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Climate Change and Food Production in Fatehpur District of Ganga-Yamuna Doab, Uttar Pradesh

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Abstract

The goals of sustainable development are to end hunger, achieve food security and improve nutritional status. Food security is dependent on agriculture in two ways: firstly, it ensures the supply of food grains and secondly, provides the livelihood for 36% (source) of the total workforce. Agriculture, in turn, is dependent on climate. Therefore, climate change, implying any alteration in parameters such as temperature and humidity, govern crop growth and therefore has a consequential impact on the quantity of food grains produced, gradually affecting the food security of a region. With this chain of understanding, an attempt has been made in this paper to analyse the impact of climate change on agricultural production in Fatehpur district of Ganga-Yamuna Doab, a region that experiences challenges for food security due to both low agricultural production and lack of nutritious food. Secondary data has been used in the context of food security of the area.

Keywords: climate change, vulnerability, food production, food accessibility, food security,

Introduction

Climate change and food insecurity are twin challenges which need to be addressed together. Climate change, now an almost globally accepted phenomenon, has significant implications for agriculture and food security creating new risks and exacerbating existing vulnerabilities from the local to the global level. Climate change can affect all dimensions of food security, owing to its impacts on both agriculture and livelihoods. The process is more likely to affect people belonging to the vulnerable groups in any region. The Fatepur district of the Ganga Yamuna Doab region of Uttar Pradesh has many reasons to be worried about because of its dependence on multiple climate-sensitive sectors like agriculture, forestry and fishing. If not addressed in time, the existing problem of food insecurity in the region will become more severe with time. It will become more difficult since more than the one-third population of the region is estimated to be extremely poor and one-half of all children malnourished in one way or another (Dev and Sharma, 2010).

Having briefly mentioned the complexity and the severity of the process, it is relevant to understand each aspect in greater detail. To begin with, Climate change refers to long term changes in average weather conditions (WMO usages); implying all changes in the climate system, and their effects (GCOs usage). Though climate change undoubtedly is a

globally accepted phenomenon, its manifest through increasing mean surface temperatures is likely to vary by location, which in turn shall have a diverse impact on crop growth (Leff, Ramankutty and Folley, 2004). For example, moderate warming (increase from 1°C to 3° C in mean temperature) is expected to benefit crop and pasture yields in temperate regions while in tropical and seasonally dry regions, it is likely to have negative impacts particularly for cereal crops (FAO Rome, 2008). Warming of more than 3° C is expected to have a negative effect of production in all regions (IPCC, 2007). Climate variables such as temperature, rainfall, soil moisture and radiation crops have threshold values beyond which growth and yield are compromised (Porter and Semenov, 2005).

Environmental, social, political and economic drivers affect the food system. This is because; food systems follow the sequence of production, processing, distribution and consumption. Therefore, in a narrow sense, a food system is a set of activities from production through to consumption. The Food and Agricultural Organization (FAO) suggested that an increase in average global temperature of just 2^0 to 4^0C above pre-industrial levels could reduce crop yields by 15-35% in Africa and Western Asia and by 5.35 % in the Middle East (FAO, 2008).

Despite fast economic growth and piling of foodstuff in the government's go-downs, India is home to the largest number of hungry and deprived people in the world, to be precise 360 million undernourished and 300 million poor people (FAO 2001). Therefore, sustaining the supply of food itself is emerging as a critical issue. Growth in food grains production is slow. During 1996-2008 it increased by just 1.2% per annum. The net food grains availability has declined from 510 grams per day per capita in 1991 to 443 grams per day per capita in 2007 (Dev & Sharma,2010). It affects poor people the most, as they have little access to the more expensive fruits, vegetables, poultry and meat products. This situation is more pronounced in central and eastern India. The study region has 87% population in rural areas which are predominantly agricultural. A good share of the population (74% of the total population is agricultural) is dependent on subsistence farming that requires long hours of hard labour out in the open and unprotected from the sun. The area's long struggle with hunger and food insecurity has become tougher. Poverty and region-based vulnerabilities are therefore key explanatory aspects of the larger process that connects climate change to food systems. This paper is therefore an attempt to understand the impacts of climate change on food security in Fatehpur district of Ganga-Yamuna Doab.

The study area

Fatehpur district is a part of the Middle Ganga Plain and it lies between $25^0$80'00" N. and 26^0 15' 00"N Latitude and 80^0 14' 00" and 81^0 20' 00"E Longitude. It has an area of 4152 sq. km. and administratively divided into 3 tahsils and 13 blocks. As per 2011 Census, the district's total population was 26, 32,733 of which males were 13, 84,722 and 12, 48,011 were females. The share of rural population to the total population of the district was 87.8%. The total decadal growth rate (2001-2011) was 14.05%. The growth rate of the male population was 13.54% while of female 14.62%. The area's population density is 634 persons per sq. km. while the sex ratio is 901 females per 1000 males. The district is situated between two important cities, Allahabad and Kanpur. It lies in the fertile land of Ganga and Yamuna. National Highway 2 (NH-2) passes through the city. The main drainage of the district belongs to the Ganga river system of which river Yamuna and Rind are tributaries (Figure1).

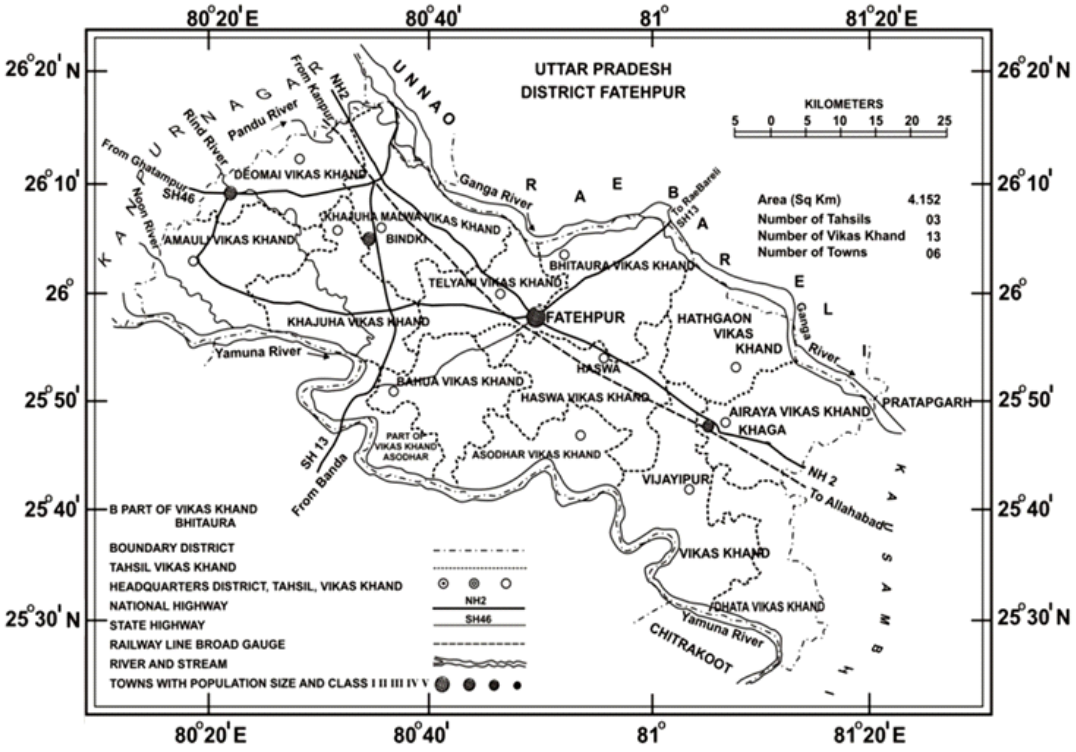

Figure 1: Location and extent of the study area

Sources of data and methodology

The secondary data has been used in designing the study. District's Statistical Magazine (Arth Evam Sankhyadhikari Fatehpur, Uttar Pradesh) provides data regarding food grains production and irrigation. These data are analyzed in the table and illustrated with graphs. Rainfall, temperature, and groundwater level fluctuation data have been collected from agricultural reports of Krishi Vigyan Kendra, Fatehpur unit of C.S.A. University Kanpur. The data of per capita nutritional intake and expenditure of broad categories of goods and services have been collected from Khadya Prasanskaran Sansthan, Lucknow.

The climate of the study area

The average annual rainfall in the study area is 932 mm. The climate is sub-humid punctuated by long and intense summer and mild winter. About 90% of annual rainfall is received from the south-west monsoon. May is the hottest month with temperature shooting up to 46.5^{0}C. January is generally the coldest month when the temperature drops down to 8^{0}C and occasionally even up to around 4^{0}C. The highest relative humidity is experienced during August (93%) and the lowest is 55% during May (Table 1).

Fluctuation in water level

Water level/table fluctuates is the result of recharge the aquifer and the withdrawal from the aquifer. The quantity of fluctuations is shown in the above table-3. A recharge takes place mainly during the rainy season. The minimum depth of water level in an area is expected sometimes at the middle or end of the monsoon period depending upon the intensity

Table 1: Temperature & Humidity of District Fatehpur, 2014-15

S No.	Month & Year	Maximum (in Centigrade)	Minimum (in Centigrade)	Humidity in %
1	April 2014	41	16	56
2	May 2014	42	19	55
3	June 2014	44	26	68
4	July 2014	41	23	68
5	August 2014	37	25	93
6	September 2014	37	24	84
7	October 2014	35	17	81
8	November 2014	31	9	60
9	December 2014	29	5	58
10	January 2015	22	4	78
11	February 2015	32	9	74
12	March 2015	32	11	68

Source: Rainfall Statistics of India 2015-16, Krishi Vigyan Kendra Fatehpur, of CSA, Kanpur

Table 2: Month-wise Rainfall in District Fatehpur (in mm)

S No.	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2004	28.9	0.0	0.0	2.2	1.5	59.9	93.4	145.4	168.2	59.0	0.0	0.0
2	2005	10.5	0.5	20.5	0.0	2.6	88.0	208.4	189.2	95.1	0.0	0.0	0.0
3	2006	0.0	0.0	10.7	0.0	13.2	43.3	228.2	87.5	55.7	7.3	8.1	0.0
4	2207	0.0	57.8	7.1	0.0	0.7	56.9	115.2	115.8	60.4	1.1	0.0	3.3
5	2008	0.0	0.0	0	0.0	2.2	219.5	431.0	229.3	109.9	5.8	11.4	0.0
6	2009	2.8	1.8	2.0	5.2	31.2	10.7	179.4	204.4	135.1	86.4	17.2	6.8
7	2010	2.2	22.1	0	0.0	0.5	14.2	148.8	166.9	139.0	25.0	20.7	0.5
8	2012	39.2	14.0	0	1.4	0.0	10.0	360.7	195.1	123.2	0.0	0.0	0.0
9	2014	16.7	11.6	44.5	0.0	0.0	23.6	100.7	39.8	58.4	33.4	0.0	21.7
10	2016	6.2	0.0	28.2	0.0	5.4	61.5	234.8	163.8	74.5	24.2	0.0	0.0

Source: Sankhyikiy Patrika, Fatehpur, 2017

and duration of the rainfall as well as soil characteristics and maximum depth to water level is expected to be just before the rainfall. The part of the rainfall in the initial period goes towards meeting the soil moisture as well as to saturate the evapotranspiration loss.

Annual seasonal fluctuation of water level has been determined from pre-monsoon (May 2012) and post-monsoon (Nov. 2012) water level data of groundwater monitoring wells. The fluctuation varies from minimum 0.065 to maximum 19.258 meters below ground level at Naubasta and Barwa places respectively. In the study area, Naubasta place had the lowest fluctuation, because, it is situated near Yamuna River in the southwestern part, so the water level is high in both seasons. While Barwa place is situated far away from both river Ganga and Yamuna, in the heart of the Fatehpur district and the water level is very low during

Table 3: Ground Water Level and Fluctuation, 2012

	Fatehpur	Pre Monsoon	Post Monsoon	Fluctuation
	Well Name	MBGL	MBGL	Meter
1	Asother	3.57	2.30	1.27
2	Bahua	11.67	9.02	2.65
3	Barwa	26.80	7.52	19.28
4	Bela	4.10	2.95	1.15
5	Bindki	9.90	6.55	3.35
6	Deori Chhoti	23.67	21.96	1.71
7	Fatehpur	11.00	8.22	2.78
8	Gazipur	-	10.00	-
9	Jahanabad	2.75	17.22	2.53
10	Lalauli	13.42	12.77	0.85
11	Musafha	6.79	4.72	2.70
12	Naubaste	12.19	11.34	0.65
13	Rampur	14.50	-	-
14	Sarai Bakewar	3.45	2.27	1.18
15	Thariyayan	14.89	13.80	1.09
16	Umradipur	7.32	5.07	2.25

pre-monsoon so the fluctuation is apparently on the higher side. A perusal of the table shows that there is a falling trend during the post-monsoon period in all the wells. The range of decline of 0.0124 mts/year was minimum at Asothar Block and the maximum was 1.0131 mts/year at Jahanabad in the Block Deomai. About 91% of the wells showed a declining trend.

Climate variability and food grains production

Climate change imperils like drought and floods (Table 2) are a challenging task for food production in the area. The impact of climate change on water availability will be particularly severe for study area because large parts of the area already suffer from water scarcity. It is important to note that the climate-sensitive sectors and the natural resources (groundwater, soil, biodiversity etc.) are already under stress due to population pressure. Climate change is likely to exacerbate the degradation of resources and condition of people. Climate variability factors like temperature, rainfall, soil moisture, radiation and crop rotation controlled the production of food grains in the study area from 2013 to 2016. The data of food grains production in the study area is given in the following table 4 and figure 2.

The production data shows that during 2014-15 the production of all crops had decreased, due to scanty of rainfall 23.6, 39.8 and 58.4 mm. in June, August and September respectively; whereas in 2016 the rainfall increased to 61.5, 234.8, 163.8 and 74.5 mm. in June, July, August and September and resulted in increased food grains production. The study region was announced as the drought-prone area in 2014, consequently, financial aid was given to the farmers.

Area's soil is most suited for the cultivation of food grains particularly wheat and rice. The production of wheat is done in the Rabi season when the rainfall is limited. Because of this

Table 4: Area and Production of Crops

Year/Crop	2013-14			2014-15			2015-16		
	A	I	P	A	I	P	A	I	P
Total Foodgrains	282093	261839	8350140	290872	272356	5497520	290872	272356	6468740
Total Pulses	73686	6490	429530	70803	6744	170700	70803	6744	358820
Total Oilseeds	25221	11338	141640	26691	10855	93330	26691	10855	120390
Commercial Crops	16319	9787	6766190	17338	10069	1991930	17336	10571	6559920
All Vegetables Crops	15645	14909	15687500	16182	15512	12193850	16182	15512	13527870

Source: District Census Handbook, Fatehpur, 2014-15, 2015-16, 2016-17
(A - Area in Hectare, I - Irrigated Area in Hectare, P - Production in Quintals)

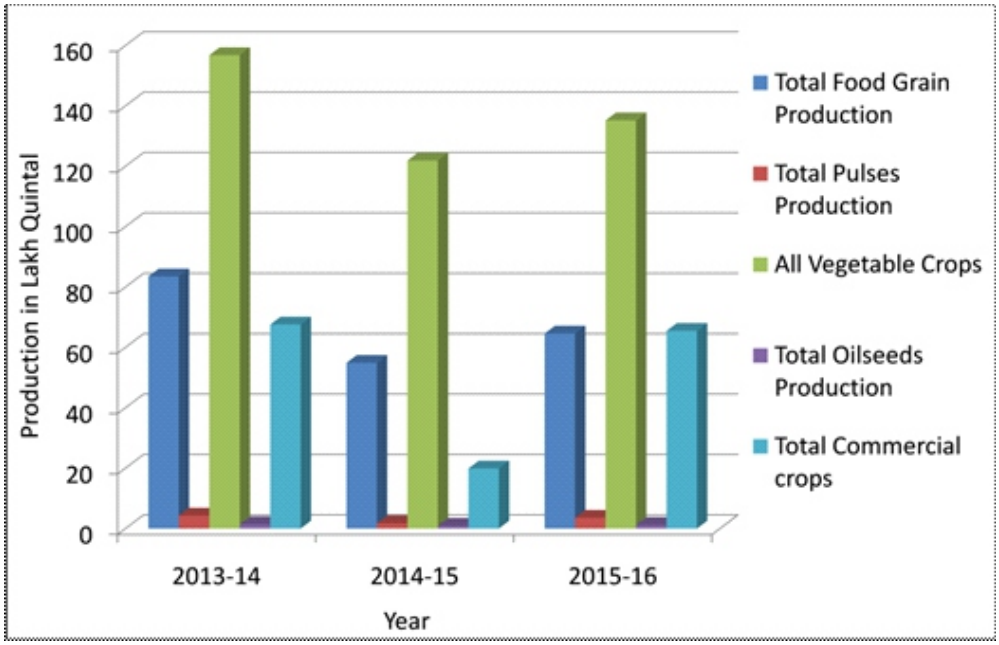

Figure 2: Year-wise Total Production

reason, the production of wheat is highest among other cereals in the area. Since wheat production is heavily dependent upon assured irrigation therefore a change in temperature is expected to affect the production of wheat. The last three years data show that the production of total food grains was 32.87 Q/ha in 2013 whereas in 2016 it was 19.62 Q/ha (Table 5).

Rice is a major crop of Kharif season in which irrigation is required in large quantity that is available in the area during this season through the monsoon. Rainfall throughout the season also maintains the temperature fluctuations. Therefore climate change is supposed to have more effect on crop production during the season not only through changes in quantity and pattern of precipitation but also change in temperature. The effect of climate change can be easily seen from the fact that there is a large scale fluctuation in the area under the cultivation in the Kharif season. The total area under food grains in 2013 was 2,82,093 hectares which increased to 2,90,872 hectares in 2016.

In comparison to the Kharif season, the positive fluctuation in the area under

Table 5: Yield in Quintal/hectare and Value Rs./Quintal

Sl. No.	Crops	2013-14		2014-15		2015-16	
		Q/ha	Rs./Q.	Q/ha	Rs./Q.	Q/ha	Rs./Q.
Cereals							
1.	Rice	26.09	2099	19.37	2206	2047	2179
2.	Wheat	32.87	1556	19.6	1582	24.85	1685
3.	Barley	33.64	1386	13.67	1589	26.63	1661
4.	Jwar	14.04	1421	8.14	1420	7.05	1428
5.	Bajara	8.56	1232	8.48	1400	8.19	1432
6.	Maize	11.03	810	18.43	1435	7.52	1532
7.	Sawan	10.00	-	10.00	-	10.00	-
Pulses							
8.	Urd	5.76	4691	3.98	11389	3.51	9697
9.	Moong	5.39	9203	4.64	11550	5.57	7864
10.	Masoor	5.36	5832	3.81	9460	4.93	8157
11.	Gram	4.36	4534	1.78	7054	5.73	9765
12.	Pea	11.14	3426	7.41	6645	9.54	6820
13.	Arhar	8.94	9854	2.07	13177	5.85	10169
14.	Total Pulses	5.83	-	2.41	-	5.57	-
Oilseeds							
15.	Mustard	-	-	4.34	4350	6.1	3791
16.	Alsi	-	-	5.89	3460	2.14	3720
17.	Til	-	-	2.02	7240	91	7800
18.	Groundnut	-	-	8.69	3550	6.75	3634
19.	Sunflower	-	-	17.04	-	3.35	-
20.	Total Oilseeds	5.62	-	-	-	-	-
Commercial Crops							
21.	Sugarcane	682.89	270	658.21	266	670.32	292
22.	Potato	204.1	1730	154.33	845	160.58	831
23.	Tobacco	30.00	-	-	3140	-	-
24.	Jute	2.66	6104	3.95	-	2.85	-
25.	Turmeric	28.91	6994	24.8	2410	11.1	2603

Source: Statistical Magazine Fatehpur, 2017

cultivation in Rabi season is high; that maybe because of the availability of assured irrigation facilities. The fluctuation in the production, as well as productivity, is also realized along with the fluctuation in the area under cultivation. This indicates that though with the availability of assured irrigation facilities the vulnerability of Rabi crops to the climate change has reduced but still the climate change has its impact on the Rabi crops too (Figure: 3 and 4).

The same result can be found out in case of total foodgrains production. A change in area under cultivation is always accompanied by a change in production and yield of the food

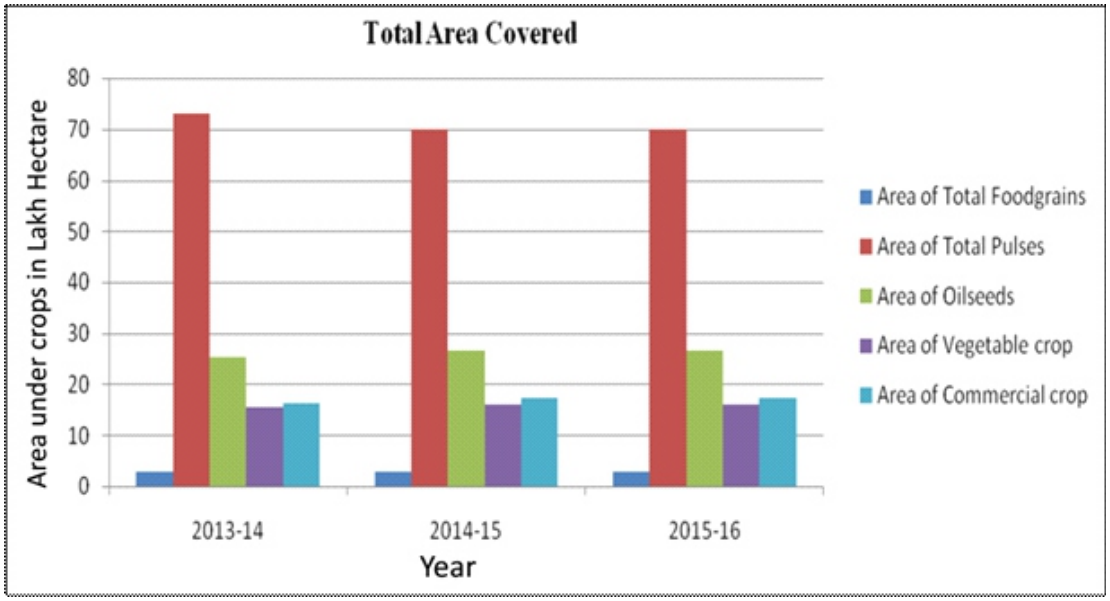

Figure 3: Total Area Covered through 2013-2016

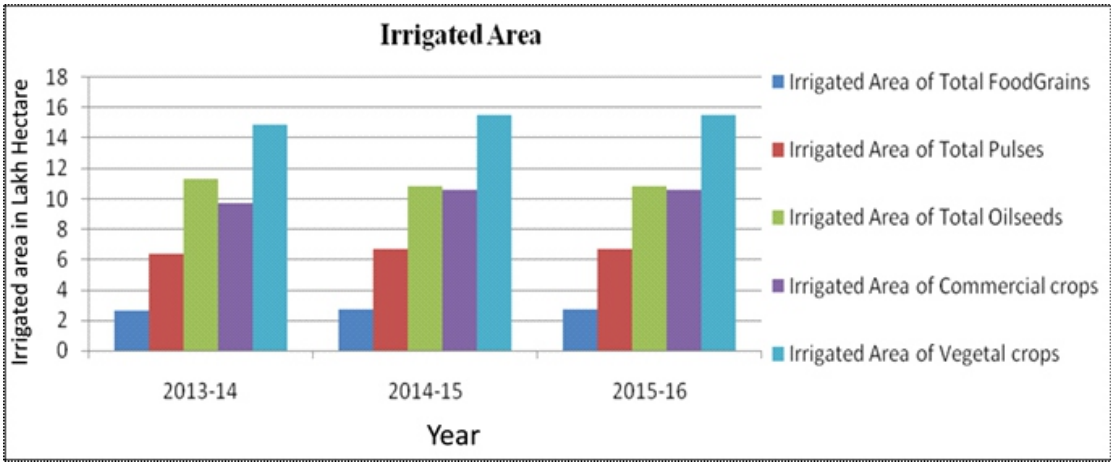

Figure 4: Total Irrigated Area covered through 2013-2016

grains. It can be therefore said that the factors which are responsible for production and yield of the crops in which the climate change is the most important and dominating.

Impact of climate change on availability, accessibility and utilization of food

Food availability is determined by the physical quantities of food that are produced, stored, processed, distributed and exchanged. High market prices for food are usually a reflection of inadequate availability; persistently high prices force poor people to reduce consumption below the minimum required for a healthy and active life and may lead to food riots and social unrest. In the study area, 86 per cent of people live in rural areas and engage in subsistence farming. Therefore, their affordability is nominal concerning high priced food required for an active and healthy life. Growing scarcities of water, land and fuel are likely to put increasing pressure on food price, in area, even without climate change. Warming of more than 3^0C is expected to have a negative effect of production in all regions (FAO Rome 2008).

In the study area, per capita, net availability of food grains declined between 2001 (274.65 kg.) and 2015 (201.43 kg.). During the same period, the production of pulses also declined from 36.25 kg. to 6.07 kg. In other words, production of essentials like food grains and pulses has not been able to keep pace with the increase in population (population change during 2001-15 needs to be cited here to understand the disparity in the two).

Food accessibility is a measure of the ability to secure entitlements, which are defined as the set of resources (including legal, political, economic and social) that an individual requires obtaining access to food. The mere presence of an adequate supply does not ensure that a person can obtain and consume food that person must first have access to food through his/her entitled. Increased risk exposure resulting from climate change will reduce people's access to entitlements and undermine their food security. The study area has a big population of (1,38,304) below the poverty line. The District's all 13 blocks have more than 50 government's control shops, yet food is distributed through the market and non-market distribution mechanisms. Factors that determine whether people will have access to food through markets are considered in the affordability aspects. The economy of the study region gives a growing rate of per capita income Rs.4644 in 1993-94 to Rs. 4894 in 2004-2005, but this is a very slow growth rate which gives its value of HDI low which is 0.5334, according to the value of GDI (gender development index) (2005) low 0.4992. Year to year due to drought-prone area climate change imperils on food security seems strong and cannot be done unavoidable in area.

Food utilization refers to the food and how a person can secure essential nutrients from the food consumed. Climatic conditions are likely to bring both negative and positive changes in dietary patterns and new challenges for food safety, which may affect nutritional status in various ways. Food insecurity is usually associated with malnutrition because the diets of people who are unable to satisfy all of their food needs usually contain a high proportion of staple foods and lack the variety needed to satisfy nutritional requirements. Declines in the availability of wild foods and limits on small scale horticultural production due to scarcity of water or labour resulting from climate change could affect nutritional status adversely. In general, the main impact of climate change on nutrition is possible to be felt indirectly, through its effects on income and capacity to purchase a diversity of foods. In Ganga –Yamuna Doab area the consumption of nutritional food and expenditure of per capita monthly on broad categories of food products is given in table 5&6, the data shows major inequality of consumption and expenditure among the people of the area. Value of consumption of food and non-food items per

person for 30 days for each quintile (The CES is traditionally a quinquennial survey conducted by the government's National Sample Survey Office) class of 5 days of monthly per capita consumer expenditure (MPCE) is given in table 5 while category wise monthly per capita expenditure is given in table 6. The total expenditure of nutritional food in Fatehpur district was highest in V-class of 5 days of Quintile flowed by IV-class and the lowest was in I-class while Category wise monthly per capita expenditure was Rs.834.31 in Fatehpur district recording highest for cereals followed by Milk & Milk Products, Fuel & Light etc.

Among the bottom 50% of the rural population ranked by Monthly Per Capita Expenditure (MPCE), 57% of households had calorie intake below 2160 Kcal/consumer

Table 5: Quintile class-wise distribution of expenditure, 2011-12

Item description	Quintile class of MPCE (class of five days)						No. of HHs reporting consumption	
	I	II	III	IV	V	VI		
Total food group	277.45	360.50	396.10	494.04	679.57	441.20	1000	256
Total Non food group	237.63	307.09	398.11	524.90	876.67	468.61	1000	256
Total Expenditure	515.08	667.59	794.21	1018.94	1556.24	909.81	1000	256

Source: Nutritional Intake in Fatehpur, 2012-13, (National Statistical Survey) NSS 68th Round (National Sample Survey Office)

unit/day, which was only 2% for the top 5% wealth fractile of the population. Average protein intake per capita per day risen steadily with MPCE to 91 gm for the top 5% and in urban India upon 44 gm. the bottom 50% to about 87 gm. for the top 5%. Per capita per day calorie intake in the rural area of study region was 2200 (Kcal.) and in urban area 2144 in 2011-12. Whereas protein intake per day per capita in rural areas 62.8 gm and urban area 61.1 gm which is above the average of Indian intake. While Fats intake of per capita per day was 42.6 in the rural area and 53 gm in the urban area in 2011-12 which is near about to national intake. The calorie and protein intake are still below the Planning Commission Benchmark of 2400 Kilo Calories per day. However, the per capita intake of fat increased steadily over time for both rural and urban population.

Conclusion

The problem of climate change and its outcome is the matter of great concern all over the world because it can make life vulnerable on earth. The present paper, based on analysis of data, brings out that all agricultural activities should be practised in a way of producing the lowest practical impact on the environment. The significance of its dimensions and the overall impact of climate change on it will differ across regions and over time. The thrust of agriculture has been the popularization of integrated pest (IPM) and nutrient management (IPNM) in field crops, integrated weeds and integrated disease management in crops, the introduction of improved cultivars and production technologies of pulses and oilseeds, diversification through introducing vegetables, mushrooms, beekeeping, fruits, medicinal plants dairy, production enhancement and conservation of green fodder for livestock, bio-pesticides, botanical pesticides should be used much more than pesticides. Farmers training on the use of chemical fertilizer, bio-fertilizer and

Table 6: Category wise monthly per capita expenditure

S No.	Broad categories of goods and services	Monthly Per capita Expenditure (Rs.)
1	Cereals	128.47
2	Cereals substitute	0.03
3	Pulses & Products	35.09
4	Milk & Milk Products	83.15
5	Sugar & Salt	15.93
6	Edible oil	34.91
7	Egg, Fish & Meat	13.25
8	Vegetables	40.06
9	Fruits Fresh	5.80
10	Fruits Dry	2.44
11	Spices	15.41
12	Beverages etc.	8.43
13	Served Processed Food	20.31
14	Packaged Processed Food	10.03
15	Pan	3.18
16	Tobacco	17.16
17	Intoxicants	0.06
18	Fuel & Light	63.69
19	Clothing	49.46
20	Bedding etc.	7.50
21	Footwear	12.78
22	Education	29.82
23	Medical non-institutional	30.06
24	Entertainment	5.96
25	Minor durable type goods	6.34
26	Toilet articles	18.25
27	Other household consumables	16.98
28	Consumer Services	56.41
29	Conveyance	39.43
30	Rent	0.72
31	Consumer taxes & cesses	0.50
32	Durable goods	62.70
	MPCE	834.31

Source: Nutritional Intake in Fatehpur, 2012-13, (National Statistical Survey) NSS 68th Round (National Sample Survey Office)

pesticides, bio-pesticides need to be introduced extensively. Empowerment of rural women and rural youths through SHGs and Vocational training popularization of organic farming amongst the farmers through the inclusion of green-manuring, vermin-culture, enhancing seed replacement rate and seed production at farmer's field is also needed. In the study area, there is a need for land reforms of Usar land and fellow land. A second green revolution

movement should be launched by the Government. The deposited soils in the dry rivers should be cleaned by MNREGA labours so that water can be available throughout the year for irrigation.

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