

**AERC, Jabalpur - Research Study No. - 130**

**Strategies to Bridge Yield Gap of Major Crops in  
Bundelkhand Region of India  
(Consolidated Report)**

**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**

**June, 2020**

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**AGRO- ECONOMIC RESEARCH CENTRE  
FOR MADHYA PRADESH AND CHHATTISGARH**

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

## PREFACE

The consolidated study entitled “Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India” 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 to Agro- Economic Research Centre, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh.

The consolidated study comprises of 180 (Bundelkhand Region of Madhya Pradesh) and 120 (Bundelkhand Region of Uttar Pradesh) constituting 300 respondents were selected from Bundelkhand Region of India related to the major crops of viz. rice, wheat, gram and soybean. The study reveals that their was found 23.33, 29.48, 43.59 and 38.87 per cent yield gap-III in rice, wheat, gram and soybean respectively, between potential and average farm yield of the farmers. The yield gap II was found to be more than yield gap I in cultivation of rice, wheat, gram and Soybean respectively, denotes that the recommended technologies for cultivation of these crops have been reached to farmers field but farmers could not adopted these technologies due to several socio-economic constraints. The major constraint which was reported by the majority of respondents was found to be high cost of input followed by unavailability of desired variety, of seed, lack of knowledge about method of seed treatment, proper doses of fertilizers, unavailability of capital and lack of labour during peak operational periods across all the regions of Bundelkhand in adoption of recommended technology of wheat cultivation.

On behalf of the Centre, I express deep sense of gratitude to Prof. P.K.Bisen, Hon'ble Vice-Chancellor and Chairman, Advisory Body of AERC, Jabalpur, Shri. P.C. Bodh, Adviser, AER Division, Ministry of Agriculture and Farmers' Welfare, Govt. of India, New Delhi, Dr. D. Khare, Dean, Faculty of Agriculture, Dr. P.K.Mishra, Director Research Services, 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.

The present study was conducted by Dr. H. O. Sharma, Dr. Deepak Rathi and Dr. H. K. Niranjana, 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 hope the findings and suggestions made in the study would be useful to policy makers of the State and Govt. of India.

**Date: 26.06.2020**

**Place: Jabalpur**

**(Hari Om Sharma)**

**Prof. & Director**



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## EXECUTIVE SUMMARY

Improvement in crop yields is essential to meet the increasing demand for food driven by the increasing population and to enhance 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 and covers to both mental acceptance and 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

### 1 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 suggest 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 (36%), rice (18%), soybean (14%) and gram (6%) were considered for analysis of yield gap in Bundelkhand Region of India. Wheat was found to be major crop grown in both the regions, while rice was found to be grown in UP Bundelkhand & soybean (14%) and gram were found to be grown in MP Bundelkhand as major crops other than wheat. Gram occupied only 6 per cent of Gross Cropped Area in Bundelkhand region of India, however, it was considered for the analysis because it was found to be major pulse crop grown in more than 10 per cent of gross cropped area 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 crop. 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%) & Damoh (-4.04%) districts were selected for gram for the study in Bundelkhand region of Madhya Pradesh, While

Lalitpur (-82.47%) & Banda (-24.71%) districts have been selected for rice and Mahoba (-51%) & Jalaun (-0.85%) districts have been selected for wheat for the study in Bundelkhand region of Uttar 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. 30 farmers each from high and low yield gap districts, total 60 farmers were selected for the each selected crops. Thus  $60 \times 3 = 180$  farmers were selected in Bundelkhand Region of Madhya Pradesh and  $60 \times 2 = 120$  farmers were selected in Bundelkhand Region of Uttar Pradesh for the study. In total 300 respondents were selected in the area under study from Bundelkhand Region of India

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 India:-

#### 3.1 Overview of Bundelkhand

- The Bundelkhand region of India occupies 70,765 square kilometer area, out of which 58% was covered by Madhya Pradesh Bundelkhand and 42% by Uttar Pradesh Bundelkhand regions. There were 14 districts (7 each in MP & UP) having 76 tehsils (50 in MP & 26 in UP), 5043 gram Panchayats (2164 in MP & 2879 in UP) and 11526 villages (6285 in MP & 5241 in UP) in Bundelkhand region of India. The population density of Bundelkhand region of India was found to be 269 persons/sq.km (209 in MP & 329 in UP).
- The total population of Bundelkhand region of India was found to be 183.35 lakhs, out of which, 53.05 and 46.95 per cent were found to be male and female, respectively. The population of rural (77.58%) was found to be more as compared to urban (22.42%) population with only 15.2% of children. The region was found to be dominated by Hindus followed by Muslims and other religions. An average literacy rate of the region was found to be 64%, which was more in male (73%) as compared to female (53%) population. The sex and child sex ratio was found to be 886 and 897 over 1000 male in the region.
- The total geographical area of Bundelkhand

region of Madhya Pradesh, Uttar Pradesh and India was found to be 41.28, 29.62 and 70.90 lakh ha, respectively. Out of total geographical area in Bundelkhand region of India 57.43, 20.06, 10.99, 7.01 and 4.65 percent was found to be net area sown, area covered under forest, land not available for cultivation, other uncultivated land excluding fallow land and fallow land, respectively.

- The net irrigated area in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 13.44, 13.70 and 27.14 lakh hectares. Amongst different sources of irrigation, well (41.84%) followed by tube Wells (19.22%), canals (15.30%) and tanks, (3.09%) in Madhya Pradesh Bundelkhand and canals (34.76%) followed by tube Wells (32.85%), wells (23.37%) and tanks (7.44%) in Uttar Pradesh Bundelkhand found to be sources of irrigation. The net irrigated area was found to be 49.5 and 50.5 Madhya Pradesh and Uttar Pradesh Bundelkhand region respectively.
- The cropping pattern of Bundelkhand region was found to be dominated during Rabi in Madhya Pradesh (57.92%), Uttar Pradesh (60.20%) and in the country (59.02%) as compared to 42.08, 39.8 and 40.98 per cent in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively. Gross cropped area of Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 32.86, 30.55 and 31.70 lakh ha with cropping

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intensity of 164, 141 and 152.5, respectively. Wheat (27.46%) followed by gram (12.31%), soybean (8.45%), rice (4.09%) and sesame (2.66%) were found to be major crops grown in Bundelkhand region of India.

- The total consumption of fertilizers in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India were found to be 3148, 521324 and 552 805 tons per year. Out of total fertilizer consumed in Bundelkhand region in India, only 6 per cent was found to be consumed Madhya Pradesh Bundelkhand, while 94 per cent by Uttar Pradesh Bundelkhand. The maximum fertilizer consumed in Bundelkhand Region of India was found to be Urea (55.45%) followed by DAP (30.00%), Complex (11.57%), SSP (2.74%) and SSP (0.23%), respectively.
- The number of different grades of regulated markets in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India were found to be 38, 58 and 96. The proportion of D, B, C & A grades regulated markets were found to be 52.63, 26.32, 13.16 & 7.89 per cent in Madhya Pradesh Bundelkhand, 46.55, 17.24, 20.69 & 15.52 per cent in Uttar Pradesh Bundelkhand and 48.96, 20.83, 17.71 & 12.50 in Bundelkhand region of India.
- The total number of land holdings in Bundelkhand region of Madhya Pradesh Uttar Pradesh and India were found to be 1291038, 1486001 and 2777039, respectively. The proportion of small and

marginal farmers was found to be around 75%, semi medium around 15%, medium around 8% and large around 1% across Bundelkhand regions of Madhya Pradesh, Uttar Pradesh and India

- The total area under different size of holdings in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India were found to be 24. 39, 21.25 and 45.64 lac hectares, respectively. Out of total area occupied by different size of holdings, the area occupied under marginal & small size of land holdings was found to be 38 and 25 per cent under semi-medium, around 30 per cent under medium and 8 percent under large categories.
- The working population in Bundelkhand region of India was found to be 1799 1426, out of which 48. 10 and 51.90 were found to be residents of Bundelkhand region of MP and UP, respectively. Bundelkhand region of MP, UP and India have more number of non-workers (56.77, 62.68 & 59.84 per cent) as compared to man (31.40, 24.92 & 28.03 per cent) and marginal (11.83, 12.40 & 12.12 per cent) workers. Out of main and marginal workers, majority of them were found to be agricultural labourers (36%) followed by cultivators (34%), other works (24%) and workers in household industry (6%).
- The total number of plough, bullock carts, electric pumps, diesel pumps, tractors and sugarcane cutter in Bundelkhand region of India were found to be 743460, 253680, 270584, 272517, 121685 and 2347.

- The total number of livestock in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 4934833, 3657154 and 8591987, respectively. Among different livestock the population of cow (36.53%) was found to be more as compared to goat (29%), buffaloes (28.74%) and sheep & pig (2.9% each). The population of cow buffaloes and pig was found to be more in MP Bundelkhand (41.62, 33.69 and 2.87 %) as compared to UP Bundelkhand (29.67, 22.07 and 2.77%), while population of goat and sheep was found to be less in MP Bundelkhand (19.89 & 1.94 %) as compared to UP Bundelkhand (41.29 & 4.21%).
- ### 3.2 Socio-economic Characteristics
- The average age of the respondents in Bundelkhand region of MP, UP and India were found to be 49, 55 and 52 years having 33, 38 and 36 years of experience in farming at overall level. Out of total respondents the majority was found to be below the age of 45 years.
  - The average family size of respondents were found to be 7, 8 & 8, out of which 3 members were found to be engaged in farming in Bundelkhand region of MP, UP and India, respectively.
  - The majority of respondents in Bundelkhand region of MP, UP and India at overall level were found to be educated upto primary level (27.88, 21.67 & 25.33 %) followed by higher secondary, (20.56, 17.50 & 19.33%), matriculation (16.67, 12.50 & 15 %), graduate (11.67, 12.50 & 12%), post graduate (4.44, 9.17 & 6.33%) and above (2.22, 5.83 ,& 3.67%). The illiterate respondents were found to be 16.67, 20.83 & 18.33 per cent respectively.
  - The majority of the respondents of Bundelkhand region of Madhya Pradesh Madhya Pradesh, Uttar Pradesh and India at overall level were found to be belong to OBC (70, 46.67 & 60.67%) followed by general (14.44, 44.17 & 26.33 %) schedule caste (12.78, 9.17 & 11.33%) and scheduled Tribes (2.78, 0.00 & 1.67 %). The proportion of OBC and general was found to be more as compared to SC and ST population in Bundelkhand region of India.
  - All of them were found to be engaged in farming and allied activities as the main source or for their livelihood security. At overall level, 22 per cent respondents were found to be engaged as agricultural labourers, 21 percent as livestock labourers and 10 per cent as non-agricultural labourers.
  - On an average annual farm income in case of medium (Rs. 65357/-) in Bundelkhand region of Madhya Pradesh, large in UP (Rs. 101029/-) and India (Rs. 82045/-) was found to be more as compared to other categories in the region. The main source of income was found to be agriculture across all the categories and regions which ranged between 71 (MP) to 75 (UP) per cent at overall level and ranged between 70.72 to 79.01 per cent across all the categories and regions. The annual average income was found to be Rs.62491, 90069 and 76730 in



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- Bundelkhand region of Madhya Pradesh Uttar Pradesh and India, respectively, out of which 71.36, 75.68 and 73.92 per cent was found to be received from agriculture and 28.64, 24.32 and 26.08 percent from other sources, respectively.
- The value of land was found to vary between Rs.434673/- (small) to Rs. 700220/- (large), Rs. 395938/- (Medium) to Rs. 412875/- (large) and Rs. 422774/- (small) to Rs. 556548 (large) per hectare with average of Rs. 558361/-, Rs.406563/- and Rs. 482462/- per hectare at overall level in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India. 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 only.
  - At overall level an average respondent was found to have 10.67, 8.57 and 9.62 acres of cultivated land with 0.77 & 0.13, 0.33 & 0.28 and 0.55 & 0.20 was leased-in/out land in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively, with 0.21 acres of uncultivated land, current fallow (0.06, 0.08 & 0.07) and old fallow (0.03, 0.01 & 0.02) constituting net operating area of 11.02, 8.33 and 9.67 acres. Out of net operated area 74, 84 & 78.5 per cent was found to be irrigated. An average operational holding of small (3.66, 3.15 & 3.40), medium (8.29, 7.45 & 7.87) and large (21.11, 14.38 & 17.74) respondents was found in Bundelkhand region of MP, UP and India.
  - At overall level open dug well (47.22%) followed by bore well (36.67%), canal (8.34%), pond (4.44%) and river (3.33%) in MP; tube-well (60.83%) followed by well (23.33%) canal (10 %) and river (4.27%) in UP and tube-well (46.33%) followed by well (37.67%), canal (9%) and river (3.67%) in Bundelkhand region of India were found to be major sources of irrigation in the area under study with minor variation across various size of holdings.
  - At overall level an average HH used to allocate maximum area in kharif (53.82%) as compared to rabi (48.14%) season out of gross cropped area (18.84 acres). In kharif season, an average farmer was found to allocate maximum area in rice (29.58%) followed by soybean (20.78%), urd (19.14%), sesam (18.01%) and moong (4.4%) and others (7.99%) in Bundelkhand region of India.
  - In rabi season, wheat was found to be dominated crop in which an average HH allocate 63.40 per cent area of total rabi season. Gram and lentil were found to be other major Rabi crops in which an average HH allocates 22.27 and 5.51 per cent of total Rabi season area respectively. The cropping intensity was found to be 190 per cent which ranged between large (186%) to small (196%) across various size of land holdings.
  - The soil of the farms was found to be tested by 43, 55 and 48 per cent respondents and 36, 34 and 35 per cent respondents reported to receive soil health card in Bundelkhand region of Madhya Pradesh, Uttar Pradesh

and India, respectively.

- The major source of information was found to be agriculture department as reported by 53, 63 and 57 per cent respondents in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively. Relatives and neighbours (25.56%), progressive farmers / krishak Mitra (16.11%) in MP Bundelkhand; progressive farmers /krishak Mitra (18.33%), relatives/ neighbours (12.5%) UP Bundelkhand and relatives/ neighbours (20.33%) and progressive farmers/ krishak Mitra (17%) in India were found to be other sources of information.

### 3.3 Yield Gap and Constraints Analysis

- A considerable yield gap III 6.87 (29.87%), 6.7 (29.13%) and 6.7 (29.48%) q/acre between potential (23q/acre) and average yield (16.13, 16.30 and 16.22 q/acre) was found on an average wheat growers' farm in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively. Out of this total yield gap (yield gap III), a gap of 11.68, 12.61 and 12.13 per cent (yield gap I) was found between potential (23 q/acre) and highest farm yield (20.31, 20.1 and 20.21 q/acre) while 20.58, 18.91 and 19.74 per cent (yield gap II) between highest (21.31, 20.1 and 20.21 q/acre) and average farm yield (16.13, 16.30 and 16.22 q/acre) in Bundelkhand region of MP, UP and India, respectively.
- The various constraints faced by the respondents in cultivation of wheat. The major constraint which was reported by

about 80 to 90% of respondents was found to be high cost of input, about 70% respondents reported that due to unavailability of desired variety of seed, lack of knowledge about method of seed treatment and proper doses of fertilizers, while around 50 per cent reported that due to unavailability of capital and lack of labour during peak operational periods across all the regions of Bundelkhand in adoption of recommended technology of wheat cultivation

- The 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
- 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.
- The 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.

- 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.
- A considerable yield gap (III) of 41.88 per cent was found between potential (28 q/acre) and average farm yield (16.3 q/acre) was found on an average rice grower's farm in production of rice. Out of this total yield gap (yield gap-III), a gap of 24.15 (yield gap-I), and 23.33 per cent (yield gap-II) was found between potential (28 q/acre) & highest farm yield (21.2 q/acre), and between the highest & average farm yield (16.3 q/acre) respectively.
- The yield gap was found due to various constraints faced by the respondents in cultivation of rice. Lack of suitable machinery for cultivation practices of crop (98.49%), high cost of input (93.33%), un-availability of desired variety of HYVs seed

(74.50%), un-availability of capital for purchase of inputs (63.77%), Lack of knowledge about proper dose of fertilizer application (58.59%) and lack of knowledge about method of seed treatment (51.16%) were found to be major constraints as reported by more than 50 per cent of respondents in adoption of recommended package of farming system.

### 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 about 85 per cent contribution of known independent variables. Independent variables like use of high yielding varieties (HYVs) seed, improved method of sowing (rice), source of seed (rice & wheat), seed rate (soybean & gram), use of DAP (soybean & wheat) application of Urea (wheat) treatment with fungicide and bio-fertilizers in rice and gram (Rhizobium, azotobacter and Phosphate Solubilizing Bacteria), irrigation (wheat, soybean and gram) soil testing (rice and wheat) were found to be positive and significant, while area under irrigation (rice), size of land holding (soybean and wheat) and seed rate (wheat) were found to be negative and significant. This indicates that with the increase in the factors which are positive and significant the yield of crop will increase and vice-versa.

### 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 India. 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, Bundelkhand Region of India followed by producers before the start of the season in the nearest KVK. The whole training must be designed keeping in the view the field staffs and producers of the area which will directly reflect into the productivity of crops.
  - ❖ One or two demonstration should be conducted in villages keeping in view the complete transfer of technology with full package of practices should be planned along with 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 be able to learn by seeing 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 desired variety seed was found to be major constraint in cultivation of crops.
  - ❖ It is also found during the course of investigation that majority of farmers did 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 India for fostering the all round growth of the region in true sense.
  - ❖ It is observed from the study that “Toll Free Number” of the Kisan Call Centre (1800-180-1551) was not reported by the respondents as main source of information dissemination for the farmers in the area under study. Hence, strategies should be made in such a way that every farmer should be 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

## Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India

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) is to be adopted to motivate farmers to accept technological change in agriculture.

Thus, the yield gap of crops can only be narrowed down through enhancing productivity by better management of

available farm resources and proper allocation of funds for purchase of inputs. This needs to strengthen of procedural knowledge of through imparting training, conducting demonstration, mass media approach through electronic means and information technologies in Bundelkhand Region of India. 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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## **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,

## Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India

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. Bundelkhand has lost its forest cover to a large extent, 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 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.

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 rice and wheat were found to be lower in Bundelkhand region of Madhya Pradesh as compared to Bundelkhand region of Uttar Pradesh and India, while average yield of gram and soybean were found to be also lower in Bundelkhand region of Madhya Pradesh as compared to Bundelkhand region of India (Table 1.1).

**Table 1.1 :Average yield of major crops in Bundelkhand region of India (q/acre)**

Particulars	Rice	Wheat	Gram	Soybean
Bundelkhand Region of Madhya Pradesh	4.1	8.5	4.2	3.1
Bundelkhand Region of Uttar Pradesh	6.46	10.92	-	-
Bundelkhand region of India	10.4	13.8	4.6	4.3

Source: Directorate of Economics and Statistics -2015-16

It seems that the farmers could not be able to adopt the recommended package of practices for cultivation of 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 been under taken in Bundelkhand region of india with following specific objectives.

### 1.2 Objectives of the Study

- To identify various socio-economic characteristics of farmers across size of holdings.
- To analyze yield gap of major crops grown by the cultivators across size of holdings.

- To determine factors affecting productivity of major crops.
- To identify various socio-economic, technological constraints in adoption of recommended package of practices in crop cultivation.
- 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. Socio-

economic characteristics of the sample respondent is presented in Chapter-IV, Yield gap and constraints analysis with determinants on yield of major crops in Bundelkhand Region of India is described in Chapter V, Summary, Conclusion and Policy Implication have been dealt in chapter VI followed by References.

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## 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. 3.1). Therefore, wheat (36%), rice (18%), soybean (14%) and gram (6%) were considered for analysis of yield

gap in Bundelkhand Region of India. Wheat was found to be major crop grown in both the regions, while rice was found to be grown in UP Bundelkhand and soybean (14%) & gram were found to be grown in MP Bundelkhand as major crops other than wheat. Gram occupied only 6 per cent of Gross Cropped Area in Bundelkhand region of India, however, it was considered for the analysis because it was found to be major pulse crop grown in more than 10 per cent of gross cropped area in Bundelkhand region of Madhya Pradesh.

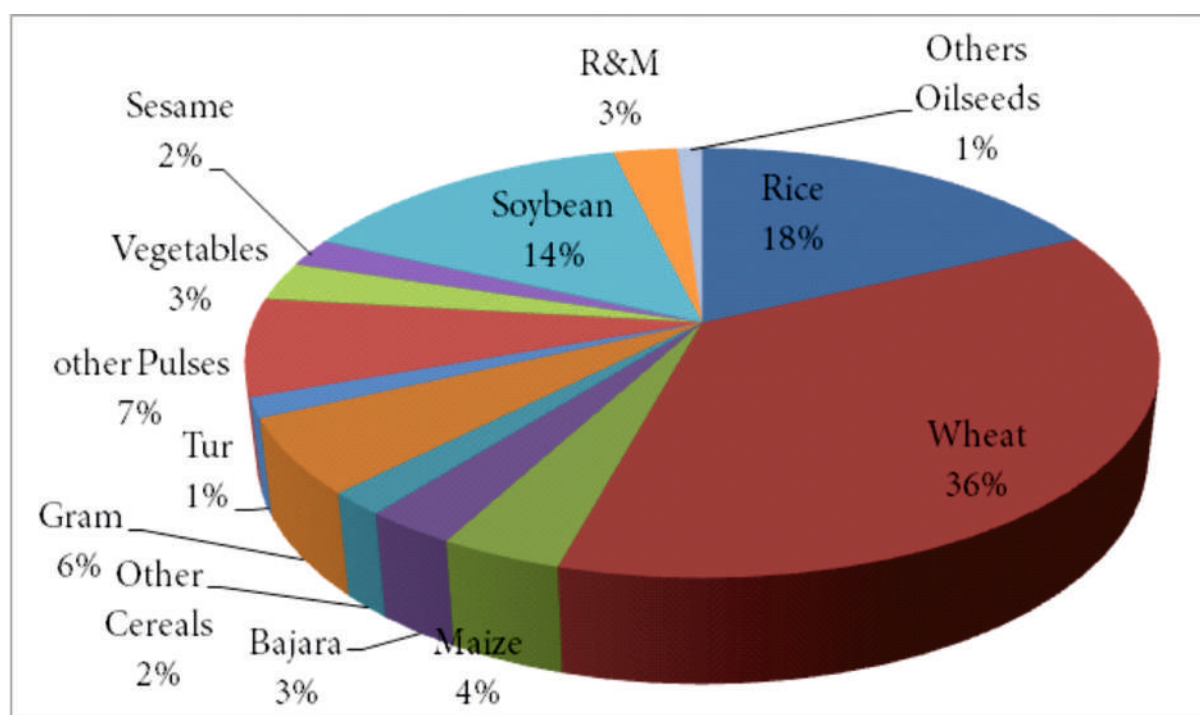


Fig.3.1 :Percentage share of different crops in Gross Cropped Area (49783573ha) of Bundelkhand Region of India

### 2.2 Selection of Districts

All the districts of Bundelkhand region of India 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

## Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India

Table 2.1 : High & Low Yield gap Districts of major crops in Bundelkhand region of 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
<b>Madhya Pradesh</b>	<b>31.15</b>	<b>11.15</b>	<b>7.53</b>
<b>Percentage difference to Madhya Pradesh (%)</b>			
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	

(-19.79%) districts have been selected for soybean, while Panna (-43.88%) & Datia (-4.78%) districts have been selected for wheat and Chhatarpur (-23.05%) & Damoh (-4.04%) districts were selected for gram in Bundelkhand

region of Madhya Pradesh. While Lalitpur (-82.47%) & Banda (-24.71%) districts have been selected for rice and Mahoba (-51%) & Jalaun (-0.85%) districts have been selected for wheat for the study in Bundelkhand region of Uttar Pradesh (Table 2.1 & 2.2).

Table 2.2 : High & Low Yield gap Districts of major crops in Bundelkhand region of Uttar Pradesh (TE 2016-17) (Unit :q/ha)

Name of Districts	Rice	Wheat
Jhansi	17.07	26.33
Lalitpur	4.59	27.80
Jalaun	12.64	36.24
Hamirpur	19.58	31.30
Mahoba	19.58	17.91
Banda	19.71	22.88
Chitrakut	18.80	26.40
<b>Uttar Pradesh</b>	<b>26.18</b>	<b>36.55</b>
<b>Percentage difference to Uttar Pradesh</b>		
Jhansi	-34.80	-27.96
Lalitpur	-82.47	-23.94
Jalaun	-51.72	-0.85
Hamirpur	-25.21	-14.36
Mahoba	-25.21	-51.00
Banda	-24.71	-37.40
Chitrakut	-38.19	-27.77

Table 2.3 :Number of Selected Farmers from various locations of Bundelkhand Region of India

Name of Selected Crops	Size of Farms	High Yield Gap District	Low Yield Gap District	Total
<b>Madhya Pradesh</b>				
<b>Wheat</b>	Small	10	10	20
	Medium	10	10	20
	Large	10	10	20
	<b>Total</b>	<b>30</b>	<b>30</b>	<b>60</b>
<b>Gram</b>	Small	10	10	20
	Medium	10	10	20
	Large	10	10	20
	<b>Total</b>	<b>30</b>	<b>30</b>	<b>60</b>
<b>Soybean</b>	Small	10	10	20
	Medium	10	10	20
	Large	10	10	20
	<b>Total</b>	<b>30</b>	<b>30</b>	<b>60</b>
<b>Sub Total of Madhya Pradesh</b>		<b>90</b>	<b>90</b>	<b>180</b>
<b>Uttar Pradesh</b>				
<b>Wheat</b>	Small	10	10	20
	Medium	10	10	20
	Large	10	10	20
	<b>Total</b>	<b>30</b>	<b>30</b>	<b>60</b>
<b>Rice</b>	Small	10	10	20
	Medium	10	10	20
	Large	10	10	20
	<b>Total</b>	<b>30</b>	<b>30</b>	<b>60</b>
<b>Sub Total of Uttar Pradesh</b>		<b>60</b>	<b>60</b>	<b>120</b>
<b>Grand Total</b>		<b>150</b>	<b>150</b>	<b>300</b>

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. 30 farmers each from high and low yield gap districts, total 60 farmers were selected for the each selected crops. Thus  $60 \times 3 = 180$  farmers were selected in Bundelkhand Region of Madhya Pradesh and  $60 \times 2 = 120$  farmers were selected in Bundelkhand Region of Uttar Pradesh for the study. In total 300 respondents were selected in the area under study from Bundelkhand Region of India (Table 2.3).

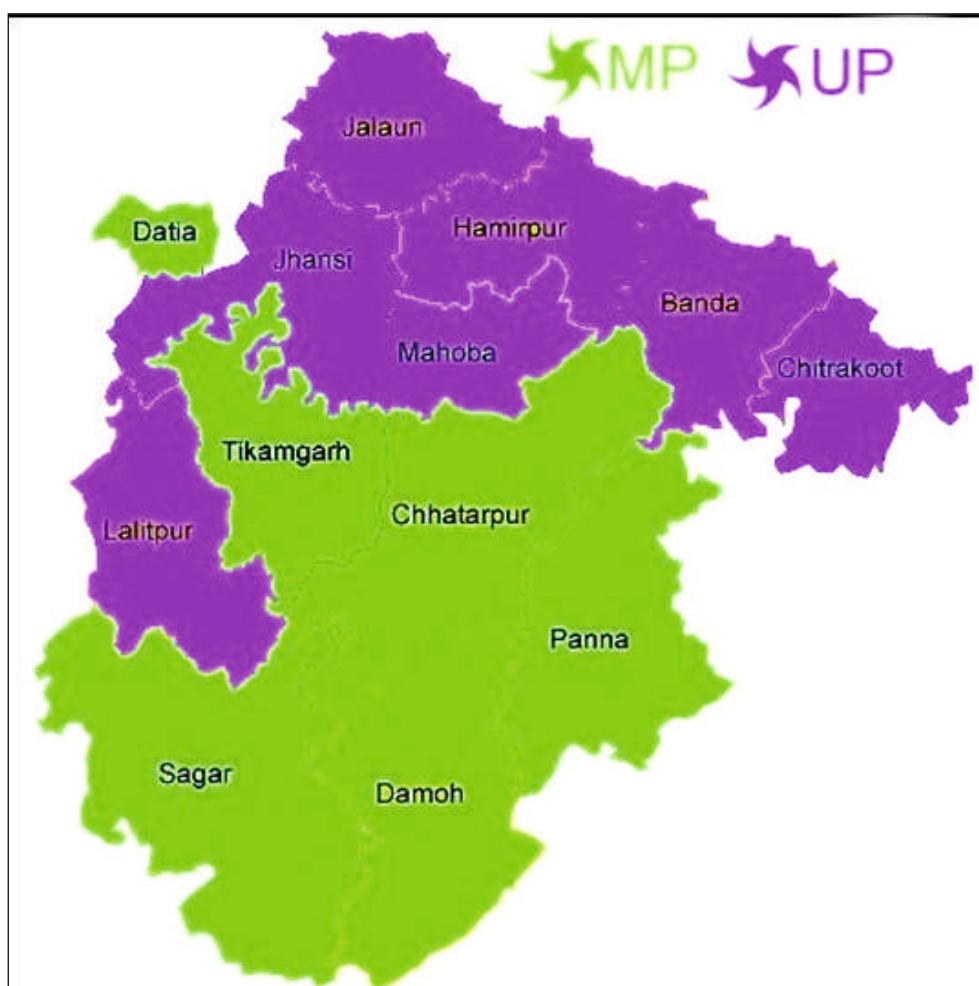


Fig. 2.2 : Map of Bundelkhand Region of India

### 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 & Datia and Jalaun, Jhansi, Hamirpur, Mahoba, Lalitpur, Banda & Chitrakoot, Department of Farmers' Welfare and Agricultural Development, Govt. of Madhya Pradesh and Uttar 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 used, 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.

### 2.5 Analysis of Data

Analysis of data was done with descriptive statistical tools i.e. mean, percentage etc. 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)

X1 = Education (in numbers)

X2 = Age in years

X3 = Source of Seed (Purchase-1, Self-0)

X4 = Soil Test (Yes-1, No-0)

X5 = Seed Rate (Kg/acre)

X6 = Seed Treatment (Yes-1, No-0)

X7 = High Yielding Varieties (HYVs-1, Local-0)

X8 = Urea (kg/acre)

X9 = DAP (kg/acre)

X10 = No. of Irrigation (acre)

X11 = Size of Holding (acre)

X12 = Method of Sowing (Line sowing=1 & Broadcasting=0)

b1 to b12 = regression coefficient of X1, X2, ..... X12

E = Error term



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

## 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 ( $Y_p$ ) & the highest farm yield ( $Y_h$ ). This yield gap exist due to difference in soil & climatic condition and non-transfer of recommended technologies to the farmer's field

$$\text{Yield Gap-I} = (Y_p - Y_h) / Y_p \times 100$$

**Yield gap – II** - It is the difference between the highest farm yield ( $Y_h$ ) & the average farm yield ( $Y_a$ ). Yield gap-II, denotes about socio-economic and technological constraints exist in the area.

$$\text{Yield Gap-II} = (Y_h - Y_a) / Y_h \times 100$$

**Yield gap – III** - It is the difference between the potential farm yield ( $Y_p$ ) & the average farm yield ( $Y_a$ ). 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.

$$\text{Yield Gap-III} = (Y_p - Y_a) / Y_p \times 100$$

**Where:**  $Y_p$  = Potential farm yield,

$Y_h$  = Highest farm yield

$Y_a$  = 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 has not 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 and Jalaun, Jhansi, Hamirpur, Mahoba, Lalitpur, Banda and Chitrakoot districts of Bundelkhand Region of Uttar Pradesh.

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## CHAPTER - III

### OVERVIEW OF THE BUNDELKHAND REGION OF INDIA

This chapter deals with the profile of the Bundelkhand region of India which includes geographical information, population parameters, land use pattern, source wise area under irrigation, cropping pattern, consumption of fertilizers, different grades of regulated markets, number and area of holdings, working population, machinery & implements and livestock population.

#### 3.1 Geographical Information of Bundelkhand Region of India

Bundelkhand region of India occupies 70,765 square kilometer area, out of which 58% was covered by Madhya Pradesh Bundelkhand and 42% by Uttar Pradesh Bundelkhand regions.

There were 14 districts having 76 tehsils, 5043 gram Panchayats and 11526 villages in Bundelkhand region of India. The number of districts were found to be same i.e. 7 in Madhya Pradesh as well as Uttar Pradesh Bundelkhand while tehsils and villages were found to be more in MP Bundelkhand (50 and 6285) as compared to Uttar Pradesh Bundelkhand (26 and 5241), while gram Panchayats were found to be more in case of Uttar Pradesh Bundelkhand (2879) as compared to Madhya Pradesh Bundelkhand (2164). The population density of Bundelkhand region of India was found to be 269 persons/sq.km, which was higher in Uttar Pradesh Bundelkhand (329) as compared to Madhya Pradesh Bundelkhand (209).(Table 3.1)

Table 3.1 :Geographical indicators of Bundelkhand Region of India

Particulars	Bundelkhand Region of MP	Bundelkhand Region of UP	Bundelkhand Region of India
Area(In sq. kms)	41330	29435	70765
No. of Districts (including Niwari)	7	7	14
No. of Tehsils	50	26	76
No. of Villages	6285	5241	11526
Gram Panchayats	2164	2879	5043
Density of Population (Person/sq. km)	209	329	269

Sources: Districts census book -2011

#### 3.2 Population Parameter

The population of male, female and child, rural and urban, various caste

composition including literacy percentage, sex ratio and child sex ratio are presented in this section.



## Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India

**Table 3.2 :Population parameters of Bundelkhand Region of India**

Particulars	Bundelkhand Region of MP	Bundelkhand Region of UP	Bundelkhand Region of India
<b>Population</b>	8653492	9681552	18335044
Male	4568243	5158031	9726274
Female	4085249	4523521	8608770
Rural	6737939	7486474	14224413
Urban	1915553	2195078	4110631
Child Population	1332963	1457342	2790305
Scheduled Tribes	715625	77965	793590
Scheduled Castes	1923144	2387808	4310952
Hindu	8167551	7402700	15570251
Muslim	329637	570545	900182
Others	156304	69373	225677
Literacy (%)	69	59	64
Male	78	68	73
Female	58	48	53
Sex Ratio(Over 1000)	894	877	886
Child Sex Ratio(Over 1000)	903	891	897
<b>Percentage to Total Population</b>			
Male	52.79	53.28	53.05
Female	47.21	46.72	46.95
Rural	77.86	77.33	77.58
Urban	22.14	22.67	22.42
Child Population	15.40	15.05	15.22
Scheduled Tribes	8.27	0.81	4.33
Scheduled Castes	22.22	24.66	23.51
Hindu	94.38	76.46	84.92
Muslim	3.81	5.89	4.91
Others	1.81	0.72	1.23
<b>Percentage to Bundelkhand Region of India</b>			
Male	47.20	52.80	100.00
Female	46.97	53.03	100.00
Rural	47.45	52.55	100.00
Urban	47.37	52.63	100.00
Child Population	46.60	53.40	100.00
Scheduled Tribes	47.77	52.23	100.00
Scheduled Castes	90.18	9.82	100.00
Hindu	44.61	55.39	100.00
Muslim	52.46	47.54	100.00
Others	36.62	63.38	100.00

Sources: Districts census book -2011

The total population of Bundelkhand region of India was found to be 183.35 lakhs, out of which, 53.05 and 46.95 per cent were found to be male and female, respectively. The population of rural (77.58%) was found to be more as compared to urban (22.42%) population with only 15.2% of children. The region was found to be dominated by Hindus followed by Muslims and other religions.

An average literacy rate of the region was found to be 64%, which was more in male (73%) as compared to female (53%) population. The sex and child sex ratio was found to be 886 and 897 over 1000 male in the region. The population parameters were found to be more or less similar in both the regions while proportion of ST population was found to be more in Madhya Pradesh Bundelkhand (8.27%) as compared to Uttar Pradesh Bundelkhand (0.81%). The proportion of male female rural-urban child schedule tribe Hindu and other population was found to be more in case of Uttar Pradesh Bundelkhand as compared to Madhya Pradesh Bundelkhand while schedule cast were found to be more in case of Madhya Pradesh Bundelkhand (90.18%) as compared to Uttar Pradesh Bundelkhand (9.82%) (Table 3.2).

### 3.3 Land Use Pattern

The total geographical area, area covered under forest, not available for

cultivation, other uncultivated land excluding fallow land and net sown area in Bundelkhand region of Madhya Pradesh Uttar Pradesh and India along with their percentage to total geographical area and percentage to Bundelkhand region of India are presented in this section.

The total geographical area of Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 41.28, 29.62 and 70.90 lakh ha, respectively. Out of total geographical area in Bundelkhand region of India 57.43, 20.06, 10.99, 7.01 and 4.65 percent was found to be net area sown, area covered under forest, land not available for cultivation, other uncultivated land excluding fallow land and fallow land, respectively.

Out of total geographical area of Madhya Pradesh and Uttar Pradesh Bundelkhand, net area sown, land not available for cultivation and fallow land were found to be more in Uttar Pradesh Bundelkhand (69.82%, 12.56% and 5.16%) as compared to Madhya Pradesh Bundelkhand (48.54%, 9.86% and 4.29%), area covered under forest and other uncultivated land excluding fallow land was found to be more in Madhya Pradesh Bundelkhand (28.55% and 8.76%) as compared to Uttar Pradesh Bundelkhand (8.24% and 4.56%). The geographical area was found to be higher in Madhya Pradesh Bundelkhand

Table 3.3 :Land use pattern in Bundelkhand Region of India (ha)

Particulars	Bundelkhand	Bundelkhand	Bundelkhand
	Region of MP	Region of UP	Region of India
Geographical Area (ha)	4128477	2961692	7090169
Forest	1178618	243909	1422527
Not Available for Cultivation	407037	371908	778945
Other Uncultivated Land Excluding Fallow Land	361807	135166	496973
Fallow Land	177041	152724	329765
Net Area Sown	2003974	2067967	4071941
<b>Percentage to Total Geographical Area</b>			
Geographical Area (ha)	100	100	100
Forest	28.55	8.24	20.06
Not Available for Cultivation	9.86	12.56	10.99
Other Uncultivated Land Excluding Fallow Land	8.76	4.56	7.01
Fallow Land	4.29	5.16	4.65
Net Area Sown	48.54	69.82	57.43
<b>Percentage to Bundelkhand Region of India</b>			
Geographical Area (ha)	58.23	41.77	100
Forest	82.85	17.15	100
Not Available for Cultivation	52.25	47.75	100
Other Uncultivated Land Excluding Fallow Land	72.80	27.20	100
Fallow Land	53.69	46.31	100
Net Area Sown	49.21	50.79	100

Sources: Directorate of Economics and Statistics -2015-16

(58.23%) as compared to Uttar Pradesh Bundelkhand (41.77%) in Bundelkhand region of India covered under forest was found to be five times higher in Madhya Pradesh as compared to Uttar Pradesh Bundelkhand, other uncultivated land excluding fallow land was found to be almost three times higher in Madhya Pradesh Bundelkhand as compared to Uttar Pradesh Bundelkhand. The fallow land and area available for cultivation were also

found to be higher in case of Madhya Pradesh Bundelkhand as compared to Uttar Pradesh Bundelkhand while net area sown was found to be almost same across both (Madhya Pradesh & Uttar Pradesh) the regions i.e. 50 per cent of Bundelkhand region of India (Table 3.3)

### 3.4 Irrigation Potential

The net irrigated area and area irrigated from various sources across Bundelkhand region of Madhya Pradesh & Uttar Pradesh and

Table 3.4 :Source wise area under irrigation in Bundelkhand Region of India

Particulars	Bundelkhand Region of MP	Bundelkhand Region of UP	Bundelkhand Region of India
<b>Area in ha</b>			
Canal	205510	476375	681885
Tank	41460	101961	143421
Tube -well	258219	450272	708491
Well	562128	320282	882410
Other Sources	276275	21772	298047
<b>Net Irrigated Area</b>	<b>1343592</b>	<b>1370662</b>	<b>2714254</b>
<b>Percentage to Net Irrigated Area</b>			
Canal	15.30	34.76	25.12
Tank	3.09	7.44	5.28
Tube -well	19.22	32.85	26.10
Well	41.84	23.37	32.51
Other Sources	20.56	1.59	10.98
<b>Net Irrigated Area</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b>Percentage to Bundelkhand Region of India</b>			
Canal	30.14	69.86	100
Tank	28.91	71.09	100
Tube -well	36.45	63.55	100
Well	63.7	36.3	100
Other Sources	92.7	7.3	100
<b>Net Irrigated Area</b>	<b>49.5</b>	<b>50.5</b>	<b>100</b>

Sources: Directorate of Economics and Statistics -2015-16

at overall level in Bundelkhand region of the country along with percent irrigated area from various sources within the region and across the region are presented in this head.

The net irrigated area in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 13.44, 13.71 and 27.14 lakh hectares. Amongst different sources of irrigation, well (41.84%) followed by tube Wells (19.22%), canals (15.30%) and tanks, (3.09%) in

Madhya Pradesh Bundelkhand and canals (34.76%) followed by tube Wells (32.85%), wells (23.37%) and tanks (7.44%) in Uttar Pradesh Bundelkhand found to be sources of irrigation.

The well and tube well in Madhya Pradesh Bundelkhand and canal and tube wells in Uttar Pradesh Bundelkhand were found to be major sources of irrigation. In Bundelkhand region of India the major area was found to be irrigated by tanks, canals and tube Well in Uttar

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Pradesh Bundelkhand while it was found to be irrigated by well and other sources in Madhya Pradesh Bundelkhand. The net irrigated area was found to be 49.5 and 50.5 Madhya Pradesh and Uttar Pradesh Bundelkhand region respectively (Table 3.4).

### 3.5 Cropping Pattern

The cropping pattern across Madhya Pradesh and Uttar Pradesh Bundelkhand region and at overall level in the country along with gross cropped area and cropping intensity is

presented in table 3.5.

The cropping pattern of Bundelkhand region was found to be dominated during Rabi in Madhya Pradesh (57.92%), Uttar Pradesh (60.20%) and in the country (59.02%) as compared to 42.08, 39.8 and 40.98 per cent in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively.

Gross cropped area of Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 32.86, 30.55 and 31.70

**Table 3.5 : Cropping pattern in Bundelkhand Region of India(ha)**

Particulars	Bundelkhand Region of MP	Bundelkhand Region of UP	Bundelkhand Region of India
Rice	187808 (5.72)	71268 (2.33)	129538 (4.09)
Soyabean	535706 (16.30)	0 (0)	267853 (8.45)
Groundnut	39856 (1.21)	0 (0)	19928 (0.63)
Sesame	168667 (5.13)	0 (0)	84334 (2.66)
Kharif pulses (Barley)	321274 (9.78)	1026474 (33.6)	673874 (21.26)
Other Kharif area	129480 (3.94)	118046 (3.86)	123763 (3.9)
<b>Total Kharif</b>	<b>1382791 (42.08)</b>	<b>1215788 (39.8)</b>	<b>1299290 (40.98)</b>
Wheat	908366 (27.64)	832889 (27.27)	870628 (27.46)
Gram	461484 (14.04)	318936 (10.44)	390210 (12.31)
Arhar(Tur)	64090 (1.95)	56336 (1.84)	60213 (1.9)
Rabi Pulses	356631 (10.85)	183566 (6.01)	270099 (8.52)
Rapeseed and Mustard	64692 (1.97)	0 (0)	32346 (1.02)
Other Rabi crops	47962 (1.46)	447187 (14.64)	247575 (7.81)
<b>Total Rabi</b>	<b>1903225 (57.92)</b>	<b>1838914 (60.2)</b>	<b>1871070 (59.02)</b>
Gross Cropped Area (GCA)	3286016 (100)	3054702 (100)	3170359 (100)
Cropping Intensity (%)	164	141	152.5

Figures in parenthesis shows percentage to total GCA

lakh ha with cropping intensity of 164, 141 and 152.5 per cent, respectively. Wheat (27.64%) followed by soybean (16.30%), gram (14.04%), rice (5.72%) and sesame (5.13%) in MP Bundelkhand, wheat (27.27%) followed by gram (10.44%) and rice (2.33%) in UP Bundelkhand and wheat (27.46%) followed by gram (12.31%), soybean (8.45%), rice (4.09%) and sesame (2.66%) were found to be major crops grown in Bundelkhand region of India (Table 3.5).

### 3.6 Consumption of Fertilizers

The contribution of various fertilizers such as urea, DAP, unit of potash single super phosphate, complex fertilizers and total fertilizers across Bundelkhand regions of India are presented in table 3.6.

The total consumption of fertilizers in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India were found to be 31481, 521324 and 552 805 tons per year. Out of total fertilizer consumed in Bundelkhand region in

**Table 3.6 :Consumption of fertilizers in Bundelkhand Region of India**

Particulars	Bundelkhand Region of MP	Bundelkhand Region of UP	Bundelkhand Region of India
<b>Consumption in T on</b>			
UREA	9029	297508	306537
DAP	19491	146359	165850
MoP	299	977	1276
SSP	1556	13608	15164
Complex	1106	62872	63978
<b>Total Fertilizers</b>	<b>31481</b>	<b>521324</b>	<b>552805</b>
<b>Percentage to Total Fertilizers</b>			
UREA	28.68	57.07	55.45
DAP	61.91	28.07	30.00
MoP	0.95	0.19	0.23
SSP	4.94	2.61	2.74
Complex	3.51	12.06	11.57
<b>Total Fertilizers</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>
<b>Percentage to Bundelkhand Region of India</b>			
UREA	2.95	97.05	100
DAP	11.75	88.25	100
MoP	23.43	76.57	100
SSP	10.26	89.74	100
Complex	1.73	98.27	100
<b>Total Fertilizers</b>	<b>5.69</b>	<b>94.31</b>	<b>100</b>

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India, only 6 per cent was found to be consumed in Madhya Pradesh Bundelkhand, while 94 per cent by Uttar Pradesh Bundelkhand.

The maximum fertilizer consumed in Bundelkhand Region of India was found to be Urea (55.45%) followed by DAP (30.00%), Complex (11.57%), SSP (2.74%) and SSP (0.23%), respectively.

### 3.7 Regulated Markets

Different grades of regulated markets across Bundelkhand region of India are presented in table 3.7.

The number of different grades of regulated markets in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India were found to be 38, 58 and 96. The proportion of D,

**Table 3.7 :Different grades of regulated markets in Bundelkhand Region of India**

Particulars	Bundelkhand Region of MP	Bundelkhand Region of UP	Bundelkhand Region of India
<b>Number of Mandi</b>			
"A" Grade	3	9	12
"B" Grade	5	12	17
"C" Grade	10	10	20
"D" Grade	20	27	47
<b>Total</b>	<b>38</b>	<b>58</b>	<b>96</b>
<b>Percentage to Total</b>			
"A" Grade	7.89	15.52	12.5
"B" Grade	13.16	20.69	17.71
"C" Grade	26.32	17.24	20.83
"D" Grade	52.63	46.55	48.96
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b>Percentage to Bundelkhand Region of India</b>			
"A" Grade	25.00	75.00	100.00
"B" Grade	29.41	70.59	100.00
"C" Grade	50.00	50.00	100.00
"D" Grade	42.55	57.45	100.00
<b>Total</b>	<b>39.58</b>	<b>60.42</b>	<b>100.00</b>

Sources: mpmandiboard

B, C & A grades regulated markets were found to be 52.63, 26.32, 13.16 & 7.89 per cent in Madhya Pradesh Bundelkhand, 46.55, 17.24, 20.69 & 15.52 per cent in Uttar Pradesh Bundelkhand and 48.96, 20.83, 17.71 & 12.50 in

Bundelkhand region of India, respectively. In Uttar Pradesh Bundelkhand, the proportions of 'C' grade markets were found to be slightly lower than 'B' grade markets and higher than 'A' grade markets. Out of total regulated markets in

Bundelkhand regions of India, 40 and 60 per cent were found to be present in Madhya Pradesh and Uttar Pradesh Bundelkhand, respectively. The similar proportion was found for 'D' grade regulated markets, while 50: 50 per cent in case of 'C' and almost 25: 75 per cent in case of A & B grades regulated markets across both the regions.

### 3.8 Number of Different Size of Holdings

Number of different size of holdings across Bundelkhand regions of Madhya

Pradesh, Uttar Pradesh and India are presented in table 3.8.

The total number of land holdings in Bundelkhand region of Madhya Pradesh Uttar Pradesh and India were found to be 1291038, 1486001 and 2777039, respectively. The proportion of small and marginal farmers was found to be around 75%, semi medium around 15%, medium around 8% and large around 1% across Bundelkhand regions of Madhya Pradesh, Uttar Pradesh and India which shows

Table 3.8 :Numbers of holdings in Bundelkhand Region of India

Particulars	Bundelkhand Region of MP	Bundelkhand Region of UP	Bundelkhand Region of India
Marginal (0-1 ha)	563328	847188	1410516
Small (1-2 ha)	401378	330253	73 1631
Semi-medium(2-4 ha)	195377	198284	393661
Medium (4-10 ha)	115732	100177	215909
Large (above 10 ha)	15223	10099	25322
<b>Total</b>	<b>1291038</b>	<b>1486001</b>	<b>2777039</b>
<b>Percentage to Total</b>			
Marginal (0-1 ha)	43.63	57.01	50.79
Small (1-2 ha)	31.09	22.22	26.35
Semi-medium(2-4 ha)	15.13	13.34	14.18
Medium (4-10 ha)	8.96	6.74	7.77
Large (above 10 ha)	1.18	0.68	0.91
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b>Percentage to Bundelkhand Region of India</b>			
Marginal (0-1 ha)	39.94	60.06	100.00
Small (1-2 ha)	54.86	45.14	100.00
Semi-medium(2-4 ha)	49.63	50.37	100.00
Medium (4-10 ha)	53.60	46.40	100.00
Large (above 10 ha)	60.12	39.88	100.00
<b>Total</b>	<b>46.49</b>	<b>53.51</b>	<b>100.00</b>

Sources: District Statistical book 2016-17



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that most of the farmers belong to two small and marginal categories. In Bundelkhand region of India 46.5 and 53.5 percent holdings belongs to MP and UP Bundelkhand, respectively.

### 3.9 Area under different Size of Holdings

The area under different size of holdings in Bundelkhand regions of Madhya Pradesh Uttar Pradesh and India are presented in table 3.9. The total area under different size of holdings in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India were found to

be 24.39, 21.25 and 45.64 lakh hectares, respectively. Out of total area occupied by different size of holdings, the area occupied under marginal & small size of land holdings was found to be 38 and 25 per cent under semi-medium, around 30 per cent under medium and 8 per cent under large categories.

Across UP and MP Bundelkhand the area occupied by marginal, small and semi-medium respondents was found to be almost 50 per cent while in medium and large categories it

**Table 3.9 :Area (ha) of holdings in Bundelkhand Region of India**

Particulars	Bundelkhand Region of MP	Bundelkhand Region of UP	Bundelkhand Region of India
Marginal (0-1 ha)	407475	393389	800864
Small (1-2 ha)	506769	458781	965550
Semi-medium(2-4 ha)	552618	550679	1103297
Medium (4-10 ha)	747536	582415	1329951
Large (above 10 ha)	225166	139644	364810
<b>Total</b>	<b>2439564</b>	<b>2124908</b>	<b>4564472</b>
<b>Percentage to Total</b>			
Marginal (0-1 ha)	16.7	18.51	17.55
Small (1-2 ha)	20.77	21.59	21.15
Semi-medium(2-4 ha)	22.65	25.92	24.17
Medium (4-10 ha)	30.64	27.41	29.14
Large (above 10 ha)	9.23	6.57	7.99
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b>Percentage to Bundelkhand Region of India</b>			
Marginal (0-1 ha)	50.88	49.12	100.00
Small (1-2 ha)	52.49	47.51	100.00
Semi-medium(2-4 ha)	50.09	49.91	100.00
Medium (4-10 ha)	56.21	43.79	100.00
Large (above 10 ha)	61.72	38.28	100.00
<b>Total</b>	<b>53.45</b>	<b>46.55</b>	<b>100.00</b>

Sources: District Statistical book 2016-17

was found to be 56.21 and 61.72% in case of MP Bundelkhand as compared to 43.79 and 38.28 percent in case of UP Bundelkhand (Table 3.9).

### 3.10 Working Population

The working population in Bundelkhand region of India was found to be 17991426, out of which 48.10 and 51.90 per cent

**Table 3.10 : Working population in Bundelkhand Region of India**

Particulars	Bundelkhand	Bundelkhand	Bundelkhand
	Region of MP	Region of UP	Region of India
<b>Number</b>			
<b>Total Population</b>	<b>8653492</b>	<b>9337934</b>	<b>17991426</b>
(i) Main Worker	2717242	2327105	5044347
(ii) Marginal Worker	1023661	1157523	2181184
(iii) Non Worker	4912589	5853306	10765895
<b>Total Workers (Main &amp; Marginal)</b>	<b>3740903</b>	<b>3828246</b>	<b>7569149</b>
Cultivators	1214646	1349481	2564127
Agriculture labourers	1383532	1358485	2742017
Workers in household industry	268893	154691	423584
Others Workers	873832	965589	1839421
<b>Percentage to Total Population</b>	<b>100</b>	<b>100</b>	<b>100</b>
(i) Main Worker	31.4	24.92	28.04
(ii) Marginal Worker	11.83	12.4	12.12
(iii) Non Worker	56.77	62.68	59.84
<b>Percentage to Total Workers (Main &amp; Marginal)</b>	<b>100</b>	<b>100</b>	<b>100</b>
Cultivators	32.47	35.25	33.88
Agriculture labourers	36.98	35.49	36.23
Workers in household industry	7.19	4.04	5.6
Others Workers	23.36	25.22	24.3
<b>Percentage to Bundelkhand Region of India</b>			
<b>Total Population</b>	<b>48.10</b>	<b>51.90</b>	<b>100</b>
(i) Main Worker	53.87	46.13	100
(ii) Marginal Worker	46.93	53.07	100
(iii) Non Worker	45.63	54.37	100
<b>Total Workers (Main &amp; Marginal)</b>	<b>49.42</b>	<b>50.58</b>	<b>100</b>
Cultivators	47.37	52.63	100
Agriculture labourers	50.46	49.54	100
Workers in household industry	63.48	36.52	100
Others Workers	47.51	52.49	100

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were found to be residents of Bundelkhand region of MP and UP, respectively. Bundelkhand region of MP, UP and India have more number of non-workers (56.77, 62.68 & 59.84 per cent) as compared to main (31.40, 24.92 & 28.03 per cent) and marginal (11.83, 12.40 & 12.12 per cent) workers.

Out of main and marginal workers, majority of them were found to be agricultural labourers (36%) followed by cultivators (34%), other works (24%) and workers in household industry (6%). These figures were found to be almost similar with minor variation across Bundelkhand region of Madhya Pradesh and Uttar Pradesh. The main marginal and non

workers were found to be almost 50 per cent in case of MP and UP Bundelkhand regions of India. Out of total main and marginal workers in Bundelkhand region of India, cultivators agricultural labourers and other workers were found to be almost 50 per cent in Bundelkhand region of MP and UP, while workers in household industry were found to be more in MP Bundelkhand (63.48%), as compared to UP Bundelkhand (36.52%) (Table 3.10)..

### 3.11 Farm Machinery and Implements

The total number of plough, bullock carts, electric pumps, diesel pumps, tractors and sugarcane cutter in Bundelkhand region of India were found to be 743460, 253680, 270584,

Table 3.11 : Farm machinery and implements used in Bundelkhand Region of India (Numbers)

Particulars	Bundelkhand Region of MP	Bundelkhand Region of UP	Bundelkhand Region of India
Plough	358162 (48.18)	385298 (51.82)	743460 (100)
Bulluck cart	120699 (47.58)	132981 (52.42)	253680 (100)
Electric Pump	266209 (98.38)	4375 (1.62)	270584 (100)
Diesel Pump	147350 (54.07)	125167 (45.93)	272517 (100)
Tractors	59252 (48.69)	62433 (51.31)	121685 (100)
Sugarcane cutter	1213 (51.68)	1134 (48.32)	2347 (100)

Figures in parenthesis shows percentage to Percentage to Bundelkhand Region of India

272517, 121685 and 2347. The plough, bullock cart, diesel pump, tractor and sugarcane cutter were found to be almost 50% in Bundelkhand

region of Madhya Pradesh and Uttar Pradesh, while electric pumps were found to be more in case of MP Bundelkhand (98.38%) as compared to UP Bundelkhand (1.62%) (Table 3.11).

### 3.12 Live Stock Population

The total number of livestock in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 4934833, 3657154 and 8591987, respectively. Among different livestock the population of cow (36.53%) was found to be more as compared to goat (29%), buffaloes (28.74%) and sheep & pig (2.9% each). The population of cow buffaloes and pig was found to be more in MP Bundelkhand (41.62, 33.69 and 2.87 %) as

compared to UP Bundelkhand (29.67, 22.07 and 2.77%), while population of goat and sheep was found to be less in MP Bundelkhand (19.89 & 1.94 %) as compared to UP Bundelkhand (41.29 & 4.21%).

Out of total bovinel population in Bundelkhand region of India, two-thirds were found to be from Bundelkhand region of Madhya Pradesh and one third from UP Bundelkhand and vice versa in case of goat and sheep, while population of pig was found to be

Table 3.12 :Live stock population in Bundelkhand Region of India

Particulars	Bundelkhand Region of MP	Bundelkhand Region of UP	Bundelkhand Region of India
<b>Number of Livestock</b>			
Cow	2053825	1085093	3138918
Buffalos	1662552	807087	2469639
Sheep	95511	153800	249311
Goat	981416	1509929	2491345
Pig	141529	101245	242774
<b>Total Livestock</b>	<b>4934833</b>	<b>3657154</b>	<b>8591987</b>
<b>Poultry Birds</b>	<b>430159</b>	<b>309535</b>	<b>739694</b>
<b>Percentage to Total</b>			
Cow	41.62	29.67	36.53
Buffalos	33.69	22.07	28.74
Sheep	1.94	4.21	2.9
Goat	19.89	41.29	29
Pig	2.87	2.77	2.83
<b>Total Livestock</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b>Percentage to Bundelkhand Region of India</b>			
Cow	65.43	34.57	100
Buffalos	67.32	32.68	100
Sheep	38.31	61.69	100
Goat	39.39	60.61	100
Pig	58.3	41.7	100
<b>Total Livestock</b>	<b>57.44</b>	<b>42.56</b>	<b>100</b>
<b>Poultry Birds</b>	<b>58.15</b>	<b>41.85</b>	<b>100</b>

### 3.13 Summary of the Chapter

The Bundelkhand region of India occupies 70,765 square kilometer area, out of which 58% was covered by Madhya Pradesh Bundelkhand and 42% by Uttar Pradesh Bundelkhand regions. There were 14 districts (7 each in MP & UP) having 76 tehsils (50 in MP & 26 in UP), 5043 gram Panchayats (2164 in MP & 2879 in UP) and 11526 villages (6285 in MP & 5241 in UP) in Bundelkhand region of India. The population density of Bundelkhand region of India was found to be 269 persons/sq.km (209 in MP & 329 in UP).

The total population of Bundelkhand region of India was found to be 183.35 lakhs, out of which, 53.05 and 46.95 per cent were found to be male and female, respectively. The population of rural (77.58%) was found to be more as compared to urban (22.42%) population with only 15.2% of children. The region was found to be dominated by Hindus followed by Muslims and other religions. An average literacy rate of the region was found to be 64%, which was more in male (73%) as compared to female (53%) population. The sex and child sex ratio was found to be 886 and 897 over 1000 male in the region.

The total geographical area of Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 41.28, 29.62 and 70.90 lakh ha, respectively. Out of total

geographical area in Bundelkhand region of India 57.43, 20.06, 10.99, 7.01 and 4.65 percent was found to be net area sown, area covered under forest, land not available for cultivation, other uncultivated land excluding fallow land and fallow land, respectively.

The net irrigated area in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 13.44, 13.70 and 27.14 lakh hectares. Amongst different sources of irrigation, well (41.84%) followed by tube Wells (19.22%), canals (15.30%) and tanks, (3.09%) in Madhya Pradesh Bundelkhand and canals (34.76%) followed by tube Wells (32.85%), wells (23.37%) and tanks (7.44%) in Uttar Pradesh Bundelkhand found to be sources of irrigation. The net irrigated area was found to be 49.5 and 50.5 Madhya Pradesh and Uttar Pradesh Bundelkhand region respectively.

The cropping pattern of Bundelkhand region was found to be dominated during Rabi in Madhya Pradesh (57.92%), Uttar Pradesh (60.20%) and in the country (59.02%) as compared to 42.08, 39.8 and 40.98 per cent in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively. Gross cropped area of Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 32.86, 30.55 and 31.70 lakh ha with cropping intensity of 164, 141 and 152.5, respectively. Wheat (27.46%) followed by gram (12.31%), soybean

(8.45%), rice (4.09%) and sesame (2.66%) were found to be major crops grown in Bundelkhand region of India.

The total consumption of fertilizers in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India were found to be 3148, 521324 and 552 805 tons per year. Out of total fertilizer consumed in Bundelkhand region in India, only 6 per cent was found to be consumed Madhya Pradesh Bundelkhand, while 94 per cent by Uttar Pradesh Bundelkhand. The maximum fertilizer consumed in Bundelkhand Region of India was found to be Urea (55.45%) followed by DAP (30.00%), Complex (11.57%), SSP (2.74%) and SSP (0.23%), respectively.

The number of different grades of regulated markets in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India were found to be 38, 58 and 96. The proportion of D, B, C & A grades regulated markets were found to be 52.63, 26.32, 13.16 & 7.89 per cent in Madhya Pradesh Bundelkhand, 46.55, 17.24, 20.69 & 15.52 per cent in Uttar Pradesh Bundelkhand and 48.96, 20.83, 17.71 & 12.50 in Bundelkhand region of India.

The total number of land holdings in Bundelkhand region of Madhya Pradesh Uttar Pradesh and India were found to be 1291038, 1486001 and 2777039, respectively. The proportion of small and marginal farmers was found to be around 75%, semi medium around

15%, medium around 8% and large around 1% across Bundelkhand regions of Madhya Pradesh, Uttar Pradesh and India

The total area under different size of holdings in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India were found to be 24.39, 21.25 and 45.64 lac hectares, respectively. Out of total area occupied by different size of holdings, the area occupied under marginal & small size of land holdings was found to be 38 and 25 per cent under semi-medium, around 30 per cent under medium and 8 percent under large categories.

The working population in Bundelkhand region of India was found to be 1799 1426, out of which 48.10 and 51.90 were found to be residents of Bundelkhand region of MP and UP, respectively. Bundelkhand region of MP, UP and India have more number of non-workers (56.77, 62.68 & 59.84 per cent) as compared to man (31.40, 24.92 & 28.03 per cent) and marginal (11.83, 12.40 & 12.12 per cent) workers. Out of main and marginal workers, majority of them were found to be agricultural labourers (36%) followed by cultivators (34%), other works (24%) and workers in household industry (6%).

The total number of plough, bullock carts, electric pumps, diesel pumps, tractors and sugarcane cutters in Bundelkhand region of India were found to be 743460, 253680, 270584,

### Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India

272517, 121685 and 2347.

The total number of livestock in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 4934833, 3657154 and 8591987, respectively. Among different livestock the population of cow (36.53%) was found to be more as compared to goat (29%), buffaloes (28.74%) and sheep & pig

(2.9% each). The population of cow buffaloes and pig was found to be more in MP Bundelkhand (41.62, 33.69 and 2.87 %) as compared to UP Bundelkhand (29.67, 22.07 and 2.77%), while population of goat and sheep was found to be less in MP Bundelkhand (19.89 & 1.94 %) as compared to UP Bundelkhand (41.29 & 4.21%).

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## **SOCIO-ECONOMIC CHARACTERISTICS OF THE SAMPLE HOUSEHOLDS**

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

### **4.1 Socio-economic Profile of the Respondents**

To understand the socio-economic characteristics of the households it is imperative to have knowledge about their characteristics

average age of the respondent level of education cost structure, number of family members, occupation and annual farm income (Table 4.1).

It forms the basis to judge the level of adaptability of innovative technologies by the farming community in the fields and to assess dependency of respondents on farm and other non-farm activities for their income. The age and experience in farming of respondents in Bundelkhand region of Mahya Pradesh, Uttar

**Table 4.1 :Age and experience in farming of respondents**

Particulars	Small	Medium	Large	Overall
<b>Bundelkhand Region of Madhya Pradesh</b>				
Age of respondents	51	46	49	49
Experience in farming (Years)	35	34	41	33
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)
<b>Total</b>	60 (100)	60 (100)	60 (100)	180 (100)
<b>Bundelkhand Region of Uttar Pradesh</b>				
Age of respondents	57	54	55	55
Experience in farming (Years)	39	36	39	38
Below 45	36 (90)	32 (80)	30 (75)	98 (81.67)
above 45	4 (10)	8 (20)	10 (25)	22 (18.33)
<b>Total</b>	40 (100)	40 (100)	40 (100)	120 (100)
<b>Bundelkhand Region of India</b>				
Age of respondents	54	50	52	52
Experience in farming (Years)	37	35	40	36
Below 45	68 (68)	69 (69)	64 (64)	201 (67)
above 45	32 (32)	31 (31)	36 (36)	99 (33)
<b>Total</b>	100 (100)	100 (100)	100 (100)	300 (100)

Figures in parenthesis show percent to total

## Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India

Pradesh and India across various size of holdings and at overall level are presented in table 4.1

It is clear from the data presented in table 4.1, that the average age of the respondents in Bundelkhand region of MP, UP and India was found to be 49, 55 and 52 years having 33, 38 and 36 years of experience in farming at overall level. Out of total respondents the majority was found

to be below the age of 45 years as compared to above 45 years of age at overall level. The similar observations were recorded across various sizes of holdings with minor variations.

### 4.2 Number of Family Members of Respondents

The number of family members and number of family members involved in farming across various categories of household in

**Table 4.2 :Number of family members of respondents**

Particulars		Small	Medium	Large	Overall
<b>Bundelkhand Region of Madhya Pradesh</b>					
No. of Family Member	Male	2 (3.33)	2 (3.33)	3 (5)	2 (1.11)
	Female	2 (3.33)	3 (5)	3 (5)	3 (1.67)
	Child	2 (3.33)	1 (1.67)	2 (3.33)	2 (1.11)
	<b>Total</b>	6 (10)	6 (10)	8 (13.33)	7 (3.89)
No. of family members involve in farming	Male	2	2	3	2
	Female	1	1	1	1
	<b>Total</b>	3	3	4	3
<b>Bundelkhand Region of Uttar Pradesh</b>					
No. of Family Member	Male	3 (7.5)	3 (7.5)	4 (10)	3 (2.5)
	Female	3 (7.5)	2 (5)	3 (7.5)	3 (2.5)
	Child	2 (5)	2 (5)	3 (7.5)	2 (1.67)
	<b>Total</b>	8 (20)	7 (17.5)	10 (25)	8 (6.67)
No. of family members involve in farming	Male	2	2	2	2
	Female	1	1	1	1
	<b>Total</b>	3	3	3	3
<b>Bundelkhand Region of India</b>					
No. of Family Member	Male	3 (3)	3 (3)	4 (4)	3 (1)
	Female	3 (3)	3 (3)	3 (3)	3 (1)
	Child	2 (2)	2 (2)	3 (3)	2 (0.67)
	<b>Total</b>	8 (8)	8 (8)	10 (10)	8 (2.67)
No. of family members involve in farming	Male	1.8	1.8	2.5	2
	Female	1.1	1.0	0.9	1
	<b>Total</b>	3	3	3	3

Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India is presented in table 4.2. The average family size of respondents was found to be 7, 8 & 8, out of which 3 members were found to be engaged in farming in Bundelkhand region of MP, UP and India, respectively.

### 4.3 Education Level of Respondents

The education level of respondents in Bundelkhand region of MP, UP and India across

various size of holdings and at overall level is presented in table 4.3

The majority of respondents in Bundelkhand region of MP, UP and India at overall level were found to be educated upto primary level (27.88, 21.67 & 25.33 %) followed by higher secondary, (20.56, 17.50 & 19.33%), matriculation (16.67, 12.50 & 15 %), graduate (11.67, 12.50 & 12%), post graduate (4.44, 9.17 & 6.33%) and above (2.22, 5.83 ,& 3.67%). The

Table 4.3 :Education level of respondents

Particulars	Small	Medium	Large	Overall
<b>Bundelkhand Region of Madhya Pradesh</b>				
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)
<b>Total</b>	<b>60</b> <b>(100)</b>	<b>60</b> <b>(100)</b>	<b>60</b> <b>(100)</b>	<b>180</b> <b>(100)</b>
<b>Bundelkhand Region of Uttar Pradesh</b>				
Illiterate	10 (25)	7 (17.5)	8 (20)	25 (20.83)
Primary	8 (20)	8 (20)	10 (25)	26 (21.67)
High School	6 (15)	5 (12.5)	4 (10)	15 (12.5)
Higher Secondary	5 (12.5)	9 (22.5)	7 (17.5)	21 (17.5)
Graduate	7 (17.5)	2 (5)	6 (15)	15 (12.5)
Post Graduate	2 (5)	6 (15)	3 (7.5)	11 (9.17)
Above Post Graduate	2 (5)	3 (7.5)	2 (5)	7 (5.83)
<b>Total</b>	<b>40</b> <b>(100)</b>	<b>40</b> <b>(100)</b>	<b>40</b> <b>(100)</b>	<b>120</b> <b>(100)</b>

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Bundelkhand Region of India				
Illiterate	22 (22)	17 (17)	16 (16)	55 (18.33)
Primary	24 (24)	28 (28)	24 (24)	76 (25.33)
High School	23 (23)	10 (10)	12 (12)	45 (15)
Higher Secondary	14 (14)	25 (25)	19 (19)	58 (19.33)
Graduate	11 (11)	7 (7)	18 (18)	36 (12)
Post Graduate	4 (4)	8 (8)	7 (7)	19 (6.33)
Above Post Graduate	2 (2)	5 (5)	4 (4)	11 (3.67)
<b>Total</b>	<b>100</b> <b>(100)</b>	<b>100</b> <b>(100)</b>	<b>100</b> <b>(100)</b>	<b>300</b> <b>(100)</b>

### 4.4 Caste Structure of Respondents

The caste structure across ideal size of holdings in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India is present in table 4.4.

The majority of the respondents of Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India at overall level were found to be belong to OBC

Table 4.4 :Cast structure of respondents

Particulars	Small	Medium	Large	Overall
<b>Bundelkhand Region of Madhya Pradesh</b>				
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)
<b>Total</b>	<b>60</b> <b>(100)</b>	<b>60</b> <b>(100)</b>	<b>60</b> <b>(100)</b>	<b>180</b> <b>(100)</b>
<b>Bundelkhand Region of Uttar Pradesh</b>				
General	8 (20)	18 (45)	27 (67.5)	53 (44.17)
Other Backward Caste	23 (57.5)	20 (50)	13 (32.5)	56 (46.67)
Schedule Caste	9 (22.5)	2 (5)	0 (0)	11 (9.17)
Schedule Tribe	0 (0)	0 (0)	0 (0)	0 (0)
<b>Total</b>	<b>40</b> <b>(100)</b>	<b>40</b> <b>(100)</b>	<b>40</b> <b>(100)</b>	<b>120</b> <b>(100)</b>

Bundelkhand Region of India				
General	11 (11)	29 (29)	39 (39)	79 (26.33)
Other Backward Caste	61 (61)	65 (65)	56 (56)	182 (60.67)
Schedule Caste	23 (23)	6 (6)	5 (5)	34 (11.33)
Schedule Tribe	5 (5)	0 (0)	0 (0)	5 (1.67)
<b>Total</b>	<b>100</b> <b>(100)</b>	<b>100</b> <b>(100)</b>	<b>100</b> <b>(100)</b>	<b>300</b> <b>(100)</b>

Figures in parenthesis show percent to total

(70, 46.67 & 60.67%) followed by general (14.44, 44.17 & 26.33 %) schedule caste (12.78, 9.17 & 11.33%) and scheduled Tribes (2.78, 0.00 & 1.67 %). The proportion of OBC and general was found to be more as compared to SC and ST population in Bundelkhand region of Madhya Pradesh, while 44.17% general, 46.67% OBC in UP Bundelkhand. These findings were found to be similar across various size of holdings with minor variations however SC and ST were found to be more in small size of holdings as compared to medium and large categories and vice versa as for as general and OBC categories are concerned.

#### 4.5 Occupation

The primary and secondary occupation across various sizes of holdings and at overall level in Bundelkhand region of MP, UP and India is presented in table 4.5

As for as occupation of respondents is concerned, all of them were found to be engaged in farming and allied activities as the main source or for their livelihood security. The maximum respondents were found to be

engaged as agricultural labourers (30.56%) followed by livestock (11.11%), non-agricultural labourers (7.78%), services (4.44%), self employed (2.78%) & daily wage labourers (1.11%) in Bundelkhand region of Madhya Pradesh, while maximum respondents were found to be engaged in livestock (36.67%) followed by non-agricultural labourers (14.17%), Agricultural labourers (9.17%), daily wage labourers (7.5%), services (3.33%) and self employment (0.83%) in Bundelkhand region of Uttar Pradesh.

At overall level, 22 per cent respondents were found to be engaged as agricultural labourers, 21 percent as livestock labourers and 10 per cent as non-agricultural labourers. The respondents employed as agricultural labourers were found to be more in small (32%) as compared to medium (19%) and large (15%) and vice versa in case of livestock. The respondents engaged in services were found to be more in medium (6%) as compared to large (5%) and small (1%) categories.

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Table 4.5 :Occupation of respondents

Particulars	Small	Medium	Large	Overall
<b>Bundelkhand Region of Madhya Pradesh</b>				
Primary Occupation – Farming	60 (100)	60 (100)	60 (100)	180 (100)
<b>Secondary Occupation</b>				
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)
<b>Total</b>	<b>60</b> <b>(100)</b>	<b>60</b> <b>(100)</b>	<b>60</b> <b>(100)</b>	<b>180</b> <b>(100)</b>
<b>Bundelkhand Region of Uttar Pradesh</b>				
Primary Occupation – Farming	40 (100)	40 (100)	40 (100)	120 (100)
<b>Secondary Occupation</b>				
Agriculture Labour	7 (17.5)	3 (7.5)	1 (2.5)	11 (9.17)
Live Stock	14 (35)	20 (50)	10 (25)	44 (36.67)
Poultry	0 (0)	0 (0)	0 (0)	0 (0)
Self Employment	1 (2.5)	0 (0)	0 (0)	1 (0.83)
Services	0 (0)	1 (2.5)	3 (7.5)	4 (3.33)
Non Agricultural Labour	10 (25)	6 (15)	1 (2.5)	17 (14.17)
Daily wages Labour	3 (7.5)	2 (5)	4 (10)	9 (7.5)
Others	5 (12.5)	8 (20)	21 (52.5)	34 (28.33)
<b>Total</b>	<b>40</b> <b>(100)</b>	<b>40</b> <b>(100)</b>	<b>40</b> <b>(100)</b>	<b>120</b> <b>(100)</b>

<b>Bundelkhand Region of India</b>				
<b>Primary Occupation – Farming</b>	100 (100)	100 (100)	100 (100)	300 (100)
<b>Secondary Occupation</b>				
Agriculture Labour	32 (32)	19 (19)	15 (15)	66 (22)
Live Stock	17 (17)	27 (27)	20 (20)	64 (21.33)
Poultry	0 (0)	0 (0)	1 (1)	1 (0.33)
Self Employment	3 (3)	1 (1)	2 (2)	6 (2)
Services	1 (1)	6 (6)	5 (5)	12 (4)
Non Agricultural Labour	17 (17)	10 (10)	4 (4)	31 (10.33)
Daily wages Labour	4 (4)	3 (3)	4 (4)	11 (3.67)
Others	26 (26)	34 (34)	49 (49)	109 (36.33)
<b>Total</b>	<b>100</b> <b>(100)</b>	<b>100</b> <b>(100)</b>	<b>100</b> <b>(100)</b>	<b>300</b> <b>(100)</b>

Figures in parenthesis show percent to total

#### 4.6 Farm Income

Annual farm income of the respondents from agriculture and other sources across various size of holdings in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India is presented in table 4.6

On an average annual farm income in case of medium (Rs. 65357/-) in Bundelkhand region of Madhya Pradesh, large in UP (Rs. 101029/-) and India (Rs. 82045/-) was found to be more as compared to other categories in the region. The main source of income was found to be agriculture across all the categories and

regions which ranged between 71 (MP) to 75 (UP) per cent at overall level and ranged between 70.72 to 79.01 per cent across all the categories and regions. The annual average income was found to be Rs.62491, 90069 and 76730 in Bundelkhand region of Madhya Pradesh Uttar Pradesh and India, respectively, out of which 71.36, 75.68 and 73.92 per cent was found to be received from agriculture and 28.64, 24.32 and 26.08 percent from other sources, respectively.



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Table 4.6 :Annual farm income of the respondents

Particulars	Small	Medium	Large	Overall
<b>Bundelkhand Region of Madhya Pradesh</b>				
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)
<b>Total</b>	<b>59057</b> <b>(100)</b>	<b>65357</b> <b>(100)</b>	<b>63060</b> <b>(100)</b>	<b>62491</b> <b>(100)</b>
<b>Bundelkhand Region of Uttar Pradesh</b>				
From Agriculture	69515 (75.89)	63430 (79.01)	73599 (72.85)	68848 (75.68)
From Others Sources	22083 (24.11)	16850 (20.99)	27430 (27.15)	22121 (24.32)
<b>Total</b>	<b>91598</b> <b>(100)</b>	<b>80280</b> <b>(100)</b>	<b>101029</b> <b>(100)</b>	<b>90969</b> <b>(100)</b>
<b>Bundelkhand Region of India</b>				
From Agriculture	55639 (73.86)	55132 (75.71)	59393 (72.39)	56721 (73.92)
From Others Sources	19689 (26.14)	17687 (24.29)	22652 (27.61)	20009 (26.08)
<b>Total</b>	<b>75328</b> <b>(100)</b>	<b>72819</b> <b>(100)</b>	<b>82045</b> <b>(100)</b>	<b>76730</b> <b>(100)</b>

Figures in parenthesis show percent to total

### 4.7 Farm Assets

The various farm assets in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India across size of holdings are presented in table 4.7.

The value of land was found to vary between Rs.434673/- (small) to Rs. 700220/- (large), Rs. 395938/- (Medium) to Rs. 412875/- (large) and Rs. 422774/- (small) to Rs. 556548 (large) per hectare with average of Rs. 558361/-, Rs.406563/- and Rs. 482462/- per hectare at

overall level in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively. An average respondent were found to have total assets excluding land of Rs. 128274/-,Rs. 102241/- and Rs. 115258/- per farm excluded land which were found to vary between Rs. 19610/- (small) to Rs. 272979/- (large), Rs. 42929/- (small) to Rs. 188274/- (large) and Rs. 31270/- (small) to Rs. 230627/- (large) per farm in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively.

Table 4.7 :Farm assets of respondents (Rs./farm)

Particulars	Small	Medium	Large	Overall
<b>Bundelkhand Region of Madhya Pradesh</b>				
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
Pump Deasel & Electric)	11986	14066	25448	17167
Micro Irrigation	1699	1769	2788	2086
Sprayers	520	779	899	733
Others	780	826	4618	2075
Land	434673	540185	700220	558361
<b>Total</b>	<b>454283</b>	<b>632414</b>	<b>973199</b>	<b>686635</b>
<b>Total ( Excluding Land)</b>	19610 (4.32)	92229 (14.58)	272979 (28.05)	128274 (18.68)
<b>Bundelkhand Region of Uttar Pradesh</b>				
Tractor	32500	49750	136750	73000
Thresher	2500	5750	18250	8833
Cultivator	375	3400	8675	4150
Seed Drill	0	4525	3950	2825
Rotavetor	0	0	3875	1292
Harvester	0	0	0	0
Pump Deasel & Electric)	5750	7625	15376	9583
Micro Irrigation	300	250	300	283
Sprayers	663	543	675	626
Others	841	3683	423	1649
Land	410875	395938	412875	406563
<b>Total</b>	<b>453804</b>	<b>471464</b>	<b>601149</b>	<b>508804</b>
<b>Total ( Excluding Land)</b>	42929 (9.46)	75526 (16.02)	188274 (31.32)	102241 (20.09)
<b>Bundelkhand Region of India</b>				
Tractor	18125	56094	161157	78459
Thresher	1500	5844	18888	8744
Cultivator	263	3438	10332	4677
Seed Drill	113	3732	6988	3611
Rotavetor	0	0	6125	2042
Harvester	0	0	1875	625
Pump Deasel & Electric)	8868	10846	20412	13375
Micro Irrigation	1000	1010	1544	1185
Sprayers	592	661	787	680
Others	811	2255	2521	1862
Land	422774	468062	556548	482462
<b>Total</b>	<b>454044</b>	<b>551939</b>	<b>787174</b>	<b>597720</b>
<b>Total ( Excluding Land)</b>	31270 (6.89)	83878 (15.2)	230627 (29.3)	115258 (19.28)

Figures in parenthesis show percent to total

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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 only.

### 4.8 Operational Land Holdings

To calculate operational land holding of the respondents the data on cultivated land, leased-in/out land, uncultivated land, current/old fallow land were analysed across

various size of percent area under irrigation as recorded by respondent is also present the percent area under irrigation as reported by respondent is also present in the table 4.8

It is observed from the data that at overall level an average respondent was found to have 10.67, 8.57 and 9.62 acres of cultivated land with 0.77 & 0.13, 0.33 & 0.28 and 0.55 & 0.20 was

**Table 4.8 :Land use pattern of respondents (acre/farm)**

Particulars	Small	Medium	Large	Overall
<b>Bundelkhand Region of Madhya Pradesh</b>				
Total Land Holding	3.1 (100)	7.99 (100)	22.19 (100)	11.09 (100)
Cultivated Land	3.05 (98.39)	7.66 (95.87)	21.3 (95.99)	10.67 (96.18)
Leased-In Land	0.66	0.96	0.70	0.77
Leased-Out Land	0.00	0.09	0.30	0.13
Un-Cultivated Land	0.02	0.09	0.51	0.21
Current Fellow	0.03	0.07	0.08	0.06
Old Fellow	-	0.08	-	0.03
Operated Holding	<b>3.66</b> /100/	<b>8.29</b> /100/	<b>21.11</b> /100/	<b>11.02</b> /100/
Irrigated Area	2.57 /70.22/	5.24 /63.21/	16.71 /79.16/	8.17 /74.17/
<b>Bundelkhand Region of Uttar Pradesh</b>				
Total Land Holding	2.37 (100)	7.74 (100)	17.1 (100)	9.07 (100)
Cultivated Land	2.37 (100)	7.57 (97.8)	15.78 (92.28)	8.57 (94.52)
Leased-In Land	0.78	0.08	0.13	0.33
Leased-Out Land	0.00	0.08	0.75	0.28
Un-Cultivated Land	0	0.09	0.54	0.21
Current Fellow	-	0.03	0.21	0.08
Old Fellow	-	-	0.03	0.01
Operated Holding	<b>3.15</b> /100/	<b>7.45</b> /100/	<b>14.38</b> /100/	<b>8.33</b> /100/
Irrigated Area	2.72 /86.35/	6.62 /88.86/	11.7 /81.36/	7.01 /84.23/
<b>Bundelkhand Region of India</b>				
Total Land Holding	2.735 (100)	7.865 (100)	19.645 (100)	10.08 (100)
Cultivated Land	2.71 (99.09)	7.615 (96.82)	18.54 (94.38)	9.62 (95.44)
Leased-In Land	0.72	0.52	0.42	0.55
Leased-Out Land	0.00	0.09	0.53	0.20
Un-Cultivated Land	0.01	0.09	0.525	0.21
Current Fellow	0.02	0.05	0.15	0.07
Old Fellow	-	0.04	0.02	0.02
Operated Holding	<b>3.40</b> /100/	<b>7.87</b> /100/	<b>17.745</b> /100/	<b>9.67</b> /100/
Irrigated Area	2.65 /77.68/	5.93 /75.35/	14.20 /80.05/	7.59 /78.5/

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

leased-in/out land in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively, with 0.21 acres of uncultivated land, current fallow (0.06,0.08 & 0.07) and old fallow (0.03, 0.01 & 0.02) constituting net operating area of 11.02, 8.33 and 9.67 acres. Out of net operated area 74, 84 & 78.5 per cent was found to be irrigated. An average operational holding of small (3.66, 3.15 & 3.40), medium (8.29, 7.45 & 7.87) and large (21.11, 14.38 & 17.74) respondents was found in Bundelkhand region of MP, UP and India. The uncultivated and leased out land were found to be more in case of large as compared to medium and small size of holdings.

#### 4.9 Sources of Irrigation

The different sources of irrigation across various size of holdings and at overall level in Bundelkhand region of Madhya Pradesh Uttar Pradesh and India are presented in table 4.9.

It is observed from the data that at overall level open dug well (47.22%) followed by bore well (36.67%), canal (8.34%), pond (4.44%) and river (3.33%) in MP; tube-well (60.83%) followed by well (23.33%) canal (10 %) and river (4.27%) in UP and tube-well (46.33%) followed by well (37.67%), canal (9%) and river (3.67%) in Bundelkhand region of India were found to be major sources of irrigation in the area under study with minor variation across various size of holdings.

Table 4.9 :Source wise irrigation of respondents (Number)

Particulars	Small	Medium	Large	Overall
<b>Bundelkhand Region of Madhya Pradesh</b>				
Well	28 (46.67)	31 (51.67)	26 (43.33)	85 (47.22)
TubeWell	22 (36.67)	17 (28.33)	27 (45)	66 (36.67)
Canal	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)
<b>Total</b>	<b>60 (100)</b>	<b>60 (100)</b>	<b>60 (100)</b>	<b>180 (100)</b>

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<b>Bundelkhand Region of Uttar Pradesh</b>				
Well	9 (22.5)	13 (32.5)	6 (15)	28 (23.33)
TubeWell	24 (60)	21 (52.5)	28 (70)	73 (60.83)
Canal	5 (12.5)	3 (7.5)	4 (10)	12 (10)
River	2 (5)	1 (2.5)	2 (5)	5 (4.17)
Pond	0 (0)	2 (5)	0 (0)	2 (1.67)
<b>Total</b>	<b>40 (100)</b>	<b>40 (100)</b>	<b>40 (100)</b>	<b>120 (100)</b>
<b>Bundelkhand Region of India</b>				
Well	37 (37)	44 (44)	32 (32)	113 (37.67)
TubeWell	46 (46)	38 (38)	55 (55)	139 (46.33)
Canal	12 (12)	8 (8)	7 (7)	27 (9)
River	3 (3)	4 (4)	4 (4)	11 (3.67)
Pond	2 (2)	6 (6)	2 (2)	10 (3.33)
<b>Total</b>	<b>100 (100)</b>	<b>100 (100)</b>	<b>100 (100)</b>	<b>300 (100)</b>

Figures in parenthesis show percent to total

### 4.10 Cropping Pattern

The preference for cultivation of various crops during kharif and Rabi season across various size of holdings is depicted in table 4.10 to 4.12.

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%), til (10.06%) and other (9.41%) in Bundelkhand region of Madhya Pradesh (Table 4.10).

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

Table 4.10 : Cropping pattern of respondents of Bundelkhand Region of Madhya Pradesh (acre/farm)

Particulars	Small	Medium	Large	Overall
<b>Kharif Season</b>				
Rice	0.92 (25.27)	1.58 (19.08)	5.75 (26.62)	2.75 (23.66)
Soybean	0.99 (27.2)	3.97 (47.95)	7.18 (33.24)	4.05 (36.13)
Urd	1.07 (29.4)	0.8 (9.66)	3.47 (16.06)	1.78 (18.37)
Sesame	0.32 (8.79)	0.98 (11.84)	2.06 (9.54)	1.12 (10.06)
Moong	0.13 (3.57)	0.43 (5.19)	0.72 (3.33)	0.43 (4.03)
Other	0.33 (8.29)	0.63 (7.09)	2.42 (10.47)	1.13 (9.41)
<b>Total Kharif</b>	3.98 (100) /55.28/	8.89 (100) /56.16/	23.12 (100) /57.34/	12.01 (100) /56.87/
<b>Rabi Season</b>				
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)
Lentil	0.26 (7.55)	0.75 (9.43)	1.46 (16.7)	0.82 (11.23)
Field Pea	0.01 (0.29)	0 (0)	0.48 (2.26)	0.16 (0.85)
Mustard	0.08 (1.74)	0.61 (7.67)	0.31 (1.46)	0.33 (3.62)
Other	0.09 (2.62)	0.04 (0.54)	0.26 (1.39)	0.13 (1.32)
<b>Total Rabi</b>	3.44 (100) /47.78/	7.44 (100) /47/	18.72 (100) /46.43/	9.85 (100) /46.64/
<b>Gross Cropped Area</b>	7.20	15.83	40.32	21.12
<b>Cropping Intensity %</b>	196.00	189.00	186.00	190.00

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

21.65 and 11.23 per cent of total Rabi season area respectively. Mustard and lentil were found to be other major crops, which were found to be cultivated by the respondents during Rabi season.

These findings 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

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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 4.10).

The preference for cultivation of various crops during kharif and rabi season across various size of holdings is depicted in table 4.11 . It is observed from the data that at overall level an average HH used to allocate maximum area in kharif (49.94%) as compared to rabi (49.82%) season out of gross cropped area (16.56 acres). In kharif season, an average farmer was found to allocate maximum area in rice (36.64%) followed by seasm (29.03%), urd (23.7%) and moong (5.20%) and others (5.93%) in Bundelkhand region of Uttar Pradesh (Table 4.11).

In rabi season, wheat was found to be dominated crop in which an average HH allocate 69.60 per cent area of total rabi season. Gram and field pea were found to be other major Rabi crops in which an average HH allocates 16.28 and 7.12 per cent of total Rabi season area respectively. Mustard and lentil 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 medium (195%) as compared to large (195%) and small (193%) size of holdings in the area under study (Table 4.11).

The preference for cultivation of various crops in Bundelkhand region of India during kharif and rabi season across various size of holdings is depicted in table 4.12 .

It is observed from the data that at overall level an average HH used to allocate maximum area in kharif (53.82%) as compared to rabi (48.14%) season out of gross cropped area (18.84 acres). In kharif season, an average farmer was found to allocate maximum area in rice (29.58%) followed by soybean (20.78%), urd (19.14%), seasm (18.01%) and moong (4.4%) and others (7.99%) in Bundelkhand region of India (Table 10.12).

In rabi season, wheat was found to be dominated crop in which an average HH allocate 63.40 per cent area of total rabi season. Gram and lentil were found to be other major Rabi crops in which an average HH allocates 22.27 and 5.51 per cent of total Rabi season area respectively. Mustard, field pea and lentil were also found to be other major crops, which were found to be cultivated by the respondents during rabi season in Bundelkhand region of India.

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



Table 4.11 :Cropping pattern of respondents of Bundelkhand Region of Uttar Pradesh (aerc/farm)

Particulars	Small	Medium	Large	Overall
<i>Kharif Season</i>				
Rice	1.11 (35.92)	2.51 (35.06)	5.46 (37.47)	3.03 (36.64)
Soybean	0 (0)	0 (0)	0 (0)	0 (0)
Urd	1.01 (32.69)	1.92 (26.8)	2.94 (20.18)	1.96 (23.7)
Sesame	0.75 (24.27)	1.99 (27.79)	4.47 (30.68)	2.4 (29.03)
Moong	0.08 (2.59)	0.4 (5.59)	0.82 (5.63)	0.43 (5.2)
Other	0.14 (4.53)	0.34 (4.75)	1.01 (6.93)	0.49 (5.93)
<b>Total Kharif</b>	<b>3.09</b> <b>(100)</b> <b>/50.74/</b>	<b>7.16</b> <b>(100)</b> <b>/48.77/</b>	<b>14.57</b> <b>(100)</b> <b>/50.38/</b>	<b>8.27</b> <b>(100)</b> <b>/49.94/</b>
<i>Rabi Season</i>				
Wheat	2.37 (79)	5.47 (72.74)	9.48 (66.06)	5.77 (69.6)
Gram	0.46 (15.33)	1.06 (14.1)	2.52 (17.56)	1.35 (16.28)
Lentil	0.01 (0.33)	0.13 (1.73)	0.39 (2.72)	0.18 (2.17)
Field Pea	0.09 (3)	0.49 (6.52)	1.19 (8.29)	0.59 (7.12)
Mustard	0.05 (1.67)	0.21 (2.79)	0.34 (2.37)	0.2 (2.42)
Other	0.02 (0.67)	0.16 (2.13)	0.3 (2.11)	0.16 (1.94)
<b>Total Rabi</b>	<b>3</b> <b>(100)</b> <b>/49.26/</b>	<b>7.52</b> <b>(100)</b> <b>/51.23/</b>	<b>14.22</b> <b>(100)</b> <b>/49.17/</b>	<b>8.25</b> <b>(100)</b> <b>/49.82/</b>
<b>Gross Cropped Area</b>	<b>6.09</b>	<b>14.68</b>	<b>28.92</b>	<b>16.56</b>
<b>Cropping Intensity %</b>	<b>193.00</b>	<b>195.00</b>	<b>194.00</b>	<b>194.00</b>

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

was found to be 190 per cent. It was found to be more in small (196%) as compared to medium (189%) and large (186%) size of holdings.

Hence, as the size of farms decrease cropping intensity was found to be decreased in Bundelkhand region of India

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Table 4.12 :Cropping pattern of respondents of Bundelkhand Region of India (acre/farm)

Particulars	Small	Medium	Large	Overall
<i>Kharif Season</i>				
Rice	1.02 (29.74)	2.05 (26.35)	5.61 (31.01)	2.89 (29.58)
Soybean	0.5 (14.58)	1.99 (25.58)	3.59 (19.85)	2.03 (20.78)
Urd	1.04 (30.32)	1.36 (17.48)	3.21 (17.74)	1.87 (19.14)
Sesame	0.54 (15.74)	1.49 (19.15)	3.27 (18.08)	1.76 (18.01)
Moong	0.11 (3.21)	0.42 (5.4)	0.77 (4.26)	0.43 (4.4)
Other	0.24 (6.78)	0.49 (6.1)	1.72 (9.12)	0.81 (7.99)
<b>Total Kharif</b>	<b>3.54</b> <b>(100)</b> <b>/53.23/</b>	<b>8.03</b> <b>(100)</b> <b>/52.62/</b>	<b>18.85</b> <b>(100)</b> <b>/54.45/</b>	<b>10.14</b> <b>(100)</b> <b>/53.82/</b>
<i>Rabi Season</i>				
Wheat	2.35 (72.98)	4.77 (63.77)	10.15 (61.37)	5.75 (63.4)
Gram	0.57 (17.7)	1.52 (20.32)	3.96 (23.94)	2.02 (22.27)
Lentil	0.14 (4.35)	0.44 (5.88)	0.93 (5.62)	0.5 (5.51)
Field Pea	0.05 (1.55)	0.25 (3.34)	0.84 (5.08)	0.38 (4.19)
Mustard	0.07 (2.17)	0.41 (5.48)	0.33 (2)	0.27 (2.98)
Other	0.06 (1.85)	0.1 (1.34)	0.28 (1.7)	0.15 (1.65)
<b>Total Rabi</b>	<b>3.24</b> <b>(100)</b> <b>/48.72/</b>	<b>7.49</b> <b>(100)</b> <b>/49.08/</b>	<b>16.49</b> <b>(100)</b> <b>/47.63/</b>	<b>9.07</b> <b>(100)</b> <b>/48.14/</b>
<b>Gross Cropped Area</b>	<b>6.65</b>	<b>15.26</b>	<b>34.62</b>	<b>18.84</b>
<b>Cropping Intensity %</b>	<b>196.00</b>	<b>189.00</b>	<b>186.00</b>	<b>190.00</b>

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

### 4.11 Status of Soil Testing and Soil Health Card of the respondents

The number of soil tested respondents and respondents received soil health card across

various size of holdings in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India is presented in table 4.13.

The soil of the farms was found to be

tested by 43, 55 and 48 per cent respondents and 36, 34 and 35 per cent respondents reported to receive soil health card in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India,

respectively. The soil testing was found to be practiced more in case of small category as compared to large and medium category respondents.

Table 4.13 :Status of soil testing and Soil Health Card (SHC) of the respondents (Numbers)

Particulars	Small	Medium	Large	Total
<b>Bundelkhand Region of India</b>				
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)
<b>Bundelkhand Region of India</b>				
No. of Respondents	40 (100)	40 (100)	40 (100)	120 (100)
No. of Soil Tested farmers	23 (58)	21 (53)	22 (55)	66 (55)
No. of farmers received SHC	15 (38)	12 (30)	14 (35)	41 (34)
<b>Bundelkhand Region of India</b>				
No. of Respondents	100 (100)	100 (100)	100 (100)	300 (100)
No. of Soil Tested farmers	52 (52)	44 (44)	48 (48)	144 (48)
No. of farmers received SHC	40 (40)	29 (29)	37 (37)	106 (35.33)

Figures in parenthesis show percent to number of respondents

#### 4.12 Sources of Information about Crop Cultivation

The source of information about various size of holdings with respect to recommended package and practices of selected crops viz soybean, wheat and gram was analysed and presented in table 4.14

The data presented in table 4.14 indicates that the major source of information was found to be agriculture department as

reported by 53, 63 and 57 per cent respondents in Bundelkhand region of Madhya Pradesh Uttar Pradesh and India, respectively. Relatives and neighbours (25.56%), progressive farmers / krishak Mitra (16.11%) in MP Bundelkhand; progressive farmers /krishak Mitra (18.33%), relatives/ neighbours (12.5%) UP Bundelkhand and relatives/ neighbours (20.33%) and progressive farmers/ krishak Mitra (17%) in India were found to be other sources of

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information. The sources of information was categories of respondents with minor found to be almost same among all the variations.

**Table 4.14 :Sources of information about crop cultivation**

Particulars	Small	Medium	Large	Overall
<b>Bundelkhand Region of Madhya Pradesh</b>				
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)
News Paper	0 (0)	0 (0)	0 (0)	0 (0)
<b>Total</b>	<b>60 (100)</b>	<b>60 (100)</b>	<b>60 (100)</b>	<b>180 (100)</b>
<b>Bundelkhand Region of Uttar Pradesh</b>				
Agriculture Department	26 (65)	20 (50)	29 (72.5)	75 (62.5)
Kisan Call Centre	1 (2.5)	3 (7.5)	0 (0)	4 (3.33)
KVK	0 (0)	2 (5)	0 (0)	2 (1.67)
Relatives/Neighbour	4 (10)	6 (15)	5 (12.5)	15 (12.5)
Progressive Farmers/ Krishak Mitra	8 (20)	9 (22.5)	5 (12.5)	22 (18.33)
News Paper	1 (2.5)	0 (0)	1 (2.5)	2 (1.67)
<b>Total</b>	<b>40 (100)</b>	<b>40 (100)</b>	<b>40 (100)</b>	<b>120 (100)</b>
<b>Bundelkhand Region of India</b>				
Agriculture Department	61 (61)	49 (49)	61 (61)	171 (57)
Kisan Call Centre	3 (3)	5 (5)	0 (0)	8 (2.67)
KVK	1 (1)	3 (3)	3 (3)	7 (2.33)
Relatives/Neighbour	17 (17)	24 (24)	20 (20)	61 (20.33)
Progressive Farmers/ Krishak Mitra	17 (17)	19 (19)	15 (15)	51 (17)
News Paper	1 (1)	0 (0)	1 (1)	2 (0.67)
<b>Total</b>	<b>100 (100)</b>	<b>100 (100)</b>	<b>100 (100)</b>	<b>300 (100)</b>

Figures in parenthesis show percent to total

### 4.13 Summary of the Chapter

The average age of the respondents in Bundelkhand region of MP, UP and India was found to be 49, 55 and 52 years having 33, 38 and 36 years of experience in farming at overall level. Out of total respondents the majority was found to be below the age of 45 years.

The average family size of respondents were found to be 7, 8 & 8, out of which 3 members were found to be engaged in farming in Bundelkhand region of MP, UP and India, respectively.

The majority of respondents in Bundelkhand region of MP, UP and India at overall level were found to be educated upto primary level (27.88, 21.67 & 25.33 %) followed by higher secondary, (20.56, 17.50 & 19.33%), matriculation (16.67, 12.50 & 15 %), graduate (11.67, 12.50 & 12%), post graduate (4.44, 9.17 & 6.33%) and above (2.22, 5.83, & 3.67%). The illiterate respondents were found to be 16.67, 20.83 & 18.33 per cent respectively.

The majority of the respondents of Bundelkhand region of Madhya Pradesh, Madhya Pradesh, Uttar Pradesh and India at overall level were found to belong to OBC (70, 46.67 & 60.67%) followed by general (14.44, 44.17 & 26.33 %) schedule caste (12.78, 9.17 & 11.33%) and scheduled Tribes (2.78, 0.00 & 1.67 %). The proportion of OBC and general was found to be more as compared to SC and ST population in Bundelkhand region of India.

All of them were found to be engaged in farming and allied activities as the main source or for their livelihood security. At overall level,

22 per cent respondents were found to be engaged as agricultural labourers, 21 percent as livestock labourers and 10 per cent as non-agricultural labourers.

On an average annual farm income in case of medium (Rs. 65357/-) in Bundelkhand region of Madhya Pradesh, large in UP (Rs. 101029/-) and India (Rs. 82045/-) was found to be more as compared to other categories in the region. The main source of income was found to be agriculture across all the categories and regions which ranged between 71 (MP) to 75 (UP) per cent at overall level and ranged between 70.72 to 79.01 per cent across all the categories and regions. The annual average income was found to be Rs.62491, 90069 and 76730 in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively, out of which 71.36, 75.68 and 73.92 per cent were found to be received from agriculture and 28.64, 24.32 and 26.08 percent from other sources, respectively.

The value of land was found to vary between Rs.434673/- (small) to Rs. 700220/- (large), Rs. 395938/- (Medium) to Rs. 412875/- (large) and Rs. 422774/- (small) to Rs. 556548 (large) per hectare with average of Rs. 558361/-, Rs.406563/- and Rs. 482462/- per hectare at overall level in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India. 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 only.

At overall level an average respondent was found to have 10.67, 8.57 and 9.62 acres of

## Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India

cultivated land with 0.77 & 0.13, 0.33 & 0.28 and 0.55 & 0.20 was leased-in/out land in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively, with 0.21 acres of uncultivated land, current fallow (0.06, 0.08 & 0.07) and old fallow (0.03, 0.01 & 0.02) constituting net operating area of 11.02, 8.33 and 9.67 acres. Out of net operated area 74, 84 & 78.5 per cent was found to be irrigated. An average operational holding of small (3.66, 3.15 & 3.40), medium (8.29, 7.45 & 7.87) and large (21.11, 14.38 & 17.74) respondents was found in Bundelkhand region of MP, UP and India.

At overall level open dug well (47.22%) followed by bore well (36.67%), canal (8.34%), pond (4.44%) and river (3.33%) in MP; tube-well (60.83%) followed by well (23.33%) canal (10 %) and river (4.27%) in UP and tube-well (46.33%) followed by well (37.67%), canal (9%) and river (3.67%) in Bundelkhand region of India were found to be major sources of irrigation in the area under study with minor variation across various size of holdings.

At overall level an average HH used to allocate maximum area in kharif (53.82%) as compared to rabi (48.14%) season out of gross cropped area (18.84 acres). In kharif season, an average farmer was found to allocate maximum area in rice (29.58%) followed by soybean (20.78%), urd (19.14%), sesam (18.01%) and moong (4.4%) and others (7.99%) in

Bundelkhand region of India.

In rabi season, wheat was found to be dominated crop in which an average HH allocate 63.40 per cent area of total rabi season. Gram and lentil were found to be other major Rabi crops in which an average HH allocates 22.27 and 5.51 per cent of total Rabi season area respectively. The cropping intensity was found to be 190 per cent which ranged between large (186%) to small (196%) across various size of land holdings.

The soil of the farms was found to be tested by 43, 55 and 48 per cent respondents and 36, 34 and 35 per cent respondents reported to receive soil health card in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively.

The major source of information was found to be agriculture department as reported by 53, 63 and 57 per cent respondents in Bundelkhand region of Madhya Pradesh Uttar Pradesh and India, respectively. Relatives and neighbours (25.56%), progressive farmers / krishak Mitra (16.11%) in MP Bundelkhand; progressive farmers /krishak Mitra (18.33%), relatives/ neighbours (12.5%) in UP Bundelkhand and relatives/ neighbours (20.33%) and progressive farmers/ krishak Mitra (17%) in India were found to be other sources of information.

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## **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 Rice**

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

#### **5.1.1 Yield Gap Analysis**

A considerable yield gap (III) of 41.88 per cent was found between potential (28 q/acre) and average farm yield (16.3 q/acre) was found on an average rice grower's farm in production of rice. Out of this total yield gap

(yield gap-III), a gap of 24.15 (yield gap-I), and 23.33 per cent (yield gap-II) was found between potential (28 q/acre) & highest farm yield (21.2 q/acre), and between the highest & average farm yield (16.3 q/acre) respectively (Table 5.1).

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 small (21.57%) as compared to medium (25.48%) and large (25.39%) farms.

Yield gap-II (23.33%) was found to be more than yield gap-I (24.15%) denoted that socio-economic constraints were found to be more important than transfer of recommended packages of practices of rice (Fig. 5.1).

**Table 5.1 :Yield gap analysis of rice of Uttar Pradesh (q/acre)**

<b>Particulars</b>	<b>Small</b>	<b>Medium</b>	<b>Large</b>	<b>Overall</b>
Potential Yield	28.0	28.0	28.0	28.0
Average Yield	16.4	15.8	16.7	16.3
Highest Yield	22.0	20.9	20.9	21.2
Yield gap-I	6.04 (21.57)	7.14 (25.48)	7.11 (25.39)	6.76 (24.15)
Yield gap-II	5.61 (25.55)	5.1 (24.42)	4.19 (20.03)	4.97 (23.33)
Yield gap-III	11.65 (41.61)	12.23 (43.68)	11.3 (40.34)	11.73 (41.88)



## Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India

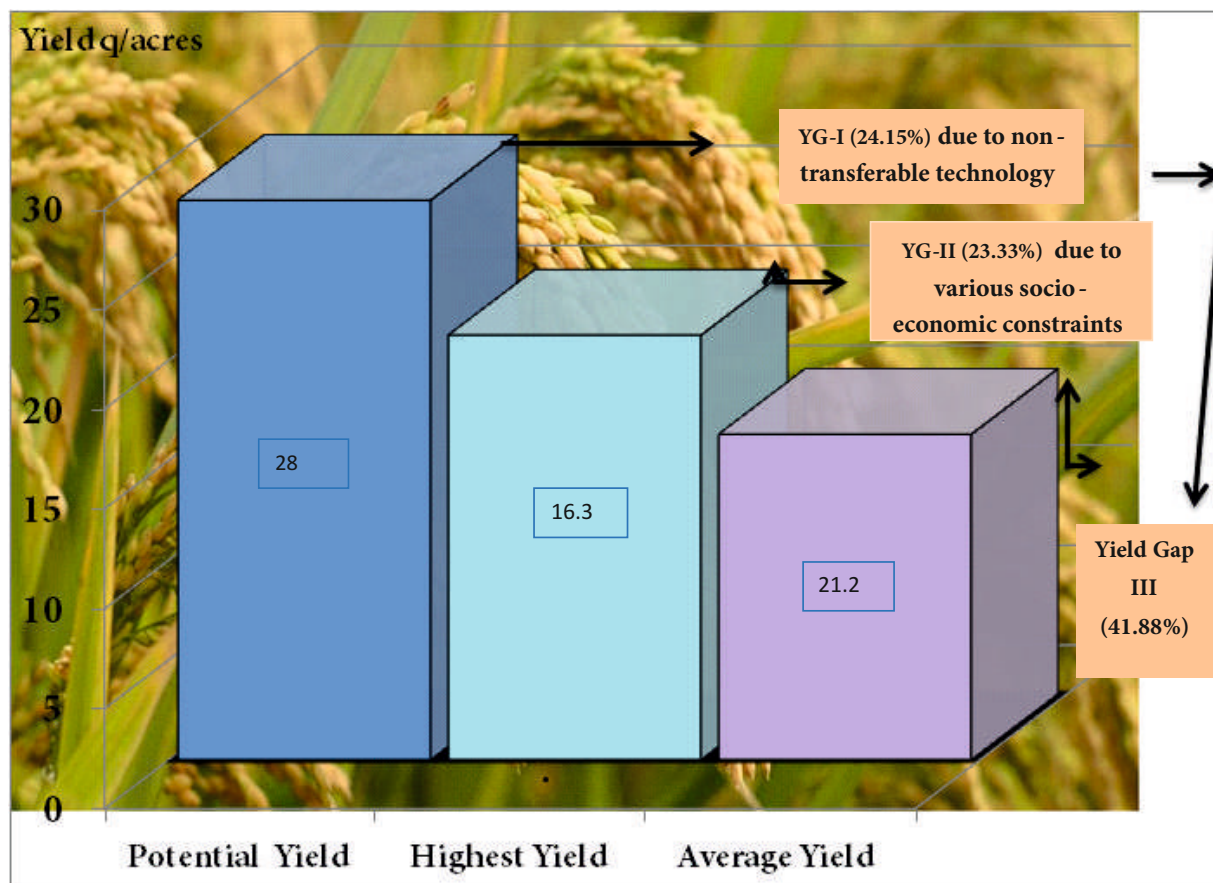


Fig. 5.1 :Yield gap in rice cultivation in Bundelkhand region of Uttar Pradesh

### 5.1.2 Constraints in adoption of recommended technology of rice Cultivation

The various constraints which were found to be faced by the respondents in

enhancing yield of rice 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 rice. Lack of suitable machinery for cultivation practices of

Table 5.2 :Constraints in adoption of recommended packages of rice of Uttar Pradesh (%)

Particulars	Small	Medium	Large	Overall
Low germination of seed	35.86	33.84	65.00	44.90
Un-availability of desired Variety of seed	84.35	64.15	75.00	74.50
Lack of suitable machinery	95.46	100.00	100.00	98.49
Lack of knowledge about method of seed treatment	51.52	46.97	55.00	51.16
High cost of input	100.00	90.00	90.00	93.33
Lack of knowledge about proper dose of fertilizer	64.15	61.62	50.00	58.59
Un-availability of capital	76.27	55.06	60.00	63.77
Un-availability of electricity on time	21.21	19.19	15.00	18.47
Lack of labour during the peak operational period	49.50	30.30	55.00	44.93
Lack of proper knowledge of Packages of practices	45.96	39.39	45.00	43.45

crop (98.49%), high cost of input (93.33%), un-availability of desired variety of HYVs seed (74.50%), un-availability of capital for purchase of inputs (63.77%), Lack of knowledge about proper dose of fertilizer application (58.59%) and lack of knowledge about method of seed treatment (51.16%) 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 labour during the peak operational periods (44.93%), low germination of seed (44.90%), lack of proper knowledge of recommended packages of practices (43.45%) and un-availability of electricity in time for peak operations of cultivation of rice (18.47%) were found to be minor constraints as reported by less than 50 per cent of respondents.

### 5.1.3 Determinants of Yield of rice

It 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 rice in Bundelkhand region of Uttar Pradesh (Table 5.3).

It is clear from the data presented in table that, the rice response in terms of productivity to use of HYV over local varieties, optimum size of holdings and improve method

Table 5.3 :Factors affecting productivity of rice of Uttar Pradesh

Particulars	Coefficients	SE	P-value
Education (X <sub>1</sub> )	7.6058N	9.0856	<b>0.4068</b>
Age (X <sub>2</sub> )	1.1152N	1.7190	<b>0.5197</b>
Source of Seed (X <sub>3</sub> )	135.2879*	53.8269	0.0154
Soil Test (X <sub>4</sub> )	81.4322**	36.2644	0.0295
Seed Rate (kg) (X <sub>5</sub> )	0.1279N	0.9016	<b>0.8878</b>
Seed Treatment(X <sub>6</sub> )	97.2556*	47.4362	0.0459
Use of HYV (X <sub>7</sub> )	154.2798**	55.2940	0.0076
Urea (kg) (X <sub>8</sub> )	1.7541	0.8949	0.0559
DAP (kg) (X <sub>9</sub> )	2.4834	1.3782	0.0780
Irrigated land (X <sub>10</sub> )	-16.9956*	7.3105	0.0245
Size of Holding (X <sub>11</sub> )	13.3519**	4.2454	0.0029
Method of Sowing (X <sub>12</sub> )	249.6084**	92.6053	0.0097
<b>R<sup>2</sup></b>	<b>0.942</b>		

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

of sowing over conventional method were found to be positive and highly significant, the use of purchased seed over owned seed, seed treatment before sowing were found to be positive and significant, while area under irrigation was found to be negative and significant. This indicates that with the use of HYVs over local varieties raising of crops in

optimum size of holdings and use of improve method of sowing over conventional method, use of purchased seed over owned farm seed, soil test based balanced application of fertilizers, proper seed treatment and optimum irrigation leads to enhancing the productivity of rice in the area under study.

## Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India

The coefficient of multiple regression model was found to be good fit as it explained 94.20 per cent ( $R^2$  0.942) of productivity of rice determined by these known independent variables and rest i.e. only 5.80 per cent was the contribution of un-known variables, which were not taken into consideration in this regression model.

### 5.2 Wheat

The potential highest and average yield along with yield gap I,II and III across various size of holdings and overall situation of Bundelkhand region of MP, UP and India presented in table 5.4

#### 5.2.1 Yield Gap Analysis

A considerable yield gap III 6.87 (29.87%), 6.7 (29.13%) and 6.7 (29.48%) q/acre between potential (23q/acre) and average yield (16.13, 16.30 and 16.22 q/acre) was found on an average wheat growers' farm in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively. Out of this total yield gap (yield gap III), a gap of 11.68, 12.61 and 12.13 per cent (yield gap I) was found between potential (23 q/acre) and highest farm yield (20.31, 20.1 and 20.21 q/acre) while 20.58, 18.91 and 19.74 per cent (yield gap II) between highest

(21.31, 20.1 and 20.21 q/acre) and average farm yield (16.13, 16.30 and 16.22 q/acre) in Bundelkhand region of MP, UP and India, respectively (Table 5.4).

The findings were found to be almost similar for all size of farms with minor variations. However yield gap I was found to be less in medium (5.87 & 9.22 %) as compared to large (12.26 & 11.57%) and small (16.91 & 15.83 %), while yield gap-II was found to be less in small (13.66 & 16.58%) as compared to large (19.87 & 18.68 %) and medium (27.34 & 23.52 %) farms in Bundelkhand region of Madhya Pradesh and India. In Bundelkhand region of Uttar Pradesh yield gap I & II were found to be less in small (10.87 & 17.56 %) as compared to medium (12.61 & 19.40 %) and large (14.78 & 19.40) farms.

The yield gap in cultivation of wheat was found to be 6.87 (29.87%), 6.7 (29.13%) and 6.7 (29.48%) q/acre with potential yield (23q/acre) in the area under study. Yield gap II (20.58, 28.91 & 19.74 %) was found to be more than yield gap I (11.70, 12.61 and 12.13 %) due to more socio-economic constraints than non-transfer of technology for cultivation of wheat in the area under study.

Table 5.4 :Yield gap analysis of wheat in Bundelkhand Region of India (q/acre)

Particulars	Small	Medium	Large	Overall
<b>Bundelkhand Region of Madhya Pradesh</b>				
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 (11.7)
Yield gap-II	2.61 (13.66)	5.92 (27.34)	4.01 (19.87)	4.18 (20.58)
Yield gap-III	6.5 (28.26)	7.27 (31.61)	6.83 (29.7)	6.87 (29.87)

## Yield Gap & Constraints Analysis and Determinants of Yield of Major Crops

Bundelkhand Region of Uttar Pradesh				
Potential	23	23	23	23
Average	15.8	16.2	16.9	16.3
Highest	19.6	20.1	20.5	20.1
Yield gap-I	3.39 (14.78)	2.89 (12.61)	2.52 (10.87)	2.93 (12.61)
Yield gap-II	3.81 (19.39)	3.88 (19.4)	3.61 (17.56)	3.77 (18.91)
Yield gap-III	7.2 (31.3)	6.77 (29.57)	6.13 (26.52)	6.7 (29.13)
Bundelkhand Region of India				
Potential	23	23	23	23
Average	16.15	15.97	16.54	16.22
Highest	19.36	20.88	20.34	20.21
Yield gap-I	3.39 (15.83)	2.89 (9.22)	2.52 (11.57)	2.93 (12.13)
Yield gap-II	3.81 (16.58)	3.88 (23.52)	3.61 (18.68)	3.77 (19.74)
Yield gap-III	7.2 (29.78)	6.77 (30.57)	6.13 (28.09)	6.7 (29.48)

Figures in parenthesis show percent yield gap

The yield gap was found to be 6.7 q/acre (29.13%) in cultivation of wheat with potential yield in the area under study. Yield gap-II

(20.58%) was found to be more than yield gap-I (11.07%) due to more socio-economic constraints than non-transfer of technologies of crop cultivation in area under study (Fig. 5.2).

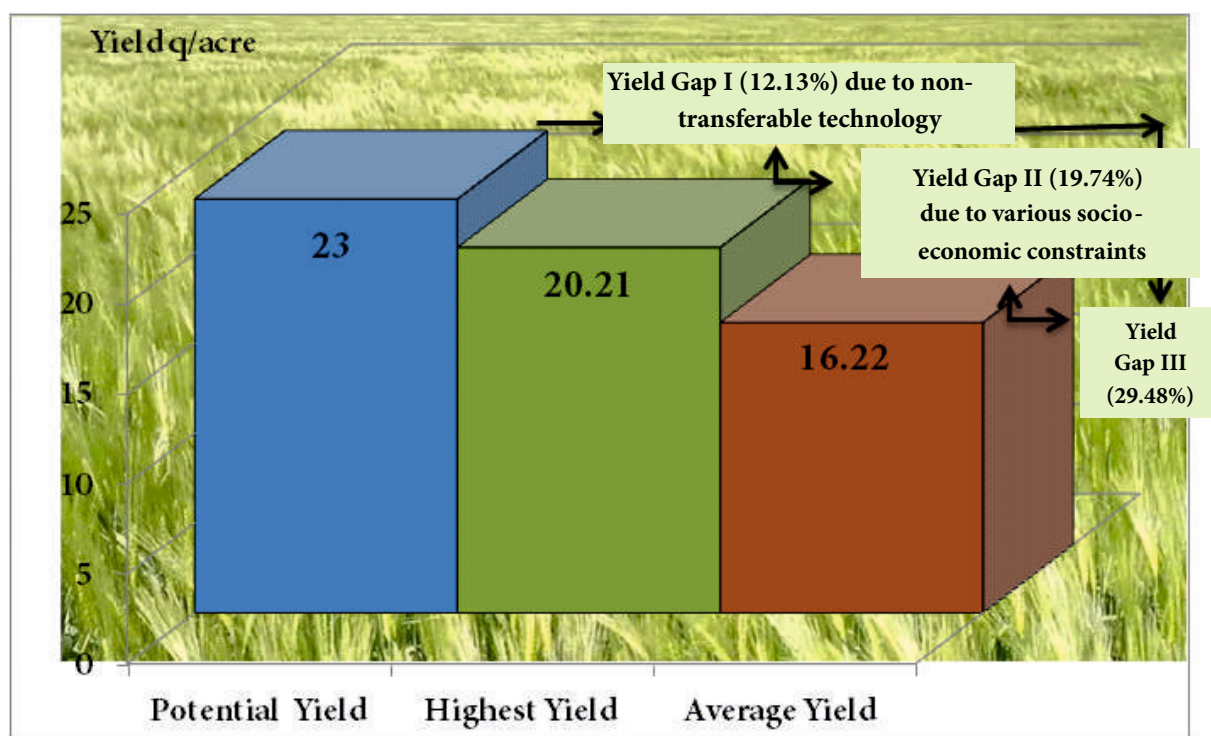


Fig. 5.2 :Yield gap in wheat cultivation in Bundelkhand region of India



### 5.2.2 Constraints in Adoption of Recommended Technology of Wheat Cultivation

The various constraints across size of holding were found to be faced by the respondents in cultivation of wheat in

Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India are presented in table 5.5.

It is observed from the data presented in table 5.5 that due to various constraints faced by the respondents in cultivation of wheat. The

Table 5.5 :Constraints in adoption of recommended packages of wheat in Bundelkhand Region of India (%)

Constraints	Small	Medium	Large	Overall
<b>Bundelkhand Region of Madhya Pradesh</b>				
Low germination of seed	30	20	20	23
Un-availability of desired variety of seed	75	85	45	68
Lack of suitable machinery	40	50	15	35
Lack of knowledge about method of seed treatment	85	80	45	70
High cost of input	85	75	60	73
Lack of knowledge about proper dose of fertilizer	80	75	55	70
Un-availability of capital	65	45	45	52
Un-availability of electricity on time	65	45	25	45
Lack of labour during the peak operational periods	45	55	30	43
Lack of proper knowledge of packages of practices	20	30	15	22
<b>Bundelkhand Region of Uttar Pradesh</b>				
Low germination of seed	65	60	85	70
Un-availability of desired variety of seed	75	60	75	70
Lack of suitable machinery	45	45	35	42
Lack of knowledge about method of seed treatment	60	70	80	70
High cost of input	95	90	85	90
Lack of knowledge about proper dose of fertilizer	40	50	70	53
Un-availability of capital	55	40	30	42
Un-availability of electricity on time	35	25	30	30
Lack of labour during the peak operational periods	40	60	85	62
Lack of proper knowledge of packages of practices	35	25	55	38
<b>Bundelkhand Region of India</b>				
Low germination of seed	48	40	53	47
Un-availability of desired variety of seed	75	73	60	69
Lack of suitable machinery	43	48	25	38
Lack of knowledge about method of seed treatment	73	75	63	70
High cost of input	90	83	73	82
Lack of knowledge about proper dose of fertilizer	60	63	63	62
Un-availability of capital	60	43	38	47
Un-availability of electricity on time	50	35	28	38
Lack of labour during the peak operational periods	43	58	58	53
Lack of proper knowledge of packages of practices	28	28	35	30

major constraint which was reported by about 80 to 90% of respondents was found to be high cost of input, about 70% respondents reported that due to unavailability of desired variety of seed, lack of knowledge about method of seed treatment and proper doses of fertilizers, while around 50 per cent reported that due to unavailability of capital and lack of labour during peak operational periods and around 30 per cent opined that due to lack of suitable machinery, unavailability of electricity on time and lack of proper knowledge of packages of practices across all the regions of Bundelkhand were found to be constraints in adoption of recommended technology of wheat cultivation.

### 5.2.3 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 India. A multiple regression model was used to draw conclusions and presented in table 5.6.

It is observed from the data that the wheat response in terms of productivity to use of purchased seed over own farm seed, soil test based application of fertilizers, balanced application of Urea and area under irrigation were found to be positive and highly significant, while use of HYV seeds and application of DAP

were found to be positive and significant. The higher seed rate and size of land holdings were found to be negative and highly significant, age of respondents was found to be negative and significant which indicates that use of higher seed rate, large size of holdings and higher age were found to be responsible for decrease in yield of wheat in area under study.

This indicates that if all things remain constant and with the present level of technological adoption of soil test based application of fertilizers, balanced use of fertilizer (Urea & DAP), use of proper seed rate, purchased seed over owned farm seeds, HYV's Seed over local varieties and proper irrigation facilities and optimum size of holdings 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 83.50 per cent ( $R^2$  0.835) of productivity of wheat determined by these known independent variables and rest i.e. only 16.50 per cent was the contribution of un-known variables which were not taken into consideration in this regression model.

### 5.3 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.

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Table 5.6 :Factors affecting productivity of wheat in Bundelkhand Region of India

Particulars	Coefficients	SE	P-value
Education (X <sub>1</sub> )	20.824	30.063	0.490
Age in years (X <sub>2</sub> )	-2.357*	1.006	0.021
Source of Seed (X <sub>3</sub> ) ( <i>Purchase-1, Self-0</i> )	148.733**	33.668	0.000
Soil Test (X <sub>4</sub> ) ( <i>Yes-1, No-0</i> )	101.797**	28.722	0.001
Seed Rate (kg) (X <sub>5</sub> )	-10.801**	3.418	0.002
Seed Treatment(X <sub>6</sub> ) ( <i>Yes-1, No-0</i> )	-17.161	33.374	0.608
Use of HYV's Seed(X <sub>7</sub> ) ( <i>HYVs-1, Local-0</i> )	75.805*	34.215	0.029
Urea (kg) (X <sub>8</sub> )	1.640**	0.580	0.006
DAP (kg) (X <sub>9</sub> )	1.561*	0.880	<b>0.079</b>
Area under Irrigation (X <sub>10</sub> )	44.273**	8.727	0.000
Size of Holding (X <sub>11</sub> )	-41.817**	7.919	0.000
<b>R<sup>2</sup> (Coefficient of Multiple Determinates)</b>	<b>0.835</b>		

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

### 5.3.1 Yield Gap Analysis

The 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 5.7).

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 (Fig. 5.3).

Table 5.7 :Yield gap analysis of gram in Bundelkhand Region of Madhya Pradesh (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



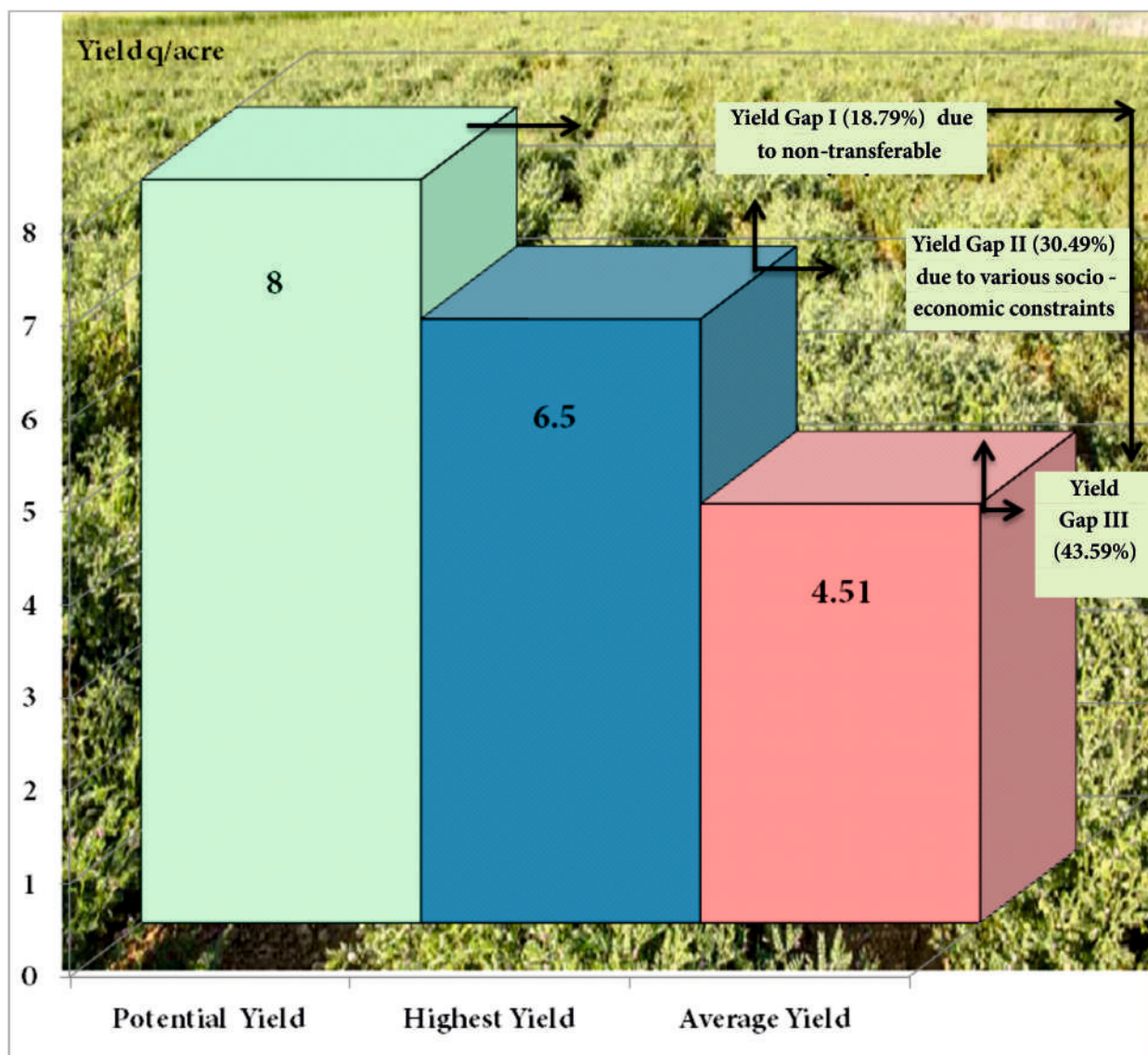


Fig. 5.3 :Yield gap in gram cultivation in Bundelkhand region of Madhya Pradesh

### 5.3.2 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 5.8. 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

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**Table 5.8 :Constraints in adoption of recommended packages of gram in Bundelkhand Region of Madhya Pradesh (%)**

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

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.

### 5.3.3 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

**Table 5.9 :Factors affecting productivity of gram in Bundelkhand Region of Madhya Pradesh**

Particulars	Coefficients	SE	P-value
Education (X <sub>1</sub> )	37.2378	17.6515	0.0401
Age in years (X <sub>2</sub> )	-1.6908	1.5099	0.2684
Source of Seed (X <sub>3</sub> ) (Purchase-1, Self-0)	49.2581	37.8205	0.1990
Soil Test (X <sub>4</sub> ) (Yes-1, No-0)	42.1450	40.5646	0.3040
Seed Rate (kg) (X <sub>5</sub> )	31.1188**	10.5891	0.0051
Seed Treatment(X <sub>6</sub> ) (Yes-1, No-0)	106.4320*	46.0713	0.0252
Use of HYV's Seed(X <sub>7</sub> ) (HYVs-1, Local-0)	154.4361**	49.6182	0.0031
Urea (kg) (X <sub>8</sub> )	35.4693**	10.5265	0.0015
DAP (kg) (X <sub>9</sub> )	2.3281	3.3762	0.4938
Area under Irrigation (X <sub>10</sub> )	63.8487*	28.0681	0.0274
Size of Holding (X <sub>11</sub> )	1.5688	1.3714	0.2583
<b>R<sup>2</sup> (Coefficient of Multiple Determinates)</b>	<b>0.839</b>		

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

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 5.9).

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 ( $R^2$  0.839) yield of gram determined by these known independent variables and rest i.e. only 15.20 per cent was the contribution of unknown variables which were not taken into consideration in this regression model.

**Table 5.10 :Yield Gap analysis of soybean in Bundelkhand Region of Madhya Pradesh (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)

## 5.4 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.

### 5.4.1 Yield Gap Analysis

The 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 5.10).

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



Figures in parenthesis show percent to yield gap

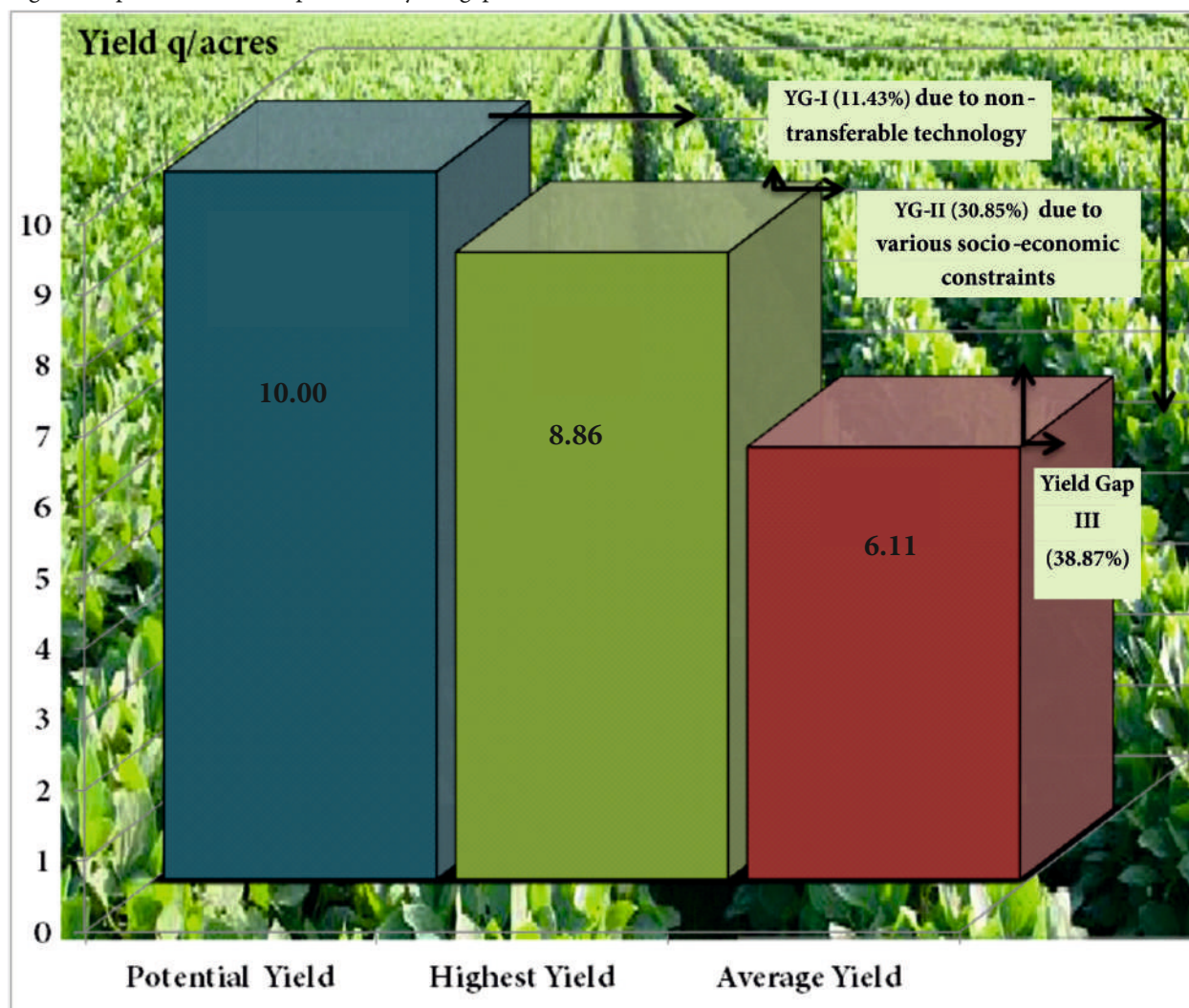


Fig. 5.4 :Yield gap in soybean cultivation in Bundelkhand region of Madhya Pradesh

socio-economic constraints were found to be more important than transfer of recommended packages of practices of soybean (Fig. 5.4).

#### 5.4.2 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 5.11.

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

Table 5.11 :Constraints in adoption of recommended packages of soybean in Bundelkhand Region of Madhya Pradesh (%)

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

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.

#### 5.4.3 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 5.12).

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

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83.90 per cent ( $R^2$  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 5.12 :Factors affecting productivity of soybean in Bundelkhand Region of Madhya Pradesh**

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 ( $X_3$ ) ( <i>Purchase-1, Self-0</i> )	103.7147	58.7358	0.0839
Soil Test ( $X_4$ ) ( <i>Yes-1, No-0</i> )	53.5092	95.6298	0.5784
Seed Rate (kg) ( $X_5$ )	3.8736*	1.7874	0.0353
Seed Treatment( $X_6$ ) ( <i>Yes-1, No-0</i> )	29.8112	46.4124	0.5238
Use of HYV's Seed ( $X_7$ ) ( <i>HYVs-1, Local-0</i> )	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 ( $X_{12}$ ) ( <i>Line sowing=1 &amp; Broadcasting=0</i> )	203.5692	107.5977	0.0647
<b><math>R^2</math> (Coefficient of Multiple Determinates)</b>	<b>0.839</b>		

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

### 5.5 Summary of the Chapter

A considerable yield gap III 6.87 (29.87%), 6.7 (29.13%) and 6.7 (29.48%) q/acre between potential (23q/acre) and average yield (16.13, 16.30 and 16.22 q/acre) was found on an average wheat growers' farm in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively. Out of this total yield gap (yield gap III), a gap of 11.68, 12.61 and 12.13 per cent (yield gap I) was found between potential (23 q/acre) and highest farm yield (20.31, 20.1 and 20.21 q/acre) while 20.58, 18.91 and 19.74 per cent (yield gap II) between highest (21.31, 20.1 and 20.21 q/acre) and average farm yield (16.13, 16.30 and 16.22 q/acre) in

Bundelkhand region of MP, UP and India, respectively.

The various constraints faced by the respondents in cultivation of wheat. The major constraint which was reported by about 80 to 90% of respondents was found to be high cost of input, about 70% respondents reported that due to unavailability of desired variety of seed, lack of knowledge about method of seed treatment and proper doses of fertilizers, while around 50 per cent reported that due to unavailability of capital and lack of labour during peak operational periods across all the regions of Bundelkhand in adoption of recommended technology of wheat cultivation

wheat response in terms of productivity to use of purchased seed over own farm seed, soil test based application of fertilizers, balanced application of Urea and area under irrigation were found to be positive and highly significant, while use of HYV seeds and application of DAP were found to be positive and significant. The higher seed rate and size of land holdings were found to be negative and highly significant, age of respondents was found to be negative and significant which indicates that use of higher seed rate, large size of holdings and higher age were found to be responsible for decrease in yield of wheat in area under study.

The 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

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.

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 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 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.

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.



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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.

A considerable yield gap (III) of 41.88 per cent was found between potential (28 q/acre) and average farm yield (16.3 q/acre) was found on an average rice grower's farm in production of rice. Out of this total yield gap (yield gap-III), a gap of 24.15 (yield gap-I), and 23.33 per cent (yield gap-II) was found between potential (28 q/acre) & highest farm yield (21.2 q/acre), and between the highest & average farm yield (16.3 q/acre) respectively.

The yield gap was found due to various constraints faced by the respondents in cultivation of rice. Lack of suitable machinery for cultivation practices of crop (98.49%), high cost of input (93.33%), un-availability of desired

variety of HYVs seed (74.50%), un-availability of capital for purchase of inputs (63.77%), Lack of knowledge about proper dose of fertilizer application (58.59%) and lack of knowledge about method of seed treatment (51.16%) were found to be major constraints as reported by more than 50 per cent of respondents in adoption of recommended package of farming system.

The rice response in terms of productivity to use of HYV over local varieties, optimum size of holdings and improve method of sowing over conventional method were found to be positive and highly significant, the use of purchased seed over owned seed, seed treatment before sowing were found to be positive and significant, while area under irrigation was found to be negative and significant. This indicates that with the use of HYVs over local varieties raising of crops in optimum size of holdings and use of improve method of sowing over conventional method, use of purchased seed over owned farm seed, soil test based balanced application of fertilizers, proper seed treatment and optimum irrigation leads to enhancing the productivity of rice in the area under study.

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### 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

Improvement in crop yields is essential to meet the increasing demand for food driven by the increasing population and to enhance 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 and covers to both mental acceptance and 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.

## Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India

- e) To suggest 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. Therefore, wheat (36%), rice (18%), soybean (14%) and gram (6%) were considered for analysis of yield gap in Bundelkhand Region of India. Wheat was found to be major crop grown in both the regions, while rice was found to be grown in UP Bundelkhand & soybean (14%) and gram were found to be grown in MP Bundelkhand as major crops other than wheat. Gram occupied only 6 per cent of Gross Cropped Area in Bundelkhand region of India, however, it was considered for the analysis because it was found to be major pulse crop grown in more than 10 per cent of gross cropped area 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 crop. 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%) & Damoh (-4.04%) districts were selected for gram for the study in Bundelkhand region of Madhya Pradesh, While Lalitpur (-82.47%) & Banda (-24.71%) districts have been selected for rice and Mahoba (-51%)

& Jalaun (-0.85%) districts have been selected for wheat for the study in Bundelkhand region of Uttar 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. 30 farmers each from high and low yield gap districts, total 60 farmers were selected for the each selected crops. Thus  $60 \times 3 = 180$  farmers were selected in Bundelkhand Region of Madhya Pradesh and  $60 \times 2 = 120$  farmers were selected in Bundelkhand Region of Uttar Pradesh for the study. In total 300 respondents were selected in the area under study from Bundelkhand Region of India

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.

## 6.1 Conclusions

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

### 6.1.1 Overview of Bundelkhand

- The Bundelkhand region of India occupies 70,765 square kilometer area, out of which 58% was covered by Madhya Pradesh Bundelkhand and 42% by Uttar Pradesh Bundelkhand regions. There were 14 districts (7 each in MP & UP) having 76 tehsils (50 in MP & 26 in UP), 5043 gram Panchayats (2164 in MP & 2879 in UP) and 11526 villages (6285 in MP & 5241 in UP) in Bundelkhand region of India. The population density of Bundelkhand region of India was found to be 269 persons/sq.km (209 in MP & 329 in UP).
- The total population of Bundelkhand region of India was found to be 183.35 lakhs, out of which, 53.05 and 46.95 per cent were found to be male and female, respectively. The population of rural (77.58%) was found to be more as compared to urban (22.42%) population with only 15.2% of children. The region was found to be dominated by Hindus followed by Muslims and other religions. An average literacy rate of the region was found to be 64%, which was more in male (73%) as compared to female (53%) population. The sex and child sex ratio was found to be 886 and 897 over 1000 male in the region.
- The total geographical area of Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 41.28, 29.62 and 70.90 lakh ha, respectively. Out of total geographical area in Bundelkhand region of India 57.43, 20.06, 10.99, 7.01 and 4.65 percent was found to be net area sown, area covered under forest, land not available for cultivation, other uncultivated land excluding fallow land and fallow land, respectively.
- The net irrigated area in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 13.44, 13.70 and 27.14 lakh hectares. Amongst different sources of irrigation, well (41.84%) followed by tube Wells (19.22%), canals (15.30%) and tanks, (3.09%) in Madhya Pradesh Bundelkhand and canals (34.76%) followed by tube Wells (32.85%), wells (23.37%) and tanks (7.44%) in Uttar Pradesh Bundelkhand found to be sources of irrigation. The net irrigated area was found to be 49.5 and 50.5 Madhya Pradesh and Uttar Pradesh Bundelkhand region respectively.
- The cropping pattern of Bundelkhand region was found to be dominated during Rabi in Madhya Pradesh (57.92%), Uttar Pradesh (60.20%) and in the country (59.02%) as compared to 42.08, 39.8 and 40.98 per cent in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India,

- respectively. Gross cropped area of Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 32.86, 30.55 and 31.70 lakh ha with cropping intensity of 164, 141 and 152.5, respectively. Wheat (27.46%) followed by gram (12.31%), soybean (8.45%), rice (4.09%) and sesame (2.66%) were found to be major crops grown in Bundelkhand region of India.
- The total consumption of fertilizers in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India were found to be 3148, 521324 and 552 805 tons per year. Out of total fertilizer consumed in Bundelkhand region in India, only 6 per cent was found to be consumed Madhya Pradesh Bundelkhand, while 94 per cent by Uttar Pradesh Bundelkhand. The maximum fertilizer consumed in Bundelkhand Region of India was found to be Urea (55.45%) followed by DAP (30.00%), Complex (11.57%), SSP (2.74%) and SSP (0.23%), respectively.
  - The number of different grades of regulated markets in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India were found to be 38, 58 and 96. The proportion of D, B, C & A grades regulated markets were found to be 52.63, 26.32, 13.16 & 7.89 per cent in Madhya Pradesh Bundelkhand, 46.55, 17.24, 20.69 & 15.52 per cent in Uttar Pradesh Bundelkhand and 48.96, 20.83, 17.71 & 12.50 in Bundelkhand region of India.
  - The total number of land holdings in Bundelkhand region of Madhya Pradesh Uttar Pradesh and India were found to be 1291038, 1486001 and 2777039, respectively. The proportion of small and marginal farmers was found to be around 75%, semi medium around 15%, medium around 8% and large around 1% across Bundelkhand regions of Madhya Pradesh, Uttar Pradesh and India
  - The total area under different size of holdings in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India were found to be 24.39, 21.25 and 45.64 lac hectares, respectively. Out of total area occupied by different size of holdings, the area occupied under marginal & small size of land holdings was found to be 38 and 25 per cent under semi-medium, around 30 per cent under medium and 8 percent under large categories.
  - The working population in Bundelkhand region of India was found to be 1799 1426, out of which 48.10 and 51.90 were found to be residents of Bundelkhand region of MP and UP, respectively. Bundelkhand region of MP, UP and India have more number of non-workers (56.77, 62.68 & 59.84 per cent) as compared to man (31.40, 24.92 & 28.03 per cent) and marginal (11.83, 12.40 & 12.12 per cent) workers. Out of main and marginal workers, majority of them were found to be

agricultural labourers (36%) followed by cultivators (34%), other works (24%) and workers in household industry (6%).

- The total number of plough, bullock carts, electric pumps, diesel pumps, tractors and sugarcane cutter in Bundelkhand region of India were found to be 743460, 253680, 270584, 272517, 121685 and 2347.
- The total number of livestock in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India was found to be 4934833, 3657154 and 8591987, respectively. Among different livestock the population of cow (36.53%) was found to be more as compared to goat (29%), buffaloes (28.74%) and sheep & pig (2.9% each). The population of cow buffaloes and pig was found to be more in MP Bundelkhand (41.62, 33.69 and 2.87 %) as compared to UP Bundelkhand (29.67, 22.07 and 2.77%), while population of goat and sheep was found to be less in MP Bundelkhand (19.89 & 1.94 %) as compared to UP Bundelkhand (41.29 & 4.21%).

### 6.1.2 Socio-economic Characteristics

- The average age of the respondents in Bundelkhand region of MP, UP and India were found to be 49, 55 and 52 years having 33, 38 and 36 years of experience in farming at overall level. Out of total respondents the majority was found to be below the age of 45 years.
- The average family size of respondents were found to be 7, 8 & 8, out of which 3 members were found to be engaged in farming in Bundelkhand region of MP, UP and India, respectively.
- The majority of respondents in Bundelkhand region of MP, UP and India at overall level were found to be educated upto primary level (27.88, 21.67 & 25.33 %) followed by higher secondary, (20.56, 17.50 & 19.33%), matriculation (16.67, 12.50 & 15 %), graduate (11.67, 12.50 & 12%), post graduate (4.44, 9.17 & 6.33%) and above (2.22, 5.83, & 3.67%). The illiterate respondents were found to be 16.67, 20.83 & 18.33 per cent respectively.
- The majority of the respondents of Bundelkhand region of Madhya Pradesh Madhya Pradesh, Uttar Pradesh and India at overall level were found to be belong to OBC (70, 46.67 & 60.67%) followed by general (14.44, 44.17 & 26.33 %) schedule caste (12.78, 9.17 & 11.33%) and scheduled Tribes (2.78, 0.00 & 1.67 %). The proportion of OBC and general was found to be more as compared to SC and ST population in Bundelkhand region of India.
- All of them were found to be engaged in farming and allied activities as the main source or for their livelihood security. At overall level, 22 per cent respondents were found to be engaged as agricultural labourers, 21 percent as livestock labourers and 10 per cent as non-agricultural labourers.



## Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India

- On an average annual farm income in case of medium (Rs. 65357/-) in Bundelkhand region of Madhya Pradesh, large in UP (Rs. 101029/-) and India (Rs. 82045/-) was found to be more as compared to other categories in the region. The main source of income was found to be agriculture across all the categories and regions which ranged between 71 (MP) to 75 (UP) per cent at overall level and ranged between 70.72 to 79.01 per cent across all the categories and regions. The annual average income was found to be Rs.62491, 90069 and 76730 in Bundelkhand region of Madhya Pradesh Uttar Pradesh and India, respectively, out of which 71.36, 75.68 and 73.92 per cent was found to be received from agriculture and 28.64, 24.32 and 26.08 percent from other sources, respectively.
- The value of land was found to vary between Rs.434673/- (small) to Rs. 700220/- (large), Rs. 395938/- (Medium) to Rs. 412875/- (large) and Rs. 422774/- (small) to Rs. 556548 (large) per hectare with average of Rs. 558361/-, Rs.406563/- and Rs. 482462/- per hectare at overall level in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India. 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 only.
- At overall level an average respondent was found to have 10.67, 8.57 and 9.62 acres of cultivated land with 0.77 & 0.13, 0.33 & 0.28 and 0.55 & 0.20 was leased-in/out land in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively, with 0.21 acres of uncultivated land, current fallow (0.06,0.08 & 0.07) and old fallow (0.03, 0.01 & 0.02) constituting net operating area of 11.02, 8.33 and 9.67 acres. Out of net operated area 74, 84 & 78.5 per cent was found to be irrigated. An average operational holding of small (3.66, 3.15 & 3.40), medium (8.29, 7.45 & 7.87) and large (21.11, 14.38 & 17.74) respondents was found in Bundelkhand region of MP, UP and India.
- At overall level open dug well (47.22%) followed by bore well (36.67%), canal (8.34%), pond (4.44%) and river (3.33%) in MP; tube-well (60.83%) followed by well (23.33%) canal (10 %) and river (4.27%) in UP and tube-well (46.33%) followed by well (37.67%), canal (9%) and river (3.67%) in Bundelkhand region of India were found to be major sources of irrigation in the area under study with minor variation across various size of holdings.
- At overall level an average HH used to allocate maximum area in kharif (53.82%) as compared to rabi (48.14%) season out of gross cropped area (18.84 acres). In kharif season, an average farmer was found to allocate maximum



area in rice (29.58%) followed by soybean (20.78%), urd (19.14%), sesam (18.01%) and moong (4.4%) and others (7.99%) in Bundelkhand region of India.

- In rabi season, wheat was found to be dominated crop in which an average HH allocate 63.40 per cent area of total rabi season. Gram and lentil were found to be other major Rabi crops in which an average HH allocates 22.27 and 5.51 per cent of total Rabi season area respectively. The cropping intensity was found to be 190 per cent which ranged between large (186%) to small (196%) across various size of land holdings.
- The soil of the farms was found to be tested by 43, 55 and 48 per cent respondents and 36, 34 and 35 per cent respondents reported to receive soil health card in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively.
- The major source of information was found to be agriculture department as reported by 53, 63 and 57 per cent respondents in Bundelkhand region of Madhya Pradesh Uttar Pradesh and India, respectively. Relatives and neighbours (25.56%), progressive farmers / krishak Mitra (16.11%) in MP Bundelkhand; progressive farmers /krishak Mitra (18.33%), relatives/ neighbours (12.5%) UP Bundelkhand and relatives/ neighbours (20.33%) and progressive farmers/ krishak Mitra

(17%) in India were found to be other sources of information.

### 6.1.3 Yield Gap and Constraints Analysis

- A considerable yield gap III 6.87 (29.87%), 6.7 (29.13%) and 6.7 (29.48%) q/acre between potential (23q/acre) and average yield (16.13, 16.30 and 16.22 q/acre) was found on an average wheat growers' farm in Bundelkhand region of Madhya Pradesh, Uttar Pradesh and India, respectively. Out of this total yield gap (yield gap III), a gap of 11.68, 12.61 and 12.13 per cent (yield gap I) was found between potential (23 q/acre) and highest farm yield (20.31, 20.1 and 20.21 q/acre) while 20.58, 18.91 and 19.74 per cent (yield gap II) between highest (21.31, 20.1 and 20.21 q/acre) and average farm yield (16.13, 16.30 and 16.22 q/acre) in Bundelkhand region of MP, UP and India, respectively.
- The various constraints faced by the respondents in cultivation of wheat. The major constraint which was reported by about 80 to 90% of respondents was found to be high cost of input, about 70% respondents reported that due to unavailability of desired variety of seed, lack of knowledge about method of seed treatment and proper doses of fertilizers, while around 50 per cent reported that due to unavailability of capital and lack of labour during peak operational periods across all the regions of Bundelkhand in adoption of recommended technology of wheat cultivation

## Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of India

- The 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
- 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.
- The 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.
- 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.
- A considerable yield gap (III) of 41.88 per cent was found between potential (28 q/acre) and average farm yield (16.3 q/acre) was found on an average rice grower's farm in production of rice. Out of this total yield gap (yield gap-III), a gap of 24.15 (yield gap-I), and 23.33 per cent (yield gap-II) was found between potential (28 q/acre) & highest farm yield (21.2 q/acre), and between the highest & average farm yield (16.3 q/acre) respectively.
- The yield gap was found due to various constraints faced by the respondents in cultivation of rice. Lack of suitable machinery for cultivation practices of crop (98.49%), high cost of input (93.33%), un-availability of desired variety of HYVs seed (74.50%), un-availability of capital for purchase of inputs (63.77%), Lack of knowledge about proper dose of fertilizer application (58.59%) and lack of knowledge about method of seed treatment (51.16%) were found to be

major constraints as reported by more than 50 per cent of respondents in adoption of recommended package of farming system.

#### 6.1.4 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 about 85 per cent contribution of known independent variables. Independent variables like use of high yielding varieties (HYVs) seed, improved method of sowing (rice), source of seed (rice & wheat), seed rate (soybean & gram), use of DAP (soybean & wheat) application of Urea (wheat) treatment with fungicide and bio-fertilizers in rice and gram (Rhizobium, azotobacter and Phosphate Solubilizing Bacteria), irrigation (wheat, soybean and gram) soil testing (rice and wheat) were found to be positive and significant, while area under irrigation (rice), size of land holding (soybean and wheat) and seed rate (wheat) were found to be negative and significant. This indicates that with the increase in the factors which are positive and significant the yield of crop will increase and vice-versa.

#### 6.2 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 India. 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, Bundelkhand Region of India followed by producers before the start of the season in the nearest KVK. The whole training must be designed keeping in the view the field staffs and producers of the area which will directly reflect into the productivity of crops.
- ❖ One or two demonstration should be conducted in villages keeping in view the complete transfer of technology with full package of practices should be planed along with 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 be able to learn by seeing 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

desired variety seed was found to be major constraint in cultivation of crops.

- ❖ It is also found during the course of investigation that majority of farmers did 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 India for fostering the all round growth of the region in true sense.
- ❖ It is observed from the study that “Toll Free Number” of the Kisan Call Centre (1800-180-1551) was not reported by the respondents as main source of information dissemination for the farmers in the area under study. Hence, strategies should be made in 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) is to be adopted to motivate farmers to accept technological change in agriculture.

Thus, the yield gap of crops can only be narrowed down through enhancing productivity by better management of available farm resources and proper allocation of funds for purchase of inputs. This needs strengthening of knowledge of producers of Bundelkhand Region of India 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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