Study No.-114

ADOPTION OF RECOMMENDED DOSES OF FERTILIZERS ON SOIL TEST BASIS BY FARMERS

AGRO- ECONOMIC RESEARCH CENTRE FOR MADHYA PRADESH AND CHHATTISGARH

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.)

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PREFACE

*The present study entitled "**Adoption of Recommended Doses of Fertilizers on Soil Test Basis by Farmers**" has been assigned by the Directorate of Economics and Statistics Ministry of Agriculture Government of India to this centre under the close coordination of Agricultural Development and Rural Transformation Centre (ADRTC), Institute for Social and Economic Change (ISEC), Bangalore.*

The study comprises 240 soil test and 120 control respondents of Shajapur & Ujjain, and Hoshangabad and Vidisha districts for soybean and wheat respectively in Madhya Pradesh. The positive impact of soil testing on productivity of soybean and wheat was observed in the area under study on an overall basis an average farmer obtained 24.4 & 20.2 per cent more income and 20.2 & 15.4 per cent more yield than the control farmers in production of soybean and wheat crop respectively. It was also observed that the yield of soybean and wheat at overall level was found to be increased by 10.20 and 8.30 per cent respectively after adoption of recommended doses of fertilizer by soil test farmers. Amongst different size of farmers the increase in yield was found maximum in marginal (17.9%) followed by large (10.5%), medium (10.0%) and small (2.5%) farmers in case of soybean, while in case of wheat it was found to be maximum in marginal (17.0%) followed by small (6.1%), medium (5.7%) and large (4.8%) farms.

The present study was conducted by Dr. H. O. Sharma and Dr. Deepak Rathi of this Centre. They have done field investigation, tabulation analysis, interpretation and drafting of the report. I wish to express my deep sense of gratitude to them and their team members namely; Mr. S.K. Upadhye, Mr. C.K. Mishra, Mr. S.C. Meena, Mr. H. K. Niranjan, S.S. Thakur, and Mr. Ravi Singh Chouhan for their untiring efforts in bringing this innovative study to its perfect shape.

I extend heartfelt thanks to the Coordinator of this study Dr. Parmod Kumar Professor & Head, Agricultural Development and Rural Transformation Centre (ADRTC), Institute for Social and Economic Change (ISEC), Bangalore for providing valuable guidelines and time to time suggestions through e-mails for conducting the study successfully.

On behalf of the Centre, I express deep sense of gratitude to Dr. V.S. Tomar, Hon'ble Vice-Chancellor and Chairman Advisory Body of AERC, Jabalpur, Shri. P. C. Bodh, Adviser, AER Division, Ministry of Agriculture, Govt. of India, New Delhi. Dr. S.S. Tomar, Director Research Services, Dr. S.K. Rao Dean, Faculty of Agriculture, and Dr. P.K. Mishra, Director Extension, Dr. N.K. Raghuwanshi, Prof. & Head (Dept. of Agril. Econ.&F.M.), Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur for providing all facilities and valuable guidance during various stages in successful completion of this study of high importance.

I express sincere thanks to Shri B.L. Pathak, Shri B.L. Billaiya, Shri A.K. Nema, and Shri B.S. Jamra Deputy Director Agriculture of Hoshangabad, Vidisha, Ujjain and Shajapur districts respectively and their field staff for providing not only secondary data but also extending great assistance in collection of field data from the selected respondents.

I hope the findings and suggestions made in the study would be useful to policy makers of the State and Govt. of India

Date : 30.01.2015 **(Hari Om Sharma)**

Place: Jabalpur **Prof. & Director**

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INTRODUCTION

The soil testing programme was started in India during the year 1955-56 with the setting-up of 16 soil testing laboratories under the Indo-US Operational Agreement for "Determination of Soil Fertility and Fertilizer Use". In 1965, five of the existing laboratories were strengthened and nine new laboratories were established with a view to serve the Intensive Agricultural District Programme (IADP) in selected districts. To meet the increasing requirement of soil testing facilities, 25 new soil testing laboratories were added in 1970. In addition to this, 34 mobile soil testing vans were established under the joint auspices of the Technical Cooperation Mission of USA (TCM), Indian Agriculture Research Institute (IARI) and Government of India to serve the farmers in remote areas and also provide education to the farmers about benefits of balanced fertilization through group discussions, demonstrations, film shows etc. The idea to create the mobile soil testing facility was to serve the farmers almost at their doorsteps. The capacity of the soil testing laboratories in the intensive agricultural districts was initially created to analyse 30,000 soil samples annually by each laboratory.

Presently, there are 661 soil testing laboratories including 120 mobile vans operating in 608 districts of the country with an annual sample analyzing capacity of 7.2 million. State-wise position of the capacity is at great variance from one State to another. Among major States, in Madhya Pradesh, Chattishgarh, Orissa, Jharkhand and Assam, the number of soil testing laboratories is less than the number of districts in each State. In other States, such as Rajasthan, Himachal Pradesh, Uttarakhand, Bihar and West Bengal, the number of labs are just about equal to the number of districts, while the remaining States have larger number of labs than the number of districts.

Soil testing is a chemical process by virtue of which requirement of nutrients for plant can be analyzed so as to sustain the soil fertility. The farmers find it extremely difficult to know the proper dose and type of fertilizer, which is suitable for his soil. While using a fertilizer one must take into account the requirement of his crops and the characteristics of the soil.

The basic objective of the soil testing programme is to provide a service to farmers to better and more economic use of fertilizers and better soil management practices for increasing agricultural production in their farm. Higher production from high yielding varieties cannot be obtained without applying proper dose of fertilizers to overcome existing deficiencies of soils. Efficient use of fertilizers is a major factor in any programme designed to bring about an economical increase in agricultural production.

Fertilizer consumption has to be crop responsive and efficient to increase production, while rationalizing input cost and minimizing environmental degradation. A fertilizer not suitable to a soil type can be called as an incorrect fertilizer used for that soil and it will contribute in consumption amounts. Different types of fertilizers are required to be used in acid and alkali soils. Where citrate soluble and water insoluble phosphatic fertilizers can be efficiently used in acid soils, they will not respond in alkali soils. Fertigation involving the use of water soluble fertilizers through sprinklers and drips is expected to give better use efficiency for both, the water and fertilizers. Site specific nutrient management involving soil test based application of fertilizers is critical to efficient utilization. Use of required sources of plant nutrients has to be promoted, coupled with the use of soil amendments in acidic/ alkaline soils for moderating acidity/alkalinity by bringing the soil pH to near neutrality so as to enhance soil nutrient availability and efficiency.

A fertilizers recommendation from a soil testing laboratories based on carefully conducted soil analysis and the results of up-to-date agronomic research on the crop, and it therefore is most scientific information available about fertilizing that is needed for a crop in a particular field. Each recommendation based on a soil test takes into account the values obtained by these accurate analysis, the research work so far conducted on the crop in the particular soil areas and the management practices of the concerned farmer. The soil test with the resulting fertilizer recommendation is therefore the actual connecting link between agronomic research and its practical application to the farmers' fields. However, soil testing is not an end in itself. A farmer who follows only the soil test recommendations is not assured of a good crop. Good crop yields are the result of the application of fertilizer and good management skills, such as proper tillage, efficient water management, good quality seed, adequate plant protection measures etc. Soil testing is essential and is the first step in obtaining high yields and maximum returns from the money invested in fertilizers.

An efficient use of fertilizers is a major factor in any programme designed to bring about an economic increase in agricultural production. The farmers involved in such a programme will have to use balance quantities of fertilizers to achieve the desired yield levels. However, the amounts and kinds of fertilizers required for the same crop vary from soil to soil, even field to field on the same soil. The use of fertilizers without first testing the soil is like taking medicine without first consulting a physician to find out what is needed. It is no doubts that the fertilizers increase yield and the farmers are aware of this. But are they applying right quantities of the right kind of fertilizers at the right time at the right place to ensure optimum profit? Without a proper fertilizer recommendation based upon a soil test, a farmer may be applying too much of a little needed plant food element and too little of another element, which is actually the principal factor limiting plant growth. This not only means an uneconomical use of fertilizers, but in some cases crop yields actually may be reduced because of use of the wrong kinds or amounts, or improper use of fertilizers.

Soil testing till today has been used mainly to formulate precise recommendations for the major nutrients i.e. Nitrogen, Phosphorus and Potassium fertilization of crops in different soils and to recommend appropriate doses of amendments for salt-affected and acidic soils. Micronutrients, comprising Zinc, Copper, Iron, Manganese, Boron and Chlorine, though required by plants in much smaller amounts, yet are as essential for them as the major nutrients. Despite that, little attention has been paid to employ the soil testing for assessing the micronutrient status of soils and determining soils requirement for micronutrient fertilizers for growing crops. With an objective to extent the advisory service to the farmers of the state regarding the nutrient problems of soils and crops and suggest appropriate remedial measures for efficient correction of the same.

Box 1.1 Basic Objectives of Soil Testing
1. *Classification of soils.* 2. *Evaluate and monitor soil fertility.* 3. *Identify salinity, alkalinity, acidity, etc., problems.* 4. *Assess the relative nutrient supplying power of soil.* 5. *Predict profitable responsiveness of soil to added fertilizers, lime, Gypsum and other amendments for optimum and economical crop production.*

Success or failure of soil testing programmes largely depends on rapidity providing correct information to farmers, ability of the programme to provide service to a large group of farmers in a particular area, proper analysis and interpretation of results and recommendations that when followed are profitable for the farmer. Then only will this service be effectively utilized to improve local agricultural production Time and quality consciousness in the service is a real challenge for the analysts in the new millennium. This compels laboratory to adopt rapid, reliable, time saving procedures and methods to meet future requirements. The farmer's confidence in the programme can be established only by demonstrating that it actually provides a means of improving his profit. Looking to the importance of the soil testing in farmers' field this study had been conducted as the review of various studies reported that the recommendations of soil testing laboratories are useful for farmers for increasing their levels of output but the majority of the farmers have not been interested in this, due to lack of knowledge about soil testing facilities, testing of soils is incredible, laboratories are situated far away, and non availability of soil testing report etc.

1.2 Objectives

The 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.

1.3 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 indiscriminate 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. There is no systematic study undertaken so far for evaluating the effectiveness of the programme 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 examines the level of adoption and constraints in the application of recommended doses of fertilisers, impact on crop productivity and relevant institutional problems.

The study will be beneficial to farmer as it provides information regarding how the soil testing analysis and how they get benefit from the analysis of soil. The study is also helpful to extension worker as it suggests how the constraint in adoption of soil testing technology will be removing as it provides feedback to them that if they carefully tested the soil samples of the farmers. The report will help in increasing the yield of crops resulting into enhancing agriculture production manifold. The findings of the study not only provide feedback to scientists and policy makers but it also suggested how the analysis of soil samples is useful for future planning.

1.4 Review of Literature

Resuming of research study is very essential for any research. The main objective of the resuming of literature is to determine what work {both theoretically and practically} have been done in the past, which could assist in delineation of problematic areas, provide a basis for conceptual frame work method and procedure used and suggest operational definitions for major concept to help in interpretation of finding. The resume of research study provides guidelines to an investigator, making his work more precise through the use of review of literature. A very little work has been done so far related to this study. However, some of the important available literatures are reviewed as under.

Anonymous (2000) discussed the current use of soil tests to predict the probability of crop response to application of fertilizers, and considered their possible use to determine if application of fertilizers and/or waste material will result in the pollution of surface and groundwater. It is suggested that using soil testing to identify the potential for an environmental impact may have value, but only if a comprehensive approach is taken.

Biswas (2002) observed that the soil testing is proven scientific tools to evaluate soil fertility for recommending balanced nutrition to crops. However, the soil testing programme in India has failed to create the desirable impact on the farming community due to extremely poor coverage and delay in timely dissemination of fertilizers recommendation to farmers. While creation of required infrastructural facilities involves huge burden on Government exchequer, application of space age technology has given ample scope to improve the analyzing capacity as well as dissemination ability of the soil testing laboratories. This, coupled with professional management through proper linkages can bring radical changes in the soil testing service in the country to the extent of consumer satisfaction.

Sharma, *et. al* (2005) reported that only 13 % of soybean growers were tested their soil for application of balance dose of fertilizer. Majority of them were not tested their soil due to lake of knowledge (70.20%), soil testing was incredible

(27.34%), soil testing laboratories situated far away (12.24%), non availability of soil testing report (11.02%) and complicated method of taking soil samples(8.97%).

Reid (2006) observed that soil testing plays an important role in crop production and nutrient management. On farms that use commercial fertilizer as the main nutrient source, it is the best way to plan for profitable fertilizer applications. On livestock farms, knowing how much nutrient is present in the soil to start with is critical. Only then can a nutrient management plan be developed to properly manage both the nutrients that have been generated on-farm and any nutrients that are being imported to the property as bio solids or commercial fertilizer. Soil testing is really a three-step process, the collection of a representative sample from each field or section, proper analysis of that sample to determine the levels of available nutrients, and use of the results to determine optimum fertilizer rates. Keeping records is an integral part of the soil-testing process; they will help determine if soil test levels are increasing, decreasing or being maintained over time.

Sahrawat, *et. al* (2011) confirmed that efficacy of the soil test-based balanced nutrient management in enhancing productivity of a range of crops in on-farm farmer participatory trials under rainfed conditions. Soil testing is indeed an effective tool for on-farm fertility management, a prerequisite for sustainably enhancing the productivity in rainfed areas in the Semi Arid Tropic regions of India. He also emphasized the need to strengthen the soil-testing infrastructure in the country.

Sahrawat, *et. al* (2012) also observed that the use of internal soil standards in an analytical service laboratory is a simple, inexpensive, and effective tool for providing feedback on the quality of soil-testing service.

Hence, it is clear from above reviews that very little work has been done so far in this particular aspect. However, these laboratories were found to work from a long period of time. Soil testing is a proven scientific tool to evaluate soil fertility and plays an important role in crop production and nutrient management. (Reid, 2006). The soil testing programme in India has failed to create the desirable impact on the farming community due to extremely poor coverage and delay in timely dissemination of fertilizers recommendation to farmers (Biswas, 2002) and very few farmers were found to be tested their soil for adoption of recommended dose of fertilizer in their farms. (Sharma et.al 2005)

1.5 Data and Methodology

The study is confined to soybean and wheat crop as these are the important crops of the Madhya Pradesh covring 56.6 and 16.4 per cent (Table 1.1) area of the country respectively.

Table 1.1: Area, Production and Productivity of Soybean and Wheat in Different States of India.

States	AREA		PRODUCTION		PRODUCTIVITY	
	000'ha	% to total	000' t	% to total	Kg/ha	% difference
Soybean						
Madhya Pradesh	5766.7	56.6	6926.7	52.5	1200.7	-8.0
Maharashtra	2976.7	29.2	4313.3	32.7	1450.3	10.6
Rajasthan	913.3	9.0	1320.0	10.0	1470.7	11.9
Andhra Pradesh	130.0	1.3	233.3	1.8	1706.7	24.0
Karnataka	186.7	1.8	183.3	1.4	945.3	-37.1
Others	210.0	2.1	253.3	1.9	-	-
All India	10183.3	100.0	13196.7	100.0	1296.3	0.0
Wheat						
Uttar Pradesh	9700.0	32.8	30196.7	33.0	3113.0	0.6
Punjab	3520.0	11.9	16620.0	18.2	4721.3	34.5
Madhya Pradesh	4843.3	16.4	10766.7	11.8	2198.3	-40.8
Haryana	2513.3	8.5	11813.3	12.9	4699.7	34.2
Rajasthan	2746.7	9.3	8493.3	9.3	3083.7	-0.3
Bihar	2153.3	7.3	4736.7	5.2	2195.0	-41.0
Gujarat	1223.3	4.1	3743.3	4.1	3056.7	-1.2
West Bengal	320.0	1.1	883.3	1.0	2772.3	-11.6
Maharashtra	913.3	3.1	1496.7	1.6	1602.7	-93.1
Uttarakhand	370.0	1.3	866.7	0.9	2342.3	-32.1
Himachal Pradesh	360.0	1.2	563.3	0.6	1565.0	-97.7
Jammu & Kashmir	296.7	1.0	456.7	0.5	1541.7	-100.7
Jharkhand	140.0	0.5	243.3	0.3	1721.0	-79.8
Karnataka	240.0	0.8	213.3	0.2	880.7	-251.4
Assam	46.7	0.2	56.7	0.1	1216.7	-154.3
Others	143.3	0.5	253.3	0.3	Na	Na
All India	29556.7	100.0	91423.3	100.0	3094.3	0.0

A multistage purposive sampling method was used to select the districts, blocks, villages and farm households. At the first stage two districts having highest area in these crops in the state have been selected purposively for soybean and wheat. Therefore, Shajapur & Ujjain, and Hoshangabad and Vidisha districts have been selected for soybean (Table 1.2) and wheat (Table 1.3) in Madhya Pradesh respectively.

In second stage, two blocks from each districts were selected again on the basis of highest area in the selected districts. Shajapur & Kalapipal blocks in Shajapur district, and Ujjain & Badnagar blocks in Ujjain district have been selected for soybean, whereas Hoshangabad & Babai blocks in Hoshanagabad, and Vidisha & Gyaraspur blocks in Vidisha district have been selected for wheat.

Table 1.2: Area, Production and Productivity of Soybean in Different Districts of Madhya Pradesh.

Districts	AREA		PRODUCTION		YIELD	
	000'ha	% to total	000' t	% to total	Kg/ha	% difference
UJJAIN	***454.0***	***7.8***	***600.4***	***8.4***	***1322.0***	***6.4***
SHAJAPUR	***354.3***	***6.1***	***440.2***	***6.1***	***1242.3***	***0.4***
DEWAS	326.0	5.6	430.7	6.0	1318.3	6.2
SAGAR	309.9	5.3	375.4	5.2	1214.0	-1.9
RAJGARH	308.6	5.3	322.6	4.5	1045.3	-18.3
SEHORE	292.2	5.0	421.6	5.9	1446.0	14.5
DHAR	272.3	4.7	378.7	5.3	1390.3	11.0
MANDSAUR	269.4	4.6	373.2	5.2	1378.0	10.2
VIDISHA	258.6	4.5	325.1	4.5	1263.7	2.1
INDORE	223.4	3.9	258.7	3.6	1159.0	-6.7
BETUL	222.3	3.8	327.1	4.6	1463.3	15.5
HOSHANGABAD	220.2	3.8	218.3	3.0	995.0	-24.3
RATLAM	216.4	3.7	264.8	3.7	1218.3	-1.5
GUNA	215.4	3.7	269.1	3.7	1249.0	1.0
HARDA	176.2	3.0	261.6	3.6	1488.7	16.9
RAISEN	172.4	3.0	155.3	2.2	911.7	-35.7
CHHINDWARA	166.5	2.9	341.3	4.8	2017.0	38.7
KHANDWA	153.6	2.6	106.9	1.5	710.3	-74.1
SHIVPURI	149.0	2.6	146.7	2.0	989.3	-25.0
NEEMUCH	123.1	2.1	149.6	2.1	1211.7	-2.1
SEONI	119.4	2.1	133.7	1.9	1121.0	-10.3
BHOPAL	107.3	1.9	144.5	2.0	1347.3	8.2
ASHOKNAGAR	95.8	1.7	147.9	2.1	1497.0	17.4
NARSINGHPUR	85.1	1.5	151.3	2.1	1782.7	30.6
DAMOH	71.1	1.2	92.3	1.3	1307.3	5.4
CHHATARPUR	60.0	1.0	39.1	0.5	641.0	-93.0
SATNA	51.9	0.9	29.2	0.4	570.0	-117.0
JHABUA	50.8	0.9	41.4	0.6	807.3	-53.2
KHARGONE	43.9	0.8	35.5	0.5	801.0	-54.4
TIKAMGARH	39.6	0.7	35.0	0.5	923.3	-34.0
REWA	34.4	0.6	19.6	0.3	572.0	-116.3
BARWANI	32.9	0.6	30.0	0.4	959.0	-29.0
SHEOPUR KALAN	25.9	0.4	30.6	0.4	1170.0	-5.7
ALIRAJPUR	16.2	0.3	13.6	0.2	837.0	-47.8
BURHANPUR	15.4	0.3	11.4	0.2	506.3	-144.3
PANNA	11.6	0.2	9.1	0.1	788.0	-57.0
JABALPUR	9.6	0.2	12.0	0.2	1215.7	-1.8
DINDORI	7.5	0.1	4.9	0.1	673.0	-83.8
SHAHDOL	7.4	0.1	5.9	0.1	703.3	-75.9
GWALIOR	4.0	0.1	7.3	0.1	1877.3	34.1
ANUPPUR	3.9	0.1	2.7	0.0	695.0	-78.0
MANDLA	3.0	0.1	2.1	0.0	729.0	-69.7
DATIA	2.4	0.0	2.1	0.0	838.0	-47.6
UMARIA	1.9	0.0	0.7	0.0	417.7	-196.2
KATNI	0.6	0.0	0.4	0.0	609.0	-103.1
MORENA	0.4	0.0	0.4	0.0	1305.0	5.2
SIDHI	0.2	0.0	0.2	0.0	522.3	-136.8
SINGROLI	0.2	0.0	0.1	0.0	635.0	-94.8
BALAGHAT	0.1	0.0	0.1	0.0	1510.7	18.1
BHIND	0.0	0.0	0.0	0.0	912.0	-35.6
M.P.STATE	**5800.1**	**100.0**	**7179.4**	**100.0**	**1237.0**	**0.0**

Table 1.3: Area, Production and Productivity of Wheat in Different Districts of Madhya Pradesh.

Districts	AREA		PRODUCTION		YIELD	
	000'ha	% to total	000' t	% to total	Kg/ha	% difference
HOSHANGABAD	***250.5***	***4.9***	***1016.8***	***7.6***	***4103.3***	***36.6***
VIDISHA	***233.4***	***4.6***	***413.7***	***3.1***	***1790.0***	***-45.3***
SEHORE	219.9	4.3	488.5	3.7	2227.0	-16.8
RAISEN	207.2	4.0	564.3	4.2	2678.3	2.9
SAGAR	193.5	3.8	321.9	2.4	1645.3	-58.1
DHAR	176.0	3.4	486.5	3.7	2811.0	7.5
SHIVPURI	156.2	3.1	413.2	3.1	2689.7	3.3
UJJAIN	156.1	3.0	398.7	3.0	2515.3	-3.4
REWA	155.0	3.0	291.2	2.2	1808.0	-43.8
CHHATARPUR	152.5	3.0	317.6	2.4	2064.0	-26.0
DEWAS	145.3	2.8	406.2	3.1	2792.7	6.9
HARDA	144.9	2.8	603.9	4.5	4214.0	38.3
SATNA	142.5	2.8	312.1	2.3	2130.3	-22.1
CHHINDWARA	132.9	2.6	395.8	3.0	3014.0	13.7
RAJGARH	131.7	2.6	294.4	2.2	2390.7	-8.8
DATIA	127.0	2.5	317.8	2.4	2544.7	-2.2
TIKAMGARH	121.7	2.4	284.2	2.1	2192.7	-18.6
SEONI	120.4	2.4	235.3	1.8	1923.0	-35.2
ASKHONAGAR	118.9	2.3	276.8	2.1	2333.0	-11.5
BETUL	110.6	2.2	203.5	1.5	1868.7	-39.2
INDORE	109.8	2.1	436.5	3.3	3999.3	35.0
SHAJAPUR	109.5	2.1	287.8	2.2	2608.3	0.3
GWALIOR	106.1	2.1	354.0	2.7	3274.3	20.6
GUNA	101.9	2.0	312.5	2.3	3031.3	14.2
JABALPUR	101.4	2.0	277.2	2.1	2774.0	6.2
MORENA	96.6	1.9	324.5	2.4	3318.0	21.6
BHIND	94.7	1.8	302.9	2.3	3191.7	18.5
KHARGONE	94.5	1.8	273.7	2.1	2597.0	-0.1
KHANDWA	91.2	1.8	245.1	1.8	2992.3	13.1
RATLAM	87.1	1.7	252.1	1.9	3051.3	14.8
DAMOH	81.9	1.6	165.3	1.2	2081.7	-24.9
KATNI	77.5	1.5	166.0	1.2	2070.7	-25.6
MANDSAUR	76.9	1.5	280.6	2.1	3476.3	25.2
BHOPAL	76.5	1.5	190.1	1.4	2502.0	-3.9
NARSINGHPUR	75.4	1.5	217.8	1.6	2947.3	11.8
SHEOPUR KALAN	75.1	1.5	288.2	2.2	3825.3	32.0
PANNA	66.9	1.3	120.2	0.9	1805.0	-44.1
SIDHI	58.8	1.1	92.9	0.7	1539.3	-68.9
NEEMUCH	41.6	0.8	128.3	1.0	3092.3	15.9
SINGROLI	37.1	0.7	59.5	0.4	1556.0	-67.1
BARWANI	35.1	0.7	102.4	0.8	2750.0	5.4
DINDORI	32.9	0.6	36.9	0.3	1065.7	-144.0
JHABUA	32.5	0.6	75.5	0.6	2290.0	-13.6
SHAHDOL	31.8	0.6	57.4	0.4	1660.7	-56.6
MANDLA	30.8	0.6	46.5	0.3	1422.7	-82.8
UMARIA	28.5	0.6	42.9	0.3	1482.3	-75.4
BALAGHAT	19.6	0.4	26.2	0.2	1368.3	-90.1
ALIRAJPUR	16.8	0.3	39.3	0.3	2533.3	-2.7
ANUPPUR	14.1	0.3	18.9	0.1	1230.7	-111.3
BURHANPUR	10.8	0.2	28.1	0.2	2611.3	0.4
M.P.STATE	**5121.6**	**100.0**	**13298.9**	**100.0**	**2600.7**	**0.0**

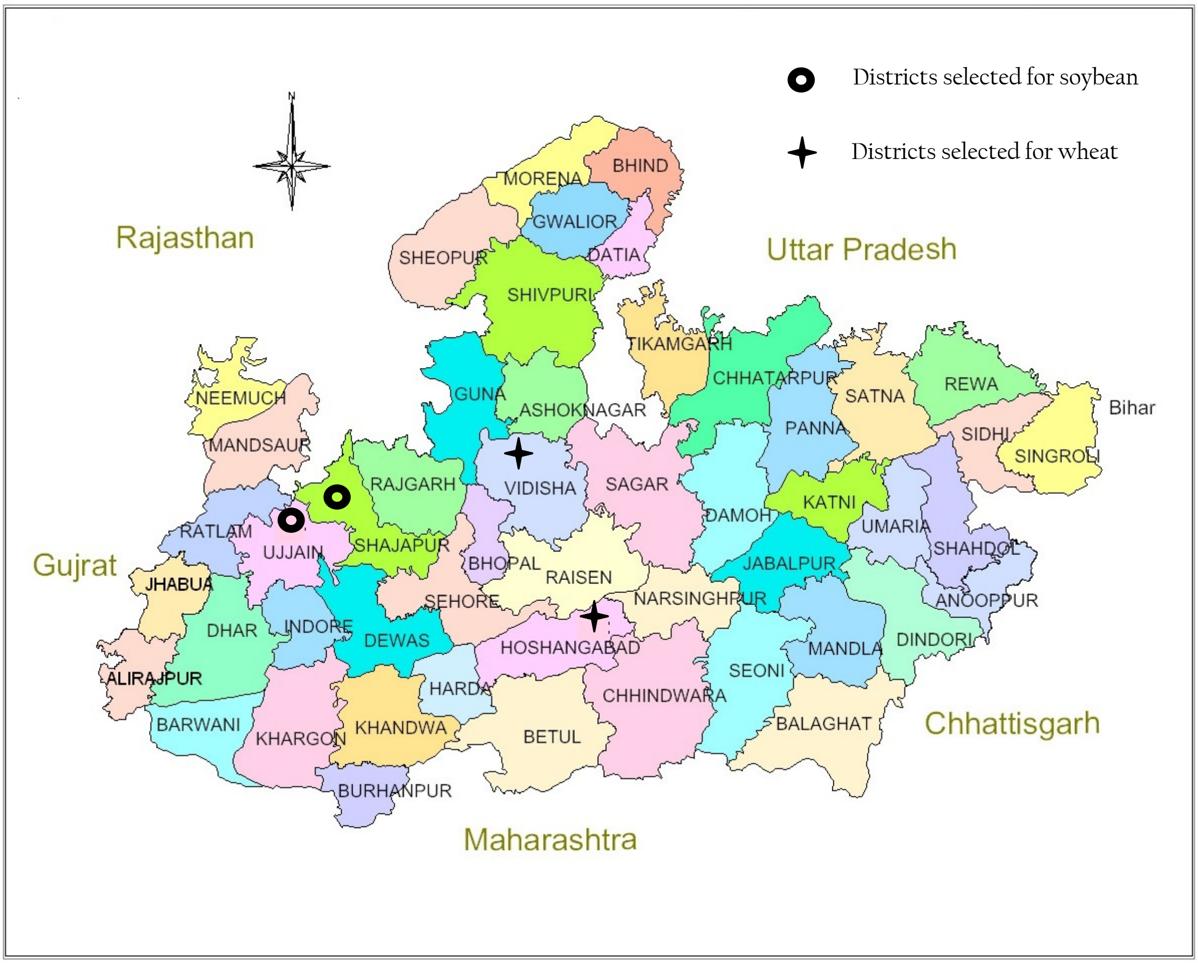

Figure 1: Selected Districts in Madhya Pradesh

A cluster of three villages in each selected block have been further selected for conducting the primary survey. A list of all the soil tested and other farmers in each village were collected from respective Soil Testing Laboratory and Department of Agriculture for the year 2012-13 and a sample of 60 soil test farmers and 30 control farmer per crop were selected randomly from each district for assessing the application of recommended dose of fertilizer and its impact on crop production. (Table 1.4)

Table 1.4: Number of Respondents in Selected Crops.

Particulars	Districts	Blocks	Villages	Sample Size (HHs)		Total Sample Size
				Treated	Control	
Soybean						
1	Shajapur	1. Shajapur	1. Uchoud	60	30	90
			2. Jhirniya			
			3. Batwari			
		2. Kalapipal	1. Pratappura			
			2. Dhavaladheer			
			3. Charak khedi			
2	Ujjain	1. Ujjain	1. Narvar	60	30	90
			2. Karohan			
			3Raghavpipariya			
		2. Badnagar	1. Injiriya			
			2. Surakhedi			
			3. Jhangeerpur			
Sub Total	2	4	12	120	60	180
Wheat						
1	Hoshangabad	1. Hoshangabad	Ridodakheda	60	30	90
			Deshmohani			
			Palashi			
		2. Babai	Chandla			
			Chaplaser			
			Sagarkheda			
2	Vidisha	1. Vidisha	Dawar	60	30	90
			Kuakhedi			
			Mirjapur			
		2. Gyaraspur	Nolash			
			Bawaliya			
			Kherua			
Sub Total	2	4	12	120	60	180
Grand Total	4	8	24	240	120	360

Thus, the study covers 240 treated and 120 control households comprising of 360 sample households, 180 each for soybean and wheat in Madhya Pradesh. These selected households were further classified into four different groups according to their size of farms i.e. marginal (less than 2.50 Acres), small (2.51-5.00 Acres), medium (5.01-10.00 Acres) and large (above 10.01 Acres) farmers. (Table 1.5)

Both primary and secondary data have been collected for the study. The primary data were collected from the sample households on different aspects of the study viz. social and economic characterises, operational holding, land utilization pattern, cropping pattern, farm assets, agriculture credit outstanding, purpose of agriculture loan, reason for soil testing, status of soil health, application of fertilizer, actual quantity of fertilizer applied, constraints in applying recommended dose of fertilizer etc. by the sample households through interview schedule provided from the coordinator (Agriculture Development and Rural Transformation Centre), Institute for Social and Economic Change, Bangalore) of the study and tested in local conditions of the Madhya Pradesh.

Table 1.5: Number of Selected Household According to their Size of Farms.

Name of crop	Marginal	Small	Medium	Large	Total
Soybean	18 (10.0)	44 (24.4)	46 (25.6)	72 (40.0)	180 (100)
Wheat	19 (10.6)	44 (24.4)	56 (31.1)	61 (33.9)	180 (100)
Total	37 (10.3)	88 (24.4)	102 (28.3)	133 (36.9)	360 (100)

The reference period of the study was 2013-14. The secondary data have been collected from *http://www.urvarak.co.in/* and Department of Farmers' Welfare and Agriculture Development, Madhya Pradesh, Bhopal on fertilizer consumption from the year 2001 to 2013 to analyze trend in fertilizer consumption in Madhya Pradesh.

The list of farmers who got their soil tested were collected from the respective soil testing laboratory and state Department of Agriculture for the year 2012-13 to assess the adoption of recommended dose of fertilisers. In light of stated objectives the classification, tabulation and analysis of data have been done by using Statistical Package for the Social Sciences (SPSS) software.

1.6 Limitations of the Study

The study does not claim its completeness in all aspects and certainty had some limitation. The data relating to the objectives of the study were collected from the selected respondents. The information provided by them is based on the face to face interview and they do not keep any record of their farming practices. Therefore, the information provide by them is entirely based on their memory thus, there is possibility of certain biasness to enter in the present study. Time series crop wise and product wise data of fertilizer consumption are not available, hence only total nutrient wise (000' tones and kg/ha) and season wise data for the years 2000-13 are incorporated to analyze trend in fertilizer consumption in Madhya Pradesh (Chapter II).

1.7 Organization of the Report

The study is organised into 7 chapters. Chapter 1 covers the introductive part of the study followed by trend in fertilizer consumption in the state (Chapter II). Socio economic characterises of the sample household covered under chapter 3. Chapter 4 deals with the soil testing and the recommended doses of fertilizer. Adoption of recommended doses of fertilizer and its constraints have been discussed in chapter 5 while, impact of adoption of recommended doses of fertilizer covers in chapter 6. Summary and conclusion are given in chapter 7.

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CHAPTER II

TREND IN FERTILIZER CONSUMPTION IN MADHYA PRADESH

This chapter deals with the trend of fertilizer consumption in the state along with general information of Madhya Pradesh i.e. location, population, land use pattern, cropping pattern, production and yield of major crops, area under irrigation and land holding. The trend of fertilizer consumption is analyzed by nutrients wise (N, P, K and Total NPK) as well as season wise (Rabi and Kharif) for the state.

2.1 Status of Agricultural Economy in Madhya Pradesh

Madhya Pradesh, in its present form, came into existence on November 1, 2000 following its bifurcation to create a new state of Chhattisgarh. The undivided Madhya Pradesh was founded on November 1, 1956. Madhya Pradesh, because of its central location in India has remained a crucible of historical currents from North, South, East and West.

Madhya Pradesh is situated in the heart of India between latitudes 21^0 53' to 22^0 53' North and longitude 77^0 47' to 78^0 44' East. It is the second largest state after Rajasthan of Indian Union with a total geographical area of 307.56 thousand square Kilometers. In terms of population (72,597,565) it occupies 7^{th} position in India (2011). It has 10 -commissionaire divisions (Chambal, Gwalior, Bhopal, Ujjain, Indore, Sagar, Rewa, Jabalpur, Hosangabad and Shahdol) divided into 51 districts, 342 Tehsil, 313 blocks & 376 towns and 54,903 villages. (Table 2.1)

It is abundantly rich in minerals and bio resources with 27 per cent of land area under forests; it supports a wide variety of animal and plant life. The state has a rich history, culture and crafts.

Table 2.1: Location of Madhya Pradesh

S. No.	Particulars	
1	Number of Division	10
2	Number of Tehsil	342
3	Number of Blocks	313
4	Number of Villages	54,903
5	Latitude	21°53' to22° 59' N
6	Longitude	76°47' to 78°44' E
7	Height from see means level (m)	50-1200
8	No of districts	51
9	No. of Gram Panchayat	23,012
10	No. of electrified Villages	35910
11	Percentage of electrified villages to total Villages	65.41

The physiography of the state exhibits a great deal of diversity with areas ranging from less than 50 meter above Mean Sea Level (MSL) to more than 1200 meter. The state falls under the catchments of Yamuna, Ganga, Narmada, Mahanadi and Godavari rivers. On the basis of broad land features and different soil and rain fall pattern, the state classified in 5 physiographic regions and 11 agro-climatic zones (Table 2.2)

1. Northern low lying plains comprising Gwalior, Bhind and Morena districts and extend to Bundelkhand up to the West of Panna range and excludes certain parts of Rewa district between Panna and Kaymore hills of Baghelkhand.

2. The Malwa and Vindhyan Plateau comprises of Vidisha, Shivpuri, Datia, Guna, Ujjain and Mandsour districts and parts of Sehore, Raisen and Dewas districts. It consists of large undulating plains of black cotton soil dotted with flat-topped hills. It has also hilly Vindhyan Plateau situated in the north of Narmada Valley and to the south of the low-lying regions of Bundelkhand and Baghelkhand. It spared from east of Malwa plateau to Maikal and Dorea hills Satpura range.

Fig. 2.1: Agro-Climatic Zones of Madhya Pradesh

3. The Narmada Valley stretching from Jabalpur in the east up to Barwani district in the West. It is nearly 560 Km long and 48 Km wide and is walled on the north by the Vindhya Range and on the south by Satpura range. It covers the districts of Jabalpur, Narsinghpur, Hosangabad, Khandwa, Khargone, Barwani, Dhar, and some parts of Raisen, Sehore, and Dewas districts.

4. The Satpura range runs from West to East for about 640 Km through Khandwa, Betul, Chhindwara, Seoni, Mandla, Bilaspur and Sarguja districts. Its northern spurs go into Hosangabad and Narsinghpur districts and in the south an extensive spur of 160 Km covers entire Balaghat districts.

5. Madhya Pradesh also covers Balaghat and Shahdol districts of Chhattisgarh Plains and Northern Hills of Chhattisgarh zone respectively. The state is bordered on the West by Gujarat, on the North-West by Rajasthan, on the North-East by Uttar Pradesh, on the East by Chhattisgarh, and on the South by Maharashtra.

Table-2.2: Agro-Climatic Regions and covered Districts /Tehsils in Madhya Pradesh.

(Area in Lakh ha)

Agro-Climatic Regions	Districts /Tehsils	Geographical Area	Percent to Geographical Area
1. Malwa Plateau	Indore, Dhar, (Dhar, Badnawar, Sardarpur tehsils) Shajapur, Mandsour, Neemuch, Ratlam, Ujjain, Dewas Rajgarh districts and Petlawad tehsil of Jhabua district	51.47	16.74
2.Vindhyan Plateau	Bhopal, Vidisha, Sehore (Sehore, Ashta, Ichhawar, Narsullaganj tehsils) Raisen (Raisen, Gairatganj, Begamganj, Silwani, Goharganj, Udaipura tehsils), Damoh, Guna (Chachora & Raghogarh tehsils) & Sagar districts	42.59	13.85
3.Central Narmada Valley	Hoshangabad (Seoni-Malwa, Hoshangabad, Sohagpur tehsils), Harda, Nasinghpur districts, Budhani and Barelli tehsil of Sehore and Raisen districts respectively	17.45	5.67
4.Satpura Plateau	Betul, Chhindwara districts	21.93	7.13
5.Jhabua Hills	Jhabua, Jobat, Alirajpur tehsils of Jhabua district & kukshi tehsil of Dhar district	6.88	2.24
6.Gird Region	Gwalior, Bhind, Morena, Shivpur-Kalan, Guna (Mungawali and Ashoknagar tehsils), Shivpuri (Shivpuri, Kalaras, Pohari tehsils)	31.85	10.36
7. Kymore Plateau	Jabalpur, Katni, Rewa, Panna, Satana, Sidhi, Seoni and Gopadbanas & Deosar tehsils of Sidhi district.	49.97	16.25
8.Bundel Khand Region	Tikamgarh, Chhatarpur, Datia districts, Karela, Pachore tehsil of Shivpuri and Guna tehsil of Guna district	22.82	7.42
9.Nimar Valley	Khandwa, Khargone, Barwani district, Manawar tehsil of Dhar district and Harda district	25.17	8.18
10.Northern Hills of Chhattisgarh	Shahdol, Umariya Mandla, Dindori district & Singrauli tehsil of Sidhi district	28.17	9.16
11.Chhattisgarh plain	Balaghat district	9.25	3.00
Madhya Pradesh		**307.56**	**100.00**

The main soil types found in Madhya Pradesh are alluvial, deep black, medium black, shallow black, mixed red and black, mixed red and yellow and skeletal soils (Table 2.3).

Table 2.3: Soil types and districts covered in Madhya Pradesh.

Types of Soil	Districts covered
Alluvial Soil	Bhind, Morena and Gwalior
Deep Black Soil	Hosangabad and Narsinghpur
Medium Black Soil	Jabalpur, Sagar, Vidisha, Sehore, Damoh, Guna, Bhopal, Raisen, Rajgarh, Indore, Dewas, Ujjain, Mandsour, Shajapur, Ratlam, Dhar, Khargone and Khandwa
Shallow Black Soil	Betul, Chhindwara and Seoni
Red & Black Soil	Shivpuri, Rewa, Satna, Panna, Sidhi, Chattarpur, Tikamgarh, Datia and some parts of Guna district.
Red & Yellow Soil	Balaghat.
Gravelly Soil	Mandla.

The climate of Madhya Pradesh by virtue of its location is predominately moist sub humid to dry sub humid, semi arid to dry sub-humid and semi arid in East, West and Central plateau and hills respectively, according to agro-climatic regions of India. The seasons in Madhya Pradesh are as given below (Table 2.4).

Table 2.4: Seasons and their periods in Madhya Pradesh

Seasons	Period	
	From	To
Rainy	June	September
Post Monsoon	October	November
Winter	December	February
Summer	March	May

The annual rainfall received in the state varies from 800 mm. in the Northern and Western regions to 1600 mm in the Eastern districts. In some years rainfall goes much below to the normal. The most of rainfall is received in the *Monsoon* season from June to September and about 10 per cent of the rainfall is received in the remaining months of the year. The maximum temperature during extreme summer reaches as high as 47^0C and the minimum during winter dips up to 2^0C. The maximum normal temperature varies between 25^0 to 35^0C and minimum normal between 10^0 to 20^0C. The relative humidity ranges from 40 to 70 per cent throughout the year.

According to 2011 census the population of the state was 72,598 thousand comprises of 51.81 per cent of male and 48.19 per cent female. Over 1000 males there were only 930 females. The state had a rural background as the 72.40 per cent of total population lives in villages and rest 27.60 per cent in urban areas (Table 2.5).

Table 2.5: Population parameters of Madhya Pradesh (Census 2011)

(In Thousand)

S. No.	Particulars	Population	Percentage to total
1	Total Population	72,598	100
A	Male	37,613	51.81
B	Female	34,985	48.19
2	Sex ratio over 1000 males	930	
3	Rural Population	52,538	72.4
4	Urban Population	20,060	27.60
5	Population of Schedule Caste*	91551	15.17
6	Population of Schedule Tribes*	12233	20.27
7	Number of Literate persons	43,827	60.37
8	Number of Farmers	11038	18.32
9	Agriculture Labour	7401	12.23
10	Home Industry	1033	1.67
11	Other Workers	6322	10.45
12	Total Main Workers	19103	31.61
13	Marginal Workers	6691	11.07
14	Total Workers	25794	42.68
15	Non Workers	34554	57.16

* Census 2001

The percentage of literacy was found only 60.37 per cent; Madhya Pradesh comes under tribal area where 20.27 per cent of total population belongs to scheduled tribes. The percentage of workers was observed to be 42.68 per cent of total population, while 57.16 per cent of total population belongs to non worker category. 31.61 per cent population classified under main worker category, while 18.32 and 12.23 per cent were farmers and agricultural laboures respectively.

Table 2.6: Land use Classification of Madhya Pradesh (Lakh ha.)

Particulars	2000-01	%to Geographical area	2012-13	%to Geographical area	Absolute Change	Relative Change
Geographical area	307.50	100.00	307.56	100.00	0.06	0.02
Forests	86.11	28.00	86.93	28.26	0.82	0.95
Not available for cultivation						
A. Land put to non-agricultural uses	18.35	5.97	21.26	6.91	2.91	15.86
B. Barren and un Culturable land	13.65	4.44	13.87	4.51	0.22	1.62
Total	32.00	10.41	35.13	11.42	3.13	9.79
Other Uncultivated land excluding fallow land						
A. Permanent pastures & other grazing lands	16.57	5.39	12.86	4.18	-3.71	-22.40
B. Land under misc. tree crops & groves.	0.15	0.05	0.20	0.06	0.05	33.04
TOTAL	16.72	5.44	13.06	4.25	-3.66	-21.90
Total Culturable waste land	28.42	9.24	23.31	7.58	-5.11	-17.99
Fallow Land						
A. Current fallows	4.86	1.58	3.75	1.22	-1.11	-22.89
B. Old fallow	5.75	1.87	4.93	1.60	-0.82	-14.31
Total	10.61	3.45	8.67	2.82	-1.94	-18.24
Cropped Area						
A. Net area sown	150.70	49.01	153.52	49.92	2.82	1.87
B. Area sown more than once	53.49	17.40	77.78	25.29	24.29	45.40
C. Gross Cropped Area	204.19	66.40	231.30	75.20	27.11	13.28
Cropping Intensity (%)	135.49		150.66		15.17	

The total geographical area of the State is 307.56 lakh ha (2012-13) out of which 49.92 per cent land was found to be under cultivation (Table 2.6) and 11.42 per cent land not available for cultivation, 7.58 and 2.82 per cent of total land was classified under cultivable waste and fallow land respectively. The cropping intensity of the state was found to be 150.66 per cent (2012-13), which was found to be increased by 15.17 percent as compared to 2000-01. The area sown more than once, land put to non agricultural uses, total fallow land and gross cropped area have been found to be increased by 45.40, 15.86, and 13.28 per cent respectively during the period 2012-13 over the year 2000-01, while total culturable waste land, total fallow land and permanent pasture have been found to be decreased by 17.99, 18.24 and 22.40 per cent respectively during this period.

Wells (39.93%), tube wells (25.42%), canals (18.31%) and tanks (2.35%) are the major sources of irrigation in M.P. The state had 5,681 thousand hectare area under irrigation. (Table 2.7)

Table 2.7: Irrigation Status of Madhya Pradesh (Thousand ha.)

S. No.	Sources	Net Irrigated Area	Percentage to total	Gross Irrigated Area	Percentage to total
1	Canal	1030	18.13	1076	18.31
2	Tanks	134	2.36	138	2.35
3	Tube-well	1449	25.51	1494	25.42
4	Well	2246	39.54	2347	39.93
5	Others	822	14.46	823	14.00
6	Total	5681	100.00	5878	100.00

The change in cropping pattern of Madhya Pradesh is presented in table 2.8. It is observed from the data that gross cropped area of Madhya Pradesh has been found to be increased by 14.61 per cent in the year 2012 – 13 (22477.2 thousand ha) over the year 1999 – 2000 (19194 thousand ha). The area under total kharif crops (14.70%) was found to be increased more as compared to Rabi crops (14.50%).

The area under total oilseeds was found to be increased (23.31%) maximum followed by total pulses (20.69%) and total cereals (2.92%) during this period. Crop wise analysis show that the highest area was found to be increased in maize (83.87%) followed by Tur (41.38%), Sugarcane (33.74%), Urid (33.53%), Pea (30.45%), Soybean (26.75%), Cotton (22.17%), Rapeseed and Mustard (20.21%), Gram (17.70%), Wheat (14.47%), Lentil (11.30%) and Paddy (1.51%). The reduction in area was found maximum in Sunflower and other oilseeds (-6900.00%) followed by Bajra (-319.37%), Jowar (-119.19%), Kodo–Kutki (-114.92%), Linseed (-110.57%), Niger (-48.10%), Teora (-46.17%), Groundnut (-7.18%) Moong (-2.51%) and Barley (-0.12%) during the period.

Table 2.8: Change in Cropping Pattern of M.P. (000'ha)

Crops	1999-2000	2012-13	Absolute Change	Relative Change
Paddy	1740	1766.6	26.6	1.51
Jowar	674	307.5	-366.5	-119.19
Maize	139	862	723	83.87
Bajara	801	191	-610	-319.37
Kodo Kutki	458	213.1	-244.9	-114.92
Other Cereals (Kharif)	72	18.4	-53.6	-291.30
Kharif Cereals	3884	3358.6	-525.4	-15.64
Wheat	4669	5459.1	790.1	14.47
Barlay	85	84.9	-0.1	-0.12
Other Cereals (Rabi)	9	4.6	-4.4	-95.65
Total Rabi Cereals	4763	5548.6	785.6	14.16
Total Cereals	8647	8907.2	260.2	2.92
Tur	311	530.5	219.5	41.38
Urid	426	640.9	214.9	33.53
Moong	90	87.8	-2.2	-2.51
Other Pulses (Kharif)	45	4.6	-40.4	-878.26
Total Pulses (Kharif)	872	1282.5	410.5	32.01
Gram	2575	3128.7	553.7	17.70
Pea	196	281.8	85.8	30.45
Lentil	507	571.6	64.6	11.30
Teora	63	43.1	-19.9	-46.17
Other Pulses (Rabi)	13	7.6	-5.4	-71.05
Total Pulses (Rabi)	3354	4046.1	692.1	17.11
TOTAL Pulses	4226	5328.6	1102.6	20.69
Total Food grain (Kharif)	4756	4641.1	-114.9	-2.48
Total food grain (Rabi)	8117	9594.7	1477.7	15.40
Total food grain	12873	14235.8	1362.8	9.57
Groundnut	224	209	-15	-7.18
Soybean	4440	6061.8	1621.8	26.75
Niger	121	81.7	-39.3	-48.10
Other oilseed	141	302.5	161.5	53.39
Total oilseeds (Kharif)	4926	6655	1729	25.98
Rape seed & Mustard	626	784.6	158.6	20.21
Linseed	231	109.7	-121.3	-110.57
Sun flower & others	7	0.1	-6.9	-6900.00
Total oilseeds (Rabi)	864	788.08	-75.92	-9.63
Total oilseeds	5790	7549.5	1759.5	23.31
Cotton	488	627	139	22.17
Sugarcane (G)	43	64.9	21.9	33.74
Total Kharif	10170	11923.1	1753.1	14.70
Total Rabi	9024	10554.1	1530.1	14.50
Gross Cropped Area	19194	22477.2	3283.2	14.61

2.1.1 Change in Production

The total production of crops in Madhya Pradesh was found to be increased by 76.50 per cent in the year 2012–13 (39209.00 thousand t) over the year 1999–2000 (22215 thousand t).

Table 2.9: Change in Production of M.P. (000't)

Crops	1999-2000	2012-13	Absolute Change	Relative Change
Paddy	1750	3022.30	1272.30	72.70
Jowar	529	542.90	13.90	2.63
Maize	1270	2399.40	1129.40	88.93
Bajara	139	384.30	245.30	176.47
Kodo Kutki	128	82.10	-45.90	-35.86
Other Cereals (Kharif)	26	7.20	-18.80	-72.31
Total Cereals (Kharif)	3842	6438.20	2596.20	67.57
Wheat	8687	16125.20	7438.20	85.62
Barley	101	172.50	71.50	70.79
Other Cereals (Rabi)	7	5.80	-1.20	-17.14
Total Cereals (Rabi)	8795	16303.50	7508.50	85.37
Total Cereals	12637	22741.70	10104.70	79.96
Tur	270	351.00	81.00	30.00
Urid	133	264.80	131.80	99.10
Moong	29	34.60	5.60	19.31
Other Pulses (Kharif)	10	5.90	-4.10	-41.00
Total Pulses (Kharif)	442	656.30	214.30	48.48
Gram	2536	3812.40	1276.40	50.33
Pea	100	195.20	95.20	95.20
Lentil	274	333.90	59.90	21.86
Teora	70	35.90	-34.10	-48.71
Other Pulses (Rabi)	5	2.90	-2.10	-42.00
Total Pulses (Rabi)	2985	4386.40	1401.40	46.95
TOTAL Pulses	3427	5042.70	1615.70	47.15
Total Food grain (Kharif)	4284	7094.50	2810.50	65.60
Total food grain (Rabi)	11780	20689.90	8909.90	75.64
Total food grain	16064	27784.40	11720.40	72.96
Groundnut	222	322.70	100.70	45.36
Soybean	4743	8264.40	3521.40	74.24
Niger	27	27.20	0.20	0.74
Other oilseed (Kharif)	33	157.90	124.90	378.48
Total oilseeds (Kharif)	5025	8772.20	3747.20	74.57
Rape seed & Mustard	625	1038.50	413.50	66.16
Linseed	93	57.40	-35.60	-38.28
Sun flower & others	2	0.10	-1.90	-95.00
Total oilseeds (Rabi)	720	938.53	218.53	30.35
Total oilseeds	5745	9868.20	4123.20	71.77
Cotton	216	1221.70	1005.70	465.60
Sugarcane (G)	190	334.70	144.70	76.16
Total Kharif	9525	17088.40	7563.40	79.41
Total Rabi	12690	22120.60	9430.60	74.32
Gross Production	22215	39209.00	16994.00	76.50

The total production of Kharif crops (79.41%) showed relatively higher change as compared to total Rabi crops (74.32%). The changes in production of total cereals were found to be maximum and it found to be increased by 79.96% followed by oilseeds (71.77%) and pulses (47.15%). As regards to the production of major crops, the changes in production of Cotton (465.60%) was found to be maximum followed by Bajra (176.47%), Urid (99%), Pea (95.20%), Maize (88.93%), Wheat (85.62%), Sugarcane (76.16%), Soybean (74.24%), Paddy (72.70%), Barley (70.79%), Rapeseed & Mustard (66.16%), Gram (50.33%), Groundnut (45.36%) Tur (30.00%) Lentil (21.86%), Moong (19.31%), and Jowar (2.63%), while the production of Sunflower and others (-95.00%), Teora (-48.71%), Linseed (-38.28%), and Kodo–Kutki (-35.86%), was found to be decreased during the period (Table 2.9).

2.1.2 Change in yields

The productivity of all the major crops has been found to be increased except Tur (-24.25%) and Teora (-25.32%) in the year 2012-13 as compared to 1999-2000.

Table 2.10: Change in yield of Madhya Pradesh. (kg/ha)

Crops	1999-2000	2012-13	Absolute Change	Relative Change
Paddy	1059	1807	748.00	70.63
Jowar	784	1809	1025.00	130.74
Maize	1586	2810	1224.00	77.18
Bajara	1008	2012	1004.00	99.60
Kodo Kutki	279	385	106.00	37.99
Wheat	1938	2959	1021.00	52.68
Barley	1192	2034	842.00	70.64
Tur	870	659	-211.00	-24.25
Urid	312	413	101.00	32.37
Moong	322	381	59.00	18.32
Kulthi	193	358	165.00	85.49
Gram	985	1220	235.00	23.86
Pea	513	694	181.00	35.28
Lentil	539	584	45.00	8.35
Teora	1106	826	-280.00	-25.32
Groundnut	992	1546	554.00	55.85
Soybean	1068	1365	297.00	27.81
Niger	225	330	105.00	46.67
Other oilseed	563	694	131.00	23.27
Rape seed & Mustard	998	1325	327.00	32.77
Linseed	402	524	122.00	30.35
Sun flower & others	286	994	708.00	247.55
Cotton	442	1059	617.00	139.59
Sugarcane (G)	4378	5163	785.00	17.93

The maximum increase in productivity of crops was noticed in Sunflower & other oilseeds (247.55%) followed by cotton (139.59%), Jowar (130.74%), Bajra (99.60%), Kulthi

(85.49%), Maize (77.18%), Barley (70.64%), Paddy (70.63%), Groundnut (55.85%), Wheat (52.68%), Niger (46.67%), Kodo-Kutki (37.99%), Pea (35.28%), Rapeseed & Mustard (32.77%), Urid (32.37%), Linseed (30.35%), Soybean (27.81%), Gram (23.86%), Moong (18.32%), and Sugarcane (17.93%) during the period under study (Table 2.10).

2.1.3 Land Holding

The total number and area of land holding has been found to be increased by 73.59 thousand to 88.73 thousand and from 163.69 thousand ha to 158.36 thousand ha respectively in the year 2009-10 as compared to 1999-2000. The percentage number of marginal and small holdings have been found to be increased from 38.57 (1999-2000) to 38.91 per cent (2009-10) and 26.51(1999-2000) to 27.60 per cent (2009-10),while in case of semi medium, medium and large holdings the number were decreased from 20.22 (1999-2000) to 18.65 per cent (2009-10), 12.45 (1999-2000) to 8.89 per cent (2009-10) and 2.26 (1999-2000) to 1.00 per cent (2009-10), while the percentage area under marginal, small and semi medium holdings has been found to be increased from 8.54 (1999-2000) to 12.09 per cent (2009-10), 17.28 (1999-2000) to 21.89 per cent (2009-10) and 25.18 (1999-2000) to 28.48 per cent (2009-10). The percentage area under medium and large size of holding has been found to be decreased from 33.28 (1999-2000) to 28.70 per cent (2009-10) and 15.73 (1999-2000) to 8.84 per cent (2009-10) respectively (Table 2.11).

Table 2.11: Change in land holding in Madhya Pradesh

Particulars	1999-2000				2010-11			
Category	Number	%	Area	%	Number	%	Area	%
Marginal (Below 1 ha.)	28.38	38.57	13.98	8.54	38.91	43.85	19.15	12.09
Small (1 ha. to 2 ha.)	19.51	26.51	28.28	17.28	24.49	27.60	34.66	21.89
Semi Medium (2 ha. to 4 ha.)	14.88	20.22	41.21	25.18	16.55	18.65	45.10	28.48
Medium (4 ha. to 10 ha.)	9.16	12.45	54.47	33.28	7.89	8.89	45.45	28.70
Large (Above 10 ha.)	1.66	2.26	25.75	15.73	0.89	1.00	14.00	8.84
TOTAL	73.59	100.00	163.69	100.00	88.73	100.00	158.36	100.00

The net and gross irrigated area was found to be increased by 14.93 and 15.20 per cent respectively in the year 2009-10 as compared to 1999-2000 (Table 2.11). The area irrigated by cannel (6.39%), well and tube wells (17.70%) and other sources (15.46%) have been found to be increased except tanks (-1.52%).

Table 2.12: Change in Source wise irrigated area in Madhya Pradesh (000, ha)

Year	1999-00	2009-10	Absolute Change	Relative Change
Canals	1002	1066	64.00	6.39
Tanks	132	130	-2.00	-1.52
Wells & tube-wells.	3712	4369	657.00	17.70
Other sources	815	941	126.00	15.46
Net irrigated area	5661	6506	845.00	14.93
Gross irrigated area.	5828	6714	886.00	15.20
% of net irrigated area to net area sown	37.6	43.2	5.60	
% of gross irrigated area to gross area sown	28.5	32.3	3.80	

As regards to changes occurred in crop wise irrigated area, the irrigated area under all the crops, viz. paddy (24.18%), maize (36.36%), barley (4.38%), gram (56.64%), oilseeds (34.16%), sugarcane (5.26%), cotton (29.90%), spices and condiments (8.55%) and vegetable (16.13%) was found to be increased in the year 2009-10 as compared to 1999-2000 except wheat which was decreased by 1.38 per cent (Table 2.13).

Table 2.13: Change in Crop wise Irrigated area in Madhya Pradesh (000, ha)

Crops	99-00	2008-09	Absolute Change	Relative Change
Paddy	244	303	59.00	24.18
Maize	11	15	4.00	36.36
Wheat	3399	3352	-47.00	-1.38
Barley	29	41	12.00	41.38
Total Cereals	3684	3711	27.00	0.73
Gram	941	1474	533.00	56.64
Others	138	241	103.00	74.64
Total Pulses	1079	1715	636.00	58.94
Oilseeds	322	432	110.00	34.16
Sugarcane	76	80	4.00	5.26
Cotton	194	252	58.00	29.90
Spices & Condiments	234	254	20.00	8.55
Fruits & Vegetables	186	216	30.00	16.13
Other Crops	39	54	15.00	38.46
ALL CROPS	**5814**	**6714**	900.00	15.48

2.2 Fertilizer Consumption

The average consumption of N,P,K and total NPK in Madhya Pradesh was found to be 49.11, 32.46,3.22 and 84.79 kg/ha respectively, which is 42.08, 2.83, 68.92 and 35.93 per cent less than the average consumption of N (84.79kg/ha), P (33.44 kg/ha), K (10.36 kg/ha) and total NPK (128.34 kg/ha) in the country, respectively (Fig 2.2).

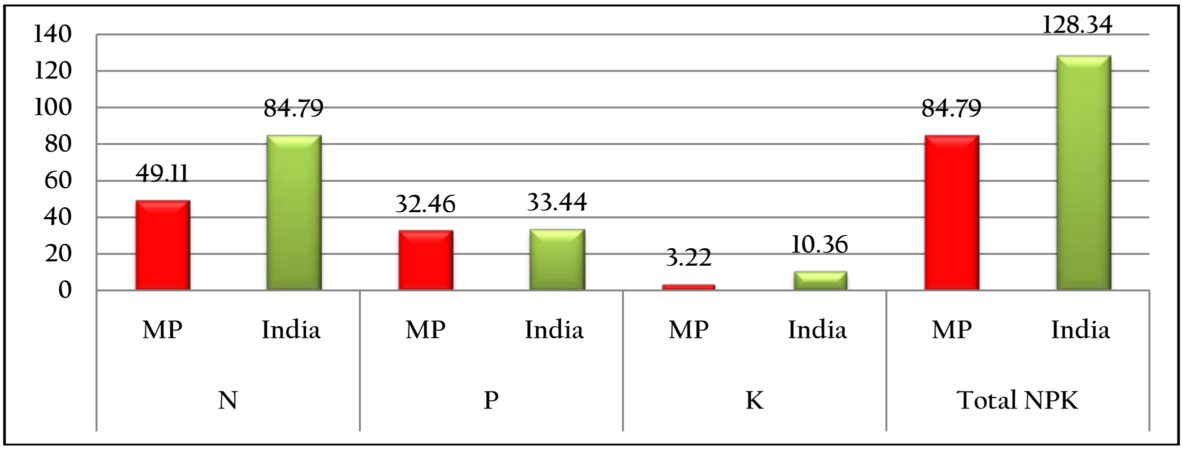

Fig. 2.2: Fertilizer Consumption (Kg/ha) in Madhya Pradesh and India (2013)

2.2.1 Trend in Fertilizer Consumption by Nutrient (000' tones)

The trend of N, P, K, and total NPK fertilizer consumption was found to be postive in Madhya Pradesh during the period 2000-13. The consumption of total NPK fertilizer was found to be increased from 943.50 (2000) to 1869.30 thousand t (2013) with the fluctuation of 35.29 per cent and showed an annual simple and compound growth of 7.93 and 8.29 per cent respectively in Madhya Pradesh (Table 2.14). Amongst the different fertilizer nutrients i.e. N, P, and K the maximum linear and compound growth was recorded for K (8.61 and 9.66 %/year) than N (7.90 and 8.45 %/year) and P (7.85 and 7.84 %/year) .

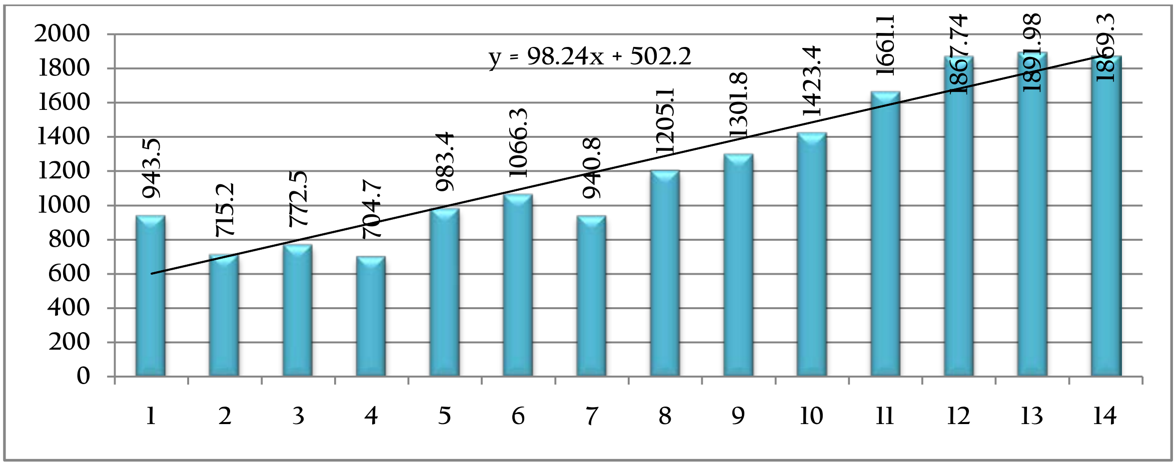

Fig.2.3: Total NPK Fertilizer Consumption during 2000-2013 in Madhya Pradesh (000't)

Table 2.14: Trend of Fertilizer consumption by Nutrient (000' Tones)

Years	N	P	K	Total
2000	527.1	372.2	44.2	943.5
2001	384.3	300.3	30.6	715.2
2002	432.1	308.4	32	772.5
2003	387.1	285	32.6	704.7
2004	586.4	347.9	49.1	983.4
2005	617.7	393.3	55.3	1066.3
2006	559.9	322.1	58.8	940.8
2007	730.1	409.8	65.2	1205.1
2008	795.7	430.3	75.8	1301.8
2009	803.4	530	90	1423.4
2010	941.8	605.6	113.7	1661.1
2011	998.3	741.11	128.33	1867.74
2012	1061.75	750.76	79.47	1891.98
2013	1082.72	715.61	70.97	1869.3
Average	707.74	465.17	66.15	1239.06
Standard Deviation	245.46	171.17	29.73	437.22
Coefficient of Variance (%)	34.68	36.80	44.95	35.29
Regression Coefficient (b)	55.92	36.63	5.70	98.25
Coefficient of determination	0.91	0.80	0.64	0.88
Simple Growth Rate (%)	7.90	7.87	8.61	7.93
Compound Growth Rate (%)	8.45	7.84	9.66	8.29

The consumption of K was found to be increased from 44.2 (2000) to 70.97 thousand t (2013) with the fluctuation of 44.95 per cent and showed an annual simple and compound growth of 8.61 and 9.66 per cent respectively in Madhya Pradesh (Table 2.14).

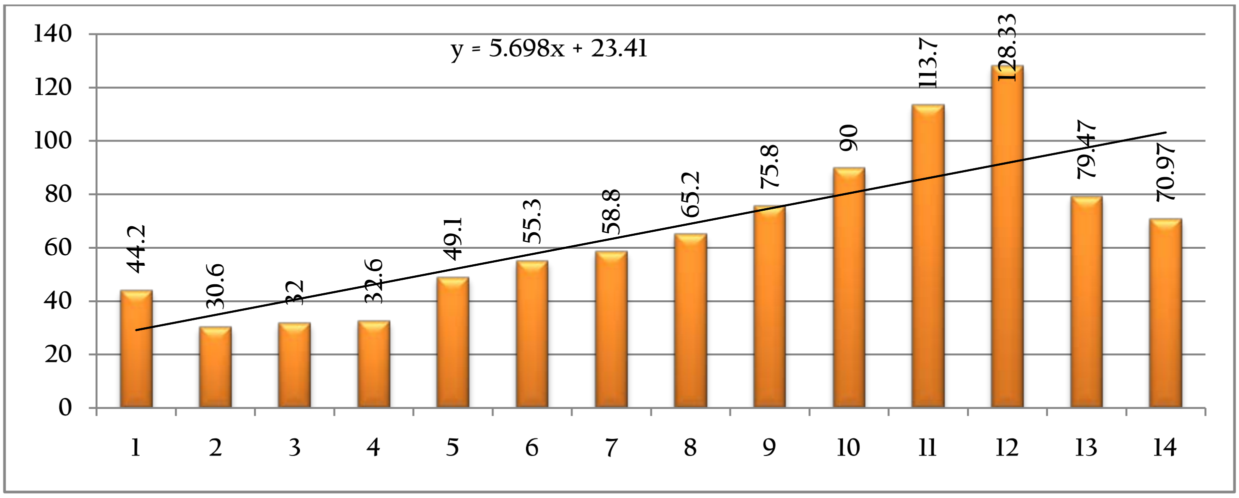

Fig. 2.4: Consumption for Potash during 2000-13 in Madhya Pradesh (000't)

The consumption of N was found to be increased from 527.1 thousand t (2000) to 1082.72 thousand t (2013) with the fluctuation of 34.68 per cent and showed an annual simple and compound growth of 7.90 and 8.45 per cent respectively in Madhya Pradesh (Table 2.14).

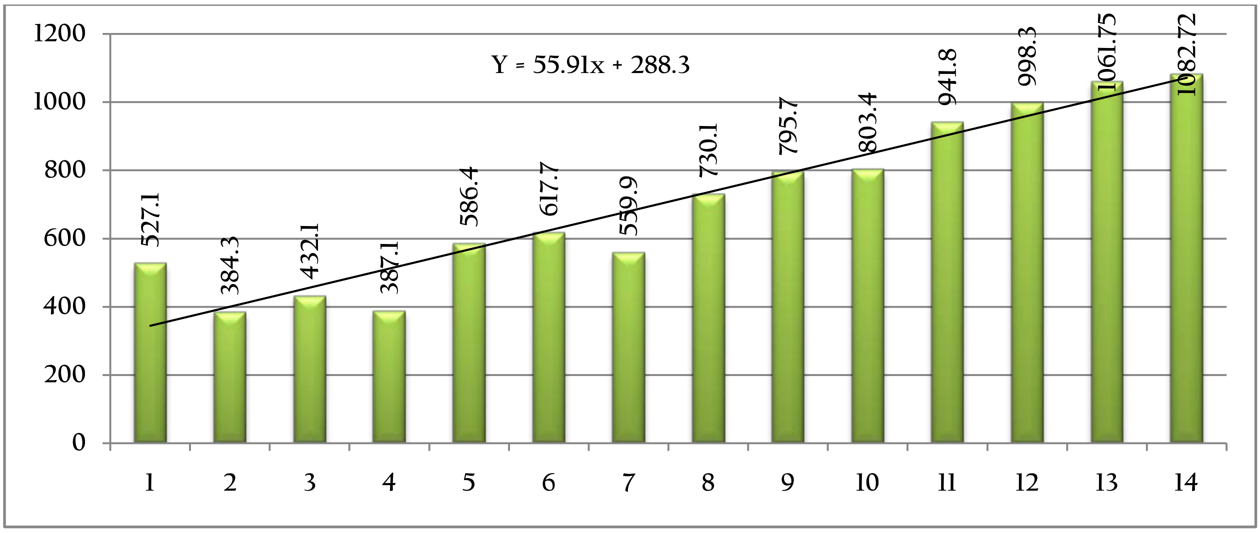

Fig. 2.5: Consumption for Nitrogen during 2000-13 in Madhya Pradesh (000't)

The consumption of P fertilizer was found to be increased from 372.2 (2000) to 715.61 thousand t (2013) with the fluctuation of 36.80 per cent and showed an annual simple and compound growth of 7.87 and 7.84 per cent respectively in Madhya Pradesh. Amongst consumption of different nutrients the fluctuation was found to be more in K (44.95%) than P (36.80%) and N (34.68%) during the period under study (Table 2.14).

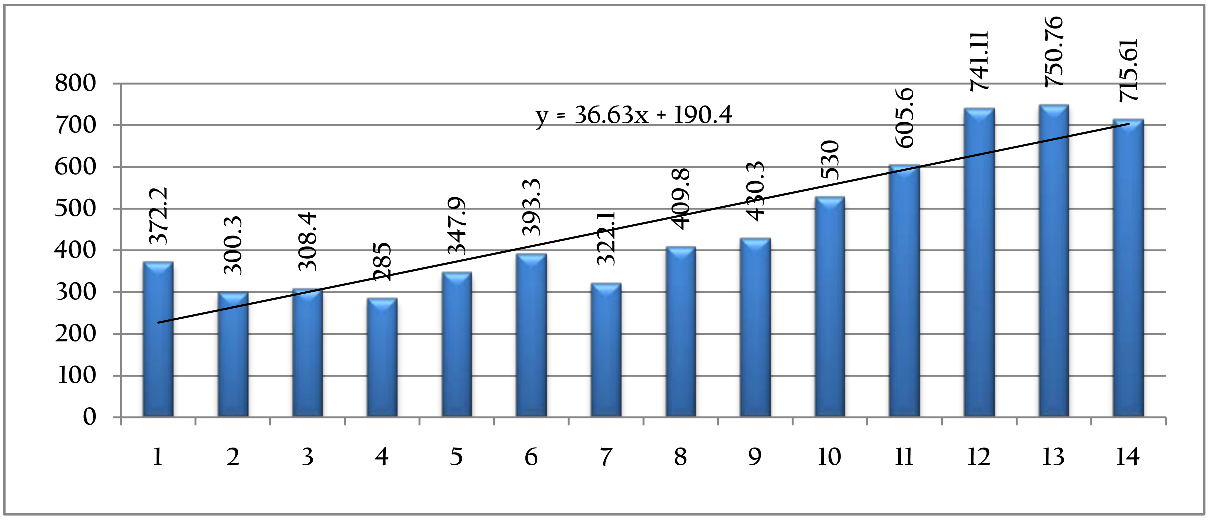

Fig. 2.6: Phosphate Fertilizer Consumption during 2000-13 in Madhya Pradesh (000't)

2.2.2 Trend in Fertilizer Consumption by Nutrient (Kg/ha)

The nutrient wise trend of N, P, K, and total NPK fertilizer consumption was also found to be positive in Madhya Pradesh during the period 2000-13. The consumption of total NPK nutrients was found to be increased from 46.3 (2000) to 84.72 Kg/ha (2013) with the fluctuation of 30.92 per cent and showed an annual simple and compound growth of 7.06 and 7.61 per cent respectively in Madhya Pradesh (Table 2.15). Amongst the different fertilizer nutrients i.e. N, P, and K the maximum linear and compound growth was recorded for K (7.92 and 9.08 %/year) than N (7.03 and 7.76 %/year) and P (6.97 and 7.17 %/year) .

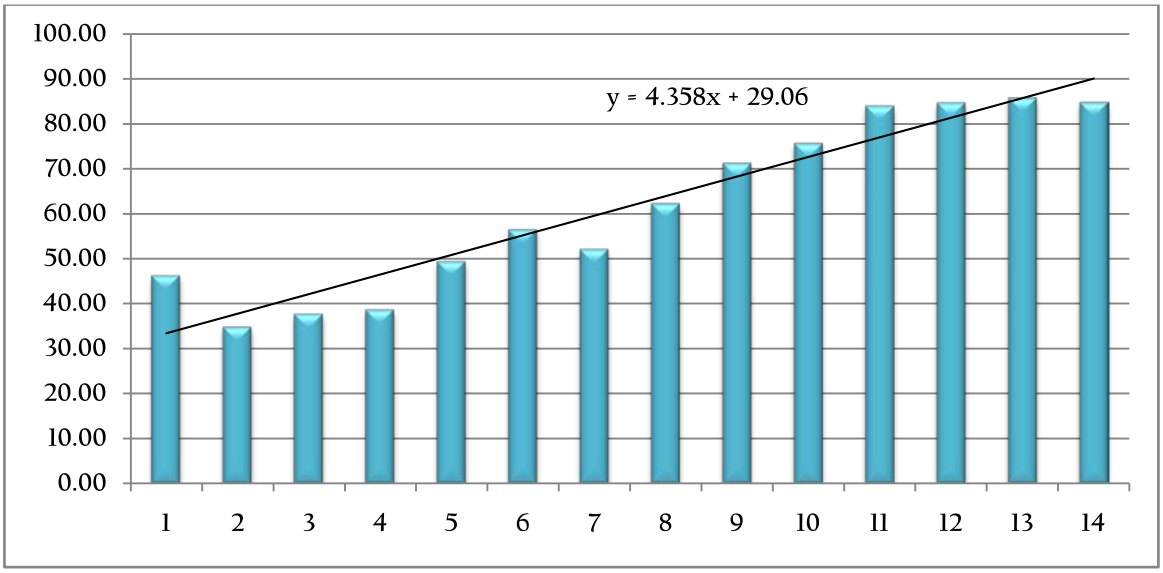

Fig 2.7: Total NPK Consumption in Madhya Pradesh (Kg/ha)

Table 2.15: Trend of Fertilizer consumption by Nutrient (Kg/ha)

Years	N	P	K	Total
2000	25.9	18.3	2.1	46.3
2001	18.8	14.7	1.5	35
2002	21.2	15.1	1.6	37.9
2003	21.3	15.7	1.8	38.8
2004	29.5	17.5	2.4	49.4
2005	32.8	20.8	2.9	56.5
2006	31	17.8	3.3	52.1
2007	37.6	21.3	3.4	62.3
2008	43.6	23.6	4.1	71.3
2009	42.7	28.2	4.8	75.7
2010	47.6	30.6	5.8	84
2011	45.28	33.62	5.82	84.72
2012	48.16	34.05	3.6	85.81
2013	49.11	32.46	3.22	84.79
Average	35.33	23.12	3.31	61.76
Standard Deviation	10.92	7.24	1.42	19.10
Coefficient of Variance (%)	30.91	31.30	43.04	30.92
Regression Coefficient	2.48	1.61	0.26	4.36
Coefficient of determination	0.91	0.87	0.59	0.91
Simple Growth Rate (%)	7.03	6.97	7.92	7.06
Compound Growth Rate (%)	7.76	7.17	9.08	7.61

The consumption of K fertilizer nutrient was found to be increased from 2.1 (2000) to 3.22 Kg/ha (2013) with the fluctuation of 43.04 per cent and showed an annual simple and compound growth of 7.92 and 7.61 per cent respectively in Madhya Pradesh (Table 2.15).

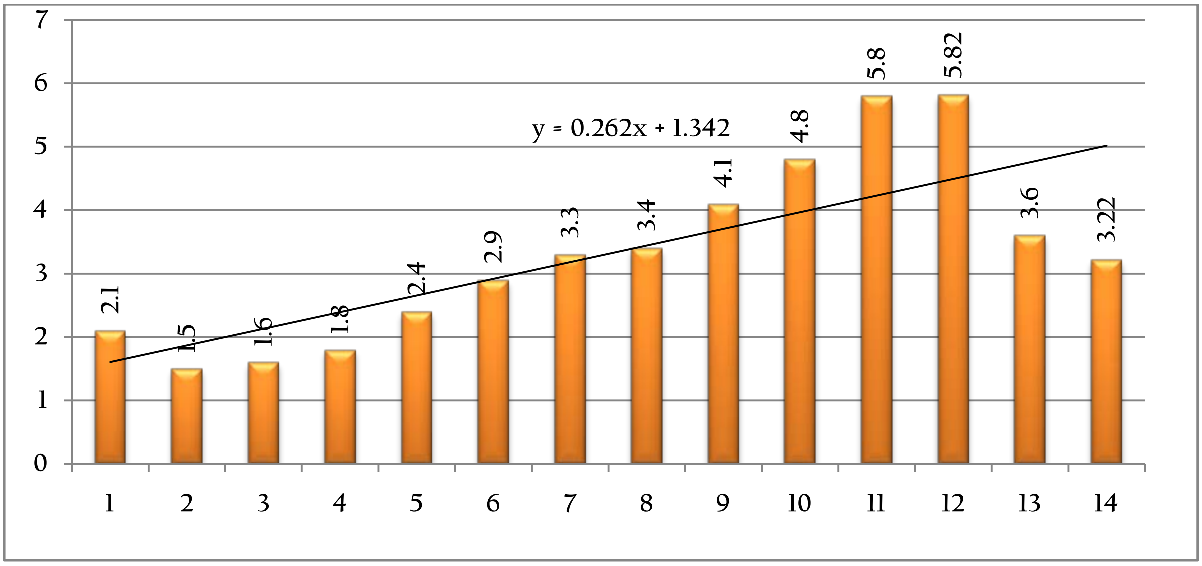

Fig. 2.8: Potash Consumption during 2000-2013 in Madhya Pradesh (Kg/ha)

The consumption of N was found to be increased from 25.9 (2000) to 49.11 Kg/ha (2013) with the fluctuation of 30.91 per cent and showed an annual simple and compound growth of 7.03 and 7.76 per cent respectively in Madhya Pradesh (Table 2.15).

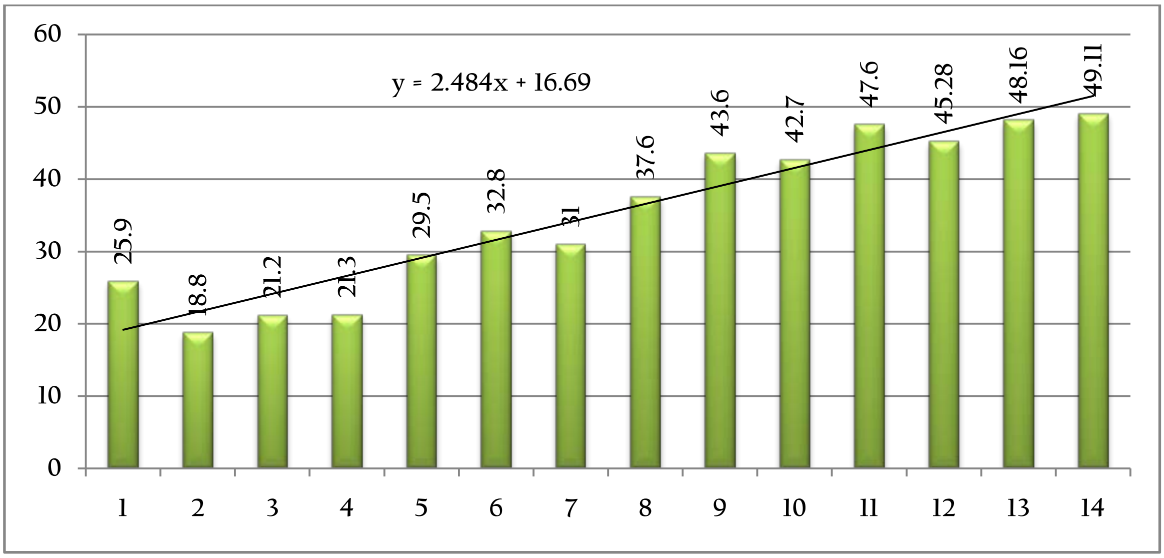

Fig. 2.9: Consumption of Nitrogen in Madhya Pradesh during 2000-2013 (Kg/ha)

The consumption of P fertilizer was found to be increased from 18.3 (2000) to 32.46 Kg/ha (2013) with the fluctuation of 31.30 per cent and showed an annual simple and compound growth of 6.97 and 7.17 per cent respectively in Madhya Pradesh (Table 2.15).

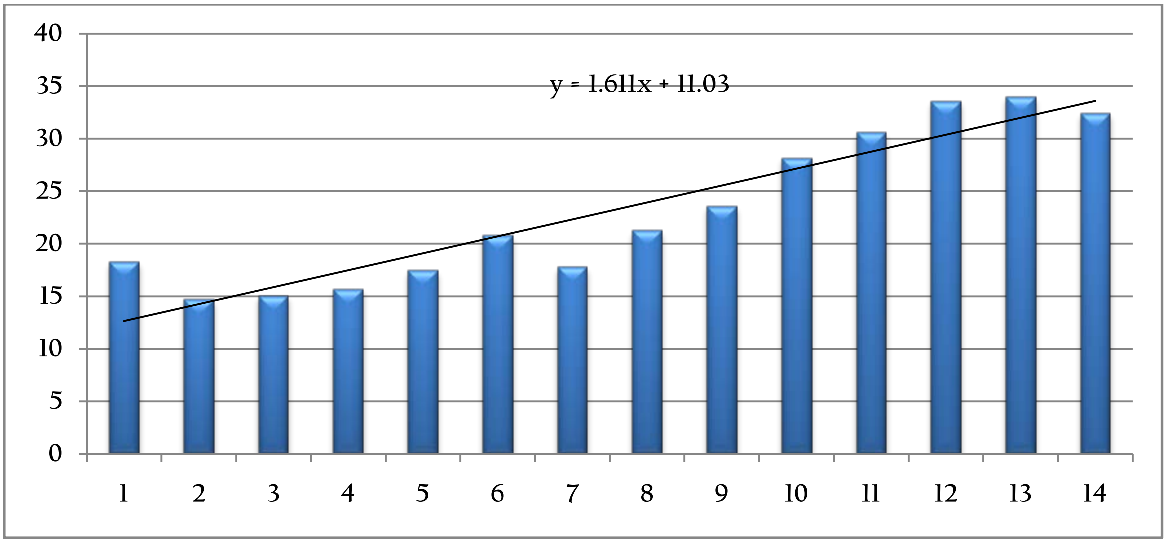

Fig. 2.10: Consumption of Phosphate in Madhya Pradesh during 2000-2013 (Kg/ha)

Amongst the different nutrients the consumption in fluctuation was found to be more in K (43.04 %) than P (31.30%) and N (30.91%) during the period under study (Table 2.15).

2.2.3 Season wise Trend of Fertilizer Consumption

The consumption of fertilizer in Madhya Pradesh was found to be more in Rabi season as compared to Kharif season in all the years of the study expect 2011 in this particular year the consumption of total NPK in kharif season (81.8 kg/ha) was somewhat more than Rabi season (81.1 kg/ha). Although, the trend of consumption of all the nutrients of fertilizer consumed by them in both season was found positive and upward. (Table 2.16)

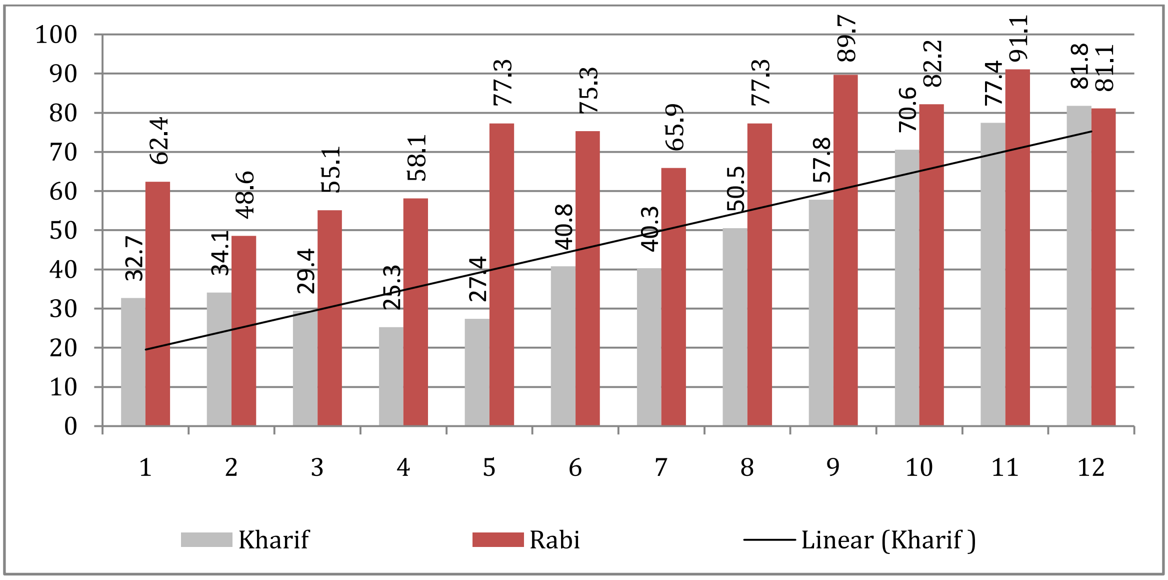

Fig. 2.11: Total NPK Consumption during 2000-2011 in different seasons in Madhya Pradesh (Kg/ha)

2.2.3.1 Trend of Kharif Season

The consumption of total NPK nutrients in kharif was found to be increased from 32.7 (2000) to 81.80 Kg/ha (2011) with the fluctuation of 42.43 per cent and showed an annual simple and compound growth of 10.71 and 10.88 per cent respectively in Madhya Pradesh. Amongst the different fertilizer nutrients i.e. N, P, and K the maximum linear and compound growth was recorded for K (14.79 and 15.72 %/year) than N (9.45 and 9.88 %/year) and P (11.59 and 11.30 %/year) in kharif season (Table 2.16).

The consumption of K fertilizer nutrient in kharif was also found to be increased from 1.8 (2000) to 6.8 Kg/ha (2011) with the fluctuation of 59.28 per cent and showed an annual simple and compound growth of 14.79 and 15.72 per cent respectively in Madhya Pradesh (Table 2.16).

The consumption of N fertilizer in kharif season was found to be increased from 17.0 (2000) to 36.4 Kg/ha (2011) with the fluctuation of 36.67 per cent and showed an annual simple and compound growth of 9.45 and 9.88 per cent respectively in Madhya Pradesh (Table 2.16).

Table 2.16: Trend of Fertilizer Consumption in different seasons (Kg/ha) (Kg/ha)

Years	Kharif Season				Rabi Season			
	N	P	K	Total	N	P	K	Total
2000	17	13.9	1.8	32.7	36.4	23.4	2.6	62.4
2001	17	15.3	1.8	34.1	28.3	18.8	1.5	48.6
2002	15.9	12.1	1.4	29.4	31.6	21.5	2	55.1
2003	13.3	10.6	1.4	25.3	32.8	22.9	2.4	58.1
2004	15.8	10	1.6	27.4	46.8	26.9	3.6	77.3
2005	22.7	15.7	2.4	40.8	44.7	27	3.6	75.3
2006	22.5	15.2	2.6	40.3	40.9	21	4	65.9
2007	26.7	20.6	3.2	50.5	51.5	22.2	3.6	77.3
2008	31.7	21.6	4.5	57.8	59.8	26.2	3.7	89.7
2009	35.2	29.3	6.1	70.6	52.4	26.8	3	82.2
2010	37.4	35.2	4.8	77.4	58.6	25.7	6.8	91.1
2011	36.4	38.6	6.8	81.8	50.5	26.4	4.2	81.1
Average	24.30	19.84	3.20	47.34	44.53	24.07	3.42	72.01
Standard Deviation	8.91	9.62	1.90	20.09	10.57	2.79	1.35	13.78
Coefficient of Variance (%)	36.67	48.48	59.28	42.43	23.75	11.60	39.60	19.13
Regression Coefficient (b)	2.30	2.30	0.47	5.07	2.51	0.45	0.28	3.24
Coefficient of determination	0.86	0.74	0.81	0.83	0.73	0.34	0.54	0.72
Simple Growth Rate (%)	9.45	11.59	14.79	10.71	5.64	1.87	8.11	4.50
Compound Growth Rate (%)	9.88	11.30	15.72	10.88	6.08	1.95	8.75	4.79

The consumption of P fertilizer in kharif season was also found to be increased from 13.9 (2000) to 38.6 Kg/ha (2011) with the fluctuation of 48.48 per cent and showed an annual simple and compound growth of 11.59 and 11.30 per cent respectively in Madhya

Pradesh. Amongst the different nutrients the consumption in fluctuation was found to be more in K (59.28 %) than P (48.48%) and N (36.67%) in kharif season during the period under study.

2.2.3.2 Trend of Rabi Season

The consumption of total NPK nutrients in Rabi was found to be increased from 62.4 (2000) to 81.10 Kg/ha (2011) with the fluctuation of 19.13 per cent and showed an annual simple and compound growth of 4.50 and 4.79 per cent respectively in Madhya Pradesh. Amongst the different fertilizer nutrients i.e. N, P, and K the maximum linear and compound growth was recorded for K (8.11 and 8.75 %/year) than N (5.64 and 6.08 %/year) and P (1.87 and 1.95 %/year) in Rabi season (Table 2.16).

The consumption of N fertilizer nutrient in Rabi was also found to be increased from 36.4 (2000) to 44.53 Kg/ha (2011) with the fluctuation of 23.75 per cent and showed an annual simple and compound growth of 5.64 and 6.08 per cent respectively in Madhya Pradesh (Table 2.16).

The consumption of P fertilizer in Rabi season was found to be increased from 23.4 (2000) to 24.07 Kg/ha (2011) with the fluctuation of 11.60 per cent and showed an annual simple and compound growth of 1.87 and 1.95 per cent respectively in Madhya Pradesh (Table 2.16).

2.3 Summary of the Chapter

The chapter highlighted the trend and growth of fertilizer consumption in state. The consumption of K fertilizer in kharif season was also found to be increased from 2.6 (2000) to 4.2 Kg/ha (2011) with the fluctuation of 39.60 per cent and showed an annual simple and compound growth of 8.11 and 8.75 per cent respectively in Madhya Pradesh. Amongst the different nutrients the consumption in fluctuation was found to be more in K (39.60%) than P (11.60%) and N (23.75%) in Rabi season during the period under study. Madhya Pradesh (84.79 kg/ha) in a state where average per ha fertilizer consumption was found to be 35.93 per cent less than the India's total per ha fertilizer consumption.

The trend of all the nutrients of fertilizer consumption was found to be positive and upward during the period 2000-2013. The total NPK fertilizer consumption was found to be increase with the annual growth of 7.93 % per annum (simple) and 8.29 per cent per annum (compound) in the state. Amongst different nutrients the growth (simple) of K (8.61%/annum) was found to maximum as compared to N (7.90%/annum) and P (7.85%/annum). The trend and growth of kg/ha consumption was also found to similar with minor variation when compared different season i.e. Kharif and Rabi. The average total fertilizer consumption was found to be maximum in Rabi (72.02 kg/ha) than Kharif season (47.34 kg/ha), as wheat and soybean were found to major crop in Rabi and Kharif season and fertilizer requirement was more for wheat as compared to soybean. The trend and growth of fertilizer consumption was found to positive and upward but growth (compound) of total fertilizer (NPK) consumption was found to more in Kharif (10.88%/annum) as compared to Rabi (4.79%/annum). This statement was also true for individual nutrients i.e. N, P and K consumption.

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CHAPTER - III

SOCIO-ECONOMIC CHARACTERISTICS OF SAMPLE HOUSEHOLDS

This Chapter deals with the socio-economic characteristics of sample households their average operation holdings, percentage of net irrigated area through different sources of irrigation, cropping pattern of sample respondents (% of Gross Cropped Area), area under High Yielding Varieties, aggregate value of crop output and output sold, number and value of farm assets, agricultural credit outstanding, purpose of agricultural loan availed and number of training programmes attended by them in a year. These informations are dealt with soil test as well as control farmers.

3.1 Socio-Economic Characteristics

The percentage of respondents related to soil test and control farmers in each size of farms and their average age, years of education, main occupation, gender, average size of family, number of family members engaged in agriculture, experience in farming and caste are presented in table 3.1.1. and table 3.1.2 respectively. It is observed from the data that 10.4, 22.5, 24.2 and 42.9 per cent of soil test farmers were found to be from marginal, small, medium and large categories respectively. An average soil test farmer had 6 members in his family out of which 2 were engaged in agriculture. An average farmer had an experience of 25 years of farming. Out of total respondent maximum number of soil test farmers were from OBC (61.3%) followed by General (24.9%) and SC (13.8%) category. (Table 3.1.1)

The 38.4% of soil test farmers were found to be member of associations such as cooperative societies, self help groups etc. Out of total soil test farmers majority (91%) of them were found to be of male. An average age of soil test farmer was found to be of 46 years. All these socio economic characters were found to be almost similar in all categories of farmers with minor variations except percentage of farmers being member of any association. The more number of large farmers (51.5%) were found to be member of any organization as compared to medium (42.6%), small (32.0%) and marginal (27.7%) farmers. (Table 3.1.1)

Table 3.1.1: Socio-Economic Characteristics of Sample Households- Soil Test Farmers.

Particulars	Marginal	Small	Medium	Large	Overall
% of farmer households	**10.4**	**22.5**	**24.2**	**42.9**	**100**
Average age of respondent (years)	46	48	44	44	46
Average years of respondent education	2	3	2	3	3
Agriculture as main occupation (% of respondents)	100	100	100	99	100
Gender (% of respondents)					
Male	88.0	88.9	91.4	97.1	91.3
Female	12.0	11.1	8.6	2.9	8.7
Average family size	6	6	6	7	6
Average number of people engaged in agriculture	2	2	2	3	2
Average years of experience in farming	25	28	23	23	25
% of farmers being a member of any association	32.0	42.6	27.6	51.5	38.4
Caste (% of households)					
SC	20.0	18.5	13.8	2.9	13.8
ST	0.0	0.0	0.0	0.0	0.0
OBC	56.0	57.4	56.9	74.8	61.3
General	24.0	24.1	29.3	22.3	24.9

As regards to socio economic characteristics of control farmers are concerned here also all the respondents were found to be of male gender their main occupation was agriculture. (Table 3.1.1) The average age of the household was found to be 46 years. The 10, 27.5, 35.8 and 26.7 per cent control farmer were found to be from marginal, small, medium and large size of land holdings respectively. The average family size and average members of family engaged in agriculture was found to be 5 and 3 respectively.

Table 3.1.2: Socio-Economic Characteristics of Sample Households- Control farmers.

Particulars	Marginal	Small	Medium	Large	Overall
% of farmer households	**10.0**	**27.5**	**35.8**	**26.7**	**100**
Average age of respondent (years)	46	45	47	47	46
Average years of respondent education	2	2	3	3	2
Agriculture as main occupation (% of respondents)	100	100	100	100	100
Gender (% of respondents)					
Male	100	100	100	100	100
Female	0.0	0.0	0.0	0.0	0.0
Average family size	5	5	4	5	5
Average number of people engaged in agriculture	3	2	2	3	3
Average years of experience in farming	23	25	25	23	24
% of farmers being a member of any association	16.7	33.3	30.2	34.4	28.7
Caste (% of households)					
SC	41.7	18.2	9.3	9.4	19.6
ST	0.0	3.0	4.7	3.1	2.7
OBC	58.3	60.6	72.1	53.1	61.0
General	0.0	18.2	14.0	34.4	16.6

An average control farmer had an experience of 24 years in agriculture. The 28.7 per cent of total control farmers were found to be member of any association. Here also more numbers of large farmers (34.4%) were found to be member of association as compared to marginal (16.7%), small (33.3%) and medium (30.2%) farmers. As regards to caste structure of control farmers is concerned, the majority were found to be from OBC (61%) followed by SC (19.6%), General (16.6%) and ST (2.7%) categories. The socio economic characteristics were found to be similar for all size of farms of control farmers with minor variations. (Table 3.1.2)

3.2 Operational Land Holdings

The operational land holding in different categories of soil test and control respondents and their own land, leased in and out, fallow land, net irrigated area, net operated area, gross cropped area and cropping intensity are presented in the table 3.2.1 and 3.2.2 respectively.

Table 3.2.1: Operational Landholding of the Sample Households (acre/household)-Soil Test Farmers.

Particular	Marginal	Small	Medium	Large	Overall
Owned land	2.1	3.9	7	16.7	7.4
Leased-in	0	0.1	1	3.9	1.3
Leased-out	0	0	0	0	0.0
Uncultivated/Fallow	0	0.3	0.6	0.1	0.3
Net operated area	2.1	4	8	20.6	8.7
Net irrigated area	2.1	3.9	7.7	19.4	8.3
Net un-Irrigated area	0	0	0.3	2.3	0.7
Gross cropped area	4.2	8	15.9	40.9	17.3
Cropping intensity (%)	200	200	199	198	199

An average soil test farmer were found to operate 8.7 Acres of land in cultivation of crops, out of which 1.3 (0.11%) and 0.3 Acres (0.02%) were found to be leased in and uncultivated/ fallow land. The 99 per cent of net operated land was found to be cultivated twice in a year by an average household as the cropping intensity of his farm was 199 per cent. An average marginal, small, medium and large soil test farmers were found to operated 2.1,3.9,7.0 and 16.7 Acres of land out of which 0.0, 0.1, 1.0 and 3.9 acres was leased in land with average cropping intensity of 200,200, 199 and 198 per cent respectively. (Table 3.2.1)

Table 3.2.2: Operational Landholding of the Sample Households (acre/household)-Control Farmers.

Particular	Marginal	Small	Medium	Large	Overall
Owned land	1.8	3.8	7	16.5	7.3
Leased-in	0	0.2	0.3	0.5	0.3
Leased-out	0	0	0	0	0
Uncultivated/Fallow	0	0	0	0	0
Net operated area	1.8	4.1	7.4	17	7.5
Net irrigated area	1.8	4	7.3	15.9	7.2
Net un-Irrigated area	0	0	0.1	0.2	0.1
Gross cropped area	3.6	8.1	14.5	33.2	14.8
Cropping intensity (%)	200	199	197	196	198

As regards to farmers related to control category, an average HH used to operate 7.5 Acres of land for cultivation of crops, out of which 0.3 acres was leased in. An average marginal, small, medium and large control farmer were found to operate 1.8, 3.8, 7.0 and 16.5 acres of land with 0.0, 0.2, 0.3 and 0.5 Acres leased in land. (Table 3.2.2) The average cropping intensity of these farms were found to be 198% and ranged between 196% (Large) to 200 % (Marginal).

3.3 Sources of Irrigation

Sources of irrigation i.e. dug well, bore well, canal, river, pond and others are reported in table 3.3.1 and 3.3.2 respectively for soil test and control farmers.

Table 3.3.1: Sources of Irrigation (% of net irrigated area)- Soil Test Farmers.

Particulars	Marginal	Small	Medium	Large	Overall
Open/ dug well	16.3	30.0	40.3	25.8	28.1
Bore well	63.5	53.0	37.0	45.7	49.8
Canal	12.5	9.9	15.9	20.3	14.7
River/Ponds and Others	7.7	7.1	6.8	8.1	7.4
Total	100	100	100	100	100

The majority of soil test farmers depends on bore well (49.8 %) followed by open drug well (28.1%), canal (14.7%). river/pond and other (7.4 %) for irrigation in cultivation of crops in the study area. (Table 3.3.1)

Table 3.3.2: Sources of Irrigation (% of net irrigated area)- Control Farmers.

Particulars	Marginal	Small	Medium	Large	Overall
Open/ dug well	32.6	44.8	30.5	35.3	35.8
Bore well	48.8	28.7	40.0	40.7	39.6
Canal	18.6	22.6	22.8	20.6	21.1
River/Ponds and Others	0.0	3.9	6.7	3.4	3.5
Total	100	100	100	100	100

As far as control farmers are concerned, the majority of them also found to be dependent on bore well (39.6%) followed by open/drug well (35.8%) canal (21.1%)

and others (3.5%). (Table 3.3.2) These figures were found to be similar in different size of farms with minor variations whether related to soil tested or control farmers.

3.4 Cropping Pattern

The cropping pattern of soil test and control farmers presented in table 3.4.1 and 3.4.2 respectively. It is observed from the data that soybean and wheat crop were found to be grown in kharif and rabi season by majority of soil test and control farmers respectively in the area under study.

Table 3.4.1 : Cropping Pattern of the Sample Households (% of GCA)- Soil Test Farmers.

Particular	Marginal	Small	Medium	Large	Overall
Kharif					
Soybean	47.1	39.8	44	42	43.2
Paddy	2.9	10.2	5.8	7.7	6.7
Rabi					
Wheat	46.2	43.5	43.7	38.6	43.0
Gram	3.8	4.6	4.1	9.3	5.5
Lentil	0	0	1	0.8	0.5
Zaid					
Other	0	1.9	1.4	1.7	1.3
GCA	100	100	100	100	100.0

They used to allocate approximately half of the gross cropped area in cultivation of these crops across all the categories of farmers. Soil test as well as control farmers devoted their less than 2 per cent gross cropped area in zaid season for cultivation of vegetables etc.

Table 3.4.2 : Cropping Pattern of the Sample Households (% of GCA)- Control Farmers.

Particular	Marginal	Small	Medium	Large	Overall
Kharif					
Soybean	38.4	43.5	45.2	48.2	43.8
Paddy	11.6	6.6	5	2.5	6.4
Rabi					
Wheat	50	43.3	40.5	34.1	42.0
Gram	0	4.3	6.8	11.7	5.7
Lentil	0	0.8	0	0.9	0.4
Zaid					
Other	0	1.5	2.5	2.6	1.7
GCA	100	100	100	100	100.0

3.5 Area under HYVs

The area under High Yielding Varieties (HYV) of major crops in different size of farms and the seed replacement rate of soil test and control farmers are presented in table 3.5.1 and 3.5.2 respectively.

Table 3.5.1: Area under HYV of major crops in different size of farms- Soil Test Farmers.

Particular	Marginal	Small	Medium	Large	Overall
Soybean	100	100	100	100	100
Paddy	100	100	100	100	100
Wheat	100	100	100	100	100
Gram	100	100	100	100	100
Lentil	0.0	0.0	100	100	100

* Seed replacement rate (%): Soyben-19.37, Wheat-13.62, Paddy-11.05, Gram-4.91 and Lentil-0.73
Source: *www.mpkrishi.org* (compendium 2008-09)

It is observed from the data that the cent percent respondents whether related to soil test or control categories were found sow HYVs seeds of major crops, while the seed replacement rate of these crops was found between 0.73 per cent (lentil) to 19.37 percent (soybean).

Table 3.5.2: Area under HYV of major crops in different size of farms- Control Farmers.

Particular	Marginal	Small	Medium	Large	Overall
Soybean	100	100	100	100	100
Paddy	100	100	100	100	100
Wheat	100	100	100	100	100
Gram	0.0	100	100	100	100
Lentil	0.0	100	0.0	100	100

* Seed replacement rate (%): Soyben-19.37, Wheat-13.62, Paddy-11.05, Gram-4.91 and Lentil-0.73
Source: *www.mpkrishi.org* (compendium 2008-09)

3.6 Value of Output

As regards to value of output of major crops grown by the respondents is concerned, an average soil test obtained Rs. 10094/Acre and sold out the output of Rs. 8240/Acre (81.6%) in the market. (Table 3.6.1)

Table: 3.6.1 Aggregate Value of Crop Output- Soil Test Farmers.

Particular	Value of output		Value of output sold	
	Rs./HH	Rs./acre	Rs./HH	Rs./acre
Marginal	19633	9439	14966	7195
Small	41574	10341	33995	8456
Medium	84082	10522	67056	8391
Large	207846	10072	183999	8916
Overall Average	88284	10094	75004	8240

While an average control farmer obtained Rs. 7688 per Acre and sold 78.0% (Rs. 5997/Acre) of output in the market. (Table 3.6.2)

Table: 3.6.2 Aggregate Value of Crop Output- Control Farmers.

Particular	Value of output		Value of output sold	
	Rs./HH	Rs./acre	Rs./HH	Rs./acre
Marginal	10357	5781	7384	4121
Small	39644	9767	29709	7319
Medium	52623	7144	42340	5748
Large	136744	8059	115356	6798
Overall Average	59842	7688	48697	5997

3.7 Farm Assets

The distribution of farm assets of soil test and control farmers viz. number and value of tractor trolley, animal shed/pump house, electric motor/ diesel engine, harrow and cultivator, thresher, bullock cart, manual/ power sprayer, drip/sprinkler and small tools are presented in table 3.7. The total value of farm assets was found to be more in soil tested farmers (Rs. 224399/HH) as compared to control farmers (Rs. 131663/HH).

Table 3.7 : Distribution of Farm Assets.

Particulars	Soil Test Farmers		Control Farmers	
	Number/ household	Value/ Household	Number/ household	Value/ household
Tractor, trailer/trolley	0.5	130458	0.3	68708
Harrow and cultivator	0.4	12150	0.2	4858
Electric motor/ Diesel Engine	1.3	18176	0.9	15996
Thresher	0.2	11702	0.3	6392
Planker	0.0	9	0.0	0
Manual/power sprayer	1.2	2016	1.0	1029
Fodder chopper	0.0	13	0.0	0
Bullock cart	0.1	3542	0.2	3983
Drip/sprinkler system	0.1	1650	0.1	942
Small tools (spade, hoe, sickle etc.)	6.4	1561	5.6	1521
Animal shed/pump house	0.8	40083	0.9	26508
Others	0.3	3039	0.3	1725
Total		**224399**		**131663**

Amongst the different farm assets used by sample households related to soil test as well as control farmer, the value of tractor trolley was found to be more followed by animal shed/pump house, electric motor/ diesel engine, harrow and cultivator, thresher, bullock cart, manual/ power sprayer, drip/sprinkler and small tools. (Table 3.7)

3.8 Agricultural Credit Outstanding

The agriculture credit outstanding of soil test and control farmers with Co-operative Credit Societies, Land Development Bank, Commercial Banks and Regional Rural Banks, Money lenders, friends/ Relatives and Traders are presented in table 3.8.1 and 3.8.2 respectively.

Table 3.8.1 Agricultural Credit Outstanding by the Sample Households (Rs/household)- Soil Test Farmers.

Particular	Marginal	Small	Medium	Large	Overall
Co-operative Credit Societies	24000 (36.00)	20889 (31.48)	25948 (34.48)	36408 (30.10)	26811 (32.08)
Land development banks	0 (0.00)	0 (0.00)	862 (1.72)	3883 (0.97)	1186 (0.83)
Commercial banks	20800 (20.00)	13241 (20.37)	19741 (17.24)	50049 (30.10)	25958 (23.75)
RRBs	12000 (4.00)	12037 (12.96)	27414 (12.07)	32039 (13.59)	20872 (12.08)
Money lenders	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Fiends/Relatives	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Traders/Commission agents	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Others	0 (0.00)	926 (1.85)	12069 (6.90)	5146 (3.88)	4535 (4.17)
Total	56800 (64.00)	47093 (66.67)	86034 (72.41)	127524 (78.64)	79363 (72.92)

Figure in the parenthesis shows percentage of farmer's availed credit facilities.

It is observed from the data that an average soil test farmer (Rs. 79363/HH) have more outstanding as compared to control farmer (Rs. 36887/HH). Agricultural credit outstanding was found to be maximum in Co-operative Credit Societies, followed by Commercial Banks and Regional Rural Banks, Land Development Bank and Others. Only 72.92 and 65.83 per cent of soil test and control farmers availed credit facilities. The Co-operative Credit Societies followed by the Commercial banks, RRBs and other were found to be major source of credit.

Table 3.8.2 Agricultural Credit Outstanding by the Sample Households (Rs/household)- control farmers.

Particular	Marginal	Small	Medium	Large	Overall
Co-operative Credit Societies	14000 (33.33)	15296 (30.30)	15000 (16.28)	18515 (37.50)	15703 (27.50)
Land development banks	0 (0.00)	0 (0.00)	3448 (2.33)	2913 (0.00)	1590 (0.83)
Commercial banks	2000 (25.00)	8241 (18.18)	22414 (20.93)	17476 (21.88)	12533 (20.83)
RRBs	0 (0.00)	0 (12.12)	9483 (13.95)	3981 (18.75)	3366 (13.33)
Money lenders	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Fiends/Relatives	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Traders/Commission agents	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Others	0 (0.00)	1852 (3.03)	12931 (6.98)	0 (0.00)	3696 (3.33)
Total	16000 (58.33)	25389 (63.64)	63276 (60.47)	39972 (78.13)	36887 (65.83)

3.9 Purpose of Agril Loan

The purpose of agricultural loan availed by the soil test and control farmers presented in table 3.9.1 and 3.9.2 respectively.

Table 3.9.1: Purpose of Agricultural Loan Availed by the Soil Test Farmers. (% of farmers)

Particular	Marginal	Small	Medium	Large	Overall
Seasonal crop cultivation	64	65	66	70	66
Purchase of tractor and other implements	0.0	0.0	6.9	8.7	3.9
Purchase of livestock	0.0	1.9	0.0	0.0	0.5
Land development	0.0	0.0	0.0	0.0	0.0
Consumption expenditure	0.0	0.0	0.0	0.0	0.0
Marriage and social ceremonies	0.0	0.0	0.0	0.0	0.0
Non-farm activities	0.0	0.0	0.0	0.0	0.0
Other expenditures	0.0	0.0	0.0	0.0	0.0
Overall	64	66.9	72.9	78.7	70.4

It is observed from the data that 70.4 per cent soil test (Table 3.9.1) and 65 per cent control farmers (Table 3.9.2) availed agricultural loan for the seasonal crop cultivation and purchase of tractors and other implements.

Table 3.9.2: Purpose of Agricultural Loan Availed by the Control Farmers. (% of farmers)

Particular	Marginal	Small	Medium	Large	Overall
Seasonal crop cultivation	50	64	60	78	63
Purchase of tractor and other implements	8	0	0	0	2
Purchase of livestock	0.0	0.0	0.0	0.0	0.0
Land development	0.0	0.0	0.0	0.0	0.0
Consumption expenditure	0.0	0.0	0.0	0.0	0.0
Marriage and social ceremonies	0.0	0.0	0.0	0.0	0.0
Non-farm activities	0.0	0.0	0.0	0.0	0.0
Other expenditures	0.0	0.0	0.0	0.0	0.0
Overall	58	64	60	78	65

3.10 Training Programmes Attended

The average number of trainings attended by the soil test farmer was found to be only 1. At overall level only 36 per cent farmers attended three days training programme only for once.

Table 3.10.1: Training Programmes Attended on Application of Chemical Fertilizers by the Soil Test Farmers.

Particulars	Marginal	Small	Medium	Large	Overall
Average number of trainings attended	0.3	0.3	0.4	0.5	1
% of farmers attended	32	31	36	46	36
Average number of days	0.8	0.7	0.7	0.7	3

The large farmers (46%) were found to attend more training as compared to medium (36%), marginal (32%) and small (31%) farmers respectively. (Table 3.10.1)

Table 3.10.2: Training Programmes Attended on Application of Chemical Fertilizers by the Control Farmers.

Particulars	Marginal	Small	Medium	Large	Overall
Average number of trainings attended	0.1	0.3	0.4	0.3	1
% of farmers attended	8	27	35	34	26
Average number of days	0.0	0.3	0.4	0.4	1

At overall level one day training programme was found to be attended by 26 per cent control farmers. Here also medium (35%) and large (34%) farmers attended more training as compared to marginal (8%) and small (27%) farmers (Table 3.10.2).

3.11 Summary of the Chapter

The chapter deals with the socio economic characteristics of soil test as well as control farmers were also observed and found that these were found to be similar as the majority of the respondents were male and their main occupation was agriculture. The average age of the respondents was found to be 46 years. The majority of respondents belong to medium and large holdings followed by marginal and small. In their family their were found 5 (control) to 6 (soil test) family members. The majority of respondent were from OBC followed by SC and ST categories. The more number of large farmers found to be member of association as compared to medium, small and marginal farmers. An average farmer found to operate 7.5 acres (control) to 8.7 acres (soil test) of cultivated land, out of which 98 to 99 per cent of land was found to be operated twice in a year. Bore wells followed by open wells, well and canals were found to be main sources of irrigation.

Soybean in kharif and wheat in rabi season were found to be main crops cultivated by the respondents in the area under study. The other crops found to be cultivated by them were paddy, gram, lentil etc. All the respondents whether related to soil test or control categories used HYVs seeds for production of cereals, pulses and oil seeds but the seed replacement rate was found to be very low and varies between 0.73-19.37 per cent per year in the area under study . The total output obtained was valued to be Rs. 7688 (control) to Rs. 10094 per acre (soil test). Out of which output of Rs. 5997 (control) to 8240 (soil test) per acre was sold out in the market. The total value of farm assets was found to be between Rs. 131663 (control) to 224399 (soil test) per households and their total agriculture outstanding was ranged to between Rs. 36887 (control) to Rs. 79363 (soil tested) per households and as the size of farm found to be increases their total assets and total agriculture outstanding found to increased. The majority of HHs were found to avail agriculture loan facilities whether related to soil test or control category. The main purpose of obtaining loan was for seasonal crop cultivation followed by purchase of tractors and live stock. As far as participation in training programme is concerned, only 26 per cent of control and 36 per cent of soil test farmers were found to attend a training of one day in the area under study.

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CHAPTER - IV

DETAILS OF SOIL TESTING AND RECOMMENDED DOSES OF FERTILIZERS

This Chapter contains the information collected from the sample respondent with regards to detail of soil testing and recommended dose of fertilizer from different categories of farmers viz. sources of information about soil testing, reason of soil testing by soil test farmers & non soil testing from control farmers and status of soil health & recommended dose of fertilizers.

4.1 Details of Soil Test Farmer

The detail information regarding soil test farmer were collected for both the selected crops i.e. soybean and wheat and presented in table 4.1.1 and 4.1.2 respectively.

Table 4.1.1: Distribution of Sample Soil Test Farmers: Soybean.

Particular	Marginal	Small	Medium	Large	Total
% of farmers tested their soil in the last three years	12.5	24.2	20.0	43.3	100.0
Average cost of soil testing (Rs/sample)	23.7	27.1	28.3	28.6	26.9
Average distance from field to soil testing lab (kms)	73.9	60.6	62.0	63.7	65.0
Average number of soil samples taken per plot	1.0	1.1	1.2	1.8	1.3
Average no. of plots considered for soil testing	1.0	1.1	1.2	1.8	1.3
Average area covered under soil test (acre)	2.3	4.1	7.0	11.5	6.2
Area covered as % of net operated area	2.6	8.8	12.4	44.3	17.0
% of farmers who collected samples themselves	33.3	37.9	45.8	28.8	36.5
% of soil sample collected by the department officials	66.7	62.1	54.2	71.2	63.5

It is observed from the data that the maximum number of large (43%) followed by small (24%), medium (20.0%) and marginal (12%) farmers got tested their soil in the last 3 year for cultivation of soybean. An average soybean grower used to cover 65 km from field to soil testing lab. The average cost incurred in testing of soil samples was found to be Rs. 26.9/sample. On an average a soybean grower had taken 1 sample per plot from a single plot which covers only 17% (6.2 acre) of his operational holding. Out of 100 farmers 36 soybean grower collected soil sample by themselves, while 64 soil samples were collected by the department officials. (Table 4.1.1)

Table 4.1.2: Distribution of Sample Soil Test Farmers: Wheat.

Particular	Marginal	Small	Medium	Large	Total
% of farmers tested their soil in the last three years	8.3	21.7	29.2	40.8	100.0
Average cost of soil testing (Rs/sample)	4.2	4.5	4.7	4.9	4.6
Average distance from field to soil testing lab (kms)	20.7	19.1	26.1	17.1	20.7
Average number of soil samples taken per plot	1.0	1.1	1.1	1.5	1.2
Average no. of plots considered for soil testing	1.2	1.2	1.4	1.6	1.4
Average area covered under soil test (acre)	1.6	3.1	3.5	6.8	3.7
Area covered as % of net operated area	1.1	5.3	8.3	22.2	9.2
% of farmers who collected samples themselves	20.0	34.6	57.1	53.1	41.2
% of soil sample collected by the department officials	80.0	65.4	42.9	46.9	58.8

As far as sample wheat growers are concerned an average wheat grower covered a distance of 21 km to test their soil sample from a soil testing laboratory in the area under study. The average cost incurred to test a sample was found to be Rs. 5/sample. He had taken only 1 sample from a plot and covered only 9.2 per cent of his operational holding (4 acre). Out of total respondents of wheat only 41 per cent of farmer collected soil sample by themselves, while 59 per cent of samples were collected by the department officials. (Table 4.1.2)

4.2 Source of Information

There were various sources of information found in the study area from where soil testing farmer got to know about recent information of soil testing technique. The main source of information of soil testing farmers was state department from where 69 per cent of soybean and 73 per cent of wheat respondents received information about soil testing technique. The other sources of information were Krishi Vigyan Kendra (KVK), neighbours, friends and private companies. This information was found to be similar for all categories of respondents with minor variations in the area under study. (Table 4.2)

Table 4.2: Sources of Information about Soil Testing by Sample Households (% of farmers)- Soil Test Farmers.

Sources	Marginal	Small	Medium	Large	Overall
Soybean					
SAUs	0.0	0.0	0.0	0.0	0.0
KVKs	20.0	13.8	20.8	9.6	16.1
Private companies	0.0	0.0	0.0	1.9	0.5
Friends/neighbors	6.7	3.4	12.5	0.0	5.7
Neigbour	13.3	3.4	8.3	7.7	8.2
State department	60.0	79.3	58.3	80.8	69.6
Total	100	100	100	100	100.0
Wheat					
SAUs	0.0	0.0	0.0	0.0	0.0
KVKs	11.1	3.8	14.3	4.1	8.3
Private companies	0.0	15.4	2.9	14.3	8.1
Friends/neighbors	0.0	0.0	11.4	8.2	4.9
Neigbour	11.1	7.7	2.9	0.0	5.4
State department	77.8	73.1	68.6	73.5	73.2
Total	100	100	100	100	100.0

4.3 Reasons for Soil Testing

The reasons for soil testing by sampled soil test farmers in different selected crops i.e. soybean and wheat are presented in table 4.3.

Table 4.3: Reasons for Soil Testing by Sample Households (% of farmers)- Soil Test Farmers.

Reasons	Soybean crop				Wheat crop			
	Most Important	Important	Least Important	Total	Most Important	Important	Least Important	Total
For availing benefits under subsidy schemes	2.5	22.5	50.8	75.8	1.7	22.5	27.5	51.7
For increasing crop yield	65.0	25.0	3.3	93.3	43.3	35.0	1.7	80.0
Motivation from village demonstration/training/ exposure visits to places with best farming practices	55.0	28.3	1.7	85.0	45.8	30.8	0.8	77.5
Peer farmers' group pressure	12.5	51.7	5.8	70.0	5.0	40.0	25.0	70.0
Adoption of new technological practices	59.2	18.3	3.3	80.8	84.2	5.0	2.5	91.7

The main reason for soil testing as reported by maximum number of soybean growers was to increase the crop yield (93.3%) followed by motivation from village demonstration/training/exposure visits to places with best farming practices (85%), adopt new technological practices (80.8%). Almost all these reasons the most important reasons were found to be for soil test increasing crop yield (65%)

followed by Adoption new technological practices (59.2%) and motivation from village demonstration/training/exposure visits to places with best farming practices (55.0%).

The majority of wheat farmers (91.7%) reported that adoption of new technological practices was the main reason for soil testing by them for getting their soil tested. Another major reason was found to be increasing crop yield (80%) and motivation from village demonstration/training/exposure visits to places with best farming practices (77.5%) Pressure of peer farmers' group (70.0%) and availing benefits under subsidy schemes (51.7%). The most important reasons amongst all these were to adopt new technological practices, motivation from village demonstration/training/exposure visits to places with best farming practices and increasing crop yield as reported by 84.2, 45.8 and 43.3% per cent of wheat grower (Table 4.3).

4.4 Reasons for not Testing Soil

The reasons for not testing soils during last 3 years by control farmer in different selected crop i.e. soybean and wheat are presented in table 4.4.

Table 4.4: Reasons for Not Testing Soil during the Last Three Years (% of Farmers)-Control Farmers.

Reasons	Soybean				Wheat			
	Most Important	Important	Least Important	Total	Most Important	Important	Least Important	Total
Do not know how to take soil samples	8.3	31.7	15.0	55.0	15.0	33.3	21.7	70.0
Do not know whom to contact for details on testing	36.7	25.0	13.3	75.0	28.3	25.0	20.0	73.3
Soil testing laboratories are located far away	28.3	30.0	5.0	63.3	25.0	36.7	10.0	71.7
Soil testing not required for my field as crop yield is good	6.7	38.3	20.0	65.0	28.3	23.3	23.3	75.0
Soil testing is not creditable	13.3	15.0	6.7	35.0	30.0	40.0	13.3	83.3
No knowledge regarding soil testing facility	33.3	13.3	10.0	56.7	10.0	13.3	71.7	95.0

The main reasons for not testing soil as reported by majority of control respondents of soybean was found that they don't know whom to contact for details on soil testing (75.0%) followed by soil testing not required for my field as crop yield is good (65.0%), soil testing laboratories are located far away (63.3%), they have no knowledge related to soil testing facility (56.7%), soil testing is not creditable (35.0%). Amongst all these reasons the most important reasons as reported by 36.7, 33.3 and 28.3 percent of soybean grower were don't know whom to contact for details on testing, no knowledge regarding soil testing facility and soil testing laboratories are located far away.

The reasons for not testing their soil by control respondents growing wheat crop were found to no knowledge related to soil testing (95%) followed by soil testing is not creditable (83.3%) do not know whom to contact for details on testing (73.3%) and soil testing not required for my field as crop yield is good (75%) soil testing laboratories are located far away (71.7%) and do not know how to take soil samples (70%). The important reasons for not testing their soil as reported by maximum percentage of wheat growers were soil testing is not creditable (30%) do not know how to take soil samples (28.3%), soil testing not required for my field as crop yield is good (28.3%) and soil testing laboratory are located far away (25%).

4.5 Status of Soil Health

The status of soil health by sample respondents by soil test farmers was found to be normal as reported by 68 per cent of soybean growers. The status of phosphorus and potassium were found to be medium as reported by 51 and 53 per cent of soybean growers respectively. The 3 per cent farmers reported that the status of sulphar was found to be low in their soil health card. (Table 4.5) As regards to wheat crop the status of nitrogen was found to below 78 per cent whereas the status of phosphorus (71%) and potassium (69%) were found to be medium in the area under study.

Table 4.5: Status of Soil Health in terms of Nutrients on the Sample Soil Test Farms (as reported in the soil health card)- Soil Test Farmers. (%)

Fertilizers	Normal	High	Medium	Low
Soybean				
Nitrogen	68	3	18	12
Phosphorus	37	2	51	11
Potassium	33	11	53	3
Sulphar	10	0	11	3
Wheat				
Nitrogen	0	0	22	78
Phosphorus	0	0	71	29
Potassium	0	30	68	3

4.6 Recommended Doses of Fertilizers

The recommended doses of nutrients applied for the soybean crop was 8 kg N: 24 kg P: 8 kg K: 8 kg S per acre which are fulfilled by using 151 Kg of SSP, 13.3 Kg Potash, (Basal application) and 17.4 Kg Urea per acre or fulfilled by using DAP, 52.6 kg, Potash 13.3 kg and Sulphur 8.09 kg. The recommended doses of nutrients for the wheat crop 49 kg N: 24 kg P: 16 kg K per acre which are fulfilled by using DAP, 52.6 kg, Potash 24.6 kg and Urea 92.9 kg per acre and Zinc 10 Kg per acre also recommended as basal application once in three years.

Table 4.6: Average Quantity of Recommended Doses of Fertilizers given Based on Soil Test (as reported in the health card)- Soil Test Farmers. (Kg/acre)

Particulars	Soybean	Wheat
Urea	17.4	92.9
DAP	52.6	52.6
SSP	151.0	-
Potash	13.3	24.6
Sulphur	8.09	-
Gypsum	46.9	-
$ZnSO_4$*	-	10.1

* Once in three year

4.7 Split Doses of Fertilizers

The average quantity of split doses (Kg/Acre) of fertilizers recommended by stage of crop growth is presented in table 4.7. It is clear from the data that only urea is recommended by stage of crop growth in split doses. In soybean 17.4 Kg/Acre Urea was found to be recommended after interculture operation while in wheat 46.4 Kg/Acre Urea was found to be recommended after interculture operation stage (23.2 kg/Acre) and at vegetative growth (23.2 kg/Acre).

Table 4.7: Average Quantity of Split Doses of Fertilizers Recommended by Stage of Crop Growth. (Kg/acre)

Particulars	Basal Application	After inter-cultivation (weeding, thinning etc)	Vegetative growth	Flowering	Grain formation
		Soybean			
Urea	0.0	17.4	0.0	0.0	0.0
DAP/SSP	52.6/151.0	0.0	0.0	0.0	0.0
Potash	13.3	0.0	0.0	0.0	0.0
Sulphur	8.09	0.0	0.0	0.0	0.0
Gypsum	46.9	0.0	0.0	0.0	0.0
		Wheat			
Urea	46.5	23.2	23.2	0.0	0.0
DAP	52.6	0.0	0.0	0.0	0.0
Potash	24.6	0.0	0.0	0.0	0.0
ZnSo4*	10.1	0.0	0.0	0.0	0.0

* Once in three year

4.8 Summary of the Chapter

The detail information of soil testing and recommended doses of fertilizers of different categories of soil test farmers of soybean and wheat crop were analyzed and observed that the maximum number of large farmers i.e. 43 per cent in soybean and 40 per cent of wheat growers tested their soil once in the last 3 year. An average farmer covered 21-65 km distance to get their soil tested and the average cost incurred in testing of soil samples was found to be Rs. 5-26.9 per sample. As the distance from farm to soil testing laboratory increases the cost of soil testing was also found to be increased. The proportionate relationship was observed between the cost of soil testing and distance from farm to soil testing laboratory. On an average a soybean and wheat grower had taken 1 sample per plot from a single plot which covered only 17 per cent (6.2 acre) and 9 per cent (3.7 acre) of their operational holding respectively.

The main source of information of soil testing farmers was State Department of Agriculture, from where 69 per cent of soybean and 73 per cent of wheat respondents received information about soil testing technique. The other sources of information were Krishi Vigyan Kendra (KVK), neighbours, friends and private companies for both the crops.

The most important reasons for soil testing by sample respondents were found to increase the crop yield and for adoption of new technological practices for their crops. The important and least important reasons for soil testing were pressure of peer farmers' group.

The main important reason for not testing soils during last 3 years by control farmers as reported by majority of respondents were found that they didn't know whom to contact for details on soil testing, no knowledge related to soil testing in cultivation of soybean and wheat crop. The most important reason for not testing soils as reported by majority of HHs was soil testing is not required for my field as crop yield is good and soil laboratories are located far away. The least important reason was they did not know how to take soil samples.

The majority of the respondents reported that the status of soil health was found to be normal. The status of phosphorus and potassium are medium. As regards to wheat crop the status of nitrogen was found to be low in the area under study.

The recommended doses of nutrients applied for the soybean crop was found to be 8 kg N: 24 kg P: 8 kg K: 8 kg S per acre which are fulfilled by using 151 Kg of SSP, 13.3 Kg Potash, (Basal application) and 17.4 Kg Urea per acre (Split dose). Or fulfilled by using DAP, 52.6 kg, Potash 13.3 kg and Sulphur 8.09 kg as basal application. The recommended doses of nutrients for the wheat crop 49 kg N: 24 kg P: 16 kg K per acre which are fulfilled by using DAP, 52.6 kg, Potash 24.6 kg and Urea 46.5 kg per acre as basal application and 23.2 Kg Urea split in 2 stages at the time of intercultural operation and during vegetative growth respectively. Zinc 10 Kg per acre as basal application once in three years.

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CHAPTER - V

ADOPTION OF RECOMMENDED DOSES OF FERTILIZERS AND ITS CONSTRAINTS

The adoption of recommended doses and constrains in applying recommended doses of fertilizers by soil test farmers are dealt in this chapter. The chapter also includes source of information, application of actual quantities of fertilizers and method of application, use of organic fertilizers and details of fertilizers purchased by sample household in the area under study.

5.1 Application of Recommended Doses of Fertilizers

The application of recommended dose of fertilizers on the reference crops i.e. soybean and wheat are presented in table 5.1. It is observed from the data that on overall basis only 43.9 and 46.1 per cent of soil test farmers applied recommended doses of fertilizers covering 58.19 and 52.37 per cent of net cultivated area under soybean and wheat crops respectively. Out of which, only 40.02 per cent of soybean and 41.9 per cent of wheat growers willing to continue applying of recommended doses of fertilizers in future.

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

Particulars	Marginal	Small	Medium	Large	Overall
Soybean					
% of farmers applied recommended doses of fertilizers	53.3	45.1	33.2	44.1	43.9
Average area (acre)	0.6	2.5	7.0	11.5	5.4
Area covered as % of net operated area	28.57	61.42	86.98	55.78	58.19
Average number of seasons applied	1.0	1.0	1.0	1.0	1.0
% of farmers willing to continue applying recommended doses of fertilizers	52.0	42.7	30.0	36.1	40.2
Wheat					
% of farmers applied recommended doses of fertilizers	43.1	37.0	49.3	55.0	46.1
Average area (acre)	1.3	2.9	3.5	6.9	3.7
Area covered as % of net operated area	59.52	72.22	44.01	33.73	52.37
Average number of seasons applied	1.0	1.0	1.0	1.0	1.0
% of farmers willing to continue applying recommended doses of fertilizers	40.1	28.5	48.7	50.3	41.9

The soil test farmers applied recommended dose of fertilizers only for a season. It is also observed from the data that the maximum per cent of marginal (53.3%) followed by small (45.1%) large (44.1%) and medium (33.2%) farmers used to apply recommended doses of fertilizers in cultivation of soybean, while in case of wheat growers maximum per cent of large (55.0%) followed by medium (49.3%), marginal (43.1%) and small (37.0%) farmers were found to apply recommended doses of fertilizers.

5.2 Constrains in Applying Recommended Doses of Fertilizers

The most important constrains in applying recommended doses of fertilizers as reported by maximum number of soil tested farmers growing soybean was soil testing report not available in time (98.3%) followed by high price of fertilizers (72.5%) and no technical advice on method and time of fertilizer application (71.7%) difficult to understand and follow the recommended doses (65.8%) adequate quantity of fertilizer not available (65%) and lack of capital to purchase fertilizers. Amongst all these constraints the most important constraints reported by majority of soybean growers were soil testing report not available in time (64.2%), difficult to understand and follow the recommended doses (29.2%) and no technical advice on method and time of fertilizer application (25.0%). The least important constraints are reported by soybean growers were adequate quantity of fertilizer not available in market (43.3%), high price of fertilizer (36.7%) and lack of capital to purchase fertilizer (31.7%).

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

Reasons	Soybean crop				Wheat crop			
	Most Important	Important	Least Important	Total	Most Important	Important	Least Important	Total
Adequate quantity of fertilizers not available	7.5	14.2	43.3	65.0	46.7	18.3	15.8	80.8
High prices of fertilizers	21.7	14.2	36.7	72.5	18.3	16.7	22.5	57.5
Lack of capital to purchase fertilizers	7.5	24.2	31.7	63.3	7.5	25.0	27.5	60.0
No technical advice on method and time of fertilizers application	25.0	38.3	8.3	71.7	13.3	36.7	6.7	56.7
Difficult to understand and follow the recommended doses	29.2	26.7	10.0	65.8	61.7	24.2	9.2	95.0
Soil testing report not available in time	64.2	27.5	6.7	98.3	30.8	19.2	23.3	73.3

As regard to constrains in applying recommended dose of fertilizers in wheat crop, the constrains as reported by the maximum per cent of wheat growers were difficult to understand and follow the recommend dose (95.0%), adequate quantity of fertilizers not available (80.8%) and soil testing report not available in time (73.3%), lack of capital to purchase fertilizer (60%), no technical advice on method, high price of fertilizer (57.5%) and time of fertilizer application (56.7%). Amongst all these constraints the most important constraints as reported by majority of wheat growers were difficult to understand and follow the recommended doses (61.7), adequate quantity of fertilizer not available in market (46.7%) and Soil testing report not available in time (30.8%). The least important constraints were lack of capital to purchase fertilizers and high price of fertilizers as reported by 27.5 and 22.5% of wheat growers.

5.3 Awareness and Sources of Information About Recommended Doses of Fertilizer

The awareness and sources of information about recommended dose of fertilizers as regards to control farmers of soybean and wheat are presented in table 5.3. It is observed from the data that on overall basis only 11.3 and 6.7 per cent of soybean and wheat growers were found to be aware about the recommended doses of fertilizers. The main source of their awareness was found to be Department of Agriculture as reported by more than 80 per cent of respondents. The others sources of information as reported by the control farmers were fellow farmers and private dealers.

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

Sources	Marginal	Small	Medium	Large	Overall
Soybean					
Aware %	2.0	11.7	15.0	16.7	11.3
Agri. Department	100.0	80.0	85.7	75.0	85.2
Private dealer	0.0	0.0	0.0	12.5	3.1
Fellow farmer	0.0	20.0	14.3	12.5	11.7
NGO	0.0	0.0	0.0	0.0	0.0
Total	100	100	100	100	100
Wheat					
Aware %	5.0	10.0	6.7	5.0	6.7
Agri. Department	100.0	66.7	80.0	75.0	80.4
Private dealer	0.0	16.7	0.0	0.0	4.2
Fellow farmer	0.0	16.7	20.0	25.0	15.4
NGO	0	0	0	0	0
Total	100	100	100	100	100

All the marginal farmers and 80, 85.7 and 75 per cent of small, medium and large farmers related to soybean crop reported that they were kept aware by the officials of Agricultural Department regarding recommended doses of fertilizers application in soybean crops.

As regard to wheat crop 100, 80, 75 and 66.7 per cent of marginal, medium, large and small farmers reported that they were getting information about recommended doses of fertilizer from the officials of Agricultural Department and rest of the sample HH could able to know this from private dealers and follow farmers.

5.4 Actual Quantity of Fertilizers Applied by the Sample Farmers

The actual quantity of fertilizers applied by both control as well as soil test farmers to soybean and wheat crops are dealt in this section.

Table 5.4.1: Actual Quantity of Fertilizers Applied by the Sample Farmers during the Reference Year (Kg/acre) - Soybean.

Particulars	Marginal	Small	Medium	Large	Overall
Soil Test Farmers					
Urea	1	6	6	4	4
DAP	38	35	36	27	34
Potash	10	5	4	3	6
SSP	52	47	49	32	45
$ZnSO_4$	10	6	7	4	7
Gypsum	6	5	5	1	4
Control Farmers					
Urea	8	2	3	1	4
DAP	69	67	63	56	64
Potash	0	0	3	0	3
SSP	42	56	40	36	44
$ZnSO_4$	0	2	3	0	1
Gypsum	0	0	0	1	1

The actual quantity of fertilizers applied by sample soil test and control farmers in cultivation of soybean are presented in table 5.4.1 it is observed from the data that on overall basis an average soybean soil test respondent was found to applying 45 kg SSP, 34 kg DAP, 7 kg $ZnSO_4$, 6 kg Potash, 4 kg Gypsum and 4 kg Urea per acre, while an average control farmers used to apply 64 kg DAP, 44 kg SSP, 4 kg Urea 3 kg Potash, 1 kg $ZnSO_4$ and 1 kg Gypsum in their field for production of soybean. The quantity of all the fertilizers was found to be more or less similar in different categories of farms. The control farmers were found to applying more fertilizer than the soil test farmers.

The actual quantity of fertilizers applied by sample soil test and control farmers in cultivation of wheat are presented in table 5.4.2 it is observed from the data that an average wheat soil test respondent was found to apply 101 kg Urea, 52 kg DAP, 2 kg Potash and 1 kg $ZnSO_4$, while a control farmer applied 100 kg Urea, 50 kg DAP, 6 kg Potash and 1 kg $ZnSO_4$ in their field for production of wheat in the area under study. The quantities of fertilizers applied were found to be similar for all the categories of farmers except for Potash. The more quantity of Potash was used by large famers as compared to other farmers. Control as well as soil test farmers used to apply somewhat same quantities of fertilizers in their field for cultivation of wheat in the area under study.

Table 5.4.2: Actual Quantity of Fertilizers Applied by the Sample Farmers during the Reference Year (Kg/acre) - Wheat.

Particulars	**Marginal**	**Small**	**Medium**	**Large**	**Overall**
Soil Test Farmers					
Urea	100	102	103	100	101
DAP	50	52	52	52	52
Potash	0	0	2	4	2
$ZnSO_4$	1	2	1	2	1
Control Farmers					
Urea	100	101	103	96	100
DAP	50	51	50	50	50
Potash	1	6	3	14	6
$ZnSO_4$	2	2	1	1	1

5.5 Actual Quantity of Split Doses of Fertilizer

The actual quantity of split doses of fertilizer applied by stage of crop growth in soybean and wheat by control as well as soil test farmers is explained in this section.

All the control as well as soil test farmers were found to applying 64 kg DAP, 44 kg SSP, 3 kg Potash, 1 kg $ZnSO_4$, 1 kg Gypsum and 34 kg DAP, 45 kg SSP, 6 kg Potash, 7 kg $ZnSO_4$ & 2 kg Gypsum respectively as basal application while 4 kg

Urea was applied as split dose after inter culture to soybean crop by soil test and control farmers. (Table 5.5.1)

Table 5.5.1 : Actual Quantity of Split Doses of Fertilizers Applied by Stage of Crop Growth during the Reference Year (Kg/acre)- Soybean.

Particulars	Basal application	After inter-cultivation (weeding, thinning etc)	Vegetative growth	Flowering	Grain formation	Total
Soil Test Farmer						
Urea	0	4	0	0	0	4
DAP	34	0	0	0	0	34
SSP	45	0	0	0	0	45
Potash	6	0	0	0	0	6
$ZnSO_4$	7	0	0	0	0	7
Gypsum	2	0	0	0	0	2
Control Farmers						
Urea		4	0	0	0	4
DAP	64	0	0	0	0	64
SSP	44	0	0	0	0	44
Potash	3	0	0	0	0	3
$ZnSO_4$	1	0	0	0	0	1
Gypsum	1	0	0	0	0	1

An average wheat soil test farmers used to apply 50 kg Urea, 52 kg DAP, 2 kg Potash and 1 kg $ZnSO_4$ as basal dose in cultivation of wheat and it was also found to apply 25 kg urea as split dose each at after inter culture operation stage and vegetative growth stage to wheat. Control farmer was also found to apply almost similar quantities of fertilizers with minor variation. (Table 5.5.2)

Table 5.5.2: Actual Quantity of Split Doses of Fertilizers Applied by Stage of Crop Growth during the Reference Year (Kg/acre)- Wheat.

Particulars	Basal application	After inter-cultivation	Vegetative growth	Flowering	Grain formation	Total
Soil Test Farmer						
Urea	50	25	25	0	0	100
DAP	52	0	0	0	0	52
$ZnSO_4$	1	0	0	0	0	1
Potash	2	0	0	0	0	2
Control Farmers						
Urea	50	25	25	0	0	100
DAP	50	0	0	0	0	50
$ZnSO_4$	1	0	0	0	0	1
Potash	8	0	0	0	0	8

5.6 Method of Application of Chemical Fertilizers

The method of application of chemical fertilizers in soybean and wheat crops by control as well as soil test farmers is presented in this section.

Broadcasting method of application was found to be more popular for application of all the fertilizers by control as well as soil test respondents except in DAP. The DAP was found to be applied with seed at the time of sowing in line application by seed drill both by control as well as soil test farmers. (Table 5.6.1)

Table 5.6.1 Method of Application of Chemical Fertilizers (% of farmers)-Soybean.

Particulars	Urea	DAP	Potash	SSP	$ZnSO_4$	Gypsum	Complex
Control Farmers							
Broadcasting	100	0	100	100	0	100	100
Dibbling	0	0	0	0	0	0	0
Fertigation	0	0	0	0	0	0	0
Line application	0	100	0	0	0	0	0
Spraying	0		0	0	0	0	0
Soil Test Farmers							
Broadcasting	100	8	100	100	100	100	100
Dibbling	0	0	0	0	0	0	0
Fertigation	0	0	0	0	0	0	0
Line application	0	92	0	0	0	0	0
Spraying	0	0	0	0	0	0	0

Broadcasting of all the fertilizers except DAP was also found to be very common in cultivation of wheat both by soil test and control farmers. The line application of DAP was also very popular in the study area. Majority of wheat growers mix DAP with seed in seed drill for sowing. SSP and $ZnSO_4$ in case of control farmers and Potash, $ZnSO_4$ and Gypsum in case of soil test farmers were also found to be apply it by line application. (Table 5.6.2)

Table 5.6.2 : Method of Application of Chemical Fertilizers (% of farmers) Wheat

Method	Urea	DAP	Potash	SSP	$ZnSO_4$	Gypsum	Complex
Control Farmers							
Broadcasting	100	0	0	0	0	0	0
Dibbling	0	0	0	0	0	0	0
Fertigation	0	0	0	0	0	0	0
Line application	0	100	0	0	100	0	0
Spraying	0	0	0	0		0	0
Soil Test Farmers							
Broadcasting	100	0	0	0	0	0	0
Dibbling	0	0	0	0	0	0	0
Fertigation	0	0	0	0	0	0	0
Line application	0	100	100	0	100	100	0
Spraying	0	0	0	0	0	0	0

5.7 Use of Organic Fertilizer

Use of organic fertilizers by soil test and control farmers with respect to soybean and wheat is presented in table 5.7.1 and table 5.7.2 respectively. It is observed from the data that 68 per cent of soil test soybean growers used to apply only Farm Yard Manures and organic manures in 23 per cent of their net cultivated area. The 48 per cent of controls farmers were also found to apply Farm Yard Manures @ 15083 Kg./Acre in 15 per cent of their net cultivated area (Table 5.7.1).

Table 5.7.1 : Use of Organic Fertilizers by the Sample Farmers in soybean.

Particulars	Farm yard manure	Other organic manure
Soil Test Farmers		
% farmers applied	68	0
Quantity applied (Kg/acre)	20363	0
Price (Rs/kg)	4	0
Area covered (% of net cropped area)	23	0
Control Farmers		
% farmers applied	48	0
Quantity applied (Kg/acre)	15083	0
Price (Rs/kg)	4	0
Area covered (% of net cropped area)	15	0

The 52 and 63 per cent of soil test and control farmers were also found to apply Farm Yard Manures @ 1224 & 1320 Kg/Acre to wheat crop covering 11 and 14 per cent of their net cultivated area. (Table 5.7.2)

Table 5.7.2 : Use of Organic Fertilizers by the Sample Farmers in wheat.

Particulars	Farm yard manure	Other organic manure
Soil Test Farmers		
% farmers applied	52	0
Quantity applied (Kg/acre)	1224	0
Price (Rs/kg)	4	0
Area covered (% of net cropped area)	11	0
Control Farmers		
% farmers applied	63	0
Quantity applied (Kg/acre)	1320	0
Price (Rs/kg)	4	0
Area covered (% of net cropped area)	14	0

5.8 Source of Purchase of Fertilizers

Co-operative societies and private fertilizers dealer were found to be main source for purchase of fertilizers. The 55 & 41 per cent, and 40 & 59 per cent of soil test and control farmers used to respectively purchased fertilizers for cultivation of soybean from these sources. This statement is true for all the categories of farmers with minor variation, whether related to soil test or control cultivators of soybean.

Table 5.8: Sources of Purchase of Fertilizers (% of farmers)

Sources	Marginal	Small	Medium	Large	Overall
Soil Test Farmers					
Private fertilizer shops/dealers	37	34	49	41	40
Company authorized dealers	0	0	0	1	0
Co-operative societies	63	57	47	53	55
Government agency	0	8	4	3	4
Others	0	1	0	2	1
Total	100	100	100	100	100
Control Farmers					
Private fertilizer shops/dealers	77	60	55	43	59
Company authorized dealers	0	0	0	0	0
Co-operative societies	23	40	45	55	41
Government agency	0	0	0	2	1
Others	0	0	0	0	0
Total	100	100	100	100	100

5.9 Quantity of Fertilizers Purchase from Different Source

The quantities of different fertilizers purchased by soil test farmers from different source are presented in table 5.9.

Table 5.9: Quantity of Fertilizer Purchased by the Sample Farmers (Per cent)

Particulars	Urea	DAP	SSP	Potash	Zn	Gypsum	Other
Soil Test Farmers							
Private fertilizer shops/dealers	51	38	6	7	75	0	0
Company authorized dealers	1	1	0	0	0	0	0
Co-operative societies	38	56	92	93	15	14	98
Government agency	9	5	0	0	9	86	2
Others	1	1	2	1	1	0	0
	100	100	100	100	100	100	100
Control Farmers							
Private fertilizer shops/dealers	90	49	2	37	100	0	36
Company authorized dealers	0	0	0	0	0	0	0
Co-operative societies	10	51	98	63	0	0	64
Government agency	0	0	0	0	0	100	0
Others	0	0	0	0	0	0	0
	100	100	100	100	100	100	100

It is observed from the data that Co-operative Societies were found to be a main source for purchase DAP (56%), SSP (92%) and Potash (93%), while Private Dealer were found to be main source for purchase of Urea (51%) and $ZnSO_4$ (75%) by soil tested farmers. The Govt. agencies were found to be main source for purchase of gypsum as reported by majority of soil test farmers (86%). In case of control farmers the private dealer were found to be main source of ZnSO4 (100%), Urea (90%) and DAP (49%), while SSP (98%), Potash (63%) and DAP (51%) are being purchased by Co-operative Societies. While all of them purchased Gypsum by Govt. agencies.

5.10 Average Price and Incurred Transportation Cost of Fertilizers

The average prices of fertilizers as reported by the soil test and control farmers of the study area are presented in table 5.10. It is observed from the data that the most costly fertilizers was DAP (Rs 23/kg), followed by $ZnSO_4$ (Rs 10/kg), Urea (Rs 4/kg), SSP (Rs 3/kg) and Potash (Rs 2/kg). The rates of these fertilizers were found to be similar with minor variations for control as well as soil test farmers.

Table 5.10: Average Price of Fertilizers and Transport Cost Incurred (Rs/kg)

Particulars	Soil Test farmers		Control farmers	
Fertilizers	Average Price	Transport cost	Average Price	Transport cost
Urea	4	0.06	4	0.06
DAP	23	0.13	20	0.43
SSP	3	0.10	2	0.28
Potash	2	0.14	1	0.05
$ZnSO_4$	10	0.31	4	0.14
Gypsum	0	0.08	0	0.08
Bio-fertilisers	0	0.11	0	0.14

5.11 Summary of the Chapter

The chapter highlighted that on overall basis only 43.9 (Soybean) and 46.1 per cent (Wheat) of soil test farmers used to apply recommended doses of fertilizers, which were ranged between 33.2 (Medium) to 53.3 per cent (Marginal), and 37 per cent (Small) to 55.0 per cent (Large) in different categories of farms respectively for soybean and wheat. The respondents were found to cover only 58.19 and 52.37 per cent of cultivated area by recommended doses of fertilizers under Soybean and Wheat respectively. These respondents were found to apply these recommended doses of fertilizer only for a season. The 40.2 and 41.9 per cent of soybean and wheat growers were willing to continue applying these doses of fertilizer in future.

The most important constraints found during the course of investigation and reported by the majority of soil test respondents were soil testing report not available in time, difficult to understand and fallow the recommended dose, no technical advice on method and time of fertilizer application and high price of fertilizer. The State Department of Agriculture was found to be main source of awareness and source of information as reported by more than 80 per cent of respondents. However, the awareness in control farmers was found only between 2 (marginal) to 16.7 per cent (large) in case of soybean growers, and 5 (marginal & large) to 10.0 per cent (small) in case of wheat growers.

The actual quantity of fertilizer applied by an average respondent for cultivation of soybean and wheat per acre were found to be 4 Kg Urea, 34 Kg DAP, 6 Kg MOP, 45 Kg SSP, 7 Kg $ZnSO_4$, & 4 Kg Gypsum, and 4 Kg Urea, 64 Kg DAP, 3 Kg MOP, 44 Kg SSP, 1 Kg $ZnSO_4$ & 1 Kg Gypsum respectively, which was found more than the recommendation. Hence, it is clear that the respondents were found to apply more fertilizers than the recommendation in cultivation of soybean and wheat in the area under study, which not only disturb the soil texture and structure of soil at one end but also causes the remarkable loss in production as well as income of the farmers on the other.

The majority of respondents whether related to soil test or control category were used to follow basal application of fertilizer using line followed by broadcasting method of application of chemical fertilizer in cultivation of soybean and wheat. The main sources of purchase of chemical fertilizer by control as well as soil test farmers were found to be Co-operative societies followed by private dealers in the area under study. Amongst different fertilizers the DAP (Rs. 23/Kg) was found to be more costly than ZnSO4 (Rs. 10 /Kg), Urea (Rs. 4/Kg), SSP (Rs. 3/Kg), and MOP (Rs. 2 /Kg) and their transportation cost was ranged between Rs. 0.06 to 0.43 per Kg. The study also revealed that in the area under study nearly 50 per cent of soybean as well as wheat growers found to apply organic fertilizer in the form of Farm Yard Manures in small quantity in their field of soybean (20363 Kg/acre) and wheat (15083 Kg/acre).

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CHAPTER - VI

IMPACT OF ADOPTION OF RECOMMENDED DOSES OF FERTILIZERS

This chapter deals with the impact of soil test based application of recommended doses of fertilizers on productivity of soybean and wheat crop in the area under study with reference to increase in productivity by application of recommended doses of fertilizers.

6.1 Impact on Productivity and Income

The impact of soil testing has been observed in two ways i.e. control and over the base year (Before and After). Impact of soil testing on productivity of soybean and wheat over control has been presented in table 6.1.1. It is observed from the data that on an overall basis an average farmer obtained 24.4 per cent more income and 16.2 per cent more yield than the control farmers in production of soybean. Amongst the different size of farmers the percentage difference in yield as well as income was found to be more in marginal category (39.4%, 52.9%) followed by small (13.9%, 20.6%), large (13.5%, 21.1%) and medium (2.3%, 8.2%) farmers. It is also observed from the data that on an overall basis an average soil test wheat grower obtained 15.4 per cent and 20.2 per cent more yield and income per acre over control farmers respectively.

Table 6.1.1 : Productivity of the Sample Crops during the Reference Year.

Particular	Average Yield (Qnt/acre)			Average value of output (Rs./acre)		
	Soil Test Farmer	Control Farmer	% difference in yield	Soil Test Farmer	Control Farmer	% difference in income
Soybean						
Marginal	4.6	3.3	39.4	14207	9293	52.9
Small	4.1	3.6	13.9	11970	9926	20.6
Medium	4.4	4.3	2.3	12950	11971	8.2
Large	4.2	3.7	13.5	12608	10409	21.1
Overall	4.3	3.7	16.2	12934	10400	24.4
Wheat						
Marginal	15.8	14.7	7.5	24524	22719	7.9
Small	14	13.4	4.5	21723	20702	4.9
Medium	14.8	12.8	15.6	22887	19684	16.3
Large	15.2	10.6	43.4	23577	15869	48.6
Overall	9.0	7.8	15.4	17487	14553	20.2

Amongst different size of farmers, the percentage difference in yield and income was found more in large category (43.4%, 48.6%) followed by medium (15.6%, 16.3%), marginal (7.5%, 7.9%) and small farmers (4.5%, 4.9%).

The impact of application of recommended doses of fertilizer also seen by before (2012-13) and after (2013-14) technique and presented in table 6.1.2 It is observed from the data that yield of soybean and wheat at overall level was found to be increased by 10.20 and 8.30 per cent respectively after adoption of recommended doses of fertilizer by soil test farmers in the area under study. Amongst different size of farmers the increase in yield was found maximum in marginal (17.9%) followed by large (10.5%), medium (10.0%) and small (2.5%) farmers in case of soybean, while in case of wheat it was found to be maximum in marginal (17.0%) followed by small (6.1%), medium (5.7%) and large (4.8%).

Table 6.1.2: Impact of Application of Recommended Doses of Fertilizers on Crop Yield-Soil Test Farmers.

Particular	Average yield (Quintal/acre)		% change in yield
	Before (2012-13)	After (2013-14)	
Soybean			
Marginal	3.9	4.6	17.9
Small	4.0	4.1	2.5
Medium	4.0	4.4	10.0
Large	3.8	4.2	10.5
Overall	3.9	4.3	10.2
Wheat			
Marginal	13.5	15.8	17.0
Small	13.2	14	6.1
Medium	14	14.8	5.7
Large	14.5	15.2	4.8
Overall	13.8	15.0	8.3

6.2 Changes Observed after Application of Recommended Doses of Fertilizers

There were various changes have been observed by soil test farmers in soybean and wheat crops after application of recommended doses of fertilizers, which is presented in table 6.2.

The changes observed by the majority of soil test farmers of soybean were improvement in grain filling (95.8%) and increase in crop yield (89.2%), while other important change were found to be less incidence of pest and diseases (87.5%), improvement in soil texture (83.3%) improvement in crop growth (82.5%) and decrease in application of other input like seed, labour, pesticide etc. in cultivation of soybean (81.7%). The most important changes observed by the majority of soil test farmers in cultivation of soybean were found to be improvement in grain filling (49.2%) and increase in crop yield (40.8%). The important change which were observed by the soil test soybean growers were found to be improvement in grain filling (34.2%) and less incidence of pest and diseases (42.5%). The less important change observed majority of soybean growers were decrease in application of other input (54.2%) improvement in soil texture (39.2%) and improvement in crop growth (30.8%).

The changes which were observed by soil test farmers after the application as reported by majority of wheat growers were found to be improvement in grain filling (94.8%) followed by improvement in crop growth (88.3%), less incidence of pest and diseases (85.89%), improvement in soil texture (82.5%), increase in crop yield (75.0%) and decrease in application of other inputs like seed, labour and pesticide etc.(73.3%).

Table 6.2: Changes Observed after the Application of Recommended Doses of Fertilizers on Reference Crops (% of farmers)-Soil Test Farmers.

Particulars	Soybean				Wheat			
	Most Important	Important	Least Important	Total	Most Important	Important	Least Important	Total
Increase in crop yield	40.8	30.8	17.5	89.2	39.2	24.2	11.7	75.0
Improvement in soil texture	19.2	25.0	39.2	83.3	22.5	25.0	35.0	82.5
Improvement in crop growth	26.7	25.0	30.8	82.5	25.8	29.2	33.3	88.3
Improvement in grain filling	49.2	34.2	12.5	95.8	54.0	31.7	9.2	94.8
Less incidence of pest and diseases	30.0	42.5	15.0	87.5	10.8	55.0	20.0	85.8
Decrease in application of other inputs like seed, labour, pesticide etc.	9.2	18.3	54.2	81.7	3.3	14.2	55.8	73.3

Amongst all these changes which were found to be observed by wheat growers the most important were improvement in grain filling, increase in crop yield, improvement in crop growth, and improvement in soil texture as reported by 54.0, 39.2, 22.8 and 22.5 per cent of wheat growers. The least important changes which were observed by 55.8, 35.0 and 33.3 per cent of soil test farmers were decrease in application of other inputs, improvement soil texture and improvement in crop growth (Table 6.2).

6.3 Summary of the Chapter

The positive impact of soil testing on productivity of soybean and wheat was observed in the area under study. On an overall basis an average farmer obtained 24.4 & 20.2 per cent more income and 16.2 & 15.4 per cent more yield than the control farmers in production of soybean and wheat crop respectively. It was also observed that the yield of soybean and wheat at overall level was found to be increased by 10.20 and 8.30 per cent respectively after adoption of recommended doses of fertilizer by soil test farmers. Amongst different size of farmers the increase in yield was found maximum in marginal (17.9%) followed by large (10.5%), medium (10.0%) and small (2.5%) farmers in case of soybean, while in case of wheat it was found to be maximum in marginal (17.0%), small (6.1%), medium (5.7%) and large (4.8%) farms.

There were various changes have been observed by soil test farmers in soybean and wheat crops after application of recommended doses of fertilizers. The most important changes reported by the majority of soil test farmers was found to be improvement in grain filling, increase in crop yield, less incidence of pest and diseases, improvement in crop growth, and decrease in application of other input like seed, labour and pesticides etc. Hence, it is clear from the above results that there is still an immense scope for increasing level of producing crop and income of farmers if all the farmers adopted the soil test based recommended doses of fertilizer in cultivation of crop, against the blanket application of fertilizer by farmers in their fields.

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CHAPTER VII

SUMMARY AND CONCLUSIONS

The soil testing programme was started in India during the year 1955-56 with the setting-up of 16 soil testing laboratories under the Indo-US Operational Agreement for "Determination of Soil Fertility and Fertilizer Use". In 1965, five of the existing laboratories were strengthened and nine new laboratories were established with a view to serve the Intensive Agricultural District Programme (IADP) in selected districts. To meet the increasing requirement of soil testing facilities, 25 new soil testing laboratories were added in 1970. In addition to this, 34 mobile soil testing vans were established under the joint auspices of the Technical Cooperation Mission of USA (TCM), Indian Agriculture Research Institute (IARI) and Government of India to serve the farmers in remote areas and also provide education to the farmers about benefits of balanced fertilization through group discussions, demonstrations, film shows etc. The idea to create the mobile soil testing facility was to serve the farmers almost at their doorsteps. The capacity of the soil testing laboratories in the intensive agricultural districts was initially created to analyse 30,000 soil samples annually by each laboratory.

Success or failure of soil testing programmes largely depends on rapidity providing correct information to farmers, ability of the programme to provide service to a large group of farmers in a particular area, proper analysis and interpretation of results and recommendations that when followed are profitable for the farmer. Then only will this service be effectively utilized to improve local agricultural production Time and quality consciousness in the service is a real challenge for the analysts in the new millennium. This compels laboratory to adopt rapid, reliable, time saving procedures and methods to meet future requirements. The farmer's confidence in the programme can be established only by demonstrating that it actually provides a means of improving his profit. Looking to the importance of the soil testing in farmers' field this study had been conducted as the review of various studies reported that the recommendations of soil testing laboratories are useful for farmers for increasing their levels of output but the majority of the farmers have not been interested in this, due to lack of knowledge about soil testing facilities, testing of soils is incredible, laboratories are situated far away, and non availability of soil testing report etc.

The 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.

The study is confined to soybean and wheat crop as these are the important crops of the Madhya Pradesh covering 56.6 and 16.4 per cent area of the country respectively.

A multistage purposive sampling method was used to select the districts, blocks, villages and farm households. At the first stage two districts having highest area in these crops in the state have been selected purposively for soybean and wheat. Therefore, Shajapur & Ujjain, and Hoshangabad and Vidisha districts have been selected for soybean and wheat in Madhya Pradesh respectively. In second stage, two blocks from each districts were selected again on the basis of highest area in the selected districts. Shajapur & Kalapipal blocks in Shajapur district, and Ujjain & Badnagar blocks in Ujjain district have been selected for soybean, whereas Hoshangabad & Babai blocks in Hoshanagabad, and Vidisha & Gyaraspur blocks in Vidisha district have been selected for wheat. A cluster of three villages in each selected block have been further selected for conducting the primary survey. A list of all the soil tested and other farmers in each village were collected from respective Soil Testing Laboratory and Department of Agriculture for the year 2012-13 and a sample of 60 soil test farmers and 30 control farmer per crop were selected randomly from each district for assessing the application of recommended dose of fertilizer and its impact on crop production. Thus, the study covers 240 treated and 120 control households comprising of 360 sample households, 180 each for soybean and wheat in Madhya Pradesh. These selected households were further classified into four different groups according to their size of farms i.e. marginal (less than 2.50 Acres), small (2.51-5.00 Acres), medium (5.01-10.00 Acres) and large (above 10.01 Acres) farmers.

Both primary and secondary data have been collected for the study. The primary data were collected from the sample households on different aspects of the study viz. social and economic characterises, operational holding, land utilization pattern, cropping pattern, farm assets, agriculture credit outstanding, purpose of agriculture loan, reason for soil testing, status of soil health, application of fertilizer, actual quantity of fertilizer applied, constraints in applying recommended dose of fertilizer etc. by the sample households through interview schedule provided from the coordinator (Agriculture Development and Rural Transformation Centre), Institute for Social and Economic Change, Bangalore) of the study and tested in local conditions of the Madhya Pradesh. The reference period of the study was 2013-14. The secondary data have been collected from *http://www.urvarak.co.in/* and Department of Farmers' Welfare and Agriculture Development (State Department of Agriculture), Madhya Pradesh, Bhopal on fertilizer consumption from the year 2001 to 2013 to analyze trend in fertilizer consumption in Madhya Pradesh.

The list of farmers who got their soil tested were collected from the respective soil testing laboratory and state Department of Agriculture for the year 2012-13 to assess the adoption of recommended dose of fertilisers. In light of stated objectives the classification, tabulation and analysis of data have been done by using Statistical Package for the Social Sciences (SPSS) software.

The major findings of the study are as follows

The consumption of K fertilizer in kharif season was also found to be increased from 2.6 (2000) to 4.2 Kg/ha (2011) with the fluctuation of 39.60 per cent and showed an annual simple and compound growth of 8.11 and 8.75 per cent respectively in Madhya Pradesh. Amongst the different nutrients the consumption in fluctuation was found to be more in K (39.60%) than P (11.60%) and N (23.75%) in Rabi season during the period under study. Madhya Pradesh (84.79 kg/ha) in a state where average per ha fertilizer consumption was found to be 35.93 per cent less than the India's total per ha fertilizer consumption.

The trend of all the nutrients of fertilizer consumption was found to be positive and upward during the period 2000-2013. The total NPK fertilizer consumption was found to be increase with the annual growth of 7.93 % per annum (simple) and 8.29 per cent per annum (compound) in the state. Amongst different nutrients the growth (simple) of K (8.61%/annum) was found to maximum as compared to N

(7.90%/annum) and P (7.85%/annum). The trend and growth of kg/ha consumption was also found to similar with minor variation when compared different season i.e. Kharif and Rabi. The average total fertilizer consumption was found to be maximum in Rabi (72.02 kg/ha) than Kharif season (47.34 kg/ha), as wheat and soybean were found to be major crops in Rabi and Kharif season and fertilizer requirement was more for wheat as compared to soybean. The trend and growth of fertilizer consumption was found to positive and upward but growth (compound) of total fertilizer (NPK) consumption was found more in Kharif (10.88%/annum) as compared to Rabi (4.79%/annum). This statement was also true for individual nutrients i.e. N, P and K consumption.

The socio economic characteristics of soil test as well as control farmers were also observed and found that these were found to be similar as the majority of the respondents were male and their main occupation was agriculture. The average age of the respondents was found to be 46 years. The majority of respondents belong to medium and large holdings followed by marginal and small. In their family their were found 5 (control) to 6 (soil test) family members. The majority of respondent were from OBC followed by SC and ST categories. The more number of large farmers found to be member of association as compared to medium, small and marginal farmers. An average farmer found to operate 7.5 acres (control) to 8.7 acres (soil test) of cultivated land, out of which 98 to 99 per cent of land was found to be operated twice in a year. Bore wells followed by open wells, well and canals were found to be main sources of irrigation.

Soybean in kharif and wheat in rabi season were found to be main crops cultivated by the respondents in the area under study. The other crops found to be cultivated by them were paddy, gram, lentil etc. All the respondents whether related to soil test or control categories used HYVs seeds for production of cereals, pulses and oil seeds but the seed replacement rate was found to be very low and varies between 0.73-19.37 per cent per year in the area under study . The total output obtained was valued to be Rs. 7688 (control) to Rs. 10094 per acre (soil test). Out of which output of Rs. 5997 (control) to 8240 (soil test) per acre was sold out in the market. The total value of farm assets was found to be between Rs. 131663 (control) to 224399 (soil test) per households and their total agriculture outstanding was ranged to between Rs. 36887 (control) to Rs. 79363 (soil tested) per households and as the size of farm found to be increases their total assets and total agriculture outstanding found to increased. The majority of HHs were found to avail agriculture loan facilities whether related to soil test or control category. The main purpose of obtaining loan was for seasonal crop cultivation followed by purchase of tractors and live stock. As far as participation in training programme is concerned, only 26 per cent of control and 36 per cent of soil test farmers were found to attend a training of one day in the area under study.

The detail information of soil testing and recommended doses of fertilizers of different categories of soil test farmers of soybean and wheat crop were analyzed and observed that the maximum number of large farmers i.e. 43 per cent in soybean and 40 per cent of wheat growers tested their soil once in the last 3 year. An average farmer covered 21-65 km distance to get their soil tested and the average cost incurred in testing of soil samples was found to be Rs. 5-26.9 per sample. As the distance from farm to soil testing laboratory increases the cost of soil testing was also found to be increased. The proportionate relationship was observed between the cost of soil testing and distance from farm to soil testing laboratory. On an average a soybean and wheat grower had taken 1 sample per plot from a single plot which covered only 17 per cent (6.2 acre) and 9 per cent (3.7 acre) of their operational holding respectively.

The main source of information of soil testing farmers was State Department of Agriculture, from where 69 per cent of soybean and 73 per cent of wheat respondents received information about soil testing technique. The other sources of information were Krishi Vigyan Kendra (KVK), neighbours, friends and private companies for both the crops.

The most important reasons for soil testing by sample respondents were found to increase the crop yield and for adoption of new technological practices for their crops. The important and least important reasons for soil testing were pressure of peer farmers' group.

The main important reason for not testing soils during last 3 years by control farmers as reported by majority of respondents were found that they didn't know whom to contact for details on soil testing, no knowledge related to soil testing in cultivation of soybean and wheat crop. The most important reason for not testing soils as reported by majority of HHs was soil testing is not required for my field as crop yield is good and soil laboratories are located far away. The least important reason was they did not know how to take soil samples.

The majority of the respondents reported that the status of soil health was found to be normal. The status of phosphorus and potassium are medium. As regards to wheat crop the status of nitrogen was found to be low in the area under study. The recommended doses of nutrients applied for the soybean crop was found to be 8 kg N: 24 kg P: 8 kg K: 8 kg S per acre which are fulfilled by using 151 Kg of SSP, 13.3 Kg Potash, (Basal application) and 17.4 Kg Urea per acre (Split dose). Or fulfilled by using DAP, 52.6 kg, Potash 13.3 kg and Sulphur 8.09 kg as basal application. The recommended doses of nutrients for the wheat crop 49 kg N: 24 kg P: 16 kg K per acre which are fulfilled by using DAP, 52.6 kg, Potash 24.6 kg and Urea 46.5 kg per acre as basal application and 23.2 Kg Urea split in 2 stages at the time of intercultural operation and during vegetative growth respectively. Zinc 10 Kg per acre as basal application once in three years.

On overall basis only 43.9 (Soybean) and 46.1 per cent (Wheat) of soil test farmers used to apply recommended doses of fertilizers, which were ranged between 33.2 (Medium) to 53.3 per cent (Marginal), and 37 per cent (Small) to 55.0 per cent (Large) in different categories of farms respectively for soybean and wheat. The respondents were found to cover only 58.19 and 52.37 per cent of cultivated area by recommended doses of fertilizers under Soybean and Wheat respectively. These respondents were found to apply these recommended doses of fertilizer only for a season. The 40.2 and 41.9 per cent of soybean and wheat growers were willing to continue applying these doses of fertilizer in future.

The most important constraints found during the course of investigation and reported by the majority of soil test respondents were soil testing report not available in time, difficult to understand and fallow the recommended dose, no technical advice on method and time of fertilizer application and high price of fertilizer. The State Department of Agriculture was found to be main source of awareness and source of information as reported by more than 80 per cent of respondents. However, the awareness in control farmers was found only between 2 (marginal) to 16.7 per cent (large) in case of soybean growers, and 5 (marginal & large) to 10.0 per cent (small) in case of wheat growers.

The actual quantity of fertilizer applied by an average respondent for cultivation of soybean and wheat per acre were found to be 4 Kg Urea, 34 Kg DAP, 6 Kg MOP, 45 Kg SSP, 7 Kg $ZnSO_4$, & 4 Kg Gypsum, and 4 Kg Urea, 64 Kg DAP, 3 Kg MOP, 44 Kg SSP, 1 Kg $ZnSO_4$ & 1 Kg Gypsum respectively, which was found more than the recommendation. Hence, it is clear that the respondents were found to apply more fertilizers than the recommendation in cultivation of soybean and wheat in the area under study, which not only disturb the soil texture and structure of soil at one end but also causes the remarkable loss in production as well as income of the farmers on the other.

The majority of respondents whether related to soil test or control category were used to follow basal application of fertilizer using line followed by broadcasting method of application of chemical fertilizer in cultivation of soybean and wheat. The main sources of purchase of chemical fertilizer by control as well as soil test farmers were found to be Co-operative societies followed by private dealers in the area under study. Amongst different fertilizers the DAP (Rs. 23/Kg) was found to be more costly than ZnSO4 (Rs. 10 /Kg), Urea (Rs. 4/Kg), SSP (Rs. 3/Kg), and MOP (Rs. 2 /Kg) and their transportation cost was ranged between Rs. 0.06 to 0.43 per Kg. The study also revealed that in the area under study nearly 50 per cent of soybean as well as wheat growers found to apply organic fertilizer in the form of Farm Yard Manures in small quantity in their field of soybean (20363 Kg/acre) and wheat (15083 Kg/acre).

The positive impact of soil testing on productivity of soybean and wheat was observed in the area under study. On an overall basis an average farmer obtained 24.4 & 20.2 per cent more income and 16.2 & 15.4 per cent more yield than the control farmers in production of soybean and wheat crop respectively. It was also observed that the yield of soybean and wheat at overall level was found to be increased by 10.20 and 8.30 per cent respectively after adoption of recommended doses of fertilizer by soil test farmers. Amongst different size of farmers the increase in yield was found maximum in marginal (17.9%) followed by large (10.5%), medium (10.0%) and small (2.5%) farmers in case of soybean, while in case of wheat it was found to be maximum in marginal (17.0%), small (6.1%), medium (5.7%) and large (4.8%) farms.

There were various changes have been observed by soil test farmers in soybean and wheat crops after application of recommended doses of fertilizers. The most important changes reported by the majority of soil test farmers was found to be improvement in grain filling, increase in crop yield, less incidence of pest and diseases, improvement in crop growth, and decrease in application of other input like seed, labour and pesticides etc. Hence, it is clear from the above results that there is still an immense scope for increasing level of producing crop and income of farmers if all the farmers adopted the soil test based recommended doses of fertilizer in cultivation of crop, against the blanket application of fertilizer by farmers in their fields.

The Suggestions and Policy Recommendations from the study are as follows

On the basis of findings of the study, the following suggestions and recommendation are emerged:

1. The impact of soil testing is found positive and encouraging hence, laboratories may be kept informed on the outcome of the recommendations made by them on fertilizer use at least on representative and typical case by case basis, e.g. where the recommendation has given as expected / better than expected results and where it has not given results as expected.
2. As the Department of Agriculture found to be an effective and live linkage between the field and the laboratory. It is to be appreciable if each lab may adopt at least one nearby village from where sample may be collected by the laboratory staff and recommendations are also communicated / handed over directly by the laboratory staff to the farmers and to follow the outcome of the programme. Each lab can take up one village as a mission to see the utility of the programme by itself and find out shortcomings so that the whole programme can be improved on the basis of such direct observation / study. Presently, the labs are literally cut off from the field and work in isolation of the whole programme.
3. Since the reports are often not received in time by the farmers, when sent through usual postal system, a system of online communication of reports may be started by which the soil testing laboratory may send the report to the Block Development Officer (BDO) to at least cut the postal delays. The farmers often visit BDO's office for various other activities and may be able to

collect reports. This however also presupposes that all the soil testing laboratories are provided with computer facilities. Keeping the cost in mind, the system of on-line communication reports and electronic soil health card on farmers mobile with recommendation of the reference crop may be started in the selected laboratories initially and then to cover all the labs. Timely availability of soil testing report was a lacuna in adoption of recommendation hence, the soil health card so issued to the farmers may be periodically updated so as the farmers are aware about the changing fertility status of their land. This card may also be useful to the farmers in getting loans for agriculture purposes where agricultural value of the land may be one of the factors.

4. Recommended fertilizers not available in local market hence, supply of recommended fertilizers should be ensured by the state government in different districts.
5. It was found during the investigation that the present infrastructure of soil testing facility is found to be insufficient in the districts under study. Whatever infrastructure is available is not functioning properly hence, coverage of target/achievement needs to be increased by employing skill and trained staff in these labs. This is needs to be increased quantity as quality of soil sample testing. There is an ample scope to improve the analyzing capacity as well as dissemination ability of the soil testing laboratories. If this, coupled with professional management through proper linkages, can bring radical changes in the soil testing service in the state to extent the farmers' satisfaction. Each laboratory may be provided with the required staff, according to its capacity. Each laboratory may be headed by a technical person having M.Sc. (Soil Science & Agri. Chemistry) as an essential qualification or B.Sc. (Ag.) with a minimum of 5 years experience of working in soil testing / soil Survey / fertilizer testing lab. There should be no relaxation in this stipulation so that the technical flaw in the programme is removed. Exploring the possibilities of setting up soil testing facilities on subsidy with private and NGO partners or students from agricultural universities could be a viable option.
6. Farmers not have skill for collection of sample and credibility of sample was found doubtful Special care may be taken for collection of representative soil

samples. Validity of sample has to ensure at all levels-starting from collection stage to storage in lab even after analysis.

7. It is clear from the study that farmers were found to attended only 1 training of one day hence, by providing training and certification on soil testing recommendation and use of bio-fertilizer and organic fertilizer and how it's benefited for improvement of soil texture and structure, government could encourage agricultural science graduates to provide basic agricultural services to the farmers at a reasonable cost. Therefore, the new policy, though in the right direction, requires a supplementary programme to provide farmers with basic agricultural extension services and empowers them with information, consultations and demonstrations. The linking of agricultural policy, fertilizer policy, water policy and environmental policy is very important from the point of view of sustainable development of land and water resources.
8. In-charge of the soil testing lab may also participate in the *kharif /rabi* conferences being organized by the state to formulate various recommendations relating to input use/crop variety etc. Orientation training of the in-charge may be organized once a year for a period of minimum 3 days in any of one the Agriculture University of the State.
9. Soil analysis and fertilizer recommendation is only a part of the soil testing service. To a good measure, the efficiency of the service depends upon the care and efforts put forth by extension workers and the farmers in collection and dispatch of the samples to the laboratories and obtaining reports timely. Its effectiveness also depends upon the proper follow up in conveying the recommendations to the farmers, including the actual use of fertilizer according to the recommendations. The role of extension service, soil chemists and the agronomists in the field is important. The service is suffering both from technological aspect and due to inadequate and untrained manpower. Weakness of the programme in its various aspects as discussed above needs improvement.
10. The awareness about soil testing facility, its need and importance is at the farmers' level hence, awareness building must be taken up by extension activities. As the adoption of recommendations of soil testing reduces cost of production of crops and increases returns. This fact may be popularized

among the farmers' so that they can be benefited. Sufficient field staff with trained personal should be kept at village level and method as well as result demonstrations of these technologies may be taken up at the village level which popularized the impact of these technologies in front of the cultivators.

11. The new nutrient-based subsidy policy should have a component of agricultural extension services with environmental education and awareness for the farmers. While farmers' willingness to adopt bio-fertilizers and organic farming is high, lack of sources of information/consultations make them reluctant to adopt them. Therefore, provision of basic agricultural extension services at village level could make the new fertilizer policy more relevant for the farmers.

*****

ANNEXURE - I

REVIEWER COMMENTS AND ACTION TAKEN REPORT

1. **Title of the draft report examined:**

   Adoption of Recommended Doses of Fertilizers on Soil Test Basis by Farmers in Madhya Pradesh

2. **Date of receipt of the Draft report:** February 07, 2015.

3. **Date of dispatch of the comments:** April 1, 2015.

4. **Comments on the Objectives of the study:**

   All the objectives of the study have been addressed

5. **Comments on the methodology**

   Common methodology proposed for the collection of field data and tabulation of results has been followed.

6. **Comments on analysis, organization, presentation etc.**

(i) **Chapter III**- Disrtibution of Sample Households by Farm Size Category (% of HHs) has to be presented seperately.

Action: Already presented in Chapter I under Data and Methodology section in Table 1.6 number of selected respondents according to their size of farms.

(ii) Table 3.1, 3.2, 3.3, 3.4, and 3.5: the data in the table is presented for different farm size categories, which is not according to the reference table format. Therefore the table should be rebuilt according to the reference table.

The analysis must be done seperately for each crop and to be presented in different tables.

Action: Done as per comment.

(iii) Table 3.4: Cropping pattern of the sample household must be presented under different seasons.

Action: Done as per comment.

(iv) Table 3.8: In present table the credit outstanding from different sources only is presented. But the percentage of farmers who availed credit from different sources is not presented which has to be added.

Action: Done as per comment.

(v) **Chapter IV:** Table 4.1: Each crop must be presented in different tables.

Action: Done as per comment.

(vi) Table 4.3 and Table 4.4: The table states that all the farmers have opined all the reasons which is not technically right, therefore it can be reanalysed. In fact, the motive of the table is to understand the important reasons for soil testing among the set of reasons given in the table as opined by sample households. Later, the percentage of farmers opining that particular reason must be presented in total column and the ranking given by them to that particular reason must be distributed among three categories of ranking like most important, important and least important.

Action: Done as per suggestion.

(vii) The table showing average quantity of fertilizer recommnded based on soil test is missing.

Action: Done as per suggestion.

(viii) Table 4.6 – Reference table format should be followed.

Action: Done as per comment.

(ix) **Chapter V** – Table 5.2: Refer the suggestions given for Table 4.3 & 4.4.

Action: Done as per comment.

(x) Table 5.6.1 and 5.6.2: The column total in each category must add upto 100.

Action: Done as per comment.

(xi) Table 5.8 Table 5.9: These particular tables have to be analysed seperately for each crop.

Action: Done as per comment.

(xii) **Chapter VI** – Table 6.2: Refer the suggestions given for Table 4.3 & 4.4.

Action: Done as per comment.

(xiii) **Chapter VII** – Authors are suggested to edit the chapter based on corrections made in the previous chapters and support the findings with suitable reasons.

Action: Done as per suggestion.

(xiv) Authors should provide economic explanation of data presented in all the chapters. **It is suggested to copy edit the report before finalizing.**

Action: Done as per suggestion.

(xv) ***Strictly adhere to the reference Table Format sent across different AERCs as it helps us in consolidation of the report.***

Action: Done as per comment.

7. **Overall view on acceptability of report**.

Authors are requested to incorporate all the comments and submit the final report for consolidation.

ANNEXURE - II

Procedure of soil sampling analysis

The testing in the laboratory requires only a few grams of the soil sample, yet the sample sent to the laboratory must be a true representative of the field in question. In a homogenous field, soil samples from plough layer (0-15cm) should be selected randomly in a zigzags manner. The samples should not be collected from near the bunds, water channels, field paths and heaps of crop straw, stubbles, manure, etc.

- The sample collected from the selected sites should be composite and mixed thoroughly in a container.
- From this lot a representative sample, about 500 gm should be taken out and air-dried under shade.

Table 1: Prescribed Area for taking Soil Samples

S. No.	Land Use	Area(ha)
1	Pastures, permanent grass	5-10
2	Cultivated Crops: -level terrain -eroded terrain -irrigated terrain	 2-5 1-2 0.5 - 1
3	Orchards, vineyards, forests	0.5 - 2
4	Vegetable gardens, irrigated	0.5 - 1
5	Greenhouse, nursery, lawns	0.1 - .2

- The air-dried sample should be transferred into a clean cloth bag bearing a slip with a mention of complete address, field number, cropping sequence being followed, source of irrigation (tube well/canal), soil type (coarse textured fine textured, alkali or waterlogged), fertilizer/manure schedule followed in the preceding crops and any other specific observation about the soil and/or the crops grown therein.
- Then the sample should be taken to the laboratory where facilities for testing soils for micronutrients are available.

When to Take Samples

At least one month before planting time. As a rule 'if soil is too wet to plow, it is too wet to sample'. Try collecting samples at the same time every year

Frequency of Soil Sampling

Soils from coastal plains, sandy, light textured soils - sample once after every 2-3 crops Salty, clay loams and mountain soils- sample once every four cropping years.

Soil Sampling Tools

Easy to clean, rust resistant, strong and easy to use

- Take small, equal volume of soil from each sub-sampling site to obtain composite size.
- Adaptable to dry sandy soils as well as moist sticky soil
- Provide uniform cores or slices of equal volume at all spots within the composite area
- Soil tube, screw auger, spade, shovel are some of the sampling tools most commonly- used.

If spade or shovel is used, it is advisable to make a 'V' shaped cut into soil at required depth and few cm thick vertical slice is removed to the same depth from both sides. Before sample collection, organic debris, rocks and trash must be removed from the surface of sampling area.

Depth of Sampling

In Table 2 the appropriate depth for taking soil sample is given follows

Table 2: Prescribed Depths of soil Sampling

S.No	Crop/Soil	Sampling Depth (c.m.)
1	Arable crops	15
2	Orchards	20-30
3	Lawns and Turf	10
4	Gardens	15
5	Deep rooted crops / Problem soils	30/60
6	Regular tillage	20
7	Minimum tillage	15
8	Zero tillage	15-20
9	Pastures and Forages	8/10

Ratings of soil test parameters

The Ratings of soil test parameters is given in table 3.

Table 3: Ratings of soil test parameters

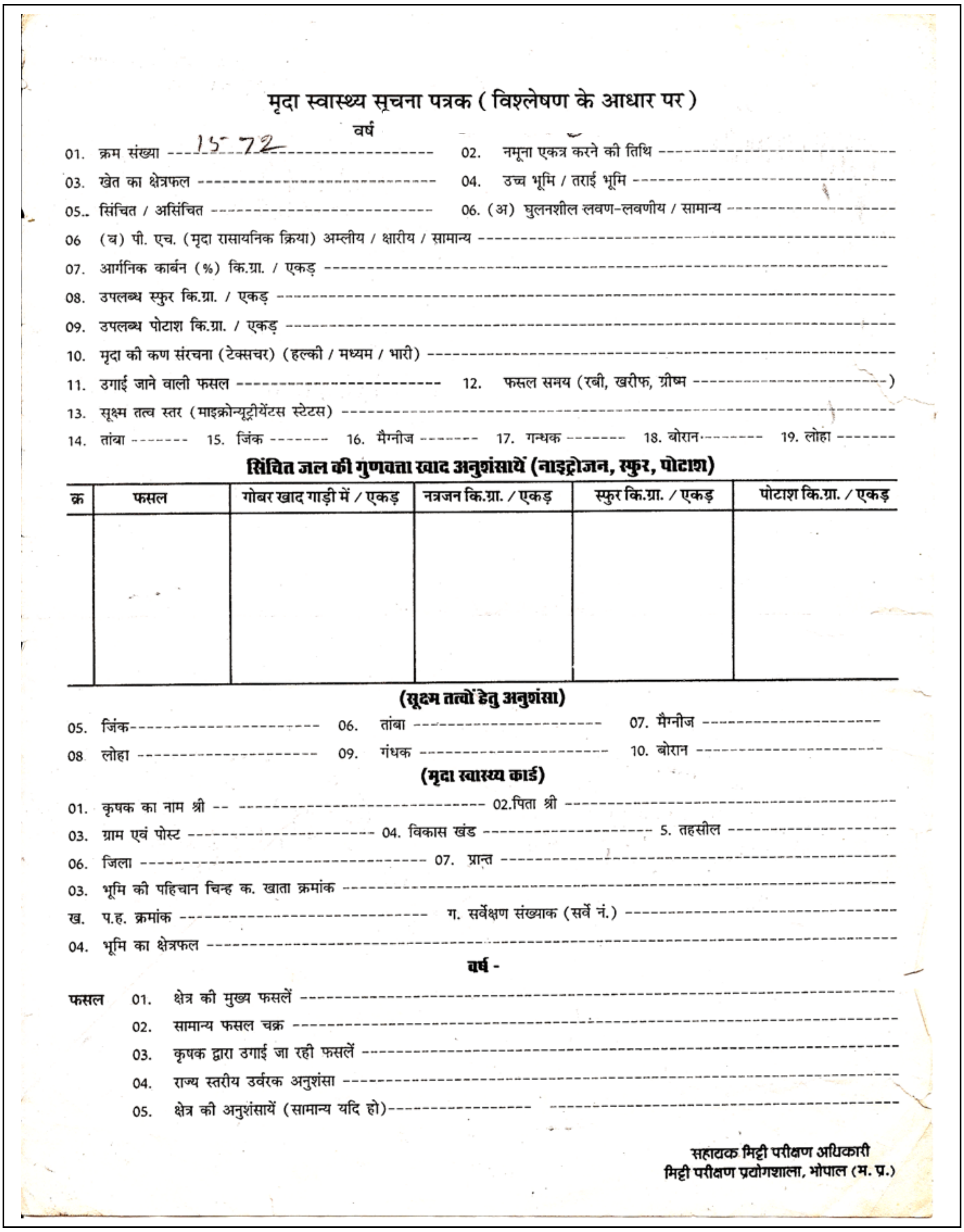
S. NO	Nutrients	High	Medium	Low
1	Organic carbon (%) as a measure of available N	<0.5	0.5 - 0.75	>0.75
2	Available N by alkaline permanganate method (kg/ha)	< 280	280-560	>560
3	Available P by Olsen's method (kg/ha)	<10	10-24.6	>24.6
4	Available K by ammonium acetate method (kg/ha)	<108	108-280	>280

ANNEXURE - III

Table 1: List of soil testing laboratories in Madhya Pradesh.

S.no.	District	Laboratory under				Total
		Agriculture Department	J.N.K.V.V. Jabalpur	Mandi board	Gov. P.G. College	
1	ASHOKNAGAR			1		1
2	ANUPPUR			1		1
3	BALAGHAT	1	1			2
4	BARWARI				1	1
5	BETUL	1				1
6	BHIND	1				1
7	BHOPAL	1				1
8	BURHANPUR			1		1
9	CHHATARPUR	1				1
10	CHHINDAWARA	1	1			2
11	DAMOH	1				1
12	DATIA			1		1
13	DEWAS			1		1
14	DHAR	1				1
15	DINDORI			1		1
16	GUNA		1	1		2
17	HARDA			1		1
18	HOSHANGABAD	1	1	1		3
19	INDORE	1	1	1		3
20	JABALPUR	1	1			2
21	JHABUA	1	1			2
22	KHANDWA	1	1			2
23	KATNI			1		1
24	KHARGONE	1	1			2
25	MANDLA			1		1
26	MANDSAUR	1				1
27	MORENA	1	1			2
28	NARSINGPUR	1				1
29	NEEMUCH			1		1
30	PANNA			1		1
31	RAISEN			1		1
32	RAJGARH		1	1		2
33	RATLAM			1		1
34	REWA	2	1			3
35	SAGAR	1	1			2
36	SEONI		1	1		2
37	SEHORE	1	1			2
38	SHAHDOL			1		1
39	SHAJAPUR			1		1
40	SHEOPUR			1		1
41	SHIVPURI			1		1
42	SIDHI		1			1
43	TIKAMGARH	1	1			2
44	UJJAIN	1	1			2
45	UMARIA			1		1
46	VIDISHA			2		2
47	GWALIAR	1	1			2
48	SATNA			1		1
TOTAL		24	19	26	1	70

ANNEXURE - III



मृदा स्वास्थ्य सूचना पत्रक (विश्लेषण के आधार पर)

वर्ष

01. क्रम संख्या ---15 72------------------ 02. नमूना एकत्र करने की तिथि ----------------------------
03. खेत का क्षेत्रफल ---------------------------- 04. उच्च भूमि / तराई भूमि ---------------------------------
05.. सिंचित / असिंचित -------------------------- 06. (अ) घुलनशील लवण-लवणीय / सामान्य -------------------
06 (ब) पी. एच. (मृदा रासायनिक क्रिया) अम्लीय / क्षारीय / सामान्य ---
07. आर्गनिक कार्बन (%) कि.ग्रा. / एकड़ ---
08. उपलब्ध स्फुर कि.ग्रा. / एकड़ ---
09. उपलब्ध पोटाश कि.ग्रा. / एकड़ --
10. मृदा की कण संरचना (टेक्सचर) (हल्की / मध्यम / भारी) --
11. उगाई जाने वाली फसल ------------------------ 12. फसल समय (रबी, खरीफ, ग्रीष्म ------------------------)
13. सूक्ष्म तत्व स्तर (माइक्रोन्यूट्रीयेंटस स्टेटस) --
14. तांबा ------- 15. जिंक ------- 16. मैग्नीज ------- 17. गन्धक ------- 18. बोरान ------- 19. लोहा -------

सिंचित जल की गुणवत्ता खाद अनुशंसायें (नाइट्रोजन, स्फुर, पोटाश)

क्र	फसल	गोबर खाद गाड़ी में / एकड़	नत्रजन कि.ग्रा. / एकड़	स्फुर कि.ग्रा. / एकड़	पोटाश कि.ग्रा. / एकड़

(सूक्ष्म तत्वों हेतु अनुशंसा)

05. जिंक---------------------- 06. तांबा ---------------------- 07. मैग्नीज ---------------------
08 लोहा --------------------- 09. गंधक ---------------------- 10. बोरान ----------------------

(मृदा स्वास्थ्य कार्ड)

01. कृषक का नाम श्री -- ---------------------------- 02.पिता श्री ---------------------------------
03. ग्राम एवं पोस्ट ---------------------- 04. विकास खंड -------------------- 5. तहसील --------------------
06. जिला --------------------------------- 07. प्रान्त --
03. भूमि की पहिचान चिन्ह क. खाता क्रमांक --
ख. प.ह. क्रमांक ----------------------------- ग. सर्वेक्षण संख्याक (सर्वे नं.) -------------------------------
04. भूमि का क्षेत्रफल --

वर्ष -

फसल 01. क्षेत्र की मुख्य फसलें ---
02. सामान्य फसल चक्र --
03. कृषक द्वारा उगाई जा रही फसलें ---
04. राज्य स्तरीय उर्वरक अनुशंसा --
05. क्षेत्र की अनुशंसायें (सामान्य यदि हो)------------------ ------------------------------------

सहायक मिट्टी परीक्षण अधिकारी
मिट्टी परीक्षण प्रयोगशाला, भोपाल (म. प्र.)

Fig. 1: Soil Test Instruction Format for farmers to test their soil.

Study No.-114

ADOPTION OF RECOMMENDED DOSES OF FERTILIZERS ON SOIL TEST BASIS BY FARMERS

Executive Summary

AGRO- ECONOMIC RESEARCH CENTRE FOR MADHYA PRADESH AND CHHATTISGARH

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.)

January 2015

EXECUTIVE SUMMARY

The soil testing programme was started in India during the year 1955-56 with the setting-up of 16 soil testing laboratories under the Indo-US Operational Agreement for “Determination of Soil Fertility and Fertilizer Use”. In 1965, five of the existing laboratories were strengthened and nine new laboratories were established with a view to serve the Intensive Agricultural District Programme (IADP) in selected districts. To meet the increasing requirement of soil testing facilities, 25 new soil testing laboratories were added in 1970. In addition to this, 34 mobile soil testing vans were established under the joint auspices of the Technical Cooperation Mission of USA (TCM), Indian Agriculture Research Institute (IARI) and Government of India to serve the farmers in remote areas and also provide education to the farmers about benefits of balanced fertilization through group discussions, demonstrations, film shows etc. The idea to create the mobile soil testing facility was to serve the farmers almost at their doorsteps. The capacity of the soil testing laboratories in the intensive agricultural districts was initially created to analyse 30,000 soil samples annually by each laboratory.

Success or failure of soil testing programmes largely depends on rapidity providing correct information to farmers, ability of the programme to provide service to a large group of farmers in a particular area, proper analysis and interpretation of results and recommendations that when followed are profitable for the farmer. Then only will this service be effectively utilized to improve local agricultural production Time and quality consciousness in the service is a real challenge for the analysts in the new millennium. This compels laboratory to adopt rapid, reliable, time saving procedures and methods to meet future requirements. The farmer's confidence in the programme can be established only by demonstrating that it actually provides a means of improving his profit. Looking to the importance of the soil testing in farmers’ field this study had been conducted as the review of various studies reported that the recommendations of soil testing laboratories are useful for farmers for increasing their levels of output but the majority of the farmers have not been interested in this, due to lack of knowledge about soil testing facilities, testing of soils is incredible, laboratories are situated far away, and non availability of soil testing report etc.

The 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.

The study is confined to soybean and wheat crop as these are the important crops of the Madhya Pradesh covering 56.6 and 16.4 per cent area of the country respectively.

A multistage purposive sampling method was used to select the districts, blocks, villages and farm households. At the first stage two districts having highest area in these crops in the state have been selected purposively for soybean and wheat. Therefore, Shajapur & Ujjain, and Hoshangabad and Vidisha districts have been selected for soybean and wheat in Madhya Pradesh respectively. In second stage, two blocks from each districts were selected again on the basis of highest area in the selected districts. Shajapur & Kalapipal blocks in Shajapur district, and Ujjain & Badnagar blocks in Ujjain district have been selected for soybean, whereas Hoshangabad & Babai blocks in Hoshanagabad, and Vidisha & Gyaraspur blocks in Vidisha district have been selected for wheat. A cluster of three villages in each selected block have been further selected for conducting the primary survey. A list of all the soil tested and other farmers in each village were collected from respective Soil Testing Laboratory and Department of Agriculture for the year 2012-13 and a sample of 60 soil test farmers and 30 control farmer per crop were selected randomly from each district for assessing the application of recommended dose of fertilizer and its impact on crop production. Thus, the study covers 240 treated and 120 control households comprising of 360 sample households, 180 each for soybean and wheat in Madhya Pradesh. These selected households were further classified into four different groups according to their size of farms i.e. marginal (less than 2.50 Acres), small (2.51-5.00 Acres), medium (5.01-10.00 Acres) and large (above 10.01 Acres) farmers.

Both primary and secondary data have been collected for the study. The primary data were collected from the sample households on different aspects of the study viz. social and economic characterises, operational holding, land utilization pattern, cropping pattern, farm assets, agriculture credit outstanding, purpose of agriculture loan, reason for soil testing, status of soil health, application of fertilizer, actual quantity of fertilizer applied, constraints in applying recommended dose of fertilizer etc. by the sample households through interview schedule provided from the coordinator (Agriculture Development and Rural Transformation Centre), Institute for Social and Economic Change, Bangalore) of the study and tested in local conditions of the Madhya Pradesh. The reference period of the study was 2013-14. The secondary data have been collected from *http://www.urvarak.co.in/* and Department of Farmers' Welfare and Agriculture Development (State Department of Agriculture), Madhya Pradesh, Bhopal on fertilizer consumption from the year 2001 to 2013 to analyze trend in fertilizer consumption in Madhya Pradesh.

The list of farmers who got their soil tested were collected from the respective soil testing laboratory and state Department of Agriculture for the year 2012-13 to assess the adoption of recommended dose of fertilisers. In light of stated objectives the classification, tabulation and analysis of data have been done by using Statistical Package for the Social Sciences (SPSS) software.

The major findings of the study are as follows

The consumption of K fertilizer in kharif season was also found to be increased from 2.6 (2000) to 4.2 Kg/ha (2011) with the fluctuation of 39.60 per cent and showed an annual simple and compound growth of 8.11 and 8.75 per cent respectively in Madhya Pradesh. Amongst the different nutrients the consumption in fluctuation was found to be more in K (39.60%) than P (11.60%) and N (23.75%) in Rabi season during the period under study. Madhya Pradesh (84.79 kg/ha) in a state where average per ha fertilizer consumption was found to be 35.93 per cent less than the India's total per ha fertilizer consumption.

The trend of all the nutrients of fertilizer consumption was found to be positive and upward during the period 2000-2013. The total NPK fertilizer consumption was found to be increase with the annual growth of 7.93 % per annum (simple) and 8.29 per cent per annum (compound) in the state. Amongst different nutrients the growth (simple) of K (8.61%/annum) was found to maximum as compared to N (7.90%/annum) and P (7.85%/annum). The trend and growth of kg/ha consumption was also found to similar with minor variation when compared different season i.e. Kharif and Rabi. The average total fertilizer consumption was found to be maximum in Rabi (72.02 kg/ha) than Kharif season (47.34 kg/ha), as wheat and soybean were found to be major crops in Rabi and Kharif season and fertilizer requirement was more for wheat as compared to soybean. The trend and growth of fertilizer consumption was found to positive and upward but growth (compound) of total fertilizer (NPK) consumption was found more in Kharif (10.88%/annum) as compared to Rabi (4.79%/annum). This statement was also true for individual nutrients i.e. N, P and K consumption.

The socio economic characteristics of soil test as well as control farmers were also observed and found that these were found to be similar as the majority of the respondents were male and their main occupation was agriculture. The average age of the respondents was found to be 46 years. The majority of respondents belong to medium and large holdings followed by marginal and small. In their family their were found 5 (control) to 6 (soil test) family members. The majority of respondent were from OBC followed by SC and ST categories. The more number of large farmers found to be member of association as compared to medium, small and marginal farmers. An average farmer found to operate 7.5 acres (control) to 8.7 acres (soil test) of cultivated land, out of which 98 to 99 per cent of land was found to be operated twice in a year. Bore wells followed by open wells, well and canals were found to be main sources of irrigation.

Soybean in kharif and wheat in rabi season were found to be main crops cultivated by the respondents in the area under study. The other crops found to be cultivated by them were paddy, gram, lentil etc. All the respondents whether related to soil test or control categories used HYVs seeds for production of cereals, pulses and oil seeds but the seed replacement rate was found to be very low and varies between 0.73-19.37 per cent per year in the area under study . The total output obtained was valued to be Rs. 7688 (control) to Rs. 10094 per acre (soil test). Out of which output of Rs. 5997 (control) to 8240 (soil test) per acre was sold out in the market. The total value of farm assets was found to be between Rs. 131663 (control) to 224399 (soil test) per households and their total agriculture outstanding was ranged to between Rs. 36887 (control) to Rs. 79363 (soil tested) per households and as the size of farm found to be increases their total assets and total agriculture outstanding found to increased. The majority of HHs were found to avail agriculture loan facilities whether related to soil test or control category. The main purpose of obtaining loan was for seasonal crop cultivation followed by purchase of tractors and live stock. As far as participation in training programme is concerned, only 26 per cent of control and 36 per cent of soil test farmers were found to attend a training of one day in the area under study.

The detail information of soil testing and recommended doses of fertilizers of different categories of soil test farmers of soybean and wheat crop were analyzed and observed that the maximum number of large farmers i.e. 43 per cent in soybean and 40 per cent of wheat growers tested their soil once in the last 3 year. An average farmer covered 21-65 km distance to get their soil tested and the average cost incurred in testing of soil samples was found to be Rs. 5-26.9 per sample. As the distance from farm to soil testing laboratory increases the cost of soil testing was also found to be increased. The proportionate relationship was observed between the cost of soil testing and distance from farm to soil testing laboratory. On an average a soybean and wheat grower had taken 1 sample per plot from a single plot which covered only 17 per cent (6.2 acre) and 9 per cent (3.7 acre) of their operational holding respectively.

The main source of information of soil testing farmers was State Department of Agriculture, from where 69 per cent of soybean and 73 per cent of wheat respondents received information about soil testing technique. The other sources of information were Krishi Vigyan Kendra (KVK), neighbours, friends and private companies for both the crops.

The most important reasons for soil testing by sample respondents were found to increase the crop yield and for adoption of new technological practices for their crops. The important and least important reasons for soil testing were pressure of peer farmers' group.

The main important reason for not testing soils during last 3 years by control farmers as reported by majority of respondents were found that they didn't know whom to contact for details on soil testing, no knowledge related to soil testing in cultivation of soybean and wheat crop. The most important reason for not testing soils as reported by majority of HHs was soil testing is not required for my field as crop yield is good and soil laboratories are located far away. The least important reason was they did not know how to take soil samples.

The majority of the respondents reported that the status of soil health was found to be normal. The status of phosphorus and potassium are medium. As regards to wheat crop the status of nitrogen was found to be low in the area under study.

The recommended doses of nutrients applied for the soybean crop was found to be 8 kg N: 24 kg P: 8 kg K: 8 kg S per acre which are fulfilled by using 151 Kg of SSP, 13.3 Kg Potash, (Basal application) and 17.4 Kg Urea per acre (Split dose). Or fulfilled by using DAP, 52.6 kg, Potash 13.3 kg and Sulphur 8.09 kg as basal application. The recommended doses of nutrients for the wheat crop 49 kg N: 24 kg P: 16 kg K per acre which are fulfilled by using DAP, 52.6 kg, Potash 24.6 kg and Urea 46.5 kg per acre as basal application and 23.2 Kg Urea split in 2 stages at the time of intercultural operation and during vegetative growth respectively. Zinc 10 Kg per acre as basal application once in three years.

On overall basis only 43.9 (Soybean) and 46.1 per cent (Wheat) of soil test farmers used to apply recommended doses of fertilizers, which were ranged between 33.2 (Medium) to 53.3 per cent (Marginal), and 37 per cent (Small) to 55.0 per cent (Large) in different categories of farms respectively for soybean and wheat. The respondents were found to cover only 58.19 and 52.37 per cent of cultivated area by recommended doses of fertilizers under Soybean and Wheat respectively. These respondents were found to apply these recommended doses of fertilizer only for a season. The 40.2 and 41.9 per cent of soybean and wheat growers were willing to continue applying these doses of fertilizer in future.

The most important constraints found during the course of investigation and reported by the majority of soil test respondents were soil testing report not available in time, difficult to understand and fallow the recommended dose, no technical advice on method and time of fertilizer application and high price of fertilizer. The State Department of Agriculture was found to be main source of awareness and source of information as reported by more than 80 per cent of respondents. However, the awareness in control farmers was found only between 2 (marginal) to 16.7 per cent (large) in case of soybean growers, and 5 (marginal & large) to 10.0 per cent (small) in case of wheat growers.

The actual quantity of fertilizer applied by an average respondent for cultivation of soybean and wheat per acre were found to be 4 Kg Urea, 34 Kg DAP, 6 Kg MOP, 45 Kg SSP, 7 Kg $ZnSO_4$, & 4 Kg Gypsum, and 4 Kg Urea, 64 Kg DAP, 3 Kg MOP, 44 Kg SSP, 1 Kg $ZnSO_4$ & 1 Kg Gypsum respectively, which was found more than the recommendation. Hence, it is clear that the respondents were found to apply more fertilizers than the recommendation in cultivation of soybean and wheat in the area under study, which not only disturb the soil texture and structure of soil at one end but also causes the remarkable loss in production as well as income of the farmers on the other.

The majority of respondents whether related to soil test or control category were used to follow basal application of fertilizer using line followed by broadcasting method of application of chemical fertilizer in cultivation of soybean and wheat. The main sources of purchase of chemical fertilizer by control as well as soil test farmers were found to be Co-operative societies followed by private dealers in the area under study. Amongst different fertilizers the DAP (Rs. 23/Kg) was found to be more costly than ZnSO4 (Rs. 10 /Kg), Urea (Rs. 4/Kg), SSP (Rs. 3/Kg), and MOP (Rs. 2 /Kg) and their transportation cost was ranged between Rs. 0.06 to 0.43 per Kg. The study also revealed that in the area under study nearly 50 per cent of soybean as well as wheat growers found to apply organic fertilizer in the form of Farm Yard Manures in small quantity in their field of soybean (20363 Kg/acre) and wheat (15083 Kg/acre).

The positive impact of soil testing on productivity of soybean and wheat was observed in the area under study. On an overall basis an average farmer obtained 24.4 & 20.2 per cent more income and 16.2 & 15.4 per cent more yield than the control farmers in production of soybean and wheat crop respectively. It was also observed that the yield of soybean and wheat at overall level was found to be increased by 10.20 and 8.30 per cent respectively after adoption of recommended doses of fertilizer by soil test farmers. Amongst different size of farmers the increase in yield was found maximum in marginal (17.9%) followed by large (10.5%), medium (10.0%) and small (2.5%) farmers in case of soybean, while in case of wheat it was found to be maximum in marginal (17.0%), small (6.1%), medium (5.7%) and large (4.8%) farms.

There were various changes have been observed by soil test farmers in soybean and wheat crops after application of recommended doses of fertilizers. The most important changes reported by the majority of soil test farmers was found to be improvement in grain filling, increase in crop yield, less incidence of pest and diseases, improvement in crop growth, and decrease in application of other input like seed, labour and pesticides etc. Hence, it is clear from the above results that there is still an immense scope for increasing level of producing crop and income of farmers if all the farmers adopted the soil test based recommended doses of fertilizer in cultivation of crop, against the blanket application of fertilizer by farmers in their fields.

The Suggestions and Policy Recommendations from the study are as follows

On the basis of findings of the study, the following suggestions and recommendation are emerged:

1. The impact of soil testing is found positive and encouraging hence, laboratories may be kept informed on the outcome of the recommendations made by them on fertilizer use at least on representative and typical case by case basis, e.g. where the recommendation has given as expected / better than expected results and where it has not given results as expected.
2. As the Department of Agriculture found to be an effective and live linkage between the field and the laboratory. It is to be appreciable if each lab may adopt at least one nearby village from where sample may be collected by the laboratory staff and recommendations are also communicated / handed over directly by the laboratory staff to the farmers and to follow the outcome of the programme. Each lab can take up one village as a mission to see the utility of the programme by itself and find out shortcomings so that the whole programme can be improved on the basis of such direct observation / study. Presently, the labs are literally cut off from the field and work in isolation of the whole programme.
3. Since the reports are often not received in time by the farmers, when sent through usual postal system, a system of online communication of reports may be started by which the soil testing laboratory may send the report to the Block Development Officer (BDO) to at least cut the postal delays. The farmers often visit BDO's office for various other activities and may be able to collect reports. This however also presupposes that all the soil testing laboratories are provided with computer facilities. Keeping the cost in mind, the system of on-line communication reports and electronic soil health card on farmers mobile with recommendation of the reference crop may be started in the selected laboratories initially and then to cover all the labs. Timely availability of soil testing report was a lacuna in adoption of recommendation hence, the soil health card so issued to the farmers may be periodically updated so as the farmers are aware about the changing fertility

status of their land. This card may also be useful to the farmers in getting loans for agriculture purposes where agricultural value of the land may be one of the factors.

4. Recommended fertilizers not available in local market hence, supply of recommended fertilizers should be ensured by the state government in different districts.
5. It was found during the investigation that the present infrastructure of soil testing facility is found to be insufficient in the districts under study. Whatever infrastructure is available is not functioning properly hence, coverage of target/achievement needs to be increased by employing skill and trained staff in these labs. This is needs to be increased quantity as quality of soil sample testing. There is an ample scope to improve the analyzing capacity as well as dissemination ability of the soil testing laboratories. If this, coupled with professional management through proper linkages, can bring radical changes in the soil testing service in the state to extent the farmers' satisfaction. Each laboratory may be provided with the required staff, according to its capacity. Each laboratory may be headed by a technical person having M.Sc. (Soil Science & Agri. Chemistry) as an essential qualification or B.Sc. (Ag.) with a minimum of 5 years experience of working in soil testing / soil Survey / fertilizer testing lab. There should be no relaxation in this stipulation so that the technical flaw in the programme is removed. Exploring the possibilities of setting up soil testing facilities on subsidy with private and NGO partners or students from agricultural universities could be a viable option.
6. Farmers not have skill for collection of sample and credibility of sample was found doubtful Special care may be taken for collection of representative soil samples. Validity of sample has to ensure at all levels-starting from collection stage to storage in lab even after analysis.
7. It is clear from the study that farmers were found to attended only 1 training of one day hence, by providing training and certification on soil testing recommendation and use of bio-fertilizer and organic fertilizer and how it's benefited for improvement of soil texture and structure, government could encourage agricultural science graduates to provide basic agricultural services to the farmers at a reasonable cost. Therefore, the new policy,

though in the right direction, requires a supplementary programme to provide farmers with basic agricultural extension services and empowers them with information, consultations and demonstrations. The linking of agricultural policy, fertilizer policy, water policy and environmental policy is very important from the point of view of sustainable development of land and water resources.

8. In-charge of the soil testing lab may also participate in the *kharif /rabi* conferences being organized by the state to formulate various recommendations relating to input use/crop variety etc. Orientation training of the in-charge may be organized once a year for a period of minimum 3 days in any of one the Agriculture University of the State.
9. Soil analysis and fertilizer recommendation is only a part of the soil testing service. To a good measure, the efficiency of the service depends upon the care and efforts put forth by extension workers and the farmers in collection and dispatch of the samples to the laboratories and obtaining reports timely. Its effectiveness also depends upon the proper follow up in conveying the recommendations to the farmers, including the actual use of fertilizer according to the recommendations. The role of extension service, soil chemists and the agronomists in the field is important. The service is suffering both from technological aspect and due to inadequate and untrained manpower. Weakness of the programme in its various aspects as discussed above needs improvement.
10. The awareness about soil testing facility, its need and importance is at the farmers' level hence, awareness building must be taken up by extension activities. As the adoption of recommendations of soil testing reduces cost of production of crops and increases returns. This fact may be popularized among the farmers' so that they can be benefited. Sufficient field staff with trained personal should be kept at village level and method as well as result demonstrations of these technologies may be taken up at the village level which popularized the impact of these technologies in front of the cultivators.
11. The new nutrient-based subsidy policy should have a component of agricultural extension services with environmental education and awareness for the farmers. While farmers' willingness to adopt bio-fertilizers and

organic farming is high, lack of sources of information/consultations make them reluctant to adopt them. Therefore, provision of basic agricultural extension services at village level could make the new fertilizer policy more relevant for the farmers.

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