CHAPTER – I

INTRODUCTION

1.1 Background

As a way of life, agriculture sector continues to be the single most important source of livelihood for the masses. The policy-makers could have succeeded in causing to develop before the farmers, government and stakeholders that achieving self sufficiency in agriculture is highly desirable for the growth of the country. In consonance with the above, the agricultural policy focus in India over decades has been on self sufficiency and self reliance on food grains production. No doubt, in the efforts to achieve self sufficiency in regard to agricultural products, discerning use of fertilizers with scientifically recommended doses is highly desirable. Considerable progress has been made on this front.

There are points to concur the fact that there has been a tremendous improvement in Indian agriculture after independence. Fertilizer uses over the years have increased. A glance on all-India consumption of fertilizers in terms of nutrients (N, P, & K) during the period 1950-51 to 2012-13; reveals a 389.27 times' increase. It was 65,600 tones in the year 1950-51 that increased to 2,55,36,100 tones in 2012-13. On seeing separately for N, P & K, it was dug out that phosphatic (P) fertilizers showed the highest increase of use by farmers (964.24 times) followed by Nitrogenous (N) fertilizers i.e., 286.56 times and Potassic (K) i.e., 200.17 times during the period 1950-51 to 2012-13. The consumption of Nitrogenous fertilizers increased from 58.7 thousand tones to 16,820.9 thousand tones during the period. The consumption of phosphatic fertilizers increased from 6.9 thousand tones to 6,653.4 thousand tones, and the same in case of potassic fertilizers increased from 10.3 thousand tones to 2061.8 thousand tones during the same period.

Table No. 1.1: All-India Consumption of Fertilizers in Terms of Nutrients (N, P, & K)

(*In '000 tones)*

Year	Nitrogenous (N)	Phosphatic (P)	Potassic (K)	Total
1950-51	58.70	6.90	---	65.60
1960-61	210.00	53.10	29.00	292.10
1965-66	574.80	132.50	77.30	784.60
1970-71	1,487.00	462.00	228.00	2,177.00
1980-81	3,678.10	1,213.60	623.90	5,515.60
1990-91	7,997.20	3,321.00	1,328.00	12,546.20
2000-2001	10,920.20	4,214.60	1,567.50	16,702.30
2010-11	16,558.20	8,049.70	3,514.30	28,122.20
2012-13	16,820.90	6,653.40	2,061.80	25,536.10

Source: Department of Agriculture & Co-operation, MoA, GoI, 2013, p. 273

Data in table 1.1 show ever increasing trend, particularly after the advent of Green Revolution, in regard to consumption of N, P & K. There was about 32.55 times increase in total consumption of nutrients N, P & K during the 46 years' period of 1965-66 to 2012-13. It was 784.6 thousand tones in the year 1965-66 that went up to 25,536.1thousand tones in 2012-13. As far the consumption of N, P & K (taken separately is concerned), these went up by 29.26 times, 50.21 times and 22.67 times respectively during the period, i.e., since the launching of green revolution.

1.1.1 Per hectare Consumption of Fertilizers

Prior to delineating picture of estimated consumption of fertilizers per hectare across the zones during the period of 2010-11 to 2012-13, it is desirable to dawn upon the names of states, that come under particular zones. Whole country has been divided in five zones, viz., (i) South zone, (ii) West zone, (iii) North zone, (iv) East zone, and; (iv) North-East zone. Southern zone comprises seven states, namely: Andhra Pradesh, (ii) Karnataka, (iii) Kerala, (iv) Tamil Nadu, (v) Puducherry, (vi) A & N Islands, and; (vii) Lakshadweep. West zone encompasses eight states. These are: (i) Gujarat, (ii) Chattisgarh, (iii) Madhya Pradesh, (iv) Maharashtra, (v) Rajasthan, (vi) Goa, (vii) Daman & Diu, and; (viii) Dadar & Nagar Haveli. North zone finites eight states of the country, namely: (i) Haryana, (ii) Punjab, (iii) Uttar Pradesh, (iv) Uttarakhand, (v) Himachal Pradesh, (vi) Jammu & Kashmir, (vii) Delhi, and; (viii) Chandigarh. East zone puts inside four states only. These states are: (i) Bihar, (ii) Jharkhand, (iii) Odisha, and; (iv) West Bengal. Under the North eastern zone, eight states are included. These states are: (i) Assam, (ii) Tripura, (iii) Manipur, (iv) Meghalaya, (v) Nagaland, (vi) Arunachal Pradesh, (vii) Mizoram, and; (viii) Sikkim.

On having a glance on the table containing data related to 'state wise estimated consumption of fertilizers per hectare (during the latest three years period, i.e., 2010-11 to 2012-13), it is revealed that except the East zone (in which Bihar, Jharkhand, Odisha and West Bengal are included), the remaining four zones showed declining fertilizer consumption per hectare taken as average of all fertilizers, i.e., N, P & K taken together in the year 2012-13 as compared to 2010-11 and 2011-12. Though, an increase of 8.40 kg/hectare only could be seen in North zone in the year 2012-13 over 2011-12. It went up to 192.32 kg/ha in the year 2012-13 in comparison to 183.92 kg/ha in 2011-12. It is interesting to note here that in East zone, total fertilizer consumption per hectare showed consecutive increases during the period 2010-11 to 2012-13. It was 130.37 kg/ha in 2010-11, increased to 157.18 kg/ha in 2011-12 and further went up to 161.08 kg/ha (average of all fertilizers) in 2012-13 in table 1.2. In regard to the uses of N, P & K separately during the period, the average of all the four states in East zone, nitrogenous fertilizers showed definite increasing trend, but phosphatic fertilizers' use remained almost same during the period. It was 41.70 kg/ha in 2010-11, and with a marginal increase, remained at 41.80 kg/ha in 2012-13.

As far potassic fertilizers are concerned, consecutive decline in its use is revealed. In the year 2010-11, per hectare use of this fertilizer was 26.37 kg, it declined to 20.97 kg in 2011-12 and further to 18.50 kg in 2012-13 (table 1.2).

Table No. 1.2: Zone wise Estimated Consumption of Fertilizers Kgs/ha during 2010-11 to 2012-13

Zone (In Avg)	2010-11				2011-12				2012-13			
	N	P	K	Total	N	P	K	Total	N	P	K	Total
South Zone	104.46	57.80	36.22	212.01	111.81	61.53	28.36	201.70	93.88	38.66	20.66	153.19
West Zone	56.46	32.95	12.03	110.73	56.86	30.77	7.78	95.40	53.25	24.69	6.71	84.64
North zone	128.74	45.21	9.88	187.29	132.97	44.42	6.53	183.92	141.43	46.30	4.59	192.32
East zone	85.06	41.70	26.37	130.37	95.63	40.57	20.97	157.18	100.79	41.80	18.50	161.08
North-East zone	26.12	11.23	12.95	52.01	27.94	9.27	12.76	49.97	29.04	9.59	13.10	51.73
All-India	86.15	41.88	13.28	146.32	86.95	39.78	12.94	139.67	139.67	33.44	10.36	128.34

Source: Department of Agriculture & Co-operation, INM Division, Govt. of India.

Data related to all-India scenario suggests a remarkable increase (nearly 1.61 times) in consumption of nitrogenous fertilizers during the recent three years' period of 2010-11 to 2012-13. It was 86.15 kg/ha in the year 2010-11 that went up to 139.67 kg/ha in 2012-13. This was quite higher than the average of east zone. In regard to consumption of phosphatic fertilizers (taken as all-India average), it declined consecutively during the period. It declined from 41.88 kg/ha of 2010-11 to 33.44 kg/ha in 2012-13. It was also quite lower in comparison to east zone in the last year. A consecutive decline in use of potassic (K) fertilizers is also expressed through data in the table taken in terms of all-India average. It fell from 13.28 kg/ha in 2010-11 to 10.36 kg/ha in the year 2012-13 (table 1.2). It is to be noted here that the all-India averages of K fertilizers are distinctly lower than that of averages of east zone (which includes Bihar also) in all the three years.

1.1.2: Varied Consumption and Indiscriminate use

Only higher quantum of chemical fertilizers being used per unit of land area will not be helpful in increasing the yield with maintenance of fertility of soil. Excess use of these fertilizers is likely to cause severe strain resulting in depletion of soil nutrients, decline in water table, build up of pest and diseases and micro-nutrient deficiency.

In India, actually level of consumption of fertilizers is highly varied within as well as between states. The consumption varied from 243 kg/ha in Punjab to 54 kg/ha in Himachal Pradesh during 2011-12. The variability in consumption of fertilizers can be attributed to different methods of cultivation, type of crops and subsidy on fertilizers. Not only this, the consumption of fertilizers also varied across farm size groups with the highest quantum of consumption recorded in case of small farmers.

Truly, indiscriminate use of chemical fertilizers by farmers with a view to increase the crop yield is a matter of genuine concerns. This has resulted into (i) deterioration of soil structure, (ii) wastage of nutrients, (iii) destruction of soil microorganisms, and; (iv) scorching of plants at the extreme cases. Intensive cultivation of crops,

differential pricing of fertilizers and subsidy like combination of factors might have contributed to excessive use of fertilizers by farmers. At the same time, many parts of the country were reported to have shown deficiency of not only primary nutrients (N,P,K), but also secondary (Sulphur, Calcium, Magnesium) and micro nutrients (i.e., Boron, Zinc, Copper and Iron). To effectively counter the threat of excessive use of chemical fertilizers, the Government of India had undertaken initiatives to ameliorate the situation and encourage the farmers for 'balanced use of fertilizers.' These initiatives among others, included (i) Decontrol of phosphatic and potassic fertilizers, (ii) National Project on Management of Soil Health and Fertility (NPMSF), and; Nutrient Based Subsidy Policy (NBSP). For revamping soil testing laboratories (STLs) in various districts under NPMSF- attempts have also been made. Further, with the view to extenuate the ill effects of excessive use of chemical fertilizers, farmers are encouraged to test their soil periodically and apply fertilizers based on the deficiency of nutrients in soil. This is actually intended to ensure balanced supply of nutrients for improving soil health and improving crop productivity.

1.2 Review of Literature

With the view to evolve wider understanding relating to the present study, the Review of Literature (RoL) has been discussed under the following heads: (i) Importance and role of fertilizers, (ii) Growth pattern of fertilizer consumption, (iii) Factors influencing fertilizer consumption, (iv) Impact of fertilizer use on production and productivity, and; (v) Other related studies.

1.2.1 Importance and Role of Fertilizer

After independence, the Indian agriculture has witnessed tremendous improvement. Fertilizer use over the years has increased. In the absence of 'scientifically budgeted cyclining of residues' to compensate nutrient export out of farms in crop production fertilizer use is the only alternative. In maximizing the agricultural production from an area, optimum fertilizer doses with other inputs play an important role.

Singh et.al (1976), in their study on 'Fertilizer use and food grain production, observed that agricultural production and level of crop yields depend upon a number of factors, like; irrigation, manures, fertilizers, improved seeds, pesticides, etc. Of these, fertilizers and improved seeds are two most important factors, as they contribute significantly towards production.

Having conducted a district level analysis on fertilizer consumption in Semi-Arid Tropics (SAT) of India using the data for the period from 1969-70 to 1978-79 *(Jha & Sarin, 1980)* found that over 62.00 per cent of the total fertilizer (N, $P_2 O_5$ & K_2O) used in the SAT districts, was consumed in the 78 irrigated districts, which had only 35.00 per cent of the SAT cropped area. It means, fertilizer consumption was mainly

concentrated in irrigated districts. Further, considerable variations were noted in fertilizer consumption between districts even within irrigated and non-irrigated categories. In terms of growth in total fertilizer consumption during the study period, the irrigated SAT districts showed better performance.

Determining the observed efficiency of fertilizers in improving the income generation capacity of small farm households, *(Prakash & Singh, 1982),* using the data from cost of cultivation project by PAU, stated that the planners should provide the right quantity of fertilizers to small farmers at right time

Having observed that the achievement in terms of fertilizer consumption was not uniform throughout the country *(Shobti Gopal, 1983)* found that the main factor, besides weather, which acted as constraints in fertilizer use, was the lack of ready, timely and adequate availability of seeds and nutrients of the right type and quality near the point of consumption. Ignorance about the efficient use of fertilizers was also cited as one of the constraints by Gopal.

Subharao, (1985), argued that there were differences in the determinants of fertilizer off-take in low, medium and high productivity districts in the region. Collating relationship between productivity levels and fertilizer off-takes during study, he noted that in both low and high productivity districts the physical and institutional environments played a dominant role in conditioning the extent of fertilizer use.

Using Cobb-Douglas production function fitted to assess the efficiency of manures and fertilizers for two major crops viz; bajra and wheat *(Gopal et.al, 1986)* observed that the efficient use of manures and fertilizer, and possibilities of the readjustment of resources further increases efficiency in relation to the productivity on small farms.

Having carried off the role of fertilizer, *(Ramasamy et. al, 1986)* highlighted that fertilizer has been one of the important factors contributing to the improvement of crop yields in India for the past one and half decades i.e., during 1971-86.

Rao et.al 1986, in their study, attempted to find out the risk involved in the application of fertilizers on paddy in West Godavari district, highlighting the importance of fertilizer and sounding a note of caution in its usage, they observed that fertilizer was the most important 'yield increasing input in agricultural technology.

Having collected data from wheat and paddy growers 1971-72, 1981-82 & 1985-86, *(Singh et.al 1987)* conducted a study on the pattern of fertilizer use in Punjab. Average yields of both wheat and paddy were found to have continuously and markedly increased since the early seventies. The co-efficient of variation in yield showed a narrowing of yield differential on different farms. The co-efficient of correlation between 'Nigtrogeneous fertilizer' and the yield of wheat and paddy clearly showed that the application of Nitrogen fertilizer had contributed significantly to increase the yield level.

Having evaluated the potential benefits to evolve a crop hierarchy suggesting the possible sequence of adoption and the potential benefits, which have influenced the actual adoption amongst farmers, *(Sah & Sah, 1992)* found that the farmer's behavior, considering and certainty of incremental return was the guiding force. But, the farmers' apprehension about the appropriateness of the soil test based recommendation, and incremental gains seemed to play a crucial role. Farmers with proper fertilizer use may perceive substantial incremental gains by increasing the use.

Srivastava, (1994) conceived that the application of fertilizers coupled with 'high yielding varieties (HYV) seeds and better irrigation facilities have played significant role in attaining self-sufficiency in food grains production in India. The consumption of fertilizer largely depended on rainfall and can be increased by creating awareness of fertilizer use among the farmers.

Studying the factors affecting the adoption of improved maize seed and fertilizer in northern Tanzania from a survey conducted on 246 farmers, *(Nikonya, et.al, 1997)* found that influence of fertilizer application on the improved maize seed was significant, but small in magnitude, whereas the effect of improved seed on the adoption of fertilizer was much greater.

Sengupta, (2009), observed that chemical fertilizers in India have played a major role in raising agricultural productivity in the past four decades, as a result of which self sufficiency in food grain production has been achieved.

Having ascertained the importance of HYV seeds, irrigation, agriculture chemicals, mechanization and credit, in addition to fertilizer, and looking at the vital role of fertilizers in agricultural production, Government of India has been announcing various policies to boost fertilizer consumption in a balanced proportion, *(Yadav, 2009).*

Describing four general principles of 'efficient fertilizer management' (EFM) namely: (i) right source, (ii) right rate, (iii) right time, and; (iv) right place, (Singh, 2010) reported that there were a number of specific practices, which could be classified as fertilizer Best Management Practices (BMPs).

1.2.2 Growth Pattern of Fertilizer Consumption

Framed by our planners, agricultural development strategy is aimed at increasing the use of chemical fertilizers. Food production has been accelerated in the country due to the factors like: (i) increasing population, (ii) foreign exchange, and; (iii) food shortages. It is also to be noted that Indian farmers have recognized the application of fertilizer to boost agricultural production.

While examining the data on fertilizer consumption for 286 districts in India during the period 1960-61 to 1968-69, *(Desai & Singh, 1973)* identified wide inter-district variability in fertilizer consumption. More than 80.00 per cent of nitrogen (N) & Phosphorus (P) was consumed in less than 1/3rd of the districts all through the period. At the other extreme, more than 50.00 per cent of the districts accounted for only 10.00 per cent of total fertilizer consumption. Considerable variation in compound growth rates (CGR) in consumption across the districts was further observed by them.

Having estimated the growth rates per hectare of fertilizer use in 18 major states of India using the data for the period 1968-69 to 1978-79, *(Krishnamacharyulu & Muralidhar, 1981)* observed significant and positive growth rates for all the states, except Kerala & Assam. Any significant shift in its fertilizer use status was not shown by any of the states. Large scale interstate variation in the levels of fertilizer use was found by them and no tendency of narrowing down over the period was seen.

The study by *(Bhatia, 1983)* on patterns of fertilizer consumption in India revealed that fertilizers for different crops were applied largely in major states. They emphasized the need for increasing the consumption of fertilizer in areas, where the then prevailing rates of consumption per unit of area were low, but potentials were higher.

Using co-efficient of variation as a measure of inequalities in fertilizer use, *(Singh, 1983)* examined interstate variations in levels of fertilizer consumption during the period 1961-62 to 1981-82. The degree of variation in levels of fertilizer use among the states had continued to remain high, despite the consumption levels in all the states increased over the period.

Study related to growth of consumption of fertilizers in the state of Andhra Pradesh and in different districts of the state conducted by *(Leela, 1985)* found that there were considerable variations in the level of per hectare consumption of fertilizers in different districts of Andhra Pradesh over a period of two decades (1960-1980).

An economic analysis of fertilizer application and yield rate of sugarcane in Maharashtra was carried out by *(Wagmare & Dhongade, 1985).* They concluded that sugarcane growers had not adopted the balanced use of N, P & K fertilizers. The gap between the recommended and observed levels of nitrogen was of the order of 10.00 per cent and 15.00 per cent.

In his study on growth pattern of fertilizer consumption in Gujarat, *(Patel, 1986)* examined district wise, as well as, inter-district variation in fertilizer consumption, and assessed the factors influencing the inter-district variation in fertilizer consumption. They found that the growth in fertilizer consumption was higher during 1970s as compared to that in 1960's. The extent of adoption of high value crops in the irrigation area was responsible for interstate variations in fertilizer consumption in Gujarat- the author observed.

Assessing the factors responsible for the glut in the consumption of fertilizer *(Chauhan, 1987)* found (i) unfavourable weather condition, (ii) lack of breakthrough in generic engineering, and; (iii) frequent increase in fertilizers prices responsible for a less than proportionate increase in the consumption of fertilizer when compared to the strides made in agricultural production.

While examining the Pattern, Growth and Determinants of Fertilizer use in different Regions of Bihar *(Thakur & Sinha, 1988)* found that the factors affecting fertilizer use in north, as well as, south were areas under high yielding varieties (HYVs) and rainfall. The study revealed that among the different regions, use of plant nutrients (N+P+K) was comparatively higher in the southern regions followed by northern and southern regions. In Chotanagpur region, the area under HYV and rainfall significantly affected fertilizer use. Expansion of area under HYVs with assured irrigation facilities for accelerating fertilizer use to ensure better productivity and higher yields were suggested by the study.

Analyzing the growth rate of fertilizer consumption *(Mohanam, 1989)* found that the rate of fertilizer consumption in Tamil Nadu is less than the all-India growth rate and the growth rates of fertilizer consumption of the districts in Tamil Nadu almost cluster around the state level growth rate. There was inter district variation in the growth of fertilizer use.

Fertilizer consumption pattern in the upper Gangetic plain region was studied by *(Kumar et.al, 1991).* Total NPK consumption in the region during 1989-90 was 1,349 thousand tones, which constituted about 11.70 per cent of the total fertilizer consumption of the country.

The results of a study by *(Shiyani et.al, 1991)* undertaken for estimating the NPK requirement for Saurashtra region of Gujarat state for the period 1969-70 to 1988-89 showed significant increase in P & K, while the requirement of N remained almost static. The consumption of NPK fertilizer showed a significant increasing trend suggesting that the gap between requirement and actual consumption decreased year after year.

The study related to the trend and pattern of fertilizer consumption in Orissa during 1968-1992 by *(Pradhan et.al, 1993)* found that the growth rate of total fertilizer consumption in Orissa was close to that of the all-India level.

Having examined the fertilizer use pattern for sugarcane in respect of three recovery zones of sugarcane in Maharashtra at different points of time, *(Inamke et.al, 1996)* observed that among the three recovery zones, the uses of N, P_2O_5 and K_2O fertilizers were not as per the recommendation. It was very low in 'low recovery zones,' where the productivity was also very low (50T/ha) as compared to other two zones.

In their study on fertilizer scenario in India, *(Sengar & Pant, 1996)* observed that there was a variation in both quantity and percentage use of fertilizer in southern, eastern and western parts of the country. It was also indicated that the application of improved seeds, weedicides and insecticide along with fertilizers would certainly increase the food grain production, and would result in real success of Green Revolution in the country.

1.2.3 Factors Influencing Fertilizer Consumption

In an agricultural economy like India, fertilizer consumption is influenced by factors, such as: (i) demand, (ii) price, (iii) subsidy, (iv) import, (v) government policies, and; (vi) other such factors. As far as farmers are concerned, their level of education, age, income and land size influences fertilizer consumption.

Out of a number of factors like: (i) irrigation, (ii) manures, (iii) fertilizers, (iv) improved seeds, (v) pesticides etc., on which agriculture production and level of crop yield depend, fertilizers and improved seed are most important as they contribute significantly towards production observed *(Singh et.al, 1976).*

In his study on Economic analysis of demand and supply of fertilizer in the United States *(Owusu, 1981)* found high degree of auto correlation. Having used pooled data through a two stage least square procedure, the results indicated that fertilizer, crop and price ratio were important in explaining the variations in fertilizer use.

Using static and dynamic models, *(Patil & Pandey, 1981)* attempted to examine the influence of economic and agronomic factors in determining the applications of phosphatic fertilizers at macro level. Having used Cobb-Douglas type of function to explore phosphatic fertilizer use in different states for the period 1955-56 to 1975-76, the study revealed that irrigation was the most dominating factor in increasing fertilizer consumption.

A study on nitrogenous fertilizer using time series data from 1955-56 to 1974-75 by *(Patil & Pandey 1982)* found that in Karnataka, irrigation was the only significant factor influencing fertilizer use over the period.

Using correlation and Regression analysis, impact of factors affecting fertilizer use in different states of India was determined by *(Nagaraj, 1983).* "Rainfall was relatively an unimportant variable in explaining the observed variation in fertilizer use." The factors like irrigation spread of HYVs and fertilizer intensive crops were found to have a positive and significant effect on fertilizer consumption.

Having attempted to investigate and quantify the different factors responsible for inter-state variation in fertilizer consumption levels by fitting linear and log linear regression models for two different time periods, 1970-71 and 1977-78 *(Singh, 1983)* demonstrated that irrigation, HYV crops and credit availability were the significant factors. Rainfall and size of land holding failed to show any significant effect on fertilizer use.

Rangaand Rertegi, 1983 argued that the only alternative to increase production per unit area was through judicious use of fertilizer and organic manures, besides proper management of other inputs.

The factors influencing the adoption and usage rate of fertilizer for wheat in Nepal were studied by *(Flinn & Shakya, 1985).* The study revealed that the factors related to fertilizer use in wheat were (i) area under the cultivation, (ii) extent of irrigation, (iii) transport cost, and; (iv) operators' tenure status.

While analyzing the policies for growth in fertilizer consumption, *(Desai, 1986)* opined that because of the constraints in lowering real prices of fertilizers, non-price

policies would be more crucial in determining the fate of future growth in India's fertilizer consumption.

In an interesting study by *(Parthasarthy et.al, 1986),* it was found that a 10.00 per cent change in irrigation results in around 3.00 per cent change in total fertilizer use, when (i) high yield varieties, (ii) cropping pattern, and; (iii) season effects are kept constant.

Having studied the factors influencing the use of fertilizers in plains and hilly regions of Gujarat using the time series data from 1983 to 1989 *(Kute, 1990)* found that weather factors, such as rainfall and temperature and irrigated area had direct relation with fertilizer use.

Taking into consideration three groups of factors viz., technological, economic and institutional for the study and their relative importance on fertilizer use in Tamil Nadu *(Mohanam, 1990)* found that among 14 variables chosen, only three variables were found to be significant, viz., (i) percentage (%) of area under irrigation, (ii) percentage of area underground water irrigation, and; (iii) credit extended for purchasing fertilizers.

A study on factors influencing fertilizer application for sustainable agriculture in West Coast plains and hilly regions of India was conducted by *(John & George, 1991).* The study revealed that (i) relatively high cost of fertilizers, (ii) low benefit cost ratio, and; (iii) lack of awareness for recommended dose of fertilizers for specific crops were the reasons behind the low use of fertilizers.

Using the multi-variate economic analysis for examining the factors affecting fertilizer adoption in less developed countries in Malawi, *(Green & Ngongola, 1993)* revealed that the crops grown (Maize or tobacco), farming system, access to credit, off-farm employment opportunities and regular labour required were the main factors influencing fertilizer adoption.

Demand for fertilizer in India was less sensitive to price changes was found by a study of *(Wagle, 1994).*

The result of an estimation related to price elasticity of fertilizer demand at macro level in India, using both static and dynamic models with annual data for 1966-67 to 1991-92 undertaken by *(Dholakia et.al 1995)* indicated that fertilizer demand is price inelastic.

On analyzing the fertilizer use pattern in different agro-climatic zones in Andhra Pradesh *(Rao et.al, 1998)* found wider variation in fertilizer use within and across agro-climatic zones of (AP), north Telangana zone and Krishna-Godavari zone with higher use of fertilizer.

A study on the fertilizer use in three crops namely: rice, sugarcane and cotton by *(Kayarkanni, 2000),* found that the relative price of fertilizers had a great influence on fertilizer use in all the three crops.

Study conducted to identify the factors affecting the adoption and use of fertilizers by farmers in Barak valley by *(Bezbaruah & Roy, 2002)* found the regression coefficient for operational holdings, tenancy and low land were significant and expectedly positive.

Apart from the economic factors, viz., (i) irrigation, (ii) cropping pattern, (iii) area under HYVs, (iv) prices of fertilizers, (v) certainty and size of income, (vi) capital rationing, and; (vii) labour cost--- natural factors, like (temperature and frequency of drought) also influenced fertilizer use *(Singh & Nasir, 2003).*

Having used a Log linear Cobb-Douglas production function to estimate the impact of major agriculture inputs (credit disbursement, the area under cultivation, fertilizer consumption and water availability), on total rice production in Pakistan, *(Hussain, 2012)* found the insignificance of credit disbursement and fertilizer consumption. It might be due to the presence of inefficiencies, which begs for some policy attention.

1.2.4 Impact of Fertilizer use on Production and Productivity

In determining the level of agricultural production, chemical fertilizers have played and will continue to play crucial role. The role of fertilizers in pushing Green Revolution towards éclat is noteworthy. There is no doubt that the use of chemical fertilizers is the surest and quickest way to boost crop production.

Sirohi et.al 1968, observed that favourable impact of fertilizers on food grains' production in India has been truly demonstrated.

In his study on 'Market and real price of fertilizer and impact of price changes on fertilizer consumption and production of crops; *(Donde, 1970)* observed that the output response to fertilizer use, and the real price of fertilizer as distinguished from its market price determine the demand for fertilizers.

Attempting to determine the yield and profit maximizing doses of fertilizer with or without weather risk factor for different varieties of Barley and maize crops at some

centres scattered over different parts of the country *(Sirohi & Goel, 1972)* found that profit maximizing doses, with no risk covered, were between 30 and 84 kgs per hectare and had similar trend among different varieties and centres as followed by yield maximizing doses of phosphorous.

Relationship between fertilizer use and crop yield variability, along with estimated fertilizer use efficiency by fitting production function for major crops in Haryana state, were studied by *(Singh & Pandey, 1981).* It was concluded that the crop yields were highly responsive to fertilizer application in the assured and semi irrigated regions.

A study by *(Jaffarulla & Khairuowall, 1984)* revealed that fertilizer consumption and the trend in the growth of food grains production have moved in the same direction.

Bhatnagar et.al, 1986, analyzed the scope and extent of fertilizer application to mustard. The study revealed that the application of even small doses of fertilizers to mustard crops are beneficial and assure remunerative returns.

While attempting to estimate the agricultural production under the normative use of nitrogenous fertilizers for each state, as well as for the country as a whole *(Singh & Sirohi, 1988)* found that there existed a large gap between potential and the actual food grains production. The untapped production reservoir existing in different crops could be harvested through the use of optimal level of fertilizers along with other complementary inputs like (i) irrigation water, (ii) seeds of high yielding varieties, (iii) credit, and; (iv) pesticides, etc.

Attempting a study on fertilizer use pattern in Haryana *(Ram & Mandal, 1994)* revealed that the level of fertilizer used per hectare in Haryana was low in less irrigated regions, kharif season and rainfed crops of small farms.

On analyzing the actual fertilizer use patterns, extent of their deviations from recommended doses and economics of crops at different locations in Andhra Pradesh *(Haffis et. al, 1997)* indicated wide deviations in fertilizer use from recommended dozes in almost all the crops and locations.

Establishing direct and positive relationship between significant increase in rice yield with increasing level of nitrogen up to 8 kgs of nitrogen per hectare (43.56 qtls/ha) in Sambalpur district of Orissa, *(Mohanty, 1998)* found that application of N: P: K as per soil test gives highest yield rate to grain (48.83 qtls/ha) by responding of 100 per cent nitrogen, which gives 28.01 per cent increase in yield over the control.

Shukla et.al, 1998 found during the course of their study that rice-wheat cropping system required large quantities of nutrients for sustained productivity. Therefore, it is generally not possible to reduce fertilizer doses in either of the crops.

In their study on fertilizer application for sustainable yield in long term experiments, *(Vats et. all, 1999)* observed that balance fertilization of nitrogen, phosphorous and potassium has shown to maintain the yield stability of crops. At a number of locations, results from the long term fertilizer experiments have shown that for most of the crops taken in cereals based cropping system, the yields obtained at one and a half times the optimum rates of fertilizer application were significantly higher than those under optimum (100 per cent NPK soil test based) levels.

While analyzing effects of fertilizers, irrigation and farm power in increasing food grain productivity in Uttar Pradesh, *(Singh & Chandra, 2001)* found that (i) the increased use of fertilizers, (ii) high yielding variety of seeds, and; (iii) adoption of mechanized farming will result in higher production.

1.2.5 Other Related Studies

Usage of fertilizer, undoubtedly conduces towards much cost and risk (i) unfavourable weather conditions, (ii) increase in energy cost, (iii) high price of fertilizer, (iv) over dosage of fertilizers, (v) transportation problems, (vi) packaging etc. do not allow farmers to use the required dosages of fertilizers.

In a study on Agricultural research and technology in economic development, *(Perpintrup-Anderson, 1982)* pointed out that fertilizer use is determined primarily by fertilizer and agricultural product prices.

Having attempted to find out the growth pattern and direction of disparities in fertilizer consumption in different states and regions of the country during the period 1970-71 and 1978-79 *(Rao, 1982)* revealed that fertilizer consumption in different states and regions during the period under study did not show any uniform trend.

While identifying socio-economic characteristics discriminating fertilizer users from non-users in Orissa *(Sarup & Pandey, 1982)* suggested solving the institutional problem of the area to boost up the fertilizer use.

On conducting a study on constraints in the use of fertilizers in West Bengal by using secondary data from 1980-81 to 1996-97 *(Datta et.al, 1985)* revealed that lack of irrigation facilities and inadequate extension services were the major constraints in fertilizer consumption.

Desai, (1986) in his study on fertilizer use in India, had pointed out that the agronomic potential of fertilizer use in a country is determined by factors like (i) soil quality, (ii) climatic environment, (iii) cropping pattern, (iv) genetic characteristics of crops, and; (v) use of inputs and other fertilizers.

Having attempted to estimate the agricultural production under the normative use of nitrogenous fertilizer for each state, as well as, for the country as a whole *(Chhotan & Sirohi, 1988)* found that there existed a large gap between the actual and potential food grains production. The untapped production reservoir existing in different crops could be harvested through the use of optimal level of fertilizer along with other complementary inputs like (i) irrigation, (ii) seed of high yielding varieties, and; (iii) credit.

Finding fertilizer use to be high on irrigated areas compared to dry land areas *(Velrasu et.al, 1999)* pointed out that there was a wide disparity in fertilizer use among various categories of farmers and crops.

While studying constraints in fertilizer use in Arid Zone of western Rajasthan (Singh et.al, 2000) found that among the fertilizer users, maximum farmers had applied more nitrogenous fertilizers as compared to phosphatic fertilizer and fertilizer applied was less than the recommended dose.

Fertilizer use was found to have increased both in terms of total, as well as per hectare in Punjab, as highlighted through the study by *(Valla & Dhawan, 2000).*

1.3 Need for the Study

There are concerns about the indiscriminate use of chemical fertilizers by farmers with a view to increase the crop yield. This has led to deterioration of soil structure, wastage of nutrients, destruction of soil microorganisms and scorching of plants at the extreme cases. A combination of factors such as intensive cultivation of crops, differential pricing of fertilizers and subsidy, might have contributed to excessive use of fertilizers by the farmers. At the same time, it is reported that many parts of India have shown deficiency of not only primary nutrients (N, P, K) but also secondary (Sulphur, Calcium and Magnesium) and micro nutrients (Boron, Zinc, Copper and Iron). Government of India had undertaken initiatives to ameliorate the situation and encourage the farmers for balanced use of fertilizers. These initiatives among others, included decontrol of phosphatic and potassic fertilizers, promotion of integrated nutrient management, production and promotion of organic manures and bio-fertilizers, National Project on Management of Soil Health and Fertility (NPMSF), and Nutrient Based Subsidy (NBS) policy. Attempts have also been made

to strengthen and revamp soil testing laboratories in various districts under NPMSF. Farmers are encouraged to test their soil periodically and apply fertilizers based on the deficiency of nutrients in soil. This is intended to ensure balanced supply of nutrients for maintaining soil health and improving crop productivity.

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 fertilizers, mismanagement of surface water and over exploitation of ground water. The over use of chemical fertilizers 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 fertilizers for increasing productivity of crops and for better absorption of nutrients from the applied fertilizers.

It is suggested that farmers should go for regular soil testing and use recommended doses of fertilizers 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., (i) strengthening of soil testing laboratories (STLs), (ii) promoting use of integrated nutrient management, and; (iii) strengthening of fertilizer 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 fertilizers 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 fertilizers, impact on crop productivity and relevant institutional problems prevailing in the state of Bihar.

1.4 Objectives of the Study

The objectives of the study are as follows:

i. *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, and;*
ii. *To analyze the impact of adoption of recommended doses of fertilizers on crop productivity and income of farmers.*

1.5 Data and Methodology

The present study is based on primary data collected from Bihar. The reference period for the study is 2013-14. At the first stage, two major crops in terms of area, i.e., rice and wheat, have been selected from Bihar. At the second stage, for each crop, two districts, namely East Champaran and Rohtas have been selected based on the crop area share (CAS) within the state. The area under paddy in East Champaran is estimated at 5.80 per cent and that in Rohtas district, it was 5.10 per cent of the total area under paddy in the state. These comprised quite larger area shares in the state as a whole. Similarly, in case of wheat also, CASs in Rohtas and East Champaran districts were higher estimated at 6.70 per cent and 5.20 per cent respectively.

At the third stage, from each district, two blocks have been selected again based on CAS itself. Thus, from East Champaran district, two blocks namely (i) Motihari, and; (ii) Kalyanpur were selected. In Rohtas district, the two selected blocks on the same basis were (i) Kargahar, and; (ii) Dinara.

At the fourth stage, from the selected blocks, two clusters of villages comprising 3-4 villages per cluster have been selected for conducting the survey. It is to be noted here that Motihari block was selected for paddy and Kalyanpur block for wheat. Two cluster of villages selected under Motihari block were (i) Bhataha, and; Baswariya. In Kalyanpur block of East Champaran district, cluster of villages selected comprised (i) Tenua, and; (ii) Parsauni. Selection of Kargahar block in Rohtas district was meant for paddy and that of Dinara for wheat. Cluster of villages (COVs) selected for detail study in Kargahar block of Rohtas district are (i) Basdiha, and; (ii) Semari and the same under Dinara block were (i) Akhodha, and; (ii) Bisikwan.

At the fifth stage, a sample of 60 soil test farmers per crop were selected randomly from each district for assessing the application of recommended dose of fertilizers and its impact on crop production. The cluster approach was followed to ensure that adequate number of soil test farmers could be available for survey. Further, desired care was taken to ensure that the selected villages fell under the agro-climatic conditions of sample districts, and that they could have certain common characteristics, such as (i) soil type, (ii) irrigation, and; (iii) crop variety.

At the sixth stage, 30 controls (non-soil-test farmers) have also been involved for each reference crop from each district selected purposively from the chosen cluster itself for differentiating the effect of the application of recommended dose of fertilizers on crop productivity and income.

In this way, a total of 120 soil test farmers and 60 control farmers for each crop (i.e., rice and wheat) in each of the two selected districts were interviewed. The sample farmers were classified into different farm size groups post survey as per the size of net operated area (NOA).

For better understanding of the sampling framework following outline is given:
60 soil test farmers (STFs) per crop from each district x 2 crops + 30 non soil test farmers (NSTFs) for each reference crop (i.e., 02) x 02 districts = 60 x 2 + 30 x 2 = 120 + 60 = 180 x 2 districts = 360. Thus, total number of respondents surveyed i.e., total sample size is 360.

1.6 Limitations of the Study

Reference period of the study was 2013-14. The soil test farmers per crop were to be selected randomly for each district for assessing the application of recommended dose of fertilizers and its impact on crop production. But, the soil test reports of the soil samples taken in 2013 couldn't be made available in hard copies (though it was mandated), to the farmers of the selected districts by the 1st week of July, 2014. So, the application of recommended doses of fertilizers and its impact on crop productivity and income of farmers could not be examined. In this sense, findings of the study have its own limitation. In this regard, the Centre has already apprised of the non-availability of soil test reports to farmers to the Co-ordinator, ADRT, ISEC, Bangalore. In response to our enciphered limitations, the Co-ordinator advised on 20th August, 2014 as noted below:

"Thanks for your letter detailing the problems in the collection of field data from the soil test farmers. As you know, major focus of this study is to examine why farmers do not test soil and if tested, what constraints they face in the application of recommended dose of fertilizers. It is clear from your letter that these research questions may not be addressed adequately in the context of Bihar state. However, since you have already collected the full information from the control farmers and partial information from the soil test farmers, you may process these information as per the table plan sent by the ADRTC. Because of the exceptional circumstances, you may slightly modify the table structure as required by you".

In the light of the above, the consequent outcome and/findings of the study will have its limited scope for generalization of facts.

1.7 Organization of the Report

Different aspects of this Chapter have been elucidated encompassing the following sections and sub-sections: 1.1 Background, 1.1.1 Fertilizers: Zone wise consumption per hectare, 1.1.2 varied consumption and indiscriminate use, 1.2 Review of literatures, 1.2.1 Importance and role of fertilizer consumption, 1.2.2 Growth pattern of fertilizer consumption, 1.2.3 Factors influencing fertilizer consumption, 1.2.4

Impact of fertilizer use on production and productivity, 1.2.5 Other related studies, 1.3 Need for the study, 1.4 Objectives of the study, 1.5 Data and Methodology, 1.6 Limitations of the Study, 1.7 Organization of the report, 1.8 Notes and references.

Besides above, the present study puts down for seven chapters. It has been mentioned as below:

Chapter-I	:	Introduction
Chapter-II	:	Trend in Fertilizer Consumption in Bihar
Chapter-III	:	Socio-Economic Characteristics of Sample Households
Chapter-IV	:	Details of Soil Testing and Recommended Doses of Fertilizers
Chapter-V	:	Adoption of Recommended Doses of Fertilizers and its Constraints
Chapter-VI	:	Impact of Adoption of Recommended Doses of Fertilizers
Chapter-VII	:	Summary and Conclusions

CHAPTER – II

TREND IN FERTILIZER CONSUMPTION IN BIHAR

2.1 Background Information

As a matter of fact, main source of nutrients in soils is chemical fertilizers. With the increase in consumption of Nitrogenous (N), Phosphatic (P) and Potassic (K) fertilizers from 1.1 million tones (MTs) in 1966-67 i.e., the year preceding the Green Revolution to 27.70 MTs in 2011-12, the all-India average consumption of fertilizers has increased from 105.50 kg/ha in 2005-06 to 144 kg/ha in 2011-12. It means that average consumption of fertilizers per hectare (ha) of land went up by 1.36 times during the last six to seven years, whereas the consumption of NPK in India showed 25.18 times increase during the 44 years' long span of 1966-67 to 2011-12. It is interesting to note here that India's consumption was much lower than that of Pakistan (205) and China (396), but little higher then Bangladesh (118). However, India must not efface in regard to fertilizer use or consumption, as its average fertilizer consumption was well above (nearly 1.34 times more) than that of the world average (i.e., 107 kg/ha). Further, very high variability has been observed in fertilizer consumption across the states and crops. While per hectare consumption was 266.11 kg in Andhra Pradesh and 243.56 kg in Punjab, the quantums of consumption were comparatively low in MP (88.36 kg/ha), Rajasthan (62.35 kg/ha), Orissa (56.52 kg/ha), Himachal Pradesh (55.18 kg/ha) and below 5 kg/ha in some of the North Eastern states.

Fertilizer consumption in Bihar was a mere 22 kg NPK/ha in TE 1982, which increased to 63 kg/ha in TE 1991 and reached a level of 82 kg/ha in TE 1998. Fertilizer consumption increased in all the zones during this period. It may be noted that growth in fertilizer consumption slackened in the 1990s as compared to the 1980s. There was wide variation in the level of its use across zones/districts. It was as high as 104 kg/ha in Zone-III and 69 kg/ha in Zone-I in TE 1998.

Total consumption of chemical fertilizers in Bihar was 731.60 thousand MT during 2004-05. The level of consumption has increased to 1064.80 thousand MT during 2006-07.

But, there is unbalanced use of N, P & K. While the ideal ratio would be 4:2:1, this was 14.7: 7:1 in 2004-05, but improved significantly to 6.8: 3:1 in 2005-06. It is hoped that this ratio may reach the desired level in the coming years. More farm households use fertilizer, improved seeds, and pesticides in the rabi (winter) season than that in the kharif season. This is primarily due to the availability of irrigation in

the winter season. For instance, 43.00 per cent of farmer households use improved seeds in the rabi season compared to an all India level of 34.00 per cent.

It is interesting to note that per hectare fertilizer (NPK) consumption in a number of districts in the state is quite high and is almost at par with those of the agriculturally advanced states like Punjab and Haryana. For instance, in 2004-05, NPK consumption per hectare was as high as 282 kgs. Khagaria, was followed by Begusarai (219 kgs), Patna (215 kgs) and Bhagalpur (211 kgs). Even in the districts like Bhojpur, Samastipur, Muzaffarpur, West Champaran, Vaishali, Purnea and Jamui consumptions were quite high ranging between 165 kgs and 176 kgs. Very low consumption per hectare was observed in Shehor 12 kgs, Supaul 19 kgs, Madhubani 28 kgs, Banka 34 kgs, Kishanganj 35 kgs and Gopalganj 37 kgs.

But despite this increase, nutrient consumption per hectare in the state is still lower than the national average. Soil Testing is another area that requires the attention of agricultural scientists and officials, so as farmers could use fertilizers judiciously. It is high time for Bihar to learn a lesson from the experience of Punjab, where soil health has suffered due to the depletion of micro nutrients and humans. Based on field level studies appropriate remedial steps have to be taken to take care of these problems.

With the view to comprehend the trend and scenario of fertilizers' consumption in Bihar, this chapter attempts to elaborately discuss the following aspects:

i. Trend of fertilizer consumption by product in the state (kg/ha), and;
ii. Trend in crop wise fertilizer consumption by nutrients (kg/ha).

2.2. Trend in Fertilizer Consumption by Product in Bihar

Table No. 2.1: Fertilizer Consumption in Bihar (kg/ha) 2009-10 to 2013-14.

Year	Fertilizer Consumption (Bihar)			Total	All-India Average			Total
	N	P	K		N	P	K	
2009-10	165.00	---	---	---	140.00	---	---	---
2010-11	175.00	---	---	---	145.00	---	---	---
2011-12	126.56	38.84	15.09	180.48	88.61	40.54	13.19	142.33
2012-13	145.31	42.58	11.77	199.66	86.15	34.08	10.56	130.79
2013-14	124.88	27.44	12.55	164.87	85.79	28.85	10.75	125.39

Source: Department of Agriculture & Co-operation, INM Division, 2014.

A glance on the table provides sufficient ground for ascertainment that during the last five years' period of 2009-10 to 2013-14, fertilizer consumption in Bihar has remained quite higher than all India average and in regard to the uses of NPK fertilizers individually also.

In the year 2009-10, fertilizer consumption in Bihar was 165 kg/ha, which was 25 kg/ha more or 1.18 times more than that of all India average i.e., 140 kg/ha. In 2010-11, there was an increase of 10 kg/ha in fertilizer consumption in Bihar (in regard to nitrogenous fertilizer), whereas the same was only 5 kg/ha in case of all-India average. The consumption of fertilizers taken together were 175 kg/ha and 145 kg/ha meant for the state and all India average respectively (table 2.1).

A quick look on data containing consumption of Nitrogen (N), Phosphatic (P) and Potassic (K) fertilizers distinctly reveal higher quantities in case of Bihar than that of all-India average during the three years' period of 2011-12 to 2013-14 except phosphatic (P) fertilizers in the years 2011-12 and 2013-14. It's all India average consumption quantities were a bit higher than that of Bihar (40.54, 28.85, 38.84 & 27.44 kg/ha) respectively.

In regard to consumption in kg/ha of NPK during the period 2011-12 to 2013-14, Bihar remained explicitly ahead of the all India average. Quantities of Nitrogenous fertilizers consumption during the above noted three years in Bihar were estimated at 126.56, 145.31 and 124.88. These were quite higher than that of all India average figures, i.e., 88.61, 86.15 and 85.79 respectively.

Consumption of phosphatic fertilizers in the year 2012-13 was quite higher in Bihar 42.58 kg/ha in comparison to all India scenario 34.08 kg/ha (table 2.1). Quantities of pottasic fertilizers consumption in Bihar were also recorded higher during the period 2011-12 to 2013-14 estimated at 15.09, 11.77 and 12.55 higher than that of all India averages i.e., 13.19, 10.56 and 10.75 respectively.

In aggregate sense, means N, P, K taken together, Bihar consumed higher quantities of fertilizer (kg/ha) in the five years i.e., 2009-10 to 2013-14, which were estimated at 165, 175, 180.48, 199.66 and 164.87, when compared with all India averages i.e., 140, 145, 142.33, 130.79 and 125.39 respectively.

2.3 Trend in Crop wise Fertilizer Consumption by Nutrients

Since the inception of Green Revolution in India, the use of fertilizers in agriculture has played a vital role in increasing productivity it. As far the state of Bihar is concerned, along with the use of better quality seeds, use of chemical fertilizers in optimum quantity (more evidently higher than even the all India average), has no doubt, played key role in increasing agricultural productivity of many crops.

Before concentrating upon consumption of fertilizers kg/ha in regard to kharif and rabi crops during 2012-13 and 2013-14, it will not be out of order to clear up the trend of Nutrient Consumption in kgs/ha during the 14 years' period from 1993-94 to 2006-07 in Bihar.

The consumption of nutrients meant for all the major crops taken together was 61.20 kg/ha in 1993-94 that went on increasing continuously till the year 2006-07 (125 kg/ha) except a decline of 8.50 kg/ha in the year 2003-04 over preceding year's consumption of 96 kg/ha.

In quantitative terms consumption of nutrients in kgs/ha increased by 2.04 times in Bihar during the fourteen years period of 1993-94 to 2005-06. It increased from 61.20 kgs/ha in 1993-94 to 125 kgs/ha in 2006-07. If calculated in percentage terms, the increase in nutrient consumption was to the tune of 104.25 per cent in the year 2006-07 as compared to the base year quantity, i.e., 61.20 kgs/ha in 1993-94 (table 2.2).

Table No. 2.2.1: Consumption of Fertilizer per hectare

SN	Year	Nutrient Consumption (In kgs./ ha)
1.	1993-94	61.20
2.	1994-95	62.50
3.	1995-96	65.00
4.	1996-97	68.00
5.	1997-98	69.00
6.	1998-99	72.00
7.	1999-00	78.50
8.	2000-01	85.00
9.	2001-02	94.00
10.	2002-03	96.00
11.	**2003-04**	**87.50**
12.	2004-05	92.15
13.	2005-06	110.00
14.	2006-07	125.00

Source: Economic Survey, Government of India

Some declines in consumption of fertilizers in regard to kharif, rabi and total crops could be seen during the last two years, i.e., in 2012-13 and 2013-14 in Bihar.

Except 28.75 per cent, 14.91 per cent and 28.15 per cent increases in total quantum of SSP and MOP fertilizers in the state in regard to rabi crops grown in the year 2013-14 and kharif and rabi crops in the same year respectively, the quantities of total consumption of Urea, DAP, SSP and Ammonium Sulphate in Bihar declined significantly in comparison to the consumption quantities of 2012-13. The total quantities of NPK fertilizers (taken together) also declined by 18.82 per cent and 16.45 per cent during kharif and rabi seasons in the year 2013-14 in comparison to previous year 2012-13 (table 2.3).

As far the quantities of consumption of fertilizer in kg/ha in the state in growing kharif and rabi crops during the years 2012-13 and 2013-14 are concerned, these declined by 19.78 per cent, 17.15 per cent and 18.26 per cent in comparison to the preceding year i.e., 2012-13 respectively in regard to kharif, rabi and total of both

crops. The quantities of fertilizer use in case of kharif and rabi crops and for the crops taken together in 2013-14 were noted as 127.17 kg/ha, 171.50 kg/ha and 150.20 kg/ha respectively.

The quantities of consumption of fertilizers kg/ha for crops grown during kharif, rabi and both the seasons taken together in the year 2012-13 were estimated at 158.53, 207.01 and 183.76 kg/ha respectively (table 2.3).

Table No. 2.3: Consumption of Fertilizers in Bihar

(000 tones)

Type of Fertilizer	2012-13			2013-14		
	Kharif	Rabi	Total	Kharif	Rabi	Total
Urea	903.03	1192.93	2095.96	861.95 (- 4.55)	1008.69 (- 15.44)	1870.64
DAP	216.52	325.16	541.68	94.52 (- 56.34)	256.63 (- 21.08)	351.15
SSP	37.13	27.42	64.55	29.96 (- 19.31)	28.75 (4.85)	58.71
MOP	44.53	69.30	113.83	51.17 (14.91)	88.81 (28.15)	139.98
Ammonium Sulphate	00	21.41	21.41	6.78	7.19 (-66.42)	13.97
Complex	98.83	178.83	277.66	40.67 (- 58.85)	117.26 (- 34.43)	157.93
Sub-total	1300.04	1815.05	3115.09	1085.05	1507.33	2592.38
N	470.89	640.39	1111.28	421.71	533.24	954.95
P	128.67	196.92	325.59	57.15	152.70	209.85
K	32.21	57.81	90.02	34.01	61.97	95.98
Total (NPK)	631.78	895.12	1526.90	512.87 (- 18.82)	747.91 (- 16.45)	1260.78
Grand Total	1931.82	2710.17	4641.99	1597.92 (- 17.28)	2255.24 (- 16.79)	3853.16
Consumption of Fertilizer (kg/ha)	158.53	207.01	183.76	127.17 (- 19.78)	171.50 (- 17.15)	150.20 (- 18.26)

Source: Department of Agriculture, Government of Bihar.

Table 2.3 would also indicate that urea takes the most important place and constitutes around 72.00 per cent of the total chemical fertilizer consumption. It can also be noted that although kharif crops are the most important crops in Bihar, the use of chemical fertilizers is comparatively higher for rabi crops. In 2013-14, whereas the farmers used 127.17 kgs/ha for kharif crops, they used 171.50 kgs/ha for rabi crops. Besides NPK, the government is making concerted efforts to promote bio-fertilizers and green manure technique on a large scale. Apart from the central subsidy, the state government is providing additional subsidy for the use of micro-nutrients. Under the Agriculture Road Map, the state government is pressing for the cultivation of *'Dhaicha'* and *'Moong,'* the green manure plants. The process has evoked immense response from farmers.

2.4 Summary of the Chapter

Fertilizer consumption in Bihar was a mere 22 kg NPK/ha in TE 1982, which increased to 63 kg/ha in TE 1991 and reached a level of 82 kg/ha in TE 1998. Fertilizer consumption increased in all the zones during this period. It may be noted that growth in fertilizer consumption slackened in the 1990s as compared to the

1980s. There was wide variation in the level of its use across zones/districts. It was as high as 104 kg/ha in Zone-III and 69 kg/ha in Zone-I in TE 1998.Total consumption of chemical fertilizers in Bihar was 731.60 thousand MT during 2004-05. The level of consumption has increased to 1064.80 thousand MT during 2006-07. During the last five years' period of 2009-10 to 2013-14, fertilizer consumption in Bihar has remained quite higher than all India average and in regard to the uses of NPK fertilizers individually also. A quick look on data containing consumption of Nitrogen (N), Phosphatic (P) and Potassic (K) fertilizers distinctly reveal higher quantities in case of Bihar than that of all-India average during the three years' period of 2011-12 to 2013-14 except phosphatic (P) fertilizers in the years 2011-12 and 2013-14. It's all India average consumption quantities were a bit higher than that of Bihar (40.54, 28.85, 38.84 & 27.44 kg/ha) respectively.

In aggregate sense, means N, P, K taken together, Bihar consumed higher quantities of fertilizer (kg/ha) in the five years i.e., 2009-10 to 2013-14, which were estimated at 165, 175, 180.48, 199.66 and 164.87, when compared with all India averages i.e., 140, 145, 142.33, 130.79 and 125.39 respectively.

The consumption of nutrients meant for all the major crops taken together was 61.20 kg/ha in 1993-94 that went on increasing continuously till the year 2006-07 (125 kg/ha) except a decline of 8.50 kg/ha in the year 2003-04 over preceding year's consumption of 96 kg/ha. Some declines in consumption of fertilizers in regard to kharif, rabi and total crops could be seen during the last two years, i.e., in 2012-13 and 2013-14 in Bihar.

The total quantities of NPK fertilizers (taken together) also declined by 18.82 per cent and 16.45 per cent during kharif and rabi seasons in the year 2013-14 in comparison to previous year 2012-13

As far the quantities of consumption of fertilizer in kg/ha in the state in growing kharif and rabi crops during the years 2012-13 and 2013-14 are concerned, these declined by 19.78 per cent, 17.15 per cent and 18.26 per cent in comparison to the preceding year i.e., 2012-13 respectively in regard to kharif, rabi and total of both crops. The quantities of fertilizer use in case of kharif and rabi crops and for the crops taken together in 2013-14 were noted as 127.17 kg/ha, 171.50 kg/ha and 150.20 kg/ha respectively.

CHAPTER – III

SOCIO-ECONOMIC CHARACTERISTICS OF SAMPLE HOUSEHOLDS

In this chapter, attempt has been made to cover and illuminate the following aspects directly or indirectly concerned with socio-economic characteristics of sample households: (i) Distribution of sample households by farm size category, (ii) socio-economic characteristics of the sample households, (iii) details of operational land holdings, (iv) sources of irrigation, (v) cropping pattern, area under HYV and value of output, (vi) farm assets' holdings, (vii) details of agricultural credit availed, and; (viii) summary of the chapter.

3.1 Distribution of Sample Households by Farm Size

A glance on table helps to elucidate that out of the total 'soil test, farmers (STFs)' and 'control farmers (CFs)' surveyed in both the districts (i.e., East Champaran & Rohtas) for paddy crop, highest percentage of households (56.66%) belonged to marginal category under control group. In case of wheat, medium farm households under STFs category were found to have dominated (40.00%) over other farm size classes and control group (CG) too. Among the STFs category, medium and large farm households (37.50% and 36.67%) respectively were ahead in getting their soil tested for growing paddy. Similarly, in case of wheat also again the medium and large equally followed by small (40.00%, 21.67% & 21.67%) respectively were ahead in getting their soil tested indicating their strong desire to get higher returns by higher productivity of crops (table 3.1). When seen in totality, highest percentage of large farm households (belonging to both STFs and CFs) of paddy growing areas was found 27.78 per cent. It was closely trailed by medium 27.22 per cent. Marginal and small farm households comprised 23.89 per cent and 21.11 per cent respectively. In regard to STFs and CFs taken together growing wheat crop, the largest distribution was in favour of medium farm households 36.67 per cent. It was followed by small 27.22 per cent. Large and marginal surveyed farm households were very much closer to each other 18.33 per cent & 17.78 per cent respectively (Table 3.1).

Table 3.1: Distribution of Sample Households by Farm Size Category (% of households)

Particulars	Crop I – Paddy			Crop II - Wheat		
	Soil test farmers	Control farmers	Total	Soil test farmers	Control farmers	Total
Marginal	7.50	56.66	23.89	16.66	20.00	17.78
Small	18.33	26.67	21.11	21.67	38.33	27.22
Medium	37.50	06.67	27.22	40.00	30.00	36.67
Large	36.67	10.00	27.78	21.67	11.67	18.33
Total	100.00	100.00	100.00	100.00	100.00	100.00

3.2 Socio-Economic Characteristics of Sample Households

Agriculture being the main occupation for STFs and control farmers CFs meant for both surveyed households of paddy and wheat (100%, 100%, 99% and 100%) respectively dominance of male (88.89%) and 100% on overall level), average years of experience in farming estimated at 25.10 and 24.20 respectively at overall level inscribe that surveyed farm households had been associated with agricultural activities for nearly half of their average ages. The average ages of STFs meant for the crops paddy and wheat (53.10 and 52.00) were a bit higher than control farmers (52.40 and 49.80) respectively. Average family size (on overall level) for the respondents of both crops was not much different (8.13 and 8.25) respectively (table 3.2 & 3.3). While no Scheduled Tribe (ST) household was found in either of the districts, caste composition directly insinuates higher presence of general caste households in the total sample households surveyed for both the crops, paddy and wheat on overall level (65.55% and 62.78%) respectively. In case of households surveyed for wheat crop, OBC households comprised almost half of general caste households (31.67%) (table 3.2). OBC farm households comprised 2.74 times less in case of paddy crop farm households (23.90%) than the surveyed households belonging to general caste (table 3.3).

Table 3.2: Socio-economic Characteristics of Sample Households- Crop - I (Paddy)

Particulars	Soil Test Farmers	Control Farmers	Overall
Number of sample farmer households	**120**	**60**	**180**
Average age of respondent (years)	53.10	52.40	52.75
Average years of respondent education	10.00	9.00	9.67
Agriculture as main occupation (% of respondents)	100.00	100.00	100.00
Gender (% of respondents)			
Male	85	96.67	88.89
Female	15	3.33	11.11
Average family size	8	8.25	8.13
Average number of people engaged in agriculture	2	2.08	2.04
Average years of experience in farming	25.81	24.38	25.10
% of farmers being a member of any association	29.17	13.33	23.90
Caste (% of households)			
SC	10.83	8.33	10.55
ST	0.00	0.00	0.00
OBC	25.00	41.67	23.90
General	64.17	50.00	65.55

Table 3.3: Socio-economic Characteristics of Sample Households- Crop – II (wheat)

Particulars	Soil Test Farmers	Control Farmers	Overall
Number of sample farmer households	**120**	**60**	**180**
Average age of respondent (years)	52.00	49.80	50.50
Average years of respondent education	11.00	8.00	9.50
Agriculture as main occupation (% of respondents)	99.00	100.00	99.50
Gender (% of respondents)			
Male	100.00	100.00	100.00
Female	0.00	0.00	0.00
Average family size	8.43	8.06	8.25
Average number of people engaged in agriculture	2	2	2
Average years of experience in farming	26.00	22.40	24.20
% of farmers being a member of any association	17.50	11.67	15.56
Caste (% of households)			
SC	1.67	13.33	5.55
ST	0.00	0.00	0.00
OBC	34.17	26.67	31.67
General	64.16	60.00	62.78

3.3 Details of Operational Land Holdings

In this section of the chapter attempt has been made to grind particulars about (i) owned land, (ii) uncultivated/fallow, (iii) net operated area (NOA), (iv) net irrigated area (NIA), (v) net un-irrigated area (NUIA), (vi) gross cropped area (GCA), and; (vii) cropping intensity (CI). These particulars have been dealt in regard to, soil test farmers, control farmers and on overall level separately for the two crops, paddy and wheat.

A glance on data in the table suggests that the average size of owned land, leased out, uncultivated/fallow, NOA, NIA, GCA, and CI (7.53 acres/household, 0.06 acre, Hh, 0.05 acre/Hh, 7.76 acres/Hh, 7.10 acres/Hh, 15.02 acres/Hh and 193.56%) respectively meant for soil test farmers (STFs) surveyed for paddy crop were as per the normal belief, greater than that of control farmers (CFs). In case of CFs, per household areas of land owned, uncultivated/fallow land, NOA, NIA, GCA all in acres (4.05, 0.03, 4.50, 4.43 and 8.67) respectively were well lower than that of STFs. The CI of these groups of surveyed Hhs (192.99%) was also a bit lower than that of the STFs (table 3.4). It provides strong ground to come through the conclusion that in regard to most of the parameters/particulars of operational land holding (OLH), the STFs enjoyed better convenient positions.

Table 3.4: Operational Landholding of the Sample Households (acres/household)- Crop - I (Paddy)

Particulars	Soil Test Farmers	Control Farmers	Overall
Owned land	7.53	4.05	5.79
Leased-in	0.29	0.45	0.37
Leased-out	0.06	0.00	0.03
Uncultivated/Fallow	0.05	0.03	0.04
Net operated area	7.76	4.50	6.13
Net irrigated area	7.10	4.43	5.77
Net un-Irrigated area	0.66	0.07	0.36
Gross cropped area	15.02	8.67	11.85
Cropping intensity (%)	193.56	192.99	193.28

As far operational land holding of the sample households surveyed for wheat crop is concerned, the data suggest to conceptualize that STFs were, unlike paddy, slightly better placed in regard to owned land, leased in, leased out, NOA, NIA, GCA and CI (6.38, 0.31, 0.10, 6.59, 6.29, 13.00 acres/household and 197.16%) respectively. Having been endowed with larger average areas, greater irrigation facilities, bigger GCA and comparatively high CI, STF category of surveyed Hhs are more inclined to get their soil tested. In case of CFs of wheat growing Hhs, areas of owned land, uncultivated/fallow, NOA, NIA, Net un-irrigated area, GCA in acres/Hh and CI were estimated at (6.00, 0.04, 6.10, 5.79, 0.31, 11.41 and 187.08%) respectively (table 3.5). Thus, in both cases, i.e., paddy and wheat, operational landholding status of STFs were found to be stronger.

Table 3.5: Operational Landholding of the Sample Households (acres/household)- Crop – II (Wheat)

Particulars	Soil Test Farmers	Control Farmers	Overall
Owned land	6.38	6.00	6.19
Leased-in	0.31	0.10	0.21
Leased-out	0.10	0.00	0.05
Uncultivated/Fallow	0.02	0.04	0.03
Net operated area	6.59	6.10	6.35
Net irrigated area	6.29	5.79	6.04
Net un-Irrigated area	0.30	0.31	0.31
Gross cropped area	13.00	11.41	12.21
Cropping intensity (%)	197.16	187.08	192.12

3.4 Sources of Irrigation

This section of the chapter picturises sources of irrigation available in case of surveyed farm Hhs meant for both the crops, viz., paddy and wheat. Having a glance on data in the tables, it is distinctly revealed that canal had been the most prominent source of irrigation for both STFs and Control farmers (CFS) in case of paddy (50% & 46.87%) respectively. Bore well remained the most important source of irrigation for both STFs and CFs (59.17%& 51.03%) respectively meant for surveyed Hhs of wheat area. Data in the table bring forward the fact that bore well remained the second major source of irrigation for the surveyed Hhs of paddy area (40% & 42%) meant for STFs and CFs respectively (table 3.6). As the surveyed farmers of wheat areas mostly belonged to canal side villages of Rohtas and East Champaran districts, so canal also could establish itself to be one of the prominent sources of irrigation after bore well (35.33% & 45%) respectively (table 3.7). On overall level, open/dug well, rivers/ponds and others and tank (4.68%, 3.68% & 1.91%) respectively were some of the less important sources of irrigation in case of paddy area surveyed Hhs. In regard to surveyed Hhs of wheat area, no tank irrigation was found. Open/dug well and rivers/ponds and others shared the responsibility of irrigating only 2.78 per cent and 2.24 per cent of total operated areas respectively.

Table 3.6: Sources of Irrigation (% of net irrigated area)-Crop - I (Paddy)

Particulars	Soil Test Farmers	Control Farmers	Overall
Open/ dug well	3.33	9.00	4.68
Bore well	40.00	42.00	40.48
Canal	50.00	46.87	49.25
Tank	2.50	0.00	1.91
River/Ponds and Others	4.17	2.13	3.68
Total	**100.00**	**100.00**	**100.00**

Table 3.7: Sources of Irrigation (% of net irrigated area)- Crop – II (Wheat)

Particulars	Soil Test Farmers	Control Farmers	Overall
Open/ dug well	3.00	2.30	2.78
Bore well	59.17	51.03	56.60
Canal	35.33	45.00	38.38
Tank	0.00	0.00	0.00
River/Ponds and Others	2.50	1.67	2.24
Total	**100.00**	**100.00**	**100.00**

3.5 Cropping Pattern, Area under HYV and Value of Output

This section of the chapter (setting apart), analyses (i) cropping pattern of the sample households (Hhs) for both the crop areas, paddy and wheat, (ii) area under HYV of major crops (in %of cropped area terms for paddy and wheat), and; (iii) aggregate value of crop output (in Rs./Hh and Rs./acre) as reported by the surveyed farm Hhs growing paddy and wheat.

3.5.1 Cropping Pattern

The table delineates cropping pattern being used by soil test farmers (STFs) and control farmers (CFs) meant for the crops, paddy and wheat. In case of sample Hhs of paddy areas, paddy, wheat and orchard (litchi, mango, etc.) were the main crops occupying larger areas on overall level during kharif, rabi and annual/perennial seasons (48.78%, 37.62% & 0.69%) respectively. In regard to crop – II (wheat) areas sample Hhs, again paddy and wheat were prominently grown during kharif and rabi seasons (42.01% & 41.91%). Whereas under summer and annual crops, moong and sugarcane (2.69% & 2.93%) respectively shared highest areas, sample Hhs of paddy growing areas were found to have devoted lower areas under basmati paddy, maize, total pulses, total oil seeds, fodder and sugarcane (2.61%, 1.98%, 3.51% 2.11%, 0.31% & 0.49%) respectively (table 3.8). While CFs of wheat growing areas were ahead in devoting more area under paddy, oilseeds, and fodder (47.05%, 2.50%, and 0.82%) respectively in comparison to STFs, CFs of paddy growing areas' sample Hhs

also were found to have followed the same trend in regard to crops like, paddy, total pulses and rabi maize (51.13%, 4.69% and 0.68%) respectively (table 3.8 & 3.9).

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

Season/crop	Soil Test Farmers	Control Farmers	Overall
Kharif			
Paddy	48.00	51.13	48.78
Basmati Rice	3.20	0.82	2.61
Maize	2.07	1.73	1.98
Total veg.	0.27	0.43	0.31
Rabi			
Wheat	37.90	36.78	37.62
Total Oilseeds	2.14	2.00	2.11
Total Pulses	3.11	4.69	3.51
Rabi Maize	0.50	0.68	0.54
Summer			
Moong	1.13	0.82	1.05
Fodder	0.31	0.30	0.31
Annual/perennial			
Sugarcane	0.59	0.21	0.49
Orchard (Litchi, Mango)	0.78	0.41	0.69
GCA	100.00	100.00	100.00

Table 3.9: Cropping Pattern of the Sample Households (% of GCA)- Crop- II (Wheat)

Season/crop	Soil Test Farmers	Control Farmers	Overall
Kharif			
Paddy	40.09	47.05	42.01
Basmati rice	2.15	0.87	1.80
Maize	0.57	0.50	0.55
Total veg.	0.20	0.08	0.17
Rabi			
Wheat	42.11	41.40	41.91
Oilseeds	2.43	2.50	2.45
Total pulses	3.77	3.31	3.64
Rabi maize	0.37	0.17	0.32
Summer			
Moong	3.00	1.87	2.69
Fodder	0.70	0.82	0.73
Annual/perennial			
Sugarcane	3.54	1.33	2.93
Orchard (Litchi, Mango)	1.07	0.10	0.80
GCA	100.00	100.00	100.00

3.5.2 Area under HYV

The table contains data showing areas under HYV of major crops grown by the STFs and CFs meant for surveyed Hhs of paddy and wheat growing areas. STFs mainly used HYV seeds of crops, namely, kharif paddy, kharif maize, wheat (rabi), oilseeds, pulses, rabi maize and summer moong. CFs also grew the same crops by using HYV seeds except oilseeds. It is interesting to note that both the STFs and CFs surveyed in the paddy and wheat growing areas used HYV kharif paddy and wheat (rabi) as major crops having devoted larger percentages of cropped area (18.70, 10.50, 10.00, 11.12 and 8.50, 10.00, 5.10, 7.35) respectively. While STFs of wheat area were seen to have used a bit larger areas under HYV seeds for the crops, namely rabi wheat and rabi maize than the CFs (11.12%, 0.15% & 10.00%, 0.13%) respectively, there the same picture was observed in case of CFs meant for wheat farmers with addition of summer moong grown by Crop-II farmers 0.10 per cent (table 3.10).

Table 3.10: Area under HYV of Major Crops (% of cropped area)

Crop name	Crop I Farmers (Paddy)	Crop II Farmers (Wheat)
Soil Test Farmers		
Kharif paddy	18.70	10.50
Kharif maize	0.28	0.17
Rabi wheat	10.00	11.12
Oilseeds	0.58	0.50
Pulses	0.89	0.71
Rabi maize	0.13	0.15
Summer moong	0.12	0.08
Control Farmers		
Kharif paddy	8.50	10.00
Kharif maize	0.09	0.00
Rabi wheat	5.10	7.35
Rabi pulses	0.42	0.36
Rabi maize	0.00	0.00
Summer moong	0.00	0.10

3.5.3 Value of Crop Output

Data in the table provides sufficient ground to put a good face on value of output achieved by paddy growing surveyed Hhs meant for both STFs and CFs in terms of Rs./Hh., Rs/Acre, value of output sold, i.e., in Rs/Hh and Rs/Acre. It is revealed that in regard to value of output and value of output sold by both STFs and CFs of paddy growing Hhs, large size farm Hhs remained ahead (Rs. 1,95,580/Hh, Rs. 17,780/acre, Rs. 1,64, 062.50, Rs. 15,625, value of output sold Rs. 1,36,906, Rs. 12,446, Rs. 1,14,843.75, and Rs. 10,937.50) respectively.

Surveyed households under STFs category of paddy area belonging to different farm sizes and all classes of farm Hhs (taken together) showed higher values of output

and values of output sold both in terms of Rs./Hh and Rs./acre than that of CFs (Rs. 1,10,195.94/Hh, Rs. 16,545.94/acre, Rs. 1,64,062.50/Hh, Rs. 15,625/acre and Rs. 79,892.06 Hh, Rs. 11,995.80, Rs. 68,712.07/Hh and Rs. 10,820.80/acre) respectively (table 3.11).

Table 3.11: Aggregate Value of Crop Output- Crop – I (Paddy)

Particulars	Value of Output		Value of Output Sold	
	Rs/household	Rs/acre	Rs/household	Rs/acre
Soil Test Farmers				
Marginal	37500.00	15312.50	28125.00	11718.75
Small	74218.75	15625.00	51953.13	10937.50
Medium	148750.00	17500.00	104125.00	12250.00
Large	195580.00	17780.00	136906.00	12446.00
Total	1,10,195.94	16,545.94	79,892.06	11,995.80
Control Farmers				
Marginal	33000.00	15000.00	23100.00	10500.00
Small	69552.00	15120.00	50077.44	10886.40
Medium	126554.40	15624.00	88588.08	10936.80
Large	164062.50	15625.00	114843.75	10937.50
Total	97,463.93	15,348.65	68,712.07	10,820.80

Having paid attention on the data in the table comprising value of output, and value of output sold by the surveyed Hhs of wheat area, again it is evident that large farm Hhs were ahead of all other farm size groups except CFs, whose value of output sold was highest in case of medium farmers (Rs. 13,050/acre). It is further noticed that farm size is directly related to value of output, and value of output sold in positive way in case of both STFs and CFs meant for both the crops. It is also interesting to note that in regard to farm class wise values of output, and values of output sold (when viewed in totality also), STFs realized greater values of output, and values of output sold as well than that of CFs (Rs. 1,30,661.56/Hh, Rs. 41,153.25/acre, Rs. 1,13,336.09/Hh, Rs. 16,890.63 and Rs. 95.056.28/Hh, Rs. 13,856.60/acre, Rs. 83,018.69/Hh and Rs. 12,372.38/acre) respectively (table 3.12).

Table 3.12: Aggregate Value of Crop Output- Crop- II (Wheat)

Particulars	Value of Output		Value of Output Sold	
	Rs/household	Rs/acre	Rs/household	Rs/acre
Soil Test Farmers				
Marginal	37835.00	16100.00	26862.85	11431.00
Small	81780.00	17400.00	57246.00	12180.00
Medium	193430.00	21025.00	145072.50	15768.75
Large	243.600.00	21750.00	182700.00	16312.50
Total	1,30,661.56	41,153.25	95.056.28	13,856.60
Control Farmers				
Marginal	37800.00	15750.00	28350.00	11812.50
Small	79207.83	16675.33	57821.72	12172.99
Medium	151380.00	17400.00	113535.00	13050.00
Large	195387.50	17762.50	136771.25	12433.75
Total	1,13,336.09	16,890.63	83,018.69	12,372.38

3.6 Farm Assets Holdings

As far the distribution of farm assets to surveyed farm Hhs of paddy and wheat areas are concerned, it is evident that STFs did own higher number of high priced farm implements/equipments than that of CFs. STFs were well ahead in regard to

possessing tractor/trolley, electric motor/diesel engine and manual/power sprayer than that of CFs applicable for both paddy and wheat growing farm Hhs (0.42/Hh, 0.67/Hh, 0.33, for CFs these were 0.21, 0.22, 0.12 and for wheat STFs, these were 0.48/Hh, 0.58/Hh, 0.23 and in case of CFs, 0.20/Hh, 0.20/Hh, 0.08/Hh) respectively. Thresher, fodder chopper, bullock cart, drip/sprinkler system, small tools and animal shed/pump house like small implements/farm assets were owned/possessed by both STFs and CFs of paddy area with no much difference in number/Hh. The numbers/Hh was 0.11, 0.74, 0.03, 0.07, 6.00 and 0.83 for STFs and 0.08, 0.83, 0.05. 0.04, 7.00 and 0.85 respectively (table 3.13). In case of surveyed farm Hhs of wheat area, except fodder chopper and animal shed/pump house (0.70) & 0.85) respectively, STFs were distinctly in better position than CFs on the parameters of owning thresher, manual/power sprayer, bullock cart and others (0.25, 0.23, 0.03, 0.03 and for CFs, 0.13, 0.08, 0.00 and 0.00) respectively (table 3.14).

Values of farm assets per household of surveyed STFs and CFs in both paddy and wheat areas were estimated at Rs. 3,15,544.17, Rs. 2,56,772.63, Rs. 3,08,366.63 and Rs. 2,13,872.67 respectively.

Table 3.13: Distribution of Farm Assets- Crop- I (Paddy)

Particulars	Soil Test Farmers		Control Farmers	
	Number/ household	Value/ household (Rs)	Number/ household	Value/ Household (Rs)
Tractor, trailer/trolley	0.42	287763.00	0.21	236519.00
Harrow and cultivator	0.18	3666.67	0.08	2083.33
Electric motor/ Diesel Engine	0.67	7500.00	0.22	1135.30
Thresher	0.11	2541.67	0.08	1708.33
Planker	0.00	0.00	0.00	0.00
Manual/power sprayer	0.33	833.33	0.12	629.00
Fodder chopper	0.74	2337.50	0.83	2916.67
Bullock cart	0.03	500.00	0.05	162.00
Drip/sprinkler system	0.07	542.00	0.04	450.00
Small tools (spade, hoe, sickle etc.)	6.00	1500.00	7.00	1712.00
Animal shed/pump house	0.83	8360.00	0.85	9457.00
Others	0.00	0.00	0.00	0.00
Total		**315544.17**		**256772.63**

NB: Others include: (i) sugarcane cultivator, (ii) rizer plough

Table 3.14: Distribution of Farm Assets- Crop- II (Wheat)

Particulars	Soil Test Farmers		Control Farmers	
	Number/ household	Value/ household (Rs)	Number/ household	Value/ Household (Rs)
Tractor, trailer/trolley	0.48	277950.00	0.20	195100.00
Harrow and cultivator	0.20	5208.33	0.06	2566.67
Electric motor/ Diesel Engine	0.58	6708.30	0.20	2040.00
Thresher	0.25	3750.00	0.13	2000.00
Planker	0.00	0.00	0.00	0.00
Manual/power sprayer	0.23	746.67	0.08	250.00
Fodder chopper	0.50	2000.00	0.70	2450.00
Bullock cart	0.03	375.00	0.00	0.00
Drip/sprinkler system	0.00	0.00	0.00	0.00
Small tools (spade, hoe, sickle etc.)	7	1800.00	7	2106.00
Animal shed/pump house	0.81	9775.00	0.85	7360.00
Others	0.03	53.33	0.00	0.00
Total		**308366.63**		**213872.67**

NB: Others include: (i) sugarcane cultivator, (ii) rizer plough

3.7 Details of Agricultural Credit Availed

In this section of the Chapter, two aspects, viz., (i) Agricultural credit outstanding in case of the sample households (Rs/Hh) for crops-I & II, and; (ii) purpose of agricultural loan availed for both the crops, paddy and wheat (as percentage of farmers), have been put together to form whole of the scenario.

3.7.1 Agricultural Credit Outstanding by Sample Households

Data in tables help in comprehending that STFs did have higher agricultural credit by commercial banks as reported by both paddy and wheat growing surveyed households (Rs. 833.33 and Rs. 2166.67) respectively. For CFs of paddy and wheat crops, the most instrumental sources of credit remained friends/relatives and commercial banks in case of wheat growing farm households only (Rs. 1783.33/Hh and Rs. 3,017/Hh) respectively. While CFs of paddy area were found to have agricultural credit outstanding on the loan provided by moneylenders, and friends and relatives (Rs. 833.33 and Rs. 1,783.33/Hh) respectively, there at the same time, traders/commission agents remained instrumental for STFs of paddy growing areas only (Rs. 233.33/Hh) (table 3.15).

In case of sample farmers of wheat area, CFs were again found to have outstanding amounts from friends/relatives apart from commercial banks (Rs. 830/Hh), the STFs had outstanding of Rs. 416.67/Hh by friends/relatives (table 3.16).

As most of the CFs belonging to both paddy and wheat growing areas were resource poor (RP) in comparison to STFs, so CFs had higher credit outstanding on them than that of STFs (Rs. 2,616.66, Rs. 3,847, in comparison to Rs. 1,883.33 and Rs. 2,583.34/Hh for STFs) respectively.

After having searched thoroughly through data in the table, it is revealed that Commercial Banks and friends and relatives were equally instrumental in regard to providing credit to STFs of paddy growing sample households 4.17 per cent and 4.17 per cent respectively. In regard to control farmers (CFs) involved in paddy growing, friends and relatives were main source of providing loans 15 per cent followed by money lenders 6.67 per cent (table 3.15) . In the case of sample households growing wheat, higher credit outstanding for STFs was found in case of Commercial Banks and friends and relatives 5 per cent and 4.17 respectively (table 3.16). With a view to purchase minor and quite a few major farm implements or other inputs on comparatively convenient terms and conditions of getting agricultural credit, the CFs and STFs preferred Commercial Banks as main source of credit in regard to crop – II sample households 13.33 per cent and 5.00 per cent respectively. On overall level, agricultural credit outstanding meant for STFs and CFs growing paddy and wheat were 10 per cent, 21.67 per cent and 9.17 per cent, 20 per cent respectively.

Table 3.15: Agricultural Credit Outstanding by the Sample Households (Rs/household)- Crop- I (Paddy)

Sources	Soil Test Farmers	In %	Control Farmers	In %
Co-operative Credit Societies	---	---	---	---
Land development banks	---	---	---	---
Commercial banks	833.33	4.17	---	---
RRBs	---	---	---	---
Money lenders	---	---	833.33	6.67
Friends/Relatives	816.67	4.17	1783.33	15.00
Traders/Commission agents	233.33	1.67	---	---
Others	---	---	---	---
Total	**1883.33**	**10.00**	**2616.66**	**21.67**

Table 3.16: Agricultural Credit Outstanding by the Sample Households (Rs/household)- Crop- II (Wheat)

Sources	Soil Test Farmers	In %	Control Farmers	In %
Co-operative Credit Societies	---	---	---	---
Land development banks	---	---	---	---
Commercial banks	2166.67	5.00	3017.00	13.33
RRBs	---	---	---	---
Money lenders	---	---	---	---
Friends/Relatives	416.67	4.17	830.00	6.67
Traders/Commission agents	---	---	---	---
Others	---	---	---	---
Total	**2583.34**	**9.17**	**3847.00**	**20.00**

3.7.2 Purpose of Agricultural Loan Availed

It is interesting to note that CFs remained much ahead in availing agricultural loan for seasonal crop cultivation, purchase of tractor and other implements, purchase of livestock and land development (taken together) for both paddy and wheat growing areas than the STFs. The percentages of the purpose of agricultural loan were (70.00, 91.67, 57.77 and 72.50) respectively on taking it in totality for agriculture and allied purposes). Shares of loan for 'marriage and social ceremonies' and non-farm activities revealed by STFs were higher than that of CFs in case of paddy farmers (24%, 18.23%, 20.00% and 10.00%) respectively (table 3.17). In regard to surveyed farm Hhs of wheat growing area also, the shares of loan availed in marriage and social ceremonies and non-farm activities were found higher in case of STFs than that of CFs (19.17%, 8.33%, 3.33% and 5.00%) respectively (table 3.18).

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

(In % to total farmers)

Purpose	Soil Test Farmers	Control Farmers
Seasonal crop cultivation	---	---
Purchase of tractor and other implements	---	---
Purchase of livestock	43.71	57.00
Land development	14.06	13.00
Consumption expenditure	---	---
Marriage and social ceremonies	24.00	20.00
Non-farm activities	18.23	10.00
Other expenditures	---	---

Table 3.18: Purpose of Agricultural Loan Availed (% of farmers)- Crop- II (Wheat)

(In % to total farmers)

Purpose	Soil Test Farmers	Control Farmers
Seasonal crop cultivation	05.00	---
Purchase of tractor and other implements	5.80	6.67
Purchase of livestock	41.67	43.33
Land development	20.03	41.67
Consumption expenditure	---	---
Marriage and social ceremonies	19.17	3.33
Non-farm activities	8.33	5.00
Other expenditures	--	---

3. 8 Summary of the Chapter

Out of the total 'soil test, farmers (STFs)' and 'control farmers (CFs)' surveyed in both the districts (i.e., East Champaran & Rohtas) for paddy crop, highest percentage of households (56.66%) belonged to marginal category under control group. In case of wheat, medium farm households under STFs category were found to have dominated (40.00%) over other farm size classes and control group (CG) too.

Agriculture being the main occupation for STFs and control farmers CFs meant for both surveyed households of paddy and wheat (100%, 100%, 99% and 100%) respectively dominance of male (88.89%) and 100% on overall level), average years of experience in farming estimated at 25.10 and 24.20 respectively at overall level inscribe that surveyed farm households had been associated with agricultural activities for nearly half of their average ages.

The average size of owned land, leased out, uncultivated/fallow, NOA, NIA, GCA, and CI (7.53 acres/household, 0.06 acre, Hh, 0.05 acre/Hh, 7.76 acres/Hh, 7.10 acres/Hh, 15.02 acres/Hh and 193.56%) respectively meant for soil test farmers (STFs) surveyed for paddy crop were as per the normal belief, greater than that of control farmers (CFs).

As far operational land holding of the sample households surveyed for wheat crop is concerned, the data suggest to conceptualize that STFs were, unlike paddy, slightly better placed in regard to owned land, leased in, leased out, NOA, NIA, GCA and CI (6.38, 0.31, 0.10, 6.59, 6.29, 13.00 acres/household and 197.16%) respectively.

It is distinctly revealed that canal had been the most prominent source of irrigation for both STFs and Control farmers (CFS) in case of paddy (50% & 46.87%) respectively. Bore well remained the most important source of irrigation for both STFs and CFs (59.17%& 51.03%) respectively meant for surveyed Hhs of wheat area.

In case of sample Hhs of paddy areas, paddy, wheat and orchard (litchi, mango, etc.) were the main crops occupying larger areas on overall level during kharif, rabi and

annual/perennial seasons (48.78%, 37.62% & 0.69%) respectively. In regard to crop – II (wheat) areas sample Hhs, again paddy and wheat were prominently grown during kharif and rabi seasons (42.01% & 41.91%).

It is interesting to note that both the STFs and CFs surveyed in the paddy and wheat growing areas used HYV kharif paddy and wheat (rabi) as major crops having devoted larger percentages of cropped area (18.70, 10.50, 10.00, 11.12 and 8.50, 10.00, 5.10, 7.35) respectively.

It is revealed that in regard to value of output and value of output sold by both STFs and CFs of paddy growing Hhs, large size farm Hhs remained ahead (Rs. 1,95,580/Hh, Rs. 17,780/acre, Rs. 1,64, 062.50, Rs. 15,625, value of output sold Rs. 1,36,906, Rs. 12,446, Rs. 1,14,843.75, and Rs. 10,937.50) respectively.

Having paid attention on the data in the table comprising value of output, and value of output sold by the surveyed Hhs of wheat area, again it is evident that large farm Hhs were ahead of all other farm size groups except CFs, whose value of output sold was highest in case of medium farmers (Rs. 13,050/acre). It is further noticed that farm size is directly related to value of output, and value of output sold in positive way in case of both STFs and CFs meant for both the crops.

It is evident that STFs did own higher number of high priced farm implements/equipments than that of CFs. STFs were well ahead in regard to possessing tractor/trolley, electric motor/diesel engine and manual/power sprayer than that of CFs applicable for both paddy and wheat growing farm Hhs (0.42/Hh, 0.67/Hh, 0.33, for CFs these were 0.21, 0.22, 0.12 and for wheat STFs, these were 0.48/Hh, 0.58/Hh, 0.23 and in case of CFs, 0.20/Hh, 0.20/Hh, 0.08/Hh) respectively.

STFs did have higher agricultural credit by commercial banks as reported by both paddy and wheat growing surveyed households (Rs. 833.33 and Rs. 2166.67) respectively. For CFs of paddy and wheat crops, the most instrumental sources of credit remained friends/relatives and commercial banks in case of wheat growing farm households only (Rs. 1783.33/Hh and Rs. 3,017/Hh) respectively.

In case of sample farmers of wheat area, CFs were again found to have outstanding amounts from friends/relatives apart from commercial banks (Rs. 830 380/Hh), the STFs had outstanding of Rs. 416.67/Hh by friends/relatives

As most of the CFs belonging to both paddy and wheat growing areas were resource poor (RP) in comparison to STFs, so CFs had higher credit outstanding on them than that of STFs (Rs. 2,616.66, Rs. 3,847, in comparison to Rs. 1,883.33 and Rs. 2,583.34/Hh for STFs) respectively. On overall level, agricultural credit outstanding

meant for STFs and CFs growing paddy and wheat were 10 per cent, 21.67 per cent and 9.17 per cent, 20 per cent respectively.

It is interesting to note that CFs remained much ahead in availing agricultural loan for seasonal crop cultivation, purchase of tractor and other implements, purchase of livestock and land development (taken together) for both paddy and wheat growing areas than the STFs. The percentages of the purpose of agricultural loan were (70.00, 91.67, 57.77 and 72.50) respectively on taking it in totality for agriculture and allied purposes).

CHAPTER – IV

DETAILS OF SOIL TESTING AND RECOMMENDED DOSES OF FERTILIZERS

4.1 Background

In this chapter, attempt has been made to arrange conceptualized facts based on empirical data related to the following aspects: (i) details of soil testing, (ii) sources of information about soil testing by soil test farmers, (iii) reasons for soil testing by soil test farmers (STFs), (iv) reasons for not testing soil by control farmers (CFs), and; (v) summary of the chapter. It is to be urgently noted here that the reference period for the study was 2013-14, and the list of farmers, who got their soil tested, were to be collected from the state department of agriculture for the year 2012-13 to assess the adoption of recommended dose of fertilizers. In Bihar, including the two selected districts, viz., East Champaran and Rohtas, the soil testing exercises could be started since rabi season of 2013, i.e., November, 2013. The soil health cards were being uploaded in the first week of June, 2014. So, the impact of recommended dose of fertilizers and its adoption by the surveyed STFs and control farmers could not be examined.

4.2 Details of Soil Testing

As the soil test exercise under NPMSHF in Bihar started since rabi season, i.e., November-December, 2013, so there was no possibility of farmers getting their soil tested during the last three years. No cost for soil testing was found to have been incurred by the surveyed households in the study area.

While higher coverage of net operated area (NOA) was visible in case of surveyed households of wheat growing area than that of paddy farm households (59.33% & 43.34%) respectively, the average area covered under soil test in wheat area was little higher than that of paddy farmers (3.91 and 3.52 acres) respectively. Farm class wise analysis reveals that marginal farm households belonging to both paddy and wheat areas were ahead in regard to areas covered as percentage to NOA (61.73 & 65.79) respectively.

Large farm households of paddy growing area and medium farmers of wheat area were found to be residing at farther distances from the soil testing laboratories (STLs) i.e., 14 kms and 25.5 kms respectively (table 4.1 & 4.2). While no farm household in both the cases was found to have collected samples themselves, number of samples taken per plot by the state Agriculture Department's personnel was viewed at five in case of both paddy and wheat farmers and across farm class wise as well. As medium and large farmers in case of both paddy and wheat crops were more effervesce of getting their soil tested, so higher average number of plots were considered for soil

testing from out of their owned land areas than that of marginal and small ones (1.2, 1.2, 1.20, 1.20 and 1, 1, 1 and 1.0) respectively (table 4.1 & 4.2).

Table 4.1: Distribution of Sample Soil Test Farmers: Crop- I (Paddy)

Particulars	Marginal	Small	Medium	Large	Total
% of farmers tested their soil in the last three years	---	---	---	---	---
Average distance from field to soil testing lab (kms)	10.00	12.50	11.50	14.00	12.00
Average number of soil samples taken per plot	5.00	5.00	5.00	5.00	5.00
Average no. of plots considered for soil testing	1.00	1.00	1.20	1.20	1.10
Average area covered under soil test (acre)	2.00	2.40	4.40	5.27	3.52
Area covered as % of net operated area	61.73	58.82	59.28	50.22	43.34
% of farmers who collected samples themselves	---	---	---	---	---
% of soil sample collected by the department officials	100.00	100.00	100.00	100.00	100.00

Table 4.2: Distribution of Sample Soil Test Farmers: Crop – II (Wheat)

Particulars	Marginal	Small	Medium	Large	Total
% of farmers tested their soil in the last three years	---	---	---	---	---
Average distance from field to soil testing lab (kms)	25.00	25.00	25.50	24.75	25.06
Average number of soil samples taken per plot	5.00	5.00	5.00	5.00	5.00
Average no. of plots considered for soil testing	1.0	1.10	1.20	1.20	1.13
Average area covered under soil test (acre)	1.25	2.31	4.28	6.88	3.91
Area covered as % of net operated area	65.79	56.56	55.88	64.04	59.33
% of farmers who collected samples themselves	---	---	---	---	---
% of soil sample collected by the department officials	100.00	100.00	100.00	100.00	100.00

4.3 Source of Information about Soil Testing by Soil Test Farmers

Data in the table is sufficient to convince that state department and friend/neighbours were the main sources of information about soil testing by STFs of both paddy and wheat growing areas. In both cases, while large farmers got information from the agencies of state department, marginal and small farm households could come to know from friend/neighbours (95.45%, 100.00%, 22.22% & 30.00%) respectively. On overall level, the functionaries of the state department followed by friends/neighbours were found to be highly instrumental in providing information about soil test to sample households of STFs meant for both the crops (90.00%, 9.17%, 84.17% & 15.83%) respectively (table 4.3). Only a few medium farmer growing paddy (2.22%) were found to have got the information about soil test by KVKs.

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

Sources	Marginal	Small	Medium	Large	Total
Crop I - (Paddy)					
SAUs	---	---	---	---	---
KVKs	---	---	2.22	---	0.83
State department	77.78	81.82	91.11	95.45	90.00
Private companies	---	---	---	---	---
Friends/neighbors	22.22	18.18	6.67	4.55	9.17
Total	100.00	100.00	100.00	100.00	100.00
Crop II – (Wheat)					
SAUs	---	---	---	---	---
KVKs	---	---	---	---	---
State department	70.00	69.23	89.58	100.00	84.17
Private companies	---	---	---	---	---
Friends/neighbors	30.00	30.77	10.42	---	15.83
Total	100.00	100.00	100.00	100.00	100.00

4.4 Reasons for Soil Testing by Soil Test Farmers

The reasons for soil testing by sample soil test farmers (STFs) meant for both paddy and wheat crops, have been depicted in table 4.4. In this section of the chapter reasons for identifying factors responsible for soil testing by sample STFs have been essayed. Increasing crop yield, motivation from village demonstration/training/exposure visits and adopt new technological practices were the prominent reasons for soil testing by STFs on overall level, while very few of the sample households total 'peer farmers' group pressure' to be instrumental (100.00%, 90.83%, 57.50% & 50.00%) respectively.

In case of paddy crop, increasing crop yield (80.83%) and in case of wheat growing farm households, the same factor (92.50%) were found as most important reasons for soil testing, while motivational factor was considered least important (63.33%) and important (60.00%) by surveyed households of paddy and wheat growing areas respectively (table 4.4). On the one hand, while availing benefits under subsidy schemes was, (by majority of surveyed from households of paddy and wheat growing areas) considered to be least important (7.50% & 41.67%) respectively, there on the other hand, adoption of new technological practices was reported as important by both paddy and wheat crops' growing farmers (55.87% & 28.33%) respectively.

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

Reasons	Crop I – (Paddy)				Crop II – (Wheat)			
	Most Important	Important	Least Important	Total	Most Important	Important	Least Important	Total
For availing benefits under subsidy schemes	2.50	5.83	7.50	15.83	---	05.00	41.67	46.67
For increasing crop yield	80.83	17.50	1.67	100.00	92.50	05.00	02.50	100.00
Motivation from village demonstration/ training/exposure visits to places with best farming practices	4.17	18.33	63.33	85.83	2.50	60.00	28.33	90.83
Peer farmers' group pressure	---	2.50	7.50	10.00	---	1.67	3.33	5.00
Adopt new technological practices	8.33	55.87	20.00	84.20	05.00	28.33	24.17	57.50

4.5 Reasons for Not Testing Soil by Control Farmers

There are sufficient data to find for the fact that (i) soil testing laboratories were located for away, (ii) lack of knowledge about taking soil samples, (iii) No knowledge about whom to contact for details on testing, and; (iv) lengthy process and no awareness were the main reasons for not testing soil during the last three years meant for paddy and wheat crops separately (88.33%, 70.00%, 91.67%, 15.67% & 81.67% and 63.33%, 98.33%, & 41.67%) respectively. As far as reasons for not testing soil by paddy farmers during the last three years are concerned, no knowledge about how to take soil samples' was termed as important by 56.66 per cent, while this reason was most important for 35.00 per cent of wheat farmers (table 4.5). No knowledge about whom to contact for details on testing was reported as important by most of the paddy and wheat growing farm households both (30.00% & 35.00%) respectively. Location of soil testing laboratories at

a distant place was cited as least important and most important by majority of the paddy and wheat farmers (41.67% & 48.33%) respectively.

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

Reasons	Crop I – (Paddy)				Crop II – (Wheat)			
	Most Important	Important	Least Important	Total	Most Important	Important	Least Important	Total
Do not know how to take soil samples	16.67	56.66	15.00	88.33	35.00	30.00	16.67	81.67
Do not know whom to contact for details on testing	11.67	30.00	28.33	70.00	10.00	35.00	18.33	63.33
Soil testing laboratories are located far away	38.33	11.67	41.67	91.67	48.33	08.33	41.67	98.33
Soil testing not required for my field as crop yield is good	---	---	---	---	---	---	---	---
Others (due to lengthy process & ignorance)	35.00	1.67	15.00	15.67	6.67	26.67	8.33	41.67

NB: During the last three years soil test exercises were not formally conducted by the district level STLs

4.6 Summary of the Chapter

While higher coverage of net operated area (NOA) was visible in case of surveyed households of wheat growing area than that of paddy farm households (59.33% & 43.34%) respectively, the average area covered under soil test in wheat area was little higher than that of paddy farmers (3.91 and 3.52 acres) respectively. Farm class wise analysis reveals that marginal farm households belonging to both paddy and wheat areas were ahead in regard to areas covered as percentage to NOA (61.73 & 65.79) respectively.

State department and friend/neighbours were the main sources of information about soil testing by STFs of both paddy and wheat growing areas. In both cases, while large farmers got information from the agencies of state department, marginal and small farm households could come to know from friend/neighbours (95.45%, 100.00%, 22.22% & 30.00%) respectively.

Increasing crop yield, motivation from village demonstration/training/exposure visits and adopt new technological practices were the prominent reasons for soil testing by STFs on overall level, while very few of the sample households total 'peer farmers' group pressure' to be instrumental (100.00%, 90.83%, 57.50% & 50.00%) respectively.

There are sufficient data to find for the fact that (i) soil testing laboratories were located for away, (ii) lack of knowledge about taking soil samples, (iii) No knowledge about whom to contact for details on testing, and; (iv) lengthy process and no awareness were the main reasons for not testing soil during the last three years meant for paddy and wheat crops separately (88.33%, 70.00%, 91.67%, 15.67% & 81.67% and 63.33%, 98.33%, & 41.67%) respectively.

CHAPTER – V

ADOPTION OF RECOMMENDED DOSES OF FERTILIZERS AND ITS CONSTRAINTS

5.1 Background

In this chapter, attempt has been made to elucidate following aspects related to adoption of doses of fertilizers and its constraints: (i) Actual quantity of fertilizers applied by the sample farmers, (ii) Actual quantity of split doses of fertilizers applied by stage of crop growth, (iii) Method of application of chemical fertilizers (percentage of farmers), (iv) Use of organic fertilizers by the sample farmers, (v) Sources of purchase of fertilizers, (vi) Quantity of fertilizer purchased by the sample farmers, and; (vii) Average price of fertilizers and transport cost incurred.

5.2 Actual Quantity of Fertilizers applied

In this section, attempt has been made to examine actual quantities of fertilizers applied by the sample farmers for both the crops separately during the reference year meant for both soil test farmers (STFs) and control farmers (CFs). Farm class wise data reveal that marginal, small and large STFs growing paddy used maximum quantities of Urea, DAP & Potash (100 kg/acre, 50 kg/acre and 7.03 kg/acre) respectively. In case of CFs, small, medium and large farm households were ahead in using these fertilizers (102, 50.25 and 1.38 kg/acre) respectively. While no sample farm household under both STFs and CFs categories was found to have used Single Super Phosphate (SSP), potash was not used by marginal farms. Having viewed in totality, urea was used in larger quantities followed by DAP and Potash in regard to both STFs and CFs (90.55 kg/acre, 45.53 kg/acre, 3.14 kg/acre and 98.98 kg/acre, 49.13 kg/acre and 0.29 kg/acre) respectively (table 5.1).

Table 5.1: Actual Quantity of Fertilizers Applied by the Sample Farmers during the Reference Year (Kg/acre) Crop I (Paddy)

Crop – (Paddy)	Marginal	Small	Medium	Large	Total
Soil Test Farmers					
Urea	100.00	95.23	89.50	87.36	90.55
DAP	46.33	50.00	45.00	43.68	45.53
Single Super Phosphate	0.00	0.00	0.00	0.00	0.00
Potash	0.00	0.29	1.33	7.03	03.14
Control Farmers					
Urea	98.44	102.00	99.00	94.00	98.98
DAP	49.00	50.06	50.25	47.00	49.13
Single Super Phosphate	0.00	0.00	0.00	0.00	0.00
Potash	0.00	0.31	1.05	1.38	0.29

Data based picture has been drawn through table 5.2 showing actual quantity of fertilizers applied (in kg/acre) by the sample farmers of wheat growing areas during the reference year. A glance on table provides sufficient ground to comprehend that small, small large and large STF households and small, medium, large and large again belonging to CFs used higher quantities of Urea, DAP, SSP and Potash in kg/acre (100.01, 62.33, 3.45 and 8.50) respectively in case of STFs and 101.00, 51.03, 2.21 and 5.11 kg/acre respectively meant for CFs. Having viewed on total basis (i.e., marginal, small medium and large farmers taken together), it is found that in case of both STFs and CFs, urea was applied in maximum quantities followed by DAP, Potash and SSP (90.89, 51.14, 5.42 and 2.39 kg/acre and 99.73, 48.78, 2.26 and 1.13 kg/acre) respectively (table 5.2). Across the farm size group, small and marginal and large farm households of STFs and CF groups were ahead in applying urea for growing wheat. The quantities of DAP applied by all farm size groups of both STFs and CFs were approximately half of that of urea. SSP and potash were applied in very little quantities by both STFs and CFs.

Table 5.2: Actual Quantity of Fertilizers Applied by the Sample Farmers during the Reference Year (Kg/acre) - Crop II (wheat)

Crop (Wheat)	Marginal	Small	Medium	Large	Total
Soil Test Farmers					
Urea	99.23	100.01	88.00	88.67	90.89
DAP	48.50	62.33	47.33	49.01	51.14
Single Super Phosphate	1.30	1.65	2.67	3.45	2.39
Potash	1.67	2.33	7.00	8.50	5.42
Control Farmers					
Urea	96.73	101.00	100.33	99.17	99.73
DAP	47.93	47.10	51.03	50.00	48.78
Single Super Phosphate	0.00	0.71	2.00	2.21	1.13
Potash	0.43	0.93	4.07	5.11	2.26

5.3 Method of Application of Chemical Fertilizers

In this chapter, attempt has been made to conjecture about the percentage of farmers applying different methods of application of chemical fertilizers. These methods of applying chemical fertilizers included. (i) broadcasting, (ii) dibbling, (iii) fertigation, (iv) line application, and; (v) spraying. It is interesting to note that both the STFs and CFs belonging to sample households of paddy and wheat growing areas applied broadcasting method (100.00%) for every of the chemical fertilizers, viz., urea, DAP, SSP & potash. Cent-per-cent of the sample households belonging to categories of STFs and CFs growing both paddy and wheat crops were separately found to have applied broadcasting method of one and all chemical fertilizers, viz., urea, DAP, SSP & potash (table 5.3 & 5.4). The use of broadcasting method of fertilizer application is due to absence of proper demonstration to use other methods of application. Therefore, traditional method of fertilizer use is still being practiced in the surveyed area.

Table 5.3: Method of Application of Chemical Fertilizers (% of farmers)-Crop I (Paddy)

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

Table 5.4: Method of Application of Chemical Fertilizers (% of farmers)-Crop II (Wheat)

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

5.4 Use of Organic Fertilizers by the Sample Households

Only Farm Yard Manure (FYM) and green manure (GM) were found to have been used by STFs and CFs growing paddy and FYM and vermin-compost/bio-gas waste (VC/BGW) by wheat growing STFs and CFs. Maximum quantities and area coverages of FYM by paddy growing STFs and CFs (1471.86 kg/acre, 25.05 % and 1415.38 kg/acre, 40.00%) respectively were observed. In case of wheat growing STFs and CFs, these figures were 469.10 kg/acre, 48.10% and 473.13 kg/acre, 25.82% respectively. 84.17 per cent of the STFs and 43.33 per cent of the CFs growing paddy were found to have applied FYM. Only 25.00 per cent and 11.67 per cent of the STFs and CFs growing paddy, that too in 5.00 per cent and 4.81 per cent of the net cropped area (NCA) respectively were found to have used GM (table 5.5). The quantities of GM applied by STFs and CFs of paddy were much lower than that of FYM (61.21 kg/acre and 69.09 kg/acre) respectively.

Table 5.5: Use of Organic Fertilizers by the Sample Farmers- Crop I (Paddy)

Particulars	Farm yard manure	Vermi-compost/ Biogas waste	Bio-fertilizer	Green manure
Soil Test Farmers				
% farmers applied	84.17	---	---	25.00
Quantity applied (Kg/acre)	1471.86	---	---	61.21
Price (Rs/kg)	1.32	---	---	2.67
Area covered (% of net cropped area)	25.05	---	---	5.00
Control Farmers				
% farmers applied	43.33	---	---	11.67
Quantity applied (Kg/acre)	1415.38	---	---	69.09
Price (Rs/kg)	1.56	---	---	2.57
Area covered (% of net cropped area)	40.00	---	---	4.81

No wheat growing CFs was found to have used VC/BGW. Only 8.33 per cent of wheat growing STFs were seen to have applied VC/BGW (112.30 kg/acre) covering only 7.00 per cent of the NCA (table 5.6). Data contained in both the tables clearly espouses that both paddy and wheat growing STFs were much ahead (in percentage terms) than that of CFs in regard to applying FYM. However, in quantitative terms, wheat growing CFs used a little higher quantity of FYM than the STFs (473.13 kg/acre and 469.10 kg/acre) respectively. It might be due to the performance of most of the STFs to remain in closer contact with scientists, extension workers, SMS and Kishan Salahkars of the Agriculture Department.

Table 5.6: Use of Organic Fertilizers by the Sample Farmers- Crop II (wheat)

Particulars	Farm yard manure	Vermi-compost/ Biogas waste	Bio-fertilizer	Green manure
Soil Test Farmers				
% farmers applied	52.50	8.33	---	---
Quantity applied (Kg/acre)	469.10	112.30	---	---
Area covered (% of net cropped area)	48.10	7.00	---	---
Price (Rs/kg)	1.07	4.89	---	---
Control Farmers				
% farmers applied	45.00	---	---	---
Quantity applied (Kg/acre)	473.13	---	---	---
Area covered (% of net cropped area)	25.82	---	---	---
Price (Rs/kg)	1.33	---	---	---

5.5 Sources of Purchase of Fertilizers (Crop – I, Paddy)

As regarding sources of purchase of fertilizers in case of soil test farmers (STFs) growing paddy are concerned, private fertilizer shops/dealers (PFS/Ds) were the main source for majority of the farm households (72.50%) followed by company authorized dealers (CADs) 27.50 per cent. Similar scenario was found in case of control farmers (CFs) i.e., (73.33% and 26.67%) respectively. Within the farm size groups, in regard to STFs of paddy growing areas, marginal farmers were ahead in purchasing fertilizers from PFS/D (88.89%) followed by medium, large and small (82.22%, 65.91% and 59.09%) respectively. On the contrary, the source of CAD was largely used for purchase of fertilizers by small farmers (40.91%) followed by large, medium and marginal farmers (34.09%, 17.78% and 11.11%) respectively. In regard to CFs growing

paddy, again PFS/D was the main source for marginal farm households (85.29%) followed by large, small and medium. Here, medium farm households were ahead in using CADs as source of purchasing fertilizers (50%) followed by small, large and marginal (43.75%, 33.33% and 14.71%) respectively (table 5.7).

Table 5.7: Sources of Purchase of Fertilizers (% of farmers) Crop – I, Paddy

Sources	Marginal	Small	Medium	Large	Total
Soil Test Farmers					
Private fertilizer shops/dealers	88.89	59.09	82.22	65.91	72.50
Company authorized dealers	11.11	40.91	17.78	34.09	27.50
Co-operative societies	---	---	---	---	---
Government agency	---	---	---	---	---
Others	---	---	---	---	---
Total	100	100	100	100	100
Control Farmers					
Private fertilizer shops/dealers	85.29	56.25	50.00	66.67	73.33
Company authorized dealers	14.71	43.75	50.00	33.33	26.67
Co-operative societies	---	---	---	---	---
Government agency	---	---	---	---	---
Others	---	---	---	---	---
Total	100	100	100	100	100

5.6 Sources of Purchase of Fertilizers (Crop – II, Wheat)

In regard to the agencies/sources, from where STFs growing wheat purchased fertilizers, again like paddy farmers PFS/D and CADs were revealed as prominent sources (52.50% and 47.50) respectively. While marginal and medium farm households were ahead in purchasing fertilizers from PFS/D, CADs were prominently used by large and small farmers (65%, 54.17%, 61.54% and 46.15%) respectively. In case of wheat growing CFs also, the two sources namely: PFS/D and CAD were the main sources at overall level (51.67% and 48.33%) respectively. Across the farm sizes marginal and medium farm households preferred the source of PFS/D (58.33% ande 55.56%) respectively, while a higher proportion of large and small farmes purchased fertilizers from CADs (57.14% and 52.17%) respectively (table 5.8).

Table 5.8: Sources of Purchase of Fertilizers (% of farmers) Crop – II, Wheat

Sources	Marginal	Small	Medium	Large	Total
Soil Test Farmers					
Private fertilizer shops/dealers	65.00	53.85	54.17	38.46	52.50
Company authorized dealers	35.00	46.15	45.83	61.54	47.50
Co-operative societies	---	---	---	---	---
Government agency	---	---	---	---	---
Others	---	---	---	---	---
Total	100	100	100	100	100
Control Farmers					
Private fertilizer shops/dealers	58.33	47.83	55.56	42.86	51.67
Company authorized dealers	41.67	52.17	44.44	57.14	48.33
Co-operative societies	---	---	---	---	---
Government agency	---	---	---	---	---
Others	---	---	---	---	---
Total	100	100	100	100	100

5.7 Quantity of Fertilizers Purchased (Crop –I, Paddy)

As regarding quantity of fertilizers purchased by the paddy growing STFs higher quantums of potash were purchased from PFS/D (54.55% & 45.45%) from CADs. Across the farm size groups, maximum quantum of urea (86.11%) was purchased from PFS/D, whereas from CADs maximum quantums of potash (54.55%) were purchased. Out of the total quantity of fertilizers purchased, from PFS/D , DAP, SSP and potash comprised (82.22%, 52.94% and 45.45%) respectively. Quantities of fertilizers purchased from CADs were estimated at urea, DAP, SSP and potash (13.89%, 17.78%, 47.06% and 54.55%) respectively (table 5.9). In case of CFs, urea was purchased in maximum quantity (80.95%) from PFS/D and potash (37.50%) from CADs. DAP, SSP and potash (83.33%), 63.64% and 62.50%) respectively were purchased from PFS/D.

Table 5.9: Quantity of Fertilizer Purchased by the Sample Farmers (%) Crop – I, Paddy

Sources	Urea	DAP	SSP	Potash	Complex	Bio-fert
Soil Test Farmers						
Private fertilizer shops/dealers	86.11	82.22	52.14	45.45	---	---
Company authorized dealers	13.89	17.78	47.06	54.55	---	---
Co-operative societies	---	---	---	---	---	---
Government agency	---	---	---	---	---	---
Others	---	---	---	---	---	---
Total	100	100	100	100	100	100
Control Farmers						
Private fertilizer shops/dealers	80.95	83.33	63.64	62.50	---	---
Company authorized dealers	19.05	16.67	36.36	37.50	---	---
Co-operative societies	---	---	---	---	---	---
Government agency	---	---	---	---	---	---
Others	---	---	---	---	---	---
Total	100	100	100	100	100	100

5.8 Quantity of Fertilizers Purchased (Crop –II, Wheat)

In this section of the chapter, attempt has been made to find out quantities of fertilizers from different sources by both the wheat growing STFs and CFs in percentage terms. Main source of purchase of fertilizers by both STFs and CFRs was CADs (82.76% and 76.92%) respectively from where they purchased larger quantums. Urea followed by SSP, DAP and Potash (76.92%, 54.84%, 52.38% and 17.24%) respectively were purchased from PFS/D by the STFs. CADs were mainly accessed for purchasing potash (82.76%) DAP and SSP (47.62% and 45.16%) respectively.

In case of CFs PFS/D were largely used to purchase bigger quantities of urea, and DAP (77.27% and 56.25%) respectively. CADs were also the main source for purchasing chemical fertilizers by the CFs in regard to SSP, Potash and DAP (77.78%, 76.92% and 43.75%) respectively (table 5.10).

Table 5.10: Quantity of Fertilizer Purchased by the Sample Farmers (%) Crop – II, Wheat

Sources	Urea	DAP	SSP	Potash	Complex	Bio-fert
Soil Test Farmers						
Private fertilizer shops/dealers	76.92	52.38	54.84	17.24	---	---
Company authorized dealers	23.08	47.62	45.16	82.76	---	---
Co-operative societies	---	---	---	---	---	---
Government agency	---	---	---	---	---	---
Others	---	---	---	---	---	---
Total	100	100	100	100	100	100
Control Farmers						
Private fertilizer shops/dealers	77.27	56.25	22.22	23.08	---	---
Company authorized dealers	22.73	43.75	77.78	76.92	---	---
Co-operative societies	---	---	---	---	---	---
Government agency	---	---	---	---	---	---
Others	---	---	---	---	---	---
Total	100	100	100	100	100	100

5.9Average Price of Fertilizers and Transport Cost

This section of the chapter brings into its ambit the primary survey based average prices and transportation costs incurred by STFs and CFs in purchasing urea, DAP, SSP and potash. It is revealed that among STFs, average prices of urea, DAP and potash (Rs. 7.29/kg, Rs. 25.96/kg and Rs. 16.81/kg) respectively were a little higher than that of CFs (Rs. 6.83/kg, Rs. 25.50/kg and Rs. 14.52/kg) respectively. But, in regard to transportation cost, these were higher in case of CFs except SSP (Rs. 0.53/kg, Rs. 0.41/kg and Rs. 0.63/kg) respectively. Transport costs (in Rs./kg) incurred in bringing/obtaining fertilizers, viz., urea, DAP, SSP and potash by STFs were calculated at 0.33, 0.40, 0.64 and 0.61 respectively (table 5.11). One of the possible reasons for transportation costs of fertilizers being a little higher in case of CFs could be that CFs, a bigger proportion of whom were comparatively resource poor, and used to live in distant or remote rural areas, had to purchase fertilizers from markets at longer distances.

Table 5.11: Average Price of Fertilizers and Transport Cost Incurred (Rs/kg)

Fertilizer type	Soil Test farmers		Control farmers	
	Average Price	Transport cost	Average Price	Transport cost
Urea	7.29	0.33	6.83	0.53
DAP	25.96	0.40	25.50	0.41
SSP	3.26	0.64	4.99	0.59
Potash	16.81	0.61	14.52	0.63
Complex.....	---	---	---	---
Bio-fertilizers	---	---	---	---

5.10 Summary of the Chapter

Farm class wise data reveal that marginal, small and large STFs growing paddy used maximum quantities of Urea, DAP & Potash (100 kg/acre, 50 kg/acre and 7.03 kg/acre) respectively. In case of CFs, small, medium and large farm households were ahead in using these fertilizers (102, 50.25 and 1.38 kg/acre) respectively.

Having viewed in totality, urea was used in larger quantities followed by DAP and Potash in regard to both STFs and CFs (90.55 kg/acre, 45.53 kg/acre, 3.14 kg/acre and 98.98 kg/acre, 49.13 kg/acre and 0.29 kg/acre) respectively. Small, small large and large STF households and small, medium, large and large again belonging to CFs used

higher quantities of Urea, DAP, SSP and Potash in kg/acre (100.01, 62.33, 3.45 and 8.50) respectively in case of STFs and 101.00, 51.03, 2.21 and 5.11 kg/acre respectively meant for CFs.

It is interesting to note that both the STFs and CFs belonging to sample households of paddy and wheat growing areas applied broadcasting method (100.00%) for every of the chemical fertilizers, viz., urea, DAP, SSP & potash.

Only Farm Yard Manure (FYM) and green manure (GM) were found to have been used by STFs and CFs growing paddy and FYM and vermin-compost/bio-gas waste (VC/BGW) by wheat growing STFs and CFs.

Maximum quantities and area coverages of FYM by paddy growing STFs and CFs (1471.86 kg/acre, 25.05 % and 1415.38 kg/acre, 40.00%) respectively were observed. In case of wheat growing STFs and CFs, these figures were 469.10 kg/acre, 48.10% and 473.13 kg/acre, 25.82% respectively. Both paddy and wheat growing STFs were much ahead (in percentage terms) than that of CFs in regard to applying FYM.

Private fertilizers shops/Dealers (PFS/D) were the main source for majority of the STF farm households growing paddy (72.50%), who purchased fertilizers from this source. When viewed in totality (i.e., including marginal, small, medium and large farmers), Company Authorized Dealers (CADs) were used by 27.50 per cent of the farm households. Control farmers (CFs) of paddy growing areas in majority used PFS/D source (73.33%) and CAD (26.67%). The two sources, namely: PFS/D and CADs were prominently used by wheat growing STFs and CFs belonging to all farm size classes on overall level (52.50%, 47.50%, 51.67% and 48.33%) respectively. Across the farm size, marginal and large STFs used PFS/D and CADs as main sources for purchasing fertilizers (65% and 61.54%) respectively. In case of CFs also, similar scenario were observed in regard to purchase of fertilizers (58.33% and 57.14%) respectively.

PFS/D sources were the most important sources for both paddy and wheat growing STFs and CFs, from which fertilizers, like: Urea, DAP, SSP and Potash were purchased. Much lower quantities (in percentage terms) of Urea, DAP, SSP and Potash were purchased by both paddy and wheat growing STFs and CFs from CADs. In case of both STFs and CFs growing wheat CADs were the main source, from where farmers purchased maximum quantities of fertilizers.

It is revealed that among STFs, average prices of urea, DAP and potash (Rs. 7.29/kg, Rs. 25.96/kg and Rs. 16.81/kg) respectively were a little higher than that of CFs (Rs. 6.83/kg, Rs. 25.50/kg and Rs. 14.52/kg) respectively. But, in regard to transportation cost, these were higher in case of CFs except SSP (Rs. 0.53/kg, Rs. 0.41/kg and Rs. 0.63/kg) respectively.

CHAPTER – VI

IMPACT OF ADOPTION OF RECOMMENDED DOSES OF FERTILIZERS

6.1 Background

It is desirable to mention here that soil testing exercises in the two selected districts were initiated in rabi season of 2013, and the health card of sample soils tested were being made available to farmers in and since first week of July, 2014. As per the suggested methodology, the reference period for the study was 2013-14. For this, the list of farmers, who got their soil tested, was to be collected from the State Department of Agriculture for the year 2012-13 to assess the adoption of recommended dose of fertilizers. Under the above circumstances, determinable assessment of impact of adoption of recommended doses of fertilizers was not possible. However, productivities of reference crops section have been dealt here.

6.2 Productivity of Reference Crops among the Sample Households

Productivity of paddy and wheat crops during the year 2013-14 has been shown in table 6.1. Data in the table delineates highest average yields (in qtl/acre) by STFs and CFs belonging to medium and large farm size groups meant for both paddy and wheat crops (14.00, 14.00, 12.40, 12.50 & 14.50, 15.00, 12.00 and 12.25 qtls/acre) respectively. Percentage differences in yield (in regard to average yield and average values of output) were also found higher among medium and large farm households than that of marginal and small ones in case of both the crops. These percentage differences in yields could be noted as 11.43, 10.71, 17.24 and 18.33 for medium and large farms surveyed for paddy and wheat crops respectively (table 6.1). The figures for marginal and small farm households were much below than the percentage differences in yield by medium and large households (4.00, 4.00, 2.17 and 4.17) respectively. One of the possible reasons for such lower differences in yield could be that marginal and small farm households of both paddy and wheat growing areas belonging to STFs & CF groups were, to a great extent, similarly competitive in all stages of growing the crops. Average values of output (Rs./Acre) were found clearly higher in case of medium and large categories of both STFs and CFs meant for paddy and wheat crops separately (17500, 17780, 15624, 15625 and 21025, 21750, 17400 & 17762.50) respectively. As revealed by the table, percentage differences in yields calculated in terms of average values of output were lower in case of marginal and small farm households surveyed for paddy and wheat crops both (2.04, 3.23 and 2.17 & 4.16) respectively than that of medium and large farm households (table 6.1).

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

Particulars	Average yield (Quintal/acre)			Average value of output (Rs/acre)		
	Soil test farmers	Control farmers	% difference in yield	Soil test farmers	Control farmers	% difference in yield
Crop I – (Paddy)						
Marginal	12.50	12.00	4.00	15312.50	15000.00	2.04
Small	12.50	12.00	4.00	15625.00	15120.00	3.23
Medium	14.00	12.40	11.43	17500.00	15624.00	10.72
Large	14.00	12.50	10.71	17780.00	15625.00	12.12
Total	13.61	12.08	11.24	17094.85	15136.10	11.46
Crop II- (Wheat)						
Marginal	11.50	11.25	2.17	16100.00	15750.00	2.17
Small	12.00	11.50	4.17	17400.00	16675.33	4.16
Medium	14.50	12.00	17.24	21025.00	17400.00	17.24
Large	15.00	12.25	18.33	21750.00	17762.50	18.33
Total	13.25	11.75	11.32	19068.75	16896.96	11.39

6.3 Summary of the Chapter

Data in the table delineates highest average yields (in qtl/acre) by STFs and CFs belonging to medium and large farm size groups meant for both paddy and wheat crops (14.00, 14.00, 12.40, 12.50 & 14.50, 15.00, 12.00 and 12.25 qtls/acre) respectively. Percentage differences in yield (in regard to average yield and average values of output) were also found higher among medium and large farm households than that of marginal and small ones in case of both the crops.

Average values of output (Rs./Acre) were found clearly higher in case of medium and large categories of both STFs and CFs meant for paddy and wheat crops separately (17500, 17780, 15624, 15625 and 21025, 21750, 17400 & 17762.50) respectively.

CHAPTER – VII

SUMMARY & CONCLUSIONS

7.1. Background

It is to be noted here that the all-India averages of K fertilizers are distinctly lower than that of averages of east zone (which includes Bihar also) in all the three years. Data related to all-India scenario suggests a remarkable increase (nearly 1.61 times) in consumption of nitrogenous fertilizers during the recent three years' period of 2010-11 to 2012-13. It was 86.15 kg/ha in the year 2010-11 that went up to 139.67 kg/ha in 2012-13. This was quite higher than the average of east zone. In regard to consumption of phosphatic fertilizers (taken as all-India average), it declined consecutively during the period. It declined from 41.88 kg/ha of 2010-11 to 33.44 kg/ha in 2012-13. It was also quite lower in comparison to east zone in the last year. A consecutive decline in use of potassic (K) fertilizers is also expressed.

There are concerns about the indiscriminate use of chemical fertilizers by farmers with a view to increase the crop yield. This has led to deterioration of soil structure, wastage of nutrients, destruction of soil microorganisms and scorching of plants at the extreme cases. A combination of factors such as intensive cultivation of crops, differential pricing of fertilizers and subsidy, might have contributed to excessive use of fertilizers by the farmers. At the same time, it is reported that many parts of India have shown deficiency of not only primary nutrients (N, P, K) but also secondary (Sulphur, Calcium and Magnesium) and micro nutrients (Boron, Zinc, Copper and Iron). Government of India had undertaken initiatives to ameliorate the situation and encourage the farmers for balanced use of fertilizers. These initiatives among others, included decontrol of phosphatic and potassic fertilizers, promotion of integrated nutrient management, production and promotion of organic manures and bio-fertilizers, National Project on Management of Soil Health and Fertility (NPMSF), and Nutrient Based Subsidy (NBS) policy. Attempts have also been made to strengthen and revamp soil testing laboratories in various districts under NPMSF. Farmers are encouraged to test their soil periodically and apply fertilizers based on the deficiency of nutrients in soil. This is intended to ensure balanced supply of nutrients for maintaining soil health and improving crop productivity.

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 fertilizers, mismanagement of surface water and over exploitation of ground water. The over use

of chemical fertilizers 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 fertilizers for increasing productivity of crops and for better absorption of nutrients from the applied fertilizers.

It is suggested that farmers should go for regular soil testing and use recommended doses of fertilizers 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., (i) strengthening of soil testing laboratories (STLs), (ii) promoting use of integrated nutrient management, and; (iii) strengthening of fertilizer 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 fertilizers 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 fertilizers, impact on crop productivity and relevant institutional problems prevailing in the state of Bihar, with following objectives:

i. *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, and;*
ii. *To analyze the impact of adoption of recommended doses of fertilizers on crop productivity and income of farmers.*

The present study is based on primary data collected from Bihar. The reference period for the study is 2013-14. At the first stage, two major crops in terms of area, i.e., rice and wheat, have been selected from Bihar. At the second stage, for each crop, two districts, namely East Champaran and Rohtas have been selected based on the crop area share (CAS) within the state. The area under paddy in East Champaran is estimated at 5.80 per cent and that in Rohtas district, it was 5.10 per cent of the total area under paddy in the state. These comprised quite larger area shares in the state as a whole. Similarly, in case of wheat also, CASs in Rohtas and East Champaran districts were higher estimated at 6.70 per cent and 5.20 per cent respectively.

At the third stage, from each district, two blocks have been selected again based on CAS itself. Thus, from East Champaran district, two blocks namely (i) Motihari, and; (ii) Kalyanpur were selected. In Rohtas district, the two selected blocks on the same basis were (i) Kargahar, and; (ii) Dinara.

At the fourth stage, from the selected blocks, two clusters of villages comprising 3-4 villages per cluster have been selected for conducting the survey. It is to be noted here that Motihari block was selected for paddy and Kalyanpur block for wheat. Two cluster of villages selected under Motihari block were (i) Bhataha, and; Baswariya. In Kalyanpur block of East Champaran district, cluster of villages selected comprised (i) Tenua, and; (ii) Parsauni. Selection of Kargahar block in Rohtas district was meant for paddy and that of Dinara for wheat. Cluster of villages (COVs) selected for detail study in Kargahar block of Rohtas district are (i) Basdiha, and; (ii) Semari and the same under Dinara block were (i) Akhodha, and; (ii) Bisikwan.

At the fifth stage, a sample of 60 soil test farmers per crop were selected randomly from each district for assessing the application of recommended dose of fertilizers and its impact on crop production. The cluster approach was followed to ensure that adequate number of soil test farmers could be available for survey. Further, desired care was taken to ensure that the selected villages fell under the agro-climatic conditions of sample districts, and that they could have certain common characteristics, such as (i) soil type, (ii) irrigation, and; (iii) crop variety.

At the sixth stage, 30 controls (non-soil-test farmers) have also been involved for each reference crop from each district selected purposively from the chosen cluster itself for differentiating the effect of the application of recommended dose of fertilizers on crop productivity and income.

In this way, a total of 120 soil test farmers and 60 control farmers for each crop (i.e., rice and wheat) in each of the two selected districts were interviewed. The sample farmers were classified into different farm size groups post survey as per the size of net operated area (NOA). *The soil test reports of the soil samples taken in 2013 couldn't be made available in hard copies (though it was mandated) to the farmers of the selected districts by the 1st week of July, 2014. So, the application of recommended doses of fertilizers and its impact on crop productivity and income of farmers could not be examined.*

7.2.1 Trend in Fertilizer Consumption

Fertilizer consumption in Bihar was a mere 22 kg NPK/ha in TE 1982, which increased to 63 kg/ha in TE 1991 and reached a level of 82 kg/ha in TE 1998. Fertilizer consumption increased in all the zones during this period. It may be noted that growth in fertilizer consumption slackened in the 1990s as compared to the 1980s. There was wide variation in the level of its use across zones/districts. It was as high as 104 kg/ha in Zone-III and 69 kg/ha in Zone-I in TE 1998.Total consumption of chemical fertilizers in Bihar was 731.60 thousand MT during 2004-05. The level of consumption has increased to 1064.80 thousand MT during 2006-07.

During the last five years' period of 2009-10 to 2013-14, fertilizer consumption in Bihar has remained quite higher than all India average and in regard to the uses of NPK

fertilizers individually also. A quick look on data containing consumption of Nitrogen (N), Phosphatic (P) and Potassic (K) fertilizers distinctly reveal higher quantities in case of Bihar than that of all-India average during the three years' period of 2011-12 to 2013-14 except phosphatic (P) fertilizers in the years 2011-12 and 2013-14. It's all India average consumption quantities were a bit higher than that of Bihar (40.54, 28.85, 38.84 & 27.44 kg/ha) respectively.

In aggregate sense, means N, P, K taken together, Bihar consumed higher quantities of fertilizer (kg/ha) in the five years i.e., 2009-10 to 2013-14, which were estimated at 165, 175, 180.48, 199.66 and 164.87, when compared with all India averages i.e., 140, 145, 142.33, 130.79 and 125.39 respectively.

The consumption of nutrients meant for all the major crops taken together was 61.20 kg/ha in 1993-94 that went on increasing continuously till the year 2006-07 (125 kg/ha) except a decline of 8.50 kg/ha in the year 2003-04 over preceding year's consumption of 96 kg/ha. Some declines in consumption of fertilizers in regard to kharif, rabi and total crops could be seen during the last two years, i.e., in 2012-13 and 2013-14 in Bihar.

The total quantities of NPK fertilizers (taken together) also declined by 18.82 per cent and 16.45 per cent during kharif and rabi seasons in the year 2013-14 in comparison to previous year 2012-13

As far the quantities of consumption of fertilizer in kg/ha in the state in growing kharif and rabi crops during the years 2012-13 and 2013-14 are concerned, these declined by 19.78 per cent, 17.15 per cent and 18.26 per cent in comparison to the preceding year i.e., 2012-13 respectively in regard to kharif, rabi and total of both crops. The quantities of fertilizer use in case of kharif and rabi crops and for the crops taken together in 2013-14 were noted as 127.17 kg/ha, 171.50 kg/ha and 150.20 kg/ha respectively.

7.2.2 Socio-Economic Characteristics of Sample Households

Out of the total 'soil test farmers (STFs)' and 'control farmers (CFs)' surveyed in both the districts (i.e., East Champaran & Rohtas) for paddy crop, highest percentage of households (56.66%) belonged to marginal category under control group. In case of wheat, medium farm households under STFs category were found to have dominated (40.00%) over other farm size classes and control group (CG) too. Marginal and Small farm households involved in paddy growing including STFs & CFs comprised 23.89 per cent and 21.11 per cent respectively. In regard to wheat growing surveyed farm households belonging to both STFs & CFs, medium and small farmers were more (36.67% & 27.22%) respectively.

Agriculture being the main occupation for STFs and control farmers CFs meant for both surveyed households of paddy and wheat (100%, 100%, 99% and 100%) respectively dominance of male (88.89%) and 100% on overall level), average years of experience in

farming estimated at 25.10 and 24.20 respectively at overall level inscribe that surveyed farm households had been associated with agricultural activities for nearly half of their average ages.

The average size of owned land, leased out, uncultivated/fallow, NOA, NIA, GCA, and CI (7.53 acres/household, 0.06 acre, Hh, 0.05 acre/Hh, 7.76 acres/Hh, 7.10 acres/Hh, 15.02 acres/Hh and 193.56%) respectively meant for soil test farmers (STFs) surveyed for paddy crop were as per the normal belief, greater than that of control farmers (CFs).

As far operational land holding of the sample households surveyed for wheat crop is concerned, the data suggest to conceptualize that STFs were, unlike paddy, slightly better placed in regard to owned land, leased in, leased out, NOA, NIA, GCA and CI (6.38, 0.31, 0.10, 6.59, 6.29, 13.00 acres/household and 197.16%) respectively.

It is distinctly revealed that canal had been the most prominent source of irrigation for both STFs and Control farmers (CFS) in case of paddy (50% & 46.87%) respectively. Bore well remained the most important source of irrigation for both STFs and CFs (59.17%& 51.03%) respectively meant for surveyed Hhs of wheat area.

In case of sample Hhs of paddy areas, paddy, wheat and orchard (litchi, mango, etc.) were the main crops occupying larger areas on overall level during kharif, rabi and annual/perennial seasons (48.78%, 37.62% & 0.69%) respectively. In regard to crop – II (wheat) areas sample Hhs, again paddy and wheat were prominently grown during kharif and rabi seasons (42.01% & 41.91%).

It is interesting to note that both the STFs and CFs surveyed in the paddy and wheat growing areas used HYV kharif paddy and wheat (rabi) as major crops having devoted larger percentages of cropped area (18.70, 10.50, 10.00, 11.12 and 8.50, 10.00, 5.10, 7.35) respectively.

It is revealed that in regard to value of output and value of output sold by both STFs and CFs of paddy growing Hhs, large size farm Hhs remained ahead (Rs. 1,95,580/Hh, Rs. 17,780/acre, Rs. 1,64, 062.50, Rs. 15,625, value of output sold Rs. 1,36,906, Rs. 12,446, Rs. 1,14,843.75, and Rs. 10,937.50) respectively.

Having paid attention on the data in the table comprising value of output, and value of output sold by the surveyed Hhs of wheat area, again it is evident that large farm Hhs were ahead of all other farm size groups except CFs, whose value of output sold was highest in case of medium farmers (Rs. 13,050/acre). It is further noticed that farm size is directly related to value of output, and value of output sold in positive way in case of both STFs and CFs meant for both the crops.

It is evident that STFs did own higher number of high priced farm implements/equipments than that of CFs. STFs were well ahead in regard to

possessing tractor/trolley, electric motor/diesel engine and manual/power sprayer than that of CFs applicable for both paddy and wheat growing farm Hhs (0.42/Hh, 0.67/Hh, 0.33, for CFs these were 0.21, 0.22, 0.12 and for wheat STFs, these were 0.48/Hh, 0.58/Hh, 0.23 and in case of CFs, 0.20/Hh, 0.20/Hh, 0.08/Hh) respectively.

STFs did have higher agricultural credit by commercial banks as reported by both paddy and wheat growing surveyed households (Rs. 833.33 and Rs. 2166.67) respectively. For CFs of paddy and wheat crops, the most instrumental sources of credit remained friends/relatives and commercial banks in case of wheat growing farm households only (Rs. 1783.33/Hh and Rs. 3,017/Hh) respectively.

In case of sample farmers of wheat area, CFs were again found to have outstanding amounts from friends/relatives apart from commercial banks (Rs. 830 380/Hh), the STFs had outstanding of Rs. 416.67/Hh by friends/relatives

As most of the CFs belonging to both paddy and wheat growing areas were resource poor (RP) in comparison to STFs, so CFs had higher credit outstanding on them than that of STFs (Rs. 2,616.66, Rs. 3,847, in comparison to Rs. 1,883.33 and Rs. 2,583.34/Hh for STFs) respectively. In percentage terms, higher agricultural credit outstanding meant for STFs of paddy and wheat areas and CFs of wheat areas only was found (4.17, 5.00 & 13.33) respectively.

It is interesting to note that CFs remained much ahead in availing agricultural loan for seasonal crop cultivation, purchase of tractor and other implements, purchase of livestock and land development (taken together) for both paddy and wheat growing areas than the STFs. The percentages of the purpose of agricultural loan were (70.00, 91.67, 57.77 and 72.50) respectively on taking it in totality for agriculture and allied purposes).

7.2.3 Details of Soil Testing and Recommended Doses of Fertilizers

While higher coverage of net operated area (NOA) was visible in case of surveyed households of wheat growing area than that of paddy farm households (59.33% & 43.34%) respectively, the average area covered under soil test in wheat area was little higher than that of paddy farmers (3.91 and 3.52 acres) respectively. Farm class wise analysis reveals that marginal farm households belonging to both paddy and wheat areas were ahead in regard to areas covered as percentage to NOA (61.73 & 65.79) respectively.

State department and friend/neighbours were the main sources of information about soil testing by STFs of both paddy and wheat growing areas. In both cases, while large farmers got information from the agencies of state department, marginal and small farm households could come to know from friend/neighbours (95.45%, 100.00%, 22.22% & 30.00%) respectively.

Increasing crop yield, motivation from village demonstration/training/exposure visits and adopt new technological practices were the prominent reasons for soil testing by STFs on overall level, while very few of the sample households total 'peer farmers' group pressure' to be instrumental (100.00%, 90.83%, 57.50% & 50.00%) respectively.
There are sufficient data to find for the fact that (i) soil testing laboratories were located for away, (ii) lack of knowledge about taking soil samples, (iii) No knowledge about whom to contact for details on testing, and; (iv) lengthy process and no awareness were the main reasons for not testing soil during the last three years meant for paddy and wheat crops separately (88.33%, 70.00%, 91.67%, 15.67% & 81.67% and 63.33%, 98.33%, & 41.67%) respectively.

7.2.4 Adoption of Recommended Doses of Fertilizers and its Constraints

Farm class wise data reveal that marginal, small and large STFs growing paddy used maximum quantities of Urea, DAP & Potash (100 kg/acre, 50 kg/acre and 7.03 kg/acre) respectively. In case of CFs, small, medium and large farm households were ahead in using these fertilizers (102, 50.25 and 1.38 kg/acre) respectively.

Having viewed in totality, urea was used in larger quantities followed by DAP and Potash in regard to both STFs and CFs (90.55 kg/acre, 45.53 kg/acre, 3.14 kg/acre and 98.98 kg/acre, 49.13 kg/acre and 0.29 kg/acre) respectively. Small, small large and large STF households and small, medium, large and large again belonging to CFs used higher quantities of Urea, DAP, SSP and Potash in kg/acre (100.01, 62.33, 3.45 and 8.50) respectively in case of STFs and 101.00, 51.03, 2.21 and 5.11 kg/acre respectively meant for CFs.

It is interesting to note that both the STFs and CFs belonging to sample households of paddy and wheat growing areas applied broadcasting method (100.00%) for every of the chemical fertilizers, viz., urea, DAP, SSP & potash.

Only Farm Yard Manure (FYM) and Green Manure (GM) were found to have been used by STFs and CFs growing paddy and FYM and vermi-compost/bio-gas waste (VC/BGW) by wheat growing STFs and CFs.

Maximum quantities and area coverages of FYM by paddy growing STFs and CFs (1471.86 kg/acre, 25.05 % and 1415.38 kg/acre, 40.00%) respectively were observed. In case of wheat growing STFs and CFs, these figures were 469.10 kg/acre, 48.10% and 473.13 kg/acre, 25.82% respectively. Both paddy and wheat growing STFs were much ahead (in percentage terms) than that of CFs in regard to applying FYM.

Private fertilizers shops/Dealers (PFS/D) were the main source for majority of the STF farm households growing paddy (72.50%), who purchased fertilizers from this source. When viewed in totality (i.e., including marginal, small, medium and large farmers), Company Authorized Dealers (CADs) were used by 27.50 per cent of the farm

households. Control farmers (CFs) of paddy growing areas in majority used PFS/D source (73.33%) and CAD (26.67%). The two sources, namely: PFS/D and CADs were prominently used by wheat growing STFs and CFs belonging to all farm size classes on overall level (52.50%, 47.50%, 51.67% and 48.33%) respectively. Across the farm size, marginal and large STFs used PFS/D and CADs as main sources for purchasing fertilizers (65% and 61.54%) respectively. In case of CFs also, similar scenario were observed in regard to purchase of fertilizers (58.33% and 57.14%) respectively.

PFS/D sources were the most important sources for both paddy and wheat growing STFs and CFs, from which fertilizers, like: Urea, DAP, SSP and Potash were purchased. Much lower quantities (in percentage terms) of Urea, DAP, SSP and Potash were purchased by both paddy and wheat growing STFs and CFs from CADs. In case of both STFs and CFs growing wheat CADs were the main source, from where farmers purchased maximum quantities of fertilizers.

It is revealed that among STFs, average prices of urea, DAP and potash (Rs. 7.29/kg, Rs. 25.96/kg and Rs. 16.81/kg) respectively were a little higher than that of CFs (Rs. 6.83/kg, Rs. 25.50/kg and Rs. 14.52/kg) respectively. But, in regard to transportation cost, these were higher in case of CFs except SSP (Rs. 0.53/kg, Rs. 0.41/kg and Rs. 0.63/kg) respectively.

7.2.5 Impact of Adoption of Recommended Doses of Fertilizers

Highest average yields (in qtl/acre) by STFs and CFs belonging to medium and large farm size groups meant for both paddy and wheat crops (14.00, 14.00, 12.40, 12.50 & 14.50, 15.00, 12.00 and 12.25 qtls/acre) respectively are delineated. Percentage differences in yield (in regard to average yield and average values of output) were also found higher among medium and large farm households than that of marginal and small ones in case of both the crops.

Average values of output (Rs./acre) were found clearly higher in case of medium and large categories of both STFs and CFs meant for paddy and wheat crops separately (17500, 17780, 15624, 15625 and 21025, 21750, 17400 & 17762.50) respectively.

7.3 Policy Recommendations

1. Soil testing laboratories (STLs) at the district levels lack adequate staff that resulted in to non-distribution of soil health cards to the farmers in hard copies. So, there should be full proof arrangement to distribute the same immediately after the results are brought out *(Directorate of Soil Testing, Dept. of Agriculture, GoB).*
2. Required inputs at the STLs should be made available in time. *(Directorate of Soil Testing, Department of Agriculture, GoB).*

3. To expedite the soil testing exercises for all farmers in time, mobile soil testing vans should be deployed *(Directorate of Soil Testing, Department of Agriculture, GoB).*
4. At present, soil testing is made for primary nutrients (NPK) only, which may be extended to secondary & micro nutrients also *(Directorate of Soil Testing, Department of Agriculture, GoB).*
5. Trainings and awareness campaigns about the benefits of balanced use of fertilizers and ill effects of its excessive use in terms of costs and human hazards should be regularly arranged at village panchayat levels *(Directorate of Soil Testing, Department of Agriculture, GoB).*
6. Extension and scientific back-ups by the extension workers and KVK Scientists are essential for adoption of the recommended doses of fertilizers, which should be made available on priority basis *(Directorate of Soil Testing, Department of Agriculture, GoB).*
7. Demonstrations on the application of fertilizers for rabi, kharif and summer crops may be arranged for exposures to farmers with the view to make them familiar in regards to its uses *(Directorate of Soil Testing, Department of Agriculture, GoB).*
8. NPMSF should be in **mission mode.** Its augmentation will enrich the health of the soil and improve the economics of agricultural practices *(Ministry of Agriculture, Government of India).*

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Annexure -I

Comments:

"ADOPTION OF RECOMMENDED DOSES OF FERTILIZERS ON SOIL TEST BASIS BY FARMERS IN BIHAR"

AERC, BIHAR & JHARKHAND, T M BHAGALPUR UNIVERSITY, BHAGALPUR - 812 007

Reviewer Comments:

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

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

2. **Date of receipt of the Draft report:** 6th July, 2015

3. **Date of dispatch of the comments:** 4th August, 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. However, it is mentioned in the Data and Methodology (1.5.1) that the list of soil testing farmers along with ***non-soil testing farmers*** as control were taken from State Department of Agriculture. Hence, clarification on the list of non-soil testing farmers can be provided in the report.

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

(i) **Chapter III**: Table 3.1- The total column of the respective crops must be presented.

(ii) Table 3.15 and 3.16 – Percentage of farmers who availed loan from respective sources must be presented in the separate column in the table.

(iii) **Chapter IV**- Table 4.1 and 4.2- Remove the row representing average cost of soil testing in both the tables as it indicates that the average cost is zero.

(iv) Tables representing status of soil health and average quantity of fertilizers recommended based on soil test are not present in the chapter IV, which have to be included.

(v) **Chapter V-** Organization of tables in the chapter is not according to the reference tables. Therefore it is suggested to organize the tables and write up according to reference table plan.

(vi) Remove the tables presenting actual quantity of split doses of fertilizers applied.

(vii) Sources of fertilizers and quantity of fertilizers purchased tables have to be analyzed separately for respective crops and presented.

(viii) Tables representing impact of application of recommended doses of fertilizers on crop yield and changes observed after the application of recommended doses of fertilizers on reference crops are not presented in the chapter. Therefore it is suggested to include those tables in the chapter.

(ix) **It is suggested to copy edit the report before finalizing.**

7. Overall view on acceptability of report

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

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Annexure -II

Action Taken Report

1. Title of the Study : Adoption of Recommended Doses of Fertilizers on Soil Test Basis by Farmers in Bihar

2. Date of Dispatch of the Draft Report & 29/06/2015 &
   Date of receipt of Comments on the draft report : 05/08/ 2015
3. Date of dispatch of Final Report : 31/08/ 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 followed. There is no mention in the draft report about the list of 'non-soil testing farmers' as control that was taken from the State Department of Agriculture.

6. Comments on analysis, organization, presentation, etc. : Actions have been taken as mentioned below:

   i. Suggestion incorporated
   ii. Done
   iii. Rows in tables 4.1 & 4.2 removed
   iv. As per the methodology, the reference period for the study was 2013-14. The list of farmers, who got their soil tested, was to be collected from the State Department of Agriculture for the year 2012-13 to assess the adoption of recommended dose of fertilizers. In Bihar, including the two selected districts, the soil testing exercises could be started in rabi season, means November, 2013. The soil test reports, i.e., soil health cards were not available to the farmers till June, 2014. So, the impact of recommended dose of fertilizers and its impact on crop productivity and income of farmers couldn't be examined. This limitation was already informed to the Co-ordinator and duly mentioned in section 1.6 of Chapter – I. Second para of section – 1.6 (i.e., Direction from the Co-ordinator) clarifies the comment. So, tables representing 'soil health' and average quantity of fertilizers recommended based on soil test could not be given.
   v. First three tables suggested in Chapter-V of the table structure for primary survey data could not be presented because of the reason /described at SN – 6 (iv) of the ATR. All remaining tables in the Chapter are according to the reference table plan.
   vi. Tables presenting actual quantity of split doses of fertilizers applied removed.
   vii. Incorporated accordingly.

viii. Reasons for not including the tables representing impact of application of recommended doses of fertilizers on reference crops have been mentioned at 6 (iv) of the ATR, besides its description in section – 1.6 of Chapter – I, section – 4.1 of Chapter IV and section – 6.1 of Chapter – VI.

ix. The report is copy edited.

7. Actions taken as far as possible.

Rajiv Kumar Sinha
&
Rosline Kusum Marandi

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