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

Prof. G.C. Tripathi

Study Sponsored by Ministry of Agriculture and Farmers Welfare

Government of India, New Delhi

Agro-Economic Research Centre
University of Allahabad
Prayagraj-211002

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Preface

During last few decades Indian Agriculture has undergone a number of changes in terms of advancements in agricultural technology and cultivation practices with the result that our country has been able to touch the record foodgrains production mark of 279.50 million tonnes in 2017-18 against 50.82 million tonnes in the year 1950-51. But still we lag behind a number of countries in respect of crop productivity i.e. the yield. As such, mainly it is the yield factor which ought to be considered as a remedial measure to increase overall aggregate crop productions for meeting the ever increasing food demand of our countrymen. The 'Yield Gap' studies in this regard are of prime importance, firstly, to identify the various causative factors and constraints for these gaps and secondly, to suggest ways and means to minimize these yield gaps. This will achieve the ultimate aim of attaining higher crop productions.

The present study has its own importance in this regard as it aims at (i) increasing yield levels of the two foremost crops i.e. paddy and wheat in the region of study, since empirical findings show that there exist high yield gaps in these two crops in the Bundelkhand region, which is the least developed region of the country and (ii) enhancing overall aggregate production of these two crops by narrowing down the crop yield gaps.

The present study has been conducted under the overall guidance of Agro-Economic Research Centre (AERC), Jabalpur, the Coordinating Centre of this study. For this I place on record our gratitude to the Coordinating Centre.

The study was undertaken under my overall supervision. The field survey, tabulation and analysis of data were conducted by Dr. H.C. Malviya, Sri. Hasib Ahmad and Sri. S.N. Shukla of the Centre and Sri Ovesh Ahmad typed nicely the report while the supervision as well as drafting of report was accomplished by Dr. Ashok Kumar, Research Officer (Contractual) of the Centre. I acknowledge, with thanks, the valuable contributions of all the concerned officials of the State, district, block, village levels and the sample farmers who assisted and cooperated in this study selflessly at various stages, and many times, at personal inconveniences.

Comments and suggestions will be thankfully acknowledged and solicited.

Agro-Economic Research Centre
University of Allahabad

(G.C. Tripathi)
Prof. & Hony. Director

Dated: 19/02/2020

Credit

Prof. G.C. Tripathi	**Overall Supervision**
Dr. Ashok Kumar R.O. (Contractual)	Supervision of the Analysis of Data and the Drafting of Report
Sri. Hasib Ahmad	Planning and Conducting of Field Survey, Tabulation & Analysis of Data
Dr. H. C. Malviya	-Do-
Sri S.N. Shukla	-Do-
Sri Ovesh Ahmad	Typing of the Report
Ms. Twinkle Thapa	Tabulation and Typing of the Report
Sri S.D. Singh	Secretarial Services
Shri H.C. Upadhyay	Photocopying of the Report
Shri. Raju Kumar	Support Service

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INTRODUCTION

1.1 Background

Among three principal components of a crop, viz. Area, Production and Yield the yield (productivity) i.e. production per unit area of land, is the key component and of vital importance. This is so, since the 'land' as an input factor in producing a crop, is the most scarce resource in agriculture and, therefore, to increase overall agricultural production, in general, and specific crop production, in particular, the main emphasis has to be laid on the yield factor. This, in turn, focuses the attention on working out strategies to Bridge Yield Gap of major crops, to the bare minimum. This aims at enhancing aggregate crop production, as a contributing factor to boost regional/national economy.

Assessing the yield gap in major food crops can help in understanding (i) yield variability, (ii) yield potential and (iii) the input use efficiency of major crops; as a guideline to indicate appropriate pathways for improving agricultural efficiencies and farm income.

Further, it is also the need of the hour to update farmer's knowledge in respect of causes of yield gaps in crops and the corresponding measures thereof to narrow these gaps through training, demonstration, field visits and monitoring by extension agencies towards achieving high yield. The government, on realizing the existence of yield gap in different crops, has, therefore, to explore the scope of increasing production as well as its main concomitant i.e. the productivity of crops by narrowing down the yield gap to the minimum to ensure food security for the rural masses, in particular, and the entire population, in general.

1.2 Need for the Study

While, few studies of this type have already been conducted in the country, the present study will be most useful in exploring the possibility of increasing farmer's income in the area of study through (i) analysis of yield gap, (ii) constraints analysis thereof and (iii) identifying the factors which affect the productivity of major crops on different size of farms.

Such studies are also of importance on account of the fact that, India has attained the record foodgrains production of 279.5 million tonnes in the year 2017-18[1] as a result of advancements in Indian Agriculture and Farmers awareness thereof. It compares well against just 50.82 million tonnes in 1950-51.But still it is lagging much behind in respect of yield factor, for major crops like wheat and rice. As per statistics of the year 2015-16[2]. India has got an average yield of only 35.85 ql./ha. as compared to that of 84.92 ql./ha. in USA and 95.30 ql./.ha. in Egypt against overall world average of 45.57 ql./ha. for Rice; while for wheat India's average is 31.46 ql./ha. against that of 73.52 ql./ha. in France and 85.78 ql./ha. in United Kingdom (UK) with world average of 33.07 ql./ha. The present study will, therefore, serve as a guideline in getting pathways of bridging yield gaps of such crops to the all possible extent, right from the micro (regional) to macro (national) level.

1.3 Specific Objectives

The specific objectives set forth for this study are underlined as under:

a) To specify various socio-economic characteristics of farmers of different categories (based on size of farms).
b) To analyze yield gap of major crops grown by the cultivators of different size of farms.
c) To identify factors affecting productivity of major crops.
d) To identify various socio-economic, technological constraints of major crops.
e) To suggest policy implication(s) to narrow down yield gap of major crops to the minimum.

1.4. Review of Literature

Due to ever increasing demographic pressure on land in terms of population rise in the country to the extent that by the year 2050, India's population is expected to surpass even that of China (which at present is the highest populated country in the world), the significance of crop yield has gained its own importance, since this is the main contributor among others to enhance overall aggregate production of crops towards availability of food to countrymen. This, in turn, focuses attention of policy makers to take suitable measures to narrow down these gaps to the bare

1. 3rd Advance Estimated for 2017-18; (State of Agriculture – 2017, P.11) Ministry of Agriculture and Farmers Welfare, Govt. of India.
2. Fertilizer Statistics 2015-16 (Uttar Pradesh Ka Krishi Akda October 2018) P. 171-172

minimum. A number of studies have come up on this issue at National and International levels, during the present and yester years; of which a few are listed herein:

- Van Ittersum etal, (2013)

M.K. Van Ittersum, K.G. Cassman, P.Grassini, J.Welf, P. Tittonel, Z. Hochman

Yield Gap Analysis with Local to Global Relevance – A Review Field Crops Research, Volume 143 (March, 2013) PP 4-17.

(i) Yield of crops must increase with sustainability over the coming decades to keep pace with global food demand driven by population and income growth.

(ii) Quantifying food production capacity on every hectare of current farm land in a consistent and transparent manner is needed, to inform decision on policy research development and investment, that aim to affect future crop yield and land use and to inform on ground action by local farmers, through their knowledge networks.

(iii) Crop production capacity can be evaluated by estimating potential yield and water limited yield as bench marks for crop production under irrigated and rainfed conditions respectively.

(iv) The differences between these theoretical yield levels and the actual farmers yield define the yield gaps; and that, precise spatially explicit knowledge about these yield gaps, is essential and the need of hour to guide sustainable intensification of agriculture.

(v) Empirical methods estimate 90 to 95thpercentiles of farmers yield; maximum yields from experiment stations; grower's yield contests or boundary functions; which are compared with crop simulation of potential or water limited yield. Based on reviews of various studies; key components for a yield gap assessment can be recommended and applied at local to global levels.

- Evans 1993, Van Ittersum and Rabbinge, (1997) :

(i) Yield Potential (Y_p) also called Potential Yield; is the yield of a crop cultivar when grown with water and nutrients non-limiting and biotic stress effectively controlled in areas without major soil constraints.

(ii) Y_p is the most relevant bench mark for irrigated systems or systems in humid climate with adequate water.

(iii) For rainfed crop; water limited yield (Y_w) equivalent to water limited potential yield, is the most relevant bench mark.

(iv) Average Yield (Y_a) is defined as the yield actually achieved in a farmers' field; while

(v) Yield Gap (Y_g) is the difference between Y_p (irrigated crops) or Y_w (rainfed crops) and the actual yield (Y_a). It is to be mentioned that, both Y_p and Y_w are highly variable across and within regions.

(vi) Since, crop yield actually achieved (obtained) in a cultivar's field, depends upon a number of factors like sowing dates, planting density, cultivar's maturity, cropping system, nutrient management, crop protection measures; finding Y_a needs special care and caution.

(vii) Potential yield is location specific because of climate; but in theory not dependent on soil properties assuming that required water and materials can be added through management; and that

(viii) Y_p, Y_w, Y_a and Y_g must be defined for a definite geographical units and timeframe. These taken together along with WP (Water Productivity) determine crop production potential of current cropping systems with available land and water resources.

- Lobell etal (2009)

The following four methods can be distinguished to estimate yield gaps at local level:
(1) Field Experiments, (2) Yield Contests, (3) Maximum Farmer Yield, based on surveys and (4) Crop model simulations.

- Lobel, Cassman and Field (2009)

Yield Gap is calculated by substriding achieved yield from the yield potential.

- Pushpa and S.K. Srivastava May 13, 2014

Yield Gap Analysis and the determinants of Yield Gap in Major Crops in Eastern Region of Uttar Pradesh:

In Uttar Pradesh, yield gap varied from 20.01 to 53.85%, 15.56 to 30.10% and 5.8 to 28.89% with the average gap of 28.86%, 20.03% and 17.5% for rice, wheat and sugarcane crops respectively in the irrigated region of Uttar Pradesh. The yield gaps are mainly caused by socio-economic, credit institutional policy related factors, extension services and lack of improved technology.

- Prem Chandra etal, 2006

Prem Chandra, Udai Raj, PP Dubey and Ashok Kumar, Sustainability of fine cereals in Bundelkhand Region of Uttar Pradesh A Growth Performance Analysis: Journal of Indian Society of Agricultural Statistics, Vol. 60, No. 3, Dec. 2006, PP 177-178.

While attempting to examine growth behavior of production, through its main concomitants AREA and YIELD and working out its instability coefficient with exploring possible reasons thereof, in Bundelkhand Region of Uttar Pradesh with district Banda as a case and confining to fine cereals paddy and wheat; based on analysis of time series data 1980-81 to 2002-03; report that (i) Both these crops have potential to be grown in the region and favoured by most of the farmers for involving relative lower risk on account of frost, diseases and pests, (ii) Paddy reflected better in terms of YIELD, (iii) Both wheat and rice suffer from inadequate availability of assured irrigation at the required time as also those of input mixes, associated with price and marketing constraints, (iv) while paddy had no competing crop on its specific land, wheat competed with pulses like lentil, gram, pea and that (v) self-sustaining growth of both wheat and rice (paddy) can be well maintained through better facility in terms of assured irrigation, adequate and timely supply of input mixes, supplemented with price incentives and marketing facilities.

- Ashok Kumar, 1984

Production's response to Rainfall and Irrigation – A case study of wheat and rice in Allahabad district of Uttar Pradesh: Journal of Indian Society of Agricultural Statistics, Vol. XXXVI, No.3 December 1984, P.163

(i) The quantum of natural rainfall and the extent of area irrigated by various man made sources like tube-well, canal play an important role in increasing the crop yield and in turn the crops aggregate production for crops Rice and Wheat (ii) The Multiple Regression Equations, nun over time series (1950-51 to 1977-78) data (Indices with TE 1952-53 as base) for district Allahabad resulted to relative more importance of irrigation by various man made sources like Tube-well, Canal for wheat and quantum of natural rainfall for rice, (iii) The average growth percentages of production, area, irrigated area and per hectare yield have been as 15.53 percent, 10.14 percent, 17.29 percent and 1.60 percent for wheat and 3.91 percent, 0.46 percent, 15.77 percent and 3.07 percent for rice; respectively; to result into importance of assured irrigation and crop yield to enhance overall crop production.

- Lobell, Cassman and Field (2009)

Yield refers to production per unit area and Yield Gap is calculated by subtracting achieved average yield from the yield potential: https://ndpublisher.in>admin>issue

- Pushpa and S.K. Srivastava (2014)

Yield Gap Analysis and Determinants of Yield Gaps in Major Crops in Eastern Region of Uttar Pradesh: Economic Affairs: p. 178:DOI: 10.5958/0976-4666. 2014. 000039.4

(i) There exist yield gaps in in different crops under the study area, ranging upto 53%.
(ii) In irrigated region of Uttar Pradesh, yield gap varied from 20.01% to 53.85% and 15.56 to 30.10% with average of 21.26% and 20.93%, respectively for rice and wheat.
(iii) The yield gaps are mainly caused by socio-economic, credit institutional/policy related factors, extension services and lack of improved technology.

(iv) Different strategies; such as Integrated Crop Management (ICM) practices, timely supply of inputs including credit to farmers, research and extension collaboration to transfer new technologies; form base to minimize yield gaps.

(v) Availability of credit to resource – poor small farmers to buy necessary inputs deserves special mention; along with the efforts to upgrade farmers knowledge on the causes of yield gaps in crops and measures thereof to narrow the gaps, through training, demonstrations, field visits and monitoring by extension agencies to achieve high yield.

(vi) The multiple regression analysis results; on determinants of 'yield gap' suggested that:

(a) For crop paddy (rice); source of seed, capital use, meeting with ADO/Ag. Scientist and technology adopting level; had significant negative effect on yield gap across the farm size groups; indicating there by that, an increase in the magnitude of these variables will minimize the gap in the paddy yield.

(b) For crop wheat; source of seed, capital use and technology adoption level; had negatively significant effect on yield gap in case of marginal farmers; while in case of small farmers; Education level, source of seed, capital use, meeting with ADO/Ag. Scientist, technology adoption level had significant negative effect on yield gap, indicating that an increase in the magnitude of these variable will minimize the gap in wheat yield.

(c) The value of coefficient of multiple determination (R^2) indicated that the combined effect of all the six explanatory (independent) variables, selected in the equation; accounted for (explained) 64% of the total variation in yield gap on overall farm size basis; for crop rice and 78% of that for crop wheat; respectively.

(vii) There are still considerable yield gaps in rainfed crops that can be bridged in future to meet the ever increasing food requirements.

- Nathanilal D. Mueller, James S., Gerber, Jonalton A Foley (2012): Nature490, 254-257 (October 11, 2012).

(i) In the coming decades, a crucial challenge for humanity will be meeting further food demands without undermining further the integrity of Earth's environmental systems.

(ii) Agricultural systems are to be taken careof in respect of above; but subject to; that the population growth and increasing calorie consumption along with other(s), are expected to roughly double the human food demand by 2050.

(iii) Responding to these pressures, there is increasing focus on "Sustainable Intensification" as a means to increase YIELDS on underperforming landscapes and simultaneously decreasing environmental impacts of agricultural systems.

(iv) Global yield variability is heavily controlled by fertilizer use, irrigation and climate.

(v) Challenges to meet "food security and sustainability" in coming decades, require considerable changes in Nutrient and Water Management.

(vi) The environmental impact of agriculture can be substantially reduced by eliminating OVERUSE of nutrient.

(vii) Large production increases (45% to 70% for most crops) are possible from.

(a) Closing yield gaps to 100% of attainable yields, and (b) taking care of changes to management practices that are needed to close yield gaps as these vary considerably by region to region and current intensity.

1.5. Limitation of the Study

As per clarity and elaborateness of the Study Design towards its set Objectives, sampling plan, Methodology, Analytical Tools thereof, provided to us by the Coordinator Centre AERC Jabalpur for carrying out the present study in Bridging the Yield Gaps of major crops viz. Rice and Wheat, in Bundelkhand region of Uttar Pradesh; apparently no limitation has come up; during the entire course of undertaking the study.

But, in view of Sensitivity and wide Applicability of such study not only at regional level, but the entire national level and maintaining the much desired Sustainability of desired and targeted goal(s) of minimizing the Crop Yield Gaps; a single year study, does not at all appear to provide a Strong Data Base towards a Long Term future planning and policy formulation(s).

As such, as a recommended measure on this issue; it is put forward for all the due consideration of the concerned authorities and policy makers; subject to its Feasibility that this study be

repeated for another two successive years with the same Objectives, Methodology, Sampling plan, Analytical tools and also the Same Set of 120 respondents or new ones and thereby on the basis of analysis of Three Annual Reports for each of the two regions of Bundelkhand Agro-Climatic Zone of India, viz. Uttar Pradesh and Madhya Pradesh; a combined comprehensive Report be prepared accordingly, towards more Realistic Approach in solving this delicate issue at Micro (Regional) to Macro (National) level.

1.6. Organization of the Study

The study comprises of six chapters. Chapter-I includes Introduction, Objectives and Limitations, Chapter-II deals with Research Methodology, while Overview of the Bundelkhand Region of Uttar Pradesh is given in Chapter-III; Chapter-IV deals with Socio-Economic Characteristics of the Sample Households; Chapter-V presents Yield Gap & Constraints Analysis and Determinants of Yield of Major Crops and lastly Summary, Conclusions and Policy Implications have been dealt in Chapter-VI; followed by References and Annexures.

Chapter – II

RESEARCH MEHTODOLOGY

The present chapter highlights the methodological step adopted as a systematic approach to meet out the set objectives of the study, aimed at bridging the yield gaps of major crops in Bundelkhand region of Uttar Pradesh. This region comprises a total of seven districts, viz. Jhansi, Lalitpur, Jalaun, Hamirpur, Mahoba, Banda and Chitrakoot. Firstly, it deals with selection of crops as per specified criterion and thereafter other details like sampling plan, sources of data, analytical tools and concepts thereof.

2.1 Selection of Crops

The criteria for selection of crops has been to select all the major crops grown by the cultivators, covering more than 10 percent of the area to the gross cropped area of Bundelkhand Region of Uttar Pradesh. As per this criteria, the crops selected are Rice and Wheat since these are the only two crops which individually covers more than 10 percent area, with respective percentages as 29 percent for Rice and 47 percent of Wheat. (Fig. 2.1)

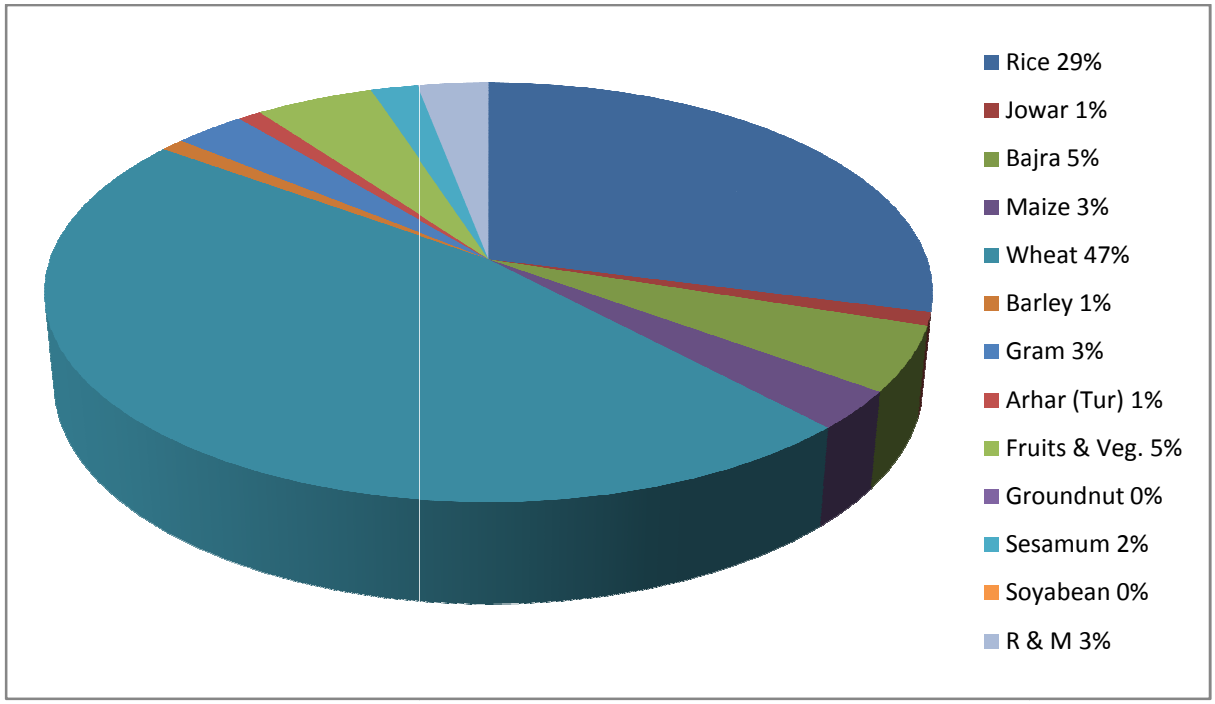

Fig.2.1: Percentage Share of different crops in Net Area Sown in Bundelkhand Region of Uttar Pradesh

2.2 Sampling Plan

After selection of crops as per specified criterion, the Districts, the Blocks, Villages and the farmers (the ultimate sampling units) have been selected using a Multi (four) Stage Stratified Sampling Plan; with districts as first stage, Blocks as second stage, villages as third stage and farmers (cultivators) as the fourth stage (or ultimate) units of sampling.

2.3(i) Selection of Districts

Districts have been selected on the basis of (i) High Yield Gap and (ii) Low Yield Gap; for each of the two crops under study i.e. Rice and Wheat; with one high yield gap district each for Rice and Wheat while one low yield gap district each for Rice and Wheat, to make a total selection of four districts for the study.

Table-2.1

Selection of Districts according to High and Low Yield Gap Districts

(Bundelkhand Yield: TE upto 2016-17)

Sl.No.	Crop	Category	Selected District	Yield Ql./ha	Percentage differences to Bundelkhand Region Yield
1	Rice	High Yield Gap	Lalitpur	4.59	(-) 82.47
2.	Rice	Low Yield Gap	Banda	19.71	(-) 24.71
1.	Wheat	High Yield Gap	Mahoba	17.91	(-) 51.00
2.	Wheat	Low Yield Gap	Jalaun	36.24	(-) 0.85
	Bundelkhand Region Yield (TE upto 2016-17) Rice 26.18 Ql./ha Wheat 36.55 Ql./ha				

As evident from Table-2.1, the districts selected under High and Low Yield Gaps are Lalitpur and Banda for crop Rice, while Mahoba and Jalaun for crop Wheat, respectively. The yield gaps of these districts as compared to Bundelkhand Region have been of the order of (-) 0.85 percent to (-) 51.00 percent for wheat and (-) 24.71 percent to (-) 82.47 percent for rice respectively.

2.3(ii) Selection of Blocks

One block has been selected in each of the four selected districts; on the basis of HIGHEST AREA under the respective crop i.e. one block each for High and Low Yield Gap districts for Rice and one block each for High and Low Yield Gap districts of wheat to make a total selection of 4 Blocks in the sample.

2.3(iii) Selection of Villages

A list of all the villages was prepared in each of the selected block and thereafter 3 villages having maximum area in order, under cultivation of the crop, were selected accordingly for the crops Rice and Wheat, to make an overall sample of 12 villages.

Table-2.2

Selection of Blocks and Villages

Sl. No.	Crop	District	Number of	
			Selected Block	Selected Villages
1.	Rice	High Yield Gap	1	3
		Low Yield Gap	1	3
2.	Wheat	High Yield Gap	1	3
		Low Yield Gap	1	3
Total			4	12

2.3(iv) Selection of Farmers

Finally, a list of all farmers (cultivators) growing the specified crops i.e. Rice and Wheat, was prepared separately for each of the two crops, after being categorized as small, medium and large farmers[1]. Thereafter, a sample of 10 farmers was selected randomly in each of the three categories, to make a total sample of 30 farmers for Rice and that of 30 farmers for wheat to make an overall sample of 60 farmers under High Yield Gap District and 60 farmers under Low Yield Gap District to result in total sample size of 120 farmers, under the study. Thus crop wise there are 60 farmers for rice and 60 farmers for wheat. (Table-2.3)

[1]Small: (Below 2 ha); Medium: (2ha –5 ha); Large: (above 5 ha)

Table-2.3

Number of Farmers Selected in the Sample for crops Rice and Wheat in High Yield Gap and Low Yield Gap Districts under different Categories of Farmers in Bundelkhand Region of Uttar Pradesh

Sl. No.	Name of Selected Crops	Size of Farms (category)	High Yield Gap District	Low Yield Gap District	Total
1.	Rice	Small	10	10	20
		Medium	10	10	20
		Large	10	10	20
2.	Wheat	Small	10	10	20
		Medium	10	10	20
		Large	10	10	20
Total number of farmers selected in the sample (Total sample Size)			**60**	**60**	**120**

2.4(a) The Data and Sources of Data

The data used in the present study comprised of both i.e. the primary data and also the secondary data. The primary data in respect of structural analysis towards specification of 'Yield Gap' level and causes thereof at the farm level, have been collected by personal interviews of Research Team of Agro-Economic Research Centre (AERC), Prayagraj (Allahabad) with the selected respondents (farmers/cultivators of rice and wheat crops) of the selected districts in the region of study, while the secondary data, in respect of topographical and other characteristics of the districts and the region, have been collected from various publications of State's Economics & Statistics Directorate, Directorate of Agriculture Statistics, Uttar Pradesh, District and Tahsil/Block Headquarters and those of Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India, as also the concerned Reports of Agro-Economic Research Centres in the country. They have been duly acknowledged.

2.4(b) The Period of Study

The present study refers to the agricultural year 2018-2019.

2.5 Analytical Tools and Data Analysis: Conceptual Framework

The conceptual framework and analytical tools are presented concisely in the coming paragraphs:

(a)Yield Gap

In its simplest form, the "yield gap" of a crop in a specified region, refers to the difference between the HIGHEST and the LOWEST recorded yields of the crop in that region. But, for all practical purposes and multidisciplinary approach towards it, by various researchers, this problem has come up as a particular activity which requires a coordinated research between farm economists (farm management researchers) and agro-biotechnologists (like agronomists, crop breeders, plant pathologists, entomologists) and is mainly a yield constraint based research. The present study incorporated two conceptual models[2], towards defining yield gap.

(i) Yield Gap-I

This refers to as, "Difference in yield per unit of area between the high yields obtainable on experiment stations and the best potentially achievable yield on farms." This is due to non-transferable technology and environmental differences.

(ii) Yield Gap-II

This is defined as, "the existing gap between actual current farm yields and the best potentially achievable yield".
This is caused by biological and socio-economic constraints.
These yield gaps and the various biological and socio-economic constraints thereof; are illustrated in Fig.2.2.

[2]As per Guidelines Report, provided by Agro-Economic Research Centre (AERC) Jabalpur; the Coordinating Centre in respect of present study.

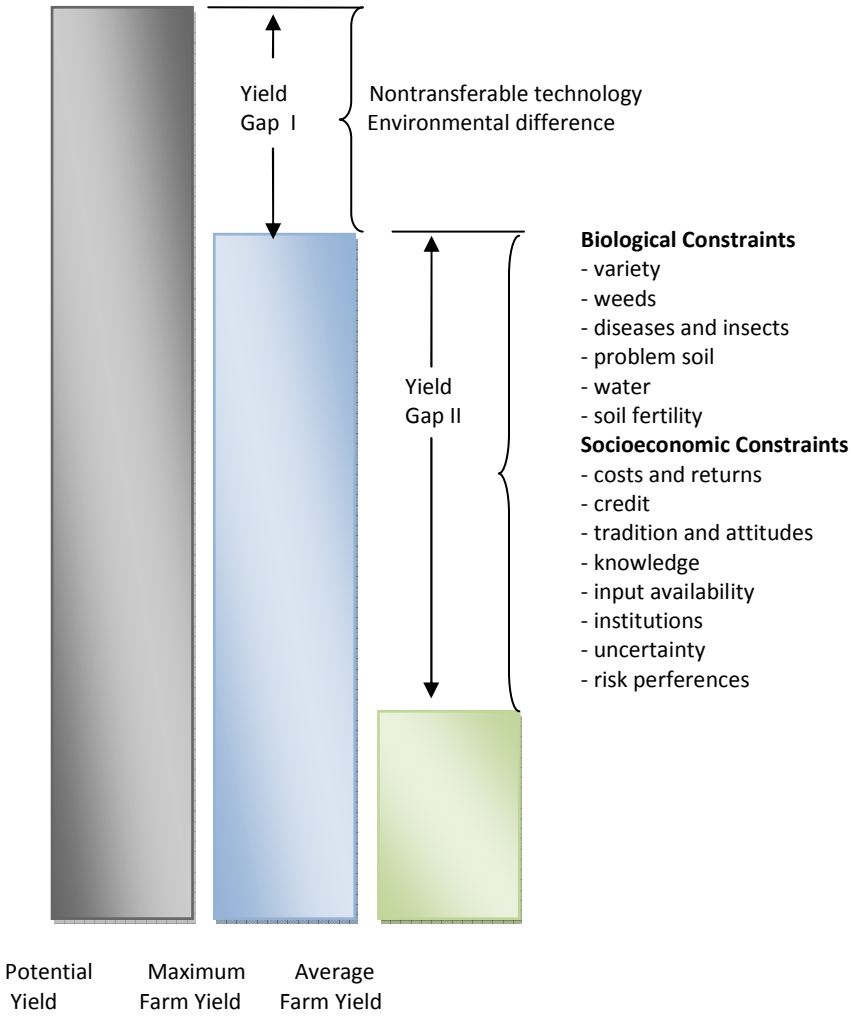

Fig. 2.2 Conceptual Framework of Yield Gap and Constraints thereof.

As clearly depicted by Fig.2.2, the Yield Gap-I is mainly caused on account of non-transferable technology and environmental variations; while under Yield Gap II, Biological constraints refer to non-application at all or poor use of even minimum required production inputs; whereas socio-economic constraints correspond to existing social and economic conditions that prevent farmers from using and adopting recommended technology. For example, a biological constraint may be that farmers are not applying the needed fertilizers and insecticides, while a socio-economic constraint may be the lack of available credit to farmers in buying such inputs.

It is to be mentioned that (i) Cooperative multi-disciplinary research methodology involving research station experiments, farm experiments and farm surveys has been developed to investigate and quantify the size of Yield Gap-II and extent to which it is caused by such particular biological and socio-economic constraints as listed in Figure 2.2 (De Dutta etal., 1978, Gomez 1977) and that (ii) This Methodology i.e. (i) has been quite successfully applied to Rice Production in a number of Asian Countries. (IRRI 1977)

Apart from the above concepts as per Evans, 1998; Van Ittersum and Rabbings 1997; "The yield gap of a crop grown in a certain location and cropping system, is defined as the difference between the yield under optimum management and the average yield achieved by the farmers." Whereas yield under optimum management is labeled as "potential yield" under fully irrigated conditions and water limited yield, under rainfed conditions.

(b) Analytical Models

The analytical models as incorporated under present study for analyzing yield gaps are as under

Yield Gap-I = Difference between potential yield and the highest farm yield.

Yield Gap-II = Difference between Highest and average farm yield.

Yield Gap-III= Difference between potential yield and average farm yield.

In percentages, these are respectively expressed as.

(i) Yg_1 = Yield Gap I = $\frac{Yp-Yh}{Yp}$ x 100

(ii) Yg_2 = Yield Gap II = $\frac{Yh-Ya}{Yh}$ x 100

(iii) Yg_3 = Yield Gap III = $\frac{Yp-Ya}{Yp}$ x 100

Where, Y_p = Potential farm yield

Y_h = Highest farm yield

Y_a = Average farm yield

Further, the average of these yield gaps was also calculated as the expression of overall Yield Gap Index, as under:

$$I_{(yg)} = \frac{P(fy) - A(fy)}{P(fy)} \times 100$$

Where; $I_{(yg)}$= Index of Yield Gap

$P_{(fy)}$= Potential Farm Yield (average) obtained by the researchers of the areas.

$A_{(fy)}$ Average Farm Yield by the different categories of farmers.

(c) Determinants of Yield Gap

To identify and analyse various determinants[3] of Yield (Factors affecting yield) of a crop; a multiple Regression Equation, expressing "Yield" as a function of several variables;

$Y = f(x_1, x_2, x_3, \ldots\ldots\ldots, x_k)$ (2.1)

Expressed in the form of a multiple regression equation as under

$$Y = a + \sum_{i=1}^{k} bixi \ldots \ldots \ldots \ldots \ldots \ldots \ldots (2.2)$$

Has been used; where

Y = Dependent Variable

$x_1, x_2, x_3, \ldots\ldots\ldots, x_k$ = Independent variable

a= pure constant intercept

$b_1, b_2, b_3, \ldots\ldots\ldots\ldots, b_k$ = Respective Regression Coefficients

with the following notation:

Y = Yield of specified crop (Ql./acre) and that, Number of independent variables (k)

= 12 for Paddy; and

= 11 for Wheat

[3]Pushpa and Srivastava (2014)
Ashok Kumar (2003)

as under

Paddy – x_1 = Education; x_2 = Age; x_3 = source of seed, x_4 = soil tests, x_5 = seed rate, x_6 = seed treatment, x_7 = varietal improvement, x_8 = urea (kg), x_9 = DAP (kg), x_{10} = irrigated land, x_{11} = size of holding, x_{12} = method of sowing.

Wheat – x_1 = Education; x_2 = Age; x_3 = source of seed, x_4 = soil tests, x_5 = seed rate (kg), x_6 = seed treatment, x_7 = varietal improvement, x_8 = urea (kg), x_9 = DAP (kg), x_{10} = irrigated land, x_{11} = size of holding.

(d) Tenability of fitted Equation

The following points are to be taken into consideration:

(i) The suitability of the fitted multiple regression equation, in respect of its tenability towards selection of independent variables in explaining variations in the values of dependent variable, is best tested on the basis of coefficient of Multiple Determination (R^2); the limits of which, are from 0 (zero) to 1 (one).

(ii) This is the value of R^2 the explanatory, power of the equation, which makes us to know as to how much of the total variations in the value of Y (the dependent variable) is controlled by the selected independent variables ($x_1, x_2, \ldots\ldots, x_k$).

(iii) A value of R^2 close to 1, is a good indicator, while a value of R^2 near to zero, is abad indicator of fitted equation.

To cite with; R^2=0.98 indicates that 98 percent of the total variations in Y is explained by selected independent variables; while R^2=0.02 indicates that the selected independent variables taken altogether explain just 2 percent of the total variations in Y and that 98 percent variations in Y remain unexplained.

(iv) In addition to providing the overall contribution of all the independent variables taken jointly on yield variability, the said equation also enables us to know the change in yield corresponding to individual variables as well, through their respective regression coefficients.

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CHAPTER-III

OVERVIEW OF THE BUNDELKHAND REGION OF UTTAR PRADESH

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

3.1 Geographical Indicators

Bundelkhand region of Uttar Pradesh lies between latitude of $24.69^{0}12^{/}$ N (Lalitpur) and $26.12^{0}71^{/}$ N (Jalaun) to longitude of $78.41^{0}38^{/}$ E (Lalitpur) and $80.86^{0}55^{/}$ E (Chitrakoot), with height to mean sea level between 80 meters (Hamirpur) to 428 meters (Lalitpur).

Table-3.1

Geographical indicators of different districts of Bundelkhand Region of Uttar Pradesh

Particulars	Banda	Jalaun	Lalitpur	Mahoba	Hamirpur	Jhansi	Chitrakoot	Overall
Area (In sq. kms)	4408	4565	5039	3144	4021	5042	3216	29435
Latitude	25.47^{0} 63/ N	26.12^{0} 71/ N	24.69^{0} 12/ N	25.29^{0} 21/ N	25.95^{0} 48/ N	25.44^{0} 84/ N	25.17^{0} 88/ N	--
Longitude	80.33^{0} 95/ E	79.47^{0} 04/ E	78.41^{0} 38/ E	79.87^{0} 24/ E	80.15^{0} 26/ E	78.56^{0} 85/ E	'80.86^{0} 55/ E	--
Height from Mean Sea Level (m)	123	164	428	214	80	285	137	--
No. of Tehsils	4	5	3	3	4	5	2	26
No. of Villages	718	1151	752	521	627	816	656	5241
Gram Panchayats	471	575	416	247	339	496	335	2879
Density of Population (Person/sq. km)	408	370	279	279	275	398	308	329

Sources: District census book -2011

There were 7 districts Banda, Jalaun, Lalitpur, Mahoba, Hamirpur,Jhansi and Chitrakoot having 26 tehsils, 5241 villages with 2879 gram panchayats in the region. The population density in Bundelkhand region was found to be 329 persons/km^2, which was maximum in Banda (408 person/km^2) followed by Jalaun (370 person/km^2), Lalitpur (279 person/km^2), Mahoba (279 person/km^2), Hamirpur (275 person/km^2) Jhansi (398 person/km^2) and (308 person/km^2) districts. Number of tehsils, villages and gram panchayats were found to be maximum in Jalaun District as compared to other districts of Bundelkhand Region of Uttar Pradesh (Table-3.1).

3.2 Population Parameters

The total population of Bundelkhand region of Uttar Pradesh was found to be 96.81 lakh, out of which 53.28 and 46.72 per cent are male and female, respectively. The population of rural (77.33%) was found to be more as compared to urban (22.67%) population.

Table-3.2

Population parameters of different districts of Bundelkhand Region of Uttar Pradesh

Particulars	Banda	Jalaun	Lalitpur	Mahoba	Hamirpur	Jhansi	Chitrakoot	Overall
Population	17,99,410 (100)	16,89,974 (100)	12,21,592 (100)	8,75,958 (100)	11,04,285 (100)	19,98,603 (100)	9,91,730 (100)	96,81,552 (100)
Male	9,65,876 (53.68)	9,06,092 (53.62)	6,41,011 (52.47)	4,66,358 (53.24)	5,93,537 (53.75)	10,57,436 (52.91)	5,27,721 (53.21)	51,58,031 (53.28)
Female	8,33,534 (46.32)	7,83,882 (46.38)	5,80,581 (47.53)	4,09,600 (46.76)	5,10,748 (46.25)	9,41,167 (47.09)	4,64,009 (46.79)	45,23,521 (46.72)
Rural	15,23,655 (84.68)	12,71,074 (75.21)	10,46,214 (85.64)	6,90,577 (78.84)	8,94,437 (81.00)	11,65,119 (58.30)	8,95,398 (90.29)	74,86,474 (77.33)
Urban	2,75,755 (15.32)	4,18,900 (24.79)	1,75,378 (14.36)	1,85,381 (21.16)	2,09,848 (19.00)	8,33,484 (41.70)	96,332 (9.71)	21,95,078 (22.67)
Child Population	2,94,972 (16.39)	2,31,997 (13.73)	2,12,205 (17.37)	1,28,129 (14.63)	1,54,355 (13.98)	2,60,373 (13.03)	1,75,311 (17.68)	14,57,342 (15.05)
Scheduled Tribes	163 (0.01)	832 (0.05)	71,610 (5.86)	647 (0.07)	474 (0.04)	3873 (0.19)	366 (0.04)	77,965 (0.81)
Scheduled Castes	3,87,855 (21.55)	4,68,178 (27.70)	2,40,519 (19.69)	220,898 (25.22)	2,41,198 (21.84)	5,62,505 (28.14)	2,66,655 (26.89)	23,87,808 (24.66)
Hindu	124,730 (6.93)	1,509,708 (89.33)	1,163,804 (95.27)	815,142 (93.06)	1,010,014 (91.46)	1,823,930 (91.26)	955,372 (96.33)	74,02,700 (76.46)
Muslim	34,113 (1.90)	171,581 (10.15)	33,724 (2.76)	57,454 (6.56)	91,269 (8.26)	147,842 (7.40)	34,559 (3.48)	570545 (5.89)
Others	1630 (0.09)	8685 (0.51)	24064 (1.97)	3362 (0.38)	3002 (0.27)	26831 (1.34)	1799 (0.18)	69373 (0.72)
Literacy (%)	67	74	64	65	69	75	65	59
Male	78	83	75	76	80	85	76	68
Female	54	62	51	53	56	64	53	48
Sex Ratio(Over 1000)	863	865	906	878	861	890	879	877
Child Sex Ratio(Over 1000)	902	881	916	878	886	866	907	891

Sources: District Census Book -2011, Figures in parenthesis shows percentage to total population

There were only 15.05 per cent of children in total population of Bundelkhand Region of Uttar Pradesh. The region was found to be dominant by Hindus (76.46%) followed by Muslim (5.89 %) religion (Table 3.2).

An average literacy rate of the region was found to be 59 per cent, which was more in male (68%) as compared to female (48%) population. The very thin sex ratio (877) and child sex ratio 891per 1000 males was found in the region. These all population parameters were found to be similar in all the districts of Bundelkhand Region of Uttar Pradesh. However, male literacy was found to be higher in Jhansi (85%) and Jalaun (83%) as compared to other districts and very thin ST population of total population was found in Banda (0.01%), Chitrakoot and Hamirpur each (0.04%) and Jalaun (0.05%), Mahoba (0.07%), Jhansi (0.19%) and Lalitpur (5.86). The composition of SC and ST population was found to be 24.66 and 0.81 per cent, respectively in the region. Amongst all the districts male was found to more educated in Jhansi (85%) followed by Jalaun (83%), Hamirpur (80%), Banda (78%), Chitrakoot and Mahoba each (76%) and Lalitpur (75%).

3.3 Land Use Pattern

The geographical area in Bundelkhand Region of Uttar Pradesh was found to be 29.62 lakh hectare. Out of total geographical area of Bundelkhand Region of Uttar Pradesh, 69.82, 8.24, 9.15, 3.41 per cent was found to be net area sown, area covered under forest, land not available for cultivation, barren and un-cultivated land, excluding fallow land respectively (Fig. 3.1).

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

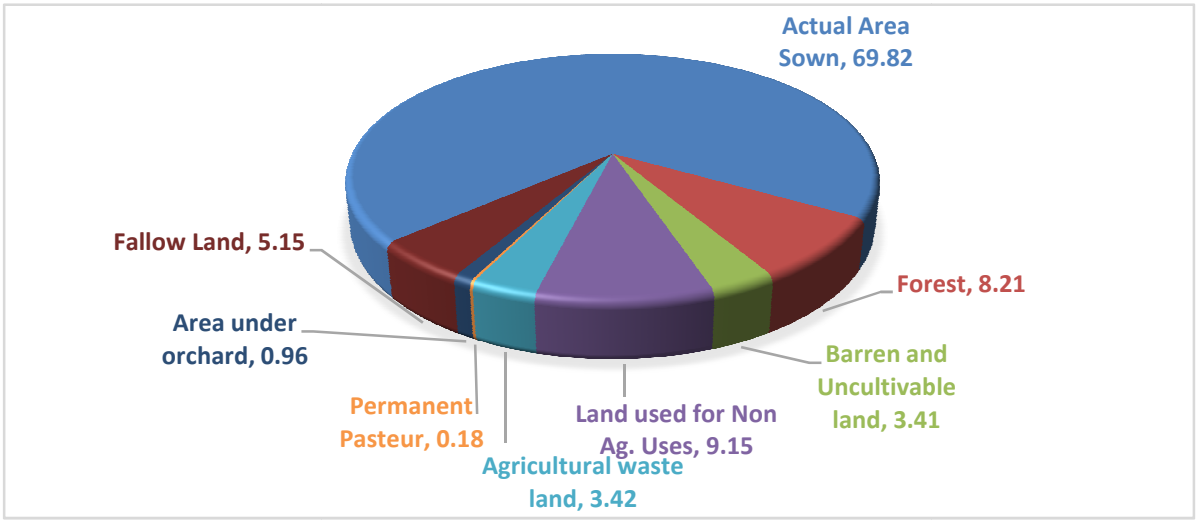
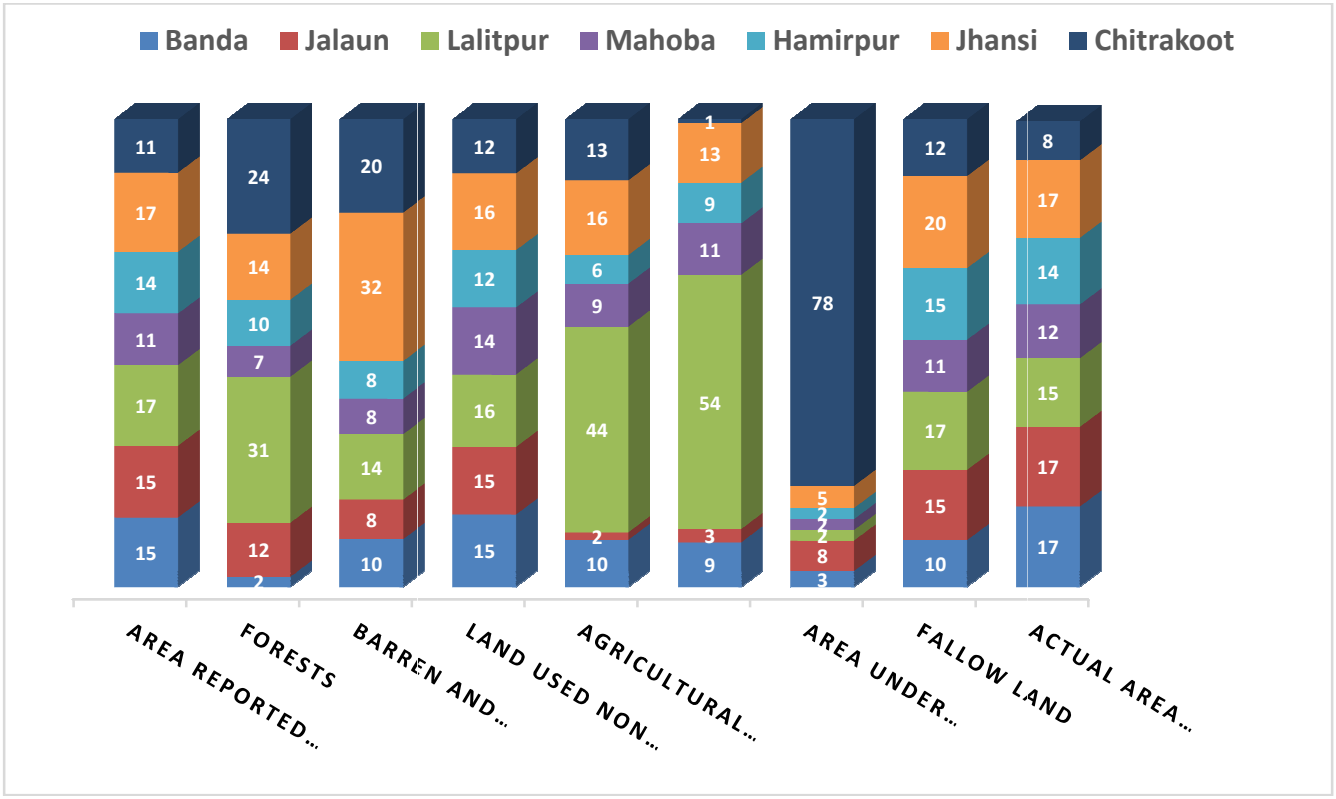


Fig. 3.2: Per cent contribution of different parameters of land use across different districts of Bundelkhand Region of Uttar Pradesh



Amongst all the districts the net area sown to total area reported for land use was found to be more in Banda (80.82 %) followed by Jalaun (77.49%), Hamirpur (75.43%), Mahoba (72.45%), Jhansi (68.24%), Lalitpur (59.63%) and Chitrakoot (51.10%).

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

S. No	Item	Area in Hectares							
		Banda	Jalaun	Lalitpur	Mahoba	Hamirpur	Jhansi	Chitrakoot	Overall
1	Area Reported for Land Use	438949 (100)	454434 (100)	509791 (100)	327429 (100)	390865 (100)	501327 (100)	338897 (100)	2961692 (100)
2	Forests	5190 (1.18)	28178 (6.20)	76158 (14.94)	16143 (4.93)	24013 (6.14)	34460 (6.87)	59767 (17.64)	243909 (8.21)
3	Barren and Uncultivable Land	10300 (2.35)	8539 (1.88)	14108 (2.77)	7691 (2.38)	8087 (2.07)	32045 (6.39)	20173 (5.96)	100943 (3.41)
4	Land used for purpose other than Agriculture	41847 (9.53)	39196 (8.62)	41943 (8.23)	38847 (8.23)	33179 (8.49)	44494 (8.88)	31459 (9.28)	270965 (9.15)
5	Agricultural Waste Land	10144 (2.31)	1633 (0.36)	44574 (8.74)	9310 (8.74)	6212 (1.59)	16179 (3.23)	13288 (3.92)	101340 (3.42)
6	Permanent Pasteur and other grazing lands	507 (0.12)	152 (0.03)	2,903 (0.57)	587 (0.18)	464 (0.12)	680 (0.14)	48 (0.01)	5341 (0.18)
7	Area under trees, groves, orchards not included in Actual Area Sown	958 (0.23)	1856 (0.41)	644 (0.13)	658 (0.20)	684 (0.17)	1342 (0.27)	22343 (6.59)	28485 (0.96)
8	Current fallow	9492 (2.16)	17388 (3.83)	15435 (3.03)	13287 (4.06)	18248 (4.67)	21972 (4.38)	12387 (3.66)	108209 (3.65)
9	Other fallow	5710 (1.30)	5592 (1.23)	10057 (1.96)	3689 (1.13)	5162 (1.32)	8056 (1.60)	6249 (1.84)	44515 (1.50)
10	Actual Area Sown	354774 (80.82)	351900 (77.44)	303978 (59.63)	237217 (72.45)	294816 (75.43)	342099 (68.24)	173183 (51.10)	2067967 (69.82)
11	Area Sown More than Once	105760	89244	241970	101956	81503	223358	21962	865753
12	Total area Sown	460534 (100)	441144 (100)	545948 (100)	339173 (100)	376319 (100)	565457 (100)	195145 (100)	2923720 (100)
	(a) Kharif	146301 (32)	115258 (26)	252947 (46)	120089 (35)	117721 (31)	212171 (37)	62307 (32)	1026794 (35.12)
	(b) Rabi	313961 (68)	322760 (73)	292418 (54)	219045 (65)	258282 (69)	349911 (62)	132563 (68)	1888940 (64.61)
	(c) Zaid	272 (N)	3028 (1)	583 (N)	39 (N)	190 (N)	3315 (1)	275 (N)	7702 (0.26)
	(d) Area of land prepared for Sugarcane	0 (0)	98 (N)	0 (0)	0 (0)	120 (N)	60 (N)	0 (0)	278 (0.01)
13	Cropping Intensity in %	129.81	125.36	179.60	142.98	127.65	165.29	112.68	141.38

Sources: Uttar Pradesh keKrishiAkde; October 2018(Figures in parenthesis show season wise breakup of Total area sown)
N – Negligible

The data recorded in Table 3.3, show that:

i. Highest area reported for land use is in district Lalitpur while lowest is in Mahoba with respective figures as 5,09,791 hectares and 3,27,429 hectares.
ii. Amongst all the districts the net area sown to total area reported for land use was found to be more in Banda (80.82) followed by Jalaun (77.44), lalitpur (59.63), Mahoba (74.45), Harmirpur (75.43), Jhansi (68.24) and Chitrakoot (51.10).
iii. District wise area sown more than once, has been of the order of 12.68% of actual area sown in district Jalaun as minimum to 79.60% of actual area sown, in district Lalitpur as the maximum. This indicates relatively much higher intensification of agriculture in district Lalitpur as compared to other districts.
iv. In terms of forests as well, the highest extent of vegetation (14.94%) is reported in district Lalitpur while lowest (1.18%) in district Banda.
v. Area under permanent pastures and other grazing land is highest in district Lalitpur, while that of trees, grooves, orchards being highest in district Chitrakoot.
vi. The district wise breakup of total area sown; as per different seasons has been varying between 26% to 46% for Kharif crops and 54% to 73% for Rabi crops, respectively.
vii. Similar to the case of whole Bundelkhand region; district wise as well Rabi crops occupy the highest percentage of total area sown; in all the seven districts selected under study.
viii. In case of district wise data as well; zaid crops area as well as area left for land preparation for sugarcane has been negligible or even nil.
ix. The highest cropping intensity (176.60%) has been recorded in district Lalitpur and lowest (112.68%) in district Chitrakoot.
x. It may be well said that among all the seven districts; district Lalitpur is recording relatively much better performance in land use statistics as compared to other districts.

But the remaining six districts are also performing satisfactorily.

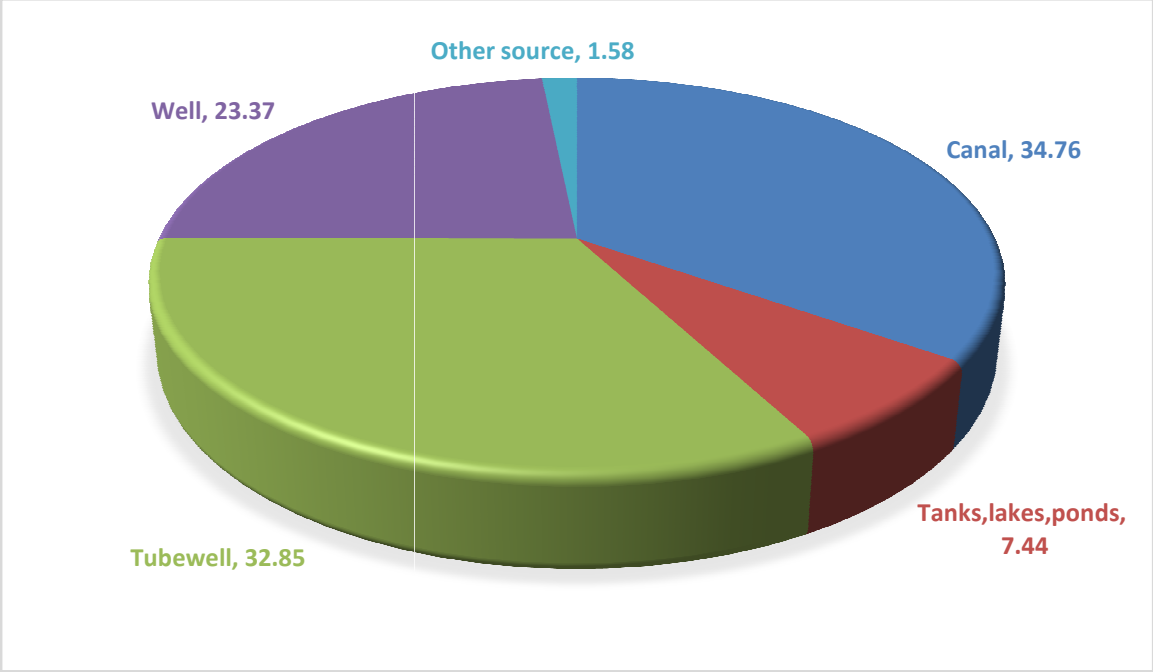
The above observation shows the signs of positivity and prosperity for the entire Uttar Pradesh Bundelkhand region so much so that in respect of agricultural intensification one of its district (Lalitpur) has not only crossed, but gone much ahead of cropping intensity level of 150%.

3.4 Irrigation Potential

The extent of irrigation and its timely availability to farmer's fields are of prime importance and the key factors in increasing farm yields and thereby narrowing down yield gaps of all major food and non-food crops like wheat, rice, sugarcane.

The net irrigated area in Bundelkhand Region of Uttar Pradesh was found to be 66.28 per cent (13.71 lakh ha). Amongst different sources of irrigation, canal (34.76%) followed by tube-well (32.85%), well (23.36%), tank, lakes, ponds (7.44%) and other sources of irrigation (1.59%) were found to be major sources of irrigation. (Fig. 3.3).

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



Canal was found to be major source of irrigation in Jalaun, Jhansi and Lalitpur as compared to other districts in Bundelkhand Region of Uttar Pradesh whereas area irrigated by tanks, lakes and ponds was found to be maximum in Jhansi followed by Lalitpur, Mahoba and other districts.

Tube-well was found to be dominated source of irrigation in Banda (21.96%) and Hamirpur (21.74%) followed by other districts. The net irrigated area was found to be highest in Jhansi (22.58%) as compared to lowest in Chitrakoot (5.47%).

Table -3.4

Source wise area under irrigation in different districts of Bundelkhand Region of Uttar Pradesh (ha)

Particulars	Banda	Jalaun	Lalitpur	Mahoba	Hamirpur	Jhansi	Chitrakoot	Overall	Source wise Irrigation %
Canal	46023 (9.66)	156772 (32.91)	96099 (20.17)	24960 (5.24)	26743 (5.61)	121078 (25.42)	4700 (0.99)	**476375 (100)**	**/34.76/**
Tank, lakes, ponds	3818 (3.74)	2895 (2.84)	26909 (26.39)	23212 (22.77)	2930 (2.87)	35249 (34.57)	6948 (6.81)	**101961 (100)**	**/7.44/**
Tubewell	98889 (21.96)	78664 (17.47)	74035 (16.44)	5561 (1.24)	97888 (21.74)	36694 (8.15)	58541 (13.00)	**450272 (100)**	**/32.85/**
Well	15323 (4.78)	16195 (5.06)	81561 (25.47)	68956 (21.53)	20101 (6.28)	113491 (35.43)	4655 (1.45)	**320282 (100)**	**/23.37/**
Other Sources	278 (1.28)	527 (2.42)	12451 (57.19)	2731 (12.54)	2728 (12.53)	2988 (13.72)	69 (0.32)	**21772 (100)**	**/1.58/**
Net Irrigated Area	164331 (11.99)	255053 (18.61)	291055 (21.23)	125420 (9.15)	150390 (10.97)	309500 (22.58)	74913 (5.47)	**1370662 (100)**	**/100/**

Sources: Directorate of Economics and Statistics -2017-18, Figures in parenthesis shows percentage to overall and figures in slashes show source wise irrigation percentage.

3.5 Cropping Pattern

Table-3.5

Cropping Pattern in different districts of Bundelkhand region of Uttar Pradesh (ha)

Particulars	Banda	Jalaun	Lalitpur	Mahoba	Hamirpur	Jhansi	Chitrakoot	Overall
Paddy (kharif)	51760 (60.96)	268 (0.87)	959 (0.49)	36 (0.06)	41 (0.09)	9247 (1.22)	8957 (22.42)	71268 (5.86)
Maize (kharif)	9 (0.01)	5 (0.02)	19851 (10.21)	26 (0.04)	0 (0.00)	886 (0.12)	5 (0.01)	20782 (1.71)
Jowar	23715 (27.93)	6861 (22.15)	291 (0.15)	1936 (3.24)	16109 (33.74)	1934 (0.26)	16806 (42.07)	67652 (5.56)
Bajra	3251 (3.83)	15033 (48.53)	0 (0.00)	0 (0.00)	651 (1.36)	4 (0.00)	10188 (25.50)	29127 (2.40)
Sawan (kharif)	14 (0.02)	0 (0.00)	27 (0.01)	9 (0.02)	5 (0.01)	23 (0.00)	14 (0.04)	92 (0.01)
Kodon	7 (0.01)	8 (0.03)	23 (0.01)	6 (0.01)	0 (0.00)	0 (0.00)	349 (0.87)	393 (0.03)
Urd (kharif)	3374 (3.97)	7906 (25.52)	168284 (86.56)	47199 (78.93)	25383 (53.16)	740532 (97.70)	1716 (4.30)	994394 (81.79)
Moong (kharif)	2777 (3.27)	896 (2.89)	4988 (2.57)	10585 (17.70)	5560 (11.64)	5357 (0.71)	1917 (4.80)	32080 (2.64)
Kharif Food Grain	**84907 (100) /21/**	**30977 (100) /10/**	**194423 (100) /44/**	**59797 (100) /31/**	**47749 (100) /16/**	757983 **(100) /61/**	39952 **(100) /23/**	1215788 **(100) /39/**
Wheat	158943 (51.88)	160362 (55.14)	152659 (62.86)	48394 (36.73)	113112 (44.11)	149640 (31.55)	49779 (36.50)	832889 (45.29)
Jau	846 (0.28)	7555 (2.60)	7357 (3.03)	3,838 (2.91)	3066 (1.20)	5091 (1.07)	4907 (3.60)	32660 (1.78)
Maize (rabi)	0 (0.00)	18 (0.01)	0 (0.00)	11 (0.01)	389 (0.15)	0 (0.00)	0 (0.00)	418 (0.02)
Gram	96314 (31.44)	13715 (4.72)	13725 (5.65)	27027 (20.51)	92802 (36.19)	29135 (6.14)	46218 (33.89)	318936 (17.34)
Pea	1543 (0.50)	69595 (23.93)	48627 (20.02)	24408 (18.53)	8472 (3.30)	30394 (6.41)	527 (0.39)	183566 (9.98)
Arhar	17753 (5.79)	3392 (1.17)	0 (0.00)	3052 (2.32)	15215 (5.93)	818 (0.17)	16106 (11.81)	56336 (3.06)
Masoor	30975 (10.11)	36216 (12.45)	20502 (8.44)	25014 (18.99)	23393 (9.12)	259157 (54.65)	18852 (13.82)	414109 (22.52)
Rabi Food Grains	**306374 (100) /79/**	**290853 (100) /90/**	**242870 (100) /56/**	**131744 (100) /69/**	**256449 (100) /84/**	**474235 (100) /39/**	**136389 (100) /77/**	**1838914 (100) /61/**
Total food grains	**391281 /100/**	**321830 /100/**	**437293 /100/**	**191541 /100/**	**304198 /100/**	**1232218 /100/**	**176341 /100/**	**3054702 /100/**

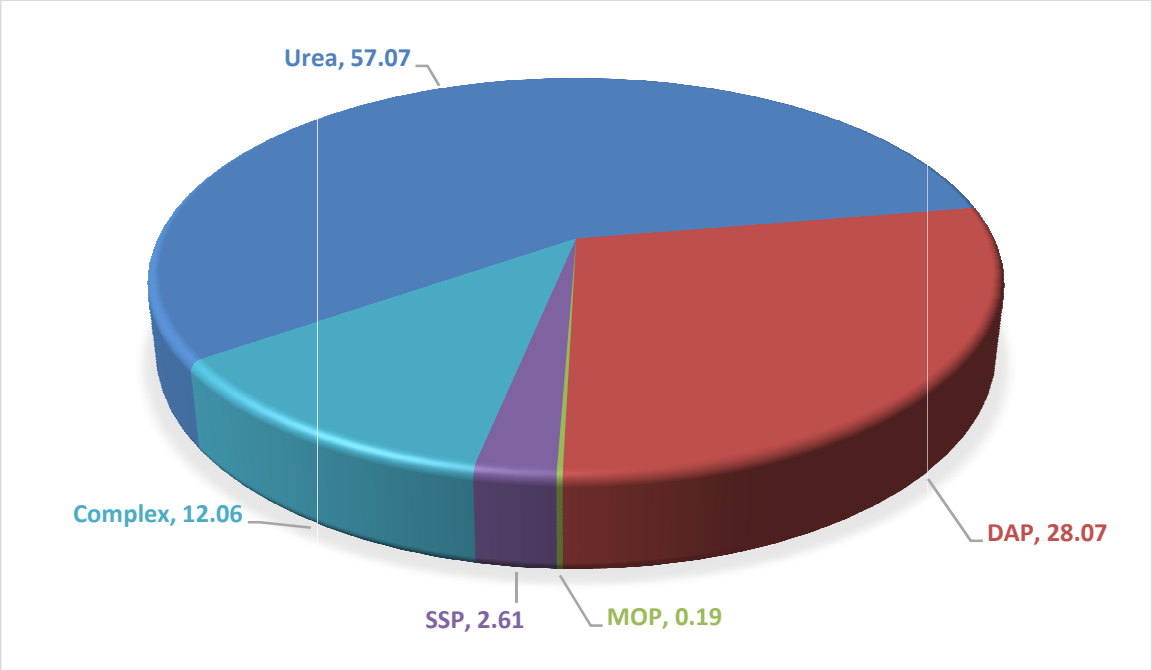
Sources: Uttar Pradesh Ke Krishi Akde, October 2018, Figures in parenthesis shows percentage to total food grains of respective season and slashes shows percentage of rabi food grains and kharif food grains to total food grains.

The cropping pattern in Bundelkhand Region of Uttar Pradesh was found to be dominated during *Rabi* (61%) as compared to *kharif* season (39%) (Table 3.5). Wheat (45.29%) followed by masoor (22.52%), gram (17.34%), pea (9.98%) were found to be major rabi crops grown in Bundelkhand Region of Uttar Pradesh. While urd (81.79%), paddy (5.86%), jowar (5.56%) and moong (2.54%) were found to be major kharif crops of the region (Fig.3.4). In kharif season paddy dominated urd in Banda and Chitrakoot, Jowar occupying higher area in Chitrakoot, Banda, Jalaun and Bajra higher percentage area in Jalaun and Chitrakoot; while in rabi crops as well no variation was found across district wise cropping pattern except that gram occupied more area in districts Hamirpur, Chitrakoot, Banda and Mahoba.

3.6 Consumption of Fertilizers

The fertilizers consumption of Bundelkhand Region of Uttar Pradesh was found to be 521324t per year. The consumption of Urea (57.07%) was found to be highest followed by DAP (28.07 %), complex fertilizers (12.06%), SSP (2.61%) and MOP (0.19%).

Fig. 3.4: Consumption of different fertilizers in Bundelkhand Region of Uttar Pradesh



Amongst different districts of Bundelkhand Region of Uttar Pradesh the fertilizer consumption was found to be more in Jhansi (22.20%) followed by Jalaun (19.55%), Lalitpur (18.57%), Hamirpur (14.66%), Banda (12.78%), Chitrakoot (6.57%) and Mahoba (5.66%).

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

Particulars	Banda	Jalaun	Lalitpur	Mahoba	Hamirpur	Jhansi	Chitrakoot	Overall	Fertilizer wise % breakup
UREA	37428 (12.58)	65367 (21.97)	45870 (15.42)	13529 (4.55)	46642 (15.68)	68456 (23.01)	20216 (6.79)	**297508** (100)	**/57.07/**
DAP	16262 (11.11)	25082 (17.14)	37148 (25.38)	6947 (4.75)	19382 (13.24)	32649 (9.13)	8889 (6.07)	**146359** (100)	**/28.07/**
MOP	675 (69.09)	60 (6.14)	92 (9.42)	2 (0.20)	4 (0.41)	137 (16.60)	7 (0.72)	**977** (100)	**/0.19/**
SSP	2462 (18.09)	2309 (16.97)	2128 (15.64)	1553 (11.41)	1807 (13.28)	2471 (18.90)	878 (6.45)	**13608** (100)	**/2.61/**
Complex	9818 (15.62)	9120 (14.51)	11582 (18.42)	7478 (11.89)	8584 (13.65)	12017 (18.95)	4273 (6.80)	**62872** (100)	**/12.06/**
Total Fertilizers	**66645 (12.78)**	**101938 (19.55)**	**96820 (18.57)**	**29509 (5.66)**	**76419 (14.66)**	**115730 (22.20)**	**34263 (6.57)**	**521324 (100)**	**/100/**

Sources: Joint Director Fertilizer, Krishi Bhawan Lucknow, Figures in parenthesis shows percentage to overall and figures in slashes show fertilizer wise percentage breakup

The consumption of DAP (25.38%) in Lalitpur, Urea (23.01%) in Jhansi, MOP (69.09%) in Banda, SSP (18.90%) in Jhansi and Complex (18.95%) in Jhansi was found to be maximum across various districts of Bundelkhand region of Uttar Pradesh. Thus, district Jhansi has been ahead of all the districts of Bundelkhand region of Uttar Pradesh, in respect of Urea, SSP and complex fertilizers (Table-3.6).

3.7 Regulated Markets

The numbers of regulated markets were found to be 58 across different grades of mandi and various districts of Bundelkhand Region of Uttar Pradesh. However, the majority of regulated market were found to be of “D” grade (46.54%) followed by “B” grade (20.70%), “C” grade (17.24 %) and “A” grade (15.52 %) (Fig.-3.5).

Fig. 3.5: Percentage of different grades of regulated markets in Bundelkhand region of Uttar Pradesh

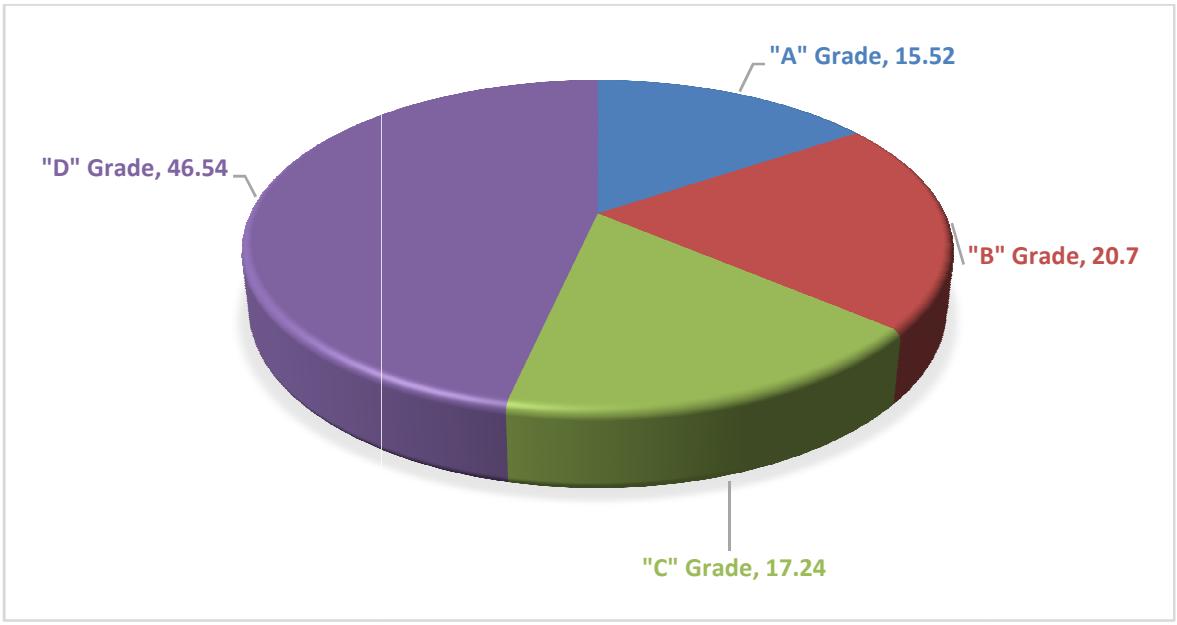
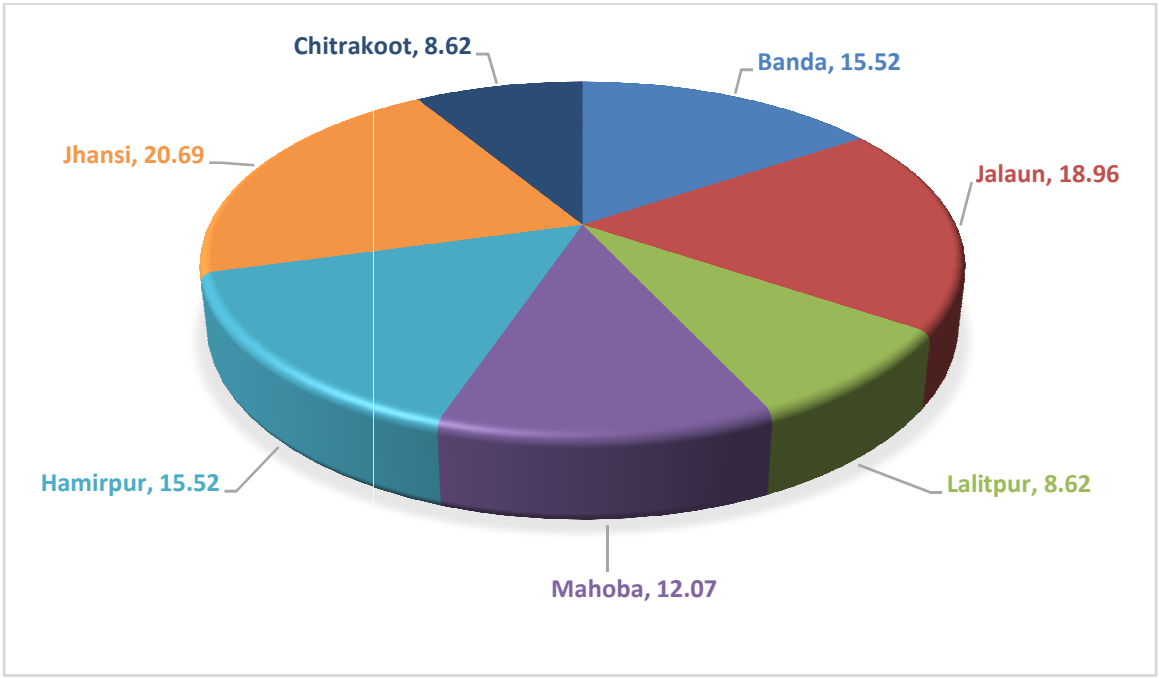


Fig. 3.6: Percentage share of different regulated markets across districts in Bundelkhand Region of Uttar Pradesh



In Bundelkhand Region of Uttar Pradesh, Jhansi district (20.69%) has more regulated markets as compared to Jalaun (18.96%), Banda and Hamirpur each (15.52%), Mahoba (12.07%) and Lalitpur & Chitrakoot each (8. 62%).All the seven districts of Bundelkhand region of Uttar Pradesh have all the four grade (i.e. grades A, B, C and D) markets, except lone district Lalitpur which does not have C grade market, but having A, B and D grade market. These findings are found to be similar with minor variation across districts of Bundelkhand Region of Uttar Pradesh (Table-3.7).

Table- 3.7
Different grades of regulated markets in different district of Bundelkhand Region of Uttar Pradesh

Particulars	Banda	Jalaun	Lalitpur	Mahoba	Hamirpur	Jhansi	Chitrakoot	Overall
Number of Mandi								
"A" Grade	1	2	1	1	1	2	1	9
"B" Grade	2	2	1	1	3	2	1	12
"C" Grade	1	3	0	1	1	3	1	10
"D" Grade	5	4	3	4	4	5	2	27
Total	**9**	**11**	**5**	**7**	**9**	**12**	**5**	**58**
Percentage to Overall								
"A" Grade	11.11	22.22	11.11	11.11	11.11	22.23	11.11	100.00
"B" Grade	16.67	16.67	8.33	8.33	25.00	16.67	8.33	100.00
"C" Grade	10.00	30.00	0	10.00	10.00	30.00	10.00	100.00
"D" Grade	18.52	14.81	11.11	14.81	14.81	18.52	7.42	100.00
Total	**15.52**	**18.96**	**8.62**	**12.07**	**15.52**	**20.69**	**8.62**	**100.00**
Percentage to Total								
"A" Grade	11.11	18.18	20.00	14.28	11.11	16.67	20.00	15.52
"B" Grade	22.22	18.18	20.00	14.29	33.33	16.67	20.00	20.70
"C" Grade	11.11	27.28	0	14.29	11.11	15.00	20.00	17.24
"D" Grade	55.56	36.36	60.00	57.14	44.45	41.66	40.00	46.54
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Sources: http://upmandiparishad.gov.in/2017-18

3.8 Number and Area under different Size of Holding

The 1486001 numbers of land holdings occupied 21.25 lakh ha area in Bundelkhand Region of Uttar Pradesh (Table 3.8). The number of holdings were found to be more in Banda (17.79%) followed by Jhansi(17.13%), Jalaun (17.00%), Lalitpur (13.94%), Hamirpur (13.50%), Chitrakoot (10.64%) and Mahoba (10.00%) (Fig. 3.8) while area under holding was found to be

more in Jalaun (15.59%) followed by Banda (17.06%), Jhansi (16.28%), Lalitpur (14.68%), Hamirpur (14.47%), Mahoba (11.12%) and Chitrakoot (8.90%) districts of Bundelkhand region of Uttar Pradesh.

Marginal and small holdings (0-2 ha) constituted 79.23% of total number of holdings, covering an area of only 40.10% of land holding area; while large holdings accounting for only 0.68% of total number of holdings, covered 6.57% of total land holding area.

Fig. 3.7: Percentage share of operatinal holding (Numbers) in different districts in Bundelkhand Region of Uttar Pradesh

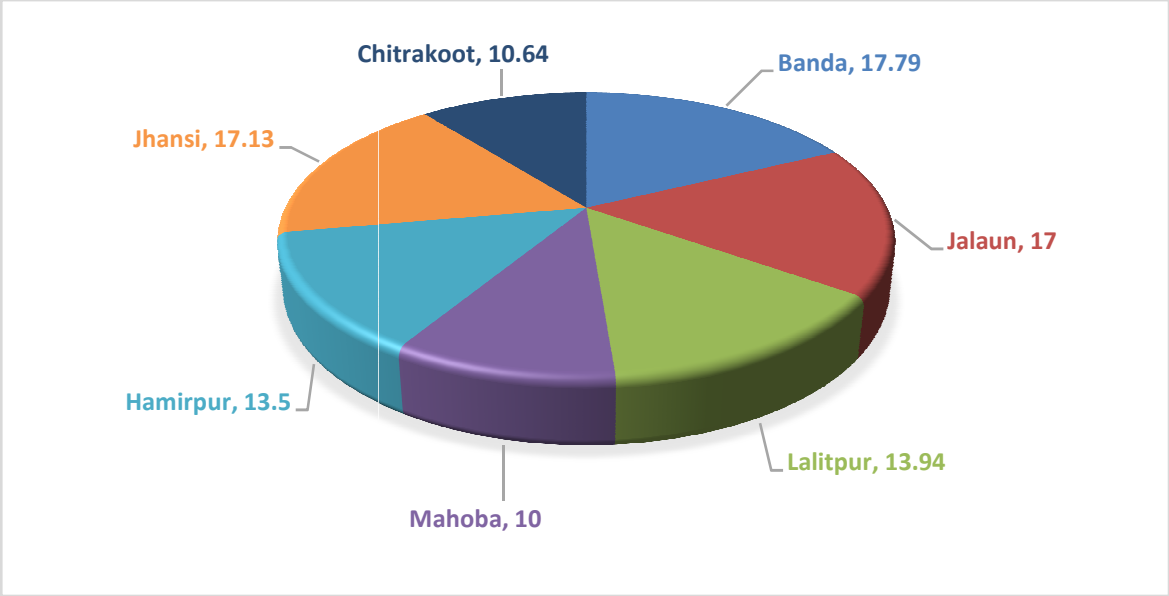


Fig. 3.8: Percentage share of operational holding (Area) in different districts in Bundelkhand region of Uttar Pradesh

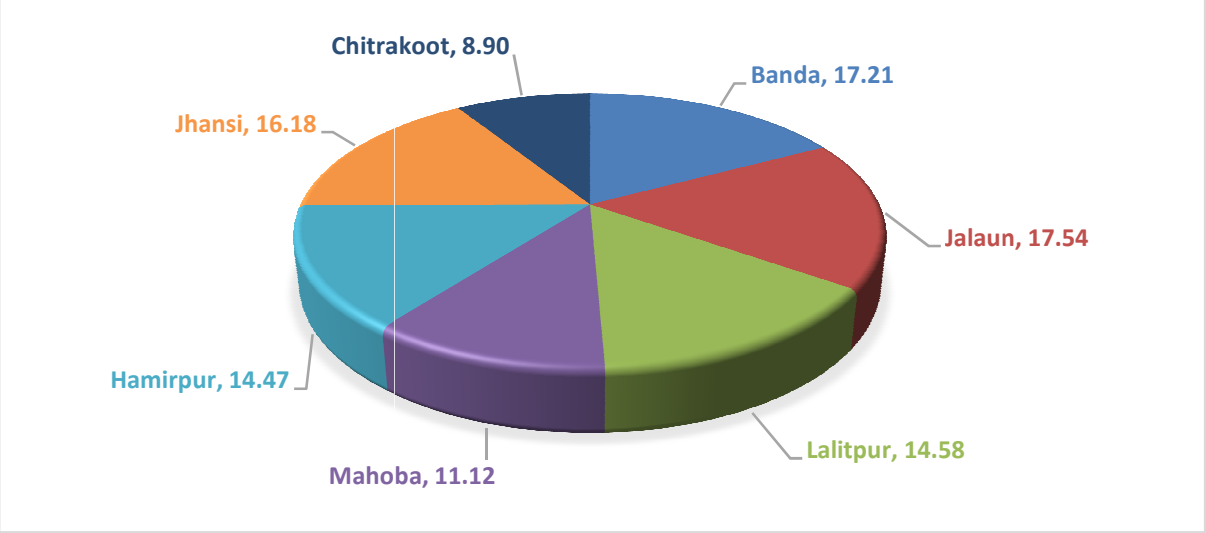


Table-3.8

Numbers and area (ha) of holdings in different districts of Bundelkhand Region of Uttar Pradesh

Particulars	Banda	Jalaun	Lalitpur	Mahoba	Hamirpur	Jhansi	Chitrakoot	Overall
Number								
Marginal (0-1 ha)	156751 (59.29)	137223 (54.31)	101240 (48.87)	76724 (51.64)	114326 (57.01)	156770 (61.59)	104154 (65.88)	847188 (57.01)
Small (1-2 ha)	54718 (20.70)	56755 (22.46)	65340 (31.54)	35269 (23.74)	38453 (19.17)	49541 (19.46)	30177 (19.09)	330253 (22.22)
Semi-medium (2-4 ha)	33975 (12.85)	36960 (14.63)	28589 (13.80)	23236 (15.64)	28520 (14.22)	31950 (12.55)	15054 (9.52)	198284 (13.34)
Medium (4-10 ha)	17111 (6.47)	20218 (8.00)	10603 (5.12)	12237 (8.24)	17067 (8.51)	15507 (6.09)	7434 (4.70)	100177 (6.74)
Large (above 10 ha)	1847 (0.70)	1520 (0.60)	1382 (0.67)	1118 (0.75)	2177 (1.09)	780 (0.31)	1275 (0.81)	10099 (0.68)
Total	264402 **(100) /17.19/**	252676 **(100) /17.00/**	207154 **(100) /13.94/**	148584 **(100) /10.00/**	200543 **(100) /13.50/**	254548 **(100) /17.13/**	158094 **(100) /10.64/**	1486001 **(100) /100/**
Area in ha								
Marginal (0-1 ha)	69860 (19.11)	64439 (17.29)	56133 (18.12)	36180 (15.31)	41790 (13.59)	79947 (23.25)	45040 (23.82)	393389 (18.51)
Small (1-2 ha)	76864 (21.02)	69642 (18.68)	93020 (30.02)	50747 (21.48)	54521 (17.73)	72783 (21.17)	41204 (21.79)	458781 (21.59)
Semi-medium (2-4 ha)	94897 (25.96)	102326 (27.45)	79095 (25.53)	64354 (27.23)	79989 (26.01)	89868 (26.13)	40150 (21.24)	550679 (25.92)
Medium (4-10 ha)	97949 (26.79)	117074 (31.41)	61240 (19.77)	70736 (29.94)	101977 (33.16)	90397 (26.29)	43042 (22.77)	582415 (27.41)
Large (above 10 ha)	26038 (7.12)	19237 (5.16)	20331 (6.56)	14276 (6.04)	29260 (9.51)	10876 (3.16)	19626 (10.38)	139644 (6.57)
Total	365608 **(100) /17.21/**	372718 **(100) /17.54/**	309819 **(100) /14.58/**	236293 **(100) /11.12/**	307537 **(100) /14.47/**	343871 **(100) /16.18/**	189062 **(100) /8.90/**	2124908 **(100) /100/**

Sources: District Statistical book 2016-17, Figures in parenthesis shows percentage to total and those in slashes show district wise percentages to total.

3.9 Working Population

Bundelkhand Region of Uttar Pradesh has more number of non-workers (62.68%) as compared to main workers (24.92%) and marginal workers (12.40%). In total number of workers (main and marginal) the majority of them were found to be agricultural labours (35.49%) followed by cultivators (35.25%), other workers (25.22%) and workers in household Industries

(4.04%). These figures were found to be almost similar with minor variation for all the districts of the Bundelkhand Region of Uttar Pradesh. (Table-3.9)

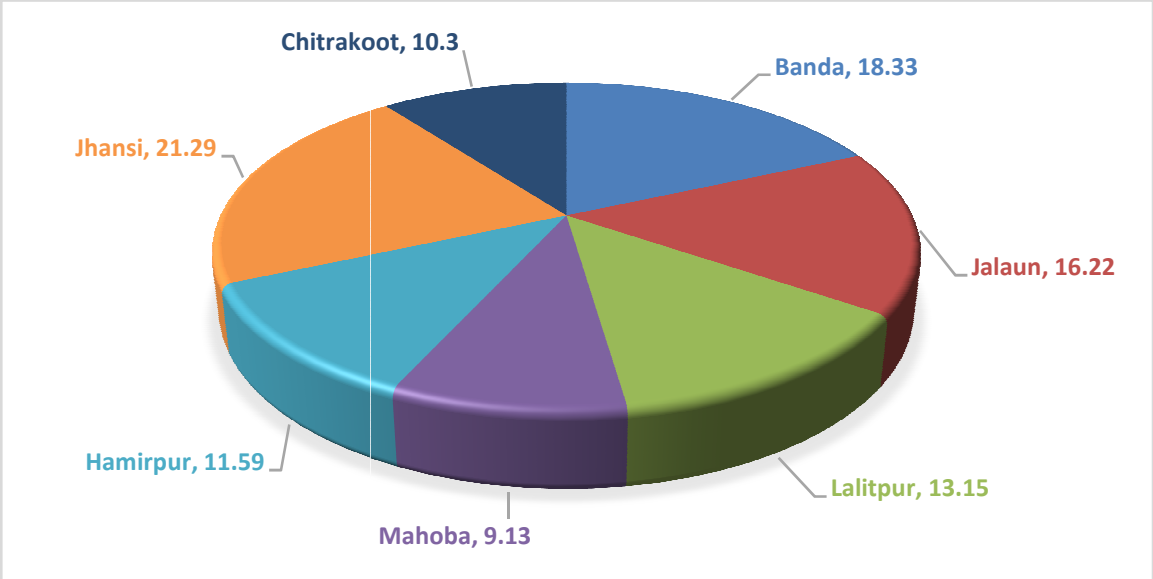
Table-3.9
Working population in different districts of Bundelkhand Region of Uttar Pradesh (Numbers)

Particulars	Banda	Jalaun	Lalitpur	Mahoba	Hamirpur	Jhansi	Chitrakoot	Overall
(i) Main Worker	483232 (26.86)	420266 (24.87)	357033 (29.22)	238712 (27.25)	290375 (26.30)	254873 (15.40)	282614 (28.50)	2327105 (24.92)
(ii) Marginal Worker	218457 (12.14)	200498 (11.86)	146318 (11.98)	110964 (12.67)	153280 (13.88)	216423 (13.08)	111583 (11.25)	1157523 (12.40)
(iii) Non Worker	1097721 (61.00)	1069210 (63.27)	718241 (58.80)	526282 (60.08)	660630 (59.82)	1183689 (71.52)	597533 (60.25)	5853306 (62.68)
Total Population	**1799410 (100)**	**1689974 (100)**	**1221592 (100)**	**875958 (100)**	**1104285 (100)**	**1654985 (100)**	**991730 (100)**	**9337934 (100)**
Cultivators	251755 (35.88)	196613 (31.67)	267580 (53.16)	114244 (32.67)	130314 (29.37)	228881 (28.09)	160094 (40.62)	1349481 (35.25)
Agriculture labourers	273458 (38.97)	243035 (39.15)	131354 (26.10)	130422 (37.30)	181449 (40.90)	248072 (30.44)	150695 (38.23)	1358485 (35.49)
Workers in household industry	19098 (2.72)	26109 (4.21)	14882 (2.96)	13523 (3.87)	19876 (4.48)	48648 (5.97)	12555 (3.18)	154691 (4.04)
Others Workers	157378 (22.43)	155007 (24.97)	89535 (17.78)	91487 (26.16)	112016 (25.25)	289313 (35.50)	70853 (17.97)	965589 (25.22)
Total Workers (Main &Marginal)	**701689 (100)**	**620764 (100)**	**503351 (100)**	**349676 (100)**	**443655 (100)**	**814914 (100)**	**394197 (100)**	**3828246 (100)**

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

However, cultivators were found to be more in Lalitpur (53.16%) followed by Chitrakoot (40.62%), Banda (35.88%), Mahoba (32.67%), Jalaun (31.67%), Hamirpur (29.37%) and Jhansi (28.09%), while agricultural labours were found to be more in Hamirpur (40.90%), Jalaun (39.15%), Banda (38.97%), Chitrakoot (38.23%), Mahoba (37.30%), Jhansi (30.44%) and Lalitpur (26.10%) districts to the total workers' population of the seven districts. Workers in household industries to total workers' population were found to be more in Jhansi (5.97%) and Hamirpur (4.48%) as compared to other districts of Bundelkhand Region of Uttar Pradesh (Table-3.9)

Fig. 3.9: Percentage share of different workers to total working population in different districts of Bundelkhand Region of Uttar Pradesh



3.10 Farm Machineries and Implements

The numbers of ploughs, bullock carts, electric pumps, diesel pumps, tractors and sugarcane crushers were found to be 385298, 132981, 4375, 125167, 62433 and 1134 in Bundelkhand Region of Uttar Pradesh (Table-3.10).

The number of ploughs (28.15%) and bullock carts (32.58%)were found to be more in Banda as compared to other districts of Bundelkhand region of Uttar Pradesh. The number of electric pumps were found to be more in Jhansi (35.77%), Banda (19.04%) and Chitrakoot (17.33%) as compared to other districts of Bundelkhand Region of Uttar Pradesh. The diesel pumps were found to be more in Lalitpur (25.91%), Jhansi (23.39%) and Mahoba (14.72%) as compared to other districts of Bundelkhand Region of Uttar Pradesh.

The number of tractors were found to be more in Jalaun (25.16%) as compared to Jhansi (19.71%), Hamirpur (18.83%) and other districts with lowest number in Chitrakoot (4.41%). The higher number of sugarcane crushers were found in Jalaun (22.66%), Hamirpur (22.57%) as compared to other districts of Bundelkhand region of Uttar Pradesh like Jhansi (8.91%) and Chitrakoot (5.11%).

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

Particulars	Banda	Jalaun	Lalitpur	Mahoba	Hamirpur	Jhansi	Chitrakoot	Overall
Plough	108447 (28.15)	31460 (8.17)	51949 (13.48)	37856 (9.82)	41310 (10.72)	62896 (16.32)	51380 (13.34)	385298 (100)
Bullock cart	43328 (32.58)	9890 (7.44)	21101 (15.87)	23902 (17.96)	19981 (15.03)	2761 (2.08)	12018 (9.04)	132981 (100)
Electric Pump	833 (19.04)	356 (8.14)	224 (5.12)	158 (3.61)	481 (10.99)	1565 (35.77)	758 (17.33)	4375 (100)
Diesel Pump	13496 (10.78)	10421 (8.33)	32437 (25.91)	18424 (14.72)	12388 (9.90)	29271 (23.39)	8730 (6.97)	125167 (100)
Tractors	5199 (8.33)	15710 (25.16)	7675 (12.29)	7034 (11.27)	11757 (18.83)	12306 (19.71)	2752 (4.41)	62433 (100)
Sugarcane crusher	207 (18.26)	257 (22.66)	126 (11.11)	129 (11.38)	256 (22.57)	101 (8.91)	58 (5.11)	1134 (100)

Sources: Statistical Abstract Book 2017-18, Figures in parenthesis shows percentage to overall

3.11 Livestock Population

The number of livestock in Bundelkhand Region of Uttar Pradesh was found to be 3657154. Amongst different types of livestock population, population of goats (41.29%) was found to be more as compared to cows (29.67%), buffalos (22.07%), sheeps (4.2%) and pigs (2.77%). Amongst different districts, the livestock population was found to be more in Jhansi (17.96%) followed by Jalaun (15.39%), Hamirpur (15.06%), Banda (15.01%), Lalitpur (14.41%), Chitrakoot (12.16%) and Mahoba (10.01%).

Fig. 3.10: Total livestock population (Numbers) in different districts of Bundelkhand Region of Uttar Pradesh

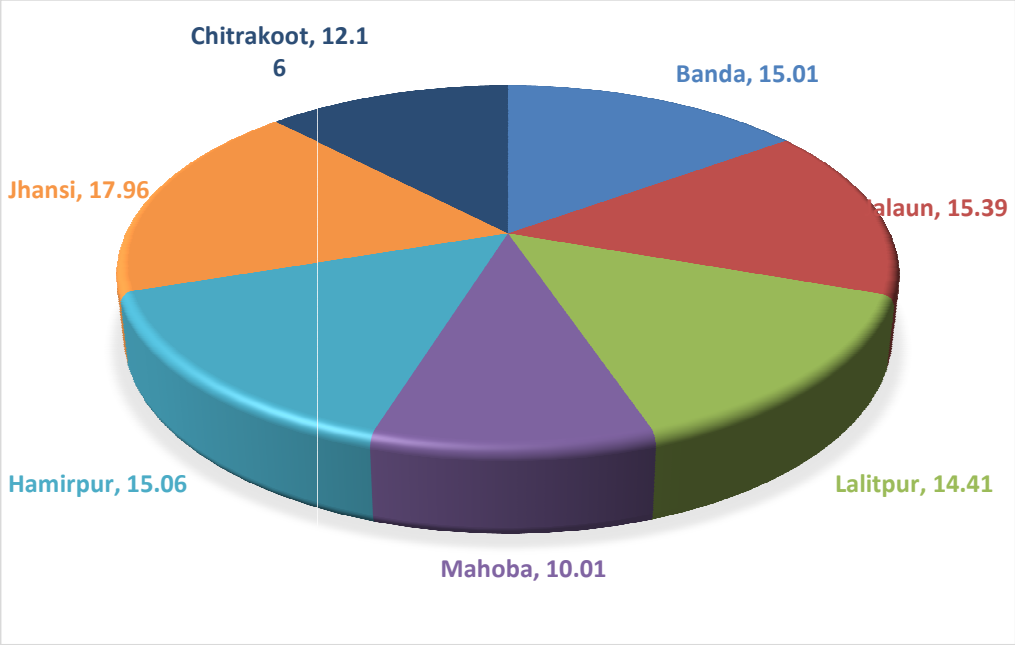


Table-3.11
Livestock population in different districts of Bundelkhand Region of Uttar Pradesh (Numbers)

Particulars	Banda	Jalaun	Lalitpur	Mahoba	Hamirpur	Jhansi	Chitrakoot	Overall
Cow	141237 (25.73)	110583 (19.65)	237378 (45.03)	105108 (28.72)	125214 (22.74)	169160 (25.76)	196413 (44.16)	1085093 (29.67)
Buffalos	167010 (30.42)	130955 (23.26)	121287 (23.01)	62088 (16.97)	102843 (18.68)	130756 (19.51)	92148 (20.72)	807087 (22.07)
Sheep	12259 (2.23)	28827 (5.12)	8023 (1.52)	14586 (3.99)	16413 (2.98)	53479 (8.14)	20213 (4.54)	153800 (4.21)
Goat	210916 (38.42)	267994 (47.61)	156838 (29.75)	162823 (44.48)	291825 (53.00)	294216 (44.80)	125317 (28.18)	1509929 (41.28)
Pig	17566 (3.20)	24530 (4.36)	3623 (0.69)	21371 (5.84)	14362 (2.60)	9105 (1.39)	10688 (2.40)	101245 (2.77)
Total Livestock	548988 **(100) /15.01/**	562889 **(100) /15.39/**	527149 **(100) /14.41/**	365976 **(100) /10.01/**	550657 **(100) /15.06/**	656716 **(100) /17.96/**	444779 **(100) /12.16/**	3657154 **(100) /100/**

Sources: 19th Animal census 2012, Department of Animal Husbandry, Lucknow, U.P. Figures in parenthesis shows percentage to total livestock population and in slashes shows district wise livestock population percentage

Fig. 3.11: Total poultry population (Numbers) in different districts of Bundelkhand

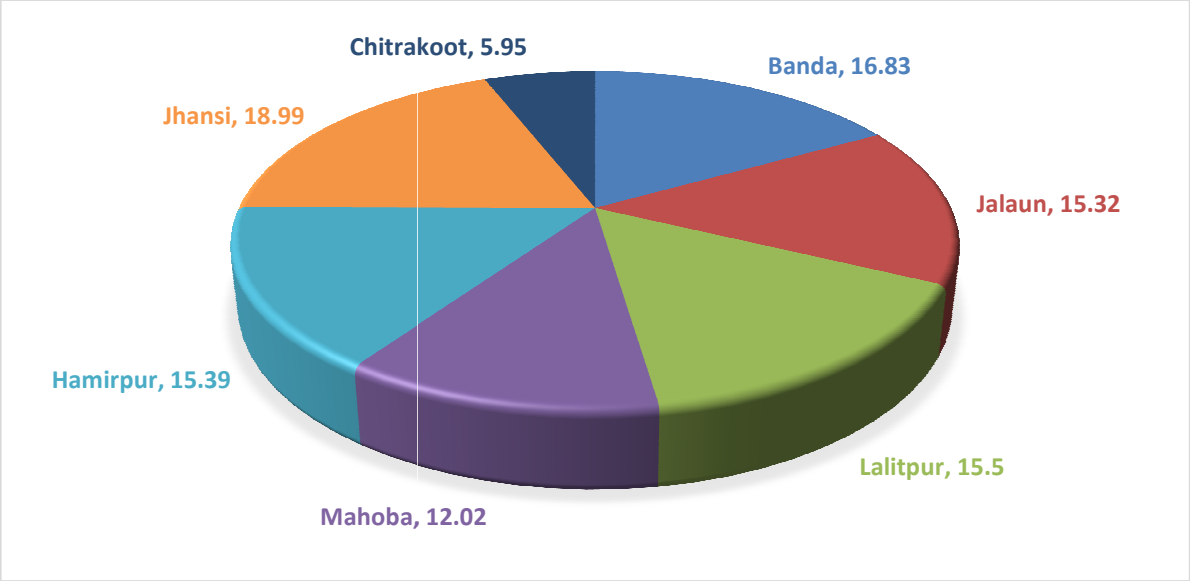


Table-3.12
Poultry population in different districts of Bundelkhand Region of Uttar Pradesh (Numbers)

Particulars	Banda	Jalaun	Lalitpur	Mahoba	Hamirpur	Jhansi	Chitrakoot	Overall
Poultry	52092 (16.83)	47420 (15.32)	47991 (15.50)	37211 (12.02)	47644 (15.39)	58766 (18.99)	18411 (5.95)	309535 (100)

Sources: 19th Animal census 2012, Department of Animal Husbandry, Lucknow, U.P. Figures in parenthesis shows percentage to total poultry population

The population of poultry birds was found to be more in Jhansi (18.99%) followed by Banda (16.83%), Lalitpur (15.50%), HamiRpur (15.39%), Jalaun (15.32%), Mahoba (12.02%) and Chitrakoot (5.95%) districts of Bundelkhand Region of Uttar Pradesh (Fig 1.12).

3.12 Summary of the Chapter

- The total population of Bundelkhand region of Uttar Pradesh was found to be 96.81 lakh, out of which 53.28 and 46.72 per cent are male and female, respectively. The rural population (77.33%) was found to be more as compared to urban population (22.67%).
- An average literacy rate of the region was found to be 59 per cent, which was more in male (68%) as compared to female (48%) population. The very thin sex ratio (877) and child sex ratio 891 over 1000 male was found in the region. There were only 15.05 per cent of children in total population of Bundelkhand Region of Uttar Pradesh. The region was found to be dominant by Hindus (76.46%) followed by Muslim (5.89 %) religion.
- The geographical area (area reported for land use) was found to be 29.62 lakh hectare. Out of total geographical of the Region, 70, 8, 9, 3 and 5 per cent was found in net area sown, area covered under forest, land used for non-agricultural use(not available for cultivation), other un-cultivated land excluding fallow land and fallow land respectively. Amongst all the districts, maximum geographical area was occupied by Lalitpur followed by Jhansi, Jalaun, Banda, Hamirpur, Chitrakoot and Mahoba districts, while the net area sown (actual area sown) to total geographical area was found to be more in Banda (80.82%) followed by Jalaun (77.44%), Hamirpur (75.43%), Mahoba (72.45%), Jhansi (68.24%), Lalitpur (59.63%) and Chitrakoot (51.10%).
- The net irrigated area in Bundelkhand Region of Uttar Pradesh was found to be 66.28 per cent (13.71 lakh ha) to total geographical area. Amongst different sources of irrigation, canal (34.76%) followed by tube-well (32.85%), well (23.37%), tank, lakes, ponds (7.44%) and other sources (1.59%) were found to be major sources of irrigation.
- The cropping pattern of the region was found to be dominated by *Rabi* (64.61%) as compared to *kharif* season (35.12%). Wheat (45.29%) followed by gram (17.34%) and pea (9.98%) followed by rice (5.86%) were found to be major *rabi and kharif* crops respectively with urd coming up in few districts.
- The fertilizers consumption of Bundelkhand region of Uttar Pradesh was found to be 521324 t per year. The consumption of Urea (57.07%), was found to be more as compared to DAP (28.07%), complex fertilizers (12.06%), SSP (2.68%) and Murate of Potash, MOP (0.19%)

- The numbers of regulated markets were found to be 58 across different grades of mandi and various districts of the Bundelkhand Region of Uttar Pradesh. However, the majority of regulated market were found to be of “D” grade (46.54%) followed by “B” grade (20.70%) “C” grade (17.24%) and “A” grade (15.52 %)
- The 1486001 numbers of land holdings occupied 21.25 lakh ha area in Bundelkhand Region of Uttar Pradesh. The number of marginal (57.01%) and small (22.22%) holdings were found to be more as compared to semi-medium (13.34%) medium (6.94%) and large (0.68%) size of holdings, while area of medium (27.41%), and semi-medium (25.92%) holdings were found to be more as compared to small (21.59%), marginal (18.51%) holdings and large holding (6.57%) in the region. The 1486001 numbers of land holdings occupied 21.25 lakh ha area in the region.
- More number of non-workers (62.68%) was found in the region as compared to main workers (24.92%) and marginal workers (12.40%). In total number of workers (main and marginal) the majority of them were found to be agricultural labours (35.49%) followed by cultivators (35.25%), other workers (25.22%) and workers in household Industries (4.04%).
- As regards to the numbers of ploughs, bullock carts, electric pumps, diesel pumps, tractors and sugarcane crushers were concerned there were found to be 385298, 132981, 4375, 125167, 62433 and 1134 in the region.
- The number of livestock in the region was found to be 3657154. Amongst them population of goats (41.29%) was found to be more as compared to cows (29.67%), buffaloes (22.07%), sheep (4.21%) and pigs (2.77%).
- The total poultry numbers in Bundelkhand region of Uttar Pradesh was found to be 309535. Amongst these the highest were in districts Jhansi (18.99%) followed by Banda (16.83%), Lalitpur (15.50%), Hamirpur (15.39%), Jalaun (15.32%), Mahoba (12.02%) and Chitrakoot (5.95%)

CHAPTER-IV

SOCIO-ECONOMIC CHARACTERISTICS OF THE SAMPLE HOUSEHOLDS

The present chapter is an attempt to highlight various socio-economic characteristics of the sample households (120 in number) like socio-economic profile, land use pattern, cropping intensity, technical inputs and labour use in production of the crop under study i.e. rice and wheat, the two major crops in Bundelkhand region of Uttar Pradesh.

4.1 Socio-economic Profile of the Respondents

The details of socio-economic profile of selected respondents like Age and sex wise distribution, Level of Education, Caste, Primary and Secondary Occupations along with Income, are shown by Table- 4.1(a) through Table-4.1(e); respectively.

(a) Age wise distribution

The Table-4.1(a) shows age-wise composition of selected respondents.

Table-4.1(a)
Age wise Composition of Respondents

Particulars	Small	Medium	Large	Overall
Age	57.00	54.00	55.00	55.00
Less Than 14	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Between 15-45	36.00 (90.00)	32.00 (80.00)	30.00 (75.00)	98.00 (81.67)
More Than 45 or above	4.00 (10.00)	8.00 (20.00)	10.00 (25.00)	22.00 (18.33)
Total	**40.00 (100.00)**	**40.00 (100.00)**	**40.00 (100.00)**	**120.00 (100.00)**

The table shows that average age of selected respondents in the study has been recorded as 57 years, 54 years, 55 years respectively in case of small, medium and large farmers, with an overall average of 55 years. The majority of respondents has been in the age group of 15 to 45 years, in

case of small, medium and large categories, as well as for the whole sample of 120 respondents, covering 75 percent to 90 percent in different categories and 81.67 percent on overall basis.

(b) Sex-wise Composition

The sex-wise composition of family members of the selected respondents is shown in Table-4.1(b), on average per family basis.

Table-4.1(b)
Sex-wise Composition

Particulars		**Small**	**Medium**	**Large**	**Overall**
No. of Family Members (per Family/Farm)	Male	3.00 (37.50)	3.00 (42.86)	4.00 (40.00)	3.33 (39.98)
	Female	3.00 (37.50)	2.00 (28.57)	3.00 (30.00)	2.67 (32.05)
	Child	2.00 (25.00)	2.00 (28.57)	3.00 (30.00)	2.33 (27.97)
	Total	**8.00 (100.00)**	**7.00 (100.00)**	**10.00 (100.00)**	**8.33 (100.00)**

The average size of family has been reported as 8.00, 7.00, 10.00 members respectively in small, medium and large categories of farmers, while 8.33 on overall basis for entire sample. On an average basis, the respective percentage of male, female and child have been 39.98 percent, 32.05 percent and 27.97 percent respectively. Category wise as well, almost the same pattern is found.

(c) Level of Education

The table-4.1(c) shows distribution of total respondents in different categories and also for the whole sample, as per levels of education.

Table-4.1(c)
Distribution of respondents according to level of Education

Particulars		Small	Medium	Large	Overall
Level of Education	Illiterate	10.00 (25.00)	7.00 (17.50)	8.00 (20.00)	25.00 (20.83)
	Primary	8.00 (20.00)	8.00 (20.00)	10.00 (25.00)	26.00 (21.67)
	High School	6.00 (15.00)	5.00 (12.50)	4.00 (10.00)	15.00 (12.50)
	Higher Secondary	5.00 (12.50)	9.00 (22.50)	7.00 (17.50)	21.00 (17.50)
	Graduate	7.00 (17.50)	2.00 (5.00)	6.00 (15.00)	15.00 (12.50)
	Post Graduate	2.00 (5.00)	6.00 (15.00)	3.00 (7.50)	11.00 (9.17)
	Above (Post Graduate)	2.00 (5.00)	3.00 (7.50)	2.00 (5.00)	7.00 (5.83)
	Total	**40.00 (100.00)**	**40.00 (100.00)**	**40.00 (100.00)**	**120.00 (100.00)**

On an overall basis, the maximum respondents have education upto primary level with respective percentage as 21.67 percent; followed by Illiterates (20.83 percent), Higher secondary (17.50 percent), High School and Graduate (each accounting for 12.50 percent), Post Graduate (9.17 percent) and above Post graduate (5.83 percent). Similar pattern is observed category wise as well. Higher illiteracy is reported in small category of respondents, while higher Post Graduate level respondents are found in medium category of respondents.

(d) Caste-wise details

Caste-wise details of the respondents are shown in Table-4.1(d)

Table-4.1(d)

Caste wise details of respondents

Particulars		Small	Medium	Large	Overall
Caste	General	8.00 (20.00)	18.00 (45.00)	27.00 (67.50)	53.00 (44.17)
	Other Backward	23.00 (57.50)	20.00 (50.00)	13.00 (32.50)	56.00 (46.66)
	Scheduled Caste	9.00 (22.50)	2.00 (5.00)	0.00 (0.00)	11.00 (9.17)
	Scheduled Tribe	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
	Total	**40.00 (100.00)**	**40.00 (100.00)**	**40.00 (100.00)**	**120.00 (100.00)**
No. of family members involved in farming	Male	1.58	1.53	2.00	1.70
	Female	1.23	0.98	0.70	0.97
	Total	**2.81**	**2.51**	**2.70**	**2.67**
Experience in farming (Years)		39.00	36.00	39.00	38.00

On an overall basis, the maximum percentage of respondents is reported in other Backward Caste (46.66 percent), followed by General caste (44.17 percent) and Scheduled caste (9.17 percent). Category wise, the highest percentage of respondents belongs to General caste (67.50 percent) in large group, other backward caste (50.00 percent) in medium group and also in small group (57.50 percent).

The per respondent (farmer) basis average number of family members involved in farming is reported as 2.81, 2.51, 2.70 in small, medium, large categories respectively and 2.67 on overall basis, while farming experience of respondents in different categories and on overall basis ranges from 36 years to 39 years.

(e) Occupation wise Distribution

The occupation wise distribution (primary and secondary) along with respective income is given in Table-4.1(e).

Table-4.1(e)
Occupation wise Distribution

Particulars		Small	Medium	Large	Overall
Primary Occupation	Farming	40.00 (100.00)	40.00 (100.00)	40.00 (100.00)	120.00 (100.00)
Secondary Occupation	Agriculture Labour	7.00 (17.50)	3.00 (7.50)	1.00 (2.50)	11.00 (9.17)
	Live Stock	14.00 (35.00)	20.00 (50.00)	10.00 (25.00)	44.00 (36.67)
	Poultry	(0.00)	(0.00)	(0.00)	(0.00)
	Goatry	(0.00)	(0.00)	(0.00)	(0.00)
	Fishery	(0.00)	(0.00)	(0.00)	(0.00)
	Self Employment	1 (2.50)	0 (0)	0 (0)	1 (0.83)
	Services	0.00 (0.00)	1.00 (2.50)	3.00 (7.50)	4.00 (3.33)
	Non-Agricultural Labour	10.00 (25.00)	6.00 (15.00)	1.00 (2.50)	17.00 (14.17)
	Daily wages Labour	3.00 (7.50)	2.00 (5.00)	4.00 (10.00)	9.00 (7.50)
	Others	5.00 (12.50)	8.00 (20.00)	21.00 (52.50)	34.00 (28.33)
	Total	**40.00 (100.00)**	**40.00 (100.00)**	**40.00 (100.00)**	**120.00 (100.00)**
Income (Rs./year/annum)	From Agriculture	69515.00 (75.89)	63430 .00 (79.01)	73599.00 (72.85)	68848 .00 (75.68)
	From Other Sources	22083.00 (24.11)	16850.00 (20.99)	27430.00 (27.15)	22121.00 (24.32)
	Total	**91598.00 (100.00)**	**80280.00 (100.00)**	**101029.00 (100.00)**	**90969.00 (100.00)**

Figures in parenthesis show percent to total

The Table-4.1(e) shows that (i) In respect of primary occupation, the entire respondents are engaged in farming, on cent percent basis; in each category i.e. small, medium and large, as well as on total sample basis. (ii) Among secondary occupation (a) on overall basis, the most dominant is livestock (36.67 percent) followed by non-agricultural labour (14.17), Agricultural labour (9.17 percent) and daily wages labour (7.50 percent) with few respondents in services (3.33 percent) and 'others' accounting for 28.83 percent. (b) Category wise pattern is same in marginal and small farmers groups while in large farmers group the main occupations are livestock, daily wage workers, service and labour (agricultural and non- agricultural); with others accounting for 52.50 percent. (c) On self employment there is a lone (single) farmer in small farmers group.

As evident from the table, the major share of income is derived from agriculture accounting for 72.85 percent to 79.01 percent in different categories and 75.68 percent on overall basis for the entire sample of 120 respondents.

4.2 Farm Machinery of Selected Respondents

The details of Farm Machinery and land possessed by selected respondents are shown in Table-4.2

Table 4.2
Farm machinery of selected respondents (Rs./farm)

Particulars	Small	Medium	Large	Overall
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
Combiner/Reaper	0	0	0	0
Straw Machine	0	0	0	0
Tractor Sprayer	0	0	0	0
Paddy/Potato Planter	0	0	0	0
Plough	93	50	0	48
Bukkhar	195	75	0	90
Hand Hoe	0	0	0	0
Diesel Pump	5125	6375	8163	6554
Electric Pump	625	1250	7213	3029
Sprinkler	300	250	300	283
Drip	0	0	0	0
Power Sprayer	425	488	561	491
Hand Sprayer	238	55	114	135
Others	553	3558	423	1511
Land	410875	395938	412875	406563
Total	**453804**	**471464**	**601149**	**508804**
Total (Excluding Land)	**42929 (9.46)**	**75526 (16.02)**	**188274 (31.32)**	**102242 (20.09)**

Figures in parenthesis show percent to total

The total farm machineries along with the value of land on per farm basis have the monetary value ranging from Rs. 458304 to Rs 601149 for different categories with average amount of Rs. 508804 for the whole sample. Among machineries the major items have been Tractor, Thresher, Cultivator, Seed drill, Diesel pump, Electric pump on overall sample basis and category-wise as well, though seed drills are not reported in case of small category farmers.

It is also noted that while sprinkler facility is available in case of all categories, though with meager amount, Drip irrigation is not at all available in any of the case. Like-wise power and Hand sprayers are also possessed by all categories of respondents but at smaller level.

Excluding land the total machineries account for 9.46 percent, 16.02 percent and 31.32 percent of total value (with land), in different categories and 20.09 percent for the total selected respondents. It is evidently seen that the large farmer categories possess machineries in relatively higher order as compared to small and medium farmers.

4.3 Land Use Pattern

The land use pattern of different categories of respondents has been shown in Table-4.3

Table 4.3
Land use Pattern (Acre/farm)

Particulars		Small	Medium	Large	Overall
Land Holding	Cultivated	2.37 (100.00)	7.57 (98.83)	15.78 (96.69)	8.57 (97.61)
	Un-cultivated	0.00 (0.00)	0.09 (1.17)	0.54 (3.31)	0.21 (2.39)
	Total	2.37 (100.00)	7.66 (100.00)	16.32 (100.00)	8.78 (100.00)
Leased-In Land		0.78	0.08	0.13	0.33
Leased-Out Land		0.00	0.08	0.75	0.28
Current Fallow		0.00	0.03	0.21	0.08
Old Fallow		0.00	0.00	0.03	0.01
Operated land Holding		3.15	7.60	15.40	8.71
Irrigated Area		2.72 /86.00/	6.62 /88.00/	11.70 /76.00/	7.01 /80.00/

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

The table 4.3 shows that:

- The average size of an operational holding has been respectively recorded as 3.15 acres, 7.60 acres, 15.40 acres for small, medium, large categories of farmers; while 8.71 acres on overall sample basis.
- The extent of irrigation has been of the order of 76 percent to 88 percent for different categories, while 80 percent on overall basis.
- Under small farmers category, total land holding is under cultivation i.e. there is no uncultivated land at all, while under medium and large categories cultivated land accounts respectively for 96.69 percent and 98.83 percent of total holding size. On an average for whole sample 97.61 percent of the total land holding is under cultivation.
- Leased in land practice is observed in all categories of respondents; but mainly in case of small farmers; while with very meager and almost negligible percentages in case of medium and large farmers. Small farmers have not at all leased out their land; while medium and larger farmers have leased out, but to very small extent. The uncultivated land and current and old fallows have also very meager or almost negligible percentages in case of medium and large sized categories with not at all in case of small category respondents.

4.4 Source of Irrigation

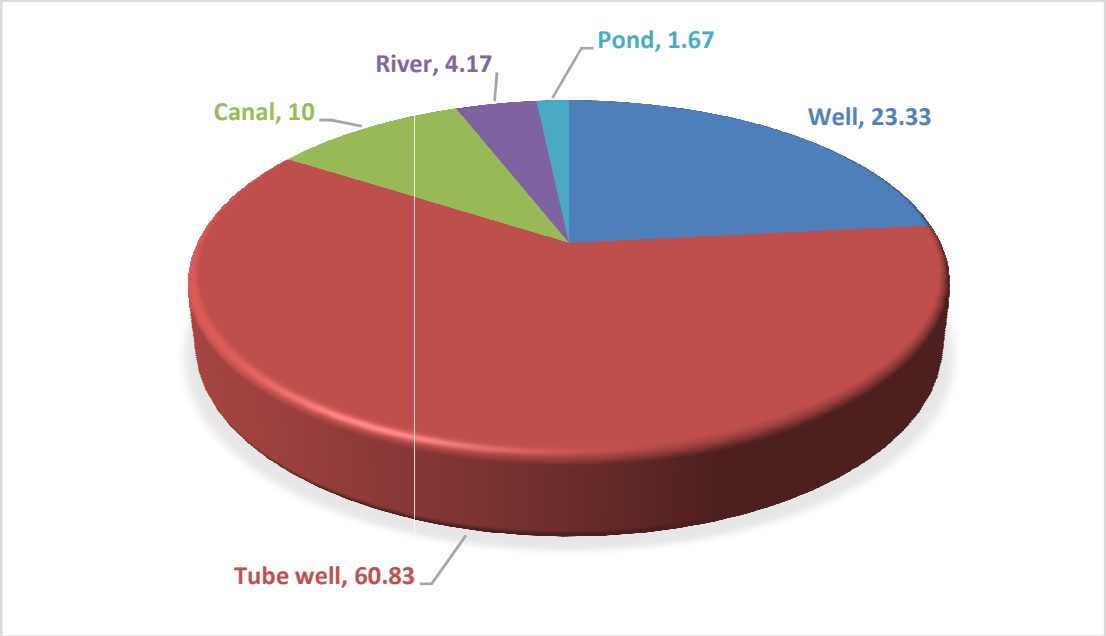
Source wise irrigation details are given in Table-4.4

Table-4.4
Source of Irrigations (No. of Respondents)

Particulars	Small	Medium	Large	Overall
Well	9.00 (22.50)	13.00 (32.50)	6.00 (15.00)	28.00 (23.33)
Tube-Well	24.00 (60.00)	21.00 (52.50)	28.00 (70.00)	73.00 (60.83)
Canal	5.00 (12.50)	3.00 (7.50)	4.00 (10.00)	12.00 (10.00)
River	2.00 (5.00)	1.00 (2.50)	2.00 (5.00)	5.00 (4.17)
Pond	0.00 (0.00)	2.00 (5.00)	0.00 (0.00)	2.00 (1.67)
Other	(0.00)	(0.00)	(0.00)	(0.00)
Total	**40.00 (100.00)**	**40.00 (100.00)**	**40.00 (100.00)**	**120.00 (100.00)**

Figures in parenthesis show percent to total

Fig 4.1: Source wise irrigation of selected households



The major sources of irrigation in the region for all categories of respondents are tube-well and well when taken together they account for 82.50 percent to 85.00 percent of the total irrigated area in different categories and 84.16 percent for the whole sample Canal is also available as a source of irrigation, but the extent of coverage ranges from 7.5 percent to 12.00 percent of total irrigated area on different categories. Apart from these, river and ponds are also noticed as source of irrigation, but almost with coverage of just 5 percent or even less than that.

4.5 Cropping Pattern of Respondents

Cropping patterns of respondents for Kharif, Rabi and Zaid crops as also total cropped area are given in Table-4.5(a) and 4.5(b) as under.

Table-4.5(a)
Cropping pattern of respondents (Acre/farm) Kharif Crops

Particulars	Small	Medium	Large	Overall
Kharif				
Paddy	1.11 (35.92)	2.51 (35.06)	5.46 (37.47)	3.03 (36.64)
Maize	0.07 (2.27)	0.05 (0.70)	0.33 (2.26)	0.15 (1.81)
Jowar	0.00 (0.00)	0.03 (0.42)	0.00 (0.00)	0.01 (0.12)
Bajra	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Soybean	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Till	0.75 (24.27)	1.99 (27.79)	4.47 (30.68)	2.40 (29.03)
Groundnut	0.04 (1.29)	0.14 (1.96)	0.15 (1.03)	0.11 (1.33)
Tur	0.03 (0.97)	0.05 (0.70)	0.08 (0.55)	0.05 (0.60)
Urd	1.01 (32.69)	1.92 (26.80)	2.94 (20.18)	1.96 (23.7)
Moong	0.08 (2.59)	0.40 (5.59)	0.82 (5.63)	0.43 (5.2)
Others	0.00 (0.00)	0.07 (0.98)	0.32 (2.20)	0.13 (1.57)
Total Kharif	**3.09** **(100.00)** **/50.74/**	**7.16** **(100.00)** **/48.77/**	**14.57** **(100.00)** **/50.38/**	**8.27** **(100.00)** **/49.94/**

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

The total per farm kharif cropped area works out to be 3.09 acres, 7.16 acres, 14.57 acres respectively on small, medium, large category respondents and as 8.27 acres on average per farm basis for total sample of 120 respondents. Among kharif crops Paddy, Til and Urd have been the most dominating crops which when taken together account for 89.37 percent of the total Kharif cropped area on overall basis. This percentage ranges from 88.33 percent to 92.88 percent for different category respondents. Among other crops sown by farmers in kharif season have been Maize, Jowar, Groundnut, Tur and Moong, while Bajra and Soyabeen have not at all being adopted by any category of respondent.

Table-4.5(b)
Cropping pattern of respondents (Acre/farm) Rabi and Zaid Crops

Particulars	Small	Medium	Large	Overall
Rabi				
Wheat	2.37 (79.00)	5.47 (72.74)	9.48 (66.06)	5.77 (69.60)
Gram	0.46 (15.33)	1.06 (14.1)	2.52 (17.56)	1.35 (16.28)
Pea	0.09 (3.00)	0.49 (6.52)	1.19 (8.29)	0.59 (7.12)
Lentil	0.01 (0.33)	0.13 (1.73)	0.39 (2.72)	0.18 (2.17)
Jow	0.00 (0.00)	0.00 (0.00)	0.13 (0.91)	0.04 (0.48)
Sugarcane	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Mustered	0.05 (1.67)	0.21 (2.79)	0.34 (2.37)	0.2 (2.42)
Linseed	0.00 (0.00)	0.05 (0.66)	0.10 (0.70)	0.05 (0.60)
Other	0.02 (0.67)	0.11 (1.46)	0.20 (1.39)	0.11 (1.33)
Total Rabi	**3.00 (100.00) /49.26/**	**7.52 (100.00) /51.23/**	**14.35 (100.00) /49.62/**	**8.29 (100.00) /50.06/**
Zaid				
Urd	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Moong	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Mentha	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Other	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Total Zaid	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Gross Cropped Area	**6.09 /100.00/**	**14.68 /100.00/**	**28.92 /100.00/**	**16.56 /100.00/**
Cropping Intensity %	**193.00**	**195.00**	**194.00**	**194.00**

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

The total per farm Rabi cropped area works out to be 3.00 acres, 7.52 acres, 14.35 acres respectively on small, medium and large category respondents and as 8.29 acres on average per farm basis for the overall sample. Among Rabi crops Wheat, Gram and Pea are the main crops which altogether account for 93.00 percent of total Rabi cropped area on overall basis, while this percentage varies from 91.91 percent to 97.33 percent for different categories of respondents.

Among other crops grown by farmers in Rabi season have been Lentil, Jow, Mustard and Linseed, but at a very smaller level and not at all in some categories.

Among Zaid crops, "No Crop" has been grown by an category of respondents. The overall Total Cropped Area on per farm basis has been 6.09 acres, 14.68 acres, 28.92 acres respectively on small, medium, large categories and 16.56 acres on overall basis, with respective cropping intensities as 193 percent, 195 percent, 194 percent and 194 percent. In case of selected sample respondents as well, Paddy and Wheat are the only two crops, each of which occupies individually more than 10 percent of the gross cropped area. Paddy (rice) accounts for 17.03 percent to 18.88 percent in different categories and 18.30 percent of gross cropped area on overall basis; while wheat occupies 32.68 percent to 38.92 percent in different categories and 34.84 percent of gross cropped area for the total sample.

This underlines, the need; to identify various factors to minimize the Yield Gap of these two crops in the study area to the minimum possible, in order to increase yield and thus the aggregate production of these two crops in this region of Uttar Pradesh.

4.6 Soil Testing and Soil Health Card (SHC) Status of Respondents

Soil Testing and Soil Health Card (SHC) status of respondents are displayed in Table-4.6

Table-4.6
Soil testing and Soil Health Card (SHC) Status of the respondents (Numbers)

Particulars	Small	Medium	Large	Total
No. of Respondents	40.00 (100.00)	40.00 (100.00)	40.00 (100.00)	120.00 (100.00)
No. of Soil Tested farmers	23.00 (58.00)	21.00 (53.00)	22.00 (55.00)	66.00 (55.00)
No. of farmers who received SHC	15.00 (38.00)	12.00 (30.00)	14.00 (35.00)	41.00 (34.00)

Figures in parenthesis show percent to total

The table depicts that out of total 120 respondents, 55 percent are Soil Tested Farmers, while only 34 percent of them have received Soil Health Cards (SHCs). Category wise as well, Soil Tested farmers' percentage ranges from 53 percent to 58 percent, while that of SHC received farmers varies from to 30 percent to 38 percent.

Thus it is worth recommending that the farmers of the region should be made more aware of the facility and also encouraged to gettheir soils tested and receive the Soil Health Cards. The concerned agencies should be entrusted with this responsibility of carrying out Soil Testing and distribution of SHCs earnestly.

4.7 Summary of the Chapter

The various points emerging out from this chapter are presented as under

i. On overall basis, the average size of a family has been recorded as 8.33 (in numbers) with respective percentages of males, females and children as 39.98percent, 32.05 percent and 27.97 percent.
ii. The average age of the respondents has been 55 years, with majority (81.67 percent) of total 120 sample respondents in the age group 15 to 45 years.
iii. Maximum respondents (21.67 percent) have education upto primary level and minimum (5.83 percent) above post graduate level and that higher illiteracy is found in small farmer category.
iv. On overall basis the maximum percentage (46.66 percent) of respondents belongs to other backward class followed by general caste (44.17 percent) and schedule caste (9.17 percent). The average number of per respondent family members involved in farming is reported as 2.67 while the farming experience of respondents in different categories as well as on overall basis, ranges from 36 to 39 years.
v. In respect of primary occupation, the entire respondents i.e. 120, are engaged in farming on cent percent basis while among secondary occupation the most dominant is livestock followed by agricultural and non-agricultural labour and daily wages labour.
vi. On an average basis, the total farm machineries including land have a monetary value of Rs.508804, while different machineries have been tractor, thresher, cultivator, seed drill, diesel pump and electric pump, sprinkler irrigation facility is available in all categories of farmers through with meagre amount and that the drip irrigation is not at all available in ant categories. Large farmers possess machineries to a higher order as compared to small and medium categories farmers.

vii. The average size of an operational holding has been recorded as 8.71 acres, with extent of irrigation as 80 percent, on overall basis. On an average, 97.61 percent of total land holdings is under cultivation.

viii. Leased in land practices is observed mainly in case of small farmers, while leased out practices in case of medium and large category farmers but to very small extent.

ix. The major source of irrigation available to all categories of farmers in the region, are tube-well and well, which when taken together account for 82.50 to 85.00 percent of total irrigated areas in category of farmers. Canal is also available as a source of irrigation but with a coverage of just 7.5 to 12 percent of the irrigated area.

x. On an average basis for the total sample (a) the total per farm kharif cropped area worked out to be 8.27 acres, which among kharif crops the most dominating are paddy, til and urd, which when taken together account for 89.37 percent of total kharif crop area. Among these kharif crops have been maize, jowar, groundnut, tur and moong. (b) The per farm rabi cropped area comes as 8.29 acres, while main rabi crops have been wheat, gram and pea accounting for all together 93.00 percent of total rabi cropped area. Other rabi crops have been lentil, jau, mustard and linseed. (c) No zaid crops has been grown by any category of the farmers.

xi. Among total 120 sample respondents, 55 percent are soil testing farmers while 34 percent are them have received soil health cards (SHCs)

CHAPTER-V

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

This chapter deals with analysis of yield gap and constraints thereof in adoption of recommended technologies, along with identifying various determinants of yield for paddy and wheat the two major crops in Bundelkhand region of Uttar Pradesh; by using multiple regression analysis. In the process the various sources of information in respect of rice and wheat cultivation(s) have also been studied and incorporated accordingly.

5.1 Yield Gap

'Yield gap', the main component of the present study to be bridged up through different strategies, as have already been conceptualized in three ways, under Research Methodology part of this study report, are respectively (i) Yield Gap-I, difference between potential (Y_p) and highest (Y_h) farm yields, (ii) Yield Gap-II, difference between highest farm yield (Y_h) and average farm yield (Y_a) and (iii) Yield Gap-III, difference between potential (Y_p) and average from yields (Y_a). These are reproduced here;

$$Yg_1 = \frac{Yp - Yh}{Yp} \times 100$$

$$Yg_2 = \frac{Yh - Ya}{Yh} \times 100$$

$$Yg_3 = \frac{Yp - Ya}{Yp} \times 100$$

These are presented in Table-5.1 to Table-5.3 for crops Paddy and Wheat.

5.1(a) Yield Gap analysis for Paddy under SRI Method

Table-5.1 presents Yield Gap analysis for crop Paddy under SRI (System of Rice Intensification) method.

Table-5.1

Yield Gap Analysis for Paddy under SRI methods (q/acre)

Particulars	Small	Medium	Large	Overall
n	**9**	**9**	**10**	**28**
Potential (Y_p)	24.00	24.00	24.00	24.00
Average (Y_a)	16.10	15.64	16.31	16.02
Highest (Y_h)	19.96	19.55	19.76	19.76
Yield gap-I	4.04 (16.83)	4.45 (18.54)	4.24 (17.67)	4.24 (17.67)
Yield gap-II	3.86 (19.34)	3.91 (20)	3.45 (17.46)	3.74 (18.93)
Yield gap-III	7.9 (32.92)	8.36 (34.83)	7.69 (32.04)	7.98 (33.26)

Figures in parenthesis show percent yield gap

Figure-5.1

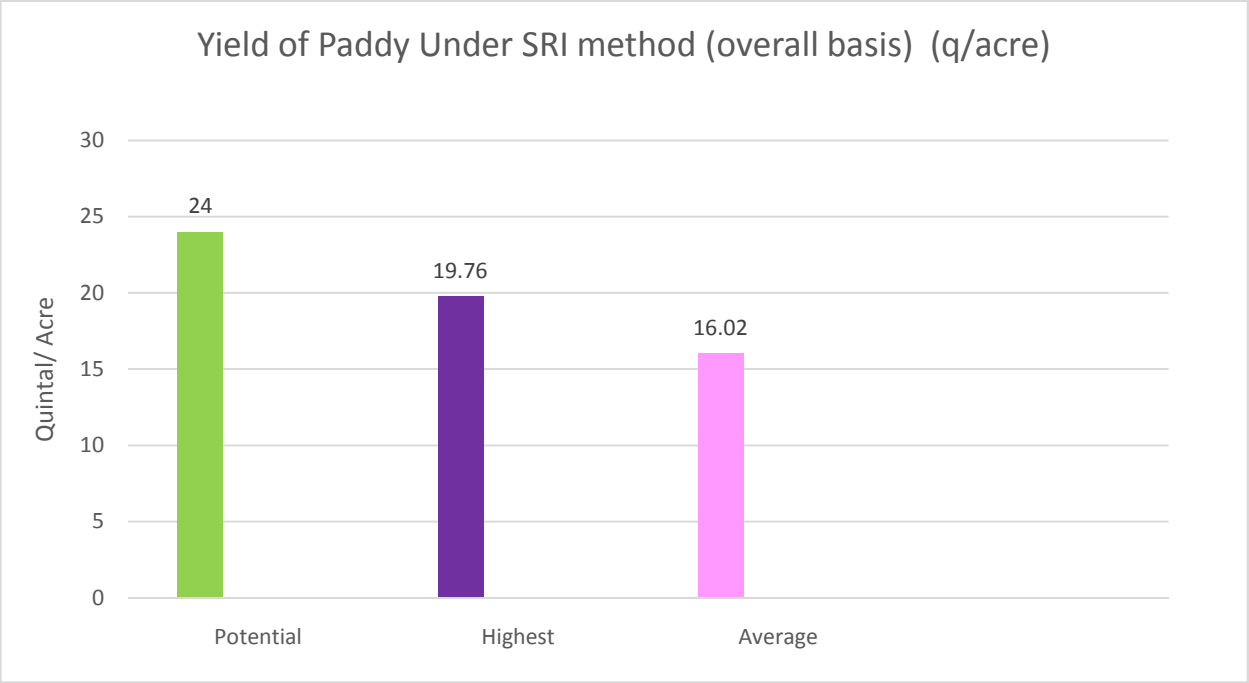
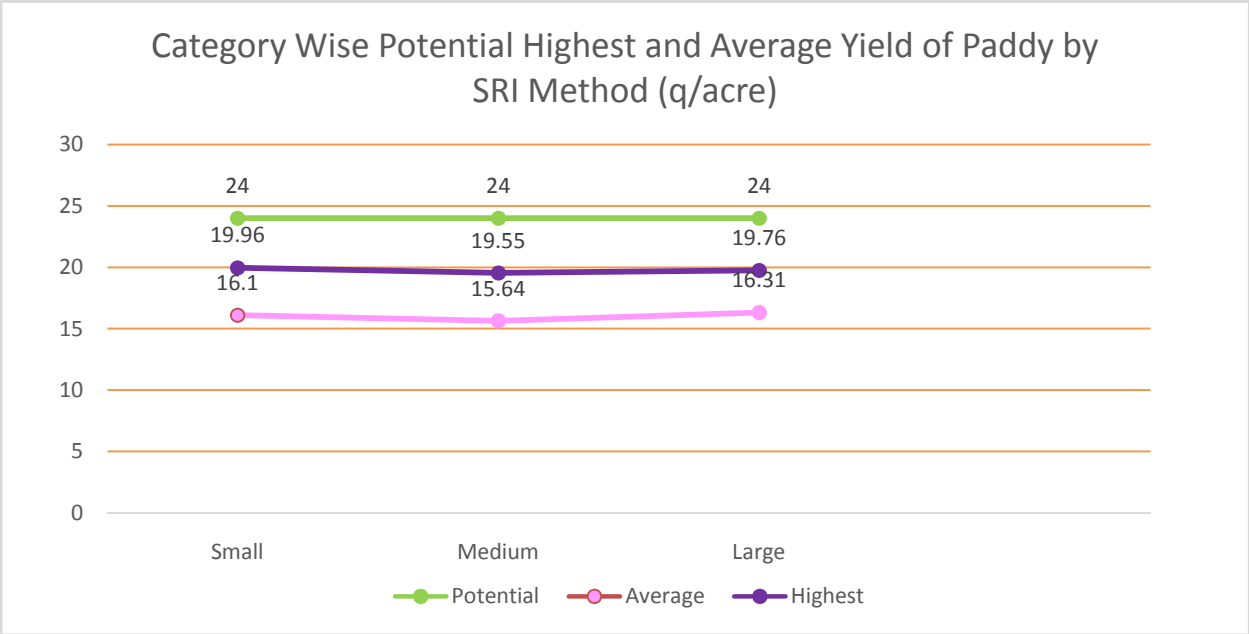


Figure-5.2



Under SRI method, the potential yield of paddy in the agro-climatic zone has been recorded as 24 quintals per acre. Against this, the highest and the average recorded yields for the whole sample as well as category wise, have been respectively 19.76 quintals per acre and 16.02 quintals per acre in the range of 19.55 to 19.96 and 15.64 to 16.31 respectively. Further (i) yield gap-I is found as 4.04 to 4.45 quintals per acre, category wise. In percentages, yield gap-I is of the order of 17.67 percent on the whole ranging between 16.83 percent and 18.54 percent over different categories. (ii) Yield gap-II is recorded as 3.74 quintals per acre, which is slightly less than that of yield gap-I. This is ranging between 3.45 and 3.91 quintals per acre category wise; with respective percentages at 18.93 percent on overall basis and in the range of 17.46 percent to 20.00 percent over categories. (iii) Yield gap-III on overall basis is found to be 7.98 quintals per acre, which is higher than both yield gap-I and II. Category wise this is ranging between 7.69 and 8.36 quintals per acre. On percentage basis as well, this is the highest among all the three of yield gaps with respective percentage an average basis as 33.26 percent in the range of 32.04 percent to 34.83 percent in different categories.

5.1(b) Yield Gap Analysis for Paddy (conventional method)

Table-5.1(b) presents Yield Gap Analysis for crop Paddy under conventional method.

Table-5.2
Yield Gap Analysis for Paddy under Conventional methods (q/acre)

Particulars	Small	Medium	Large	Overall
n	**11**	**11**	**10**	**32**
Potential (Y_p)	16.00	16.00	16.00	16.00
Average (Y_a)	8.30	7.95	8.55	8.27
Highest (Y_h)	11.98	11.09	11.01	11.36
Yield gap-I	4.02 (25.13)	4.91 (30.69)	4.99 (31.19)	4.64 (29)
Yield gap-II	3.68 (30.72)	3.14 (28.31)	2.46 (22.34)	3.09 (27.12)
Yield gap-III	7.70 (48.13)	8.05 (50.31)	7.45 (46.56)	7.73 (48.33)

Figures in parenthesis show percent yield gap

Figure-5.3

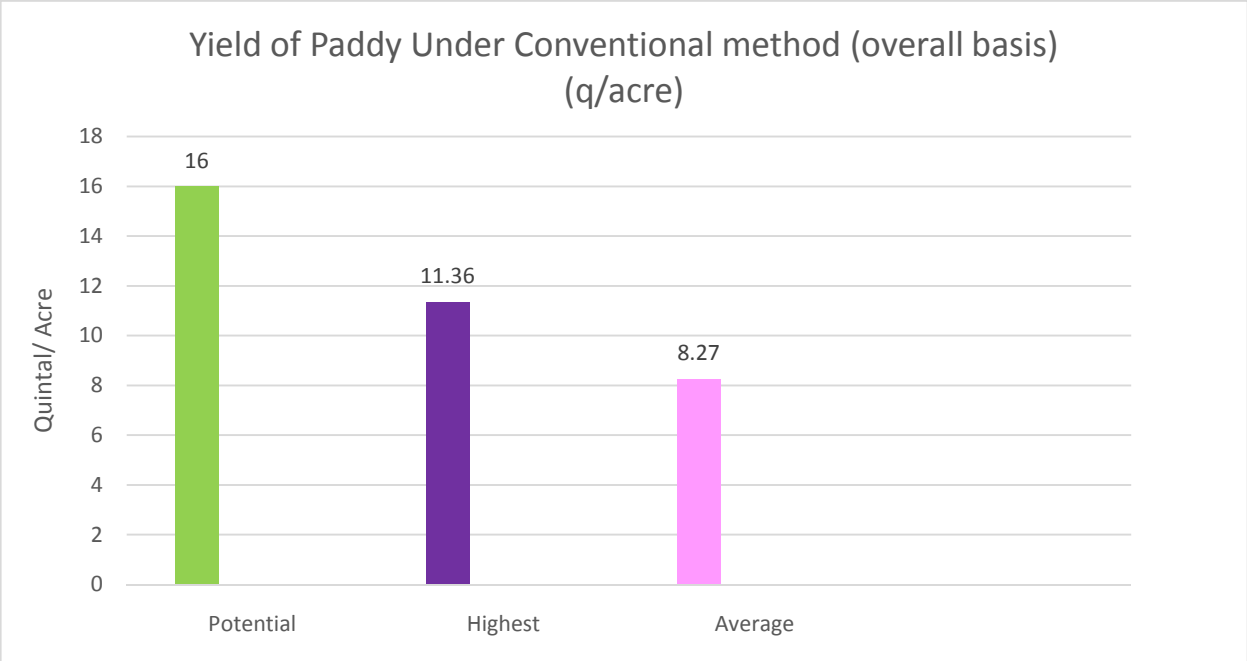
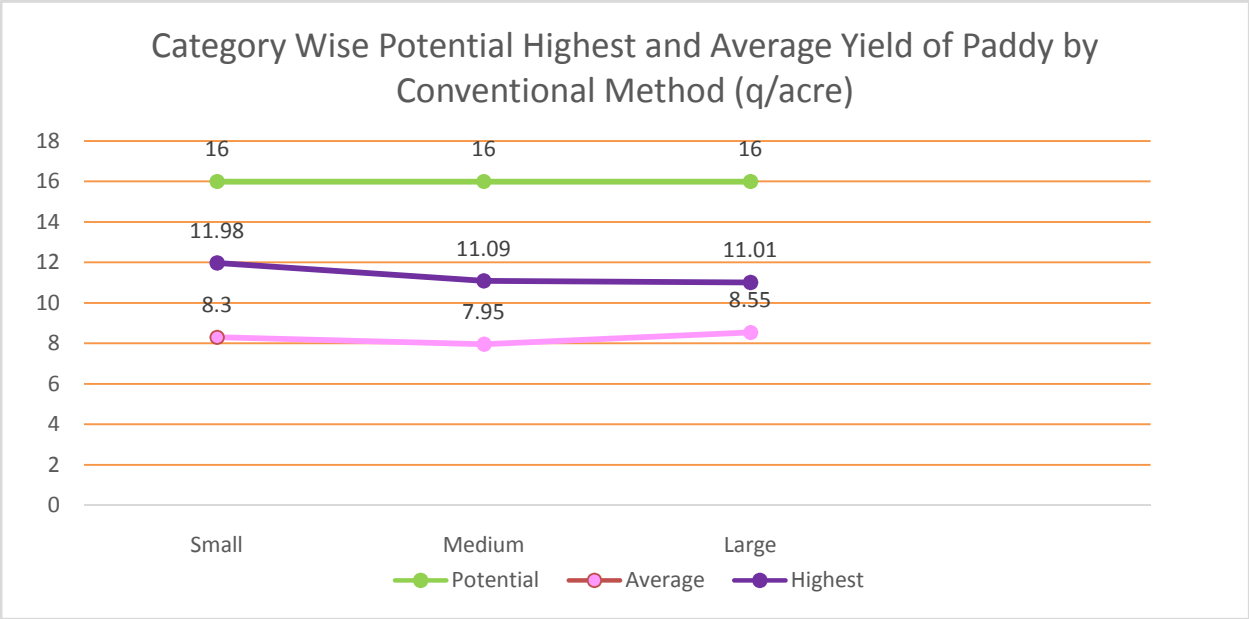


Figure-5.4



Under conventional method of Paddy cultivation, yield gap analysis refers to a total of 32 farmers on overall basis and 11, 11 and 10 farmers in categories I, II and III. Under this method: (i) Against potential yield of 16 quintals per acre, the highest and average yields are recorded as 11.36 quintals per acre and 8.27 quintals per acre as on overall basis. The category wise the yields are in the vicinity of overall average itself, (ii) Yield gap-I is 4.64 quintals per acre which is slightly more than that under SRI method and category wise it is ranging between 4.02 and 4.99 quintals per acre. The percentage yield gap in this case has been 29 percent against that of only 17.67 percent under SRI method. Category wise it is varying from 25 percent to 31 percent, (iii) Yield gaps-II and III under this method as well have been of the same order as under SRI method and even slightly lower than those under SRI method, but relatively with much higher percentages, (iv) On the overall average basis the respective yield gap percentages of yield gap-II and III have been 27.12 percent and 48.33 percent against those of only 18.93 percent and 33.26 percent under SRI method (v) Category wise also the same pattern is observed.

5.1(c) Yield Gap Analysis for Wheat

Table-5.1 (c) presents Yield Gap Analyses for wheat crop.

Table-5.3
Wheat Yield Gap(q/acre)

Particulars	Small	Medium	Large	Overall
Potential	23.0	23.0	23.0	23.0
Average	15.8	16.2	16.9	16.3
Highest	19.6	20.1	20.5	20.1
Yield gap-I	3.39 (14.74)	2.89 (12.57)	2.52 (10.96)	2.93 (12.75)
Yield gap-II	3.81 (19.43)	3.88 (19.29)	3.61 (17.63)	3.77 (18.77)
Yield gap-III	7.2 (31.3)	6.77 (29.43)	6.13 (26.65)	6.7 (29.13)

Figures in parenthesis show percent yield gap

Figure-5.5

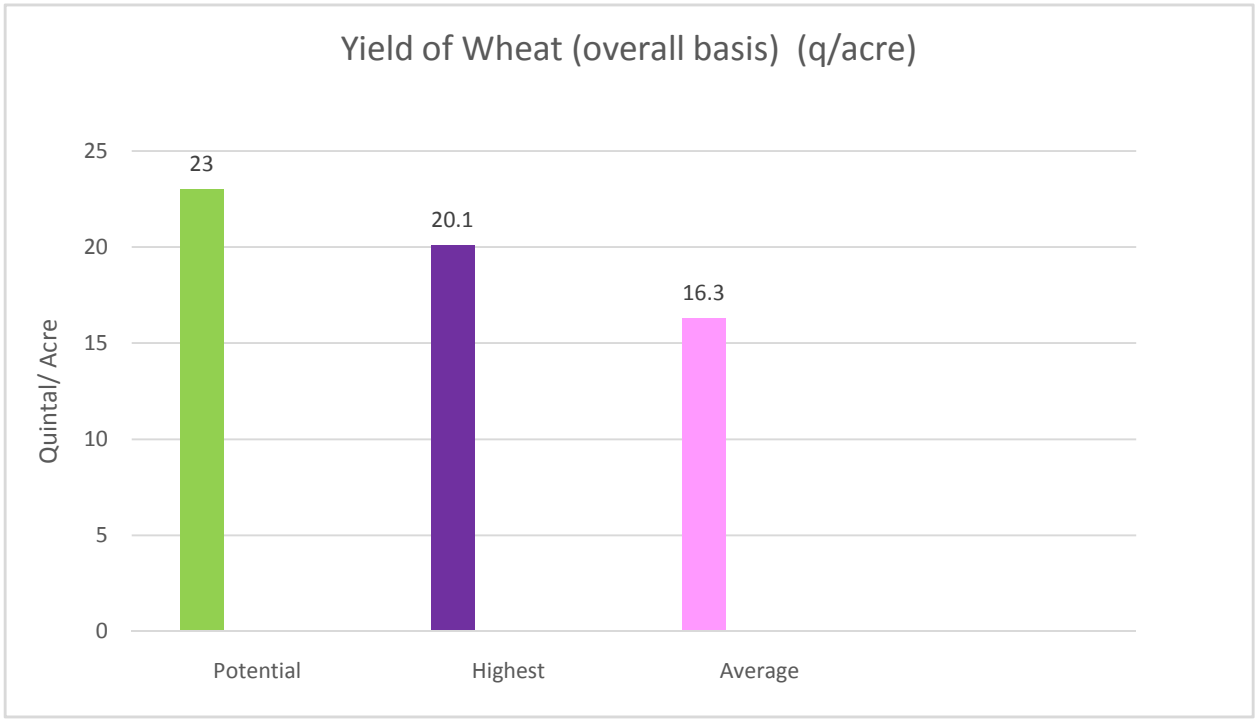
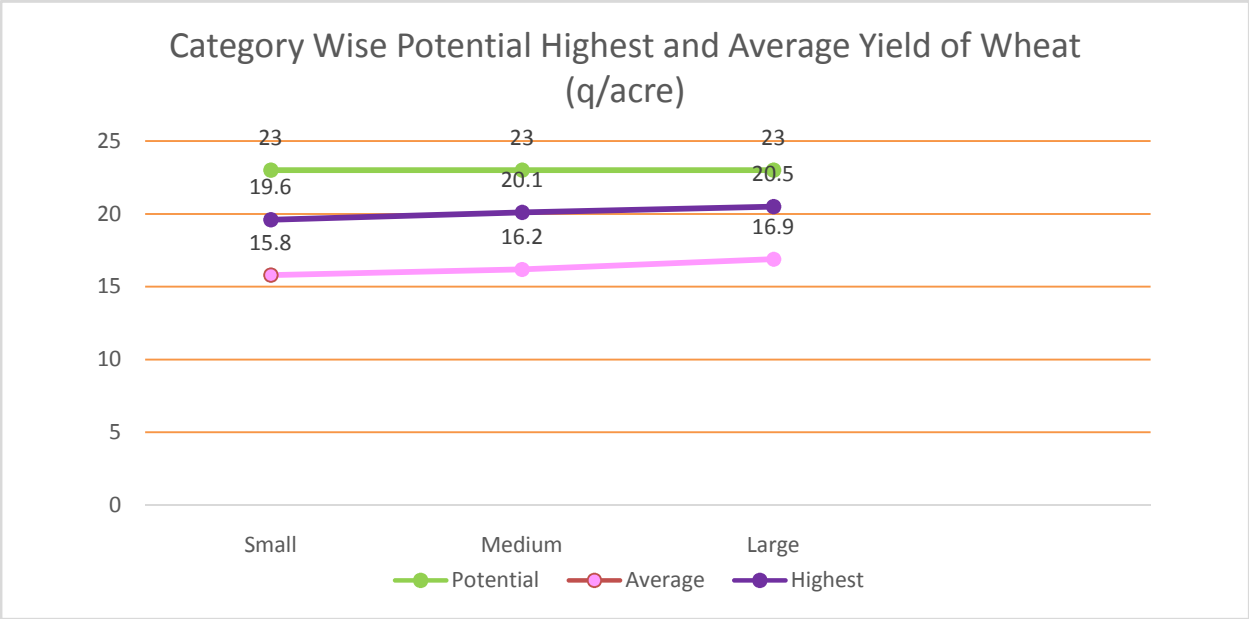


Figure-5.6



The various observations discerned from Table-5.3 in respect of yield gap analysis for wheat crop shows that (i) the potential yield, highest yield as also the average yield of wheat are matching with respective paddy yields under SRI method, but are relatively higher than those of paddy yields under conventional method on overall basis as well as category wise. Thus it may be recommended that the paddy farmers (respondents) under conventional method should also be incentivised to adopt SRI method as it is possible (ii) on total sample basis, potential yield, highest yield and the average yield are recorded as 23.00 quintals/acre, 20.10 quintals/acre and 16.30 quintals/acre respectively. Category wise also these yields are in the same vicinity as for total sample. (iii) yield gap-I and III in case of wheat crop are observed to be slightly lower than those of paddy crop; while yield gap-II has been of the same order as of paddy. (iv) percentage wise all yield gaps levels i.e. yield gaps-I, II and also III for wheat crop have been lower than the corresponding ones in case of paddy crop, whether under SRI or conventional method, on overall basis as well as category wise.

5.2 Major Sources of Information

(a) The major sources of information in respect of paddy cultivation; SRI adoption and conventional method are shown in Table-5.4

Table-5.4
Sources of Information

Particulars	SRI Methods				Conventional Methods			
	Small	**Medium**	**Large**	**Overall**	**Small**	**Medium**	**Large**	**Overall**
Agriculture Department	5.00 (55.56)	4.00 (44.45)	6.00 (60)	15.00 (53.57)	8.00 (72.73)	7.00 (63.64)	8.00 (80.00)	23.00 (71.88)
Kisan Call Centre	0.00 (0.00)	0 .00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
KVK	0.00 (0.00)	1.00 (11.11)	0.00 (0.00)	1.00 (3.57)	0.00 (0.00)	1.00 (9.09)	0.00 (0.00)	1.00 (3.13)
Relatives/ Neighbour	1.00 (11.11)	1.00 (11.11)	3.00 (30.00)	5.00 (17.86)	1.00 (9.09)	1.00 (9.09)	0.00 (0.00)	2.00 (6.23)
Progressive Farmers	3.00 (33.33)	3.00 (33.33)	1.00 (10)	7.00 (25)	2.00 (18.18)	2.00 (18.18)	1.00 (10)	5.00 (15.63)
News Paper	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	1.00 (10)	1.00 (3.13)
TV/Radio	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Total	**9.00 (100.00)**	**9.00 (100.00)**	**10.00 (100.00)**	**28.00 (100.00)**	**11.00 (100.00)**	**11.00 (100.00)**	**10.00 (100.00)**	**32.00 (100.00)**

Figures in parenthesis show percent to total

The table shows that (i) out of total 60 respondents adopting paddy (rice) crop; 28 are using SRI methods and 32 the conventional methods of paddy cultivation. (ii) among SRI and as well as conventional methods, the main sources of information regarding paddy cultivations being in order, Agriculture Department, progressive farmers and Relatives/Neighbour, which when taken together, account for 96.43 percent of total paddy cultivators in case of SRI method and 93.76 percent of those in case of conventional method, respectively. (iii) Krishi Vigyan Kendra (KVK) is also providing some information in this regard, but with a very meagre coverage of merely 3.57 percent of farmers under SRI and 3.13 percent under conventional methods. (iv) TV/Radio and News Paper as sources of information are of no utility in providing information to any category of paddy grower either under SRI or conventional method, with the sole exception of one farmer of large category adopting conventional method. (v) Category wise distribution of total farmers as small, medium, large has been 9, 9, 10 out of total 28 in SRI and 11, 11, 10 out

of total 32 in conventional method, respectively. (vi) Category wise as well, same information system is observed as on that overall basis, for both the SRI and conventional methods.

This shows positive role of Agriculture Department, progressive farmers and Relatives/Neighbours, in providing required and needful information in respect of paddy cultivation, to paddy growers of this region towards enhancing aggregate paddy production in this agro-climatic zone of the country as well, and that sources like TV/Radio, Kisan Call Centre, News papers have still to come up take special care in the regard.

(b) The table-5.5given below presents details about various sources of information in respect of wheat cultivation.

Table-5.5
Source of Information about Wheat cultivation

Particulars	Small	Medium	Large	Overall
Agriculture Department	13.00 (65.00)	9.00 (45.00)	15.00 (75.00)	37.00 (61.67)
Kisan Call Centre	1.00 (5.00)	3.00 (15.00)	0.00 (0.00)	4.00 (6.67)
KVK	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Relatives/ Neighbour	2.00 (10.00)	4.00 (20.00)	2.00 (10.00)	8.00 (13.33)
Progressive Farmers	3.00 (15.00)	4.00 (20.00)	3.00 (15.00)	10.00 (16.66)
News Paper	1.00 (5.00)	0.00 (0.00)	0.00 (0.00)	1.00 (1.67)
TV/Radio	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Total	**20.00 (100.00)**	**20.00 (100.00)**	**20.00 (100.00)**	**60.00 (100.00)**

Figures in parenthesis show percent to total

The table reveals that (i) similar to paddy cultivations, in case of wheat cultivation as well, the main sources of information have been, in order, as Agriculture Department, Progressive Farmers and Relatives/Neighbours, constituting 91.67 percent of total 60 wheat cultivators, (ii) In case of wheat, Kisan Call Centre and News paper have also been effective in somewhat feeble

way in providing information to concerned farmers, their respective share being just 6.67 percent and 1.67 percent of the total 60 wheat growers. (iii) News paper has relatively more coverage i.e. 5 percent of total small category wheat growers, as compared to overall sample coverage of just 1.67 percent with no beneficiary from medium and large category farmers. (iv) The pattern of source wise information to the small, medium and large has also been in the same order as it is in the case on overall basis.

This can be safely concluded that, while Agriculture Department, Progressive Farmers and Relatives/Neighbour have been successfully providing desired information to wheat growers, the sources like TV/Radio, Kisan Call Centre and News paper have to strive hard to become an effective source of information to farmers of this region.

5.3 Constraints in Adoption of Recommended Packages

The various constraints in the adoption of recommended packages towards crop cultivation, for paddy (SRI and conventional methods) and wheat are described through Table-4.12 to 4.14. To be specific, it may be mentioned here that the Table-4.12 to 4.14 depict the respective percentages of the farmers under various heads of constraints, on Non-mutually exclusive basis.

(a) Paddy (SRI Method)

The constraints for paddy crop (SRI) method are shown in Table-5.6

Table-5.6
Constraints in adoption of recommended packages of SRI (%): Crop Paddy

Particulars	Small	Medium	Large	Overall
Low germination of seed	44.44	22.22	60.00	42.86
Un-availability of desired Variety of seed	77.78	55.56	80.00	71.43
Lack of suitable machinery	100.00	100.00	100.00	100.00
Lack of knowledge about method of seed treatment	66.67	66.67	40.00	57.14
High cost of input	100.00	80.00	90.00	100.00
Lack of knowledge about proper dose of fertilizer	55.56	77.78	40.00	57.14
Un-availability of capital	88.89	55.56	60.00	67.86
Un-availability of electricity on time	33.33	11.11	20.00	21.43
Lack of labour during the peak operational period	44.44	33.33	60.00	46.43
Lack of proper knowledge of Packages of practices of SRI	55.56	33.33	50.00	46.43

The facts emerging from the above table on over all basis are that (i) The two major constraints to paddy growers under SRI method in adopting recommended packages are Lack of Suitable Machinery and High Cost of Inputs and these two are felt on cent percent basis by all the farmers, irrespective of category. This necessitates that special care should be taken in respect of these two constraints to make available the required inputs and the needed machineries to the concerned farmers to aid their respective pocket sizes through adequate and timely subsidies (ii) The other constraints as reported by SRI method are unavailability of desired variety of seeds, unavailability of capital, lack of knowledge about method of seed treatment and also the lack of knowledge about proper doses of fertilizers. Each of these factors as a constraint has been reported by farmers ranging between 57.14 percent to 71.43 percent of total 28 farmers. This emphasizes the need for special provision for providing financial assistance, supply of desired variety seeds and Soil Health Cards as remedial measures. (iii) Among other sources of constraints under SRI method have been low germination of seed, unavailability of labour at the peak operational periods, unavailability of electricity at required time and the lack of proper knowledge of packages of practices of SRI. While low germination of seed is a constraint to be explored on scientific basis, the unavailability of labour in peak periods like sowing and harvesting is a common problem which needs to be talked. (iv) The constraints of unavailability electricity at the required time and also the lack of proper knowledge of packages of SRI practices, deserve special mention and is of serious nature, but easily controllable, so it must be talked accordingly, for bridging the yield gaps. (v) Category wise as well almost similar pattern of response is observed as on overall basis, while unavailability of capital as a constraint is felt mainly by small category farmers.

(b) Paddy (Conventional Method)

Table-5.7 shows various constraints of paddy cultivation using conventional method.

Table-5.7
Constraints in adoption of recommended packages of Conventional (%): Crop Paddy

Particulars	Small	Medium	Large	Overall
Low germination of seed	27.27	45.45	70.00	53.57
Un-availability of desired Variety of seed	90.91	72.73	70.00	89.29
Lack of suitable machinery	90.91	100.00	100.00	96.87
Lack of knowledge about method of seed treatment	36.36	27.27	70.00	50.00
High cost of input	100.00	100.00	90.00	96.87
Lack of knowledge about proper dose of fertilizer	72.73	45.45	60.00	67.86
Un-availability of capital	63.64	54.55	60.00	67.86
Un-availability of electricity on time	9.09	27.27	10.00	17.86
Lack of labour during the peak operational period	54.55	27.27	50.00	50.00
Lack of proper knowledge of Packages of practices	36.36	45.45	40.00	46.43

The table reveals that (i) similar to the SRI method; under conventional method of paddy cultivation also, on over all basis, the two main constraints have been lack of suitable machinery and high cost of input, each accounting 96.87 percent of total paddy growers (32 in number) and these need special care, since machinery and input both from the base of crop cultivation (ii) Next to these, the other constraints of conventional method of paddy cultivation have been, in order, unavailability of desired variety of seeds, lack of knowledge about proper dose of fertilizers, unavailability of capital, low germination of seed and lack of labour during peak operational period, each of which is respectively by 89.28 percent, 67.86 percent, 67.86 percent and 50.00 percent of total 32 conventional method paddy growers. (iii) This is a matter of concern and it needs proper care and suitable action by the concerned authorities. (iv) The other two constraints as well viz. lack of proper knowledge of packages of practices along with unavailability of electricity at proper time, are respectively 46.43 percent and 17.86 percent. (v) Category wise as well, no marked difference is observed in response pattern of respondents regarding various constraints of paddy cultivation as observed on overall basis.

(c) Wheat

The various constraints in adoption of recommended packages for wheat cultivation, are as given in Table-5.8

Table-5.8
Constraints in adoption of recommended packages of Wheat (%)

Particulars	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	70.00	80.00	70.00
High cost of input	95.00	90.00	85.00	90.00
Lack of knowledge about proper dose of fertilizer	40.00	50.00	70.00	53.33
Un-availability of capital	55.00	40.00	30.00	41.67
Un-availability of electricity on time	35.00	25.00	30.00	30.00
Lack of labour during the peak operational period	40.00	60.00	85.00	61.67
Lack of proper knowledge of Packages of practices	35.00	25.00	55.00	38.33

The percentages of respondents in respect of various constraints in adoption of recommended packages for crop wheat, evince that (i) Similar to crop paddy (both SRI and conventional method) high cost of input is a major constraint in case of crop wheat as well, being reported by 90 percent of the total wheat growers and (60 in number). As such this needs special consideration and should be taken care of through subsidized packages of inputs to wheat growers. Further, the same is the position among all categories of farmers, apart from on overall basis. (ii) The next three constraints are unavailability of desired variety of seeds, low germination of seeds, lack of knowledge about method of seed treatment, each of them has been noted by 70 percent of the total wheat cultivators (i.e. 60). Among these, unavailability of desired variety of seed has been a main constraint for paddy cultivation as well, and, therefore ,the concerned authorities/agencies should take it up, to provide desired variety of seeds to paddy and wheat cultivator for enhancing aggregate production in the region. (iii) Apart from the above, the other constraints in case of wheat have been lack of knowledge about proper doses of fertilizers, lack of suitable machinery, lack of labour during peak operational period, un-availability of electricity at required hours and lastly un-availability of capital, with respective reporting percentages as 53.33 percent, 41.67 percent, 61.67 percent, 30.00 percent and 41.67 percent. (iv) In case of wheat as well, category-wise pattern of respondents in respect of various constraints in adoption of recommended packages has been the same as on overall basis.

The above observations in respect of various constraints, reveal that (a) High Cost of Input and un-availability of desired variety of seed, have main constraints in case of both Paddy and wheat crops (b) Un-availability of labour at peak operational period has also been a serious concern for both the crops in general (c) Lack of suitable machinery as also un-availability of capital have also been felt in case of both the crops, but to a greater extent in case of paddy as compared to wheat. As such all these deserve special care.

Among others, like lack of knowledge about seed treatment and packages of fertilizers can be talked through proper distribution of Soil Health Cards along with explanatory demonstrations; while un-availability of Electricity at required time too needs due care to be taken care of, so that irrigation and other power generated operations are not affected and farmers are saved from suffering on account of these constraints.

5.4 Factors Affecting Productivity of Paddy and Wheat Crops (Multiple Regression Equations)

To identify various factors as affecting the productivity of Paddy and Wheat crops; multiple regression equations as under have been fitted for both the crops.

(a) Crop Paddy

$$Y= a+b_1x_1 + b_2x_2 + \ldots\ldots\ldots\ldots\ldots\ldots + b_{12}x_{12}$$

Where, Y= dependent Variable = Yield of Paddy in ql./acre
$x_1, x_2, \ldots\ldots\ldots\ldots\ldots\ldots x_{12}$ = Independent variables

(b) Crop Wheat

$$Y= a+b_1x_1 + b_2x_2 + \ldots\ldots\ldots\ldots\ldots\ldots + b_{11}x_{11}$$

Where, Y= dependent Variable = Yield of Wheat in ql./acre
$x_1, x_2, \ldots\ldots\ldots\ldots\ldots\ldots x_{11}$ = Independent variables

The respective independent variables for these two crops being as under.

Variable	Denoting	Crop	
		Paddy	Wheat
X_1	Education	√	√
X_2	Age in year	√	√
X_3	Source of seed	√	√
X_4	Soil Test (yes/no)	√	√
X_5	Seed Rate (kg.)	√	√
X_6	Seed Treatment (yes/no)	√	√
X_7	Varietal Improvement (yes/no)	√	√
X_8	Urea (kg.)	√	√
X_9	DAP (kg.)	√	√
X_{10}	Irrigated Land (acre)	√	√
X_{11}	Size of Holding (acre)	√	√
X_{12}	Method of Sowing	√	--

The values of various statistical constants; (Regression coefficients – b_1, b_2, …….) along with their respective standard errors and P – value as also the coefficient of Multiple Determination (R^2) for Paddy and Wheat crops have been respectively shown through Table-5.9 and 5.10.

Table-5.9
Factors affecting productivity of paddy

Particulars	Coefficients	SE	P-value
Education (X_1)	7.6058	9.0856	**0.4068N**
Age (X_2)	1.1152	1.7190	**0.5197N**
Source of Seed (X_3)	135.2879	53.8269	0.0154**
Soil Test (X_4)	81.4322	36.2644	0.0295**
Seed Rate (kg) (X_5)	0.1279	0.9016	**0.8878N**
Seed Treatment(X_6)	97.2556	47.4362	0.0459**
Varietal Improvement (X_7)	154.2798	55.2940	0.0076***
Urea (kg) (X_8)	1.7541	0.8949	0.0559*
DAP (kg) (X_9)	2.4834	1.3782	0.0780*
Irrigated land (X_{10})	-16.9956	7.3105	0.0245**
Size of Holding (X_{11})	13.3519	4.2454	0.0029***
Method of Sowing (X_{12})	249.6084	92.6053	0.0097***
R^2	**0.942**		

, ** & significant at 10(P<0.10),5 (P<0.05) & 1 (P<0.01) percent, respectively***

The result of Multiple Regression Analysis, is that (i) Out of the 12 independent variables; 9 variables have been found to have statistically significant effect at 10%, 5% or 1% level of

significance; while the rest 3 do not have significant effect even at 10% level of significance. (ii) The variables which are affecting yield significantly include X_8 (Urea) and X_9 (DAP) at 10% level; X_3 (Source of seed), X_4 (Soil Test), X_6 (Seed Treatment) and X_{10} (Irrigated Land) at 5% level;, while X_7 (Varietal Improvement), X_{11}(Size of Holding) and X_{12} (Method of Sowing), at 1% level of significance (iii) Among the variables with insignificant (not significant) effects on yield level have been X_1 (Level of Education), X_2 (Age) and X_5 (Seed Rate). (iv) While the most encouraging value of coefficient of Multiple Determination (R^2) as 0.942 indicates that, apart from significance/insignificance of a variable in controlling 'yield' variation, all the 12 independent variables selected in the fitted multiple regression equation, have their own significance in one way or the other, since when taken jointly, they altogether control 94.20% of total variations in the 'yield' of crop paddy and only 5.80% variation remain unexplained. (v) However the variable X_{10} (irrigated land) has negative coefficient, which is also statistically significant at 5% level of significance. This indicates that an increase in the magnitude of this variable will affect adversely the yield of paddy crop. (vi) Interestingly (a) variables X_3 (Source of seed), X_4 (Soil Test), X_6 (Seed Treatment), X_7 (Varietal Improvement), X_8 (Urea), X_9 (DAP), X_{11} (Size of Holding) and X_{12} (Method of Sowing); all have positive coefficients as well as being significant at 10% or 5% or 1% level. This indicates that these variables are affecting significantly in increasing the 'yield' of paddy, and thereby contributing effectively in narrowing down the yield gap of paddy. (b) variables X_1 (Level of Education), X_2 (Age) and X_5 (Seed Rate) have also positive coefficients, but statistically not significant, so no statistical inference can be drawn about their degree of impact on the yield.

This can be concluded that considering the Respondents' Educational status along with their knowledge of cultivation practices the farmers should be suitably trained. The training should be through demonstrations, by Government/Nodal agencies, extension personnel, researchers, soil health workers, in respect of knowledge of Soil Health Cards (SHCs) and SHC based cropping schemes, source of seeds, proper seed treatment, varietal improvement, Urea/DAP applications. This will achieve the objectives of getting more crop yields towards minimizing the existing crop yield gaps.

Wheat

Factors affecting productivity of wheat are shown in Table-5.10

Table-5.10
Factors affecting productivity of Wheat

Particulars	Coefficients	SE	P-value
Education (X_1)	3.9079	7.6797	**0.6132N**
Age (X_2)	-2.9822	1.3885	0.0368**
Source of Seed (X_3)	89.1319	22.2670	0.0002***
Soil Test (X_4)	22.8821	19.4767	**0.2459N**
Seed Rate (kg) (X_5)	-0.2949	0.1273	0.0249**
Seed Treatment(X_6)	10.6329	18.8898	**0.5761N**
Varietal Improvement (X_7)	14.6168	18.1652	**0.4250N**
Urea (kg) (X_8)	1.7891	0.9796	0.0740*
DAP (kg) (X_9)	4.0615	2.2745	0.0805*
Irrigated land (X_{10})	33.6030	8.7769	0.0004***
Size of Holding (X_{11})	10.0994	10.0779	**0.3213N**
R^2	**0.862**		

, ** & significant at 10 (P<0.10),5 (P<0.05) & 1 (P<0.01) percent, respectively***

The result of Multiple Regression Analysis after identifying various factors affecting the 'Yield' of crop wheat, shows that (i) Among 11 independent variables 6 variables have been found to have statistically significant effect at 10%, 5% or 1% level of significance, while 5 variables are not significant even at 10% level. (ii) The significant variables have beenX_8 (Urea) and X_9 (DAP) at 10% level,X_2 (Age), X_5 (Seed Rate) at 5% level; while X_3 (Source of seed) and X_{10} (irrigated land) at 1% level of significance. (iii) The variables reported with insignificant effects are X_1 (Education), X_4 (Soil Test), X_6 (Seed Treatment), X_7 (varietal improvement) and X_{11}(Size of holding). (iv) In case of crop wheat the value of coefficient of Multiple Determination (R^2) comes to be quite satisfactory as 0.862 (through slightly lower than that in case of paddy); to indicate that apart from individual significance/insignificance all the 11 selected independent variable are important in one way or the other to explain jointly 86.20% of total variation in the 'yield' of crop wheat, while only 13.80% of total variation remain unexplained. (v) As compared to crop paddy, where only a single variable X_{10} (Irrigated land) had negative coefficient, for crop wheat the two variables i.e. X_2(Age)and X_5(Seed rate) have negative coefficient and both of which are statistically significant as well at 5% level of significance. This indicates that, each of

these two variables is responding negatively towards enhancement of yield of crop wheat. (vi) Further (a) As compared to paddy where eight variables had positive significant coefficients, crop wheat has only four variables, viz. X_3 (Source of seed), X_8(Urea), X_9 (DAP) and X_{10} (Irrigated land) with positive and significant coefficients at 10% or 1% level; showing that increase in their magnitudes results into increase in wheat yield as well. As such their use is useful in their use, for reducing or narrowing down yield gap. (b) For crop wheat; five variables X_1 (Education), X_4 (Soil Test), X_6(Seed treatment), X_7(Varietal improvement) and X_{11}(Size of Holding) have positive coefficients but all are insignificant and as such no definite idea can be formed statistically regarding their impact on increasing the yield of wheat.

To summarize, the main points emerging out from theMultiple Regression Analysis for both the paddy and wheat crops for enhancing the respective crop yields it can be noted that:

- Among 12 independent variables selected for paddy, 9 have statistically significant effect on yield and out of 11 variables for wheat only 6, at 10%, 5% or 1% level of significance. Among these, the two variables affecting significantly the yield for both the paddy and wheat crops are Urea (X_8) and DAP applications (X_9); with positive coefficients.
- Irrigated land (X_{10}), the sole variable in case of paddy while Age (X_2) and Seed rate (X_5) the two variables in case of wheat are having Negative and statistically significant coefficients at 5% level of significance to show their adverse contribution towards increasing yields of these two crops.
- On overall basis, all the selected variables, 12 in paddy and 11 in wheat, when taken jointly are respectively explaining 94.20% of total variations in 'Yield' for crop paddy and 86.20% of that for crop wheat. This may be taken as a quite satisfactory performance of all the selected independent variables.
- Apart above; all such variables which have Positive but insignificant Coefficient, need special care, caution and attention in their respective application(s) to make their individual impacts as well, effective in enhancing yield of wheat and rice crops.
- It may also be mentioned that very high coefficients in case of some variables, may possibly be due to their over (excessive) or under (meagre) application(s).

- In this regard, apart from different schemes already launched/being launched by the Government, the various adoptive measures and care to be taken by various Government/Nodal Agencies, Extension Workers, Researchers, Soil Scientists/Soil Health Workers are to take care of Respondents' Educational status and knowledge level of appropriate cultivation practices to impart training through Demonstrations, Field Trials for proper seed treatment, source of seed, varietal improvement, Soil Health Card (SHC) based recommendations in adopting cropping schemes for the need based fertilizer (Urea/DAP) application(s), as also optimum utilization of the land holdings. The main focus of such training/scheme should be to increase the crop yield to all possible extent and correspondingly narrowing down the yield gap to the least.

5.5 Summary of the Chapter

The main points of this chapter are summarized as under:

i. Under SRI (System of Rice Intensification) method, on overall average basis, the potential paddy yield, highest yield and the average recorded yield of paddy have respectively been as 24 quintals per acre, 19.76 quintal per acre and 16.02 quintals per acre. Against these, the respective per area yield under conventional method of paddy have been as potential (16.00q/acre), highest (11.36q/acre) and average (8.27q/acre). Category wise all the thee yield have been in the same vicinity.

ii. The potential yield, highest yield and also average yield of wheat are matching with respective paddy yields under SRI method, but are relatively higher than those of paddy yields under conventional method paddy growers should be encouraged to adopt SRI method.

iii. Percent wise all groups i.e. yield gap I.II and III for wheat crops have been lower than the corresponding once in case of paddy crop, whether under SRI or conventional method, on overall basis as well as category wise.

iv. Among SRI as well as conventional method of paddy cultivation the main source of information have been agriculture department, progressive farmers and relatives/neighbours, Krishi Vikas Kendra (KVK) is also proving same

information, but with very meagre coverage, while TV/radio and newspapers has still to come up.

v. In case of wheat growers as well while agriculture department, progressive farmer, relatives/neighbours have been successfully providing desired information, sources like TV/radio, Kisan Call Centre and newspaper have to strive hard as an effective source of information in this region.

vi. Two major constraints under both i.e. SRI and conventional method of paddy cultivation have been the lack of suitable machinery and High Cost of Inputs; feet by majority (above 95%) of paddy growers. The other constraints in order are unavailability of desired variety of seed and capital, lack of knowledge above method of seed treatment and proper doses of fertilizer, followed by low germination of seed, unavailability of labour at peak operational periods and also electricity at required time.

vii. In case of crop wheat as well the major constraint has been the high cost of input. The next three constraints are unavailability of desired variety of seeds, low germination of seeds and lack of knowledge about method of seed treatment; followed by lack of (i) knowledge about proper doses of fertilizers (ii) suitable machinery (iii) labour at peak hours like sowing/harvesting (iv) availability of electricity at needed time and lastly the unavailability of capital.

viii. Among 12 independent variables selected for paddy, 9 are statistically significant while out of 11 for wheat 6 are statistically significant at 10 percent, 5 percent or 1 percent level of significance among these two variables X_8 (Urea) and X_9 (DAP applications) are significant for both rice and wheat crops, with positive coefficient.

ix. Irrigated land (X_{10}) the sole variable in case of paddy, while age (X_2) and seed rate(X_5) the two variables in case of wheat are having negative and significant coefficients at 5 percent level of significance.

x. On overall basis, all the selected variables, 12 in paddy and 11 in wheat, when taken jointly are respectively explaining 94.20 percent of total variance in yield for crop paddy and 86.20 percent of that for crop wheat, which may be taken as

quite satisfactory performance of the selected variables in controlling yield variations.

xi. In these regard the various adoptive measures towards increasing crop yields and there by narrowing down yield gap to all possible minimum, comprise of (i) Taking care of respondents' educational status and knowledge level of appropriate cultivation practices. (ii) Impart training/demonstration towards proper seed treatments, source of seed, variety improvement, Soil Health Card (SHCs) based recommendations, need based fertilizers (urea/DAP) applications all focusing to enhance crop yield and reduce the yield gap.

CHAPTER-VI

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

6.1.: Summary

Crop Yield is the main task force and of key importance in undertaking any crop as an enterprise. Among a number of factors, it is mainly the yield factor which contributes significantly in enhancing overall (i.e. aggregate) crop production(s). In this light, improving crop yield is most essential and an urgent need of the hour to account for ever increasing demographic pressure on land the scarcest resource in Indian agriculture. It is essential for feeding millions and millions of people and boosting farm income thereby improving the agricultural cum overall economy of the country.

The study of yield variability in terms of existing 'yield gaps' from farm to farm, at micro level and correspondingly bridging these gaps to all possible minimum at macro level, has become imperative, not particularly for a single crop but in general for all the major field crops, for upgrading the agricultural sector of Indian economy. In this regard, the words of Van Iltersun (1st March, 2013) may be well quoted, "Yield Gap Analysis is an increasingly popular concept, as powerful method to reveal and understand the bio physical opportunities to meet the projected increase in demand for agricultural products towards 2050, and to support Decision Making on research, policies, development and investment that is needed."

The yield gap study of a crop is thus serving a multi-faceted solution(s) on adoption of improved agricultural technology with proper management practices. It identifies various factors causing the existing yield gap and also highlights various constraints such as respondents lack of knowledge, method of seed treatment, proper doses of fertilizers, unavailability of desired verities of seed, required input mixes, labour force, timely irrigation, high costs of input(s). This underlines the need to take due care for maintaining soil nutrients and their basic characteristics. This would result ultimately into minimizing the yield gap(s) coupled with maintenance of ecological balance.

The present study has been conducted mainly to analyse the 'yield gap' of Rice (Paddy) and wheat, the two foremost crops in the respective seasons viz. Kharif and Rabi, as also among total foodgrains, in the entire Bundelkhand region of Uttar Pradesh and that each covering above 10 percent of acreage under the crop in relation to net area sown. The study aims to analyse yield gaps of these two crops grown by the cultivators of different size of farms to identify the factors affecting the yield gaps of these two crops, along with various socio-economic, technological and environmental constraints. The following objectives were set forth:

(i) To specify various socio-economic characteristics of farmers of different categories (i.e. size of farms).
(ii) To analyze yield gap of major crops grown by the cultivators of different size of farms.
(iii) To identify factors affecting productivity of major crops.
(iv) To identify various socio-economic, technological constraints of major crops.
(v) To suggest policy implication(s) to narrow down yield gap of major crops to the minimum.

A Field Survey has been conducted, using a Multi (Four) Stage Stratified Random Sampling; with Districts forming the first stage, Blocks within district the second stage, villages within block as the third stage and farmers (wheat/rice growers) as the fourth stage or the ultimate units of sampling. The selection procedure has been (a) At first stage selecting two districts viz. Lalitpur and Banda on the basis of High Yield Gap and Low Yield Gap for crop rice and accordingly two districts viz. Mahoba and Jalaun on the basis of High Yield Gap and Low Yield Gap, for crop wheat, to make a total selection of four districts (b) At the second stage level, selecting one block in each of the four selected districts based on maximum area under the respective crop. (c) At third stage, selecting a cluster of 3 villages from each selected block and finally (d) At fourth stage; a list of all Small (less than 2 hectare), Medium (2 to less than 5 hectare) and Large (5 hectares and more) farmers (paddy/wheat growers) was prepared and then selecting 10 farmers randomly from each list, to make a total sample of 60 farmers for paddy and 60 farmers for wheat resulting into an overall sample of 120 farmers for the entire study. The corresponding primary data pertaining to the year 2018-19 was collected from the respondents through personal interview by the AERC Research Team.

6.2.: Conclusions

The findings and conclusions obtained from the present study on strategies to bridge yield gaps of Rice and Wheat crops in Bundelkhand region of Uttar Pradesh, are presented as under.

- Out of total 120 respondents, 55 percent were Soil Tested Farmers, while only 34 percent of them had received Soil Health Cards (SHCs).
- Under SRI method, the potential yield of paddy in this region has been recorded as 24 quintals per acre. Against this, the highest and the average recorded yields for the whole sample, have been respectively as 20 quintals per acre and 16 quintals per acre.

  Under conventional method of Paddy cultivation, against potential yield of 16 quintals per acre, the highest and average yields are recorded as 11.36 quintals per acre and 8.27 quintals per acre on overall basis.
- The yield gap analysis for crop wheat shows that, the potential yield, highest yield and also the average yield of wheat match with respective paddy yields under SRI method, but they are relatively higher than those of paddy yields under conventional method on overall basis and category wise.

  Percentage wise all yield gaps levels i.e. yield gaps -I, II and III for crop wheat have been lower than the corresponding ones in case of crop paddy whether under SRI or conventional method on overall and category wise basis.
- Among SRI and conventional methods, the main sources of information regarding paddy cultivations are in order; Agriculture Department, Progressive Farmers and Relatives/Neighbours, while TV/Radio and News Paper as sources of information are not used by any category of paddy grower either under SRI or conventional method, except a single farmer of large category adopting conventional method.
- Similar to paddy cultivations, in case of wheat cultivation also the main sources of information to wheat cultivators have been in order as Agriculture Department, Progressive Farmers and Relatives/Neighbours.
- The two major constraints for paddy growers under SRI method in adopting recommended packages are Lack of Suitable Machinery and High Cost of Inputs and

these two are felt on cent percent basis. Other constraints as reported by SRI method for paddy cultivators, have been in order, unavailability of desired variety of seeds, unavailability of capital, lack of knowledge about method of seed treatment as also lack of knowledge about proper doses of fertilizers.

- Similar to SRI method, under conventional method of paddy cultivation also, on over all basis, the two main constraints have been lack of suitable machinery and high cost of inputs.
- As in case of crop paddy (both SRI and conventional methods)high cost of inputs is a major constraint for wheat crop also.

  Among other constraints, the unavailability of desired variety of seed has also been a main constraint for paddy and wheat cultivation.
- Among 12 independent variables selected for paddy and 11 for wheat, 9 variables have statistically significant effect on yield of paddy and 6 in case of wheat at 10%, 5% and 1% level of significance. Among these, the two variables affecting significantly the yield for both paddy and wheat crops are urea (X_8) and DAP applications (X_9), with positive coefficients.
- The variables which are statistically significant with positive coefficients; have been X_3 (source of seed), X_4 (soil test), X_6 (seed treatment), X_7 (varietal improvement), X_8 (urea application), X_9 (DAP application), X_{11} (size of holding) and X_{12} (method of sowing) for crop paddy and those of X_3 (source of seed), X_8 and X_9 (Urea and DAP applications) and X_{10} (irrigated land) for crop wheat; to record their positive contribution(s) in increasing respective crop yields.
- Irrigated land (X_{10}), the sole variable in case of paddy while Age (X_2) and Seed rate (X_5) the two variables in case of wheat are having Negative and Statistically Significant coefficients at 5% level of significance to show their adverse contribution towards enhancing yield of these two crops.
- On overall basis, all the selected variables, 12 in paddy and 11 in wheat, when taken jointly are respectively explaining 94.20% of total variations in 'Yield' for crop paddy and 86.20% for crop wheat. This may be taken as quite satisfactory performance of selected variables in case of both the crops towards increasing crop productivity.

- It may also be mentioned that very high coefficients in case of some variables, may be possibly, due to their over (excessive) or under (meagre) application(s).

6.3.: Policy Implication

- The awareness level of the farmers of the region need to be enhanced regarding testing of soils and the farmers should be encouraged to get Soil Health Cards. For this the directions to concerned agencies entrusted with the responsibility of carrying out Soil Testing and distribution of SHCs should be issued to take care of this aspect as earnestly as possible.
- The dominance and importance of Agriculture Department, Progressive Farmers and Relatives/Neighbours in providing required and needful information to paddy growers of the region for enhancing aggregate production need special mention. For this the sources like TV/Radio, Kisan Call Centre, Newspapers should take special care.
- Further while Agriculture Department, Progressive Farmers and Relatives/Neighbours have been successfully providing desired information to the wheat growers, the sources like TV/Radio, Kisan Call Centre and Newspaper should strive hard to become an effective source of information to farmers.
- Special care has to be taken in respect of (i) making available required inputs and the needed machineries to the concerned farmers to aid and support their respective pocket sizes, through subsidies on recommended input mixes (packages) and their timely availability, and (ii) providing financial assistance, supply of desired variety of seeds and Soil Health Cards as remedial measures to them.
- The findings in respect of various constraints reveal that (a) High Cost of Input and un-availability of desired variety of seed, have been the main constraints for both Paddy and wheat crops, (b) Un-availability of labour at peak operational period has also been a serious concern for both the crops. And, in general (c) Lack of suitable machinery as also un-availability of capital are the constraints for both the crops, but to a greater extent in case of paddy. As such all these too need special care.

- All such variables which have Positive but insignificant Coefficients need caution and due attention in their respective application(s) to underline their individual impact(s) as well in increasing the crop yield and accordingly narrowing down the existing yield gaps of wheat and paddy crops, to the minimum.
- Apart from different schemes already launched/being launched by the Government, the various Government/Nodal Agencies, Extension Workers, Researchers, Soil Scientists/Soil Health Workers should devise Training Programmes Keeping in view the Respondents Educational status and knowledge level of appropriate cultivation practices. The Training may be imparted through Demonstrations and Field Trials for proper seed treatment, source of seed, varietal improvement, Soil Health Card (SHC) based recommendations in adopting cropping schemes and the need based fertilizer (Urea/DAP) application(s). This should have the prime motto of increasing crop yields and thereby the aggregate crop production of rice and wheat in this region of Uttar Pradesh.
- As an effective policy implication in respect of sensitivity and wide applicability of this prime issue of Bridging Yield Gaps of major Field Crops at micro (regional)and macro (national) level, it is recommended to have Three year based strong data base instead of single year. Therefore, this study should be continued for another two successive years for both the parts, i.e. Uttar Pradesh and Madhya Pradesh region of Bundelkhand Agro climatic zone of India, one of the least developed regions of the country. The respondents for the successive studies may remain the same or new respondents may be selected.

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Annexure-I

COMMENTS ON THE REPORT

Submitted by

Agro-Economic Research Centre, Allahabad, Uttar Pradesh

1. **Title of the draft report examined:** *Strategies to Bridge Yield Gap of Major Crops in Budelkhand Agro-Climatic Region of Uttar Pradesh.*

2. **Date of receipt of the Draft report:** 29st January, 2020

3. **Date of dispatch of the comments:** 01th February, 2020

4. **Title of the draft report :**

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

5. **Comments on the Introduction:**

   Up to the mark

6. **Comments on the Methodology**

   Up to the mark

7. **Chapter-III-Current Scenario of Bundelkhand Region (Uttar Pradesh): An Overview.**

   a) Title of the chapter change as "**Overview of the Bundelkhand Region of Uttar Pradesh"**

   b) Please considered all the districts with Bundelkhand Region for all the sub-head of the chapter i.e. Geographical Indicators, Population Parameters, Land Use Patter, Irrigation Potential, Cropping Pattern, Consumption of Fertilizers, Regulated Markets, Number and Area under different Size of Holding, Working Population, Farm Machineries and Implements, Inputs Used, Livestock Population etc. for overview of Bundelkhand Region of Uttar Pradesh and in last please include 'Summary of the Chapter'.

8. **Chapter-IV-**

   Title of the chapter is missing

   Please divide chapter IV in two chapters

   In chapter IV, please considered as Socio-Economic Characteristics of the Sample Households with 'Summary of the chapter' and in Chapter-V, Please considered as Yield Gap & Constraints Analysis and Determinants of Yield of Major Crops with 'summary of the chapter'.

9. **Chapter-IV- Summary, Conclusions and Policy Implications**

   Please considered it as chapter VI

10. **Comment on analysis, organization & Presentation**

    Up to the mark

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

Authors are reported to incorporate all the comments and submit in final report

Annexure-II

Comment wise Action Taken on Draft Report entitled "Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of Uttar Pradesh"

Sl. No.	Comment	Action Taken
1.	Title of the Draft Report examined	As per comment, title of the draft report amended by deleting Agro-Climatic, as "Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of Uttar Pradesh".
2.	Date of receipt of the draft report	Action not required.
3.	Date of dispatch of comments	Action not required.
4.	Title of the draft report	As per comment, the title of the draft report has now been modified as "Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of Uttar Pradesh".
5.	Comments on Introduction	No action to be taken.
6.	Comments on Methodology	No action to be taken.
7.	(a) Title of Chapter-III to be Changed.	As per comment, title of Chapter-III changed as: "OVER VIEW OF THE BUNDELKHAND REGION OF UTTAR PRADESH"
	(b) All the seven districts of Bundelkhand Region of Uttar Pradesh to be considered for all the sub heads of the Chapter.	• As per comment, all the seven districts of Bundelkhand Region of Uttar Pradesh have been considered for all the sub heads of the Chapter. • Summary of the Chapter has also been included.
8.	Title of Chapter-IV and its division in two Chapters, as Chapter-V and Chapter-VI	• As per comment, Chapter-IV has been split in two chapters as Chapter-IV and Chapter-V. • Title of Chapter-IV is "SOCIO-ECONOMIC CHARACTERISTICS OF THE SAMPLE HOUSEHOLDS. • Summary of the chapter is also included. • Title of Chapter-V is "YIELD GAP & CONSTRAINTS ANALYSIS AND DETERMINANTS OF YIELD OF MAJOR CROPS." • Summary of the chapter is also included.
9.	Summary, Conclusion and Policy Implication to be considered as Chapter-VI	As per comment, "**Summary, Conclusion and Policy Implications"** has been considered as Chapter-VI
10.	Comment on Analysis, Organisation and Presentation	No action to be taken.
11.	Overall view on acceptability of the Report	Action taken and incorporated all the comments in the Final Report.