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Technical Bulletin 2/2018

Options and Strategies for Farmers' Income Enhancement in Bundelkhand Region of Central India

ISO 9001:2015

ICAR-Central Agroforestry Research Institute
Jhansi-284 003 (U.P.)

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This Technical Bulletin is based on the impact generated by interventions of various projects implemented by the Indian Council of Agricultural Research-Central Agroforestry Research Institute (ICAR-CAFRI), Jhansi since its inception. Along with a range of information from various published, unpublished literature, reports, documents, and web-resources.

Disclaimer

The results of this bulletin are based on the data obtained from various sources for which authors and the Institute are not responsible. The opinions expressed in this bulletin are suggestive. The views expressed in this bulletin are those of the authors and do not necessarily reflect the views of ICAR-CAFRI, Jhansi, Uttar Pradesh, India.

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Recommended citation

Singh, M., K.B. Sridhar, Dhiraj Kumar, R.K. Tewari, Inder Dev, Asha Ram, A.R. Uthappa, Veeresh Kumar, Ramesh Singh and R.P. Dwivedi (2018). Options and Strategies for Farmers' Income Enhancement in Bundelkhand Region of Central India. Technical Bulletin No.2/2018. ICAR-Central Agroforestry Research Institute (CAFRI), Jhansi, India. pp. 50.

Acknowledgement

The authors have benefitted immensely from the valuable comments and suggestions of the learned experts in preparation of this technical bulletin. Authors are also grateful to farmers for sharing their experiences. However, the authors own any errors that remain in the paper.

Cover illustrations

The photos in the centre symbolizes Bundelkhand farmers. Photos to the left represents farmers' friendly schemes and right indicates the cost effective technologies for enhancing farmers' income.

Cover Designed by

K.B. Sridhar, Dhiraj Kumar, Mahendra Singh and Rajesh Srivastava.

Printed at

Darpan Printers & Lamination
Agra

Foreword

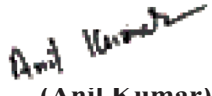
Indian Council of Agricultural Research under the aegis of Ministry of Agriculture and Farmers Welfare, Government of India, has developed various region specific technologies and imparts quality education in agriculture for aspiring professionals through deemed Institutes and various State Agricultural Universities (SAUs) across the country. The council under its subject matter 'Natural Resource Management (NRM)' Division promotes sustainable management of natural resources for achieving food, nutritional, environmental and livelihood security in the country.

The technical bulletin on 'Options and Strategies for Farmers' Income Enhancement in Bundelkhand Region of Central India' has been prepared by ICAR-Central Agroforestry Research Institute, Jhansi (U.P.), India, based on the credible research carried out by the Institute for the last three decades. The institute has thrived hard in bringing back the trees into agriculture landscapes, also brought millions of hectares of land under agroforestry and disseminating agroforestry technology throughout the country, particularly in Bundelkhand region of Central India.

This technical bulletin highlights the existing available resources for agricultural development and income enhancement along with suggestions for appropriate adoption of technologies according to specific condition of the farmers in Bundelkhand region. The selected success stories based on the impact of our Institute's technologies adopted by farmers especially in Bundelkhand region, have been incorporated in the text.

I am grateful to Dr. T. Mohapatra, Secretary, Department of Agriculture Research and Education (DARE), Government of India and Director General, ICAR for his valuable guidance and suggestions.

This document emphasizes on the enhancement of farmers' income through adoption of various cost effective technologies and implementation of farmers' friendly schemes. It is open to suggestions and critics by the peer and public for its further improvement.



(Anil Kumar)
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Dated the 4th May, 2018

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Executive Summary

Indian farming is changing rapidly and significant shifts in the combination and productivity of resources used in farming have been important aspects of transformation of agriculture sector. The substitution of capital goods incorporating new technologies for labour has been a central point of this change. The substitution of capital goods for labour has been supported by the opportunity for rural people to migrate to urban areas and be better off if they had stayed in rural areas. However, incentives to substitute capital inputs for labour have been decelerating and new generation of problems such as groundwater pollution due to over use of fertilizers and pesticides, air pollution and smog formation due to burning of wheat and rice straw, development of resistance in insect pests against existing pesticides, volatility of agricultural produce especially high value commodities (HVCs), etc., which led to increase in risk for operation of agriculture. These complicated problems are responsible for distress of the farmers and affect their income adversely.

Keeping in view, Government of India has included various new farmers' friendly schemes since 2016-17 and set target of 'Doubling farmers' income by 2022-23'. It is common parlance that, the synergistic relationship between farmers' friendly policies and economic viable technologies are necessary to achieve this challenging target set within due course of time. In fact, there is diversity in the context of agro-climate and farmers' resource endowments, which require specific suggestions.

Bundelkhand region of central India, which falls under Central Plateau and Hills Agro-climatic region is amongst the most degraded ecosystem and the socio-economic status of the people is below the state and national average. Out of 13 districts of this region, three districts namely, Damoh, Chhatarpur and Chitrakoot have been selected under 'Transformation of aspirational districts' for their holistic development by NITI Aayog.

This bulletin has been divided into four parts namely, situation assessment of the farmers; resource endowments; strategies for enhancement of farmers' income; and some success stories in the region due to technological interventions of our Institute. Our findings show that there is huge difference in the context of source of income according to land holding size of household. The status of availably of natural resources are also varied among the districts within the region. Therefore, specific suggestions are given for different farmers as per their resource endowments in the region. The success stories can play the role of search-light and may encourage the farmers to adopt tested technologies in the region. To enhance the income of farmers specifically small and marginal there is need to integrate all the available scarce natural resources along with government policy towards agriculture development and region specific economically viable technology should be integrated in a holistic way.

1. Introduction

Sustainable Development Goals (SDGs) are search-light for optimum utilization of available resources to achieve over-all socio-economic development of any country. There are 17 SDGs with 169 targets, which are inter-dependent and their full impact cannot be achieved in isolation. The goal two of SDGs envisage "End hunger, achieve food security and improve nutrition and promote sustainable agriculture" and its target 2.3 clearly indicates that "By 2030, the agricultural productivity and incomes of small-scale food producers, particularly by women, indigenous people, family farmers, pastoralists and fishers" is to be doubled.

The National Commission for Farmers has submitted its fifth and final report entitled "Serving Farmers and Saving Farming" in the year 2006 and recommended that, to improve the economic viability of farming by ensuring that farmers earn a minimum net income and agricultural progress is measured by the advance made in improving that income.

Keeping in view, the Hon'ble Prime Minister shared his commitment of doubling farmers' income at his Bareilly address on 28th February, 2016. Further, the Government of India has included various new farmers' friendly schemes in the budget 2016-17 and set target of "Doubling Farmers' Income by 2022-23" before eight years fixed by United Nations Organization (UNO). The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), Soil Health Card, Pradhan Mantri Fasal Bima Yojana (PMFBY), National Agriculture Market (e-NAM), Paramparagat Krishi Vikas Yojana (PKVY), Sub-Mission on Agroforestry (SMAF) under National Mission for Sustainable Agriculture (NMSA) and Mahila Kisan Sashaktikaran Pariyojana (MKSP) are the important schemes launched to achieve the target set by Government of India.

Past strategies for development of agriculture sector in India has focused primarily on raising agricultural output and improving food security. However, those strategies did not explicitly recognize the need to raise farmers' income and did not mention any direct measure to promote farmers welfare (Chand, 2016).Agriculture growth has special powers in reducing poverty and Gross Domestic Product (GDP) growth originating in agriculture, at least twice as effective in reducing poverty as GDP growth originating outside agriculture (WDR, 2008).

The agriculture and allied sector continues to be important for the sustainable development despite its declining share in GDP, which is a natural phenomenon of a developing country like us. However, in despite of deceleration in its share in the national income, the share in employment decreased only from 58.2 to 54.6% and cultivators from 54.4 to 45.1%, while share of agricultural labourers increased from 45.6 to 54.6% in during 2001 to 2011 in Indian agriculture. This reciprocal change in the share between cultivators and agricultural labourers clearly indicate that about 10% of cultivators converted into agricultural labourers during last decade which might be due to decline in the size of land holdings. The other challenges before Indian agriculture are declining quantity and quality of natural resources (especially soil and groundwater and

deceleration in growth rate of Total Factor Productivity (TFP), higher price volatility of farmers produce (especially High Value Commodities (HVCs) like fruits and vegetables) and frequent adverse impact of climate variability.

Low income of farmers and its fluctuations causing detrimental effect on activities related to backward and forward linkage with agriculture sector. The important socio-economic impact of unattractive image of agriculture sector on distress migration and increase in slum population in urban areas along with it can cause adverse effect on development of this sector in future also.

There are inadequate studies on income estimates of farmers at both micro and macro level in India. Few seminal studies (Chand, *et al*., 2015; Chandrasekhar & Malhotra, 2016; Satyasai & Bharti, 2016 and Satyasai, 2016) are available based on large sample survey namely 'Situation Assessment Survey of Agricultural Households' conducted by National sample Survey office (NSSO) during 2003 (59^{th} round) and 2013(70^{th} round). However, the definition of farmer was different in both survey. In 59^{th} round, farmer was defined as a person who possessed and operated some land and was engaged in agricultural activities, however, in 70^{th} round, the possession of land an eligibility criterion of a farmer was dropped and any significant agricultural activity can be carried out without possessing of any land included.

Chand *et al*. (2015) suggested that 'decent growth in farm income require high growth in output, favorable farm produce prices and some cultivators moving out of agriculture'. Satyasai (2016) reported that doubling the real income of the farmers within six years is a challenging task and suggested that strategies should address enhancing returns and reducing costs and making the income sustainable keeping in view the natural resource base and emphasized on need of time-series reliable data on income of the farmers.

Food and Agriculture Organization (FAO, 2016) in a working paper on 'Can smallholders double their productivity and incomes by 2030?' concluded that 'During past 51 years (between 1961 and 2012) the overall land or labour productivity doubled on average worldwide'. Study suggested that findings should be complemented through further research using micro data from farm and household surveys and potential for raising smallholder productivity and incomes and the transformation of agriculture and rural economies more broadly.

FAO (2015) conducted a study on: The economic lives of smallholder farmers: an analysis based on household data from nine countries. Study concluded that 'Across all countries, smallholders rely less on crop and livestock production for their income as compared with other farmers. Households in the highest quarter of the farm size distribution (the 25 % of farmers with the larger farms in data or the 4th quartile) derive a higher share of their income from crop and livestock production than those at the bottom quarter of the farm size distribution (the 1st quartile).

Keeping in view the problems associated with the farmers in Bundelkhand region, this policy paper focuses on following specific objectives:

a) Situation assessment of farmers;

b) Resource availability for production of agriculture; and

c) Strategies for enhancement of farmers' income.

2. Bundelkhand Region

The Bundelkhand region, located in Central India encompassing seven districts of Uttar Pradesh *viz.* Banda, Chitrakoot, Hamirpur, Jalaun, Jhansi, Lalitpur and Mahoba and six districts of Madhya Pradesh *viz*. Chhatarpur, Datia, Damoh, Panna, Sagar and Tikamgarh (Fig 1). The region falls under Central Plateau and Hills Agro-climatic Region. This region is amongst the most degraded ecosystems characterized by undulating and rugged topography, highly eroded and dissected land, poor soil fertility and low water holding capacity and scarce ground water resources. The 56% area of Bundelkhand region comes under the red soil (Alfisols and Entisols), which is characterized by coarse gravelly and light textured with poor water holding capacity. Therefore, establishment of woody perennials is very difficult without soil and water conservation measures, particularly in red soils of the region. Remaining 44% area comes under black soil which is low lying and suffers from inadequate drainage, cracking and shrinking, and thus gives narrow time for soil working.

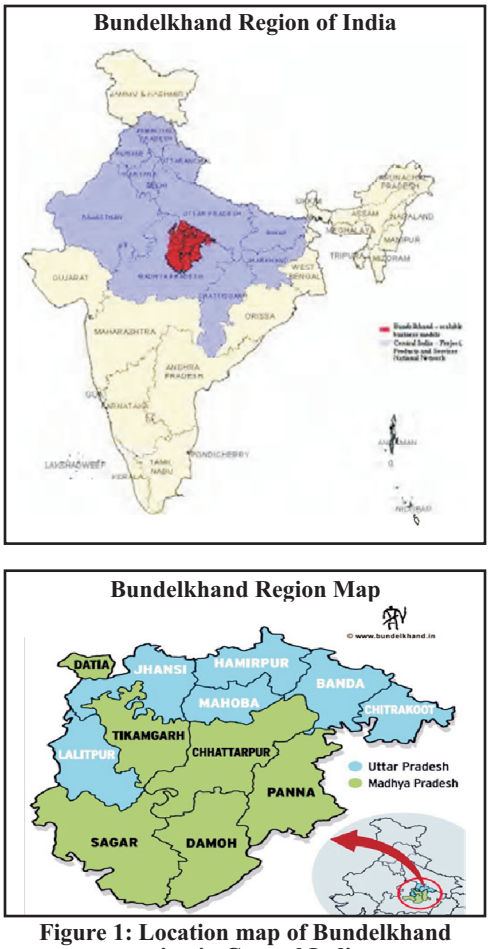

Figure 1: Location map of Bundelkhand region in Central India

3. Situation of farmers in Bundelkhand region

The average monthly income from different sources per agricultural household in the state of Madhya Pradesh and Uttar Pradesh for the agricultural year July 2012 to June 2013 for each size class of land possessed are depicted in Table1a & 1b. In the state of Madhya Pradesh about 77 per cent of monthly income contributed by farm business (cultivation and farming of animals) and about 23 per cent generated by income from wage/salary employment and non-farm income. Percentage share of income from farming of animals decreased with increase in land possession, however, this statement is not applicable with land size classes1.01-2.00, 2.01-4.00 and 4.01-10.00 ha. Net receipt from non-farm business also decrease with increase in land possession except land size class 4.01-10.00 ha might be due to custom hiring of their farm machineries especially tractors. Income from wages/salary also followed same pattern due to better employment opportunities in service sector. The average monthly income from different sources of agricultural household in state of Uttar Pradesh shows that the average monthly income for all category of agricultural household was estimated as ₹4929. Out of which about 69 percent of monthly income contributed by farm business (cultivation and farming of animals) and about 21 percent generated by income from wage/salary employment and non-farm income. There was positive correlation between share of income from cultivation and size of land possession. The share of income from farming of animals' decrease with increase in land possession, however, this statement is not applicable with land size class 4.01-10.00 ha. Net receipt from non-farm business also decrease with increase in land possession except land size class 1.01-2.00 ha. Income from wages/salary also followed same pattern as land possession increases income from this source except land size class with more than 10.00 ha, might be due to better employment opportunities in service sector.

In fact, there are wide variations among agro-climatic zones in these two states. Singh (2013) reported that 59.35, 17.87, 0.33, 9.43, 8.95 and 4.08 per cent of income from agriculture, livestock and fisheries, industry and trade, wage, service and other sources of farmers households in Bundelkhand region of Uttar Pradesh in comparison to 51.19, 13.07, 1.95, 7.46, 16.46 and 9.86 per cent respectively in overall state of Uttar Pradesh. In another study Pandey and Reddy (2012) concluded that there is strong effects of land productivity on reduction in rural poverty in Bundelkhand region of Uttar Pradesh, while weak association between these two in Eastern agro-climatic zone of Uttar Pradesh. It implies that enhancement of the farmers' income in a specific agro-climatic zone requires specific strategies for various category of farmers.

The average value of various category of asset and cash loan outstanding with rural household in state of Uttar Pradesh, Madhya Pradesh, India on 30th June, 2012 is depicted in Table 2. Land and building together, in the rural areas, clearly form the predominant component of assets and jointly holding about 94 per cent share in the total value of assets at the national level, Madhya Pradesh and in Uttar Pradesh. The share of other category of assets jointly contributed about 6 per cent only. The share of average value of cash loan outstanding per rural household were about 3 per cent at national level and 2 per cent at both the state.

Table1a. Average monthly income of agricultural household for each class of land possessed in Madhya Pradesh, 2012-13.

(₹/household)

Size class of land possessed (ha)	Net receipt from cultivation	Net receipt from farming of animals	Net receipt from non-farm business	Income from wages/ salary	Total
<0.01	1	549	415	2666	3631
0.01-0.40	621	564	176	1866	3227
0.41-1.00	1522	345	66	1447	3380
1.01-2.00	4578	485	85	1098	6246
2.01-4.00	6327	1108	48	559	8042
4.01-10.00	16502	2752	669	289	20212
>10.00	30219	509	77	840	31645
All sizes	3968	661	123	1234	5986
% share of total agricultural income					
<0.01	0.0	15.1	11.4	73.4	100
0.01-0.40	19.2	17.5	5.5	57.8	100
0.41-1.00	45.0	10.2	2.0	42.8	100
1.01-2.00	73.3	7.8	1.4	17.6	100
2.01-4.00	78.7	13.8	0.6	7.0	100
4.01-10.00	81.6	13.6	3.3	1.4	100
>10.00	95.5	1.6	0.2	2.7	100
All sizes	66.3	11.0	2.1	20.6	100

Table1b. Average monthly income of agricultural household for each class of land possessed in Uttar Pradesh, 2012-13.

(₹/household)

Size class of land possessed (ha)	Net receipt from cultivation	Net receipt from farming of animals	Net receipt from non-farm business	Income from wages/ salary	Total
<0.01	-7	513	819	2358	3683
0.01-0.40	851	377	354	1143	2725
0.41-1.00	2860	416	262	1067	4605
1.01-2.00	5892	976	542	992	8402
2.01-4.00	12591	1711	533	1025	15860
4.01-10.00	19564	1743	439	1219	22965
>10.00	56014	19	341	5231	61605
All sizes	2855	543	376	1150	4924

% share of total agricultural income					
<0.01	-0.2	13.9	22.2	64.0	100
0.01-0.40	31.2	13.8	13.0	41.9	100
0.41-1.00	62.1	9.0	5.7	23.2	100
1.01-2.00	70.1	11.6	6.5	11.8	100
2.01-4.00	79.4	10.8	3.4	6.5	100
4.01-10.00	85.2	7.6	1.9	5.3	100
>10.00	90.9	0.0	0.6	8.5	100
All sizes	58.0	11.0	7.6	23.4	100

Source: Authors' estimate with data from 'Income, Expenditure, Production Assets and Indebtedness of Agricultural Households in India', 2016, Report No. 576, 70th round, National Sample Survey Office (NSSO), 2012-13, Ministry of Statistics and Programme Implementation, Government of India.

Table 2. Average value of various category of asset and cash loan outstanding with rural household in state of Uttar Pradesh, Madhya Pradesh, India on 30th June, 2012.

Asset category	Madhya Pradesh	Uttar Pradesh	India	Madhya Pradesh	Uttar Pradesh	India
	(₹/rural household)			% in total value of asset		
Land	768241	775291	731047	78.0	74.4	72.6
Building	159268	209790	212778	16.2	20.1	21.1
Livestock and poultry	18586	19066	16225	1.9	1.8	1.6
Farm business equipment	8161	5213	4426	0.8	0.5	0.4
Non-farm business equipment	473	2457	2492	0.0	0.2	0.2
Transport equipment	23502	18172	21342	2.4	1.7	2.1
Shares, etc.	9	54	746	0.0	0.0	0.1
Deposit, etc.	6359	11448	16662	0.6	1.1	1.7
Amount receivable	649	410	1286	0.1	0.0	0.1
Total	985248	1041901	1007004	100.0	100.0	100.0
Average value of cash loan outstanding (₹)	21249	22199	32522	2.2	2.1	3.2

Source: Authors' estimate with data from 'Key Indicators of Debt and Investment in India', 2014, 70th round, National Sample Survey Office (NSSO), 2013, Ministry of Statistics and Programme Implementation, Government of India

The performance of marketing and farm friendly reforms in state of Madhya Pradesh, Uttar Pradesh, India, during October, 2016 is presented in Table 3. The state of Madhya Pradesh achieved higher rank than Uttar Pradesh. The share of agriculture and allied sector in Gross State Domestic Product (GSDP) was about 29 and 20 per cent in the state of Madhya Pradesh and Uttar Pradesh respectively during 2014-15 at constant 2004-05 prices. This implies that in spite of lion's share of agriculture and allied sector in GSDP appropriate reforms in agricultural marketing and other farmers' friendly reforms not yet implemented so far. Hence, there is need for adoption of these reforms in these two states.

Table 3. Status of marketing and farm friendly reforms in state of Madhya Pradesh and Uttar Pradesh, October, 2016.

Sl. No.	Reform indicator	Madhya Pradesh	Uttar Pradesh
1	Setting up market in private sector		
a	Provision in the Act	No	No
b	Notified	No	No
2	Direct marketing		
a	Provision in the Act	Yes	No
b	Notified	Yes	No
3	Farmer-Consumer market		
a	Provision in the Act	No	No
b	Notified	No	No
4	Contract Farming		
a	Provision in the Act	Yes	No
b	Notified	Yes	No
c	No. of crops	1	0
5	E-Trading		
a	Provision in the Act	Yes	Yes
b	Notified	Yes	Yes
6	Single Point Levy in market		
a	Provision in the Act	Yes	Yes
b	Notified	Yes	Yes
7	Single Trader License		
a	Provision in the Act	Yes	Yes
b	Notified	Yes	Yes
8	Fruits and Vegetables out of APMC regulation		
a	Provision in the Act	No	No
b	Notified	No	No
c	Fee/ Service Charge	Yes	Yes
9	Joining e-NAM	Yes	Yes
a	Markets Enrolled	20	66
10	Tax/Levies/Fee on Agricultural Commodities (%)	2	4
11	Restrictions on Felling of Trees and Transit	Partial	Partial
12	Legal Status of Land Leasing Restriction	Ban	Partial
a	Model Land Lease Law	Yes	No
	State's score	69.5	47.8

Source: Ramesh Chand and Jaspal Singh (2016) Study Report on Agricultural Marketing and Farmer Friendly Reforms Across Indian States and UTs. National Institution for Transforming India, NITI Aayog, New Delhi.

4. Resources availability in the region

Bundelkhand has dubious distinction of being rainfed, vulnerable to drought and one of the low productive region of the country. The district-wise land resources classified as Desirable ecological resources comprises area under forests, permanent pastures and other grazing lands and area under miscellaneous trees and groves not included in net sown area; Un-Desirable ecological resources consists area under barren and un-culturable land; Non-agricultural land resources include area under non-agricultural uses; and Agricultural land resources include area under culturable wasteland, current fallows and net sown area. Desirable ecological resources support to strengthen the sustainable production of agricultural and allied activities especially for landless and marginal farmers who depend on common property resources. Panna and Chitrakoot districts ranked first among other districts in the region of Madhya Pradesh and Uttar Pradesh in term of highest area under desirable ecological resources. The share of area under desirable ecological resources was below 9 per cent of state average in all the districts of the region except Chitrakoot and Lalitpur in the state of Uttar Pradesh, while in Madhya Pradesh all the districts in the region having more share than state average of 33 per cent except Datia and Tikamgarh. It implies that part of the region under Madhya Pradesh are much ecologically desirable than Uttar Pradesh (Table 4).

Table 4. District-wise share of various land resources in Bundelkhand region, 2014-15.

(per cent)

District	Land use group			
	Area under forests, permanent pastures and grazing lands and area under miscellaneous trees and grooves not included in net sown area	Area under barren and un-culturable land	Area under non-agricultural uses	Area under culturable wasteland, current fallows and area under net sown
Banda	1.7	2.5	7.2	88.6
Chitrakoot	25.3	6.2	9.1	59.4
Hamirpur	6.6	2.4	8.4	82.6
Jalaun	6.6	2.5	8.6	82.3
Jhansi	7.2	6.3	8.8	77.7
Lalitpur	15.6	2.8	8.1	73.5
Mahoba	5.3	2.5	11.8	80.4
All Uttar Pradesh	8.6	2.0	11.7	77.7
Chatarpur	32.9	0.2	5.3	61.6
Damoh	41.7	7.9	4.4	46.0

Datia	12.8	5.3	5.9	76.0
Panna	44.2	3.2	6.2	46.3
Sagar	36.7	1.2	5.7	56.4
Tikamgarh	17.5	10.9	7.5	64.2
All Madhya Pradesh*	32.5	4.4	7.0	56.1

Source: Authors estimates based on data from Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India data accessed on 31-3-2017 from http://agcensus.dacnet.nic.in

*The district-wise data for the state of Madhya Pradesh was used for the year 2013-14.

The marginal and small holdings (below 2.00 ha.) constituted 85, 93 and 72 per cent in all operational holdings at all India level, Uttar Pradesh and Madhya Pradesh, respectively during 2010-11. The highest share of this group of farmers were in Chitrakoot and lowest share in Tikamgarh district in the region. The semi-medium and medium operational holdings (2.00 ha. – 9.99 ha.) Were 14, 7 and 28 per cent at all India level, Uttar Pradesh and Madhya Pradesh, respectively? The highest share of both these size class of farmers were in Tikamgarh and lowest share in Chitrakoot districts in the region. The large holdings (10.00 ha. & above) were only 0.7, 0.1 and 1.0 per cent of total number of holdings at all India level, Uttar Pradesh and Madhya Pradesh, respectively. However, the maximum share of large farmers were in Hamirpur and Jhansi districts respectively in the region (Table 5).

Table 5. District-wise share of various category of farm holding in Bundelkhand region, 2010-11.

District	% Share in numbers of various size class of farms				
	Marginal (below 1 ha)	Small (1.00-1.99 ha)	Semi-Medium (2.00 - 3.99 ha)	Medium (4.00 - 9.99 ha)	Large (10.00 and above)
Banda	59.3	20.7	12.9	6.5	0.7
Chitrakoot	65.9	19.1	9.5	4.7	0.8
Hamirpur	57.0	19.2	14.2	8.5	1.1
Jalaun	54.3	22.5	14.6	8.0	0.6
Jhansi	61.6	19.5	12.6	6.1	0.3
Lalitpur	48.9	31.5	13.8	5.1	0.7
Mahoba	51.6	23.7	15.6	8.2	0.8
All Uttar Pradesh	**79.5**	**13.0**	**5.7**	**1.7**	**0.1**
Chatarpur	39.9	32.2	19.3	7.8	0.9
Damoh	48.2	26.8	16.7	7.3	1.0
Datia	50.6	24.8	16.1	7.9	0.6
Panna	47.1	28.9	16.9	6.7	0.5
Sagar	43.1	31.6	16.5	7.9	1.0
Tikamgarh	44.5	26.4	21.4	7.4	0.3
All Madhya Pradesh	**43.9**	**27.6**	**18.7**	**8.9**	**1.0**
All India	**67.1**	**17.9**	**10.0**	**4.3**	**0.7**

Source: Authors estimates based on data from Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India data accessed on 31-3-2017 from http://agcensus.dacnet.nic.in

The average size in all size class of operational holding was 1.15, 0.76 and 1.78 ha at all India level, Uttar Pradesh and Madhya Pradesh respectively during 2010-11. The highest size of holding of this group were in Chhatarpur and Chitrakoot districts in the region. The average size of holding in all the districts were higher than national and state averages. This implies that there is more scope to increase farm business in comparison to other districts of these two states (Table 6).

Table 6. District-wise average size of holding (ha) in Bundelkhand region, 2010-11.

District	Marginal (below 1 ha)	Small (1.00-1.99 ha)	Semi-Medium (2.00 - 3.99ha)	Medium (4.00 - 9.99 ha) above)	Large (10.00 and	All Size Classes
Banda	0.45	1.40	2.79	5.72	14.10	1.38
Chitrakoot	0.43	1.37	2.67	5.79	15.39	1.20
Hamirpur	0.37	1.42	2.80	5.98	13.44	1.53
Jalaun	0.47	1.23	2.77	5.79	12.66	1.48
Jhansi	0.51	1.47	2.81	5.83	13.94	1.35
Lalitpur	0.55	1.42	2.77	5.78	14.71	1.50
Mahoba	0.47	1.44	2.77	5.78	12.77	1.59
All Uttar Pradesh	**0.39**	**1.40**	**2.72**	**5.52**	**15.01**	**0.76**
Chatarpur	0.54	1.42	2.69	5.73	14.59	1.76
Damoh	0.51	1.43	2.75	5.75	16.72	1.67
Datia	0.49	1.42	2.71	5.61	13.75	1.56
Panna	0.47	1.41	2.68	5.61	13.68	1.53
Sagar	0.54	1.42	2.76	5.79	15.31	1.75
Tikamgarh	0.50	1.25	2.62	5.18	14.43	1.54
All Madhya Pradesh	**0.49**	**1.42**	**2.73**	**5.76**	**15.77**	**1.78**
All India	**0.39**	**1.42**	**2.71**	**5.76**	**17.38**	**1.15**

Source: Authors estimates based on data from Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India data accessed on 31-3-2017 from http://agcensus.dacnet.nic.in.

The groundwater situation in various district of Bundelkhand region is presented in Table 7. It shows that the stage of water development is less than 100 except the district of Mahoba, Uttar Pradesh. It implies that the annual groundwater extraction rate is below the net annual water recharge. The net groundwater availability for irrigation is highest in Sagar and lowest in Mahoba district. The decadal changes in groundwater level indicate that all districts except Mahoba showed fall in water table ranging between 5 to 43 per cent of wells in category of more than four metre depth between post–Monsoon season of 2006 to 2016. The highest share recorded in Chitrakoot district where over 40 per cent of wells showed fall in water-table in category of more than four metre depth of water table.

Table7. District-wise groundwater situation in Bundelkhand region, 2011.

District	Stage of ground water develop-ment (%)	Net ground water availability for future irrigation use (billion cubic meters) (bcm)	Percentage of wells showing fluctuation during January, 2006-2016					
			Rise			Fall		
			0-2 m	2-4 m	>4 m	0-2 m	2-4 m	>4 m
Banda	55	0.30	14.29	14.29	0	50.00	7.14	14.29
Chitrakoot	66	0.08	0	0	0	42.86	14.29	42.86
Hamirpur	64	0.17	66.67	0	0	22.22	0	11.11
Jalaun	29	1.30	11.11	3.70	0	51.85	22.22	11.11
Jhansi	89	0.19	26.32	0	0	52.63	15.79	5.26
Lalitpur	62	0.18	25.00	0	0	33.33	33.33	8.33
Mahoba	112	0.00	71.43	0	0	14.29	14.29	0
All Uttar Pradesh	**74**	**19.64**	**40.00**	**0**	**0**	**30.00**	**20.00**	**10.00**
Chhatarpur	67	0.23	10.26	0	2.56	33.33	41.03	12.82
Damoh	62	0.13	27.27	4.55	0	36.36	22.73	9.09
Datia	48	0.16	10.00	10.00	0	40.00	20.00	20.00
Panna	26	0.37	19.23	0	3.85	46.15	15.38	15.38
Sagar	59	0.48	5.00	2.50	0	50.00	37.50	5.00
Tikamgarh	72	0.14	15.00	0	0	40.00	35.0	10.00
All Madhya Pradesh	**57**	**13.90**	**22.21**	**4.92**	**1.84**	**39.66**	**19.23**	**12.07**

Source: Authors estimates based on data from the report on 'Dynamic Ground Water Resources of India (As on 31st March,2011),2014; and Groundwater Yearbook, Uttar Pradesh, 2015-16, Central Ground Water Board, Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India, data accessed on 31-3-2017 from http://agcensus.dacnet.nic.in

*Stage of groundwater development= (Total ground water extraction/ Net annual groundwater availability)*100

The district of Chitrakoot and Panna have less than 50 per cent net irrigated area while Lalitpur and Datia have over 90 per cent net irrigated area in 2013-14. However, majority of districts have net and gross irrigated area below share than their state average. The groundwater is major source of irrigation and contributing over 60 per cent in all the districts except Datia, Jalaun and Panna district. Canal irrigation is major source of irrigation in Datia and Jalaun and other sources in Panna district (Table 8).

Table 8. District-wise irrigation availability situation in Bundelkhand region, 2013-14.

District	% of irrigated area to net area sown	% of irrigated area to gross area sown	% share of net irrigated area by different sources of irrigated area, 2014-15				
			Tubewell	Other wells	Canal	Tank	Others
Banda	44	46	60.2	9.3	28.0	2.3	0.2
Chitrakoot	30	29	78.1	6.2	6.3	9.3	0.1
Hamirpur	51	42	65.1	13.4	17.8	1.9	1.8
Jalaun	71	62	30.8	6.3	61.5	1.1	0.2
Jhansi	81	56	11.9	36.7	39.1	11.4	1
Lalitpur	95	53	25.4	28	33.0	9.2	4.3
Mahoba	53	39	4.4	55	19.9	18.5	2.2
All Uttar Pradesh	**85**	**79**	**71.2**	**9.3**	**18.2**	**0.8**	**0.4**
Chhatarpur	61	43	5.2	73.6	10.1	1.6	9.5
Damoh	57	35	20.0	20.9	11.6	4.8	42.7
Datia	90	75	11.1	23.7	64.6	0	0.7
Panna	42	28	7.8	14.4	8.2	1.4	68.2
Sagar	61	38	25.7	45.6	3.4	1.6	23.7
Tikamgarh	84	59	12.7	64.8	9.4	8.0	5.2
All Madhya Pradesh	**61**	**41**	**32.9**	**32.9**	**17.2**	**2.8**	**14.3**

Source: Authors estimates based on data from Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India data accessed on 31-3-2017 from http://agcensus.dacnet.nic.in; and Statistical Diary, Directorate of Economics and Statistics, Government of Uttar Pradesh, 2015.

National Rainfed Area Authority has prioritized the rainfed districts on the basis of Rainfed Areas Prioritization Index (RAPI) which was derived by assigning two-thirds weight to natural resource (NR) priority index and one-third weight to livelihood priority index. Natural Resource Index (NRI) comprising of nine variables, *viz.*, rainfall, frequency of drought, available water content, extent and per cent of degraded and wastelands, irrigation intensity, extent and per cent of rainfed areas and ground water status. Similarly, an "Integrated Livelihood Index" (ILI), is a composite of three sub-indices, viz., socio-economic index, health and sanitation index and infrastructure index. In majority of the districts, natural resources status and livelihood status are inversely related. Top rankers districts with RAPI need immediate attention for enhancing productivity and livelihood as resource-wise they are rich but the productivity and livelihood status are poor. On the basis of status of the priority rank in India, Panna and Chitrakoot need special attention for agricultural development in Bundelkhand region through dissemination of technology, infrastructure development, marketing facilities, strengthening the credit facilities, bridging the knowledge gap along with forward and backward linkages (Table 9).

Table 9. Prioritization of districts on the basis of Natural Resources Index (NRI), Integrated Livelihood Index (ILI) and Rainfed Area Prioritization Index (RAPI) in Bundelkhand region, 2012.

District	Natural Resources Index (NRI)	Integrated Livelihood Index (ILI)	Rainfed Area Prioritization Index (RAPI)	Priority Rank in India
Uttar Pradesh				
Banda	0.764	0.345	0.376	75
Chitrakoot	0.810	0.293	0.363	94
Hamirpur	0.765	0.402	0.356	108
Jalaun	0.812	0.483	0.298	252
Jhansi	0.776	0.452	0.332	155
Lalitpur	0.841	0.332	0.329	165
Mahoba	0.811	0.307	0.357	103
Madhya Pradesh				
Chhatarpur	0.831	0.328	0.336	145
Damoh	0.843	0.320	0.332	158
Datia	0.841	0.499	0.273	316
Panna	0.804	0.288	0.368	85
Sagar	0.831	0.314	0.342	133
Tikamgarh	0.875	0.352	0.299	245

Source: Prioritization of Rainfed Areas in India, National Rainfed Area Authority, Planning Commission, Government of India, 2012

Districts with medium to high NRI status but low ILI indicating scope for improving the livelihoods through better access and utilization of natural resources. Areas having low NRI deserve creation of off-farm employment opportunities with focus on land use diversification, micro-enterprises and industrialization. All districts having high to medium milk potential should get high priority for milk production through rearing of improved quality of milch animals. The marginal and landless farmers without capital should be encouraged for goatary, which is much profitable for available un-skilled abundant labour (Table10).

The Soil fertility status of Bundelkhand region

The soils of UP Bundelkhand region is very typical with its flat, alluvial, sandy texture with mix of red and black soils, swallow and have low water holding capacity. While in the MP Bundelkhand region, the land feature is very undulating with deep to very deep heavy texture soils. In most of the cases, farmers of these regions are resource poor, with small holdings of land. They mostly use N (Nitrogen) and P (Phosphorus) fertilizers, with no or little use of K (Potassium). The status of fertility in 7 districts of UP Bundelkhand and 6 districts of MP Bundelkhand is given as follows (Table11 &12):

Table10. District-wise Milk Production Potential in Bundelkhand region, 2012.

District	Status of Natural Resources Index (NRI)	Cow density	% of crossbred cow	Buffalo density	Milk production index	Potential
Uttar Pradesh						
Banda	Low	43.14	0.55	50.64	0.870	Medium
Chitrakoot	Medium	53.36	0.31	38.03	0.880	Medium
Hamirpur	Low	32.28	2.87	37.41	0.897	High
Jalaun	Medium	35.93	2.29	40.82	0.889	Medium
Jhansi	Low	34.31	0.52	29.40	0.914	High
Lalitpur	Medium	51.00	0.13	30.03	0.896	Medium
Mahoba	Medium	40.32	0.78	31.78	0.903	High
Madhya Pradesh						
Chhatarpur	Medium	35.34	0.33	32.13	0.909	High
Damoh	Medium	49.31	0.24	13.97	0.923	High
Datia	Medium	30.92	0.69	60.78	0.867	Medium
Panna	Medium	42.84	0.30	18.41	0.923	High
Sagar	Medium	53.40	0.62	18.85	0.910	High
Tikamgarh	High	64.23	1.23	49.63	0.847	Medium

Source: Prioritization of Rainfed Areas in India, National Rainfed Area Authority, Planning Commission, Government of India, 2012

Table 11. The soil fertility status of different districts of Uttar Pradesh Bundelkhand region

Districts	Macronutrients				Micronutrients			
	N	P	K	S	Zn	Cu	Fe	Mn
Jhansi	L	VL	H	M+	M+	S	S	S
Jalaun	L	VL	H	D	M+	S	S	S
Mahoba	L	L	H	D	M+	S	S	S
Chitrakoot	VL	VL	M	M+	M+	S	M	S
Banda	VL	VL	M	M+	M+	S	S	S
Hamirpur	L	VL	H	D	M+	S	S	S
Lalitpur	L	VL	H	D	M+	S	S	S

Note: VL- Very Low, L- Low, H- High, M- Medium, M+-Marginal, S- Sufficient, D- Deficient

(**Source:** Synthesis Report, NRAA, NitiAayog, GOI, New Delhi).

Table 12. The soil fertility status of different districts of Madhya Pradesh Bundelkhand region.

Districts	N	P	K	Zn deficit (%)
Datia	L	M	H	40
Tikamgarh	L	L	H	88
Sagar	L	H	L	78
Damoh	L	H	L	70
Panna	L	L	H	60
Chhattarpur	L	L	H	53

Note: L- Low, M- Medium, H- High

(**Source:** Synthesis Report, NRAA, Niti Aayog, GOI, New Delhi).

As such, in UP Bundelkhand region, the status of N availability is low to very low, P is also very deficient available, K availability is medium to high, S is marginal to deficient. Among the micronutrient availability, the Zn is marginal, otherwise Cu, Fe and Mn were found to be sufficient.

In MP Bundelkhand region, the status of N availability is low. P availability is medium in Datia, high in Sagar and Damoh districts and low in Tikamgarh, Panna and Chhattarpur. The level of K is between low to high. Especially, among the micronutrients, the zinc deficiency level is widespread ranging from 40% to 88%. Thus we can say that, the soil of Bundelkhand region are very poor in fertility status as far as the N and P are concerned, and also suffer from zinc deficiency. There may be number of reasons for this, might be due to very high soil degradation due to climatic variability, high temperature, undulating topography. Spatial variability of soil fertility status is also very high. The farmers of this region are mostly using N and P fertilizers and FYM and compost to some extent but little aware of other organic sources of fertilizers like green manuring, biofertilizers etc. Thus, the integrated use of inorganic and organic fertilizers i.e., to say integrated nutrient management (INM) are very important for maintaining the soil fertility status as well as sustaining the agricultural productivity on long term basis. Due to indiscriminate use of fertilizers and even under use had led to many multifaceted problems in the soil of the region. To fulfill the mismatch between the nutrient removed by the crop and the amount used in actual, there is need to apply the nutrients in adequate amount and that too at particular growth stages of the crop. Even, the application of neem coated urea, foliar application of micronutrients for horticultural crops and use of fertilizers on the basis of soil test is desirable. Especially the use of Soil Health Card for the application of fertilizers and organic sources should be done to harness maximum benefits.

The district-wise cropping pattern in Uttar Pradesh is depicted in Table13. Its shows that the highest cropping intensity was reported in the Lalitpur followed by Jhansi and Banda district. The maximum area covered by wheat, gram, other pulses and sesame. These crops are suitable for this region because of low water requirement and low production cost except wheat.

Table13. District-wise cropping pattern(per cent) in Bundelkhand region of Uttar Pradesh, 2014-15.

Crop	Banda	Chitra-koot	Hamir-pur	Jalaun	Jhansi	Lalit-pur	Mahoba	All Uttar Pradesh
Rice	12.15	6.70	0.02	0.38	2.82	0.24	0.01	23.47
Jowar	5.36	6.03	4.20	1.60	0.14	0.02	0.53	0.62
Bajra	0.69	7.97	0.12	3.29	0.00	0.00	0.00	3.72
Maize	0.00	0.00	0.02	0.00	0.12	3.29	0.00	2.64
Wheat	35.92	37.12	29.31	35.94	28.45	34.64	20.40	38.43
Barley	0.18	1.80	1.32	1.93	3.63	1.94	2.16	0.60
Other Cereals and Millets	0.00	0.02	0.00	0.00	0.04	0.00	0.00	0.13
Gram	20.14	17.89	18.78	8.40	9.46	2.23	18.09	2.04
Arhar (Tur)	4.28	5.71	4.26	1.21	0.09	0.00	0.91	1.05
Other Pulses	11.52	8.87	20.48	25.43	33.39	43.28	37.24	5.57
Sugarcane	0.10	0.11	1.47	0.29	0.03	0.01	1.14	8.47
Other Sugar	0.00	0.00	0.03	0.02	0.01	0.00	0.00	0.12
Total Condiments and Spices	0.04	0.02	0.13	0.03	0.01	0.15	0.04	0.24
Total Fruits	0.01	0.01	0.00	0.00	0.04	0.02	0.00	1.14
Total Vegetables	0.43	0.75	0.57	1.75	0.89	0.51	0.61	3.24
Groundnut	0.19	0.04	0.06	0.00	5.40	2.08	3.97	0.39
Sesamum	6.44	2.85	13.69	15.81	12.77	1.23	10.55	1.46
Rapeseed and Mustard	0.85	2.93	4.27	2.58	1.54	0.76	1.97	2.23
Linseed	0.86	0.31	0.55	0.05	0.03	0.00	2.05	0.09
Soyabean	0.01	0.00	0.00	0.01	0.31	9.56	0.10	0.21
Other Oilseeds	0.02	0.00	0.04	0.04	0.07	0.00	0.01	0.01
Total Fibres	0.03	0.06	0.10	0.02	0.01	0.00	0.03	0.03
Total Drugs, Narcotics and Plantation Crops	0.00	0.00	0.13	0.60	0.48	0.00	0.13	0.97
Fodder Crops	0.78	0.79	0.44	0.50	0.13	0.04	0.02	2.93
Green Manure	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.06
Other Non-Food Crops	0.00	0.00	0.00	0.08	0.12	0.00	0.02	0.16
Cropping intensity	130	113	128	125	165	180	143	158

Source: Authors estimates based on data from Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India data accessed on 31-3-2017 from http://agcensus.dacnet.nic.in

The cropping intensity was higher in Tikamgarh, Damoh and Sagar districts even more than state average of Madhya Pradesh. The maximum area is under wheat, soyabean, gram, other pulses and sesamum in all the districts in the region. Surprisingly, the share of rice is over 19 per cent in Panna district where groundwater table is declining rapidly during last decade. Rice is water guzzling crop which should be discouraged in this water scarced region (Table 14).

Table14. District-wise cropping pattern (Per cent) in Bundelkhand region of Madhya Pradesh, 2013-14.

Crop	Chhatar-pur	Damoh	Datia	Panna	Sagar	Tikam-garh	All Madhya Pradesh
Rice	0.81	10.72	4.52	19.31	0.54	2.44	7.79
Jowar	1.56	0.06	0.45	0.93	0.09	0.22	1.02
Bajra	0.01	0.00	0.30	0.00	0.00	0.00	0.80
Maize	0.08	0.32	0.26	0.83	0.31	0.37	3.54
Wheat	29.13	17.07	50.70	20.41	25.79	33.94	25.46
Barley	3.02	0.03	1.28	0.90	0.08	2.56	0.35
Other Cereals and Millets	0.02	0.02	0.00	0.16	0.05	0.04	0.84
Gram	14.17	34.30	6.48	19.94	20.40	4.21	11.54
Arhar (Tur)	1.48	1.62	0.08	3.18	0.68	0.01	1.65
Other Pulses	15.35	9.36	13.43	15.59	8.70	22.43	6.41
Sugarcane	0.08	0.02	2.20	0.11	0.05	0.08	0.42
Other Sugar	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Condiments and Spices	0.44	0.20	0.06	0.47	0.23	0.63	1.44
Total Fruits	0.01	0.02	0.01	0.10	0.01	0.07	0.21
Total Vegetables	1.75	0.88	0.72	1.76	1.29	2.13	1.35
Groundnut	1.67	0.02	2.46	0.08	0.17	4.28	0.90
Sesamum	10.49	0.23	7.78	8.69	0.12	6.45	1.12
Rapeseed and Mustard	3.18	0.12	5.44	1.02	0.05	4.76	2.92
Linseed	1.04	0.04	0.00	0.11	0.09	0.01	0.37
Soyabean	13.35	24.77	0.66	6.28	39.64	12.97	27.21
Other Oilseeds	0.00	0.00	0.51	0.00	0.06	0.00	0.05
Total Fibres	0.10	0.00	0.10	0.03	0.00	0.00	2.41
Total Drugs, Narcotics and Plantation Crops	1.24	0.00	0.00	0.05	0.01	0.00	0.18
Fodder Crops	0.87	0.19	2.36	0.00	1.49	2.39	1.66
Green Manure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Non-Food Crops	0.00	0.00	0.21	0.00	0.01	0.00	0.04
Cropping intensity	142	163	127	154	162	168	156

Source: Authors estimates based on data from Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India data accessed on 31-3-2017 from http://agcensus.dacnet.nic.in

The district-wise share of animals is presented in Table 15. It shows that share of cattle and buffalo jointly contributes over 70 per cent of total livestock population in year 2012. The goat also contributed substantially. The goatary enterprise is much attractive for resource poor farmers provided common pasture lands availability is sufficient however, the area under common property resources is continuously decreasing along with their quality.

Table 15. Share of animals in total livestock (Per cent) in various districts of Bundelkhand region, 2012.

District	Total No. of livestock (000)	% Share in total livestock			
		Cattle	Buffalo	Goat	Others
Banda	940	39.5	34.5	22.4	3.6
Chitrakoot	762	55.3	24.1	16.5	4.2
Hamirpur	793	34.0	25.2	36.8	4.1
Jalaun	804	28.0	31.9	33.4	6.8
Jhansi	954	37.0	25.5	30.8	6.7
Lalitpur	887	54.5	26.5	17.7	1.4
Mahoba	563	40.5	24.1	28.9	6.5
All Uttar Pradesh	**68715**	**28.5**	**44.6**	**22.7**	**4.3**
Chatarpur	850	40.5	28.1	30.0	1.4
Damoh	797	70.1	13.4	15.3	1.2
Datia	364	29.5	41.3	27.4	1.8
Panna	693	59.8	20.5	18.1	1.6
Sagar	1165	68.9	18.3	12.1	0.7
Tikamgarh	868	42.3	26.7	25.8	5.2
All Madhya Pradesh	**36333**	**54.0**	**22.5**	**22.1**	**1.5**

Source: Authors estimates based on data from 19th Livestock Census District Wise Report 2012, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India.

The number of animals per households presented in Table 16 shows that maximum number of livestock per households are in Chitrakoot followed by Lalitpur and Jhansi district (2012). In case of cattle Chitrakoot rank first followed by Lalitpur and Panna; and in case of buffaloes Lalitpur, Jhansi and Chitrakoot respectively. However, in case of goatary maximum number per household are in Hamirpur followed by Jhansi and Mahoba districts.

Table 16. Number of animals rearing by per household in various districts of Bundelkhand

District	Total No. of House-hold (000)	No. of animals /household				
		livestock	Cattle	Buffaloes	Goat	Others
Banda	342	2.75	1.09	0.95	0.62	0.10
Chitrakoot	175	4.34	2.40	1.05	0.71	0.18
Hamirpur	207	3.82	1.30	0.96	1.41	0.16

Jalaun	270	2.98	0.83	0.95	0.99	0.20
Jhansi	229	4.17	1.54	1.06	1.29	0.28
Lalitpur	212	4.19	2.28	1.11	0.74	0.06
Mahoba	156	3.61	1.46	0.87	1.04	0.24
All Uttar Pradesh	**36930**	**1.86**	**0.53**	**0.83**	**0.42**	**0.08**
Chatarpur	337	2.52	1.02	0.71	0.75	0.04
Damoh	284	2.81	1.97	0.38	0.43	0.03
Datia	148	2.45	0.72	1.01	0.67	0.04
Panna	199	3.49	2.09	0.71	0.63	0.06
Sagar	482	2.42	1.67	0.44	0.29	0.02
Tikamgarh	277	3.13	1.32	0.84	0.81	0.16
All Madhya Pradesh	**16933**	**2.15**	**1.16**	**0.48**	**0.47**	**0.03**

Source: Authors estimates based on data from 19th Livestock Census District Wise Report 2012, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India.

5. Strategy for income enhancement of farmers' in India

Strategy is a consistency framework for bringing together diverse policy initiatives in an overarching logical structure that adopts a long–term view of any sector prospect. Agricultural sectors are populous and very diverse and therefore a compelling vision of the sector's potentiality is necessary in order to mobilize support. There are various strategies suggested by policy makers and policy analyst for speedy enhancement of farmers' income in our country as follows:

A) Prime Minister's seven-point strategy for doubling farmers' income by 2022

1. Focus on irrigation with per drop-more crop;
2. Quality seed and soil health;
3. Investments in warehousing and cold chains;
4. Value addition through food processing;
5. Creation of a national farm market;
6. New revolutionary crop insurance scheme to mitigate risks at affordable costs; and
7. Promotion of ancillary activities like poultry, beekeeping and fisheries.

5.1 Suggested plans for income enhancement of farmers' in Bundelkhand region

The strategy for income enhancement of farmers' in less-favored areas like Bundelkhand region is challenging. The share of marginal and small farmers is over 75 per cent in Bundelkhand region of Uttar Pradesh, which is less than their state average of 93 per cent. While the share of marginal and small farmers in Madhya Pradesh part of Bundelkhand region is over 71 per cent which is less than state average of 72 per cent. It implies that the size of holdings in this region are relatively larger than other regions of the respective state. However, the farmers of the region regularly face the problem of climatic vagaries like frequent drought, resulting in distress migration from the region. Some enterprises are suggested to increase the income and sustain even in the drought condition in the region.

The income under rainfed and irrigated agriculture system varies with different enterprises and components involved. In order to enhance the income of the farmers under these conditions few plans has been suggested and depicted in Table 17 and 18.The income from crop cultivation can be enhanced through crop diversification, selection of improved varieties, improved crop management practices, adoption of timber / or fruit based agroforestry systems, rain water harvesting and use of micro/ pressurized irrigation methods. The animal productivity can be enhanced by selection of improved breeds, livestock diversification and providing balanced nutrition. The income from non-farm and wages can be increased through imparting skill development trainings, linkages, capacity building and farming user groups or self-help groups (SHGs).

In case of marginal category farmers under rainfed condition, the existing income of Rs 4605 may be enhanced with best management practices within the same piece of land. By crop diversification, improved varieties, improved crop management practices and small interventions to harvest rain water through formation of bunds and digging small farm pond will help in retaining moisture and storing of water. In addition by introducing grass component and keeping improved breed of livestock result in enhancing the milk productivity and help in soil and moisture conservation. Under no farm income category, to meet out immediate exigencies the farmers can collectively form SHGs for a specific activity say vermicomposting, nursery development, poultry rearing, common irrigation, etc. If he enhances the skill through skill development programmers such as ber budding, grafting etc his overall income will get enhanced. Hence by practicing all the listed best management practices his overall income will rise to ₹ 8059.

Table 17. Comparison of existing status and suggested plan for various category of farmers in Bundelkhand region under Rainfed condition.

Category of farmers	Rainfed			
	Existing Status		Suggested Plan	
	Enterprise	Average monthly net income (₹)	Enterprise/ Approaches	Average monthly net income (₹)
Marginal (below 1 ha)	Crop cultivation	2860	Crop diversification, improved varieties, improved crop management practices and rain water harvesting	5005
	Animals	416	Improved breed; green fodder; livestock diversification	700
	Non-farm	262	User Groups/ SHGs; linkages and skill development	450
	Wages/salary	1067	Capacity building	1867
	Total	4605		8022
Small (1.00-1.99 ha)	Crop cultivation	5892	Crop diversification, improved varieties, improved crop management practices and rain water harvesting	10211
	Animals	976	Improved breed; green fodder; balanced nutrition; livestock diversification	1700
	Non-farm	542	User Groups/ SHGs; linkages and skill development	900
	Wages/salary	992	Capacity building	1736
	Total	8402		14547

Semi-Medium (2.00-3.99 ha)	Crop cultivation	12591	Improved varieties, improved crop management practices; integrated farming system; vegetable cultivation; small timber agroforestry system and rain water harvesting	22100
	Animals	1711	Balanced nutrition; green fodder; improved breed; livestock diversification	2994
	Non-farm	533	Group activity; linkages	850
	Wages/salary	1025	-	1754
	Total	15860		27698
Medium (4.00-9.99 ha)	Crop cultivation	19564	Improved varieties, improved crop management practices; integrated farming system; vegetable cultivation; small timber agroforestry system; organic farming; rain water harvesting and micro irrigation	34100
	Animals	1743	Balanced nutrition; green ; fodder improved breed; livestock diversification	2990
	Non-farm	439	Farm produce based small industry	760
	Wages/salary	1219	-	2033
	Total	22965		39883
Large (10.00 and above)	Crop cultivation	56014	Improved varieties, improved crop management practices; integrated farming system; vegetable cultivation; fruit orchards, small timber agroforestry system; organic farming; rain water harvesting with farm pond and micro irrigation	98025
	Animals	1900	Balanced nutrition; green fodder; improved breed; livestock diversification	3325
	Non-farm	341	Farm produce based small industry	597
	Wages/salary	5231	-	9154
	Total	63486		11101

Table 18. Comparison of existing status and suggested plan for various category of farmers in Bundelkhand region under irrigated condition.

Category of farmers	Irrigated			
	Existing Status		Suggested Plan	
	Enterprise	Average monthly net income (₹)	Enterprise/ Approaches	Average monthly net income (₹)
Marginal	Crop cultivation	3500	Crop diversification, improved varieties, improved crop management practices; rain water harvesting	6430
	Animals	700	Improved breed; green fodder; livestock diversification	1280
	Non-farm	200	User Groups/ SHGs; linkages and skill development	420
	Wages/salary	890	Capacity building and skill	1650
	Total	5290		9780
Small (1.00-1.99 ha)	Crop cultivation	6780	Crop diversification, improved varieties, improved crop management practices; rain water harvesting	12750
	Animals	1870	Improved breed; green fodder; livestock diversification	3753
	Non-farm	300	User Groups/ SHGs; linkages and skill development	475
	Wages/salary	400	Capacity building	740
	Total	9350		17718
Semi-Medium (2.00-3.99 ha)	Crop cultivation	15770	Improved varieties, improved crop management practices; integrated farming system; vegetable cultivation; small timber agroforestry system; rain water harvesting	29981
	Animals	2940	Balanced nutrition; green fodder; improved breed; livestock diversification	5575
	Non-farm	200	Group activity; linkages	375
	Wages/salary	300	-	590
	Total	19210		36521

Medium (4.00-9.99 ha)	Crop cultivation	25400	Improved varieties, improved crop management practices; integrated farming system; vegetable cultivation; Fruit/ small timber agroforestry system; organic farming ; rain water harvesting and micro irrigation	48260
	Animals	4500	Balanced nutrition; green fodder; improved breed; livestock diversification	8520
	Non-farm	500	-	970
	Wages/salary	1200	-	2330
	Total	31600		60080
Large (10.00 and above)	Crop cultivation	68100	Improved varieties, improved crop management practices; integrated farming system; vegetable cultivation; fruit / small timber agroforestry system; organic farming; rain water harvesting and micro irrigation	129420
	Animals	3000	Balanced nutrition; green fodder; improved breeds; livestock diversification, fishery	5670
	Non-farm	600	-	1175
	Wages/salary	1000	-	1925
	Total	72700		138190

5.2 Management practices for crop cultivations

Most of the small and marginal farmers of Bundelkhand region doing the subsistence farming and have lack of knowledge of good management practices *viz.* Quality seeds, time and method of sowing, seed rate, varieties, nutrient, irrigation, weed, pests and disease-management. Best management practices for different crops in Bundelkhand region is given in Table 19 & 20.

Figure 2. Management practices for crop production

Table 19. Best management practices for *Kharif* crops in Bundelkhand region

Crops	Soils	Varieties	Sowing time and seed rate	Nutrient management	Water management	Weed management	Pest and disease management
Greengram (*Vigna radiata*)	Well drained loamy soil, however can be grown on heavy clay loam soils	Samrat, Meha, SML 668, HUM16, IPM 02-3, Sweta	Onset of monsoon, 15-20 kg ha^{-1}; 30cm x 10 cm spacing	20 kg ha^{-1}-N, 40 kg ha^{-1} P_2O_5, 20 kg ha^{-1}-S. (100 kg DAP and 120 kg gypsum recommended for nutrient management)	In *kharif* season it is grown without irrigation, however life saving irrigation can be given in case of long dry spell.	Pre-emergence application of Pendimethalin or fluchloralin @ 1 kg ha^{-1} + One hand weeding at about 25-30 DAS can suppress most of the weeds. Imazethapyr @ 0.05 kg a.i. ha^{-1}also found effective in post emergence application.	For sucking insects like Aphids, Jassids, Thrips apply monocrotophos (0.04%) or Dimethoate (0.03%). For pod borers, fenval (0.04%) or melathion 5% D is more effective. Yellow mosaic virus disease is common in Bundelkhand region so farmers are advised to use virus free seed after treating seed with carbendazim 50wp + thirum 75WP (1:1) at 2 g/kg seed. Foliar spray of 0.02% imidaclorpid at 30 and 45 DAS may be done for reducing spread of YMV.
Blackgram (*Vigna mungo*)	Well drained loamy soil, however can be grown on heavy clay loam soils	Uttara, Azad Urd 2, Shekhar 1, Shekhar 2, Narendra Urd 1	Onset of monsoon, 12-15 kg ha^{-1}; spacing 30cm x 10 cm	20 kg ha^{-1}-N, 40 kg ha^{-1} P_2O_5, 20 kg ha^{-1}-S. (100 kg DAP and 120 kg gypsum recommended for nutrient management)	Hardy crop and grown without irrigation, however life saving irrigation can be given in case of long dry spell		
Sesame (*Sesamum indicum*)	Well drained soils. Red soils of Bundelkhand region is suitable for sesame crop.	T 78, Sekhar, Pragati, Tarun	Onset of monsoon, seed rate- 4-6 kg ha^{-1}; spacing 30cm x 15cm.	30 kg ha^{-1}-N, 20 kg ha^{-1} P_2O_5, 15 kg ha^{-1}-S.	Rainfed crop, however sensitive to drought as well as water logged conditions.	Weeds can be controlled by application of Pendimethalin @ 1 kg ha^{-1} + One hand weeding at about 25-30 DAS	Phyllody disease cause severe damage to sesame crop. To reduce vector population, application of phorate at 10 kg ha^{-1} as soil application or alternatively spray of dimethoate or monocrotophos (0.04%).

Groundnut (*Arachis hypogaea*)	Well drained, light coloured, loose and friable soil. Black soils (Kabar and Mar) not suitable for groundnut cultivation.	Amber, ICGS 5, ICGS 1, Prakash, GG 14, Girnar 2, Muktajyoti	Onset of monsoon, seed rate-100-120 kg ha^{-1} for bunch type varieties; spacing-30cm x 10cm.	25 kg ha^{-1}-N, 50 kg ha^{-1} P_2O_5, 40 kg ha^{-1}-K_2O. Band placement of gypsum @ 500 kg ha^{-1} at the time of pegging is essential for higher yields.	Predominantly rainfed crop, however in case of long dry spell life saving irrigation can be given at flowering or pegging stage.	Pre-plant incorporation of fluchloralin @ 1.5 kg a.i. ha^{-1} or pre-emergence application of pendimethalin @ 1.0 kg a.i. ha^{-1}.	For sucking pests apply dimethoate 0.05% solution. Application of carbofuron @ 1.0 kg a.i. ha^{-1} or Thimet 10G @ 20-25 kg a.i. ha^{-1} can reduce infestation of white grub. Seed treatment with bavistin @ 2.0g /kg seed or spray of bavistin 0.05% along with Diathene M 45 at 0.2% should be sprayed 2-3 times for controlling the early and late spot disease.
Maize (*Zea mays* L.)	Loamy sand to clay loam, Sensitive to water logging and salinity, requires well aerated, moist and weed free seed bed	PHEM-2, Malviya Hybrid Makka 2, Buland, Pro-Agro 4212, Bio-9681	Onset of monsoon, 20 kg ha^{-1}; spacing 60cm x 25cm	100 kg ha^{-1}-N, 40 kg ha^{-1} P_2O_5, 20 kg ha^{-1}-K_2O, 25 kg ha^{-1} $ZnSO_4$.7H2O.	Rainfed but late knee high, tasseling, 50% silking and dough stages are the critical stages for irrigation.	Pre-emergence application of simazine @ 1.0-1.5 kg ha^{-1}a.i. or Trifluralin @ 1.0 kg ha^{-1} as pre-plant incorporation.	For control of maize borer, stubbles in the field should be burn and Trichocard (*Trichogramma chilonis*) should be released. Carbaryl 4% G.R. is found effective against maize stem borer. Seed should be treated with apron 35ws @ 2.5 g/kg seed to avoid infection of downy mildew.
Pigeonpea (*Cajanus cajan*)	Loamy soils, however can be grown on heavy clay loam soils,	Narendra Arhar 1, Amar, MAL 13 and	Last week of June or first week of July; 8-10 kg ha^{-1} for longer	20-25 kg ha^{-1}-N, 60-80 kg ha^{-1} P_2O_5, 20 kg ha^{-1}-S.	Branching, flowering and pod filling are the critical stages where moisture	The combination of pre emergence application of Pendimethalin @ 1 kg ha^{-1}+ one	For sucking insects like Aphids, Jassids, and Thrips apply monocrotophos (0.04%) or Dimethoate (0.03%).

	saline and alkali soils	BSMR 736	duration, 10-12 kg ha^{-1} for medium and 12-15 kg ha^{-1} for short duration varieties; Spacing 40-60cm x 10-15cm (Short and Medium duration varieties) and 60-120cm x 10-20 cm (Long duration varieties)		stress conditions cause adverse effects on growth and development.	hand weeding is observed best method to weed control. Imazethapyr @ 0.05 kg a.i. ha^{-1} also found effective as post emergence application.	For pod borers, fenval (0.04%) or melathion 5% D is more effective. Spray of metasystox (0.1%) controls the mite which spread sterility mosaic virus in pigeon pea.
Sorghum (*Sorghum bicolor*)	Clay loam or loam texture with good water retention capacity. Most of the Bundelkhand soils are suitable for sorghum cultivation. Tolerant to water stress conditions.	Bundela, CSV 10, CSV 11, CSH 9, CSH 16, SPV 462	Onset of the monsoon, timely sowing essential for escape from shoot fly. Seed rate- 10-12 kg ha^{-1}; Spacing 45cm x 15cm.	50 kg ha^{-1}-N, 40 kg ha^{-1} P_2O_5, 20 kg ha^{-1}- K_2O.	Drought tolerant and can be grown successfully as rainfed crop in Bundelkhand region.	Pre-emergence application of atrazine @ 0.75-1.0 kg ha^{-1} a.i. or Pendimethalin @ 1.0 kg ha^{-1}, 0.5 kg a.i. ha^{-1} 2,4-DEE for control of broad leaf weeds.	For control of shoot fly, crop should be sown timely and seed should be treated with imidaclorpid70 WS @ 10-15 g a.i./kg seed.

Table 20. Best management practices for *Rabi* crops in Bundelkhand region

Crops	Soils	Varieties	Sowing time and seed rate	Nutrient management	Water management	Weed management	Pest and disease management
Wheat (*Triticum aestivum*)	Wheat can be grown on all types of soils except on water-logged soils. Medium loam, well drained soils are suitable for its cultivation.	Early and timely sown HW 2004, HI 1500, HI 1531, Raj 1555, Lok 1, GW 273 Late sown-GW 173 MP 4010 HD 2932 (Pusa wheat-111), Vidisha	Early-15-30 October, Timely-5-25 November, Late-25 Nov.-15 Dec., Seed rate-100kg ha^{-1} for irrigated conditions and 150 kg ha^{-1} for rainfed conditions; Spacing-22.5cmx5 cm.	Irrigated-120 kg ha^{-1}-N (Three split), 60 kg ha^{-1} P_2O_5, 40 kg ha^{-1}- K_2O. Rainfed-80 kg ha^{-1}-N (Two split), 40 kg ha^{-1} P_2O_5, 40 kg ha^{-1}- K_2O.	There are six critical stages for irrigation but depending upon the water resources available with the farmers irrigation can be given as 01 irrigation-at CRI (21 DAS), 02 irrigation-CRI and Flowering (F) (85 DAS), 03 irrigation-CRI, late jointing (LJ) (60 DAS) and milk (M) (95 DAS), 04 irrigation-CRI, Late tillering (LT) (42 DAS), flowering and milk stage, 05 irrigation-CRI, LT, LJ, F and M, 06 irrigation-CRI+LT+LJ+F+M+Dough	Pendimethalin 1.5 litres/ha as pre-emergence and isoproturon @ 0.75 kg a.i. ha^{-1}+2,4-D @ 0.5kg ha^{-1} as post emergence (25-30 DAS) found effective.	For termite control treat the seed with chlorpyriphos 20 EC @ 4ml/kg seed or mix 2 litres chlorpyriphos 20 EC with 25 kg sand ha^{-1}. Smut can be controlled by seed treatment with vitavex or raxil @ 1.5g ka^{-1} seed
Barley (*Hordeum vulgare*)	Barley thrives best on well drained loam soil but can be successfully raised even on poor sandy soils. Barley requires very	RD-2508, RD-2552, K-125, K-603	Last week of October to first week of November; Seed rate-100 kg ha^{-1} (irrigated) conditions and 125 kg	Irrigated-60 kg ha^{-1}-N, 40 kg ha^{-1} P_2O_5, 30 kg ha^{-1}-K_2O. Rainfed-40 kg ha^{-1}-N, 30 kg ha^{-1}	Drought tolerant having very limited water requirement. However for higher yield, irrigation can be given at 30-35 DAS (Active tillering) and at 60-65 DAS		

	less water than wheat.		ha^{-1} (rainfed) conditions; Spacing- 22.5cmx5cm.	P_2O_5, 20 kg ha^{-1}- K2O.	(Booting).		
Chickpea (*Cicer arietinum*)	It requires a loose and well aerated seedbed. Light soils, mostly sandy loams are preferred in Bundelkhand Region.	DCP 92-3, JG 16, KWR 108 & KGD 1168, GG-1, Pragati	last week of September to mid of October under rainfed condition; Seed rate- 75-80 kg ha^{-1}; Spacing- 30cmx10cm.	20 kg ha^{-1}-N, 40 kg ha^{-1} P_2O_5, 20 kg ha^{-1}-S, 25 kg ha^{-1} $ZnSO_4$. $7H_2O$.	Drought tolerant. For higher yield one irrigation can be given at pre flowering stage.	Pendimethalin 1.5 litres/ha as pre-emergence should be apply to control weeds.	Wilt resistant varieties are: JG 16, Vijay, JAKI 9218, JG 315, JG 74 and JGK-1 should be preferred in areas where wilt is a severe problem. Deep sowing, seed treatment with bavistin or Trichoderma and crop rotation reduces the wilt incidence. Spray of NSKE 5% / NPV 250 LE/Indoxacarb 500 ml/ha for controlling the Pod borer.
Lentil (*Lens culinaris*)	Lentil can be grown on all types of soils except the water logged soils	Jl3, DPL 62 and IPL406, Narendra masoor 100, L4076	2nd and 3rd week of October best time for sowing; Seed rate- 30 to 40 kg ha^{-1} (small seeds) and 50 to 60 kg seed ha^{-1} (large seed); Spacing- 30cm x 5cm.		Like chickpea, lentil is also taken without irrigation. However, one irrigation at the time of flower initiation/ pod formation stage increases the yield.		For wilt control measures are use of wilt resistant varieties, seed treatment before sowing with fungicides and crop rotation up to three years. Ploughing of field during summer season also help in reducing the occurrence of wilt disease.
Field Pea (*Pisum sativum*)	Field Pea can be grown on all types of soils except the	Prakash, Adarsh, Vikas, Ambika, Shikha,	Mid of October to mid of November; Seed rate-		Generally 2-3 irrigation are required; first at flower initiation stage & Second	Generally 2 to 3 weedings are necessary to keep the field free from weeds.	Powdery mildew is most severe disease so resistant varieties like Rachana, Hans, P 185, P 388 can be sown. Use of fungicide in

	water logged soils.	Indra, Aparna, Prakash	80 to 100 kg ha^{-1}; Spacing- 30cmx10cm.		at grain filling stage. Soil moisture deficit reduces growth and also hampers nodulation.	Pendimethalin 1.0kg ha^{-1} as pre-emergence	seed treatment and foliar spray reduces its incidence.
Rapeseed & Mustard (*Brassica* spp.)	Rapeseed-mustard crops are grown on sandy loam and clay-loam soils. Requires fine seed bed	Early sown- Kranti, NDRE-4, Pusa Mahak, Pusa Agrani, Pusa mustard 25 Timely sown- NRCHB 506 (Hybrid), DMH 1 (Hybrid), Coral PAC 432 (Hybrid), Maya, Vasundhara, Rohini, Basanti, Urvashi, JM 1, JM 2.	2^{nd} and 3^{rd} week of October best time for sowing; Seed rate- 4-6 kg ha^{-1}; Spacing- 30cm x 10cm.	40 kg ha^{-1}-N, 30 kg ha^{-1} P_2O_5, 20 kg ha^{-1}-S.	If water is available, two irrigations, first just before flowering and the second at the pod filling stage. In case of one irrigation, it may be provided at initiation of flowering.	Intercultural operations should be done 15-25 days after sowing of the crop. Pre sowing incorporation of 1 kg ha^{-1} a.i. fluchloralin (45 EC) or pre emergence application of Pendimethalin (30 EC) chemically controls the weeds.	Use Oxydemeton methyl 25 EC or Dimethoate 30 EC @ 625, 850 and 1000ml dissolved in 625, 850 and 1000 litres of water ha^{-1}, respectively in 3 sprays at 15 days interval.

Note-Seed of pulses should be treated with their respective *Rhizobium* culture @ 200g packet/10 kg seed.

5.3 Agroforestry models for income enhancement

Climate is an ever changing phenomenon. In recent past, the changes have been fast and erratic, therefore have drawn attention of every common man and being referred to as climate change. It is believed that climate change will lead to more extreme weather events that include heat waves, droughts, strong winds, and heavy rains etc. With this climate change, agriculture is worst affected, because majority of crops are unable to survive more than 15 days dry spell or heavy rainstorm. Although in nature, several herbal vegetation have adapted well to withstand such changes, and others have disappeared which could not adapt to. But, such adaptations are very slow and take generations' time. Cultivated crops are no exception, many varieties of important crops have disappeared, while many more new and more competitive varieties have been developed through selection and organized breeding programs. Recent developments in bio-technology have brought in hopes and speeded up development of varieties which can withstand not only insect-pest-disease attack, but also weather vagaries to a large extent and yield satisfactorily. Further, improvement in quality of agriculture produces by incorporation of specific quality gene from innumerable sources has proved bonus to nutritional security through crops.

In spite of genetic capability of crops to combat weather vagaries, there are ample chances of reaping good harvest from existing crop varieties through manipulation of cropping practices and systems. Role of management practices in enhancing crop productivity has been well documented. However, sustainability in agriculture is only possible when woody perennials are embedded into the system because they suffer least from climatic aberrations and withstand weather vagaries on account of woody nature. Further, AF provides shelter to companion crops against bad weather. Therefore, agroforestry stands as a perfect strategy to combat climatic aberrations.

Among all the weather vagaries, drought appears to be main culprit in crop production. The drought condition may arise due to i) rainfall below critical level, ii) delayed monsoon, iii) early cessation of rains and iv) long dry spells during active monsoon period. Based on above patterns, drought is classified in two categories i) agricultural drought (crop shows wilting symptoms due to very low soil moisture) and hydrological droughts (water not available in water bodies). Both kinds of drought affect life prospects, hence warrant attention for combating it.

Besides droughts, many other weather aberrations like untimely high rainfall, storm, high wind velocity, sudden rise in temperature, cold stress etc., and affect the crop yields. Due to commercialization of agriculture, the farmers want maximum earning, therefore they prefer monocropping, which is prone to high risk in this era of climate change. Crop diversification and agroforestry planning can be effective tools for combating not only droughts, but also other climatic aberrations. During February and March, 2015, there was unexpected rainfall in most of the area in the country, which caused huge loss to rabi crops like wheat, chickpea, pea, lentil etc., but mustard crop remained unaffected. It was observed that farmers who grew array of crops were less affected due to untimely rains. Similarly, presence of trees on croplands also mitigates ill effect of such incidences.

Agroforestry based crop diversification planning will be a win-win strategy for combating various weather aberrations. In agroforestry, trees reduce the soil erosion by

decreasing force of raindrop, lowering velocity of water. Leaf litter present on soil surface inhibits the evaporation losses and check weed growth, besides increasing biological activity in soil. Trees on boundary lower the wind velocity; hence problem of crop lodging is less under agroforestry system. Thus, agroforestry based crop diversification planning ensures assured income under all type of weather constraints. If one crop is damaged due to high rainfall or lodging or drought, then he can get income from other crops which are less prone to weather vagaries and production from tree (fuel wood, fodder, fruit, biomass etc.) as bonus. Under the situation when all the crops fail, the trees will give some income to farmers in terms of timber, fuel wood, fruits, fodder etc.

Diversified crop plan is done separately for both the seasons (*kharif* and *rabi*). This does not aim at maximizing production, but it aims at sustained production at optimum level. This is virtually a risk proof mechanism, which rests upon farmer centric planning.

Land use appropriation depends upon following considerations:

1. Water availability in well/pond/bore well. This is directly related to water table.
2. Family needs.
3. Soil type.
4. Resourcefulness
5. Market trends/access
6. Animal's need

Considering above factors, farmer should plan what proportion of land in a given season to be put under low water requiring crops, medium water requiring crops and luxuriant crops. With regards to agroforestry, fruit, fodder, fuel and timber trees must be accommodated either on bund or boundary. The selection of trees should be in tandem with soil type, climate and cropping system. This will ensure some returns and production even during worst affected years. Land use appropriation becomes essential in light of the fact that weather vagaries are uncertain and agricultural practices are time bound. Moreover, farmers in general, have low risk bearing capacity and as such it is not feasible to replace one crop by another in the same season.

Some of the land use appropriations for varying size of holding for arid and semi-arid areas have been given below for red as well as black soil for both (*kharif* and *rabi*) seasons based on our own experiences.

Selection of agroforestry systems:

Depending upon holding size, farmer can opt various agroforestry systems viz. boundary and block plantation. Boundary plantation must be followed, wherever land has consolidated. Boundary plantation must include long lived trees with wider canopy at wider spacing (10-20m) and tall plants with slender canopy in between. Thus, teak, mahua, neem, babul can be planted on farm boundary at 10-20 m spacing, whereas bamboo, eucalyptus, *Ingadulcius, Lawsonia alba* etc., in between trees on boundary, so as to form fence, mediate microclimate and delineate holding. Large farmer can go for block plantation of timber trees, energy plantations and orchards, besides field bund plantation. Small and medium must go for field bund plantation with suitable tree

species. However, field plantation of fruit trees, timber trees or industrial woody perennials (*Eucalyptus, Ailanthus*) can also be taken up. If irrigation facility exists, farmers can go for papaya cultivation along with vegetables and flower cultivation as they are quite remunerative.

Further, depending upon cash needs, farmers can go for teak, shisham plantation as long term investment and bamboo, fruit plants for continuous gain after four years gestation period. Homestead plantation of fruits and timber is must for every farmer to ensure nutritional security. On high fertile lands, fruit plants in rectangular system or paired row planting system should be adopted. Row to row spacing of tree is doubled or tripled, however plant to plant spacing is fixed as recommended for given fruit species. This ensure space for crop cultivation, conserves and optimizes utilization of natural resources viz., air, water, soil and makes best use of fertilizer applied to crops, besides mediating micro-climate.

5.4 Land Use Diversification for reducing risk

At present, the farmers concentrate mainly on crop production which is subjected to a high degree of uncertainty in income and employment to the farmers. Achieving more income from same land would be possible if the farmers considers agriculture as an enterprise. Integration of various agricultural enterprises *viz.*, cropping, animal husbandry, fishery, forestry etc. have great potentialities in the agricultural economy. These enterprises not only supplement the income of the farmers but also help in increasing the family labour employment.

Integrated Farming System is a viable approach to solve many problems coming on the way of livelihood of small and marginal land holders in India. The approach encourages organic farming and resource conservation which help in keeping environment clean and safe andagriculture more economic. Agroforestry based integrated farming system is one of the best option. Through integration of trees in the system, the risk bearing capacity of the system increases.

COMPONENTS OF INTEGRATED FARMING SYSTEM

1. Crop: monocrop, mixed/intercrop, multi-tier crops of cereals, legumes (pulses), oilseeds, forage etc.
2. Livestock: milch cow, goat, sheep, poultry, bees.
3. Tree: timber, fuel, fodder and fruit trees.

Hon'ble Prime Minister of India stressed the need to divide farming practices into three sectors, traditional farming, tree or timber plantation (along the periphery and borders of fields) and livestock rearing (Fig 3). IIFSR, Modipuram has developed an Integrated farming system for Western plains of Uttar Pradesh. The model developed on 1.5 hectare area comprises of crops (0.72 ha), dairy (0.32 ha), horticulture (0.22 ha), fishery (0.10 ha) and miscellaneous (0.14 ha) whichwas used for goat, apiary, vermicompost, threshing floor and farm building etc. In addition, fruit plants (Bael, jackfruit, aonla, jamun and citrus spp. Kagji Nimboo) were also planted all around the farm boundaries as wind breaks to protect the field crops and add in to income of the farm. At boundary of horticultural unit's *Carissa carandas* locally known as “karonda” was planted which served as live fencing and provided considerably high fruit yield (4-6q/year) as a bonus.

Besides fulfilling all the requirement of 7 members' household food and fodder demand (animals)inclusive cost of production, could create an additional average annual savings of ₹ 47000/- in first four years of its establishment and more than ₹ 50,000 in subsequent years. (Singh *et al*., 2011).

Different IFS models can be advocated for this region considering the needs and requirement of the farmers. The models will differ from each other based on the number of components and their arrangements (Fig. 4). The integrated farming system approach introduces a change in the farming techniques for maximum production in the cropping pattern and takes care of optimal utilization of resources. The farm wastes are better recycled for productive purposes in the integrated system. A judicious mix of agricultural enterprises for a given agro-climatic conditions and socio-economic status of the farmers would bring prosperity in the farming.

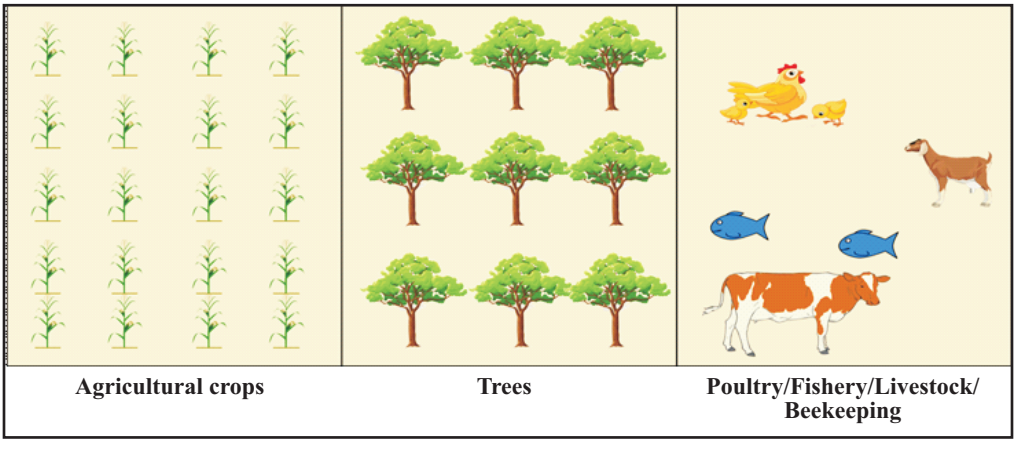

Figure 3: Income generation model advocated by the Prime Minister

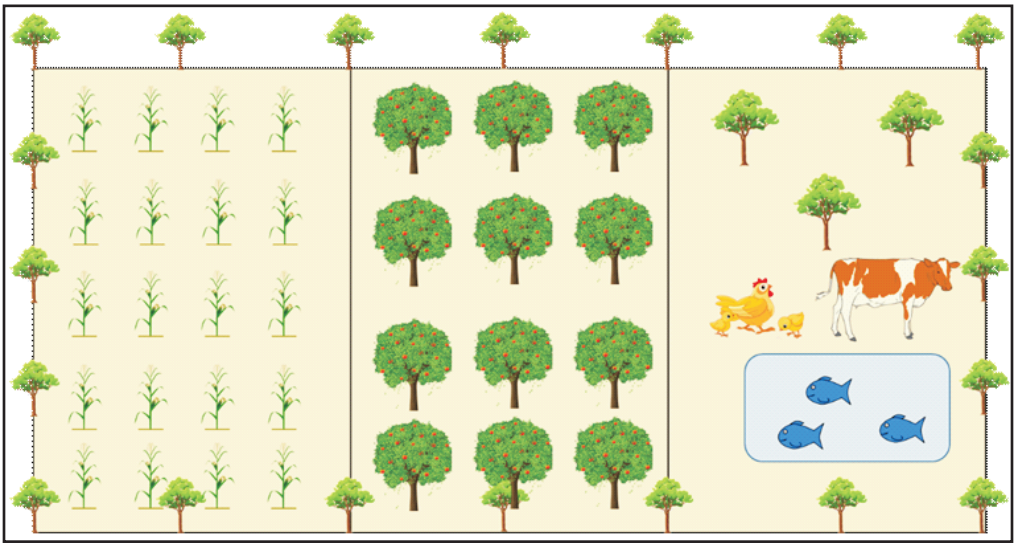

Figure 4: Integrated farming system model–II

5.5 Bee keeping and crop pollination to maximize farmer income

Crop pollinators are external agents that help in the pollination of crops. Prescott-Allen and Prescott-Allen (1990) have reported that over 75% of the world's crops depend on pollination. Morse and Calderone (2001) estimate that in the United States alone, honey bee contribute about USD 14.6 billion every year through pollination. Gallaiand Vaissière (2009) estimated the annual economic value of pollination services provided by insect pollinators to agriculture worldwide about EUR 153 billion (USD 193 billion). Pollinators visit the flowers of plants to obtain nectar and pollen, and in return pollinate them. This contributes for the higher crop production (Table 21). Farmer can get around 15-20 kg of honey from a single hive per year. A farmer markets honey at ₹ 100 per kg. A box of Indian bees costs around ₹ 5000/- while, Italian bees costs around ₹ 3000/-. Farmer can multiply as many number of colonies from a single box over a period of time. Economics involved in bee keeping mentioned in the Table 22.

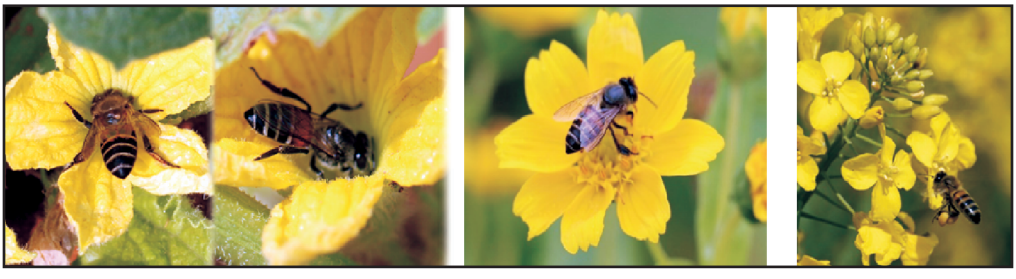

Figure 5 : Bees pollinating crops

Table 21: Table: Increase in crop yield from insect pollination (%) (Uma *et al.*, 2012)

Crop	Yield (%)
Citrus	7-233
Peas	39
Pigeon pea	10-15
Mustard	13-222
Rapeseed	100-133
Sesame	180-360
Groundnuts	20-30
Sunflower	21-3400
Linseed	20-50
Cucurbits	21-6700

Table 22. Economics of Bee keeping under Mustard cropping system in Bundelkhand region.

Category of farmers	First year			5th year			10th Year		
	No. of colonies	Cost incurred (₹)	Profit (₹)	No. of colonies	Cost incurred (₹)	Profit (₹)	No. of colonies	Cost incurred (₹)	Profit (₹)
Marginal (below 1 ha)	4-5	12000-15000	6000-7500	60	30000	90000	900	450000	1350000
Small (1.00-1.99 ha)	8-10	24000-30000	12000-15000	120	60000	180000	1800	900000	27000000
Semi-Medium (2.00 -3.99 ha)	10-12	30000-36000	15000-18000	150	75000	225000	2250	1125000	33750000
Medium (4.00 -9.99 ha)	16-25	48000-75000	24000-37500	240	120000	360000	3600	1800000	54000000
Large (10.00 and above)	>25	>75000	>37500	>240	>120000	>360000	>3600	>1800000	>54000000

Note: *Apis mellifera* colony costs around ₹ 3000. Every year three colonies can be multiplied from each colony. Multiplied colony expenditure around ₹ 500. Each colony produces an average of 15 kg of honey per year under Mustard cropping system. Market value of honey is ₹ 100 per year. Farmer should take care of bees during summer by providing artificial sugar syrup @4-5kg sugar per year per colony. Grow flowering plants on the field bunds to supply continuous food to the bees. Migratory bee keeping can be practiced to sustain bee colony during summer.

Figure 6: Bee hives and its honey

5.6 Goatary for marginal farmers

Goat rearing contributes the major share of the total farm income and provided livelihood security to the farm family in the poorly endowed arid region. Diversification and strengthened linkages among different components of the farming system had a synergistic effect on the functioning of the entire farming system and resulted in higher income. However, the farmers of the existing goat production need to be finely tuned with the modern goat rearing practices. The economics of goatary is presented in Table 23.

Table 23: Costs and returns from goat rearing in Rajasthan (₹/annum)

Particulars	Goat-based integrated farming system	
	I (Rainfed)	II (Partially irrigated)
Costs		
Fixed cost	2084	1978
Variable cost		
Feed and fodder (straw, pala, tree leaves, concentrate, oil)	3375	3006

Imputed value of family labour	7050	8410
Other expenditure (grazers charges, medicines, repairs, hiring of breeding male)	235	226
Total variable cost	10660	11642
Total cost	12744	13620
Total cost, excluding family labour cost	5694	5210
Paid-up cost per doe	531	440
Return		
Value of milk	8062	8819
Value of kids and other sold stock	12672	14742
Value of manure and income from buck	1453	1242
Gross return	22187	24803
Net return	9443	11183
Family labour income	16493	19593
Family labour income per goat	1539	1654
Income from goat per human day	117	116

Source: Sailendra Kumar and A.D. Upadhyay (2009) Goat farmers coping strategy for sustainable livelihood security in arid Rajasthan: An empirical analysis. *Agricultural Economics Research Review*, 22: 281-290.

5.7 Income generation from agriculture and allied activities

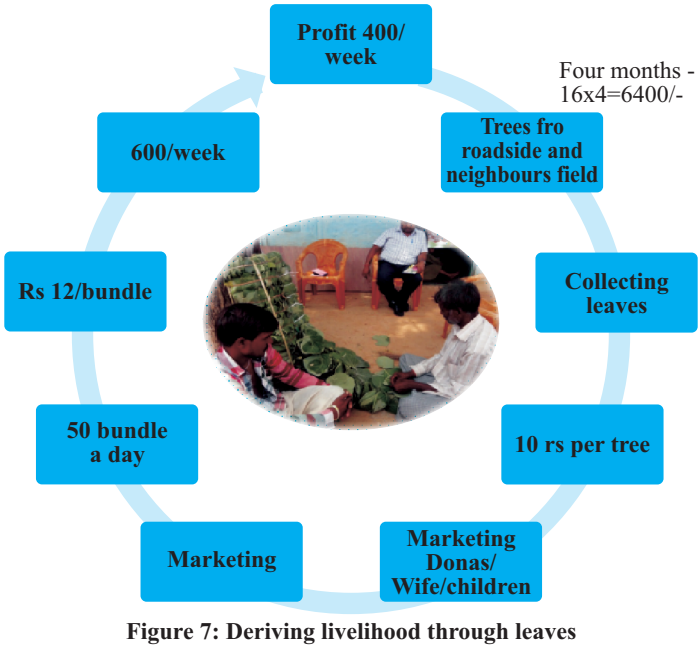

Figure 7: Deriving livelihood through leaves

The farmer, Kashiram hails from Gopalpura village, Jhansi. His profession is making donas. He heads towards Jhansi along with leaf bowls of 50 bundles which fetch him ₹12 per bundle and totally he will get ₹ 500 by selling all these bundles. He is in this profession since from ages. Even he told his parents, forefathers, and grandparents were

all in to this. He said, he has 15 trees in his farm and rest he will collect it from other neighboring fields and pay for it. Every fourth day a week he will go and distribute these leaves. The remaining days his entire family will spend on collecting leaves and making Dona and bundling. If he start integration of lac cultivation in all his trees it fetcheshim around ₹ 500 – 1500 per kilogram.

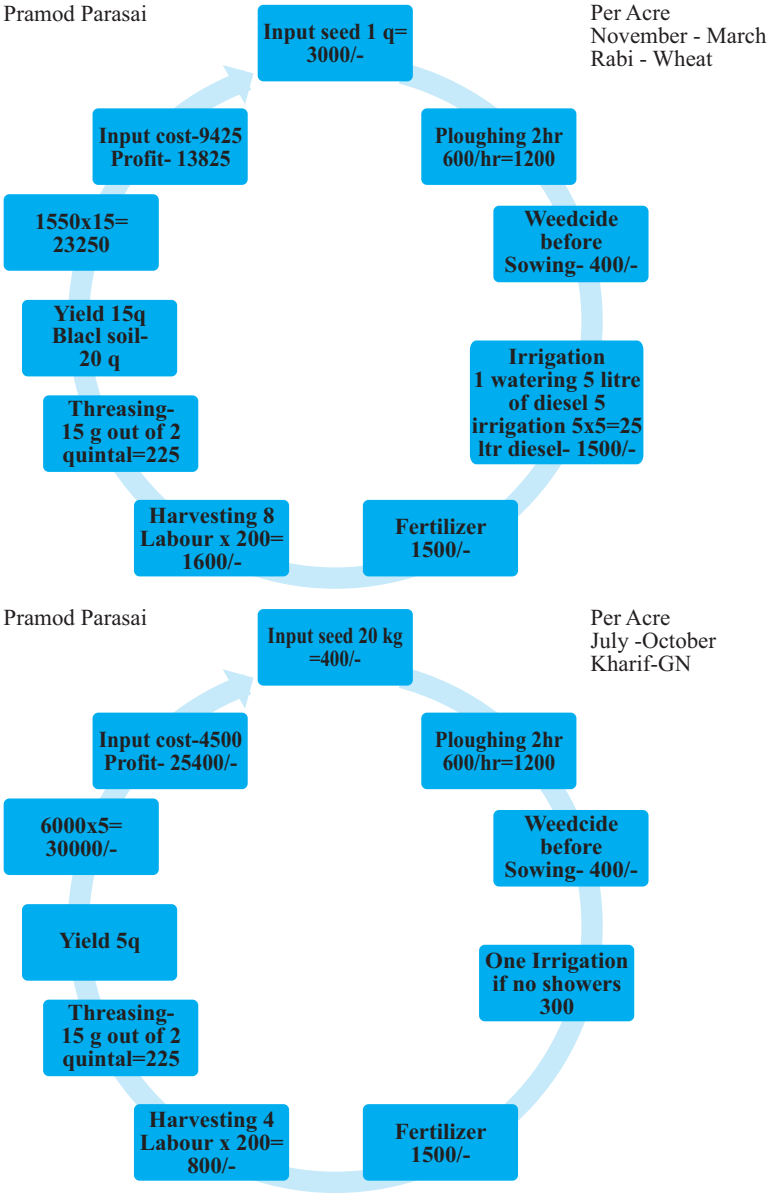

Figure 8: Existing expenditure and income from two croping seasons – *Rabi* and *Kharif* at Village Parasai, Jhansi

Shri Pramod hails from village Parasai, block Babina, Jhansi District. He takes two crop a year. In case of Rabi crop he cultivates wheat and earns a handsome profit of Rs 13825 as against his capital cost. In case of irrigation, he is irrigating his wheat crop for 7 times. That has to be reduced. He is an agriculture farmer and cultivates sole crop. There is need

to diversify his farm with integration of subsidiary activities. In case of *Kharif*, he cultivates groundnut. He earns an attractive profit of ₹ 25400. During the cropping season, if rain recedes, only once he irrigates groundnut crop.

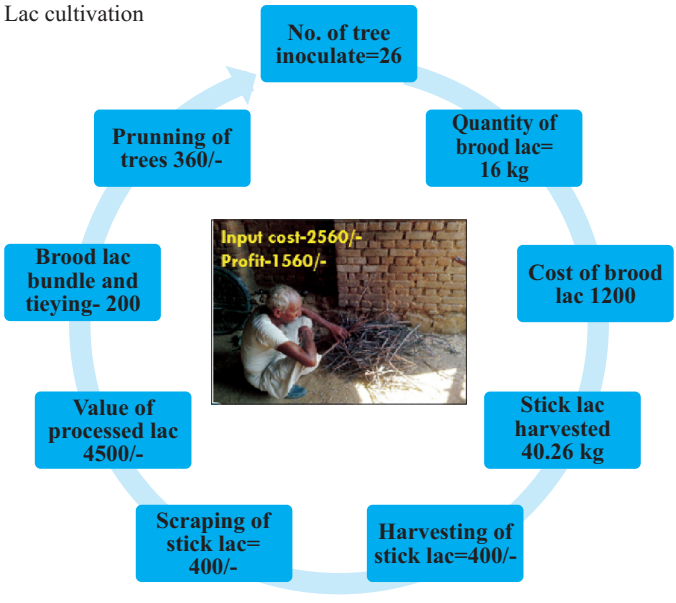

Fig 9: Deriving livelihood through lac cultivation

Shri Chandraban who hails from village Parasai, block Babina, Jhansi District of Central India. He has cultivated lac in addition to his main crops. The village has plenty of *Butea monosperma* trees on field boundaries. These can be utilized for lac cultivation. He has infected in nearly 26 trees. With minimal capital cost of ₹ 2560. He earns a handsome profit of ₹ 1560 through lac cultivation which adds to his main crop income.

5.8 Accurate weather forecasting for the field operations.

Bundelkhand region always remain in news for its harsh climatic conditions. Drought or drought like situation is a regular phenomenon of this region. Agriculture is the main livelihood of the inhabitants of Bundelkhand but the weather is certainly the most important factor determining the success or the failure of agricultural crops. A greater proportion of the total annual crop loss results from aberrant weather conditions *i.e.* late onset of monsoon, long dry spells (early and late season), untimely rainfall, excess rainfall and early cessation of monsoon etc. which force the farmers to prefer *rabi* crops as compared to *kharif* crops. Last few years, weather vagaries were also noticed in *rabi* crops i.e. wheat, barley, chickpea, pea, lentil etc and 50-90% loss were reported in these crops. Increasing use of high cost inputs and continuous failing of agriculture crops forced farmers to take loans from private or banks and ultimately farmers entrap in debts. It is estimated that weather accounts for approximately three fourth of the annual loss in farm production both directly and indirectly. However, these crop losses can be minimized substantially by adjustments through timely and accurate weather forecasts.

In the era of much erratic change in climatic pattern and successive droughts especially in the major parts of the country, weather based advisory and the SMS services related to

crop cultivation, is the need of the hour. There are numerous climate related risks related to drought, hailstorm, rainfall pattern, winds, frosts, floods and many more. In these circumstances, if the information related to such events could reach the farmers in time, it would be a blessing for the resource poor farmers especially in the Bundelkhand region. There are government call centers, free SMS services by state level agencies, mobile apps etc. They not only deal with weather related advisories but also give information on the crop prices in market, best management practices, method of input application, what to sown, when to harvest, credits information etc. Effective follow up of these services will definitely contribute in raising income of farming community of the region, and their risk for crop cultivation could be reduced substantially.

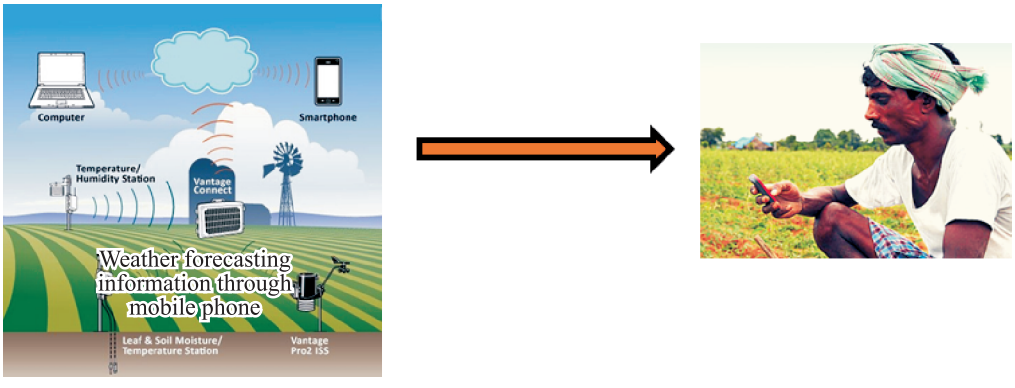

Figure 10: Effective dissemination of weather forecasting through ICT.

The information on specific rainfall related aspects of significance to farming such as late/early onset of monsoon, unequal distribution of rainfall, long dry spell during crop growing season, excess rainfall in peak flowering or harvesting season, untimely rains and inadequate amount of rainfall can be informed to farmers so that they can adjust field operations for maximizing benefits. For farmers and Extension Agencies like the Agriculture Department who provide crop management advisories, key decision points impacted by climate information are as listed in Table 24.

Table 24: Key decision points impacted by climate information

S.No.	Key decision points key	Climate variable that informs the decisions
1.	Time of sowing Onset of monsoon Choosing of crops/crop variety	Total rainfall and its intra-seasonal distribution
2.	Irrigation management - in terms of timing of irrigation and quantity of water to be applied	Total rainfall and its intra-seasonal distribution
3.	Resource Use Allocation - both labour and finance	Total rainfall and its intra-seasonal distribution

4.	Fertiliser application - the quantity and type of fertiliser as well as the timing of application of fertilisers on crops	Distribution of rainfall across the crop growth stages
5.	Timing of pesticide application	Wind direction, wind speed and distribution of rainfall across the crop growth stages
6.	Time of Harvest	Distribution of rainfall during the crop maturation stages

The currently short range, and medium range forecasts are given by the Indian Meteorological Department. Farmers can forecast information through television, radio, newspapers and SMSs on mobile phones. Officials of Agricultural Departments and KVK scientists can receive daily forecast information from the automatic weather stations and can disseminate to farmers through using information technologies.

5.9 Linkages in Agricultural processing and Marketing Channel

The income of the farmers also depends on the number of shareholders in the marketing channels. The research institutions will play key role in educating the farmers regarding the best technologies in crop production, processing and value addition and marketing of the goods (Fig 3). The farmers can direct by sell their produce to the agricultural processing industries through contract farming. Or they can sell their produce to middlemen who will in turn sell the produce to industries. In order to decrease the price spread along the channels, the middlemen has to be eliminated. Since majority of our farmers fall under the marginal and small category, their retention capacity and economic conditions are very poor. Nowadays, farmers are forming farmers group in order to sell their produce. Through the mechanism farmers are getting good price for their produce. Farmers group can also form a cooperative based agricultural processing industries and thereby directly market their goods.

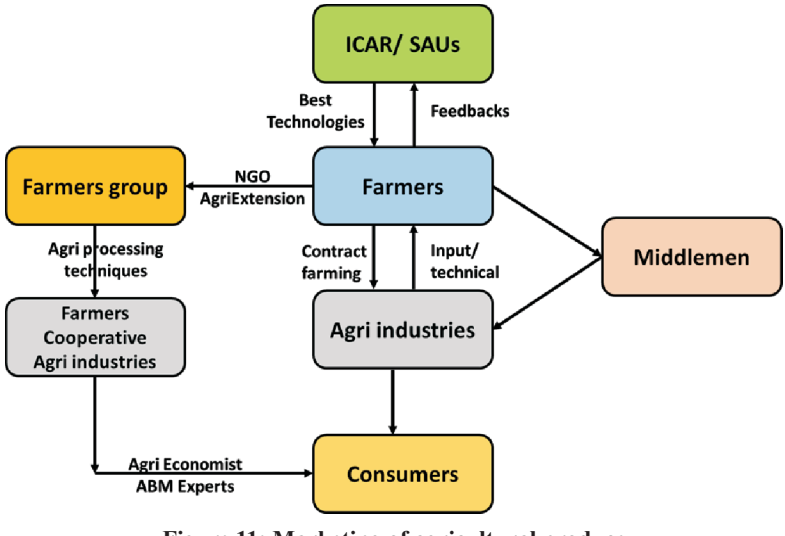

Figure 11: Marketing of agricultural produce

6. ICAR-CAFRI's role in the region for income enhancement

6.1 Boundary plantation of bamboo for income enhancement in Bundelkhand region

In the region, *Dendrocalamus strictus* is widely grown in forest, wasteland and field bunds but grows clumsy, as such, exploitation of single culm is difficult. *Bambusa vulgaris*, a hollow bamboo species planted on field boundary of Sh. Ram Singh S/o Sh. Sarman, village Hastinapur, Ambawai of Jhansi district (U.P.). 97 saplings were planted at 4.0 m spacing on field boundary in 2008. He harvested culms in 2015 and supplied to Forest Department, Datia (M.P.) and earned ₹ 1.15 lakh in addition to his routine crop cultivation. Bamboo cultivation along farm boundary acts as protection against stray cattle.

6.2 Natural resource conservation and agroforestry interventions in Garhkundar watershed boosted rural economy

Garhkundar watershed of 850 ha in Niwari Tehsil of District Tikamgarh (M.P.) was developed during 2006-2009. Consequent upon water harvesting in check dams, use of gabions in low order streams, *khadin* in depressions and field bunding particularly along water courses coupled with agroforestry development under teak, guava, citrus, aonla and crop demonstrations through improved variety of seed, balanced nutrition to crops resulted in 15-40% increase in crop yields, brought resilience to drought, increased ground water recharge and surface availability of water for irrigation and drinking. Consequent upon increased crop area due to regular water availability, fodder availability also increased. This resulted in high milk production, regular employment, reduced input cost in farming and improved socio-economic status of farmers. Average income of farmers has doubled in just 4 years. Vegetable cultivation in summer has further increased income of farmers. Due to increased cropping intensity, *Anna Pratha* of rearing cattle has been curbed and migration controlled.

6.3 Where there is a will there is a way

Sh. Himmat Ahirwar of Shivrampur, Tehsil Niwari, District Tikamgarh (M.P.) owns his land adjacent to forest. Due to heavy biotic pressure, he was unable to grow crop and trees. Sh. Himmat was determined to grow Aonla based agroforestry in his holding. He was motivated by ICAR-CAFRI, Jhansi and supplied with quality planting material

(Aonla var.NA-7 and seeds of Wheat var.WH147, Urd var. T-9). He fenced his plants using brushwood and planted *A.senegal* on boundary as live fence, irrigated plants in basin during summer through bucket and thus saved his plantation for initial 3 years. Now, fruit plants have gone beyond the reach of animals and he is getting fruit yield besides crop produce. The land use has not only doubled his income but also brought drought resilience to poor farmer of down trodden community.

6.4 Agroforestry brings back smile to Sh. Dhani Ram

Sh. Dhani Ram Kushwaha, a poor farmer from village Ubawca, Tehsil Niwari, District Tikamgarh owns 4.0 acre land which is red lateritic, sloppy with poor organic matter. His holding is near to forest area. A nallah passes through his holding. Gabion was used in nallah to check runoff water velocity. Field bunding was done across the slope. He was motivated to plant guava and citrus based agroforestry system in one acre each. Improved crop variety seed for *rabi* and *kharif* crop was provided to the farmer besides quality planting material of fruits (Allahabad Safed, Kagzi Lime, respectively). The land use and his devotion in field resulted in tripling the income from fruit and crops within 8 years.

6.5 Sh. Siya Tiwari could stop his children from migration and separation

Sh. Siya Tiwari of Kundar, Nai Basti, Tehsil Niwari, District Tikamgarh (M.P.) adopted guava based agroforestry in 1.2 acre and top worked 14 desi ber plants on field bunds. Within 3 years guava started bearing fruits while ber from 2nd year onwards. Increased income from fruit plants and crops (improved wheat var. Lok-I and Urd var.T-9) increased his returns from agriculture. He started cultivating vegetables in summer under agroforestry. As such, his two sons who were about to migrate to metros in search of job decided to stay back in village, look after farming and age old parents. One of his sons opened a petty shop in village itself and other one is looking after farming. Sh. Tiwari thanks agroforestry for saving his family.

6.6 Agroforestry interventions enhanced economy of Sh. Salim

Sh. Salim, village Shyamasi, Tehsil Niwari, District Tikamgarh (M.P.) is a small farmer. His holding is sandwitched between nallah and forest. He has one well near nallah. There were two check dams constructed in this nallah above and down side of his holding. His well is benefitted from these check dams. Sh. Salim earlier raised Colocacia during summer and wheat in rabi. He also cultivated groundnut in small portion of his holding. He was motivated to plant guava under agroforestry and crops in interspace in 2007. He was supplied with quality planting material of Aonla (L-49 variety) and crop seeds of wheat, ground nut. Due to continuous recharge in well, he is presently renting two times more agricultural land to tribal farmers and earn huge income. Guava plantation has brought resilience to climate change. Ground water recharge in well consequent upon water resource development in watershed has tripled his income.

6.7 Water resources and livelihood improved through people's participation

Participation of locals in development is key to success in watershed development programs. This fact was highlighted in Meta analysis of watershed projects throughout India. ICAR-CAFRI, Jhansi initiated a watershed development project "Parasai-Sindh Watershed" in Babina block of District Jhansi (U.P.) in year 2011. Complete plan was discussed with watershed dwellers. They were asked to form watershed committee and decide suitable locations for water harvesting, supervising the construction work for quality and procure raw material for construction. For productivity enhancement, they were asked to plan crop varieties and cropping pattern, crop mixtures in due consultation with scientific team of institute. This generated huge interest of villagers in development. Within a span of 4 years, 10 rain water harvesting structures were constructed. Two ponds were dug. One *Haweli* structure which had 8 ha submergence was repaired. Thus, a capacity of 1.25 lakh m^3 water storage in watershed was created. Field bunding was done. Construction work in terms of quality was excellent and 3 times cheaper than that implemented by other organizations. Water resource development resulted in cultivation of additional 60 ha area of watershed for the first time under wheat. Crop productivity of all farmers went up several folds. Farmers were motivated to plant teak on field bunds. More than 150 acre was brought under teak based agroforestry on farmer's field. About 70 households planted fruit trees in their homestead for nutritional security. Huge employment in farming was generated. Many farmers constructed brick houses after getting benefit from crop lands and purchased buffalo for strengthening dairy. Fodder crops area

increased in the watershed. Drinking water hardship was totally resolved and activities generated huge employment in farming and development activities. Income of farmers in watershed across the communities increased several folds. Such a dramatic change would not have been possible without active people's participation.

6.8 Rajveer's prosperity due to water resource development on watershed scale:

Sh. Rajveer Singh village Parasai, block Babina, District Jhansi is a humble farmer. His holding is about 1.0 km away from *haweli* pondage area. He could hardly make his ends meet from agriculture prior to repairing of *haweli*. He has one dug well in his holding. With a view to improve water resource in his holding he decided to dig one more well in his holding and borrowed 3.0 lakh from villagers and relatives. Consequent upon repair of *haweli* in village, his old well has enough water to support agriculture. He is growing crops in his total 5.0 acre holding as against earlier 2.5 acre only. He grows summer vegetables in about 1.0 acre. After getting benefit from agriculture, he diversified his farming and placed due emphasis on dairying. He now grows MP Chari in 1.0 acre and has purchased high milk yielding buffaloes. He is earning handsomely from dairy and agriculture. His income has gone up several folds within 5 years.

6.9 Fallow land brought to cultivation after developing water resources

In Parasai-Sindh watershed, village Parasai is located on the upstream side. The village is largely rainfed. As such, about 60 ha land on the fringes of watershed was lying uncultivated. This patch of land was occasionally cultivated during *kharif* under til. After repair of *haweli* structure in the watershed which stored around 75000 m^3 water, shallow dug wells in this patch were fully recharged. Farmers grew groundnut and wheat in this patch and harvested bumper crop for the first time. Sh. Kalyan Singh, ex-Pradhan of Parasai says that he never harvested grains from this patch in his lifetime. The cost of repair of *haweli* structure was recovered within a year from increased area under agriculture and bumper production. This clearly indicated that natural bounty of rainfall in the region is enough to support agriculture provided it is properly managed through storage and efficient utilization. Ground water has no discrimination. It benefits all in its jurisdiction.

Source: These success stories were the account from Garh Kundar-Dabar and Parasai-Sindh watershed developed by ICAR-CAFRI and documented in Tech. Bull. 1 and 2.

7. Conclusions and Recommendations

Agricultural development cannot take place without new innovations encompassing both land and labor productivity enhancement. Innovation cannot occur without the creation, accumulation, sharing, and use of knowledge. The involvement of farmers and other stakeholders and their network in this process is the key, and requires building their capacity so as to seek knowledge either in the form of information or new findings and process it into innovations. Research and technology alone will not drive agricultural development. The interaction between technology and policy is critical. The full beneficial effects of agricultural research and technological change will materialize only if government policies are appropriate. The removal of distortions in input and output markets, asset ownership, other institutional and market along with access of credit, infrastructure development are necessary for adoption of any new technology.

To take pressure of land, non-agricultural sectors must be strengthened in addition to improving agricultural productivity. Non-farm activities that involve technological innovation designed for higher productivity of land and labour. These activities must translate into higher profitability for the farmers at lower cost to the environment and must be compatible with the constrained resource position of the small farmers.

Since the area is prone to drought, hence rain water harvesting structures and effective micro irrigation techniques has to be strengthened for sustainable water utilization. Improvement in marketing efficiency through strengthening of supply and value chain in agriculture and allied sector is required for risk aversion and sustainable income for farming community particularly wood and Non Timber Forest products. To enhance the income of farmers specifically small and marginal there is need to integrate all the available scarce natural resources along with government policy towards agriculture development and region specific economically viable technology should be integrated in a holistic way.

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ACRONYMS AND ABBREVIATIONS

B:C Ratio	Benefit Cost Ratio
CAFRI	Central Agroforestry Research Institute
CS	Central Sector Schemes
DAY-NRLM	Deen Dayal Antyodaya Yojana - National Rural Livelihood Mission
DIPA	Directorate of Information and Publications in Agriculture
e-NAM	Electronic- National Agriculture Market
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GSDP	Gross State Domestic Product
GVA	Gross Value Added
HVC	High Value crops
ICAR	Indian Council of Agricultural Research
IIFSR	Indian Institute of Farming System Research
ILI	Integrated Livelihood Index
INM	Integrated Nutrient Management
MKSP	Mahila Kisan Sashaktikaran Pariyojana
NAIP	National Agriculture Innovation Project
NITI	National Institution for Transforming India
NMSA	National Mission for Sustainable Agriculture
NRAA	National Rainfed Area Authority
NRI	Natural Resource Index
NSSO	National Sample Survey Office
PKVY	Paramparagath Krishi Vikas Yojana
PMFBY	Pradhana Mantri Fasal Bhima Yojana
PMKSY	Pradhana Mantri Krishi Sinchai Yojana
RAPI	Rainfed Area Prioritization Index
RKVY	Rastriya Krishi Vikas Yojana
SAU	State Agriculture University
SDG	Sustainable Development Goals
SMAF	Submission on Agroforestry
TFP	Total Factor Productivity
UNO	United Nations Organization
USDA	United States Department of Agriculture

Swachh Bharat Abhiyan

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Darpan Printers & Lamination