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**Perception about changes in Climate and Potential impact of such changes on Ecosystems, Biodiversity, Agriculture and Livelihoods at local level in Jhansi district of Bundelkhand region of Uttar Pradesh**

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**Abstract**

India is the country of small farm holders. About 85 per cent farmers come under small and marginal farming categories. Stagnation in productivity and profitability of different enterprises, are posing serious challenges. Therefore, poor income of farmers especially farming youth is a matter of national discussion, which causes luring of farming youth to non farm sectors. On this background, purposively a study was conducted in Bundelkhand Region of U.P. to find out the perception of rural youth on Farming as well as grounding information regarding youth. Study reveals that participation of rural farming youth (up to 25 year age group) is declining day by day and marginal farming youth quits farming more as compared to small and large farmers. The average annual income of small and marginal farmer was less as compare to unskilled labour. About 92 per cent farmers practice farming due to lack of any other options, while near about 89 per cent farmers accept that farming is not beneficial, 88 per cent farming youth accept that poor income and poor living standard is responsible for luring rural youth to non farm sector. Study also showed an alarming situation that 92 per cent of young farmers have not adopted farming innovations during the last five years in their field as well as educated youth has not taken interest in farming. The present paper deals with data regarding perception of peoples at local level in Jhansi district of Bundelkhand region of Uttar Pradesh.

**Key-words:** Perception, Climate, Jhansi

**Introduction**

Climate change refers to the rise in average surface temperature on Earth. An overwhelming scientific consensus maintains that climate change is primarily due to the human use of fossil fuels, which releases carbon dioxide and other greenhouse gases into the air. The gases trap heat within the atmosphere, which can have a range of effects on ecosystems, including rising sea levels, severe weather events, and droughts that render landscapes more susceptible to wildfires. There is broad-based agreement within the scientific community that climate change is real. The U.S. Environmental Protection Agency, the National Aeronautics and Space Administration, and the National Oceanic and Atmospheric Administration concur that climate change is indeed occurring and is most certainly due to human activity.<sup>1-3</sup>

Climate change is projected to affect agricultural and natural ecosystems around the world, and there is no reason to expect that agroforestry systems will be spared. Like all other plants and animals, those existing within agroforestry systems will be exposed to temperatures that are higher than those of the past, to higher carbon dioxide concentrations and they may also experience changes in precipitation. These changes will probably affect all system components, and they may even modulate interactions between components.<sup>4-8</sup>

For all agricultural systems, appropriate adaptation to climate change requires an understanding of how well existing and potential future systems will perform in future climates. The development of tools and methods for reliable climate change impact projections on agricultural systems has therefore been a research priority for agricultural and climate modelers in recent years, and several robust crop models are now available for agricultural adaptation planning. Most of these tool development efforts have focused on annual crops grown in

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monocultures, for which climate change impacts can therefore be projected quite reliably.<sup>9-10</sup>

### Material and Methods

#### Sample collection and isolation of bacteria from soil

##### Study Area and Environmental setting

Jhansi is well connected to all other major towns in Uttar Pradesh by road and railway networks. The National Highways Development Project has supported development of Jhansi. Srinagar to Kanyakumari North-South corridor passes through Jhansi as does the East-West corridor; consequently there has been a sudden rush of infrastructure and real estate development in the city. A greenfield airport development has been planned. On 28 August, 2015 Jhansi was selected among 98 cities for smart city initiative by Government of India.

According to the 2011 census, Jhansi has a population of 505,693, its urban agglomeration a population of 547,638. The literacy rate of Jhansi is 83.02%, higher than the state average of 67.68%. The sex ratio is 905 females for every 1000 males. Jhansi city has 57th rank among the most populated cities of India, according to the 2011 census. According to the Indian Census of 200 there were 21,917 people in Jhansi Cantonment, of whom 56% were male and 44% female (men 12,264; women 9,653; children 2,612). The rate of literacy was 80%. Jhansi is located at 25.4333 N 78.5833 E. It has an average elevation of 284 metres (935 feet). Jhansi lies on the plateau of Central India, an area dominated by rocky relief and minerals underneath the soil. The city has a natural slope in the north as it is on the south western border of the vast *Tarai* plains of Uttar Pradesh and the elevation rises on the south. The land is suitable for species of citrus fruit and crops include wheat, pulses, peas, and oilseeds. The region relies heavily on the Monsoon rains for irrigation purposes. Under an ambitious canal project (the Rajghat canal), the government is constructing a network of canals for irrigation in Jhansi and Lalitpur and some part of Madhya Pradesh. The trade in agricultural products (including grain and oilseeds) is of great economic importance.

##### Data collection and compilation

For survey and collection of data, descriptive survey research design was utilized. One district- Jhansi, representative of Bundelkhand region was purposively selected for the study. From the selected districts 10 villages were selected considering potential impact of climate change in the area. Thus

total ten villages were studied. The sample respondents were drawn from selected ten villages randomly. In Jhansi district- Digara, Goramachia, Chhapra, Gadmau, Palar, Goraiya, Kochhabhawar, Kharaila, Kashipura and Amla village were selected. General information on number of households, their economic status, animal population, and literacy status of selected villages/blocks is given in results.

Door-to-door survey was done through personal interview with individual households (N - 100) covering various age groups and gender mixes, with emphasis on older persons. An open-ended questionnaire was designed to identify the evidences of changes in weather and climate for the past decade, impact of climate change on agriculture, biodiversity, animal husbandry and adaptation strategies. The respondents were interviewed personally by the investigator with help of a well structured interview schedule. Besides, in all these villages 2 or 3 focused Group consisting of at least five elderly farmers were interviewed to analyze and refine the perception of climate change and the adaptation strategies adopted by the farmers to cope up with these changes. Data collected focuses on farming status and its history, past memory of extreme climate events and their impact, and management responses to those adverse situations, present-day scenario and likely future consequences.

In focused group discussion which, consisted of at least five elderly farmers of the village, other farmers were allowed to participate and involve freely for refinement of information recorded on interview schedule. To know the adaptation strategies, detailed discussion was held with elderly persons of the village's focused group. Besides, representative soil samples were also collected from each village to assess organic carbon stock in the soil. All the refined information was compiled/analyzed and results were interpreted for conclusion.

### Results and Discussion

The primary cause of climate change is burning of fossil fuels, such as oil and coal, which emit greenhouse gases into the atmosphere—primarily carbon dioxide. Other human activities, such as agriculture and deforestation, also contribute to the proliferation of greenhouse gases that cause climate change. In India, Bundelkhand Region of Uttar Pradesh has been in the news for starvation suicide death, exploitation of people, mining of natural resources, land grabbing, rural migration, etc. This is one of the largest Region of Uttar Pradesh and consists of seven districts (Banda, Chitrakoot, Hamirpur, Mahoba, Jalaun, Jhansi and Lalitpur),

considered to be 'backward'. It suffers from extreme level of poverty and environmental degradation. This unique agro-ecological situation is best suited for rainfed agriculture including pulses. Hot climate, undulating topography, residual and low depth of soil and impermeable rock on the surface are the characteristics of this region. The economy of this region is mainly based on agriculture with traditional farming pattern. Due to soil conditions and lack of adequate irrigation facilities generally mono cropping is prevalent. Rearing cattle, buffalo, goat and sheep are common as per their purchasing capacity, needs and priority, with very low productivity.

But youth power is a big opportunity for this region and also for India. If educated youth choose to live in villages and launch the new agriculture movement based on the integrated application of science and social wisdom, our untapped demographic dividend will become our greatest strength. During his visit American President Barak Obama pointed out that India is fortunate to have a youthful population with over half of the total population of 1.2 billion being under the age of 30. Out of the 600 million young persons, over 60 per cent live in villages. Most of them are educated. Thus, major share of Indian agriculture is also in the hands of rural youth. With the shrinkage of the land holdings day by day and declining profitability in farms, large scale migration of rural youth to cities in search of employment is taking place, which is creating major concern to policy makers and the government. Luring of farming youth to non-farm sector is a greater challenge for sustaining growth of agriculture. According to A K Singh & Sarju Narain (2012), migration of rural farming youth from U.P. Bundelkhand is the major bottleneck in adopting agricultural innovations. The National Commission on Farmers (NCF) stressed the need for attracting and retaining educated youth in farming. On the basis of above background it is necessary that to collect the perception of rural farming youth on different farming aspects including future plan & option as well as know the present farming facts. For this purpose the study was conducted in Bundelkhand Region of Uttar Pradesh (India) with following objectives:

- To quantify the land holding pattern, age group, educational level and income of rural youth (upto 35 year age) involved in farming.
- To know the perception of farming youth on farming.

Table 1, represents the data regarding distribution of house hold in selected ten village viz., Digara, Goramachia, Chhapra, Gadmau, Palar, Goraiya,

Kochhabhwar, Kharaila, Kashipura and Amlia of Jhansi district of Uttar Pradesh. Maximum number of households were recorded in Kochhabhwar village with total of 12050 whereas the minimum number was recorded in Goraiya village with a total of 5 only. It was observed that percentage of OBC population is maximum in all the villages amongst other categories, with 78 percent OBC population in Goraiya village. Table 2, presents the data regarding economic status of total house hold in selected ten village viz., Digara, Goramachia, Chhapra, Gadmau, Palar, Goraiya, Kochhabhwar, Kharaila, Kashipura and Amlia of Jhansi district of Uttar Pradesh. Economic status of village having maximum BPL was recorded in Kochhabhwar village i.e., 1150 whereas minimum was recorded in Chhapra village i.e., 207. Kochhabhwar village was recorded to have maximum Non-BPL 10900 and Kharaila was recorded with minimum Non BPL with 199. Table 3, presents the data regarding Livestock population of selected ten village viz., Digara, Goramachia, Chhapra, Gadmau, Palar, Goraiya, Kochhabhwar, Kharaila, Kashipura and Amlia of Jhansi district of Uttar Pradesh. In this criterion the total number of livestock were recorded in each village. Amlia village had maximum number of cows i.e. 650, maximum number of buffaloes as well as maximum number of sheep / goats. Table 4, presents the data regarding literacy rate of block Jhansi. The rural literacy was found to be 85.77 % whereas urban literacy was found to be 85.77 %. Table 5, represents the data, regarding number of male, female and children in selected ten villages viz., Digara, Goramachia, Chhapra, Gadmau, Palar, Goraiya, Kochhabhwar, Kharaila, Kashipura and Amlia of Jhansi district of Uttar Pradesh. The maximum number of male were recorded in Kochhabhwar village (3200) and minimum in Kharaila village (120), whereas maximum number of female were recorded in Kochhabhwar (1824) and minimum in Kharaila (85). Similarly, maximum number of children are in Kochhabhwar (7025) and minimum in Kharaila (100). Table 6 presents the data regarding distribution of respondents according to their farming status of Jhansi district of Uttar Pradesh. In this study, size of farm, number of animals/farm, annual food grain production, total no. of trees/farm, total fruit yield and total fuel yield were recorded. Table 7, presents the data regarding dominant crop and tree species of Jhansi district of Uttar Pradesh. In this study total 12 crop and 12 tree species were illustrated and were presented. It was found that Mango was the most dominant agroforestry species whereas Ber was

second most preferred species while in case of crops, Wheat was the most dominant crop and the least preferred was Chick pea. Table 8, presents the data regarding soil character distribution of respondents according to their farming status of Jhansi district of Uttar Pradesh. In this study organic carbon, pH, EC, bulk density and available N were recorded. Table 9, presents the data regarding distribution of respondents to perceived impact of climate change on rainfall, temperature and wind of Jhansi district of Uttar Pradesh. In this study various parameters of monsoon were recorded. Variation in onset of monsoon with normal or no change was perceived by 9 % of respondent whereas 81% have perceived late monsoon. 86% respondents informed about early withdrawal of monsoon. Also, perception of deviation in rainy days and distribution over season. 48% perceived reduced rainy season and variations in rainfall intensity and frequency. 50% perceived alternate slow and fast rainfall. 20% of respondent have a perception of normal easterly wind while 63% perceived about increased dust storm and variations in seasonal winds. About 52% respondents perceived hot wind blow in summer while 44% perceived very hot wind blow in summer. 44% respondent's perceived unusual variation in season and perceived temperature in summer increasing and summer season has become unbearable due to rise in temperature. Variations in weather results in harmful effect and diseases in more increased 45% respondents perceived that tree/crop is badly affected whereas 99% respondents perceived that there is no beneficial effect of extreme weather events. Table 10, presents the data regarding perception of farmers about impact of climate change on phenological behavior of crop/plants of Jhansi district of Uttar Pradesh. In this study various phenological parameters of viz., flowering characters and fruiting status were recorded.

Farmers' perception about deviation in flowering time indicates that there is late flowering as 54 % respondents perceived the same. 34% respondents perceived low/less flowers where as 37% respondents perceived that shape/ size and smell changes in flowers. Variations and deviation in fruit bearing pattern, 80% respondents perceived the change and 50% perceived deviation in fruit shape / size /taste. 68% respondents perceived change in grain quality of grains/pulses/ cereals/ oil seeds. 60 % respondents perceived change in pattern food grain storage. Change in germination time of crop has been recorded as 45% and is normal as perceived by the respondents. Table 11, represents the data regarding

perception of farmers about impact of climate change on biodiversity of Jhansi district of Uttar Pradesh. In this study various biodiversity parameters of crop/plants were recorded. 30 % of farmers agreed to the fact that grass spp. like Anjan have disappeared, whereas 70% farmers revealed that crop like Bajra, Soybean, barley etc. have a disappearance rate.

However, incase of appearance of new crop plant species 36% farmers agreed that new grasses like Gajarghass, barseem, Lucern, other unknown speacies have appeared and though no new crop has appeared. As far as change in seasonality of plant species is concerned, considerable change has been observed by the farmers.

When the question about unusual change in growth behavior of any plant species was asked, maximum respondent i.e. 45% answered that no change was observed, whereas 32% have observed about slow growth and 14% answered about increased growth. Maximum number of respondents i.e. 52% agreed to the wild bird's disappearance, whereas 36% agree to the disappearance of the wild animals like Jackal, Hyena, and Fox. In case of appearance of new animals only 6% respondent named blue ball. While asking about deviation in behavior of animals, the maximum of farmers i.e. 56% replied about no change, while 28% said that domestic as well as stray cattle and stray dog have become more aggressive / notorious. For change in wild animals species behavior 26% farmers observed change in Jackal, 25% unwired for change in another animal. Table 12, presents the data regarding perception of farmers about impact of climate change on behavior of livestock/domestic animals of Jhansi district of Uttar Pradesh. In this study various parameters on behavior of cattle's were studied and recorded. As far as feeding habits of domestic animals are concerned, majority i.e 38% of respondents agreed that there is a trend of increased stall feeding whereas 20% agree to the point that there has been no change in feeding habit in last few years. When the question regarding changes in habit of first calving of cattle was asked maximum respondents (82%) replied that it has increased. For change in calving pattern of cattle maximum numbers i.e 44% replied that there is no change in calving pattern while 80% of the respondents have noticed an increase in milk production. Table 13, presents the data regarding adaptation strategies of farmers against climate change of Jhansi district of Madhya Pradesh. In this study various adaptations parameters such as weather and risk were studied and recorded. Data on adaptation strategies of farmers is presented in Table

14 for different climate adversities, farmers have evolved their own adoption mechanism for protection from extreme summers and winters. 26% farmers used thatched or kachha house while 60% used fan or coolers. Some of the respondents i.e. 02% used bamboo made hand fan to get relief from heat and 05% prefer to confine themselves inside house during extreme hot summer. Tree shelter was used by 07% of respondents for escaping from heat. Most of the respondent i.e. 65% used woolen clothes and fire to keep their bodies warm during winter season and extreme cold winters. For fire, fuel wood from Babool and Shisham were obtained from trees planted on farmland and used. For protecting animals from cold, 35% respondent used jute blanket made-up of old / used gunny bags (bardana). To minimize risk in crop production, majority 89% of respondents favored change in sowing time of different crops. Most of summer crops are sown on arrival of

monsoon, a sizeable selection section 11% of respondents have changed the cropping sequence to cope up with the climate change. All the farmers believed that adoption of agroforestry land is best remedy for minimizing farming risk in changing climate scenario. Planting trees on field boundary has been adopted by 80% of respondents while 20% have planted trees as block plantation. In agroforestry plantation, fruit bearing trees such as mango, guava, amla and ber are given preference. In addition, many farmers have planted fruit bearing plants in their home- yard / back-yard where protection from stray animals and irrigation are ensured. These fruit plants provide nutritional security to rural people, who most often do not purchase and consume fruits from market due to economic considerations.

**Table 1: Distribution of total households selected village**

S/No.	Village	Total	GEN%	OBC%	SC%	ST%
1.	Digara	4850	10	53	35	02
2.	Goramachhia	2200	12	50	32	06
3.	Chhapra	2050	10	65	25	00
4.	Gadmau	4050	20	25	55	00
5.	Palar	5250	22	55	23	00
6.	Goraiya	1230	05	78	17	00
7.	Kochhabhawar	12050	15	38	47	00
8.	Kharaila	305	45	50	00	05
9.	Kashipura	1700	20	40	40	00
10.	Amla	1800	30	30	40	00

Table 2: Economic status Total Households in selected villages

S/No.	Village	BPL	Non- BPL
1.	Digara	1117	3733
2.	Goramachhia	511	1689
3.	Chhapra	207	1843
4.	Gadmau	266	3784
5.	Palar	196	5054
6.	Goraiya	227	1003
7.	Kochhabhawar	1150	10900
8.	Kharaila	106	199
9.	Kashipura	623	1077
10.	Aqli	453	1347

Table 3: Livestock population in selected village

S/No.	Village	Cows	Buffaloes	Sheeps/Goats
1.	Digara	500	350	320
2.	Goramachhia	260	70	270
3.	Chhapra	220	475	230
4.	Gadmau	225	350	570
5.	Palar	65	550	825
6.	Goraiya	55	130	188
7.	Kochhabhawar	425	600	1350
8.	Kharaila	145	55	36
9.	Kashipura	600	1050	850
10.	Aqli	650	900	3500

Table 4: Literacy rate of studied block of Jhansi district

Block of Jhansi district	Rural literacy (%)			Urban literacy (%)			Total		
	M	F	T	M	F	T	M	F	T
Jhansi	83.19	88.35	85.77	83.19	88.35	85.77	83.19	88.35	85.77

**Table 5: Number of Male, Female and Childrens in villages of Jhansi district**

S.N	Village	Male	Female	Children
1	Digara	2650	1500	700
2	Goramachhia	1150	700	350
3	Chhapra	900	750	400
4	Gadmau	1825	1525	1150
5	Palar	1600	1175	2475
6	Goraiya	530	400	300
7	Kochhabhawar	3200	1824	7025
8	Kharaila	120	85	100
9	Kashipura	750	550	400
10	Amlia	700	580	520

**Table 6: Distribution of respondents according to their farming status**

S/No.	Farming Characteristic	Distribution	% Respondents	Total	Remark
1.	Size of farm holding (hec)	0 to 1	20		
		1 to 2	44		
		2 to 5	15		
		5<	21		
2.	Number of animals / farm (buffalo, cow, oxen, goat, & sheep)	0 to 5	51		More number of buffalo & goats than cows
		5 to 10	31		
		10 to 20	12		
		20<	06		
3	Annual food grain production (q/farm)	2 to 5	39		More production of wheat & Gram
		5 to 10	25		
		10 to 20	28		
		20 <	08		
4	Total number of trees/farm	5>	37		Mango & Guava is more dominant
		5 to 10	34		
		10 to 20	23		

		20<		06	
5.	Total fruit yield from farm trees	1>		39	More Yield of Mango & Gauva
		1 to 2		26	
		2 to 5		28	
		5<		07	
6.	Total fuel wood yield from farm trees	1>		25	
		1 to 2		35	
		2 to 5		28	
		5<		12	

**Table 7: Dominant crop and agroforestry tree species on farmer’s field in Jhansi district**

S/No.	Crop	S/No.	Tree Species
1.	Wheat { <i>Triticum astivum</i> }	1.	Mango ( <i>Mangifera indica</i> )
2.	Chik pea{ <i>Cicer aritinum</i> }	2.	Ber ( <i>Zizphus mauritiana</i> )
3.	Groundnut ( <i>Arachis hypogea</i> )	3.	Guava ( <i>Psidium guajava</i> )
4.	Black gram ( <i>Vigna mungo</i> )	4.	Aonla ( <i>Emblica officinalis</i> )
5.	Green gram( <i>Vigna radiata</i> )	5.	Jamun ( <i>Syzygium cumini</i> )
6.	Sugarcane ( <i>Saccharum officinarum</i> )	6.	Babul ( <i>Acacia nilotica</i> )
7.	Mustard ( <i>Brassica spc. </i> )	7.	Arjun ( <i>Terminalia arjuna</i> )
8.	Sesame ( <i>Sesanum indicum</i> )	8.	Neem ( <i>Azadirachata indica</i> )
9.	Lentil ( <i>Lens esculenta</i> )	9.	Mahua ( <i>Madhuca indica</i> )
10.	Pea ( <i>Pisum sativum </i> )	10.	Sissoo ( <i>Dalbergia sissoo</i> )
11.	Maize ( <i>Zea mays</i> )	11.	Bamboo ( <i>Dandrocalamus strictus</i> )
12.	Paddy ( <i>Oryza sativa </i> )	12.	Teak ( <i>Tectona grandis </i> )

**Table 8: Soil characteristics of farmer’s agroforestry field in Jhansi district**

S/No.	Soil Characteristics	Jhansi District
1.	Organic carbon	0.39
2.	pH	7.12
3.	EC	0.90
4.	Bulk density g/cm	1.05
5.	Available N kg/hect	282.4



**Table 9: Distribution of respondents according to perceived impact of climate change on rainfall, temperature and wind**

S.N	Perceived impact	Distribution of respondent	% of respondent total	Remark
1	Deviation in onset of monsoon	Early	01	Monsoon arrival is late
		Late	81	
		Normal/ no change	09	
2	Deviation in withdrawal of monsoon	Early	86	
		Late	04	
		Normal/ no change	10	
3	Deviation in rainy days and distribution over season	No variation	03	2-3 days intermittent dry period Number of rainy days reduced from earlier 40-50 to now 25-30
		Variation	22	
		Rainy days reduced	48	
		More difference in rain events/intermittent Long dry spell	28	
4	Change in rainfall intensity and frequency	No change	02	At starting rain intensity is more and slowly reduced thereafter
		Slow/less intensity	40	
		Fast/ more intensity	08	
		Alternate slow and fast	50	
5	Change in drought/ dry spells year	Drought for 1 year	00	
		Drought for 2 year	02	
		Drought for 3 year	66	
		Drought for 4 year	32	
6	Change in pattern of	Normal rain/ no	02	

	winter rain	change		
		Low rain	56	Rainfall in winter season has declined
		Very low	40	
		No rain	02	
7	Variation in winds speed and direction	Normal easterly wind	40	
		High speed easterly wind	18	
		High speed western wind	14	
		Normal wind	16	
		North east wind	12	
8	Change in pattern of dust storms	Dust storm increased	63	Earlier dust storm were less number which now increased
		Dust storm decreased	30	
		Normal/ no change	00	
		Other	08	Not certain
9	Variation of seasonal winds	No change	00	
		Hot wind blow in summer	52	In summer season hot wind blows
		Very hot wind blow in summer	44	Very hot wind blows in summer
		Other	04	
10	Unusual variation in seasons	No change	00	
		Very hot summer	50	
		Temperature in summer increasing	44	Summer season has become unbearable due to temperature increase
		More hot summer and more cold winter	06	No of cold days reduced but severity of coldness increased in winter season
11	Event of weather extremes	Increasing summer	92	
		Increasing winter	01	
		No change	07	

12	Harmful effect of weather extremes	Disease increase	45	Disease is more increased
		Tree/crop is badly affected	45	
		No change	10	
13	Beneficial effect of extremes weather events	No beneficial effect	99	Fruit is early mature
		Beneficial effect	01	

**Table 10: Perception of farmers about impact of climate change on phenological behavior of crop / plant**

S.N	Impact	Response of farmers	% of total respondent	Remark
1	Deviation in flowering time	Early	16	Flower arrival is late
		Late	54	
		Normal/ no change	10	
		Not timely	17	
2	Deviation in flowering intensity	Low/ less flower	34	Alternate flowering in mango tree
		Heavy / more flower	07	
		Normal/ no change	42	
		More flower but fall down	17	Flowering in guava is heavy but fruit set is minimum due to flower drop.
3	Change in flower shape / size /smell	No difference	22	
		Shape/ size and smell changed	37	Earlier time smell of mustard flower was very intense but now –days it has very light smell
		Smell flower	18	
		Less smell	23	Fragrance of mustard flower is reduced
4	Deviation in fruit bearing pattern	No change	20	
		Changed	80	In summer early and in winter

				late bearing
5	Deviation fruit shape / size /taste	No change	04	
		Small size	50	In comparison to earlier time fruit size of mango & ber has reduced. In hybrid variety of mango & guava fruits are large in size for 5 to 6 years & thereafter fruit size is reduced slowly and slowly
		Bad taste	26	Earlier time mango & guava, ber fruit tasted sweet but now taste is not god due to increase in temperature & lack of rain fall
		Change in taste	20	The taste of jamun is changed. Gives more dryness in throat
6	Deviation in maturity duration of crop	No change	00	
		Early	52	Wheat & chickpea mature early due to increase in temperature & deficiency of water
		Late	48	
7	Change in keeping quality of fruit / vegetables	No change/ normal	04	
		Easily decay	62	Easily decay of tomato and pea within 6 to 8

				days
		Less decay	30	Less decay of potato and onion
		Other	04	
8	Change in grain quality of grains/pulse/ cereals/ oil seeds	Grain size reduced	68	Grain size of soybean reduced due to deficiency of water
		Changed grain shape	60	The grain of wheat shrunk
		Decrease in oil content	16	Reduction of % oil in mustard
		Increase in oil content	05	
		Normal	05	
9	Change in pattern food grain storage	Use iron tank	30	Earlier food grain was stored in clay-made bins
		Use jute bag	60	
		Other	10	
10	Change in sowing or harvesting time of crop	Normal sowing	18	
		Early sowing & late harvesting	10	
		Late sowing & early harvesting	50	
		Late sowing & late harvesting	22	Late sowing & Late harvesting of paddy due to rainfall variation
11	Change in germination time of crop	Normal	54	
		Early	22	Early germination in pea
		Late	24	
12	Change in productivity of crop/fruits/vegetables	Normal/ no change	00	
		Food grain decreasing	76	Paddy & mustard production declining
		Vegetable decreasing	12	Production of tomato is

				decreasing
		Increasing	12	

**Table 11: Perception of farmers about impact of climate change on biodiversity**

S.N	Character	Response of farmers	% of farmers	Remarks
1.	Disappearance of existing crop/ plant species	Grasses	30	Anjan, Besram, Krashan neel
		Crop	70	Bajra, Soybean, barley, lentil, ghamra, kakun, kodon
2.	Appearance of new crop/ plant species	Grasses	36	Gajarghass, barseem, lusarn other unknown grasses
		Crops	00	No new crop
		No change	64	
3.	Change in seasonality of any plant species	No change	100	
		Changed	00	
4.	Unusual change in growth behavior of any plant species	No change	45	
		Not observed	08	
		Slow growth	32	
		Fast growth	14	
5.	Appearance / disappearance of any wild animal	Disappearance of wild birds	52	Cheel(hawk), Vulchur(giddh), Peacock
		Disappearance of wild animals	36	Jackal,hyena fox
		Appearance of new birds	06	Unknown
		Appearance of new animals	06	Blue ball
		Normal/ no change	00	
6.	Deviation in behavior of animals	Normal/ no change	56	
		Become more aggressive/notorious	28	Domestic as well as stray cattle & stray dog
		Become more friendly	16	Stall fed domestic animals

7.	Change in wild animal species or behavior	Normal/ no change	10	
		Change in stray dog	26	More barking in night, size has become small
		Change in jackal	25	Running slow, not living in group, create more noise in night, became more scafy
		Change in other animal	25	Now more frequently visible in village
		Become more notorious	14	Damage more crop in groups and tree planting

**Table 12: Perception of farmers about impact of climate change on behavior of livestock / domestic animals**

S.No	Character	Response of farmers	% of farmers	Remark
1.	Change in feeding habit of domestic animals	Normal/ no change	20	
		Increase in stall feeding	38	Cow & buffalo stall fed
		Decrease in grazing/browsing	19	Cow, buffalo and goat
		Both stall feeding and grazing/ browsing have increased	23	Cow, buffalo and goat
2.	Change in age of 1st calving of cattle	No change	08	
		Age of 1st calving reduced	10	Heifers of cross bred animal come early(2-3 years) in calving
		Age of 1st calving increased	82	Earlier about 3 year now more than 3 years(3-4 year
3.	Change in calving pattern of cattle	Normal/ no change	44	
		Changed	30	Veterinary doctor to be consulted as complications at the time of calving are increasing
		Increase in calf death	26	

		rate		
4.	Change in milk production	No change	00	
		Decreased	20	
		Increased	80	
5.	Unusual behavior of poultry	Do not domesticate	72	Rearing of poultry is not in practice
		Increase pollution	28	

**Table 13: Adaptation strategies of farmers against climate change**

S.No.	Vulnerability / risk factor	Adaptation strategies	% of total respondents	Remark
1	Hot weather	Use Thatched or kachha house	26	
		Use fan/coolers	60	
		Remain inside house	05	
		Use bamboo made hand fan	02	
		Use tree shade	07	In summer season villagers take shelter under neem trees
2	Cold weather	Use of woollen cloth and fire for human	65	The fuel wood from babool & shisham is used to make fire for protection from extreme winter
		Use of jute blanket made of old bags for animals	35	
3	Minimizing risk in crop production	Changing sowing time	89	Sowing of paddy depends on rain
		Changing cropping sequence	11	
4	Minimizing farming risk through agroforestry	Planting tree on field boundary	80	Preference is given to fruit trees like mango and guava
		Planting trees as block plantation	20	



### Conclusion

The present study entitled “Farmers’ Perception about changes in Climate and Potential impact of such changes on Ecosystems, Biodiversity, Agriculture, and Livelihoods at local level in Jhansi district of Bundelkhand region of Uttar Pradesh” was conducted in Jhansi during January, 2017 to February, 2017. The research findings in details have been discussed in previous chapter. A summarized conclusion is present below:

The survey manifested that local communities in the Jhansi district of Bundelkhand seem to have extensive knowledge and clear cut perception about climate change and its impacts on agriculture, animal husbandry and biodiversity. Moreover their knowledge confirms to the findings generated by other studies in different parts of the country.

Delayed onset early withdrawal of monsoonal rains, decrease in number of rainy days, increase in dust storm and droughts, temperature and extreme weather events in summer as well as in winter have multitude of impacts on livelihood and biodiversity of the region.

Deviation in flowering time, flower intensity, shape, size and smell of flower, fruit bearing pattern, and shape, size, and taste of fruits have been observed. In crops change in maturity time, quality of grain, sowing and harvesting time and yield is indicated. Decline in productivity of all crops was unanimously felt by the villagers.

The biodiversity of the area has been changing for some time and being manifested in disappearance/appearance of certain crop, grasses, wild animals and birds and unusual behavior of animals.

The livestock production system appears to be at risk due to changing weather and climate. In comparison to earlier time, now there is increase in stall feeding, age of heifers to reach at 1<sup>st</sup> calving, complications in calving process resulting in more death of new born calves and decrease in milk production.

Based on their own knowledge and skills, farmers in study site have taken some adaptation initiatives for minimizing risk in farming activities, livestock production and coping up with extreme weather events. Modification in sowing time of crops and cropping sequence according to monsoon rain, and adoption of agroforestry land use by planting trees on field boundaries and home yard are the main adaptation strategies in the study area.

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