AERC, Jabalpur - Research Study No. - 128

Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of Madhya Pradesh

Study Sponsored by
Ministry of Agriculture and Farmers Welfare
(Govt. of India)

AGRO- ECONOMIC RESEARCH CENTRE
Jawaharlal Nehru Krishi Vishwa Vidyalaya,
Jabalpur (M.P.) 482004

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PROJECT TEAM

Data Collection & Tabulation of Data

Mr. Satyendra S. Thakur
Mr. Prem R. Pandey
Mr. Rajendra S. Bareliya
Mr. Akhilesh Kuril
Mr. Pradeep K. Patidar

Interpretation and Report Writing

Dr. Hari Om Sharma
Dr. Deepak Rathi
Dr. H. K. Niranjan

Coordinator

Agro- Economic Research Centre
Jawaharlal Nehru Krishi Vishwa Vidyalaya,
Jabalpur Madhya Pradesh- 482004 (India)

AGRO- ECONOMIC RESEARCH CENTRE
FOR MADHYA PRADESH AND CHHATTISGARH

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

PREFACE

The present study entitled "Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of Madhya Pradesh" has been assigned by the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers' Welfare Government of India to this centre in the year 2019-20.

The study comprises 180 farmers of Datia, Chhatarpur, Tikamgarh Panna, & Damoh districts of Madhya Pradesh related to the major crops of viz. wheat, gram and soybean of Bundelkhand Region of Madhya Pradesh. The study revealed that the maximum yield gap between potential and average farm yield was found in cultivation of gram (43.59%) followed by soybean (38.87%) and wheat (29.86%). The yield gap II was found to be more than yield gap I in cultivation of wheat, gram and soybean denotes that the recommended technologies for cultivation of these crops have been reached to farmer's field but farmers are could not adopted these technologies due to several socio-economic constraints. It is also observed that factors like use of high yielding varieties (HYVs) seed, improved method of sowing, seed replacement (purchase seed), consumption of fertilizers as per soil test recommendation, treatment with fungicide and bio-fertilizers (Rhizobium, Azotobacter and Phosphate Solubilizing Bacteria), increase educational status, proper seed rate, increase consumption of DAP were found to be positively related to yield of all the major crops.

On behalf of the Centre, I express my deep sense of gratitude to Prof. P.K.Bisen, Hon'ble Vice-Chancellor and Chairman, Advisory Body of AER Center, Jabalpur, Shri. P.C. Bodh, Adviser, AER Division, Ministry of Agriculture and Farmer's Welfare, Govt. of India, New Delhi, Dr. P.K.Mishra, Director Research Services, Dr. D. Khare, Dean, Faculty of Agriculture, Dr. (Smt.) Om Gupta, Director Extension Services and Dr. R.M.Sahu, Dean, College of Agriculture /Prof. & Head (Dept. of Agril. Econ.&F.M.), Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur for providing the valuable guidance and all facilities during various stages in successful completion of this study of high importance.

I extend heartfelt thanks to Dr. H.C. Malviya and Mr. Hasib Ahmad, Research Associate, AER Centre, Allahabad and Mr. Vikash Arora, Technical Officer, Ahemadabad, Computer-Assisted Personal Interviews (CAPI) to Coordinate this study successfully.

The present study was conducted by Dr. H. O. Sharma, Dr. Deepak Rathi and Dr. H. K. Niranjan of this centre. The field investigation, tabulation, analysis, interpretation and drafting of the report were performed by them. I wish to express my deep sense of gratitude to team members namely; Mr. S. K. Upadhye, Mr. S. S. Thakur, Mr. P. R. Pandey, Mr. R. S. Bareliya and Mr. Akhilesh Kuril & Mr. P. K. Patidar for their untiring efforts in bringing this innovative study to its perfect shape.

I express sincere thanks to Shri R. M. Sharma, Shri Manoj Kashyap, Shri S. K. Shrivastava, Shri A. P. Suman and Shri R. S. Sharma, Deputy Director of Agriculture, of Datia, Chhatarpur, Tikamdarh, Panna and Damoh districts respectively and their field staff for providing not only secondary data but also extending great assistance in collection of primary data from the selected respondents.

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

Date: 29.01.2020
Place: Jabalpur

(Hari Om Sharma)
Prof. & Director

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EXECUTIVE SUMMARY

Improving crop yields is essential to meet the increasing demand for food driven by the increasing population and income growth in the 21st century. Increasing agricultural productivity or yield is critical to economic growth and development. This can be achieved by using improved agricultural technologies and proper management techniques. Adoption of agricultural technologies differs from farmer to farmer which refers to both mental acceptance and also covers the use of new agricultural technologies. This can be achieved by using high yielding management practices (Yang et al., 2008), minimizing yield gaps in major crops by using optimal management practices may lead to improvements in production, while offering both environmental benefits and economic value.

Bundelkhand is a mountain range in central India and divided between the States of Uttar Pradesh and Madhya Pradesh with the larger portion lying in M.P. Bundelkhand comprises 14 districts: Jhansi, Lalitpur, Jalaun, Hamirpur, Mahoba, Banda and Chitrakoot (all in UP), and Datia, Tikamgarh,Niwari, Chhatarpur, Panna, Sagar and Damoh (all in MP). The Bundelkhand is rocky and has a high percentage of barren and uncultivable land. The soil form is the mixture of black and red-yellow which is not considered very fertile. Rainfall is sparse and the agricultural production is low. Poverty level is significantly high. The MP is rich in forest, Bundelkhand has lost its forest cover to a large extent. So, the forest as a means of livelihood is becoming destroyed day by day. It seems that the farmers could not be able to adopt the recommended package of practices for cultivation crops due to several socio-economic, technological constraints etc. resulting into low farm income. This is the main cause of farmers' dissatisfaction and farmers have no other options except to feel satisfied at low level of income in the area.

Keeping aforesaid facts in mind the present study has under taken in Bundelkhand region of the Madhya Pradesh with following specific objectives

a) To identify various socio-economic characteristics of farmers across size of holdings

b) To analyze yield gap of major crops grown by the cultivators across size of holdings

c) To determine factors affecting productivity of major crops

d) To identify various socio-economic, technological constraints in adoption of recommended package of practices in crop cultivation

e) To suggests policy implication to narrow down yield gap of major crops.

2 Data and Methodology

All the major crops having more than 10 per cent share in gross cropped area have been selected for the study. Therefore, wheat (27.64%), soybean (16.30%) and gram (14.04%) have been considered for analysis of yield gap in Bundelkhand Region of Madhya Pradesh.

All the districts of Bundelkhand region of Madhya Pradesh have been taken into consideration for the study considering yield gap between the average yield of major crops in the district and average yield of that particular crop in Bundelkhand region of Madhya Pradesh. A higher yield gap and a low yield gap districts have been selected for each selected crops. Hence, Panna (-43.96%) and Tikamgarh (-19.79%) districts have been selected for soybean, while Panna (-43.88%) and Datia (-4.78%) districts have been selected for wheat and Chhatarpur (-23.05%) and Damoh (-4.04%) districts were selected for gram for the study in Bundelkhand region of Madhya Pradesh

A block in each selected district was further selected from the each selected districts on the basis of the highest area under selected crop. A list of all the villages in the each selected block was prepared and 3 villages having maximum area under cultivation of crop were selected for the study. A list of all the cultivators growing the selected crop was further prepared and classified them into small (<2 ha), medium (2-5ha) and large (>5ha) categories and 10 farmers in each category were selected randomly for the study. (Table 2.2). 30 farmers each from high and low yield gap districts, total 60 farmers were selected for the each selected crops. Thus 60x3=180 farmers were selected for the study.

An orientation training programme regarding introduction of Computer-Assisted Personal Interviewing (CAPI) was organized for collection of data related to interview schedule. All the related points of interview schedule were discussed in detail for better understanding in collection and analysis of data. A pre-tested interview schedule through CAPI was used for collection of required data from the respondents.

3 Conclusions

The following conclusions are emerged from the study of Bundelkhand Region of Madhya Pradesh:-

3.1 Overview of Bundelkhand

The total population of Bundelkhand region of Madhya Pradesh was found to be 86.53 lakh, out of which 52.79 and 47.21 per cent are male and female, respectively. The population of rural (77.86%) was found to be more as compared to urban (22.14%) population. An average literacy rate of the region was found to be 69 per cent, which was more in male (78%) as compared to female (58%) population. The very thin sex ratio (894) and child sex ratio 903 over 1000 male was found in the region.There were only 15.40 per cent of children in total population of Bundelkhand Region of Madhya Pradesh. The region was found to be dominant by Hindus (94.38%) followed by Muslim (3.81 %) religion.

The geographical area of the region was found to be 41.28 lakh ha. Out of total geographical of the Region, 48, 29, 10, 9 and 4 per cent was found in net area sown, area covered under forest, land not available for cultivation, other un-cultivated land excluding fallow land and fallow land respectively. Amongst all the district, maximum geographical area was occupied by Sagar (25%) followed by Chhatarpur (21%), Damoh (18%), Panna (17%), Tikamgarh (12%) and Datia (7%) districts, while the net area sown to total geographical area was found to be more in Datia (67.8 %) followed by Tikamgarh (54.86%), Sagar (53.31%), Chhatarpur (47.11%), Damoh (43.8%) and Panna (35.33%). The net irrigated area of the region was found to be 32.54 per cent (13.44 lakh ha) to total geographical area. Amongst different sources of irrigation, well (41.84%) followed by tube-well (19.22%), canal (15.3%) and tank (3.09%) were found to be major sources of irrigation, while other sources (ponds & rivers) were also found to be a source of irrigation contributing 20.56 per cent of net irrigated area. The 1291038 numbers of land holdings occupied 24.39 lakh ha area in Bundelkhand Region of Madhya Pradesh. The number of marginal (43.64%) and small (31.09%) holdings were found to be more as compared to semi-medium (15.13%) medium (8.96%) and large (1.18%) size of holdings, while area of medium (30.64%), and semi-medium (22.65%) holdings were found to be more as compared to small (20.77%), marginal (16.70%) and large holding (9.23%) in the region. The 1291038 numbers of land holdings occupied 24.39 lakh ha area in the region.

The cropping pattern of the region was found to be dominated by Rabi (57.92%) as compared to kharif season (42.08%). Wheat (27.64%) followed by gram (14.04%) and soybean (16.30%) followed by rice (5.7%) were found to be major rabi and kharif crops respectively. Farmers of the region were found to be consumed 31481 t per year of fertilizers. The consumption of Di-ammonium Phosphate, DAP (61.92%) was found to be more as compared to Urea (28.68%), Single Super Phosphate, SSP (4.94%), Complex Fertilizer (3.5%) and Murate of Potash, MOP (0.95%)

The numbers of regulated markets were found to be 38 across different grades of mandi and various districts of the Region. However, the majority of regulated market were found to be of “D” grade (52.63%) followed by “C” grade (26.32%) “B” grade (13.16%) and “A” grade (7.86 %). As regards to the numbers of ploughs, bullock carts, electric pumps, diesel pumps and sugarcane cutters were concerned there were found to be 358162, 120699, 266209, 147350 and 1213 in the Region. The cultivators of the region of Madhya Pradesh used 1023858, 254211, 2033497 and 311362't of High Yielding Varieties (HYVs) seed, seed treatment chemicals, fertilizers and plant protection chemicals for cultivation of various crops in their field.

More number of non-workers (56.77%) was found in the region as compared to main workers (31.40%) and marginal workers

(11.83%). In total number of workers (main and marginal) the majority of them were found to be agricultural labours (36.98%) followed by cultivators (32.47%), other workers (23.36%) and workers in household Industries (7.19%).

The number of livestock in the region was found to be 4934833. Amongst their population of cows (41.62%) was found to be more as compared to buffaloes (33.69%), goats (19.89%), sheeps (1.94%) and pigs (2.87%).

3.2 Socio-economic Characteristics

The majority of respondents were found to be of OBC (70%) with 82 per cent level of literacy. The family comprises of 7 members with 3 members engaged in farming with average experience of 33 years in farming. An average respondent was found to earn 71.60 per cent (Rs 62291/year) of total annual income from farming. The value of land was found to vary between Rs Rs. 454283 to Rs. 973199/ acre across the Region. An average HH has farm assets of only Rs. 128227 on his farm, which varies between Rs.19599 (small) to 272979 (large) per farm. An average HH of small, medium and large farmers were found to be 3.68, 8.38 and 21.62 acres of operated land in Bundelkhand Region of Madhya Pradesh.

Out of gross cropped area (21.12 acre) an average respondent was found to allocate maximum area in cultivation of kharif (52.94%) as compared to rabi (47.06%) season. Soybean (36.13%), followed by rice (23.66%) and wheat (60.49%) followed gram (21.65%) were found to be major kharif and rabi seasons, respectively. The cropping intensity of area was found to be 190 per cent, which was found more in small (196%) as compared to large (180%) farms. It is also observed that only 43 per cent of HH were found to test soil of their farms and only 36 per cent received Soil Health Cards.

The majority of them were dependent on the officers of Farmers Welfare and Agriculture Development Department (53.75%) for recent information of crop cultivation. Relatives/ neighbour (25.42%), progressive farmers/ krishak mitra (16.25%), Krishi Vigyan Kendra (2.92%) and Kisan Call Centre (1.25%) were found to be other source of information in the area under study.

3.3 Yield Gap and Constraints Analysis

The maximum yield gap between potential and average farm yield was found in cultivation of gram (43.59%) followed by soybean (38.87%) and wheat (29.86%). The yield gap II was found to be more than yield gap I in cultivation of wheat, gram and soybean denotes that the RPP cultivation of these crops have been reached to farmers field, but farmers are could not adopted these technologies due to un-availability of desired variety of seed, high cost of input, lack of knowledge about proper dose of fertilizers as per soil test recommendation, lack of knowledge about method of seed treatment. Low germination of seed of soybean (70%) as reported by majority of soybean was the major constraints identified in the study area. The respondents also reported un-availability of capital, un-availability of electricity and lack of

labour during the peak operation in cultivation of these crops.

3.4 Determinants of Yield

A multiple regression model was used to find out determinants yield of major crops and was found to be good fit as it explain more than 80 per cent contribution of known independent variables. Independent variables like use of high yielding varieties (HYVs) seed, improved method of sowing, seed replacement (purchase seed), consumption of fertilizers as per soil test recommendation, treatment with fungicide and bio-fertilizers (Rhizobium, azotobacter and Phosphate Solubilizing Bacteria), increase educational status, proper seed rate, increase consumption of DAP were found to be positively related to yield of all the major crops. Factors like adoption of soil test recommendation, proper seed rate, seed replacement through purchase seed, consumption of Urea were found to be positive and significant in case of yield of wheat.

In case of gram cultivation, seed replacement with purchased seed, proper seed rate, use of HYVs seed and increase consumption of urea were found to be positive and significant. While consumption of DAP, area under irrigation, proper seed rate and use of High yielding varieties of seed over local seed were found to be positive and significant in case of yield of soybean. Seed replacement with HYVs seed, soil test recommendation, proper seed rate and increase consumption of a kg of Urea would be able to enhance yield of wheat to 101.89, 135.23, 3.04 and 3.41 kg per acre respectively in cultivators fields, while increase in 1.00 acre size of holding would able to decrease yield of wheat with -4.27 kg per acre in Bundelkhand region of Madhya Pradesh.

In case of gram independents variables like use of HYVs seed, seed treatment, area under irrigation, increase a kg of Urea and proper seed rate would be able to enhance yield of gram to 154, 106, 63, 35 and 31 kg per acre in cultivators fields respectively in Bundelkhand region of Madhya Pradesh. In case of soybean use of HYVs seed, proper seed rate, increase area under irrigation and one kg increase in DAP per acre would be able to enhance yield of soybean to 81.88, 3.87, 51.07 and 5.74 kg per acre respectively in cultivators fields, while increase in one acre size of holding would able to decrease yield of soybean with 51.07 kg per acre in Bundelkhand region of Madhya Pradesh.

4 Policy Recommendations

- From the above conclusions it was found that there was more than 30 per cent yield gap between potential and average farm yield of major crops in Bundelkhand Region of Madhya Pradesh. Therefore, following strategies should be formed to reduce the yield gap and enhance the income of the farmers.
- Need based training programme based on RPP of cultivation of crops in the area must be organized for the field staff of the Farmer Welfare and Agriculture Development Department, Madhya Pradesh followed by

producers before the start of the season in the nearest KVK. The whole training must be designed in the view of the field staffs and producers of the area which will directly reflect into the productivity of crops.

- One or two demonstration should be organized in a villages should be planned for complete transfer of technology with full package of practices and component wise packages of practices of cultivation of crops in the field of key farmers. If there is a problem or incidence of insects or diseases, a field day should be organized in front of all the farmers of the Village so that they will learn by seeing, it is for their better and proper understanding of all the package of practices of crop cultivation.
- Online portal of government on seed distribution needs to be created to show the variety wise and class wise availability of seed with the facility of online purchase/booking, as majority of farmers reported that un-availability of desire variety of seed was found to be major constraint in cultivation of crops.
- It is also found during the course of investigation that majority of farmers are not adopted need based Integrated Farming System (IFS) in a true sense. Hence, efforts should be made to introduce need based integrated farming system in the area. And, at least one Seed Producer Company, Producer Company, Custom Hiring Centre are required to be established in each and every Gram Panchayat/Development Block of Bundelkhand Region of Madhya Pradesh.
- It is observed from the study that "Toll Free Number" of the Kisan Call Centre (1800-180-1551) yet not be a come main source of information dissemination for the farmers in the area under study. Hence, strategies should made in a such a way that every farmer should able to use this particular number to solve his problem related to crop and animal husbandry.
- Technology adoption in agriculture is a long drawn process, which involves developing appropriate need-based technology, testing the new technology, taking it from lab-to-land, and optimum application of it for obtaining the desired benefit for its sustainability. Willingness to adopt the new technology by farmers is a crucial challenge, especially in view of the financial and knowledge constraints of farmers. Moreover, the new technology needs to be integrated with the extent systems and policies for wider acceptability.
- Digital technology requires uses of computers, internet, mobile technology, application tools, etc. It may not be easy for majority of farmers with their current level of education, exposure and remoteness of their locations. To certain extent, capacity building on the principle of seeing & believing (Demonstration) it to be adopted to motivate farmers to accept technological change in agriculture.

Thus, the yield gap of crops is only be narrowed through enhancing productivity by batter management of available farm resources and proper allocation of funds for purchase inputs. This needs strengthening of knowledge of producers of Bundelkhand Region of Madhya Pradesh through imparting trainings, conducting demonstration, mass media approach through electronic means and information technologies. There is also a need of Public Private Partnership (PPP) for knowledge management, required into supply and procurement of produce at reasonable price, which works as a catalytic agent for increasing adoption of crop production technologies leading to break yield barriers in crop production.

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CHAPTER - I

INTRODUCTION

1.1 Background

Improving crop yields is essential to meet the increasing demand for food driven by the increasing population and income growth in the 21st century. Increasing agricultural productivity or yield is critical to economic growth and development. This can be achieved by using improved agricultural technologies and proper management techniques. Adoption of agricultural technologies differs from farmer to farmer which refers to both mental acceptance and also covers the use of new agricultural technologies. This can be achieved by using high yielding management practices (Yang et al., 2008), minimizing yield gaps in major crops by using optimal management practices may lead to improvements in production, while offering both environmental benefits and economic value.

Yield refers to the production per unit area. The yield gaps were attributable to the inability of the farmers to apply critical inputs to the recommended level. The yield gap between on–farm demonstrations and actual farm yield has failed to show appreciable reduction over the past two decades in India. The yield gap is the difference between the potential farm yield and the actual average farm yield. (Basavaraja 2000; Lobell et al. 2009; Jha et al. 2011; Mondal 2011). Assessing the yield gaps in major field crops can help us understand yield variability, yield potential, and the input use efficiency of major crops and may indicate appropriate strategies to bridge yield gap for improving agricultural efficiencies and farm income (Fischer et al., 2009; Van Ittersum et al., 2013).

Prevailing farmers' practices were treated as control for comparison with recommended practices (Pushpa and Srivastava 2014; Joshi et al.; 2014 and Soni et al. 2014). Yield gap is a useful measurement for crop productivity and the extent to which crop productivity falls below some potential level (Hussain A., et al., 2014). Understanding the yield gap is very crucial as it can assist in crop yield predictions since yield potential shows the probable future productivity to be achieved. Also, information on the determinants of yield can be used in policy interventions for enhancing crop production. In order to meet the increasing demand of food due to increasing population and income, food production in India needs to be increased. The production of food grains in India increased considerably since 1960 due to increasing in the arable area, large-scale cultivation of high yielding semi-dwarf varieties and increased applications of irrigation, fertilizers, and pesticides. India became food secure in the last three decades at a gross level because of the increase in food production.

Bundelkhand is a mountain range in central India and divided between the States of Uttar Pradesh and Madhya Pradesh with the larger portion lying in M.P. Bundelkhand comprises 14 districts: Jhansi, Lalitpur, Jalaun,

Hamirpur, Mahoba, Banda and Chitrakoot (all in UP), and Datia, Tikamgarh,Niwari, Chhatarpur, Panna, Sagar and Damoh (all in MP). The Bundelkhand is rocky and has a high percentage of barren and uncultivable land. The soil form is the mixture of black and red-yellow which is not considered very fertile. Rainfall is sparse and the agricultural production is low. Poverty level is significantly high. The MP is rich in forest, Bundelkhand has lost its forest cover to a large extent. So, the forest as a means of livelihood is becoming destroyed day by day. Mining of minerals and stone-quarrying has emerged as a major non-farm activity but is based on exploitative wage labour.

Bundelkhand has a population of around 15.5 million. The total population of UP Bundelkhand districts was around 8.2 million and the population of MP Bundelkhand districts was around 7.3 million (Census 2011). The largest population was found in Sagar district (20.2 lakhs) and lowest population was found in Datia district (6.2 lakhs). There is a clear variation in intra-regional distribution of population. There is higher population density (213) in the Bundelkhand Intermediate region areas (particularly in Tikamgarh (286), and lower population density in Bundelkhand Upland (particularly in Panna (112) and Chhatarpur (203) and the southern Damoh (173), Datia (271) and Sagar (232) plateaus.

Bundelkhand's northern boundary is defined by the Yamuna; the western boundary is defined by the Sind; in the south, the Narmada flows a few kilometres from the boundaries of Sagar district. But none of these rivers play a direct large role in Bundelkhand's economy. Groundwater, mainly extracted from open wells, which is the main source of irrigation in Bundelkhand. In UP Bundelkhand canals are major source of irrigation. In MP Bundelkhand, canals are the major source of irrigation only in Datia. In Panna, Sagar and Damoh water from mountain springs are other source of irrigation. Some tanks built by medieval Chandela and Bundela rulers are used for canal irrigation, especially in Tikamgarh district. Dug (open) wells provide water to over 40% of the net irrigated area in Jhansi, Mahoba, Datia and Sagar districts and over 70% of the net irrigated area in Chhatarpur and Tikamgarh districts. A large number of tanks are seen in the Bundelkhand Intermediate and Bundelkhand Upland sub region, which also abound in natural or manmade ponds talabs.

Agriculture is the predominant occupation in Bundelkhand, land available and used for cultivation in the region is considerably lower than in other agriculture zones of the country. Area cultivated more than once a year does not generally exceed 30% of total cultivated area, except in Jhansi, Lalitpur, Sagar and Tikamgarh districts. Rising input costs and frequent incidence of drought are pushing agricultural labourers and small farmers out of agriculture. The majority of rural households in most parts of Bundelkhand rely on income from annual or seasonal or migration for work. The agriculture is the foundation of Bundelkhand's economy, yield is affected by the poor water retention capacity of the soil, weather fluctuations and large amount of wasteland. Land use pattern across districts of UP and MP Bundelkhand is not significantly different from the rest of UP and MP respectively. Net sown

area in all MP Bundelkhand districts except Datia is considerably lower than in UP Bundelkhand. Around 7% of cultivable land in UP Bundelkhand and around 5% of cultivable land in MP Bundelkhand lies fallow year after year. In MP Bundelkhand as a whole, marginal holdings accounted for 40% of all holdings. The average yield of all the major crops were found to be lower in Bundelkhand Region of Madhya Pradesh as compared to average yield of Madhya Pradesh and India (Table 1.1).

It seems that the farmers could not be able to adopt the recommended package of practices for cultivation crops due to several socio-economic, technological constraints etc. resulting into low farm income. This is the main cause of farmers' dissatisfaction and farmers have no other options except to feel satisfied at low level of income in the area.

Keeping aforesaid facts in mind the present study has under taken in Bundelkhand region of the Madhya Pradesh with following specific objectives

Table 1.1 : Average yield of major crops in Bundelkhand as compared to Madhya Pradesh and India (q/acre)

Particulars	Rice	Wheat	Gram	Soybean
Bundelkhand Region of Madhya Pradesh	4.1	8.5	4.2	3.1
Madhya Pradesh	8.2	12.1	5.2	4.3
India	10.4	13.8	4.6	4.3

1.2 Objectives of the Study

a) To identify various socio-economic characteristics of farmers across size of holdings

b) To analyze yield gap of major crops grown by the cultivators across size of holdings

c) To determine factors affecting productivity of major crops

d) To identify various socio-economic, technological constraints in adoption of recommended package of practices in crop cultivation

e) To suggests policy implication to narrow down yield gap of major crops.

1.3 Limitation of the Study

The study doesn't claim its completeness in all aspects and certainly had some limitations. The data related to the objectives of the study were collected from the selected respondents. The information provided by them is based on interview and they don't keep any record of their farming practices. Therefore, the information provided by them is entirely based on their recall memory thus, there is possibility of certain biasness enter in the study.

1.4 Organization of the Study

The study comprises five chapters, chapter I include introduction, objectives & limitations. Chapter II deals with research methodology. Current scenario of Agriculture in Bundelkhand Region of Madhya Pradesh has been discussed in detail in chapter III. Yield gap

and constraints analysis with determinants of yield of major crops in Bundelkhand Region of Madhya Pradesh is described in Chapter IV, Summary, Conclusion and Policy Implication have been dealt in chapter V followed by References.

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CHAPTER - II

RESEARCH METHODOLOGY

The sampling techniques, nature and types of data required for the investigation, tools and methods of data collection and concept used, while interpretation of the analyzed data for the study are presented in this chapter.

2.1 Selection of Crops

All the major crops having more than 10 per cent share in gross cropped area have been selected for the study (Fig. 2.1). Therefore, wheat (27%), soybean (29%) and gram (10%) have been considered for analysis of yield gap in Bundelkhand Region of Madhya Pradesh.

2.2 Selection of Districts

All the districts of Bundelkhand region of Madhya Pradesh have been taken into consideration for the study considering yield gap between the average yield of major crops in the district and average yield of that particular crop in Bundelkhand region of Madhya Pradesh. A higher yield gap and a low yield gap districts have been selected for each selected crops. Hence, Panna (-43.96%) and Tikamgarh (-19.79%) districts have been selected for soybean, while Panna (-43.88%) and Datia (-4.78%) districts have been selected for wheat and Chhatarpur (-23.05%) and Damoh (-4.04%) districts were selected for gram for the study in Bundelkhand region of Madhya Pradesh (Table 2.1).

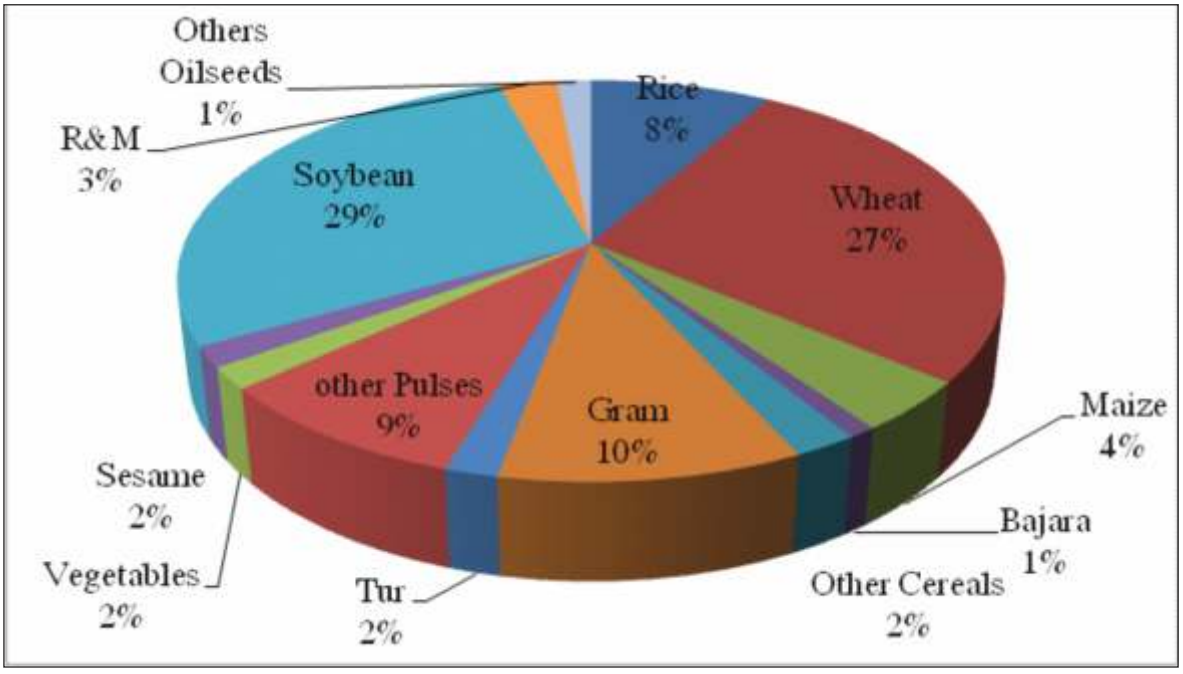

Fig. 2.1: Percentage share of different crops in Gross Cropped Area (23580256 ha) of Madhya Pradesh

Table 2.1: High & Low Yield gap Districts of major crops in Bundelkhand Region of Madhya Pradesh

Madhya Pradesh (TE 2016-17) (Unit : q/ha)

Districts	Wheat	Gram	Soybean
Sagar	21.93	10.4	4.82
Damoh	20.15	10.7	13.14
Panna	17.48	11.55	4.22
Tikamgarh	19.16	9.77	6.04
Chattarpur	18.33	8.58	10.24
Datia	29.66	11.57	8.01
Madhya Pradesh	31.15	11.15	7.53
Percentage difference to Madhya Pradesh (%)			
Sagar	-29.60	-6.73	-35.99
Damoh	-35.31	-4.04	74.50
Panna	-43.88	3.59	-43.96
Tikamgarh	-38.49	-12.38	-19.79
Chattarpur	-41.16	-23.05	35.99
Datia	-4.78	3.77	6.37
High Yield gap District		Low Yield gap District	

A block in each selected district was further selected from the each selected districts on the basis of the highest area under selected crop. A list of all the villages in the each selected block was prepared and 3 villages having maximum area under cultivation of crop were selected for the study. A list of all the cultivators growing the selected crop was further prepared and classified them into small (<2 ha), medium (2-5ha) and large (>5ha) categories and 10 farmers in each category were selected randomly for the study. (Table 2.2). 30 farmers each from high and low yield gap districts, total 60 farmers were selected for the each selected crops. Thus 60x3=180 farmers were selected for the study.

Table 2.2: Number of Selected Farmers from various locations of Bundelkhand Region of Madhya Pradesh

Name of Selected Crops	Size of Farms	High Yield Gap District	Low Yield gap District	Total
Wheat	Small	10	10	20
	Medium	10	10	20
	Large	10	10	20
	Total	30	30	60
Gram	Small	10	10	20
	Medium	10	10	20
	Large	10	10	20
	Total	30	30	60
Soybean	Small	10	10	20
	Medium	10	10	20
	Large	10	10	20
	Total	30	30	60
Sub Total Madhya Pradesh		90	90	180

Fig. 2.2 : Map of Bundelkhand Region of Madhya Pradesh

2.3 Nature and Sources of Data

The study is based on both primary and secondary data. The secondary data have been collected from the office of District Statistics and respective Deputy Director Agriculture of Sagar, Damoh, Chhatarpur, Tikamgarh, Panna and Datia, Department of Farmers' Welfare and Agricultural Development, Govt. of Madhya Pradesh. The primary data were collected from the selected respondents through pre-tested interview schedule of different locations of the study area.

2.4 Tools of Data Collection

An orientation training programme regarding introduction of Computer-Assisted Personal Interviewing (CAPI) was organized for collection of data related to interview schedule. All the related points of interview schedule were discussed in detail for better understanding in collection and analysis of data. A pre-tested interview schedule through CAPI was used for collection of required data from the respondents.

The interview schedule having all the information essential for the study viz. General information, land utilization pattern, sources of irrigation, cropping pattern, machinery use, soil testing status, sources of information and yield of different crops with constraints faced by the cultivators in adoption of Recommended Packages of Practices (RPP). The primary data were collected from the individual respondents through survey method by personal contact. The required primary data were collected for the agricultural year 2019-20.

Fig. 2.3 : Orientation training programme

Fig. 2.4 : Pre-testing of interview schedule through CAPI in Jabalpur District

Fig. 2.5 : Collection of data through CAPI in Tikamgarh District

Fig. 2.6 : Collection of data through CAPI in Damoh District

2.5 Analysis of Data

Analysis of data was done with suitable statistical tools i.e. mean and percentage. A following multivariate regression analysis was done to identify determinants of yield.

$Y=a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8+b_9X_9+b_{10}X_{10}+b_{11}X_{11}+b_{12}X_{12}+E$

Where,

Y = Productivity of ith crop (kg/acre)

X_1 = Education (in numbers)

X_2 = Age in years

X_3= Source of Seed (Purchase-1, Self-0)

X_4 = Soil Test (Yes-1, No-0)

X_5 = Seed Rate (Kg/acre)

X_6 = Seed Treatment (Yes-1, No-0)

X_7= High Yielding Varieties (HYVs-1, Local-0)

X_8= Urea (kg/acre)

X_9= DAP (kg/acre)

X_{10}= No. of Irrigation (acre)

X_{11}= Size of Holding (acre)

X_{12}= Method of Sowing (Line sowing=1 & Broadcasting=0)

b_1 to b_{12} = regression coefficient of X_1, X_2, …….. X_{12}

E=Error term

2.6 Concept Used

The following concept of yield gap analysis was used in the study

Yield gap – I – It is the difference between the potential farm yield (Yp) & the highest farm yield (Yh). This yield gap exist due to difference in soil & climatic condition and non-transfer of recommended technologies to the farmer's field

$$Yied\ Gap\ -\ I = \frac{Yp\ -\ Yh}{Yp} \cdot 100$$

Yield gap – II- It is the differece between the highest farm yield (Yh) & the average farm yield (Ya). Yield gap-II, denotes about socio-economic and technological constraints exist in the area.

$$Yield\ Gap\ -\ II = \frac{Yh\ -\ Ya}{Yh} \cdot 100$$

Yield gap – III- It is the difference between the potential farm yield (Yp) & the average farm yield (Ya). Yield gap-III exist due to difference in soil & climatic condition, non-transfer of recommended technologies in cultivation of crops and various socio-economic constraints exist in the area.

$$Yield\ Gap\ -\ III = \frac{Yp\ -\ Ya}{Yp} \cdot 100$$

Where: Yp =Potential farm yield,

Yh =Highest farm yield

Ya =Average farm yield

2.7 Limitation of Data

Niwari district just emerged by bifurcation of Tikamgarh district (2018) in Madhya Pradesh. Therefore, secondary data related to Niwari district have not been available. It was considered in Tikamgarh district for the study. Hence, study comprised of 6 districts i.e. Sagar, Damoh, Chhatarpur, Tikamgarh, Panna and Datia districts of Bundelkhand Region of Madhya Pradesh.

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CHAPTER - III

OVERVIEW OF THE BUNDELKHAND REGION OF MADHYA PRADESH

This chapter deals with the profile of the Bundelkhand Region of Madhya Pradesh related to geographical indicators, population parameters, land use pattern, fertilizers consumption, irrigation potential, cropping pattern, regulated markets, working population, numbers & size of land holdings, inputs used in production, status of farm machinery & implements and livestock population.

3.1 Geographical Indicators

Bundelkhand region of Madhya Pradesh lies between latitude of 23048'N (Damoh)and 25068'N (Datia) to longitude of 78040'E (Sagar) and 80018'E (Panna) with height to mean sea level between 249 (Datia) to 606 meter (Chhatarpur).

Table 3.1 : Geographical indicators of different districts of Bundelkhand Region of Madhya Pradesh

Particulars	Sagar	Damoh	Chhatarpur	Tikamgarh	Panna	Datia	Overall
Area(In sq. kms)	10252	7306	8687	5048	7135	2902	41330
Latitude	23°48 N	23°87 N	24°91 N	24°74 N	24°48 N	25°68 N	
Longitude	78°40 E	79°47 E	79°58 E	78°83 E	80°18 E	78°56 E	
Height from Mean Sea Level (m)	536	595	606	427	410	249	
No. of Tehsils	13	7	11	7	8	4	50
No. of Villages	2075	1210	1187	171	1011	631	6285
Gram Panchayats	753	89	558	88	395	281	2164
Density of Population (Person/sq. km)	232	173	203	286	142	271	209

Sources: District census book -2011

There were 6 districts (Sagar, Damoh, Chhatarpur, Tikamgarh, Panna and Datia) having 50 tehsils, 6285 villages with 2164 gram panchayats in the region. The population density in Bundelkhand region was found to be 209 person/km, which was maximum in Tikamgarh (286 person/km) followed by Datia (271 person/km), Sagar (232 person/km), Chhatarpur (203 person/km), Damoh (173 person/km) and Panna (142 person/km) districts. Number of tehsils, villages and gram panchayats were found to be maximum in Sagar as compared to other districts of Bundelkhand Region of Madhya Pradesh (Table 3.1).

3.2 Population Parameters

The total population of Bundelkhand region of Madhya Pradesh was found to be 86.53 lakh, out of which 52.79 and 47.21 per cent are male and female, respectively. The population of rural (77.86%) was found to be more as compared to urban (22.14%) population.

Table 3.2 : Population parameters of different districts of Bundelkhand Region of Madhya Pradesh

Particulars	Sagar	Damoh	Chhatarpur	Tikamgarh	Panna	Datia	Overall
Population	2378458 (100.00)	1264219 (100.00)	1762375 (100.00)	1445166 (100.00)	1016520 (100.00)	786754 (100.00)	8653492 (100.00)
Male	1256257 (52.82)	661873 (52.35)	936121 (53.12)	760355 (52.61)	533480 (52.48)	420157 (53.4)	4568243 (52.79)
Female	1122201 (47.18)	602346 (47.65)	826254 (46.88)	684811 (47.39)	483040 (47.52)	366597 (46.6)	4085249 (47.21)
Rural	1669662 (70.2)	1013668 (80.18)	1363359 (77.36)	1195293 (82.71)	891185 (87.67)	604772 (76.87)	6737939 (77.86)
Urban	708796 (29.8)	250551 (19.82)	399016 (22.64)	249873 (17.29)	125335 (12.33)	181982 (23.13)	1915553 (22.14)
Child Population	356903 (15.01)	191968 (15.18)	282794 (16.05)	227564 (15.75)	163620 (16.1)	110114 (14)	1332963 (15.4)
Scheduled Tribes	221936 (9.33)	166295 (13.15)	73597 (4.18)	67857 (4.7)	170879 (16.81)	15061 (1.91)	715625 (8.27)
Scheduled Castes	501630 (21.09)	246337 (19.49)	405313 (23)	361604 (25.02)	207990 (20.46)	200270 (25.46)	1923144 (22.22)
Hindu	2198297 (92.43)	1186420 (93.85)	1676918 (95.15)	1383475 (95.73)	974748 (95.89)	747693 (95.04)	8167551 (94.38)
Muslim	103480 (4.35)	47966 (3.79)	70351 (3.99)	44143 (3.05)	35214 (3.46)	28483 (3.62)	329637 (3.81)
Others	76681 (3.22)	29833 (2.36)	15106 (0.86)	17548 (1.21)	6558 (0.65)	10578 (1.34)	156304 (1.81)
Literacy(%)	76	70	64	61	65	73	69
Male	85	79	73	72	74	84	78
Female	67	59	54	50	54	59	58
Sex Ratio(Over 1000)	893	910	883	901	905	873	894
Child Sex Ratio(Over 1000)	925	928	900	892	914	856	903

Sources: District census book -2011, Figures in parenthesis shows percentage to total population

There were only 15.40 per cent of children in total population of Bundelkhand Region of Madhya Pradesh. The region was found to be dominant by Hindus (94.38%) followed by Muslim (3.81 %) religion (Table 3.2).

An average literacy rate of the region was found to be 69 per cent, which was more in male (78%)

as compared to female (58%) population. The very thin sex ratio (894) and child sex ratio 903 over 1000 male was found in the region. These all population parameters were found to be similar in all the districts of Bundelkhand Region of Madhya Pradesh. However, male literacy was found to be higher in Sagar (85%) and Damoh (84%) as compared to other districts and very thin ST population of total population was found in Datia (1.91%), Tikamgarh (4.18%) and Chhatarpur (4.77%) as compared to Panna (16.81%), Damoh (13.15%) and Sagar (9.33%). The composition of SC and ST population was found to be 22.22 and 8.27 per cent, respectively in the region. Amongst all the districts male was found to more populated in Chhatarpur (53.12%) followed by Datia (53.40%), Sagar (52.82%), Tikamgarh (52.61%), Panna (52.48%) and Damoh (52.35%) districts.

3.3 Land Use Pattern

The geographical area in Bundelkhand Region of Madhya Pradesh was found to be 41.28 lakh hectare. Out of total geographical area of Bundelkhand Region of Madhya Pradesh, 48, 29, 10, 9 and 4 per cent was found to be net area sown, area covered under forest, land not available for cultivation, other un-cultivated land excluding fallow land and fallow land respectively (Fig. 3.1).

Amongst all the district, maximum geographical area was occupied by Sagar (25%) followed by Chhatarpur (21%), Damoh (18%), Panna (17%), Tikamgarh (12%) and Datia (7%) districts (Fig. 3.2).

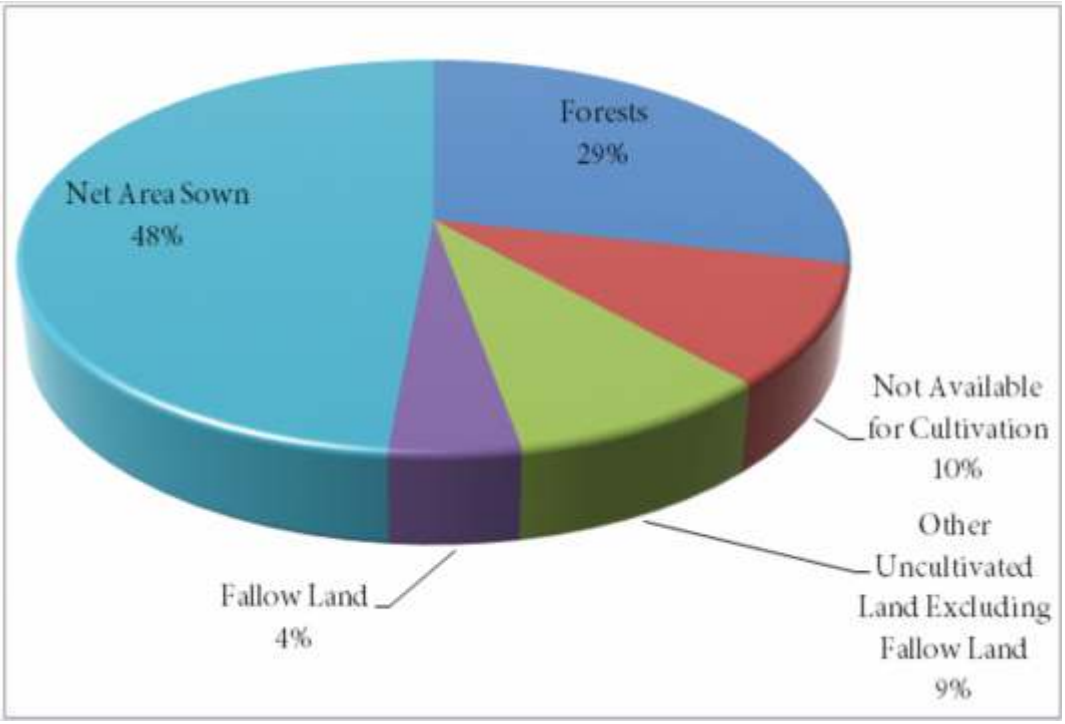

Fig. 3.1 : Per cent contribution of different parameters of land use in Bundelkhand Region of Madhya Pradesh

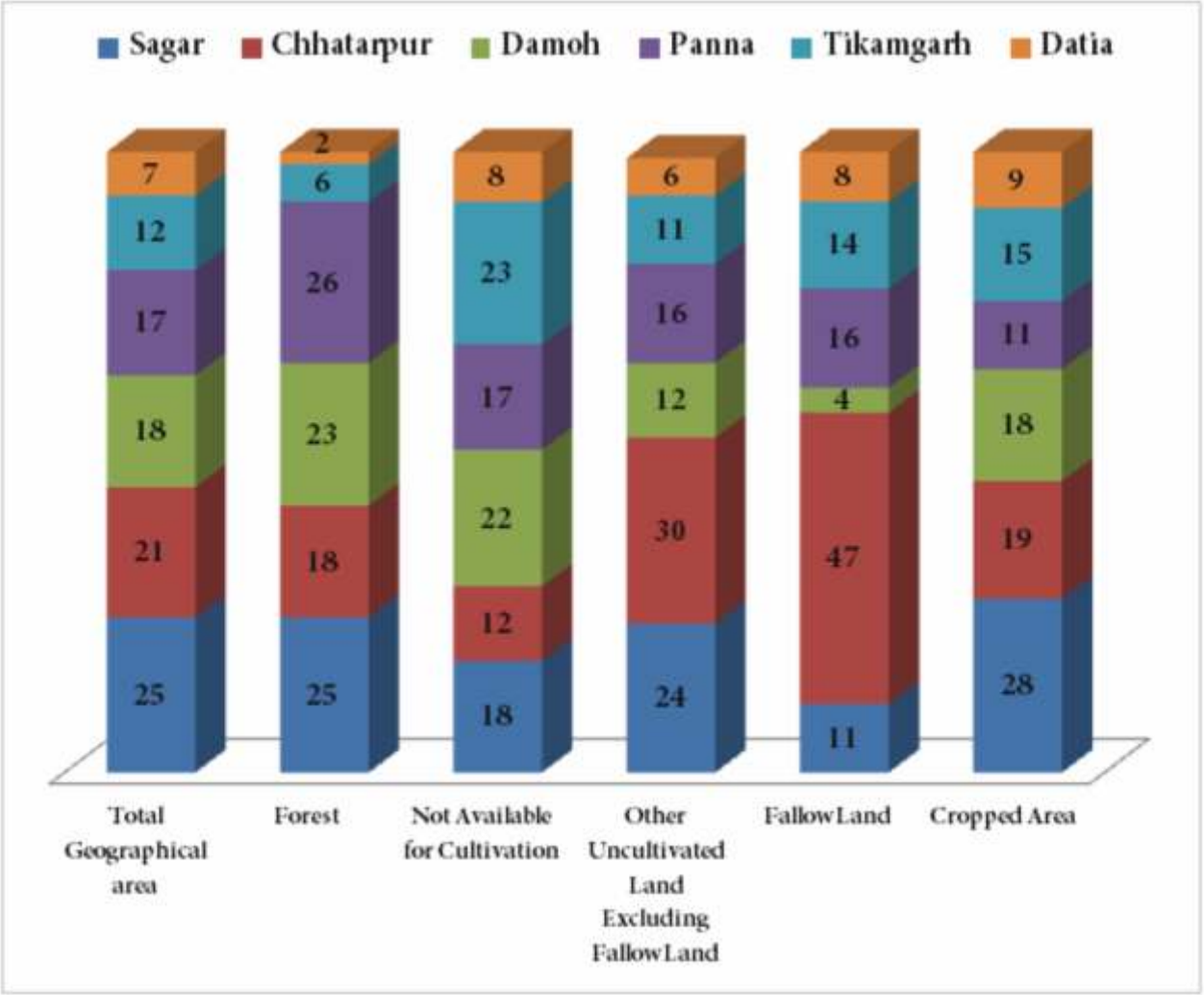

Fig. 3.2 : Per cent contribution of different parameters of land use across different districts of Bundelkhand Region of Madhya Pradesh

Amongst all the districts the net area sown to total geographical area was found to be more in Datia (67.8 %) followed by Tikamgarh (54.86%), Sagar (53.31%), Chhatarpur (47.11%), Damoh (43.8%) and Panna (35.33%). The forest area to total geographical area was found to be more in Panna (42.78%) as compared to Damoh(36.66%), Sagar(29.13%), Chhatarpu(24.80%), Tikamgarh (13.76%) and Datia (9.58%) districts (Table 3.3).

The area under land not available for cultivation to total geographical area was found to be more in Tikamgarh (18.32%) followed by Damoh (12.56%), Datia (11.26%), Panna (9.73%), Sagar (6.97%) and Chhatarpur (5.67%) districts, while area under other un-cultivated land excluding fallow land to total geographical area was found to be more in Chhatarpur (12.7%) as compared to Sagar (8.65%) Tikamgarh (8.22%), Panna (8.12%), Datia (6.73%) and Damoh (6.11%).

The area under fallow land to total geographical area was found to be more in Chhatarpur district (9.71%) as compared to Tikamgarh (4.89 %), Datia (4.63%), Panna (4.04%), Sagar (1.94 %) and Damoh 0.8%) districts. The area under forest in Bundelkhand Region of Madhya Pradesh was found to be

Table 3.3 : Land use pattern in different districts of Bundelkhand Region of Madhya Pradesh (ha)

Particulars	Sagar	Damoh	Chhatarpur	Tikamgarh	Panna	Datia	Overall
Geographical Area (ha)	1022759 (100)	728583 (100)	863036 (100)	504002 (100)	702924 (100)	307173 (100)	4128477 (100)
Forest	297932 (29.13)	267118 (36.66)	214032 (24.80)	69375 (13.76)	300723 (42.78)	29438 (9.58)	1178618 (28.55)
Not Available for Cultivation							
Area Under Non Agricultural Uses	58690	32377	47904	49152	45293	18479	251895
Barren and Unculturable Land	12607	59121	993	43201	23103	16117	155142
Total	71297 (6.97)	91498 (12.56)	48897 (5.67)	92353 (18.32)	68396 (9.73)	34596 (11.26)	407037 (9.86)
Other Uncultivated Land Excluding Fallow Land							
Permanent Pasture and Other Grazing Land	76361	35028	75675	18394	12914	6065	224437
Land Under Misc. Tree Crops and Groves not Included in Net Area Sown	620	35	209	48	255	3995	5162
Culturable Waste Land	11515	9424	33819	22963	43881	10606	132208
Total	88496 (8.65)	44487 (6.11)	109703 (12.71)	41405 (8.22)	57050 (8.12)	20666 (6.73)	361807 (8.76)
Fallow Land							
Fallow Lands Other Than Current Fallows	10714	3586	22018	9820	7924	6879	60941
Current Fallow	9116	2797	61809	14530	20505	7343	116100
Total	19830 (1.94)	6383 (0.88)	83827 (9.71)	24350 (4.83)	28429 (4.04)	14222 (4.63)	177041 (4.29)
Net Area Sown	545204 (53.31)	319097 (43.8)	406577 (47.11)	276519 (54.86)	248326 (35.33)	208251 (67.8)	2003974 (48.54)

Sources: Directorate of Economics and Statistics -2017-18, Figures in parenthesis shows percentage to total Geographical

11.78 lakh ha, out of which Panna (26%) occupied maximum forest area as compared to Sagar (25%), Damoh (23%), Chhatarpur (18%), Tikamgarh (6%) and Datia (2%) districts (Fig. 3.2)

3.4 Irrigation Potential

The net irrigated area in Bundelkhan Region of Madhya Pradesh was found to be 32.54 per cent (13.44 lakh ha). Amongst different sources of irrigation, well (41.84%) followed by tube-well (19.22%), canal (15.3%) and tank (3.09%) were found to be major sources of irrigation. The area irrigated from other sources (ponds & rivers) was found to be 20.56 per cent to net irrigated area (Fig. 3.3).

Canal was found to be major source of irrigation only in Datia (62.58%) as compared to other districts in Bundelkhand Region of Madhya Pradesh where as area irrigated by tank

was found to be maximum in Damoh (28.30%) followed by Tikamgarh (28.14%), Sagar (21.05%), Chhatarpur (17.6 %) and Panna (4.91%).

Tube-well was found to be dominated source of irrigation in Sagar (30.57%) followed by Damoh (18.20%), Chhatarpur (18.02%), Datia (15.08%), Tikamgarh (11.12%) and Panna (7.02%). The net irrigated area was found to be more in Sagar (26.28%) as compared to Chhatarpur (19.71%), Tikamgarh (15.45%), Damoh (14.92%), Datia (14.73%) and Panna (9.48%) in Bundelkhand Region of Madhya Pradesh (Table 3.4).

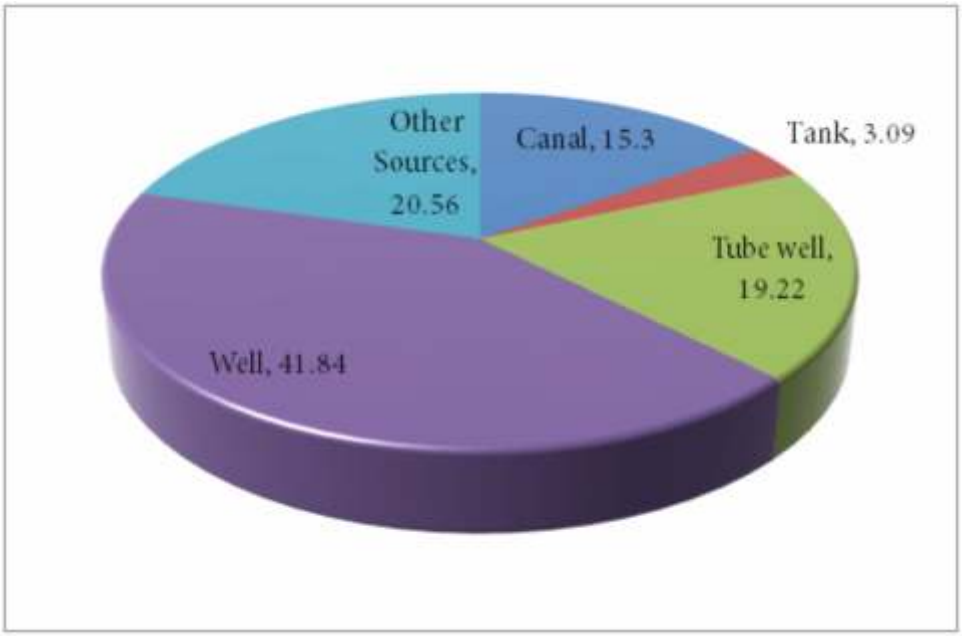

Fig. 3.3 : Percentage of major sources of irrigation to net irrigated area of Bundelkhand Region of Madhya Pradesh

Table 3.4 : Source wise area under irrigation in different districts of Bundelkhand Region of Madhya Pradesh (ha)

Source	Sagar	Damoh	Chhatarpur	Tikamgarh	Panna	Datia	Overall
Canal	13455 (6.55)	24773 (12.05)	25031 (12.18)	2297 (1.12)	11336 (5.52)	128618 (62.58)	205510 (100)
Tank	8728 (21.05)	11732 (28.3)	7296 (17.6)	11667 (28.14)	2037 (4.91)	0 (0)	41460 (100)
Tubewell	78938 (30.57)	46985 (18.2)	46523 (18.02)	28707 (11.12)	18138 (7.02)	38928 (15.08)	258219 (100)
Well	178547 (31.76)	55202 (9.82)	161227 (28.68)	122685 (21.83)	19890 (3.54)	24577 (4.37)	562128 (100)
Other Sources	70724 (25.6)	61735 (22.35)	24736 (8.95)	42203 (15.28)	75918 (27.48)	959 (0.35)	276275 (100)
Net Irrigated Area	350392 (26.08)	200427 (14.92)	264813 (19.71)	207559 (15.45)	127319 (9.48)	193082 (14.37)	1343592 (100)

Sources: Directorate of Economics and Statistics -2017-18, Figures in parenthesis shows percentage to overall

3.5 Cropping Pattern

The cropping pattern in Bundelkhand Region of Madhya Pradesh was found to be dominated during Rabi (57.92%) as compared to kharif season (42.08%) (Table 3.5). Wheat (27.64%) followed by soybean (16.30%), gram (14.04%) rice (5.7%) were found to be major crops grown in Bundelkhand Region of Madhya Pradesh. While Sesame (5.13%), rapeseed & mustard (1.97%), tur (1.95%), barley (1.35%) and groundnut (1.21%) were found to be minor crops of the region (Fig.3.4). The 9.78 and 10.85 per cent of gross cropped area was occupied by other kharif and Rabi pulses like moong, urd and field pea etc. The concentration of these crops were found to be similar with minor variation across various districts of Bundelkhand region of Madhya Pradesh. However soybean (37.62%) followed by wheat (15.15%) and gram (5.15%) in Sagar. Gram (29.91%) followed by wheat (16.34%), rice (12.14%) and soybean (12.03%) in Damoh.

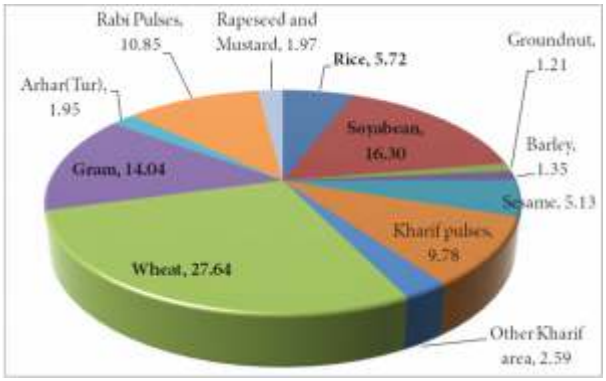

Fig. 3.4 : Percentage share of different crops to Gross Cropped Area in Bundelkhand Region of Madhya Pradesh

Wheat (29.87%), sesame (13.80%) and soybean (9.11%) and gram (7.89%) were in Chhatarpur, Wheat (33.60%) followed by soybean (7.89%) sesame (6.73%) and rapeseed & mustard (3.40%) in Tikamghara, Gram (20.86%) followed by wheat (19.96%), sesame (8.11%) and soybean (5.54%) in Panna and wheat (49.54%) followed by sesame (12.39%) and rice (5.30%) in Datia were found to be major crops grown across districts in Bundelkhand Region of Madhya Pradesh.

Table 3.5 : Cropping pattern in different districts of Bundelkhand Region of Madhya Pradesh (ha)

Particulars	Sagar	Damoh	Chhatarpur	Tikamgarh	Panna	Datia	Overall
Rice	6593 (0.71)	71018 (12.14)	3470 (0.55)	9360 (1.95)	61428 (16.46)	35939 (12.39)	187808 (5.72)
Soyabean	347461 (37.62)	70411 (12.03)	57658 (9.11)	37933 (7.89)	20692 (5.54)	1551 (0.53)	535706 (16.3)
Groundnut	1065 (0.12)	1081 (0.18)	11352 (1.79)	19430 (4.04)	178 (0.05)	6750 (2.33)	39856 (1.21)
Barley	3006 (0.33)	79 (0.01)	20034 (3.16)	13407 (2.79)	3714 (0.99)	4203 (1.45)	44443 (1.35)
Sesame	935 (0.1)	2372 (0.41)	87342 (13.8)	32396 (6.73)	30268 (8.11)	15354 (5.3)	168667 (5.13)
Kharif pulses	41922 (4.54)	33787 (5.77)	87946 (13.89)	99545 (20.69)	40199 (10.77)	17875 (6.16)	321274 (9.78)
Other Kharif area	21125 (2.29)	8849 (1.51)	23197 (3.66)	13669 (2.84)	8636 (2.31)	9561 (3.3)	85037 (2.59)
Total Kharif	422107 (45.7)	187597 (32.06)	290999 (45.96)	225740 (46.93)	165115 (44.23)	91233 (31.46)	1382791 (42.08)

Wheat	243806 (26.4)	95628 (16.34)	189127 (29.87)	161624 (33.6)	74522 (19.96)	143659 (49.54)	908366 (27.64)
Gram	139937 (15.15)	174990 (29.91)	49959 (7.89)	8265 (1.72)	77871 (20.86)	10462 (3.61)	461484 (14.04)
Arhar(Tur)	7996 (0.87)	32794 (5.61)	10589 (1.67)	109 (0.02)	12189 (3.27)	413 (0.14)	64090 (1.95)
Rabi Pulses	97817 (10.59)	86881 (14.85)	58630 (9.26)	5360 (11.14)	32890 (8.81)	26812 (9.25)	356631 (10.85)
Rapeseed and Mustard	637 (0.07)	2622 (0.45)	21495 (3.4)	21828 (4.54)	5879 (1.57)	12231 (4.22)	64692 (1.97)
Other Rabi crops	11251 (1.22)	4564 (0.78)	12321 (1.95)	9865 (2.05)	4804 (1.29)	5157 (1.78)	47962 (1.46)
Total Rabi	501444 (54.3)	397479 (67.94)	342121 (54.04)	255292 (53.07)	208155 (55.77)	198734 (68.54)	1903225 (57.92)
Gross Cropped Area (GCA)	923551 (100)	585076 (100)	633120 (100)	481032 (100)	373270 (100)	289967 (100)	3286016 (100)
Area Sown More Than Once	378347	265979	226543	204513	124944	81716	1282042
Net Area Sown	545204	319097	406577	276519	248326	208251	2003974
Cropping Intensity (%)	169	183	156	174	150	139	164

Sources: Directorate of Economics and Statistics -2017-18, Figures in parenthesis shows percentage to total GCA

3.6 Consumption of Fertilizers

The fertilizers consumption of Bundelkhand Region of Madhya Pradesh was found to be 31481 t per year. The consumption of Di-ammonium Phosphate (DAP - 61.92%) was found to be more as compared to Urea (28.68%), Single Super Phosphate (SSP - 4.94%), Complex Fertilizer (3.5%) and Murate of Potash (MOP - 0.95%) (Fig 3.5).

Amongst different districts of Bundelkhand Region of Madhya Pradesh the fertilizer consumption was found to be more in Sagar (34.53%) followed by Chhatarpur (22.71%), Datia (17.16%), Damoh (12.55%), Tikamgarh (9.16%) and Panna (3.88%) districts.

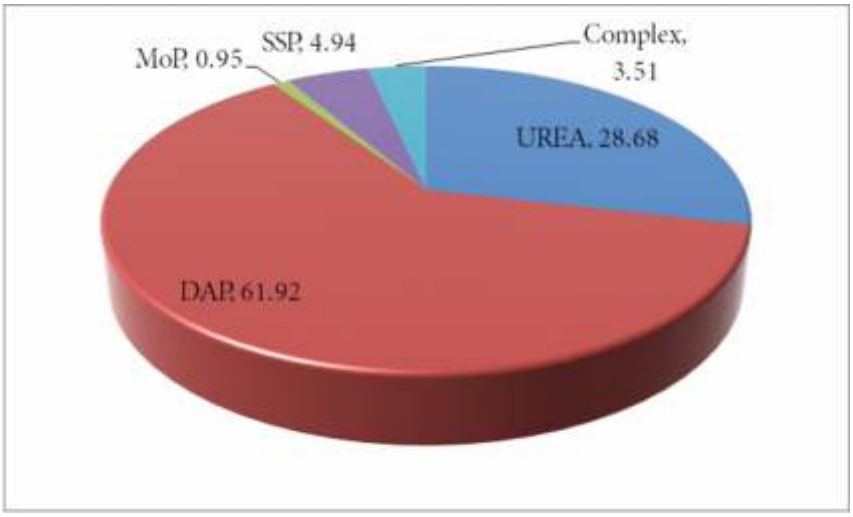

Fig. 3.5 : Consumption of different fertilizers in Bundelkhand Region of Madhya Pradesh

Table 3.6 : Consumption of fertilizers in different district of Bundelkhand Region of Madhya Pradesh (Unit – Ton)

Particulars	Sagar	Damoh	Chhatarpur	Tikamgarh	Panna	Datia	Overall
UREA	676 (7.49)	689 (7.63)	3051 (33.79)	1119 (12.39)	532 (5.89)	2962 (32.81)	9029 (100)
DAP	7893 (40.5)	3124 (16.03)	3996 (20.5)	1665 (8.54)	641 (3.29)	2172 (11.14)	19491 (100)
MoP	147 (49.16)	30 (10.03)	61 (20.4)	31 (10.37)	20 (6.69)	10 (3.35)	299 (100)
SSP	1123 (72.17)	102 (6.56)	26 (1.67)	69 (4.43)	12 (0.77)	224 (14.4)	1556 (100)
Complex	1030 (93.13)	7 (0.63)	16 (1.45)	0 (0)	18 (1.63)	35 (3.16)	1106 (100)
Total Fertilizers	10869 (34.53)	3952 (12.55)	7150 (22.71)	2884 (9.16)	1223 (3.88)	5403 (17.16)	31481 (100)

Sources:mpkrishi.org 2017-18, Figures in parenthesis shows percentage to overall as Bundelkhand Region of Madhya Pradesh

The consumption of DAP (40.50%) in Sagar, Urea (33.79%) in Chhatarpur, MoP (49.16%), SSP (72.17%) and Complex (93.13%) in Sagar was found to be maximum across various districts of Bundelkhand region of Madhya Pradesh (Table 3.6).

3.7 Regulated Markets

The numbers of regulated markets were found to be 38 across different grades of mandi and various districts of Bundelkhand Region of Madhya Pradesh. However, the majority of regulated market were found to be of "D" grade (52.63%) followed by "C" grade (26.32%) "B" grade (13.16%) and "A" grade (7.86 %) (Fig. 3.6).

In Bundelkhand Region of Madhya Pradesh, Sagar district (34.21%) has more regulated markets as compared to Chhatarpur (18.42%), Tikamgarh (15.79%), Panna (13.16%), Damoh (10.53%) and Datia (7.89%) districts (Fig. 3.7). None of the market was linked with e-NAM due to lack of

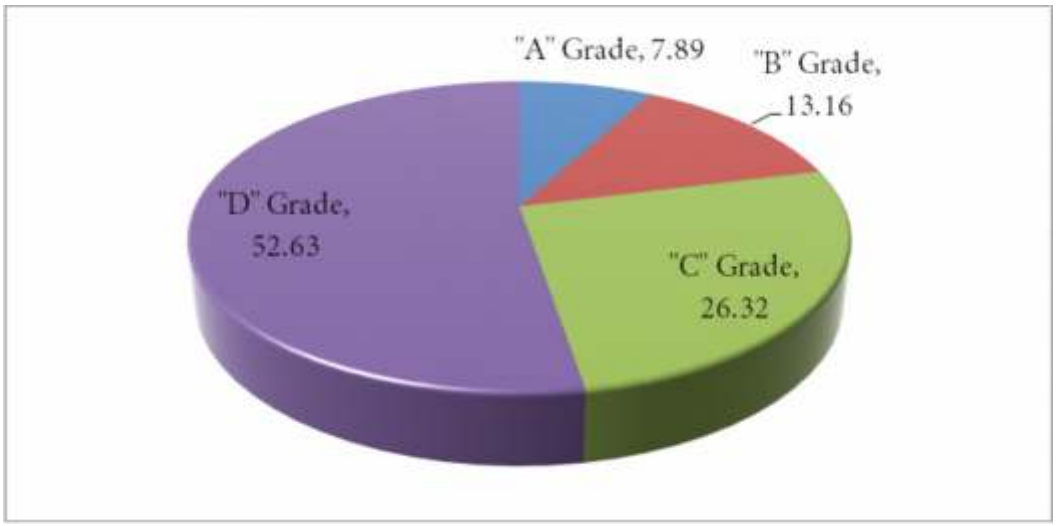

Fig. 3.6 : Percentage of different grades of regulated markets in Bundelkhand region of Madhya Pradesh

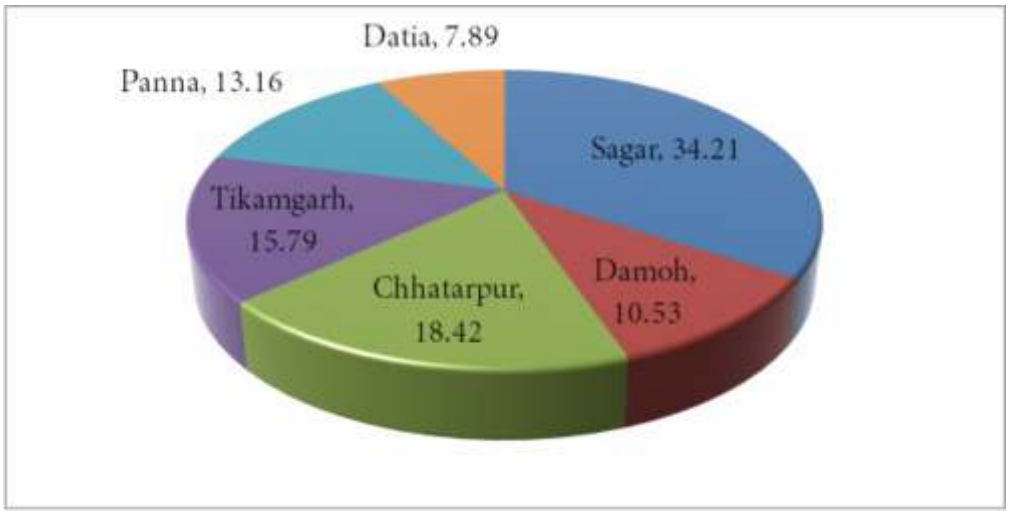

Fig. 3.7 : Percentage share of different regulated markets across districts in Bundelkhand Region of Madhya Pradesh

communication facilities. Except Sagar, Damoh and Tikamgarh districts none of the district have "A" grade regulated markets in Bundelkhand Region of Madhya Pradesh. These findings are found to be similar with minor variation across districts of Bundelkhand Region of Madhya Pradesh (Table 3.7).

Table 3.7 : Different grades of regulated markets in different district of Bundelkhand Region of Madhya Pradesh

Particulars	Sagar	Damoh	Chhatarpur	Tikamgarh	Panna	Datia	Overall
Number of Mandi							
"A" Grade	1	1	0	1	0	0	3
"B" Grade	2	0	1	1	0	1	5
"C" Grade	3	2	2	2	0	1	10
"D" Grade	7	1	4	2	5	1	20
Total	13	4	7	6	5	3	38
Percentage to Overall							
"A" Grade	33.33	33.33	0.00	33.33	0.00	0.00	100.00
"B" Grade	40.00	0.00	20.00	20.00	0.00	20.00	100.00
"C" Grade	30.00	20.00	20.00	20.00	0.00	10.00	100.00
"D" Grade	35.00	5.00	20.00	10.00	25.00	5.00	100.00
Total	34.21	10.53	18.42	15.79	13.16	7.89	100.00
Percentage to Total							
"A" Grade	7.69	25.00	0.00	16.67	0.00	0.00	7.89
"B" Grade	15.38	0.00	14.29	16.67	0.00	33.33	13.16
"C" Grade	23.08	50.00	28.57	33.33	0.00	33.33	26.32
"D" Grade	53.85	25.00	57.14	33.33	100.00	33.33	52.63
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Sources: http://mpmandiboard.gov.in/2017-18,

3.8 Number and Area under different Size of Holding

The 1291038 numbers of land holdings occupied 24.39 lakh ha area in Bundelkhand Region of Madhya Pradesh (Table 3.8). The number of holdings were found to be more in Sagar (27.56%) followed by Chhatarpur (20.75%), Tikamgarh (15.70%), Panna (15.26%), Datia (10.59%) and Damoh (10.15%) (Fig. 3.8), while area under all the holdings was found to be more in Sagar (31.53%) followed by Chhatarpur (19.45%), Damoh (15.97%), Panna (12.58%), Tikamgarh (11.71%) and Datia (8.76%) districts of Bundelkhand Region of Madhya Pradesh (Fig. 3.9).

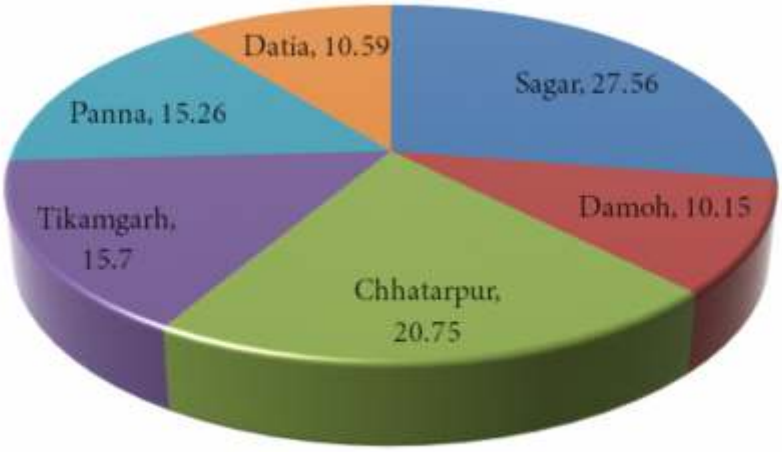

Fig. 3.8 : Percentage share of operatinal holding (Numbers) in different districts in Bundelkhand region of Madhya Pradesh

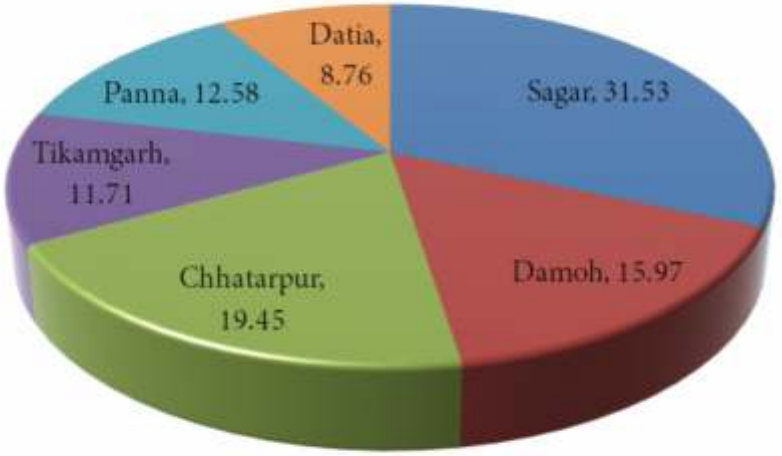

Fig. 3.9 : Percentage share of operational holding (Area) in different districts in Bundelkhand region of Madhya Pradesh

The number of marginal (43.64%) and small (31.09%) holdings were found to be more as compared to semi-medium (15.13%) medium (8.96%) and large (1.18%) size of holdings, while area of medium (30.64%), and semi-medium (22.65%) holdings were found to be more as compared to small (20.77%), marginal (16.70%) and large holding (9.23%) in Bundelkhand Region of Madhya Pradesh.

Table 3.8 : Numbers and area (ha) of holdings in different districts of Bundelkhand Region of Madhya Pradesh

Particulars	Sagar	Damoh	Chhatarpur	Tikamgarh	Panna	Datia	Overall
Number							
Marginal (0-1 ha)	137325 (38.6)	56036 (42.78)	106921 (39.91)	101175 (49.93)	92590 (47.01)	69281 (50.65)	563328 (43.63)
Small (1-2 ha)	138853 (39.03)	28860 (22.03)	86165 (32.17)	56820 (28.04)	56816 (28.85)	33864 (24.76)	401378 (31.09)
Semi-medium (2-4 ha)	31172 (8.76)	24393 (18.62)	51544 (19.24)	32987 (16.28)	33310 (16.91)	21971 (16.06)	195377 (15.13)
Medium (4-10 ha)	42646 (11.99)	17074 (13.03)	20944 (7.82)	11132 (5.49)	13129 (6.67)	10807 (7.9)	115732 (8.96)
Large (above 10 ha)	5781 (1.62)	4633 (3.54)	2310 (0.86)	536 (0.26)	1106 (0.56)	857 (0.63)	15223 (1.18)
Total	355777 (100)	130996 (100)	267884 (100)	202650 (100)	196951 (100)	136780 (100)	1291038 (100)
Area in ha							
Marginal (0-1 ha)	195208 (25.38)	24806 (6.37)	57685 (12.16)	51436 (18)	44691 (14.57)	33649 (15.74)	407475 (16.7)
Small (1-2 ha)	134716 (17.51)	41703 (10.7)	122617 (25.85)	78989 (27.65)	80511 (26.24)	48233 (22.56)	506769 (20.77)
Semi-medium (2-4 ha)	108671 (14.13)	66715 (17.12)	140756 (29.67)	87785 (30.72)	89075 (29.03)	59616 (27.88)	552618 (22.65)
Medium (4-10 ha)	246397 (32.03)	181930 (46.69)	119546 (25.2)	60372 (21.13)	78779 (25.68)	60512 (28.3)	747536 (30.64)
Large (above 10 ha)	84233 (10.95)	74487 (19.12)	33784 (7.12)	7131 (2.5)	13745 (4.48)	11786 (5.51)	225166 (9.23)
Total	769225 (100)	389641 (100)	474388 (100)	285713 (100)	306801 (100)	213796 (100)	2439564 (100)

Sources: District Statistical book 2016-17, Figures in parenthesis shows percentage to total

These results were found to be similar with minor variation in all the districts. However, area under medium holdings was found to be more in Damoh (46.69%) as compared to other districts of Bundelkhand Region of Madhya Pradesh (Table 3.8).

3.9 Working Population

Bundelkhand Region of Madhya Pradesh has more number of non-workers (56.77%) as compared to main workers

(31.40%) and marginal workers (11.83%). In total number of workers (main and marginal) the majority of them were found to be agricultural labours (36.98%) followed by cultivators (32.47%), other workers (23.36%) and workers in household Industries (7.19%). These figures were found to be almost similar with minor variation for all the districts of the Bundelkhand Region of Madhya Pradesh. (Table 3.9)

However, cultivators were found to be more in Datia (47.61%) followed by Tikamgarh (46.68%), Chhatarpur (14.20%), Panna (31.35%), Sagar (20.24%) and Damoh (19.95%), while agricultural labours were found to be

Table 3.9 : Working population in different districts of Bundelkhand Region of Madhya Pradesh (Numbers)

Particulars	Sagar	Damoh	Chhatarpur	Tikamgarh	Panna	Datia	Overall
(i) Main Worker	779093 (32.76)	389993 (30.85)	553862 (31.43)	470432 (32.55)	276633 (27.21)	247229 (31.42)	2717242 (31.4)
(ii) Marginal Worker	226942 (9.54)	184602 (14.6)	197935 (11.23)	184886 (12.79)	155365 (15.28)	73931 (9.4)	1023661 (11.83)
(iii) Non Worker	1372423 (57.7)	689624 (54.55)	1010578 (57.34)	789848 (54.65)	584522 (57.5)	465594 (59.18)	4912589 (56.77)
Total Population	2378458 (100)	1264219 (100)	1762375 (100)	1445166 (100)	1016520 (100)	786754 (100)	8653492 (100)
Cultivators	203600 (20.24)	114611 (19.95)	302228 (40.2)	305859 (46.68)	135445 (31.35)	152903 (47.61)	1214646 (32.47)
Agriculture labourers	378560 (37.63)	250165 (43.53)	238364 (31.71)	223852 (34.16)	198847 (46.03)	93744 (29.19)	1383532 (36.98)
Workers in household industry	140458 (13.96)	67383 (11.73)	26390 (3.51)	15622 (2.38)	12201 (2.82)	6839 (2.13)	268893 (7.19)
Others Workers	283417 (28.17)	142436 (24.79)	184815 (24.58)	109985 (16.78)	85505 (19.8)	67674 (21.07)	873832 (23.36)
Total Workers (Main & Marginal)	1006035 (100)	574595 (100)	751797 (100)	655318 (100)	431998 (100)	321160 (100)	3740903 (100)

Sources: District census book 2017-18, Figures in parenthesis shows percentage to total

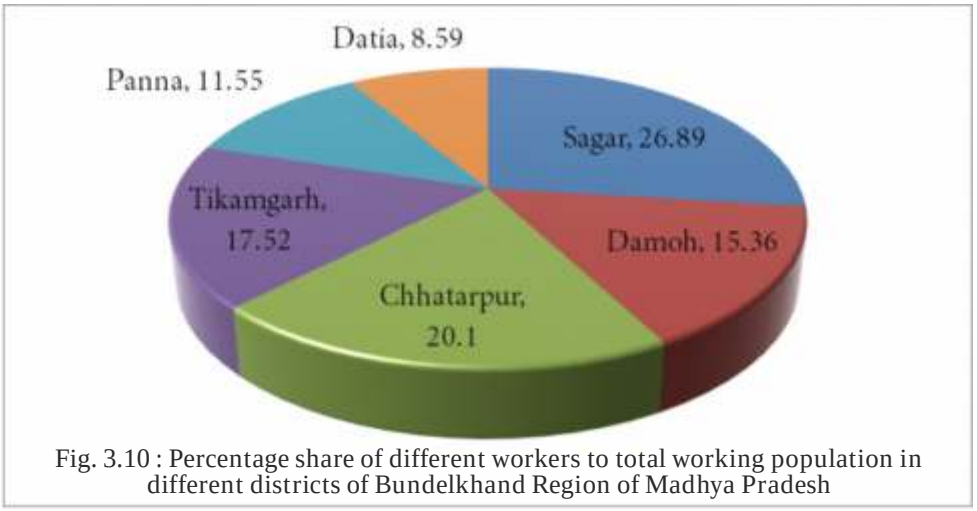

Fig. 3.10 : Percentage share of different workers to total working population in different districts of Bundelkhand Region of Madhya Pradesh

more in Panna (46.03%), Damoh (43.53%), Sagar (37.63%), Tikamgarh (34.16%), Chhatarpur (31.71%) and Datia (29.19%) districts to the total workers population of the districts. Workers in household industries to total workers population were found to be more in Sagar (13.96%) and Damoh (11.73%) as compared to other districts of Bundelkhand Region of Madhya Pradesh (Table 3.9)

Amongst all the districts of Bundelkhand Region of Madhya Pradesh, Sagar district (26.89%) has more workers population as compared to Chhatarpur (20.10%), Tikamgarh (17.52%), Damoh (15.36%) Panna (11.55%), and Datia (8.59%) districts (Fig. 3.10).

3.10 Farm Machineries and Implements

The numbers of ploughs, bullock carts, electric pumps, diesel pumps and sugarcane cutters were found to be 358162, 120699, 266209, 147350 and 1213 in Bundelkhand Region of Madhya Pradesh (Table 3.10).

The number of tractors to perform various operations of production and marketing was found to be 59252. The number of ploughs (55.20%) and bullock carts (27.00%) were found to be more in Panna as compared to other districts of Bundelkhand region of Madhya Pradesh. The number of electric pumps were found to be more in Sagar (24.94%) , Chhatarpur (25.21%) and Tikamgarh (23.08%) as compared to other districts of Bundelkhand Region of Madhya Pradesh. The diesel pumps were found to be more in Chhatarpur (23.68%), Panna (22.27%) and Tikamgarh (19.5%) as compared to other districts of Bundelkhand Region of Madhya Pradesh.

Table 3.10 : Farm machinery and implements used in different districts of Bundelkhand Region of Madhya Pradesh (Numbers)

Particulars	Sagar	Damoh	Chhatarpur	Tikamgarh	Panna	Datia	Overall
Plough	47196 (13.18)	38149 (10.65)	12507 (3.49)	38715 (10.81)	197913 (55.26)	23682 (6.61)	358162 (100)
Bulluck cart	19230 (15.93)	8233 (6.82)	29590 (24.52)	12901 (10.69)	32591 (27)	18154 (15.04)	120699 (100)
Electric Pump	78500 (29.49)	26287 (9.87)	67109 (25.21)	61454 (23.08)	20540 (7.72)	12319 (4.63)	266209 (100)
Diesel Pump	22000 (14.93)	9328 (6.33)	34897 (23.68)	29392 (19.95)	32811 (22.27)	18922 (12.84)	147350 (100)
Tractors	19800 (33.42)	5335 (9)	12134 (20.48)	7885 (13.31)	7383 (12.46)	6715 (11.33)	59252 (100)
Sugarcane cutter	70 (5.77)	0 (0)	307 (25.31)	618 (50.95)	0 (0)	218 (17.97)	1213 (100)

Sources: District Statistical Book 2016-17, Figures in parenthesis shows percentage to overall

The number of tractors were found to be more in Sagar (33.42%) as compared to Chhatarpur (22.48%), Tikamgarh (13.31%), Panna (12.46%) and Datia (11.33%) districts. The number of sugarcane cutters were found only in Tikamgarh (50.95%), Chhatarpur (23.31%), Datia (17.97%) and Sagar (5.77%) districts of Bundelkhand region of Madhya Pradesh.

3.11 Inputs Used

The cultivators of Bundelkhand Region of Madhya Pradesh used 1023858, 254211, 2033497 and 311362't of High Yielding Varieties (HYVs) seed, seed treatment material, fertilizer and plant protection chemicals for cultivation of various crops in their field.

The area under High HYVs Seed was found to be more in Sagar (36.14%) followed by Datia (27.94%), Tikamgarh (12.98%), Panna (10.01%), Damoh (6.77 %) and Chhatarpur (6.7%) districts, while use of seed treatment chemical was found to be more in Tikamgarh (47.91%) as compared to Damoh (28.44%), Sagar (21.49%) and Chhatarpur (1.35%) districts of Bundelkhand Region of Madhya Pradesh. The use of seed treatment material was found to be negligible in Chhatarpur, Panna and Datia districts of Bundelkhand Region of Madhya Pradesh (Table 3.11).

Table 3.11 : Inputs used in different districts of Bundelkhand Region of Madhya Pradesh (Qty in t)

Particulars	Sagar	Damoh	Chhatarpur	Tikamgarh	Panna	Datia	Overall
HYVs Seed	370000 (36.14)	69272 (6.77)	63137 (6.17)	132919 (12.98)	102500 (10.01)	286030 (27.94)	1023858 (100)
Seed Treatment	54624 (21.49)	72300 (28.44)	3430 (1.35)	121803 (47.91)	1254 (0.49)	800 (0.31)	254211 (100)
Fertilizers	254865 (12.53)	310000 (15.24)	372866 (18.34)	421180 (20.71)	388556 (19.11)	286030 (14.07)	2033497 (100)
Plant Protection	10546 (3.39)	52200 (16.77)	19294 (6.2)	215200 (69.12)	13160 (4.23)	962 (0.31)	311362 (100)

Sources: District Statistical book 2016-17, Figures in parenthesis shows percentage to overall

Fertilizer consumption was found to be more in Tikamgarh (20.71%) followed by Panna (19.11%), Chhatarpur (18.34%), Damoh (15.24%), Datia (14.07%) and Sagar (12.53%) districts of Bundelkhand Region of Madhya Pradesh. The use of plant production chemicals were also found more in Tikamgarh (69.12%) as compared to the Damoh (16.77%), Chhatarpur (6.2%), Panna (4.23%) and Sagar (3.39%) districts of Bundelkhand Region of Madhya Pradesh. The consumption of plant protection chemical was found to be negligible in Datia (0.31%) district of Bundelkhand region of Madhya Pradesh.

3.12 Livestock Population

The number of livestock in Bundelkhand Region of Madhya Pradesh was found to be 4934833 (Table 3.12). Amongst different types of livestock population, population of cows (41.62%) was found to be more as compared to buffaloes (33.69%), goats (19.89%), sheeps (1.94%) and pigs (2.87%). Amongst different districts, the livestock population was found to be more in Panna (24.23%) followed by Chhatarpur (22.36%), Sagar (17.10%) Damoh (15.29%), Tikamgarh (12.49%) and Datia (8.52%) districts of

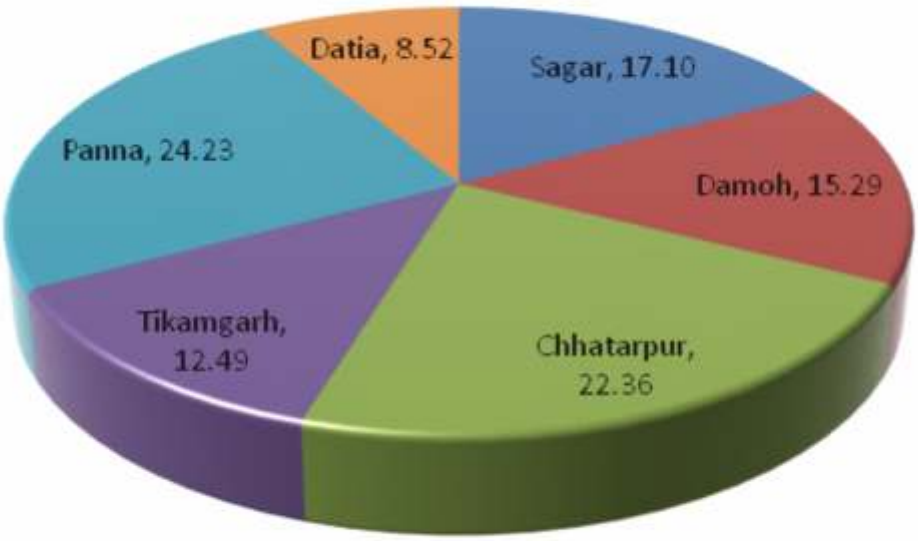

Fig. 3.11 : Total livestock population (Numbers) in different districts of Bundelkhand Region of Madhya Pradesh (4934833)

Table 3.12 : Live stock population in different districts of Bundelkhand Region of Madhya Pradesh (Numbers)

Particulars	Sagar	Damoh	Chhatarpur	Tikamgarh	Panna	Datia	Overall
Cow	410587 (48.65)	293491 (38.89)	400913 (36.33)	197077 (31.97)	633637 (52.99)	118120 (28.09)	2053825 (41.62)
Buffalos	289311 (34.28)	362091 (47.98)	365477 (33.12)	141000 (22.87)	318992 (26.68)	185681 (44.15)	1662552 (33.69)
Sheep	454 (0.05)	7654 (1.01)	17215 (1.56)	49917 (8.1)	8402 (0.7)	11869 (2.82)	95511 (1.94)
Goat	137239 (16.26)	88133 (11.68)	302056 (27.37)	214716 (34.83)	139425 (11.66)	99847 (23.74)	981416 (19.89)
Pig	6286 (0.74)	3243 (0.43)	17862 (1.62)	13813 (2.24)	95291 (7.97)	5034 (1.2)	141529 (2.87)
Total Livestock	843877 (100)	754612 (100)	1103523 (100)	616523 (100)	1195747 (100)	420551 (100)	4934833 (100)
Poultry Birds	69650	46419	92614	164085	48505	8922	430195

Sources: District Statistical book 2016-17 Figures in parenthesis shows percentage to total livestock population

Bundelkhand Region of Madhya Pradesh (Fig 3.11).

The population of poultry birds was found to be more in Tikamgarh (38%) followed by Chhatarpur (22%), Sagar (16%) Damoh (11%), Panna (11%) and Datia (2%) districts of Bundelkhand Region of Madhya Pradesh (Fig 3.12).

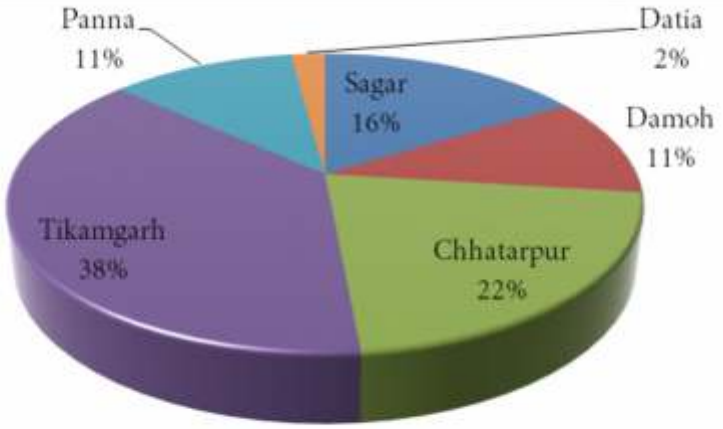

Fig. 3.12 : Poultry population in different districts of Bundelkhand Region of Madhya Pradesh (430159)

3.13 Summary of Chapter

The total population of Bundelkhand region of Madhya Pradesh was found to be 86.53 lakh, out of which 52.79 and 47.21 per cent are male and female, respectively. The population of rural (77.86%) was found to be more as compared to urban (22.14%) population.

An average literacy rate of the region was found to be 69 per cent, which was more in male (78%) as compared to female (58%) population. The very thin sex ratio (894) and child sex ratio 903 over 1000 male was found in the region. There were only 15.40 per cent of children in total population of Bundelkhand Region of Madhya Pradesh. The region was found to be dominant by Hindus (94.38%) followed by Muslim (3.81 %) religion.

The geographical area was found to be 41.28 lakh hectare. Out of total geographical of the Region, 48, 29, 10, 9 and 4 per cent was found in net area sown, area covered under forest, land not available for cultivation, other un-cultivated land excluding fallow land and fallow land respectively. Amongst all the district, maximum geographical area was occupied by Sagar (25%) followed by Chhatarpur (21%), Damoh (18%), Panna (17%), Tikamgarh (12%) and Datia (7%) districts, while the net area sown to total geographical area was found to be more in Datia (67.8 %) followed by Tikamgarh (54.86%), Sagar (53.31%), Chhatarpur (47.11%), Damoh (43.8%) and Panna (35.33%).

The net irrigated area in Bundelkhan Region of Madhya Pradesh was found to be 32.54 per cent (13.44 lakh ha) to total geographical area. Amongst different sources of irrigation, well (41.84%) followed by tube-well (19.22%), canal (15.3%) and tank (3.09%) were found to be major sources of irrigation, while other sources (ponds & rivers) were also found to be a source of irrigation contributing 20.56 per cent of net irrigated area

The cropping pattern of the region was found to be dominated by Rabi (57.92%) as compared to kharif season (42.08%). Wheat (27.64%) followed by gram (14.04%) and

soybean (16.30%) followed by rice (5.7%) were found to be major rabi and kharif crops respectively.

Farmers of the region were found to be 31481 t per year consumed of fertilizers. The consumption of Di-ammonium Phosphate, DAP (61.92%) was found to be more as compared to Urea (28.68%), Single Super Phosphate, SSP (4.94%), Complex Fertilizer (3.5%) and Murate of Potash, MOP (0.95%)

The numbers of regulated markets were found to be 38 across different grades of mandi and various districts of the Region. However, the majority of regulated market were found to be of "D" grade (52.63%) followed by "C" grade (26.32%) "B" grade (13.16%) and "A" grade (7.86 %)

The 1291038 numbers of land holdings occupied 24.39 lakh ha area in Bundelkhand Region of Madhya Pradesh. The number of marginal (43.64%) and small (31.09%) holdings were found to be more as compared to semi-medium (15.13%) medium (8.96%) and large (1.18%) size of holdings, while area of medium (30.64%), and semi-medium (22.65%) holdings were found to be more as compared to small (20.77%), marginal (16.70%) and large holding (9.23%) in the region. The 1291038 numbers of land holdings occupied 24.39 lakh ha area in the region.

More number of non-workers (56.77%) was found in the region as compared to main workers (31.40%) and marginal workers (11.83%). In total number of workers (main and marginal) the majority of them were found to be agricultural labours (36.98%) followed by cultivators (32.47%), other workers (23.36%) and workers in household Industries (7.19%).

As regards to the numbers of ploughs, bullock carts, electric pumps, diesel pumps and sugarcane cutters were concerned there were found to be 358162, 120699, 266209, 147350 and 1213 in the Region.

The cultivators of the region of Madhya Pradesh used 1023858, 254211, 2033497 and 311362't of High Yielding Varieties (HYVs) seed, seed treatment chemicals, fertilizers and plant protection chemicals for cultivation of various crops in their field.

The number of livestock in the region was found to be 4934833. Amongst their population of cows (41.62%) was found to be more as compared to buffaloes (33.69%), goats (19.89%), sheeps (1.94%) and pigs (2.87%).

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CHAPTER - IV

SOCIO-ECONOMIC CHARACTERISTICS OF THE SAMPLE HOUSEHOLDS

This chapter deals with socio-economic profile of the respondents their operational holding, cropping pattern, farm assets, status of soil testing and soil health card (SHC) and sources of information.

4.1 Socio-economic Profile of the Respondents

To understand the socio-economic characteristics of the household (HHs) related to selected crops viz. wheat, soybean and gram. It is imperative to understand their general characteristics; i.e. average age of the respondent, level of education, caste structure, number of family member, occupation and annual farm income. It forms the basis to judge the level of adoptability of innovative technologies by the farmers in their fields and to assess dependency of respondents on farm, agriculture & other for their income.

4.1.1 Age & Numbers of Family Members

The age, number of family members and number of family members involved in farming etc. of the respondents are presented in Table 4. 1. It is clear from the data that the average age of respondents was found to be 49 years having farming experience of 33 years with an average family size of 7 members, out of which 3 members were engaged, fully in farming. Out of total respondents majority were found to be below 45 years of age (57.22%) followed by above 45 years (42.78%). These findings were found to be similar in different size of farms with minor variation.

Table 4.1 Age and number of family members of respondents

Particulars		Small	Medium	Large	Overall
Age of respondents		51	46	49	49
Below 45		32 (53.33)	37 (61.67)	34 (56.67)	103 (57.22)
Above 45		28 (46.67)	23 (38.33)	26 (43.33)	77 (42.78)
Total		60 (100)	60 (100)	60 (100)	180 (100)
No. of Family Member	Male	2 (33.33)	2 (33.33)	3 (37.50)	2 (28.57)
	Female	2 (33.33)	3 (50.00)	3 (37.50)	3 (42.86)
	Child	2 (33.33)	1 (16.67)	2 (25.00)	2 (28.57)
	Total	6 (100)	6 (100)	8 (100)	7 (100)
No. of family members involve in farming	Male	2	2	3	2
	Female	1	1	1	1
	Total	3	3	4	3
Experience in farming (Years)		35	34	41	33

Figures in parenthesis show percent to total

4.1.2 Education level and caste structure

As far as level of education of respondents is concerned the majority of the respondents were found to be educated up to primary level (27.78%) followed by higher school (20.56%), matriculation (16.67%) and graduate (11.67%), post-graduate (4.44%) & above (2.22%). The illiterate respondents were found to be 16.67 per cent.

The majority of the respondents belongs to the Other Backward Cast (OBC) (70.00%) followed by General (14.44%), Schedule Tribe (SC) (12.78%) and Schedule Caste (ST) (2.78%) categories at overall level (Table 4.2). These findings were found to be similar in different size of farms with minor variation. However, SC and ST farmers were found more in small size (23.33 & 8.33%) of farm as compared to medium (6.67 & 0%) and large size (8.33 & 0%) of farms.

Table 4.2 : Education level and cast structure of respondents

Particulars	Small	Medium	Large	Overall
Level of Education				
Illiterate	12 (20)	10 (16.67)	8 (13.33)	30 (16.67)
Primary	16 (26.67)	20 (33.33)	14 (23.33)	50 (27.78)
High School	17 (28.33)	5 (8.33)	8 (13.33)	30 (16.67)
Higher Secondary	9 (15)	16 (26.67)	12 (20)	37 (20.56)
Graduate	4 (6.67)	5 (8.33)	12 (20)	21 (11.67)
Post Graduate	2 (3.33)	2 (3.33)	4 (6.67)	8 (4.44)
Above Post Graduate	0 (0)	2 (3.33)	2 (3.33)	4 (2.22)
Total	60 (100)	60 (100)	60 (100)	180 (100)
Caste				
General	3 (5)	11 (18.33)	12 (20)	26 (14.44)
Other Backward Caste	38 (63.33)	45 (75)	43 (71.67)	126 (70)
Schedule Caste	14 (23.33)	4 (6.67)	5 (8.33)	23 (12.78)
Schedule Tribe	5 (8.33)	0 (0)	0 (0)	5 (2.78)
Total	60 (100)	60 (100)	60 (100)	180 (100)

Figures in parenthesis show percent to total

4.1.3 Occupation

As regards to occupation of respondents is concerned all the respondents were found to be engaged in farming and allied activities as a main occupation for their livelihood security, while in allied activity the maximum i.e. 30.56 per cent respondents were found to be engaged as agriculture labour followed by live stock (11.11%), non-agricultural labour (7.78%), services (4.44%), self employment (2.78%) and daily wages labour (1.11%) (Table 4.3).

Table 4.3 : Occupation of respondents

Particulars	Small	Medium	Large	Overall
Primary Occupation – Farming	60 (100)	60 (100)	60 (100)	180 (100)
Secondary Occupation				
Agriculture Labour	25 (41.67)	16 (26.67)	14 (23.33)	55 (30.56)
Live Stock	3 (5)	7 (11.67)	10 (16.67)	20 (11.11)
Poultry	0 (0)	0 (0)	1 (1.67)	1 (0.56)
Self Employment	2 (3.33)	1 (1.67)	2 (3.33)	5 (2.78)
Services	1 (1.67)	5 (8.33)	2 (3.33)	8 (4.44)
Non-Agricultural Labour	7 (11.67)	4 (6.67)	3 (5)	14 (7.78)
Daily wages Labour	1 (1.67)	1 (1.67)	0 (0)	2 (1.11)
Others	21 (35)	26 (43.33)	28 (46.67)	75 (41.67)
Total	60 (100)	60 (100)	60 (100)	180 (100)

There was no remarkable difference was observed in occupation of HHs of different size of farms. However, respondents engaged as agricultural labour were found to be more in small (41.67%) as compared to medium (26.67%) and large (23.33%) size of holdings. The activity of live stock was found more in large size of holdings (16.67%) as compared to medium (11.67%) and small (5.00%). The respondents engaged in services were found to be more in medium (8.33%) as compared to large (3.33%) and small farm size of holdings (1.67%). The respondents engaged non-agricultural labour activities were found to be more in small (11.67%) as compared to medium (6.67%) and large (5.00%) size of holdings. The respondents engaged in other secondary sources were found to be more in large (46.67%) as compared to medium (43.33%) and small (35.00%) size of holdings.

4.1.4 Farm Income

An average medium HH (Rs. 65357) was found to earn more annual income as compared to large (Rs. 63060) and small (Rs.59057). The main source of income of respondent was found to be agriculture. The annual income per HH was found to be Rs. 44594/year from agriculture and Rs. 17897/year from other sources at overall level. The total income was found to be Rs. 62491 per HH per annum from agriculture and allied sector (Table 4.4).

Table 4.4 : Annual farm income of the respondents (Rs./HH/annum)

Particulars	Small	Medium	Large	Overall
From Agriculture	41763 (70.72)	46833 (71.66)	45187 (71.66)	44594 (71.36)
From Others Sources	17294 (29.28)	18524 (28.34)	17873 (28.34)	17897 (28.64)
Total	59057 (100)	65357 (100)	63060 (100)	62491 (100)

Figures in parenthesis show percent to total

4.2 Farm Assets

The value of land was found to vary between Rs. 454283 (small) to Rs. 973199 (large) per ha with average of Rs. 686635 per ha in the area under study. An average HH have total

Table 4.5 : Farm assets of respondents (Rs./farm)

Particulars	Small	Medium	Large	Overall
Tractor	3750	62438	185563	83917
Thresher	500	5938	19525	8654
Cultivator	150	3475	11988	5204
Seed Drill	225	2938	10025	4396
Rotavetor	0	0	8375	2792
Harvester	0	0	3750	1250
Straw Machine	0	0	4125	1375
Plough	293	360	149	267
Bukkhar	301	360	65	242
Hand Hoe	11	18	15	15
Diesel Pump	3591	3275	3534	3467
Electric Pump	8395	10791	21914	13700
Sprinkler	949	1644	2413	1669
Drip	750	125	375	417
Power Sprayer	62	238	437	246
Hand Sprayer	458	541	462	487
Others	175	88	264	176
Land	434673	540185	700220	558361
Total	454283	632414	973199	686635
Total (Excluding Land)	19610 (4.32)	92229 (14.58)	272979 (28.05)	128274 (18.68)

Figures in parenthesis show percent to total

assets excluding land of Rs. 128274/farm, which were found to be more in large (Rs. 272979/farm) as compared to medium (Rs. 92229/farm) and small (Rs. 19610/farm) size of farms (Table 4.5). The farm assets were found to be owned across various size of holdings except rotavator, harvester and straw machine which were found to be owned by large size of holdings of HHs.

4.3 Operational Land Holding

To calculate operational land holding of the respondents, the data on cultivated land, uncultivated/fallow land, leased in /out land were analysed across various size of holdings. The per cent area under irrigation reported respondents is also presented in table 4.6.

Table 4.6 : Land use pattern of respondents (acre/farm)

Particulars	Small	Medium	Large	Overall
Total Land Holding	3.07 (100)	7.75 (100)	21.81 (100)	10.88 (100)
Cultivated Land	3.05 (99.35)	7.66 (98.84)	21.3 (97.66)	10.67 (98.62)
Leased-In Land	0.66 (17.93)	0.96 (11.46)	0.7 (3.24)	0.77 (10.88)
Leased-Out Land	0.00	0.09	0.30	0.13
Un-Cultivated Land	0.02 (0.65)	0.09 (1.16)	0.51 (2.34)	0.21 (1.38)
Current Fellow	0.03	0.07	0.08	0.06
Old Fellow	0.00	0.08	0.00	0.03
Operated Holding	3.68 /100/	8.38 /100/	21.62 /100/	11.23 /100/
Irrigated Area	2.57 /70/	5.24 /63/	16.71 /77/	8.17 /70/

Figures in parenthesis show percent to total land holding, while figures in slashes show percentage to operated land holding

It is observed from the data that at overall level an average HH was found to have 10.67 acres of cultivated land with 0.77 and 0.13 acres of leased in and leased out land, respectively with 0.21 acres uncultivated, 0.06 current fallow & 0.03 old fallow land constituting his net operated area of 11.23 acres. Out of the total net operated area 70 per cent was found to be irrigated. An average operational holding in case of small, medium and large respondents was found to be 3.68, 8.38 and 21.62 acres, respectively (Table 4.6).

The irrigated area was found to be 70, 63 and 77 per cent across small, medium and large size categories, respectively. The un-cultivated land was found to be maximum in large (2.34%) as compared to medium (1.16%) and small (0.65%) size of holdings, respectively. The leased in land was found to be more in practice under small (17.93) category as compared to medium (11.46%) and large (3.24%) categories (Table 4.6).

4.4 Sources of Irrigation

The sources of irrigation of the respondents across different size of farms presented in table 4.7. It is observed from the data that at overall level open/dug well (47.22%) followed by bore well (36.67%), canal (8.33%), pond (4.44%) and river (3.33%) were found to be major sources of irrigation in the area under study with minor variation across various size of holdings.

Table 4.7 : Source wise irrigation of respondents (Number)

Particulars	Small	Medium	Large	Overall
Well	28 (46.67)	31 (51.67)	26 (43.33)	85 (47.22)
Tube-Well	22 (36.67)	17 (28.33)	27 (45)	66 (36.67)
Cannel	7 (11.67)	5 (8.33)	3 (5)	15 (8.33)
River	1 (1.67)	3 (5)	2 (3.33)	6 (3.33)
Pond	2 (3.33)	4 (6.67)	2 (3.33)	8 (4.44)
Total	60 (100)	60 (100)	60 (100)	180 (100)

Figures in parenthesis show percent to total

4.5 Cropping Pattern

The preference for cultivation of various crops during kharif and rabi season across various size of holdings is depicted in table 4.8 . It is observed from the data that at overall level an average HH used to allocate maximum area in kharif (52.94%) as compared to rabi (47.06%) season out of gross cropped area (21.12 acres). In kharif season, an average farmer was found to allocate maximum area in soybean (36.13%) followed by rice (23.66%), urd (18.37%) and til (10.06%). The respondents were also found to cultivated ground nut, maize, moong and tur in kharif season as other crops.

In rabi season, wheat was found to be dominated crop in which an average HH allocate 60.49 per cent area of total rabi season. Gram and lentil were found to be other major Rabi crops in which an average HH allocates 21.65 and 11.23 per cent of total Rabi season area respectively. Jowar, mustard, linseed were found to be other major crops, which were found to be cultivated by the respondents during Rabi season.

These finding were found to be almost same with minor variation across different size of farms in Bundelkhand Region of Madhya Pradesh. The cropping intensity at overall level was found to be 190 per cent. It was found to be more in small (196%) as compared to medium (189%) and large (180%) size of holdings. Hence, as the size of farms increases cropping intensity was found to be decreases in the area under study.

Table 4.8 : Cropping pattern of respondents (acre/farm)

Particulars	Small	Medium	Large	Overall
Kharif Season				
Rice	0.92 (25.27)	1.58 (19.08)	5.75 (26.62)	2.75 (23.66)
Maize	0.00 (0.00)	0.00 (0.00)	0.22 (1.02)	0.07 (0.34)
Soybean	0.99 (27.2)	3.97 (47.95)	7.18 (33.24)	4.05 (36.13)
Sesame	0.32 (8.79)	0.98 (11.84)	2.06 (9.54)	1.12 (10.06)
Groundnut	0.06 (1.65)	0.26 (3.14)	1.06 (4.91)	0.46 (3.23)
Urd	1.07 (29.4)	0.8 (9.66)	3.47 (16.06)	1.78 (18.37)
Moong	0.13 (3.57)	0.43 (5.19)	0.72 (3.33)	0.43 (4.03)
Tur	0.04 (1.1)	0.13 (1.57)	0.24 (1.11)	0.14 (1.26)
Others	0.11 (3.02)	0.13 (1.57)	0.9 (4.17)	0.38 (2.92)
Total Kharif	3.64 (100)/50.56/	8.28 (100)/52.31/	21.6 (100)/53.57/	11.18 (100)/52.94/
Rabi Season				
Wheat	2.32 (67.34)	4.07 (61.26)	10.81 (52.88)	5.73 (60.49)
Gram	0.68 (19.74)	1.97 (19.75)	5.4 (25.47)	2.68 (21.65)
Field Pea	0.01 (0.29)	0.00 (0.00)	0.48 (2.26)	0.16 (0.85)
Lentil	0.26 (7.55)	0.75 (9.43)	1.46 (16.7)	0.82 (11.23)
Jowar	0.12 (1.74)	0.11 (1.38)	0.00 (0.00)	0.08 (1.04)
Mustard	0.08 (1.74)	0.61 (7.67)	0.31 (1.46)	0.33 (3.62)
Linseed	0.00 (0.00)	0.03 (0.38)	0.00 (0.00)	0.01 (0.13)
Other	0.09 (1.6)	0.01 (0.13)	0.26 (1.23)	0.12 (0.99)
Total Rabi	3.56 (100)/49.44/	7.55 (100)/47.69/	18.72 (100)/46.43/	9.94 (100)/47.06/
Gross Cropped Area	7.2 /100/	15.83 /100/	40.32 /100/	21.12 /100/
Cropping Intensity %	196	189	186	190

Figures in parenthesis show percentage to respective total, while figures in slashes show percentage to gross cropped area

4.6 Status of Soil Testing and Soil Health Card

Only 43 and 36 per cent HHs were found to test soil of their farms and received Soil Health Card (SHC) respectively in Bundelkhand region of Madhya Pradesh. The soil testing done by small (48%) farmers was found to be more as compared to large (43%) and medium (39%) farmers (Table 4.9).

Table 4.9 : Status of soil testing and Soil Health Card (SHC) of the respondents (Numbers)

Particulars	Small	Medium	Large	Total
No. of Respondents	60 (100)	60 (100)	60 (100)	180 (100)
No. of Soil Tested farmers	29 (48)	23 (39)	26 (43)	78 (43)
No. of farmers received SHC	25 (41)	17 (29)	23 (38)	65 (36)

Figures in parenthesis show percent to number of respondents

4.7 Sources of Information about Crops Cultivation

Sources of information regarding recommended packages and practices (RPP) related to cultivation of wheat, soybean and gram, respectively analyzed and presented in table 4.10.

Table 4.10 : Sources of information about crop cultivation

Particulars	Small	Medium	Large	Overall
Agriculture Department	35 (58.33)	29 (48.33)	32 (53.33)	96 (53.33)
Kisan Call Centre	2 (3.33)	2 (3.33)	0 (0)	4 (2.22)
KVK	1 (1.67)	1 (1.67)	3 (5)	5 (2.78)
Relatives/ Neighbour	13 (21.67)	18 (30)	15 (25)	46 (25.56)
Progressive Farmers/ Krishak Mitra	9 (15)	10 (16.67)	10 (16.67)	29 (16.11)
Total	60 (100)	60 (100)	60 (100)	180 (100)

Figures in parenthesis show percent to total

It is observed from the data that major source of information was found to be Agricultural Department from where 53.33 per cent of respondents received information regarding recent RPP of crop cultivation. Relatives/neighbour (25.56%), progressive farmers/ krishak mitra (16.11%), Krishi Vigyan Kendra (2.78%) and Kisan Call Centre (2.22%) were found to be other sources of information. These sources of information were found to be similar amongst all the categories of respondents with minor variation.

4.8 Summary of the Chapter

It can be concluded from the above findings that the majority of respondents were found to be of OBC (70%) with 83.33 per cent level of literacy. The family comprises of 7 members with 3 members engaged in farming with average experience of 33 years in farming. They all were found to be engaged in allied activities such as agricultural labour, livestock, no-agricultural activities etc. for their livelihood security. An average respondent was found to earn 71.60 per cent (Rs 62291/year) of total annual income from farming. The value of land was found to vary between Rs 454283 to Rs. 973199 / ha across of Bundelkhand Region of Madhya Pradesh.

An average HH has farm assets of only Rs. 128227 on his farm, which varies between Rs.19599 (small) to 272979 (large) per farm. An average HH of small, medium and large farmers were found to be 3.68, 8.38 and 21.62 acres of operated land in Bundelkhand Region of Madhya Pradesh. Out of gross cropped area (21.12 acre) an average respondent was found to allocate maximum area in cultivation of kharif (52.94%) as compared to rabi (47.06%) season. Soybean (36.13%), followed by rice (23.66%) and wheat (60.49%) followed gram (21.65%) were found to be major kharif and Rabi crops, respectively. Cultivators were also found to be cultivated sesame, groundnut, tur, urd and moong in kharif and field pea, lentil, jowar, mustard and linseed in rabi season on their farms. The cropping intensity of area was found to be 190 per cent, which was found more in small (196%) as compared to large (180%) farms.

It is also observed that only 43 per cent of HH were found to test soil of their farms and only 36 per cent received Soil Health Card. The majority of them were dependent on the officers of Department of Agriculture (53.33%) for recent information of crop cultivation. Relatives/neighbour (25.56%), progressive farmers/ krishak mitra (16.11%), Krishi Vigyan Kendra (2.78%) and Kisan Call Centre (2.22%) were found to be other source of information in the area under study.

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CHAPTER - V

YIELD GAP & CONSTRAINTS ANALYSIS AND DETERMINANTS OF YIELD OF MAJOR CROPS

This chapter deals with the analysis of yield gap, constraints in adoption of recommended technologies and determinants of yield of all the major crops viz. wheat, gram and soybean considered for the study in Bundelkhand Region of Madhya Pradesh.

5.1 Wheat

The wheat was found to be major rabi crop grown in Bundelkhand region of Madhya Pradesh. The yield gap & constraints analysis with determinants of yield of wheat cultivation was carried out for the study.

5.1.1 Yield Gap Analysis

A considerable yield gap (III) of 29.86 per cent between potential (23 q/acre) and average farm yield (16.13 q/acre) was found on an average wheat grower's farm. Out of this total yield gap (yield gap-III), a gap of 11.68 (yield gap-I), and 20.29 per cent (yield gap-II) was found between potential (23 q/acre) & highest farm yield (20.31 q/acre), and between highest & average farm yield (16.13 q/acre), respectively.

These findings were found to be similar for all size of farms with minor variation. However, yield gap I was found to be less in medium (5.87%) as compared to large (12.26%) and small (16.91%), while yield gap II was found to be less in small (13.66%) as compared to large (19.87%) and medium (27.34%) farms (Table 5.1).

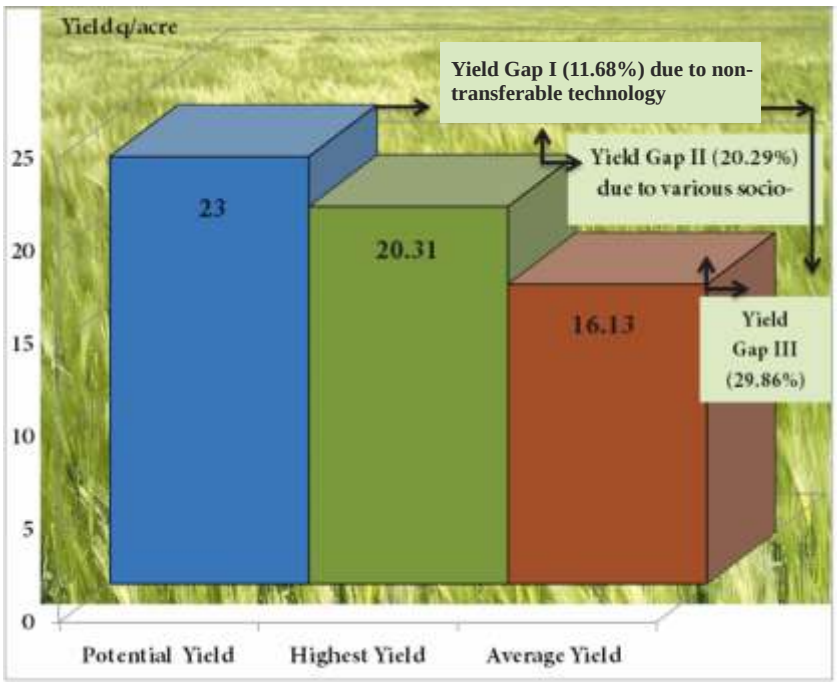

Fig. 5.1 : Yield gap in wheat cultivation

The yield gap was found to be 6.87 q/acre (29.86%) in cultivation of wheat with potential yield in the area under study. Yield gap-II (22.29%) was found to be more than yield gap-I (11.68%) due to more socio-economic constraints than non-transfer of technologies of crop cultivation in area under study (Fig. 5.1).

Table 5.1 : Yield gap analysis of wheat (q/acre)

Particulars	Small	Medium	Large	Overall
Potential Yield	23	23	23	23
Average Yield	16.5	15.73	16.17	16.13
Highest Yield	19.11	21.65	20.18	20.31
Yield gap-I	3.89 (16.91)	1.35 (5.87)	2.82 (12.26)	2.69 (11.68)
Yield gap-II	2.61 (13.66)	5.92 (27.34)	4.01 (19.87)	4.18 (20.29)
Yield gap-III	6.5 (28.26)	7.27 (31.61)	6.83 (29.70)	6.87 (29.86)

Figures in parenthesis show percent yield gap

5.1.2 Constraints in adoption of recommended technology of Wheat Cultivation

The various constraints which were found to be faced by the respondents in enhancing yield of wheat are presented in table 5.2.

It is observed from the data that the yield gap was found due to various constraints faced by the respondents in cultivation of wheat. Un-availability of capital for purchase of inputs (73.33%), lack of knowledge about method of seed treatment (70%) and lack of knowledge about proper dose of fertilizer application (70%), un-availability of desired variety of HYVs seed (68.33%), un-availability of capital (51.67%) were found to be major constraints as reported by more than 50 per cent of respondents. The un-availability of electricity on time for peak operational period of cultivation (45%), lack of labour during the peak

Table 5.2 : Constraints in adoption of recommended packages of wheat (%)

Constraints	Small	Medium	Large	Overall
Low germination of seed	30.00	20.00	20.00	23.33
Un-availability of desired variety of seed	75.00	85.00	45.00	68.33
Lack of suitable machinery	40.00	50.00	15.00	35.00
Lack of knowledge about method of seed treatment	85.00	80.00	45.00	70.00
High cost of input	85.00	75.00	60.00	73.33
Lack of knowledge about proper dose of fertilizer	80.00	75.00	55.00	70.00
Un-availability of capital	65.00	45.00	45.00	51.67
Un-availability of electricity on time	65.00	45.00	25.00	45.00
Lack of labour during the peak operational periods	45.00	55.00	30.00	43.33
Lack of proper knowledge of packages of practices	20.00	30.00	15.00	21.67

operational periods (43.33%), lack of suitable machinery for sowing, intercultural operations and harvesting (35%), low germination of seed (23.33%), lack of proper knowledge of packages of practices (21.67%) were found to be minor constraints as reported by less than 50 per cent of respondents. These constraints were found to be similar in different size of farmers. However, more constraints reported by small farmers were found to be more as compared to medium and large farmers in cultivation of wheat.

5.1.3 Determinants of Yield of Wheat

The yield of wheat was found to be determined by education (x1), age (x2), sources of seed (x3), status of soil test report (x4), seed rate (x5), seed treatment (x6), use of HYVs seed (x7), consumption of Urea (x8), consumption of DAP (x9), irrigated area (x10) and size of land holding (x11) variables in Bundelkhand Region of Madhya Pradesh. A multiple regression model was used to draw conclusions and presented in table 5.3

Table 5.3 : Factors affecting productivity of wheat

Particulars	Coefficients	SE	P-value
Education (X_1)	-0.0541	0.1040	0.6057
Age in years (X_2)	-0.0181	0.0167	0.2831
Source of Seed (X_3) *(Purchase-1, Self-0)*	1.0517*	0.4419	0.0213
Soil Test (X_4) *(Yes-1, No-0)*	1.5739**	0.3800	0.0001
Seed Rate (kg) (X_5)	0.0262**	0.0050	0.0000
Seed Treatment(X_6) *(Yes-1, No-0)*	-0.2309	0.3863	0.5528
Use of HYV's Seed(X_7) *(HYVs-1, Local-0)*	0.3258	0.4434	0.4659
Urea (kg) (X_8)	0.0274*	0.0136	0.0498
DAP (kg) (X_9)	0.0469	0.0281	0.1014
Area under Irrigation (X_{10})	0.1172	0.0689	0.0955
Size of Holding (X_{11})	-0.1079*	0.0485	0.0309
R^2 (Coefficient of Multiple Determinates)	0.855		

* & ** significant at 5 (P<0.05) & 1 (P<0.01) percent, respectively

It is observed from the data that the wheat response in terms of productivity in to soil testing based application of fertilizers and use of proper seed rate, which were found to be positive and highly significant, while use of purchased seed over own farm seed and consumption of Urea were found to be positive and significant. The size of holding was found to be negative and significant. Use of HYVs over local and area under irrigation were found to be positive but non-significant, while education, age and seed treatment were found to be negative but non-significant. This indicates that if all things remain constant and with the present level of technological adoption of soil test recommended and balance use of fertilizer, use of proper seed rate and balanced application of fertilizers (Urea) would be able to increase yield of wheat in the area under study.

The multiple regression model was found to be good fit as it explained 85.50 per cent (R2 0.855) of productivity of wheat determined by these known independent variables and rest i.e. only 14.50 per cent was the

contribution of un-known variables which were not taken into consideration in this regression model.

5.2 Gram

The gram was found to be major Rabi crop grown in Bundelkhand region of Madhya Pradesh. The yield gap & constraints analysis with determinants of yield of gram was carried out for the study.

5.2.1 Yield Gap Analysis

A considerable yield gap (III) of 43.59 per cent between potential (8 q/acre) and average farm yield (4.51 q/acre) was found on an average gram grower's farm. Out of this total yield gap (yield gap-III), a gap of 18.76 (yield gap-I), and 30.49 per cent (yield gap-II) was found between potential (23 q/acre) & highest farm yield (6.5 q/acre), and between highest & average farm yield (4.51 q/acre), respectively (Table 5.4).

Table 5.4 : Yield gap analysis of gram (q/acre)

Particulars	Small	Medium	Large	Overall
Potential Yield	8	8	8	8
Average Yield	4.56	4.27	4.71	4.51
Highest Yield	6.82	6.13	6.54	6.5
Yield gap-I	1.18 (14.75)	1.87 (23.38)	1.46 (18.25)	1.5 (18.79)
Yield gap-II	2.26 (33.14)	1.86 (30.34)	1.83 (27.98)	1.98 (30.49)
Yield gap-III	3.44 (43.00)	3.73 (46.63)	3.29 (41.13)	3.49 (43.59)

Figures in parenthesis show percent yield gap

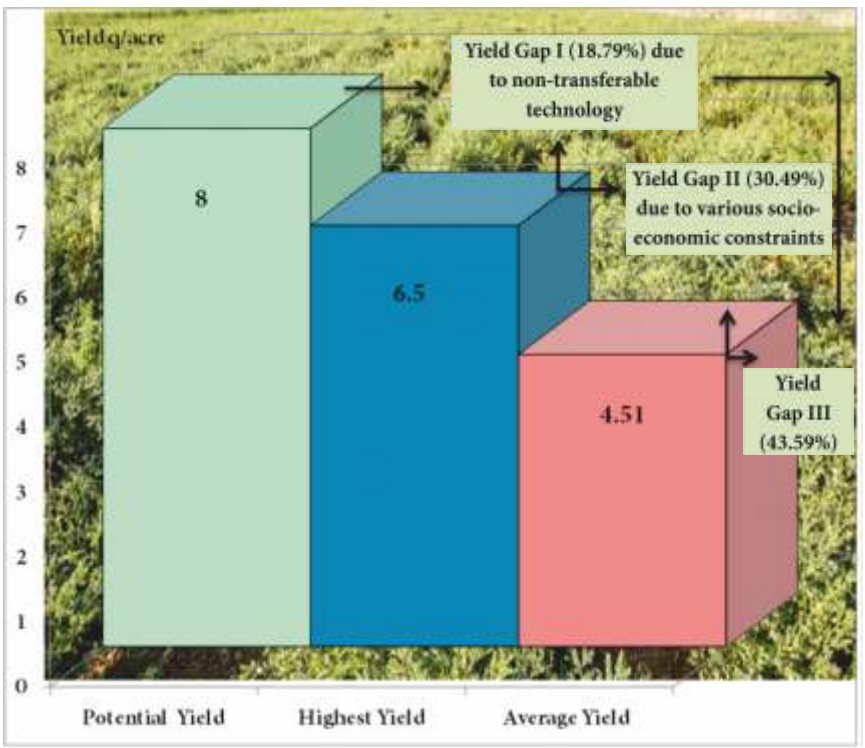

Fig. 5.2 : Yield gap in gram cultivation

The findings were found to be similar to overall level with minor variation across various size of holdings. However, yield gap I was found to be less in small (14.75%) as compared to large (18.25%) and medium (23.38%) farms. Yield gap-II was found to be more than yield gap-I denoted that socio-economic constraints more as compared to transferable of recommended packages of practices of gram in the area under study.

5.2.2 Constraints in adoption of recommended technology of Gram Cultivation

The various constraints which were found to be faced by the respondents in enhancing yield of gram area presented in table 5.5. It is observed from the data that the yield gap was found due to various constraints faced by the respondents in cultivation of gram. Un-availability of desired variety of HYVs seed (86.67%), lack of knowledge about method of seed treatment (70%), lack of knowledge about proper dose of fertilizer application (63.33%) and un-availability of capital for purchase of inputs (61.67%) were found to be major constraints as reported by more than 50 per cent of respondents.

Lack of proper knowledge of RPP (43.33%), low germination of seed (36.67%), un-availability of capital (33.33%), lack of suitable machinery for sowing, intercultural operations and harvesting of crop (31.67%), lack of labour during the peak operational periods (21.67%), un-availability of electricity on time for peak operations of cultivation of gram (13.33%) were found to be minor constraints as reported by less than 50 per cent of respondents. These constraints were found to be similar across different categories of farmers with minor variance. However, more constraints reported by small farmers were found to be more as compared to medium farmers in cultivation of gram.

Table 5.5 : Constraints in adoption of recommended packages of gram (%)

Particulars	Small	Medium	Large	Overall
Low germination of seed	20.00	35.00	55.00	36.67
Un-availability of desired variety of seed	95.00	95.00	70.00	86.67
Lack of suitable machinery	20.00	30.00	45.00	31.67
Lack of knowledge about method of seed treatment	80.00	60.00	70.00	70.00
High cost of input	60.00	70.00	55.00	61.67
Lack of knowledge about proper dose of fertilizer	70.00	60.00	60.00	63.33
Un-availability of capital	25.00	35.00	40.00	33.33
Un-availability of electricity on time	20.00	5.00	15.00	13.33
Lack of labour during the peak operational period	25.00	25.00	15.00	21.67
Lack of proper knowledge of packages of practices	55.00	35.00	40.00	43.33

5.2.3 Determinants of Yield of Gram

The yield of gram was found to be determined by education (x1), age (x2), source of seed (x3), soil test recommendation (x4), seed rate (x5), seed treatment (x6), Use of HYV's seed (x7), consumption of Urea (x8), consumption of DAP (x9), area under irrigated (x10) and size of

holding (x11) variables. A multiple regression model was performed to find out factors affecting productivity of gram in Bundelkhand region of Madhya Pradesh with above mentioned variables (Table 5.6).

Table 5.6 : Factors affecting productivity of gram

Particulars	Coefficients	SE	P-value
Education (X_1)	37.2378	17.6515	0.0401
Age in years (X_2)	-1.6908	1.5099	0.2684
Source of Seed (X_3) *(Purchase-1, Self-0)*	49.2581	37.8205	0.1990
Soil Test (X_4) *(Yes-1, No-0)*	42.1450	40.5646	0.3040
Seed Rate (kg) (X_5)	31.1188**	10.5891	0.0051
Seed Treatment(X_6) *(Yes-1, No-0)*	106.4320*	46.0713	0.0252
Use of HYV's Seed(X_7) *(HYVs-1, Local-0)*	154.4361**	49.6182	0.0031
Urea (kg) (X_8)	35.4693**	10.5265	0.0015
DAP (kg) (X_9)	2.3281	3.3762	0.4938
Area under Irrigation (X_{10})	63.8487*	28.0681	0.0274
Size of Holding (X_{11})	1.5688	1.3714	0.2583
R^2 (Coefficient of Multiple Determinates)	0.839		

* & ** significant at 5 (P<0.05) & 1 (P<0.01) percent, respectively

It is observed from the data that the crop response in terms of productivity in gram with respect to use of HYVs seed over local, consumption of urea and seed rate, which were found to be positive and highly significant, while, area under irrigation and seed treatment were found to be positive and significant over increase of yield of gram.

The education, status of soil test, seed replacement (source of seed) and size of land holding use of balanced fertilizers (DAP) as per soil test value were found to be positive but non-significant, in case of age found to be negative and non-significant in enhancing productivity of gram. This indicates that if other things remain constant and with present level of technological adoption use of HYVs seed, proper seed rate, seed replacement increase area under irrigation would able to enhance productivity of gram in the area under study. The fitted of multiple regression model was found to be good fit as it explained 83.90 per cent (R2 0.839) yield of gram determined by these known independent variables and rest i.e. only 15.20 per cent was the contribution of un-known variables which were not taken into consideration in this regression model.

5.3 Soybean

The soybean was found to be major Kharif crop grown in Bundelkhand region of Madhya Pradesh. The yield gap and constraints analysis of soybean was carried out for the study.

5.3.1 Yield Gap Analysis

A considerable yield gap (III) of 38.87 per cent was found between potential (10

q/acre) and average farm yield (6.11 q/acre) was found on an average soybean grower's farm in production of soybean. Out of this total yield gap (yield gap-III), a gap of 11.43 (yield gap-I), and 30.85 per cent (yield gap-II) was found between potential (10 q/acre) & highest farm yield (8.86 q/acre), and between the highest & average farm yield (6.11 q/acre) respectively (Table 5.7).

Table 5.7 : Yield Gap analysis of soybean (q/acre)

Particulars	Small	Medium	Large	Overall
Potential Yield	10	10	10	10
Average Yield	6.32	5.91	6.11	6.11
Highest Yield	8.88	9.25	8.44	8.86
Yield gap-I	1.12 (11.20)	0.75 (7.50)	1.56 (15.6)	1.14 (11.43)
Yield gap-II	2.56 (28.83)	3.34 (36.11)	2.33 (27.61)	2.74 (30.85)
Yield gap-III	3.68 (36.8)	4.09 (40.90)	3.89 (38.90)	3.89 (38.87)

Figures in parenthesis show percent to yield gap

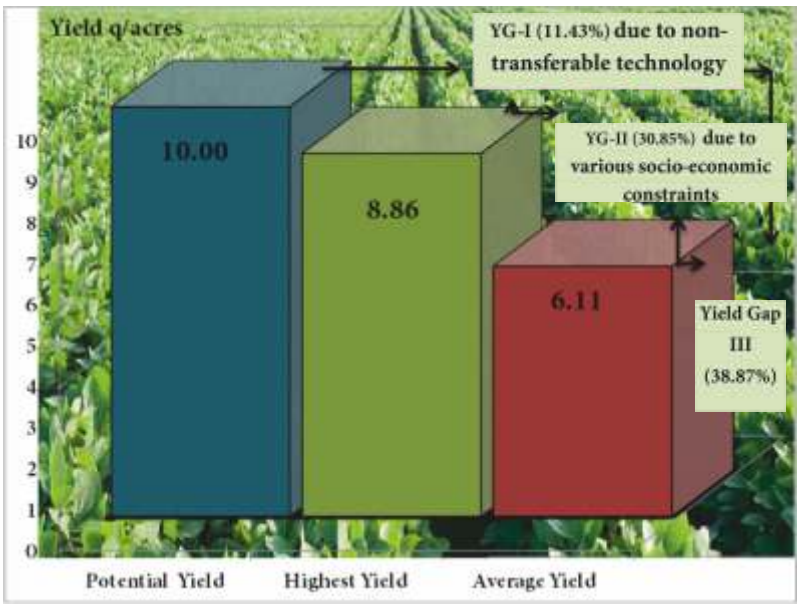

Fig. 5.3 : Yield gap in soybean cultivation

These findings were found to be similar for all size of farms with minor variation. However, yield gap I was found to be less in medium (7.50%) as compared to small (11.20%) and large (15.60%) farms.

Yield gap-II (30.85%) was found to be more than yield gap-I (11.43%) denoted that socio-economic constraints were found to be more important than transfer of recommended packages of practices of soybean (Fig. 5.3).

5.3.2 Constraints in adoption of recommended technology of Soybean Cultivation

The various constraints which were found to be faced by the respondents in enhancing yield of soybean are presented in table 5.8.

Table 5.8 : Constraints in adoption of recommended packages of soybean (%)

Constraints	Small	Medium	Large	Overall
Low germination of seed	65.00	60.00	85.00	70.00
Un-availability of desired variety of seed	75.00	60.00	75.00	70.00
Lack of suitable machinery	45.00	45.00	35.00	41.67
Lack of knowledge about method of seed treatment	60.00	30.00	80.00	56.67
High cost of input	60.00	25.00	90.00	58.33
Lack of knowledge about proper dose of fertilizer	40.00	25.00	70.00	45.00
Un-availability of capital	30.00	25.00	40.00	31.67
Un-availability of electricity on time	35.00	10.00	30.00	25.00
Lack of labour during the peak operational periods	30.00	35.00	35.00	33.33
Lack of proper knowledge of packages of practices	25.00	20.00	40.00	28.33

It is observed from the data that the yield gap was found due to various constraints faced by the respondents in cultivation of soybean. Low germination of seed (70%), un-availability of desired variety of HYVs seed (70%), high cost of input (58.33%) and lack of knowledge about method of seed treatment (56.67%) were found to be major constraints as reported by more than 50 per cent of respondents in adoption of recommended package of farming system. Lack of knowledge about proper dose of fertilizer application (45%), lack of suitable machinery for sowing, intercultural operations and harvesting (41.67%), lack of labour during the peak operational periods (33.33%), un-availability of capital for purchase of inputs (31.67%), lack of proper knowledge of recommended packages of practices (28.33%) and un-availability of electricity in time for peak operations of cultivation of soybean (25%) were found to be minor constraints as reported by less than 50 per cent of respondents.

5.3.3 Determinants of Yield of Soybean

The factors affecting yield of Soybean was carried out with education (x1), age (x2), sources of seed (x3), adoption of soil test recommendation (x4), seed rate (x5), adoption of seed treatment technology (x6), replacement of seed HYVs (x7), consumption of Urea (x8), consumption of DAP (x9), area under irrigation (x10), increase size of holding (x11) and improve method of sowing (X12) independents variables. A multiple regression model was carried out find out factor affecting productivity of soybean in Bundelkhand region of Madhya Pradesh (Table 5.9).

The results obtain showed that the crop response in terms of productivity in soybean with respect to application of DAP and area under irrigation were found to be positive and highly significant, while seed rate and use of HYVs seed over local were found to be positive and significant. The size of holdings was found to be negative and highly significant, education of respondents, replacement of HYVs seed, seed treatment and method of sowing gave positive but non-significant. while age in years and consumption of Urea were found to be negative and non-significant.

The coefficient of multiple regression model was found to be good fit as it explained 83.90 per cent (R2 0.839) of productivity of soybean determined by these known independent variables and rest i.e. only 16.10 per cent was the contribution of un-known variables, which were not taken into consideration in this regression model.

Table 5.9 : Factors affecting productivity of soybean

Particulars	Coefficients	SE	P-value
Education (X_1)	11.0281	5.8421	0.0652
Age in years (X_2)	-1.2299	0.8275	0.1439
Source of Seed (X_3) *(Purchase-1, Self-0)*	103.7147	58.7358	0.0839
Soil Test (X_4) *(Yes-1, No-0)*	53.5092	95.6298	0.5784
Seed Rate (kg) (X_5)	3.8736*	1.7874	0.0353
Seed Treatment(X_6) *(Yes-1, No-0)*	29.8112	46.4124	0.5238
Use of HYV's Seed(X_7) *(HYVs-1, Local-0)*	81.8860*	34.7229	0.0226
Urea (kg) (X_8)	-0.5941	5.1535	0.9087
DAP (kg) (X_9)	5.7391**	2.1198	0.0094
Area under Irrigation (X_{10})	51.0759**	16.6743	0.0036
Size of Holding (X_{11})	-32.4088**	11.6433	0.0077
Method of Sowing (X_{12}) (Line sowing=1 & Broadcasting=0)	203.5692	107.5977	0.0647
R^2 (Coefficient of Multiple Determinates)	0.839		

* & ** significant at 5 (P<0.05) & 1 (P<0.01) percent, respectively

5.4 Summary of the Chapter

In this chapter, the analysis of major crops i.e. wheat, gram and soybean was taken into consideration for Bundelkhand Region of Madhya Pradesh. An attempt has also been made to identify constraints in adoption of recommended package of practices of these crops. The factors affecting yield of these crops have also been analysed for the study.

The maximum yield gap between potential and average farm yield was found in cultivation of gram (43.59%) followed by soybean (38.87%) and wheat (29.86%). The yield gap II was found to be more than yield gap I in cultivation of wheat, gram and soybean denotes that the RPP cultivation of these crops have been reached to farmers field, but farmers are could not adopted these technologies due to un-availability of desired variety of seed, high cost of input, lack of knowledge about proper dose of fertilizers as per soil test recommendation, lack of knowledge about method of seed treatment. Low germination of seed of soybean (70%) as reported by majority of soybean was the major constraints identified in the study area. The respondents also reported an availability of capital, un-availability of electricity and lack of labour during the peak operation in cultivation of these crops.

The constraints faced by the cultivators in adoption of recent technology for cultivation of all the major crops were also identified in the study of area and it is found that majority of cultivators not able to adopt the recent technology of crop due to un-availability of desire variety of seed, high cost input, lack of

knowledge about proper dose of fertilizers as per soil test recommendation, lack of knowledge about method of seed treatment constraints prevailed in cultivation all these major crops.

A multiple regression model was used to find out determinants yield of major crops and was found to be good fit as it explain more than 80 per cent contribution of known independent variables. Independent variables like use of High Yielding Varieties seed, Improved method of sowing, Seed replacement (purchase seed), consumption of fertilizers as per soil test recommendation, treatment with fungicide, and bio-fertilizers (Rhizobium, Azotobacter and Phosphate Solubilizing Bacteria), increase educational status, proper seed rate, increase consumption of DAP were found to be positively related to yield of all the major crops.

Factors like adoption of soil test recommendation, proper seed rate, seed replacement through purchase seed, consumption of Urea were found to be positive and significant in case of yield of wheat.

In case of gram cultivation, seed replacement with purchased seed, proper seed rate, use of HYVs seed and increase consumption of urea were found to be positive and significant, while consumption of DAP, area under irrigation, proper seed rate and use of High yielding varieties of seed over local seed were found to be positive and significant in case of yield of soybean.

Thus, it is clear from the above results that if all the things remains constant and with level of technological adoption. Seed replacement with HYVs seed, soil test recommendation, proper seed rate and increase consumption of a kg of Urea would be able to enhance yield of wheat to 101.89, 135.23, 3.04 and 3.41 kg per acre respectively in cultivators fields, while increase in 1.00 acre size of holding would able to decrease yield of wheat with -4.27 kg per acre in Bundelkhand region of Madhya Pradesh.

In case of gram independents variables like use of HYVs seed, seed treatment, number of irrigation, increase a kg of Urea and proper seed rate would be able to enhance yield of gram to 154, 106, 63, 35 and 31 and kg per acre in cultivators fields respectively in Bundelkhand region of Madhya Pradesh,

While in case of soybean use of HYVs seed, proper seed rate, increase area under irrigation and one kg increase in DAP per acre would be able to enhance yield of soybean to 81.88, 3.87, 51.07 and 5.74 kg per acre respectively in cultivators fields, while increase in one acre size of holding would able to decrease yield of soybean with 51.07 kg per acre in Bundelkhand region of Madhya Pradesh.

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CHAPTER - VI

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

This chapter deals with the background of the study, conclusions drawn from the findings and policy recommendation related to increase in yield of the major crops in the region.

6.1 Background

Improving crop yields is essential to meet the increasing demand for food driven by the increasing population and income growth in the 21st century. Increasing agricultural productivity or yield is critical to economic growth and development. This can be achieved by using improved agricultural technologies and proper management techniques. Adoption of agricultural technologies differs from farmer to farmer which refers to both mental acceptance and also covers the use of new agricultural technologies. This can be achieved by using high yielding management practices (Yang et al., 2008), minimizing yield gaps in major crops by using optimal management practices may lead to improvements in production, while offering both environmental benefits and economic value.

Bundelkhand is a mountain range in central India and divided between the States of Uttar Pradesh and Madhya Pradesh with the larger portion lying in M.P. Bundelkhand comprises 14 districts: Jhansi, Lalitpur, Jalaun, Hamirpur, Mahoba, Banda and Chitrakoot (all in UP), and Datia, Tikamgarh,Niwari, Chhatarpur, Panna, Sagar and Damoh (all in MP). The Bundelkhand is rocky and has a high percentage of barren and uncultivable land. The soil form is the mixture of black and red-yellow which is not considered very fertile. Rainfall is sparse and the agricultural production is low. Poverty level is significantly high. The MP is rich in forest, Bundelkhand has lost its forest cover to a large extent. So, the forest as a means of livelihood is becoming destroyed day by day. It seems that the farmers could not be able to adopt the recommended package of practices for cultivation crops due to several socio-economic, technological constraints etc. resulting into low farm income. This is the main cause of farmers' dissatisfaction and farmers have no other options except to feel satisfied at low level of income in the area.

Keeping aforesaid facts in mind the present study has under taken in Bundelkhand region of the Madhya Pradesh with following specific objectives

a) To identify various socio-economic characteristics of farmers across size of holdings

b) To analyze yield gap of major crops grown by the cultivators across size of holdings

c) To determine factors affecting productivity of major crops

d) To identify various socio-economic, technological constraints in adoption of recommended package of practices in crop cultivation

e) To suggests policy implication to narrow down yield gap of major crops.

All the major crops having more than 10 per cent share in gross cropped area have been selected for the study (Fig. 2.1). Therefore, wheat (27.64%), soybean (16.30%) and gram (14.04%) have been considered for analysis of yield gap in Bundelkhand Region of Madhya Pradesh.

All the districts of Bundelkhand region of Madhya Pradesh have been taken into consideration for the study considering yield gap between the average yield of major crops in the district and average yield of that particular crop in Bundelkhand region of Madhya Pradesh. A higher yield gap and a low yield gap districts have been selected for each selected crops. Hence, Panna (-43.96%) and Tikamgarh (-19.79%) districts have been selected for soybean, while Panna (-43.88%) and Datia (-4.78%) districts have been selected for wheat and Chhatarpur (-23.05%) and Damoh (-4.04%) districts were selected for gram for the study in Bundelkhand region of Madhya Pradesh

A block in each selected district was further selected from the each selected districts on the basis of the highest area under selected crop. A list of all the villages in the each selected block was prepared and 3 villages having maximum area under cultivation of crop were selected for the study. A list of all the cultivators growing the selected crop was further prepared and classified them into small (<2 ha), medium (2-5ha) and large (>5ha) categories and 10 farmers in each category were selected randomly for the study. (Table 2.2). 30 farmers each from high and low yield gap districts, total 60 farmers were selected for the each selected crops. Thus 60x3=180 farmers were selected for the study.

An orientation training programme regarding introduction of Computer-Assisted Personal Interviewing (CAPI) was organized for collection of data related to interview schedule. All the related points of interview schedule were discussed in detail for better understanding in collection and analysis of data. A pre-tested interview schedule through CAPI was used for collection of required data from the respondents.

6.2 Conclusions

- The following conclusions are emerged from the study of Bundelkhand Region of Madhya Pradesh:-

6.2.1 Overview of Bundelkhand

- The total population of Bundelkhand region of Madhya Pradesh was found to be 86.53 lakh, out of which 52.79 and 47.21 per cent are male and female, respectively. The population of rural (77.86%) was found to be more as compared to urban (22.14%) population. An average literacy rate of the region was found to be 69 per cent, which was more in male (78%) as compared to female (58%) population. The very thin sex ratio (894) and child sex ratio 903 over 1000 male was found in the region.There were only 15.40 per cent of children in total population of Bundelkhand Region of Madhya Pradesh.
- The region was found to be dominant by Hindus (94.38%) followed by Muslim (3.81 %) religion.
- The geographical area of the region was found to be 41.28 lakh ha. Out of total geographical of the Region, 48, 29, 10, 9 and

4 per cent was found in net area sown, area covered under forest, land not available for cultivation, other un-cultivated land excluding fallow land and fallow land respectively. Amongst all the district, maximum geographical area was occupied by Sagar (25%) followed by Chhatarpur (21%), Damoh (18%), Panna (17%), Tikamgarh (12%) and Datia (7%) districts, while the net area sown to total geographical area was found to be more in Datia (67.8 %) followed by Tikamgarh (54.86%), Sagar (53.31%), Chhatarpur (47.11%), Damoh (43.8%) and Panna (35.33%). The net irrigated area of the region was found to be 32.54 per cent (13.44 lakh ha) to total geographical area. Amongst different sources of irrigation, well (41.84%) followed by tube-well (19.22%), canal (15.3%) and tank (3.09%) were found to be major sources of irrigation, while other sources (ponds & rivers) were also found to be a source of irrigation contributing 20.56 per cent of net irrigated area. The 1291038 numbers of land holdings occupied 24.39 lakh ha area in Bundelkhand Region of Madhya Pradesh. The number of marginal (43.64%) and small (31.09%) holdings were found to be more as compared to semi-medium (15.13%) medium (8.96%) and large (1.18%) size of holdings, while area of medium (30.64%), and semi-medium (22.65%) holdings were found to be more as compared to small (20.77%), marginal (16.70%) and large holding (9.23%) in the region. The 1291038 numbers of land holdings occupied 24.39 lakh ha area in the region.

- The cropping pattern of the region was found to be dominated by Rabi (57.92%) as compared to kharif season (42.08%). Wheat (27.64%) followed by gram (14.04%) and soybean (16.30%) followed by rice (5.7%) were found to be major rabi and kharif crops respectively. Farmers of the region were found to be consumed 31481 t per year of fertilizers. The consumption of Di-ammonium Phosphate, DAP (61.92%) was found to be more as compared to Urea (28.68%), Single Super Phosphate, SSP (4.94%), Complex Fertilizer (3.5%) and Murate of Potash, MOP (0.95%)

- The numbers of regulated markets were found to be 38 across different grades of mandi and various districts of the Region. However, the majority of regulated market were found to be of “D” grade (52.63%) followed by “C” grade (26.32%) “B” grade (13.16%) and “A” grade (7.86 %). As regards to the numbers of ploughs, bullock carts, electric pumps, diesel pumps and sugarcane cutters were concerned there were found to be 358162, 120699, 266209, 147350 and 1213 in the Region. The cultivators of the region of Madhya Pradesh used 1023858, 254211, 2033497 and 311362't of High Yielding Varieties (HYVs) seed, seed treatment chemicals, fertilizers and plant protection chemicals for cultivation of various crops in their field.

- More number of non-workers (56.77%) was found in the region as compared to main workers (31.40%) and marginal workers (11.83%). In total number of workers (main and marginal) the majority of them were found to be agricultural labours (36.98%) followed by cultivators (32.47%), other workers (23.36%) and workers in household Industries (7.19%).

- The number of livestock in the region was found to be 4934833. Amongst their population of cows (41.62%) was found to be more as compared to buffaloes (33.69%), goats (19.89%), sheeps (1.94%) and pigs (2.87%).

6.2.2 Socio-economic Characteristics

- The majority of respondents were found to be of OBC (70%) with 82 per cent level of literacy. The family comprises of 7 members with 3 members engaged in farming with average experience of 33 years in farming. An average respondent was found to earn 71.60 per cent (Rs 62291/year) of total annual income from farming. The value of land was found to vary between Rs Rs. 454283 to Rs. 973199/ acre across the Region. An average HH has farm assets of only Rs. 128227 on his farm, which varies between Rs.19599 (small) to 272979 (large) per farm. An average HH of small, medium and large farmers were found to be 3.68, 8.38 and 21.62 acres of operated land in Bundelkhand Region of Madhya Pradesh.
- Out of gross cropped area (21.12 acre) an average respondent was found to allocate maximum area in cultivation of kharif (52.94%) as compared to rabi (47.06%) season. Soybean (36.13%), followed by rice (23.66%) and wheat (60.49%) followed gram (21.65%) were found to be major kharif and rabi seasons, respectively. The cropping intensity of area was found to be 190 per cent, which was found more in small (196%) as compared to large (180%) farms. It is also observed that only 43 per cent of HH were found to test soil of their farms and only 36 per cent received Soil Health Cards.
- The majority of them were dependent on the officers of Farmers Welfare and Agriculture Development Department (53.75%) for recent information of crop cultivation. Relatives/ neighbour (25.42%), progressive farmers/ krishak mitra (16.25%), Krishi Vigyan Kendra (2.92%) and Kisan Call Centre (1.25%) were found to be other source of information in the area under study.

6.2.3 Yield Gap and Constraints Analysis

- The maximum yield gap between potential and average farm yield was found in cultivation of gram (43.59%) followed by soybean (38.87%) and wheat (29.86%). The yield gap II was found to be more than yield gap I in cultivation of wheat, gram and soybean denotes that the RPP cultivation of these crops have been reached to farmers field, but farmers are could not adopted these technologies due to un-availability of desired variety of seed, high cost of input, lack of knowledge about proper dose of fertilizers as per soil test recommendation, lack of knowledge about method of seed treatment. Low germination of seed of soybean (70%) as reported by majority of soybean was the major constraints identified in the study area. The respondents also reported un-availability of capital, un-availability of electricity and lack of labour during the peak operation in cultivation of these crops.

6.2.4 Determinants of Yield

- A multiple regression model was used to find out determinants yield of major crops and was found to be good fit as it explain more than 80 per cent contribution of

known independent variables. Independent variables like use of high yielding varieties (HYVs) seed, improved method of sowing, seed replacement (purchase seed), consumption of fertilizers as per soil test recommendation, treatment with fungicide and bio-fertilizers (Rhizobium, azotobacter and Phosphate Solubilizing Bacteria), increase educational status, proper seed rate, increase consumption of DAP were found to be positively related to yield of all the major crops. Factors like adoption of soil test recommendation, proper seed rate, seed replacement through purchase seed, consumption of Urea were found to be positive and significant in case of yield of wheat.

- In case of gram cultivation, seed replacement with purchased seed, proper seed rate, use of HYVs seed and increase consumption of urea were found to be positive and significant. While consumption of DAP, area under irrigation, proper seed rate and use of High yielding varieties of seed over local seed were found to be positive and significant in case of yield of soybean. Seed replacement with HYVs seed, soil test recommendation, proper seed rate and increase consumption of a kg of Urea would be able to enhance yield of wheat to 101.89, 135.23, 3.04 and 3.41 kg per acre respectively in cultivators fields, while increase in 1.00 acre size of holding would able to decrease yield of wheat with -4.27 kg per acre in Bundelkhand region of Madhya Pradesh.

- In case of gram independents variables like use of HYVs seed, seed treatment, area under irrigation, increase a kg of Urea and proper seed rate would be able to enhance yield of gram to 154, 106, 63, 35 and 31 kg per acre in cultivators fields respectively in Bundelkhand region of Madhya Pradesh. In case of soybean use of HYVs seed, proper seed rate, increase area under irrigation and one kg increase in DAP per acre would be able to enhance yield of soybean to 81.88, 3.87, 51.07 and 5.74 kg per acre respectively in cultivators fields, while increase in one acre size of holding would able to decrease yield of soybean with 51.07 kg per acre in Bundelkhand region of Madhya Pradesh.

6.3 Policy Recommendations

From the above conclusions it was found that there was more than 30 per cent yield gap between potential and average farm yield of major crops in Bundelkhand Region of Madhya Pradesh. Therefore, following strategies should be formed to reduce the yield gap and enhance the income of the farmers.

- Need based training programme based on RPP of cultivation of crops in the area must be organized for the field staff of the Farmer Welfare and Agriculture Development Department, Madhya Pradesh followed by producers before the start of the season in the nearest KVK. The whole training must be designed in the view of the field staffs and producers of the area which will directly reflect into the productivity of crops.

- One or two demonstration should be organized in a villages should be planned for complete transfer of technology with full package of practices and component wise packages of practices of cultivation of crops in the field of key farmers. If there is a problem or incidence of insects or diseases,

a field day should be organized in front of all the farmers of the Village so that they will learn by seeing, it is for their better and proper understanding of all the package of practices of crop cultivation.

- ❖ Online portal of government on seed distribution needs to be created to show the variety wise and class wise availability of seed with the facility of online purchase/booking, as majority of farmers reported that un-availability of desire variety of seed was found to be major constraint in cultivation of crops.
- ❖ It is also found during the course of investigation that majority of farmers are not adopted need based Integrated Farming System (IFS) in a true sense. Hence, efforts should be made to introduce need based integrated farming system in the area. And, at least one Seed Producer Company, Producer Company, Custom Hiring Centre are required to be established in each and every Gram Panchayat/Development Block of Bundelkhand Region of Madhya Pradesh.
- ❖ It is observed from the study that "Toll Free Number" of the Kisan Call Centre (1800-180-1551) yet not be a come main source of information dissemination for the farmers in the area under study. Hence, strategies should made in a such a way that every farmer should able to use this particular number to solve his problem related to crop and animal husbandry.
- ❖ Technology adoption in agriculture is a long drawn process, which involves developing appropriate need-based technology, testing the new technology, taking it from lab-to-land, and optimum application of it for obtaining the desired benefit for its sustainability. Willingness to adopt the new technology by farmers is a crucial challenge, especially in view of the financial and knowledge constraints of farmers. Moreover, the new technology needs to be integrated with the extent systems and policies for wider acceptability.
- ❖ Digital technology requires uses of computers, internet, mobile technology, application tools, etc. It may not be easy for majority of farmers with their current level of education, exposure and remoteness of their locations. To certain extent, capacity building on the principle of seeing & believing (Demonstration) it to be adopted to motivate farmers to accept technological change in agriculture.

Thus, the yield gap of crops is only be narrowed through enhancing productivity by batter management of available farm resources and proper allocation of funds for purchase inputs. This needs strengthening of knowledge of producers of Bundelkhand Region of Madhya Pradesh through imparting trainings, conducting demonstration, mass media approach through electronic means and information technologies. There is also a need of Public Private Partnership (PPP) for knowledge management, required into supply and procurement of produce at reasonable price, which works as a catalytic agent for increasing adoption of crop production technologies leading to break yield barriers in crop production.

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ANNEXURE-I

COMMENTS AND ACTION TAKEN ON THE REPORT SUBMITTED BY

Agro-Economic Research Centre, Jabalpur, Madhya Pradesh

1. Title of the draft report examined: Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of Madhya Pradesh.

2. Date of receipt of the Draft report: 1st February, 2020

3. Date of dispatch of the comments: 12th February, 2020

4. Title of the draft report: Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of Madhya Pradesh

5. Comments on the Introduction:

   Up to the mark

6. Comments on the Methodology

   Up to the mark

7. Chapter-III- Overview of the Bundelkhand Region of Madhya Pradesh

   a) Table no. 3.11, Inputs used in different districts of Bundelkhand region of Madhya Pradesh was not in original chapter plan Presented by AERC Jabalpur.

   Action: Since this chapter in an overview of Bundelkhand Region of Madhya Pradesh and crop yield depending upon inputs uses therefore, table number 3.11 inputs uses in different district of the Bundelkhand Region of Madhya Pradesh has been included in chapter III.

   b) Table of poultry population is missing. Please check it.

   Action: It has been incorporated in the table

8. Chapter-IV- Socio-Economic Characteristics of the Sample Households

   Up to the mark

9. Chapter-V- Yield gap & Constraints Analysis and Determinants of Yield of Major Crops

   Up to the mark

10. Chapter-VI- Summary, Conclusions and Policy Implications

    Up to the mark

11. Comment on Analysis, Organization and Presentation

    Up to the mark

12. Overall view on acceptability of report

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

Agro Economic Research Centre for Madhya Pradesh & Chattishgarh

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) 482 004

Phone: 0761 - 2680315, Tele-Fax: 0761 - 2680315, E-mail: aerc_jbp@yahoo.co.in, Web: www.aerc.jnkvv.org