre in case of maize soil test farmers.

Across different categories of farmers, medium farmers in case of paddy realized maximum productivity by 11 per cent over all other categories of farmers followed by large farmers (8.56%), small farmers (8.26%) and marginal farmers (7.16%) whereas in case of maize, even though their productivity was less than the all categories of control farmers before the application of recommended doses of fertilizers, highest benefits were derived by large farmers (18.97%) after the application of recommended doses of fertilizers followed by marginal farmers (2.68%). However, the productivity found to be declined in case of small and medium farmers may be due to difference in the management practices adopted.

As far as increase in average value of output is concerned, the percent difference in yield and value of output shows there was no much difference between the categories among both the crops as the market price remains same for all categories of farmers. In addition to yield and returns, the soil test farmers would have also benefited by reduction in cost of cultivation due to the balanced use of fertilizers. However, the present study couldn't support this result as the study has not collected the data on cost of cultivation aspects of these crops.

Table 6.1: Productivity of the Sample Crops during the Reference Year

Particulars	Average yield (Quintal/acre)			Average value of output (Rs/acre)		
	Control Farmers	Soil Test Farmers	% difference in yield	Control farmers	Soil Test Farmers	% difference in Value of output
Paddy						
Marginal	17.75	19.12	7.16	24850	26768	7.17
Small	20.94	22.67	8.26	29316	31738	8.26
Medium	22.55	25.06	11.14	31569	35087	11.14
Large	22.41	24.51	8.56	31379	34316	8.56
Total	23.38	24.63**	8.35	32729	34482	8.38
Maize						
Marginal	19.12	19.63	2.68	23898	24538	2.68
Small	23.23	21.14	-8.98	29036	26429	-8.98
Medium	20.51	19.59	-4.47	25633	24487	-4.47
Large	15.33	18.23	18.97	19158	22793	18.97
Total	18.53	19.24*	3.84	23158	24047	3.84

Note: *** significant at one per cent level, ** significant at 5 per cent level, and * significant at 10 per cent level.

The t-test was also carried out for understanding the statistical significance in terms of yield differences between the adopters and non-adopters of the recommended doses of fertilizers for the selected crops such as paddy and maize. The results revealed that there is a significant difference between the yield of paddy farmers who adopted the recommended doses of fertilizers than the non-adopters, which was significant at 5 per cent level. In case of maize, there was no significant difference between the yields among the adopters and non-adopters of recommended doses of fertilizers. It may be due to the fact that paddy was mostly cultivated in irrigated/ waterlogged condition in canal areas in the study area, wherein there is a problem of salinity and hence, there is a need for regular soil testing and adoption of recommended doses of fertilizers as it was found in the results. In case of maize, there were no such issues as it grown in dry land/ rainfed condition and application of recommended doses of fertilizer might not play a major role in terms of yield as obtained in the results.

6.3 Impact of Application of Recommended Doses of Fertilisers on Reference Crops (Before and After Approach)

There are two ways to analyze the impact of any technology, either by comparing the productivity between control and treatment groups at the same point of time, or comparing between the productivity of treated group before and after adoption. It would be important to see the impact of recommended doses on yield of particular crop, i.e. change in crop yield after application of recommended doses of fertilisers. Therefore, efforts was also made to assess the impact through collecting the information from the farmers on yield before and after application of recommended doses among soil test farmers and the results are presented in Table 6.2.

It was observed from the table that the change in yield after the use of recommended fertilisers was upbeat by 22.72 per cent in case of paddy and 28.24 per cent in case of maize soil test farmers. Among all categories, the increase in yield of paddy ranged from 8.26 per cent in case of marginal farmers to 26.06 per cent in case of large farmers, whereas the increase in yield of maize ranged from 21.50 percent in case large farmers to 32 per cent in case of marginal farmers.

Overall, the results of both tables (Table 6.1 and Table 6.2) reflects that soil test technology in case of both paddy and maize sample farmers has increased the productivity and proven to be useful technology in cultivation of both the crops. But, the negative changes in productivity of small and medium farmers in case of maize might be due to mismanagement practices adopted by those farmers, and hence farmers should try to adopt good agricultural practices in their cultivation to reap better results of any technologies.

Table 6.2: Impact of Application of Recommended Doses of Fertilizers on Crop Yield-Soil Test Farmers

Particulars	Average yield (Quintal/acre)		% change in yield
	Before	After	
Paddy			
Marginal	32.33	35.00	8.26
Small	30.77	37.04	20.38
Medium	26.21	32.50	24.00
Large	27.21	34.30	26.06
Total	**28.21**	**34.62**	**22.72**
Maize			
Marginal	24.20	32.00	32.23
Small	23.14	29.71	28.39
Medium	19.71	25.14	27.55
Large	17.90	21.50	20.11
Total	**20.68**	**26.52**	**28.24**

Table 6.3: Changes Observed after the Application of Recommended Doses of Fertilisers on Reference Crops (% of farmers)-Soil Test Farmers

Particulars	Paddy				Maize			
	Most Important	Important	Least Important	Total	Most Important	Important	Least Important	Total
Increase in crop yield	27.87	0	0	27.87	30	0	0	30
Improvement in soil texture	1.63	11.47	0.8	13.93	4.284117	8.569805	2.856078	15.71
Improvement in crop growth	5.73	10.65	6.55	22.95	1.429476	21.42414	2.856381	25.71
Improvement in grain filling	3.27	3.27	6.55	13.11	4.286238	4.286238	4.286238	12.86
Less incidence of pest and diseases	1.63	9.01	5.73	16.39	-	2.858	11.432	14.29
Decrease in application of other inputs like seed, labour, pesticide etc.	0.615	1.23	0.615	2.46	-	1.43	-	1.43
Others	-	2.46	-	2.46	-	-	-	0.00

In addition, to increase in crop yield, several other changes can be expected from the adoption of any particular technologies. Therefore changes observed after application of recommended doses of fertilisers on reference crop in farmers opinion is presented in Table 6.3. As presented in the table around 28 per cent of the paddy farmers and 30 per cent of the maize farmers found that increase in crop yield was the major reason noticed after the adoption of recommended doses of fertilisers, for which almost all these respondents ranked it as the most important reason in terms of level of importance. In addition, improvement in crop growth, improvement in soil texture, fewer incidences of pest and diseases, and improvement in grain filling were the other major benefits experienced by the sample farmers. In terms of level of importance, majority of them ranked these reasons as important. However, decrease in application of other inputs like seed, labour, pesticides etc., were also stated by around two per cent of the sample farmers, yet this was the least important reason according to the maize sample farmers.

To sum up, average yield of soil test paddy farmers was estimated higher than control farmers. In fact, soil test farmers had achieved yield level by 8.35 per cent over control farmers. In case of maize, soil test farmers realized better yield by 3.84 per cent compared to control farmers. Among farm size groups, medium farmers achieved higher level of yield than other farmers. There was mixed pattern of yield difference between soil test and control farmers of maize for different farm size groups. Notwithstanding, average yield of soil test maize farmers was higher than control farmers. Most sample farmers of paddy and maize opined that use of recommended doses of fertilisers helped to increase yield. Some farmers also mentioned better crop growth, less incidence of pest and diseases, and improvement of soil health due to soil test based application of fertilisers.

CHAPTER VII

SUMMARY AND CONCLUSIONS

7.1 Background

Green Revolution technology helped to increase crop output and farmer's income considerably over time. Adoption of high yielding varieties along with irrigation and chemical fertilizer resulted in higher crop yield. However, owing to the change in preferences in crop production techniques over a period of time, several new challenges have emerged impacting long term food security. Deteriorating soil health is one of the concerns borne out of the intensive cultivation of the land. The practice of integrated nutrient management has great scope for maintenance of soil fertility and of plant nutrient supply from all possible sources of organic, inorganic and biological components in an integrated manner.

Chemical fertilisers are the important source of nutrients for plant growth. With the advent of fertiliser responsive crop varieties, total consumption of nitrogenous, phosphatic and potassic fertilisers increased from about 1.1 million tonnes in 1966-67 to 27.8 million tonnes in 2011-12. The level of consumption of fertilisers is highly varied across states from 54 Kg/ha in Himachal Pradesh to 243 Kg/ha in Punjab during 2011-12. It is reported that many parts of India shown deficiency of not only primary nutrients, but also secondary and micro nutrients. Government of India had undertaken initiatives to ameliorate the situation and encourage the farmers for balanced use of fertilisers. Farmers are encouraged to test their soil periodically and apply fertilisers based on the deficiency of nutrients in soil. This is intended to ensure balanced supply of nutrients for maintaining soil health and improving crop productivity.

However, there is no systematic farmers survey based study available assessing the effectiveness of these programmes on crop productivity, extent of soil testing for nutrient deficiency and adoption of recommended doses of fertilisers by farmers based on the soil tests. The present study focussed on adoption of soil testing, constraints in the application of recommended doses of fertilisers and its impact on crop productivity on two selected crops such as paddy and maize in the state of Karnataka.

The present study relied on the primary data collected from the sample farmers growing paddy and maize for the reference period of 2012-13. Sample of 150 farmers were selected for each crop for assessing the application of recommended dose of fertilisers and its impact on crop production. The survey also involved control group of 100 farmers for each crop for assessing the effect of the application of the recommended dose of fertilisers on crop productivity and income.

7.2 Summary of Findings

7.2.1 Trend in Fertilizer Consumption

The consumption of NPK fertilisers has increased considerably in the state of Karnataka overtime. However, there is a large variation in fertiliser consumption across districts. The top fertiliser consuming districts are Belgaum, Bellary, Raichur, Koppal and Bagalkot. Among the fertiliser types, urea accounted for about 65 per cent of the total consumption of straight N fertilizers, DAP accounted for 51 per cent of total P_2O_5 consumption and other complex fertilizers accounted for 37 per cent. Despite increase in consumption of fertilises, deficiency of nutrients particularly micronutrients in soil has been reported.

7.2.2 Socio-economic Characteristics of the Sample Households

Out of soil test paddy farmers, small farmers accounted for a large proportion followed by large farmers, marginal farmers and medium farmers. In case of control farmers also, small farmers constituted the largest proportion followed by large farmers and marginal farmers. The average age of both soil test and control farmer was worked out almost same in these two independently drawn sample. Similarly, there was not much difference in the education status of control and soil test farmers with average years of schooling recorded at 8.7. Average family size, number of people engaged in agriculture, and average years of experience in agriculture were also by and large same among the sample farmer groups.

With respect to maize soil test farmers, small farmers constituted about 37.40 per cent followed by medium (28.30%), large (21.20%) and marginal farmers (12.90%). A similar pattern was also observed for maize control farmers with dominance of small famers whose proportion in total sample was 42.2 per cent. Average age of control farmers was 46 years whereas for soil test farmers it was 44 years. Average year of education attained by maize soil test farmers was higher than that of control farmers. There was considerable difference in the percentage of farmers' being member in any associations. It was found that 27 per cent of control farmers and 18 percent of soil test farmers were member of agriculture related associations within the village.

7.2.3 Details of Operational Land Holdings

The net area operated by paddy soil test farmers was higher than that of control farmers. In fact, land operated by soil test farmers was 9.29 acres, out of which 7.85 acres was irrigated and 1.44 acres un-irrigated. For control farmers, net operational area was worked out at 8.99 acres, out of which about seven acre was irrigated and two acres un-irrigated. Cropping intensity among soil test farmers was estimated higher than control farmers. In case of maize soil test farmers, leased-in land, leased-out land and uncultivated land was negligible with the net operational area of 8.22 acres. For control farmers, net operated area was worked out at 7.5 acres, out of which 4.18 acres was irrigated and 3.31 acres was un-irrigated. Cropping intensity was higher among the soil test farmers.

7.2.4 Source of Irrigation

Canal water was the major source of irrigation for the paddy sample farmers in the study area followed by river/ponds and bore wells. In fact, canal water irrigated over 50 per cent of the net irrigated area. In case of maize farmers, bore well was the predominant source of irrigation with overall coverage of 46 per cent of the net irrigated area. For control farmers, the second important source of irrigation was open/dug well, while for soil test farmers after bore well irrigation, the rest of the area was spread more or less equally under open/dug well, river/pond and canal.

7.2.5 Cropping Pattern, Area under HYVs and Value of Output

Among soil test and control paddy farmers, the proportion of area allocated for paddy cultivation was significantly higher at 74% of gross cropped area. Paddy was cultivated in all the three seasons in the study area. Other important crops grown by the sample farmers were maize, cotton and jowar. The sample farmers allocated significant area for cultivation of plantation crops like arecanut and betel leaves. In case of maize, sample farmers cultivated it during kharif and rabi seasons. Overall, kharif maize occupied about 58 per cent, while rabi maize accounted for 7.6 per cent of GCA. Other important crops grown were cotton and sugarcane. Interestingly, all the sample farmers cultivated improved varieties of paddy and maize.

Value of output per acre varied from Rs. 37826 for large farmers to Rs. 48586 for marginal farmers among control farmers. However, for soil test farmers, value of output per acre was recorded the highest for large farmers followed by marginal and small farmers. Similarly, for maize farmers also, value of output varied across farm size groups with no distinct pattern. For maize control farmers, per acre value of output was the highest for small farmers followed by large and medium farmers. Among soil test farmers, large farmers registered the highest value of output per acre followed by medium and small farmers.

7.2.6 Details of Farm Assets Holding

The level of mechanisation was observed to be more or less uniform across control and soil test farmers of paddy and maize. Density of tractor was relatively high among paddy famers as compared to maize farmers. In fact, number of tractor per household varied from 0.45 to 0.46 among paddy farmers, while it varied from 0.20 to 0.22 among maize farmers. However, density of harrow and cultivators was relatively high for maize farmers. The sample farmers had electric motors and sprayers. The density of bullock cart was higher among maize farmers. Overall, value of assets per household was higher for paddy farmers than maize farmers.

7.2.7 Agricultural Credit Availed

About 93 per cent of soil test paddy farmers and 88 per cent of control farmers availed credit from the institutional sources of lending. Among the institutional sources, a high proportion of sample farmers taken credit from the cooperative credit societies and commercial banks. However, average credit per household was relatively high for non-institutional sources such as money lenders indicating that institutional sources have large clientele base, but average loan advanced per household was lower. A similar pattern was observed for maize farmers also.

7.2.8 Soil Testing

Analysis of survey data revealed that relatively a high proportion of small and medium farmers of paddy and maize tested their soil in the last three years. Average area covered under soil test was high for large farmers. However, small farmers registered the highest proportion of area covered under soil test (86.7% of net operated area) as compared to other farmer categories. Area covered under soil test for marginal farmers was 75.7 per cent. Most of the soil samples were reportedly collected by the officials of the Department of Agriculture. In case of maize, small farmers constituted about 37.4 per cent of total soil tested farmers followed by medium and large farmers. Average area covered under soil test was high for large farmers. But, in terms of area covered as percentage of net operated area, it was the highest for marginal farmers followed by small farmers and medium farmers.

Among soil tested paddy farmers, around 92 per cent stated that increase in crop yield was the reason behind soil testing. The next important reasons stated were the peer farmer pressure, motivation from village demonstration/training/exposure visits to places with best farming practices and interest to adopt of new technological practices. Maize sample farmers also mentioned similar reasons with a slight variation in their proportion for testing of soil. In case of control farmers of paddy, 71 per cent of farmers opined that they did not test their soil because they did not know whom to contact for details on soil testing. Second major reason indicated was that they did not know how to take soil sample. Further, soil test laboratories were reportedly located far away from villages, which desists them from soil testing. With respect to maize control farmers, about 72 per cent mentioned that they did not know how to take soil samples and 64 per cent indicated that they did not know whom to contact for getting details on soil testing. About 50 per cent of maize farmers also mentioned that soil testing laboratories are located far away from villages.

7.2.9 Application of Recommended Doses of Fertilizers by Soil Test farmers

The level of adoption of recommended doses of fertilizers by the soil test farmers was around 23 per cent in case of paddy growers and 11 per cent in case of maize farmers. Interestingly, a large proportion of paddy farmers (94%) expressed willingness to continue to apply recommended doses of fertilisers as it helps to maintain better soil health and provides better yields. However, in case of maize farmers, only 59 per cent showed interest to continue to apply recommended doses of fertilisers as there was reportedly decline in yield. Among farm size groups, relatively a high proportion of medium farmers in case of paddy and large farmers in case of maize expressed willingness to follow the soil test based fertiliser application in future.

The paddy and maize sample farmers expressed various constraints in the application of recommended doses of fertilisers. The important constraints faced by the farmers included no technical advice on method and time of fertilizer application, difficult to understand and follow the recommended doses and high prices of chemical fertilizers. Analysis of actual quantity of fertilisers applied showed that control farmers of paddy and maize applied more amounts of fertilisers than soil test farmers. In addition to chemical fertilisers, about 55 per cent of the control farmers and 67 per cent of the soil test farmers used organic manures in paddy. A high proportion of soil test farmers applied organic manures as compared to control farmers. Both quantities applied and area covered was also higher for soil test farmers. However, use of organic manure in maize was limited. Soil test farmers of maize applied both farm yard manure and vermi-compost, while control farmers applied farm yard manure along with some amount of bio fertilisers.

7.2.10 Impact of Adoption of Recommended Doses of Fertilisers

Average yield of paddy was estimated at 24.63 quintal per acre for soil test farmers and 23.38 quintal for control farmers indicating that soil test farmers had achieved yield level by 8.35 per cent over control farmers. In case of maize, soil test farmers realized better yield by 3.84 per cent compared to control farmers. In fact, average yield of soil test maize farmers was 19.24 quintal per acre and those of control farmers it was 18.53 quintal. Among farm size groups, medium farmers achieved higher level of yield than other farmers. There was a mixed pattern of yield difference observed between soil test and control farmers of maize for different farm size groups. Notwithstanding, average yield of soil test maize farmers was higher than control farmers. Most sample farmers of paddy and maize opined that use of recommended doses of fertilisers helped to increase yield.

7.3. Conclusions

Based on the detailed analysis of data and summary of findings, the following conclusions have been drawn.

(i) Small farmers constituted the highest proportion of total soil test farmers of paddy and maize. That is, small farmers showed more interest to adopt soil testing which was reflected in terms of area covered under soil testing. The proportion of small farmers' paddy area covered under soil testing was 86.7 per cent of net operated area and in case of maize it was 85.4 per cent. The proportion of maize area of marginal farmers covered under soil testing was 90.5 per cent.

(ii) Among soil tested paddy and maize famers, over 90 per cent mentioned the reason for testing soil was to increase the crop yield. The other important reasons indicated were peer farmer pressure and motivation from the village demonstrations/training given by the state Department of Agriculture.

(iii) About 70 per cent of paddy control farmers and 72 per cent of maize control farmers indicated that they did not know how to take soil samples. Almost the same proportion of paddy and maize control farmers also indicated that they did not know whom to contact to know details of soil testing as the reasons for not adopting soil testing.

(iv) The level of adoption of recommended doses of fertilisers among the soil test farmers was very low at 23 per cent for paddy and 11 per cent for maize. A significant proportion of these farmers expressed willingness to continue to follow the soil test based fertiliser application. Among farm size groups, a high proportion of medium farmers in case of paddy and large farmers in case of maize expressed willingness to follow recommended doses of fertilisers.

(v) Among the constraints faced in the adoption of recommended doses of fertilisers, most soil test paddy and maize farmers indicated lack of technical advice on method and time of application, difficulty in understanding and following the recommended doses, and high prices of chemical fertilisers.

(vi) With respect to actual quantity of chemical fertilisers, analysis showed that control farmers of paddy and maize applied more amounts of fertilisers than soil test farmers. However, as compared to control farmers, soil test farmers applied a relatively large amount of organic manures.

(vii) Average yield of paddy and maize of soil test farmers was much higher than yield achieved by control farmers. Average yield of paddy of soil test farmers was 24.63 quintal and the yield of maize was 19.24 quintal per acre. In case of paddy, yield difference between soil test farmers and control farmers was 8.35 per cent and for maize it was 3.84 per cent.

7.4 Policy Recommendations

(i) There is greater awareness about soil testing among the farmers. But, soil testing facilities are not easily accessible and unfortunately all the state government controlled soil testing laboratories at the district level have been closed. There is a need to revive the soil testing laboratories preferably at the taluk level with modern facilities and adequate staff for generating accurate and reliable results.

(ii) The concept of soil health and importance of maintaining soil fertility should be incorporated in all the training programmes. Farmers should also be educated the ways of enriching soil fertility through appropriate cultivation practices such as crop rotation, mulching and minimum tillage.

(iii) The scientific method of collection of soil samples is very important to assess the nutritional status of soil. There is a need for conducting regular training programmes for building capacity of farmers on collection of soil samples and reading of soil test results, understanding of which is utmost important for adoption of recommended doses of fertilisers. Further, soil health cards should be printed on laminated sheets to protect them from soiling and damaging.

(iv) Impact of excessive use of chemical fertilisers on soil has been well recognised by the farmers. However, organic inputs are not readily available in adequate quantity. Regular training programmes and method demonstrations should be organised to educate the farmers for producing their own organic inputs by utilising available farm wastes.

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Annexure

Action Taken Report

Adoption of Recommended Dosage of Fertilizer on Soil Test Basis by Farmer in Karnataka

Referee: Centre for Management in Agriculture, IIM, Ahmedabad

Title: Adoption of Recommended Doses of Fertilisers on Soil Test Basis by Farmers in Karnataka

Date of Receipt of Draft Report: May, 2015

Date of Comments Received: October, 2015

Comments on the Methodology: As per the comments received from the reviewer on the methodology, t-test was carried out for understanding the statistical significance in terms of yield differences between the adopters and non-adopters of the recommended doses of fertilizers for the selected crops in the study.

Comments on the presentation, Get up etc:

i & v. Regarding the sources of information, it was clearly listed in the Table 4.3 that the farmers get information from more than one source namely SAUs, KVKs, Private companies, Friends, Neighbors, Agriculture Departments and others. However, the sources of getting information about recommended doses of fertilizers covered in the others category was expanded further in Table 5.3.

ii & iv. The composite scores were not worked out for the suggested tables (Table 4.4, 4.5, 5.1 & 5.2) for the reason that the present tables were sufficient to convey the better inferences on the importance of reasons both horizontally and vertically to the readers.

iii & vi. Because of the non-availability of the quantity of individual complex fertilizers applied, it was difficult to compute the extent of adoption of technology and partial adoption in terms of nutrient quantity variations in actual fertilizer use from the recommended doses of fertilizers. The average fertilizer used by adopters was significantly lower than the control farmers may be due to the fact that adopters were aware of package of practices, benefits of soil testing, use of recommended doses of fertilizers (not applying high quantity or less) and awareness on improved method of fertilizer application rather than broadcasting alone.

vii. Table 5.10 clearly shows that farmers purchased fertilizers and other inputs from more than one source. Further, we have listed others as one of the sources, but none of them reported in that category.

viii. The average prices paid by the control and soil test farmers for fertilizers are almost same. The small price difference might be due to regional difference in prices for the fertilizers & transportation costs.

ix. In Table 6.1 soil test farmers includes only those farmers who applied recommended doses of fertilizers. It is the fact that application of recommended doses of fertilizers is one of the major reasons for higher yield and the same results were reflected in Table 6.2 & Table 5.5. It is revealed from the results that both soil testing and application of recommended doses of fertilizers will reduce cost & quantity of fertilizer application (by avoiding over use/ less use).

x. Table 6.2 clearly shows that application of fertilizers was one of the significant factors contributed for higher yield in the study. Of course, there could be some other factors contribute for higher yield, for which the study has not made any attempt.