Climate Resilient Agriculture in Chhattisgarh

Training Manual

Cover Photo Credit - Devendra Shukla

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Training Manual

January 2019

Training Manual Contents

Training Objective

- To help participants understand about climate change, its causes and impacts with special reference to Chhattisgarh environmental conditions and Agriculture.
- Enable them to relate the coping strategies in the light of CSA (Climate Smart Agriculture) for higher agriculture productivity.

Duration

180 minutes

Learning Outcomes

Through this session the participants will:

- Learn about climate change concept, causes and its impact.
- Understand challenges of local agricultural systems and CSA strategies for increasing productivity and higher profitability from agriculture
- Role of women in agriculture and gender sensitive climate adaptation strategies.

Material, Tools, Equipment

Computer/Laptop & Screen, Projector, Mike system

Teaching AID

Hand-out, PPT, Notepads, White Board & Marker

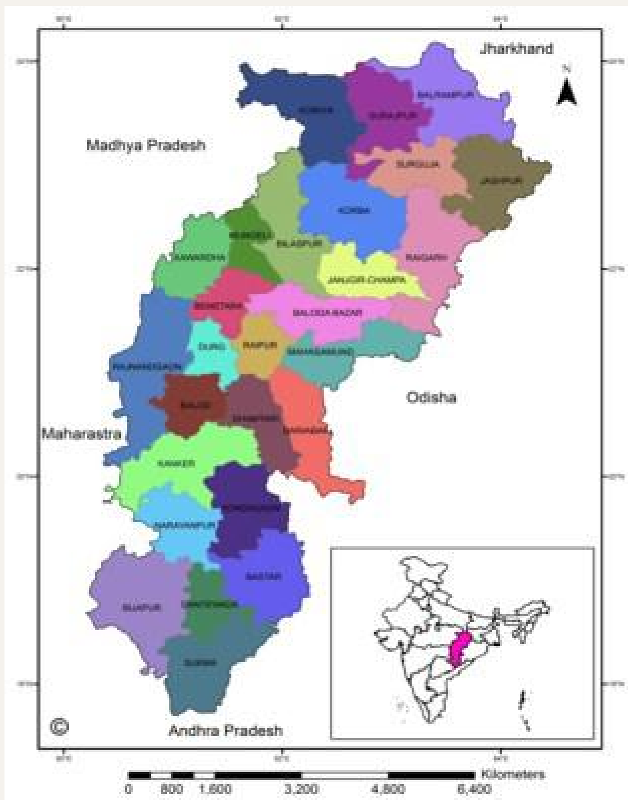
Time	Session Name	Methods
30 Min	Weather and climate of Chhattisgarh state	PPT, Video (ACT Climate Change documentary – 10 min)
30 Min	Climate Change adaptation and mitigation strategies in agriculture for Chhattisgarh State	PPT, Lecture, group discussion
30 Min	Soil &Water Conservation in context of Climate Change.	PPT, Lecture, group discussion
30 Min	Integrated Farming System –effective approach to cope up with climate change.	PPT, Lecture, group discussion
30 Min	Women in agriculture and Climate Change	PPT, Lecture, group discussion
30 Min	Question and Answer session	Interactive session

Session-1

Weather and climate of Chhattisgarh state

Introduction:

Chhattisgarh, a 21st Century State, came into existence on November 1, 2000. Chhattisgarh state situated in eastern India stretches between 80˚15′ to 84˚24′ E longitude & 17˚46′ to 24˚. It covers total geographical area of about 13.5 m. hectare and larger than Kerala and Tamil Nadu in terms of geographical area. The state has three Agro-climatic zones viz., Chhattisgarh plains, Bastar plateau and Northern hills region. Its climate is mainly of dry sub-humid type. The monsoon starts mid-June in southern part and withdrawing from mid-September in northern parts and 25th September it is completely withdrawn from the entire state.



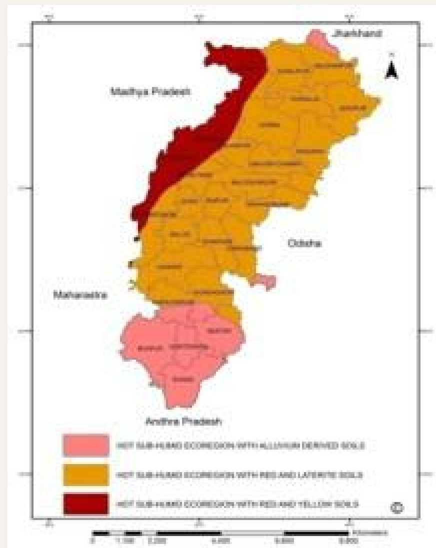
Map of Chhattisgarh with district boundaries

Agro-climatic zones of Chhattisgarh

The state of Chhattisgarh is divided into three major agro-climatic zone namely Chhattisgarh Plains (CP), Northern Hills Zone (NHZ), and Bastar Plateau (BP).Covering 51.0%, 28.0% and 21.0% of the geographical area, respectively. The location of the state is such that it is close to the Bay of Bengal, which is instrumental in bringing monsoon in the Southern side of the country. The cropping intensity of the state is about 135%.

Agro-ecological zones of Chhattisgarh

On the basis of soils physiographic, length of growing period and bioclimaticconsideration, National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) NAGPUR, India, has delineatedthe entirecountry in different Agro ecological Region (AER). Based on agro ecological classification map has also been prepared for the entire Chhattisgarh state by superimposing GIS figures of district boundaries. The base figure of 20 AER of NBSS & LUP (Gajbhiye and Mandal, 2000) has been utilized for this demarcation. Major geographical area of the state lies in zone 11. Chhattisgarh/Mahanadi Basin Agro-eco-region (J3 C3), moderately to gently sloping Chhattisgarh/Mahanadi Basin, hot moist/dry sub humid transitional Ecological Sub Region (ESR) with deep loamy to clayey Red and Yellow soils, medium Available Water Content (AWC) and LGP 150-180 days (J3Cd/Cm5) as shown inthe figure below. Further classification of this zonation into sub-regions is same as there is no further sub-division in any of the zone.



Agro-climatic zones of Chhattisgarh　　*Agro-ecological zonations of Chhattisgarh*

2.Annual and Seasonal rainfall

Nature is very kind to Chhattisgarh in terms of all climatic parameter including rainfall as compared to its neighbouring states. The state receives pretty decent amount of annual rainfall with an average of 1190 mm and about 88% of the total rainfall is confined in the monsoon season (ie., 15th June to September). Since it falls under the rice agro-climatic zone, rainfall proves to be the main source of irrigation. A significant variation in the seasonal as well as annual rainfall adversely affects the harvest. Due to the limited availability of complete rainfall datasets, rainfall analysis has been carried out accordingly.

The mean annual and seasonal rainfall for 27 districts is furnished in Tableand the spatial distribution is depicted in figure where the annual rainfall, southwest monsoon rainfall and coefficient of variation, northeast monsoon rainfall and coefficient of variation, summer rainfall and winter rainfall are shown. On the basis of available database, the mean annual rainfall of Chhattisgarh is 1190 mm with a coefficient of variation of 26%. Annual rainfall is highest over Bastar plateau zone (1348 mm) and lowest in Chhattisgarh plains (1127 mm) while it is intermediary over the Northern hill's zones (1253 mm). There is a large variability in rainfall across the districts with highest being in Dantewada (1432 mm), followed by Narayanpur (1385 mm) and Sukma district (1359 mm). In Chhattisgarh plains, Jangir-Champa receives the highest rainfall (1190 mms) followed by Raigarh (1188 mm). Lowest rainfall in Chhattisgarh plain has been found in Kawardha (990 mm) followed by Baloda Bazar (1032 mm) and Mungelidistrict's amount of rainfall is at third lowest (1049 mm). The annual rainfall is highly variable and highest value of coefficient of variation (CV) is found in Dantewada district (40%) followed by Bemetara district (28%). Therefore, it can be interpreted that there is higher risk and uncertain factor in rainfed rice production in these two districts. The variability in the rainfall during southwest monsoon (south west monsoon) season was found to be highest in Bijapur (31%) followed by Bemetara (30%) and lowest in Dantewada and Raigarh Districts (17%). The variability during the northeast monsoon (North east monsoon) period is high in comparison to south west monsoon which is obvious for this state because of the fact that maximum concentration of annual rainfall is in south west monsoon season. Highest variability in North east monsoon rainfall is observed in Korba value (129%) followed by Gariyaband (119%) and a relative consistency in North east monsoon was observed in Rajnandgaon district (75.3%). The rainfall in different seasons, as a percentage, of the total annual rainfall in three zones of the state is presented in Table. South west monsoon rainfall accounts for 88% of the annual on overall state basis. Rainfall during

North east monsoon season is highest in Chhattisgarh plains whereas winter rain is almost same in all agro-climatic zone and North east monsoon rainfall is highest in Bastar Plateau.

2.1. Features of South west monsoon rainfall

Figure below shows that the highest South west monsoon rainfall has been observed for Dantewara (1302.6 mm) while lowest has been observed for Kawardhaabout 900 mm. The impact factor can be observed that the intensity of cyclonic depression decreases significantly particularly when cyclone depressions reach in the western part of the state. Chhattisgarh state receives about 1000 mm of rainfall during south west monsoon season. At the district level, Chhattisgarh state as a whole is subjected to 23 per cent variable monsoon rainfall which is relatively high compared to All India South West monsoon rainfall variability (11%). Region wise lowest variability is seen in Chhattisgarh plain and northern hills zone (tied at 22 per cent) and highest in Bastar plateau. At the district level, highest variability in the monsoon rainfall is observed in Balrampur district followed by Bijapur (30%) and lowest variability is found in Dantewada and Raigarh district.

2.2. Features of north east monsoon rainfall

North east monsoon is also a crucial factor and production of rainfed rice grown largely depends on the quantity that too coinciding with the flowering phase of long duration varieties of this state. Rainfall during North east monsoon season for the entire state is 70 mms with a variability of 86% which is almost three times and significantly higher than the variability observed for the monsoon season rainfall. Bastar plateau receives significant amount of rainfall (86 mm) mainly in the Dantewada district followed by Bastar district. North east monsoon receives a fairly good amount of 70 mm rainfall mainly in the Surguja and Jashpur district. Study of long-term data indicates that the chances of receiving rainfall over Chhattisgarh plains are relatively less. Among the districts in Chhattisgarh plains zone, Raigarh district receives abundant rainfall (91 mm) during this season followed by Raipur district (85 mm) and is lowest in Korba district.

Zone wise annual rainfall distribution in different seasons as per cent of Annual Rainfall

Region	Rainfall (mm)					Rainfall (%)			
	Annual	Winter	Summer	South West	North East	Winter	Summer	South West	North East
Chhattisgarh Plains	1127	25	45	995	78	2	4	88	6
Bastar Plateau	1348	18	60	1186	85	1	4	88	7
Northern hills	1253	25	31	1106	72	2	2	88	7
State	1190	24	45	1050	70	2	4	88	6

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur

2.3. Districts wise monthly rainfall of Chhattisgarh state

Monthly distribution of district wise rainfall is given in table. It can be seen that on onset of monsoon, CV value comes down drastically. In June month CV value is 13.9% and state average of June month is 175.5 mm. There are some districts like Surguja, Surajpur, Narayanpur, Jashpur and Bastar which are crossing rainfall quantity of 200 mm. In July month, only three districts viz., Dantewada, Surajpur and Jashpur are crossing the value of 400 mm and CV value for the state falls below 12%. In August month, only Dantewada and Narayanpur districts are crossing the value of 400 mm. It is significant to note that CV in this month is coming below the value of 13%. In September month, highest value is found in Sukma district and lowest value is found in Raipur.

The average annual rainfall and rainy daysof Chhattisgarh is shown in the figure. It can be very well seen that maximum concentration of rainfall is in monsoonal months while CV value goes down in monsoonal season as shown by lines.

2.4.Distribution of weekly rainfall

Commencement of growing season, length of growing season, choice of cropping systems, allocation of resources and inputs depend significantly on the weekly distribution of rainfall. Distribution of rain on a weekly basis for the state and for individual districts along with their statistics is mentioned in the table. Considerable rain (more than 20 mm per week) occurs over the state occurring in the period from 24th standard meteorological week (SMW) to 40th standard meteorological weeks and this indicates a significant total growing period of 17 weeks. This is very important factor which determined the date of sowing according to duration of varieties. So that crop could not suffer due lack of moisture especially at their critical stage.

Districts wise monthly rainfall of Chhattisgarh state

S.No	Districts	Jan	Feb	March	April	May	June	July	August	September	October	November	December
1	Balod	7.0	6.1	3.7	3.0	5.1	145.9	361.8	329.9	194.7	42.7	10.0	2.7
2	Baloda Bazar	6.6	9.4	14.8	9.1	9.5	172.3	324.1	269.1	165.3	39.0	8.6	4.4
3	Balrampur	3.0	10.0	51.0	11.0	18.4	124.7	363.8	287.3	230.8	60.5	1.0	2.1
4	Bastar	9.3	6.9	17.4	37.2	63.3	211.3	343.0	356.1	216.4	71.9	17.0	5.2
5	Bemetara	10.4	5.0	6.1	5.0	8.1	173.1	351.9	297.4	178.7	44.2	5.1	6.7
6	Bijapur	22.0	15.8	12.9	17.7	15.2	145.5	395.3	351.6	197.5	50.0	17.4	13.0
7	Bilaspur	27.1	19.5	30.2	21.4	31.4	172.5	306.2	323.6	198.3	55.7	15.6	6.9
8	Dantewada	9.3	2.4	2.5	4.5	15.7	189.7	453.3	440.3	219.3	82.3	5.9	7.0
9	Dhamtari	12.9	7.6	7.9	14.5	17.5	183.6	306.9	307.7	190.1	43.9	11.0	6.0
10	Durg	5.2	1.0	2.6	1.1	6.7	163.4	397.8	326.2	170.3	35.5	8.4	5.0
11	Garyiband	4.9	8.8	6.6	8.2	8.9	198.1	350.4	341.8	192.3	38.4	5.0	3.0
12	Janjgirchampa	15.3	13.9	10.6	8.4	8.8	154.5	366.4	372.5	208.2	44.2	11.2	8.1
13	Jashpur	14.0	10.8	10.5	10.7	19.4	201.4	409.7	361.7	223.9	56.1	10.7	7.4
14	Kanker	9.6	4.4	4.9	5.9	15.9	170.5	330.7	357.5	182.1	54.8	5.8	2.6
15	Kawardha	12.9	19.5	18.6	8.2	10.6	128.4	265.1	285.0	169.7	55.5	12.2	3.8
16	Kondagaon	15.5	23.1	8.9	9.4	31.9	168.2	312.1	331.7	156.6	36.6	8.6	13.2
17	Korba	8.4	6.4	9.2	6.7	9.6	185.1	386.8	337.2	174.5	32.9	8.6	5.1
18	Koriya	12.8	18.0	10.7	5.6	5.5	170.2	395.3	350.6	206.6	43.9	13.7	8.0
19	Mahasamund	10.1	7.1	10.8	12.2	9.4	174.4	374.6	341.5	206.5	47.7	6.0	5.7
20	Mungeli	14.2	14.9	11.6	9.8	10.2	143.9	318.5	283.3	172.0	47.7	14.7	7.7
21	Narayanpur	7.4	8.5	16.9	18.9	30.8	221.0	389.7	431.0	188.8	60.9	9.3	1.2
22	Raigarh	16.5	18.5	22.9	24.0	25.0	185.6	339.3	286.1	191.1	59.7	16.4	14.8
23	Raipur	20.5	20.0	21.5	18.0	23.2	174.5	335.2	284.3	152.9	41.5	18.9	16.2
24	Rajnandgaon	9.6	8.9	11.8	4.2	7.9	172.9	355.0	323.9	167.4	45.2	8.1	7.4
25	Surguja	25.2	22.7	19.1	14.2	19.3	200.0	396.8	342.7	218.6	58.1	16.9	11.9
26	Sukma	4.1	2.9	5.6	14.4	26.3	197.7	392.0	379.1	250.6	71.8	11.0	3.4
27	Surajpur	14.0	6.7	4.7	2.3	26.5	208.9	422.0	314.2	179.7	43.9	3.3	2.3
	Mean	12.1	11.1	13.1	11.3	17.8	175.5	360.9	333.8	192.7	50.5	10.4	6.7
	SD	6.2	6.5	10.1	7.9	12.4	24.4	41.9	41.9	24.0	12.1	4.7	4.0
	CV(%)	50.9	58.9	77.4	69.7	69.6	13.9	11.6	12.6	12.4	23.8	45.6	60.2

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur

Districts wise Weekly rainfall of Chhattisgarh state

Districts	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
BALOD	2	1	0	1	4	3	1	0	2	1	1	0	0	1	1	1	0	1	1	1	1	2	13	43	39	56
BALODABAZAR	2	1	0	2	3	2	2	1	3	3	4	4	3	4	1	2	1	4	2	1	2	2	12	43	53	70
BALRAMPUR	4	2	0	0	0	5	0	0	0	5	2	0	0	1	9	1	0	0	2	0	1	0	14	38	48	57
BASTAR	3	3	1	1	2	2	3	1	2	3	3	4	5	7	7	11	10	13	7	15	12	25	30	50	54	76
BEMETARA	1	2	2	3	4	2	1	1	1	1	1	2	2	1	1	1	2	3	1	1	1	4	17	40	52	76
BIJAPUR	10	5	2	2	3	7	3	3	5	2	4	1	3	4	3	4	5	4	3	4	2	3	13	26	51	57
BILASPUR	5	6	3	8	8	5	6	2	6	11	5	5	7	7	4	6	3	8	5	7	8	9	15	41	55	68
DANTEWADA	0	9	0	0	0	0	2	0	1	1	1	0	0	0	2	1	1	3	3	4	3	8	17	52	63	60
Dhamtari	3	3	2	2	2	3	2	2	2	2	2	1	2	3	2	3	5	5	3	6	4	4	14	41	70	68
DURG	1	1	0	2	2	0	0	0	0	2	0	0	1	1	0	0	0	0	2	1	4	3	15	54	46	56
GARIYABAND	1	4	1	1	1	1	1	1	1	1	1	0	1	1	1	1	2	3	2	4	3	5	15	49	60	61
JANJGIR-CHAMPA	5	2	1	5	5	3	5	2	3	4	1	2	2	2	1	3	1	5	2	1	1	2	11	29	52	73
JASHPUR	3	3	2	5	3	3	4	2	2	5	1	1	3	2	2	3	3	5	4	5	4	7	19	36	74	83
KANKER	4	4	0	1	1	1	2	1	1	1	2	0	0	0	1	2	2	3	3	7	2	6	16	48	51	56
KAWARDHA	2	4	2	2	5	6	6	2	7	3	5	4	3	1	2	2	3	3	3	3	1	4	9	31	44	52
KONDAGAON	4	6	2	3	4	6	10	1	4	5	1	0	3	2	1	1	3	8	5	5	11	10	29	37	57	50
KORBA	2	2	0	2	3	2	2	2	2	3	1	3	1	2	2	2	1	2	2	3	1	7	22	41	60	68
KORIYA	3	0	2	5	4	3	9	2	3	4	4	0	1	2	2	1	0	2	2	0	1	2	13	26	68	76
MAHASAMUND	2	1	1	3	4	2	2	2	2	3	2	1	3	5	2	2	3	3	2	3	2	5	14	44	56	65
MUNGELI	4	5	1	4	2	8	4	1	3	4	2	3	1	4	1	1	3	1	4	3	1	5	11	26	52	63
NARAYANPUR	1	3	1	2	0	2	4	2	2	3	2	6	4	6	3	3	6	7	8	10	3	7	30	57	63	78
RAIGARH	5	6	1	2	3	11	3	1	4	12	3	3	3	10	7	3	3	6	11	6	2	7	21	36	63	67
RAIPUR	7	8	1	2	3	13	4	1	2	12	2	4	2	8	5	3	1	4	11	4	3	3	19	39	54	59
RAJNANDGAON	2	2	1	1	2	3	2	1	3	3	2	1	0	1	1	0	1	1	2	2	1	2	11	38	58	75
SARGUJA	6	6	4	6	7	5	8	3	6	7	5	1	3	3	2	4	3	7	5	4	3	5	14	39	71	86
SUKMA	0	2	0	1	2	0	1	1	2	2	1	0	1	3	2	4	5	3	7	9	5	8	20	62	58	58
SURAJPUR	2	1	2	7	4	2	2	0	1	1	2	1	1	0	0	1	0	1	1	3	10	18	25	42	67	77
MEAN	3	3	1	3	3	4	3	1	3	4	2	2	2	3	2	2	3	4	4	4	3	6	17	41	57	66
SD	2	2	1	2	2	3	3	1	2	3	1	2	2	3	2	2	2	3	3	3	3	5	6	9	9	10
CV (%)	71	66	78	75	65	86	78	62	70	84	62	98	81	85	91	87	87	77	72	82	94	86	35	22	15	15

Districts	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
BALOD	63	78	89	97	88	69	81	68	73	70	47	42	17	16	15	7	5	1	3	4	1	1	2	0	0	0
BALODABAZAR	63	75	81	78	66	60	67	52	58	55	45	32	19	16	10	7	7	1	5	2	1	1	2	2	0	0
BALRAMPUR	68	82	88	84	86	69	73	49	50	88	63	52	25	25	15	0	7	3	7	0	0	0	6	0	0	1
BASTAR	70	71	93	84	83	88	74	67	79	68	48	55	28	29	19	10	10	11	3	5	2	0	1	2	1	1
BEMETARA	73	71	87	87	72	69	82	55	53	54	45	41	25	20	11	6	7	2	1	1	1	2	2	2	1	1
BIJAPUR	80	74	102	91	89	80	86	66	68	64	46	41	18	19	10	10	7	7	4	3	3	3	2	4	2	3
BILASPUR	62	70	71	75	76	77	76	67	66	61	54	43	20	27	14	7	8	5	4	5	2	2	2	1	2	2
DANTEWADA	101	90	127	107	101	120	88	86	89	61	55	52	29	42	20	11	9	2	2	2	1	2	2	2	0	3
Dhamtari	60	67	77	66	76	69	68	60	64	56	51	42	20	18	10	7	8	3	2	5	1	2	2	1	1	1
DURG	75	87	106	91	86	70	74	68	74	62	39	38	12	12	8	10	6	3	3	2	0	1	2	1	0	0
GARIYABAND	79	82	103	88	88	87	77	71	76	60	48	44	20	24	12	9	7	3	2	3	1	2	2	2	0	1
JANJGIR-CHAMPA	75	94	88	74	86	100	82	78	69	75	51	42	22	19	9	7	8	2	3	2	3	3	3	1	1	1
JASHPUR	83	94	103	94	80	84	91	69	83	70	65	36	31	24	13	10	7	7	2	2	1	3	2	1	1	2
KANKER	69	87	77	67	87	91	79	74	66	64	48	34	21	28	14	5	7	3	3	1	0	0	1	1	0	0
KAWARDHA	57	61	57	64	67	74	71	51	52	45	39	46	28	19	14	12	10	4	2	6	1	1	1	1	1	0
KONDAGAON	65	81	76	71	65	67	89	68	61	45	53	25	24	17	5	6	8	3	5	2	0	0	9	1	1	3
KORBA	81	83	97	91	90	87	75	61	63	50	52	33	23	17	6	6	5	1	3	3	1	1	1	3	0	1
KORIYA	70	95	110	82	83	92	78	84	55	73	55	39	22	22	10	4	5	7	3	4	1	1	1	3	0	4
MAHASAMUND	69	82	99	87	89	78	83	66	72	71	48	47	21	21	12	8	6	2	3	1	0	1	1	1	1	2
MUNGELI	64	73	82	76	62	70	63	57	61	55	50	30	21	18	8	9	10	4	3	4	4	4	2	1	2	1
NARAYANPUR	78	86	94	95	95	110	105	76	91	57	48	43	22	25	15	11	7	6	1	1	3	1	0	1	0	0
RAIGARH	63	74	93	76	67	70	71	62	57	56	52	44	24	24	14	9	11	4	12	1	1	2	9	1	1	2
RAIPUR	56	70	89	81	60	50	87	58	58	51	41	31	14	12	12	8	8	2	13	2	1	1	13	1	0	1
RAJNANDGAON	63	77	93	84	92	77	76	65	61	53	45	32	19	17	9	11	7	1	2	1	1	2	2	1	0	2
SARGUJA	72	103	89	99	93	85	80	64	64	85	50	45	19	27	12	7	10	8	3	6	2	2	2	2	1	7
SUKMA	86	80	96	93	99	91	96	73	75	85	53	49	39	31	19	11	11	4	3	2	2	1	1	2	1	0
MEAN	71	81	91	84	82	80	79	66	67	63	49	40	22	22	12	8	8	4	4	3	1	1	3	1	1	2
SD	10	11	14	11	11	15	9	9	11	12	6	8	5	6	4	3	2	3	3	2	1	1	3	1	1	1
CV (%)	14	14	15	13	14	19	12	14	16	18	12	19	24	30	31	33	25	71	78	68	72	72	115	56	91	93

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur

2.5. Seasonal distribution of rainy days for Chhattisgarh State

Zone wise seasonal distribution of total annual rainy days has been presented in the Table which indicates that the state received maximum rainy days i.e. 49 days in south west monsoon. Among three agro-climatic zonesbastar plateau is receiving maximum no of rainy days (54 days) followed by northern hills region (52 days) and Chhattisgarh plain (48 days). This type of information is important for selection of crops, their varieties and cropping system / cropping sequence consider the other factors of location in rainfed agriculture. State also received rains during summer season in Table. This moisture should be efficiently considered for agriculture operations.

Seasonal distribution of rainy days for Chhattisgarh State

Region	Rainfall (mm)					Rainfall (%)			
	Annual	Winter	Summer	South West	North East	Winter	Summer	South West	North East
Chhattisgarh Plain	56	2	3	48	4	4	5	86	7
Baster Plateau	65	1	4	54	5	2	6	83	8
Northern Hills	61	2	3	52	4	3	5	85	7
State	58	2	3	49	4	3	5	84	7

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur

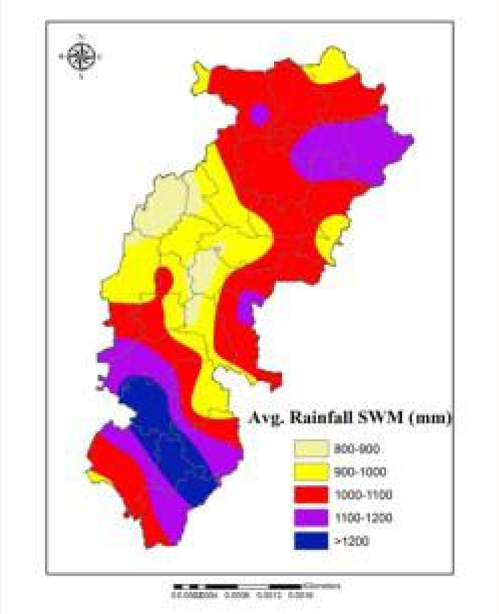
2.6. Districts wise mean annual and seasonal rainy days (mm)

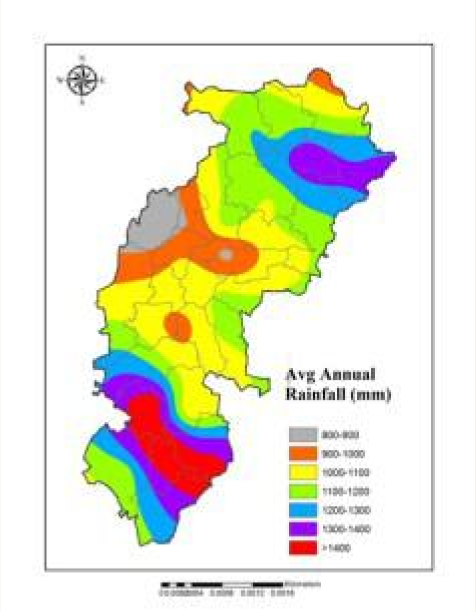
It is quite clear from Table that all districts receive rains mainly concentrated in SW monsoon season within 43 to 56 days. When we analyze the average value of district wise rainfall data, we observed that there is variability among different districts as Durg district receives 43 rainy days in SW monsoon season while Narayanpur and Bastar districts are receiving 56 rainy days each. When we see the variability on annual basis, this figure is varying between 47 days (Durg) to 72 days (Bastar). Rainy days received during other seasons are very less and next season is NE monsoon season only. Surguja and Bastar districts are receiving 6 days each in this NE monsoon season as this happens to be forested area. Depending upon its nature and its coincidence with rice stages, this rainfall will have its impact on production & productivity of Kharif crops. Rainfall during NE monsoon season is also beneficial for rabi crops. During winter season, number of rainy days are very less. On overall state basis, its average is 2 while in district wise Bilaspur and Surguja districts are receiving 4 rainy days each in this winter season. Summer season rainy days can prove to highly beneficial for the start of kharif growing season and also for very few crops like vegetables and summer moong. However, in case summer rains match with physiological maturity stage of rabi crops viz., gram, lathyrus and wheat etc. it can have negative effects on crop production. Farmers are also making use of the rains received during summer season specially for summer ploughing. Summer ploughing largely helps in conservation of moisture through deep ploughing, control of weed infestation and exposing disease-pests' spores etc. through long & bright sunshine hours.

Districts wise mean annual and seasonal rainy days (mm) with its standard deviation and coefficient of variation

Districts	Annual			Winter			Summer			South West			North East		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
BALOD	52	12	23	1	0	56	1	1	62	44	3	7	3	0	14
BALODABAZAR	51	10	20	1	0	14	2	0	10	44	0	0	3	0	10
BALRAMPUR	54	11	20	1	1	182	1	2	203	48	8	17	3	3	87
BASTAR	72	9	13	1	2	126	9	4	42	56	8	14	6	4	63
BEMETARA	49	14	28	1	2	174	1	2	173	44	13	29	3	3	104
BIJAPUR	63	12	20	2	3	137	3	3	106	50	16	32	5	5	103
BILASPUR	64	12	19	4	1	20	6	2	36	51	3	6	5	0	9
DANTEWADA	61	10	17	0	1	202	1	3	212	54	9	17	5	4	82
DHAMTARI	53	17	31	1	0	11	3	0	7	45	2	4	4	0	9
DURG 47	9	19	0	0	28	1	0	14	43	1	2	3	0	7	
GARIYABAND	54	10	18	1	0	60	2	1	34	48	3	5	3	1	23
JANJGIR-CHAMPA	55	9	16	2	0	15	2	1	35	47	1	2	4	0	9
JASHPUR	69	14	20	2	0	22	3	0	13	59	2	3	4	0	10
KANKER	53	13	24	1	0	13	2	1	32	46	1	2	4	0	1
KAWARDHA	56	11	19	2	3	127	3	3	102	46	9	20	4	4	81
KONDAGAON	65	13	20	3	4	131	5	4	73	52	9	18	4	4	90
KORBA	56	15	26	1	2	174	2	3	135	50	14	29	3	3	107
KORIYA	54	10	19	2	2	134	1	2	146	48	9	19	3	4	101
MAHASAMUND	57	9	15	1	1	64	2	2	112	50	4	8	4	0	13
MUNGELI	61	18	29	2	3	121	2	3	105	52	17	33	5	3	76
NARAYANPUR	65	10	15	1	1	174	4	7	205	56	11	19	5	3	73
RAIGARH	61	14	22	2	1	65	4	2	50	50	9	19	5	2	33
RAIPUR	56	8	15	2	3	116	4	4	110	43	5	12	4	3	72
RAJNANDGAON	53	11	20	1	1	47	2	1	60	46	3	7	3	1	26
SURGUJA	68	10	15	4	3	68	5	4	71	54	9	16	6	4	68
SUKMA	63	12	19	0	1	280	3	3	127	55	11	19	5	4	89
SURAJPUR	58	9	16	1	2	153	2	3	135	51	9	17	3	3	97
State	58	11	20	2	1	100	3	2	89	49	7	14	4	2	54

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur





3.Meteorological drought probabilities for different seasons of Chhattisgarh:

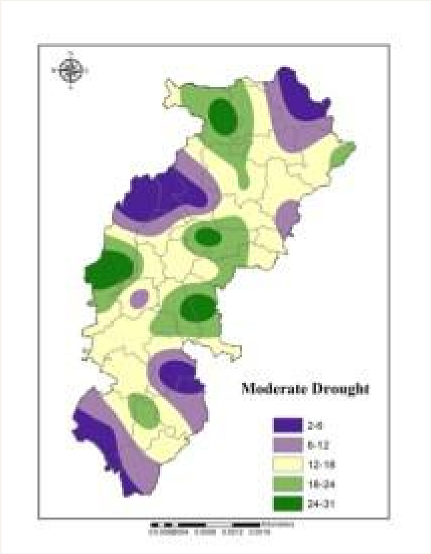
Drought is a common phenomenon now a days, considering the climate change drought analysis has also been carried out and outcome is depicted in the above figure.

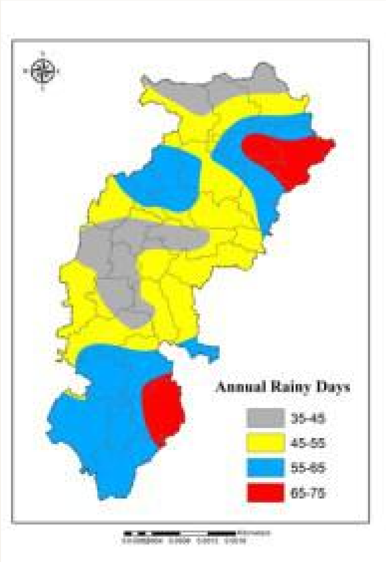
One can see that drought probability is varying between 79% and 100% while moderate drought probability is varying between 2% (Mungeli) to 22% (Rajnandgaon). Severe drought probability is varying between 0% to (Balod, Balrampur, Bastar, Bijapur, Durg, Janjgir, Jashpur, Kanker, Kawardha, Kondagaon, Korba, Koriya, Mahasamund, Mungeli, Narayanpur, Raigarh, Raipur, Rajnndgaon, Sukma, Surajpur, Surguja) to 5% (Bilaspur, Dantewada). It is a fortunate situation in Chhattisgarh state that severe drought are lesser in frequency and percentage probability is may less and can be managed through mitigation technique/ adaptation strategies.

Meteorological Drought probabilities for different districts of Chhattisgarh

District	No of year	No Drought	Moderate Drought	Severe Drought
Baload	52	94%	6%	0%
Balodabazar	56	79%	20%	2%
Balrampur	9	100%	0%	0%
Bastar	36	94%	6%	0%
Bemetara	54	89%	7%	4%
Bijapur	58	93%	3%	0%
Bilaspur	44	93%	2%	5%
Dantewara	43	79%	16%	5%
Dhamtari	58	83%	12%	2%
Durg	23	87%	13%	0%
Gariaband	44	77%	20%	2%
Janjgir	56	89%	11%	0%
Jaspur	44	86%	14%	0%
Kanker	35	86%	14%	0%
Kawardha	53	100%	0%	0%
Kondagaon	17	100%	0%	0%
Korba	56	88%	13%	0%
Koriya	42	81%	19%	0%
Mahasamund	42	91%	9%	0%
Mungeli	44	98%	2%	0%
Narayanpur	42	90%	10%	0%
Raigarh	44	93%	7%	0%
Raipur	58	86%	10%	0%
Rajnandgaon	54	78%	22%	0%
Sukma	44	91%	9%	0%
Surajpur	43	91%	9%	0%
Surguja	35	86%	14%	0%

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur





Districts wise annual and South-western rainfall trend :

It is quite clear from the Table that Balrampurdistrict showing a significantly decreasing trend in annual rainfall @1.04mm/year while significant increasing trend is observed in Bemetara (2.76 mm/year), Korba (1.83mm/year) Mahasamund (3.01 mm/year) and Surguja (1.75mm/year). During the South Western Monsoon season, Balrampurdistrict is showing a significant decreasing trend @-2.14mm/year while Bemetara, Korba, Raigarh and Raipur showing a significant increasing pattern of about 3.37mm, 1.64mm, 2.4mm and 3.5 mm/year, respectively.

Districts wise trend of annual and south west monsoon rainfall

S.No	District	Annual RF(mm)	Significant Level	SWM RF(mm)	Significant Level
1	Balod	0.576	NS	0.142	NS
2	Baloda Bazar	-0.431	NS	-0.883	NS
3	Balrampur	-1.037***	S (0.1)	-2.135*	S (0.01)
4	Bastar	-0.395	NS	0.15	NS
5	Bemetara	2.76*	S (0.01)	3.312*	S (0.01)
6	Bijapur	-0.834	NS	-1.039	NS
7	Bilaspur	0.637	NS	-0.335	NS
8	Dantewada	-0.523	NS	1.509	NS
9	Dhamtari	-0.951	NS	0.700	NS
10	Durg	-0.951	NS	-1.056	NS
11	Garyiband	-0.597	NS	-0.475	NS
12	Janjgirchampa	-0.742	NS	-1.421	NS
13	Jashpur	-0.318	NS	-0.431	NS
14	Kanker	1.25	NS	1.079	NS
15	Kawardha	0.621	NS	0.008	NS
16	Kondagaon	-1.03	NS	-1.195	NS
17	Korba	1.823***	S (0.1)	1.647***	S (0.1)
18	Koriya	0.065	NS	-0.152	NS
19	Mahasamund	3.014*	S (0.01)	-0.152	NS
20	Mungeli	-1.264	NS	-1.639	NS
21	Narayanpur	0.802	NS	0.13	NS
22	Raigarh	0.035	NS	2.396**	S (0.05)
23	Raipur	0.233	NS	3.456*	S (0.01)
24	Rajnandgaon	-0.701	NS	-0.403	NS
25	Surguja	1.75***	S (0.1)	-1.136	NS
26	Sukma	-1.079	NS	0.961	NS
27	Surajpur	-0.507	NS	0.245	NS

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur

Season wise distribution of PET:

Distribution of PET values of Raipur, Bilaspur, Ambikapur and Jagdalpur was calculated for different seasons viz. winter, summer, south-west and post-monsoon seasons is shown in Table. Summer season consisting only two months i.e. April and May months. But the cumulative value of PET for summer season is round about 600 mm, though it is varying between 547 mm in Bilaspur to 671 mm in Raipur. During winter season, spatial variability across the four stations is 189 mm in Bilaspur to 222 mm in Jagdalpur. During the South-western monsoon season, the cumulative PET value ranges between 496 mm in Jagdalpur to 584 mm in Raipur. In post-monsoon season, the PET value ranges between 283 mm in Ambikapur to 323 mm in Raipur.

Annual PET of four stations using different methods

Stations	**Modified Penman**	**Hargreaves**	**Turc**	**Thornthwaite**	**Blaney-Criddle**	**Christiansen**	**Open Pan**	**FAO Penman Montieth**
Ambikapur	1590	1667	1371	1430	1534	1399	1235	1380
Jagdalpur	1557	1717	1298	1434	1390	1106	951	1372
Raipur	1848	1798	1421	1842	1739	1537	1260	1627
Bilaspur	1521	1735	1378	1768	1553	1301	1157	1297

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur

Seasonal values of PET for representative

Season	Raipur	Bilaspur	Ambikapur	Jagdalpur
Winter	212	199	189	222
Summer	671	547	592	594
South west monsoon	584	501	525	496
Post monsoon	323	304	283	317

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur

Session-2

Climate Change adaptation and mitigation strategies in agriculture for Chhattisgarh State

Climate change and Global warming

Meteorology is the study of phenomena of the atmosphere – includes the dynamics, physics and chemistry of the atmosphere. (from the Greek meteōros – 'lofty') and it is more commonly thought of as restricted to the dynamics and thermodynamics of the atmosphere as it affects human life. It is the state of the atmosphere; mainly with respect to its effects upon human activities. Weather is short term variability of the atmosphere (time scales of minutes to months).

Popularly thought of in terms of: temperature, wind, humidity, precipitation, cloudiness, brightness, and visibility. Therefore weather is a category of individual/combined atmospheric phenomena which describe the conditions at the time of an observation. On the other hand, climate is the long term statistical description of the atmospheric conditions, averaged over a specified period of time - usually decades (minimum 30 years data is taken into account).

Climate change and global warming have become significant issues in relation to agriculture in recent times. One serious concern for agriculture in this country is the impact of climate change. Swedish chemist and Noble prize winner Svante Arrhenius in early 1896 discussed about the rise in average global surface air temperature around 5 - 6°C which would trigger by doubling of CO2 in lower part of atmosphere. At the time of maximum glaciation, the global mean temperature was supposed to be 5-7 degree centigrades lower than the present. During the last century, earth's climate warmed by 0.3-0.6 degree centigrades. During the last 100 to 150 years for which the records are available, remarkable climatic fluctuations are identified. The earth surface temperature is already higher by 0.6 degree centigrade as compared to the year 1860. The climate response to the increasing CO2 and other Green House Gases (GHGs) has been assessed through mathematical models. The surface air temperature due to CO2 doubling as simulated by variety of General atmospheric circulation models (GCMs) yields warming of the order of 4.2 degree centigrade.

There are two theories that higher surface temperature will cause more evaporation and thereby higher water vapour concentrations and water vapour in itself is important infra-red absorber. Another theory is that higher surface temperature will lead to more melting of snow and ice cover on land and sea which will lead to greater absorption of incoming solar radiation instead of its reflection back into space.

Effect of Climate Change on Agriculture:

Agriculture is crucial for ensuring food, nutrition and livelihood security of India. It engages almost two-third of the workforce in gainful employment and accounts for a significant share in India's Gross Domestic Product (GDP). Several industries depend on agricultural production for their requirement of raw materials. On account of its close linkages with other economic sectors, agricultural growth has a multiplier effect on the entire economy of the country. On the other hand, the increased rate of population is pressurizing the agricultural sector for enhanced food production. The task is very challenging because about 60% of the net cultivated area is rainfed and exposed to stresses arising from climatic variability and climate change. More than 80% of Indian farmers are marginal (cultivating agricultural land up to 1 hectare) and small (cultivating between 1 hectare and 2 hectares) with poor coping capacity. Furthermore, the Indian farms are diverse, heterogeneous and unorganized.

Indian agriculture is highly prone to the risks due to climate change; especially to drought, because 2/3rd of the agricultural land in India is rainfed, and even the irrigated system is dependent on monsoon. Flood is also a major problem in many parts of the country, especially in eastern part, where frequent flood events take place. In addition, frost in north-west, heat waves in central and northern parts and cyclone in eastern coast also cause havoc.

In recent years, the frequency of these climatic extremes are getting more due to the increased atmospheric temperature, resulting in increased risks with substantial loss of agricultural production. Climate change can affect agriculture through their direct and indirect effects on the crops, soils, livestock and pests. Increase in atmospheric carbon dioxide has a fertilization effect on crops with C3 photosynthetic pathway and thus promotes their growth and productivity.

Increase in temperature can reduce crop duration, increase crop respiration rates, alter photosynthesis process, affect the survival and distributions of pest populations and thus developing new equilibrium between crops and pests, and hasten nutrient mineralization in soils, decrease fertilizer use efficiencies, and increase evapo-transpiration. Climate change also have considerable indirect effects on agricultural land use in India due to availability of irrigation water, frequency and intensity of droughts and floods, soil organic matter transformations, soil erosion, changes in pest profiles, decline in arable areas due to submergence of coastal lands, and availability of energy.

A significant increase in runoff is projected in the wet season that may lead to increase in frequency and duration of floods and also soil erosion. However, the excess water can be harvested for future use by expanding storage infrastructure. The water balance in different parts of India is predicted to be disturbed and the quality of groundwater along the coastal track will be more affected due to intrusion of sea-waters.

According to World Bank Report under 2°C warming by the 2050s, India may need to import more than twice the amount of food-grain than would be required without climate change

Climate Smart Agriculture:

This section describes the history and evolution of climate-smart and climate-resilient agriculture, defines what it means, and reviews the evidence. This is dealt with at three levels: on a global front; more locally, where there are a growing number of initiatives within the sub-continent, and within India.

Climate-smart agriculture (CSA) is a term first coined by FAO in a background document prepared for the 2010 Hague Conference on Food Security, Agriculture and Climate Change. FAO have produced a Sourcebook which outlines its potential and limitations, as a reference tool for planners, practitioners and policy makers working in agriculture, forestry and fisheries at national and subnational levels[1] . The CSA concept was developed with a strong focus on food security (FAO's mandate), including adaptation to climate change.

CSA and Climate Resilient Agriculture (CRA) are similar, and the two are used interchangeably here. CRA reflects the more recent focus on address vulnerability through building resilience, and since this is at the core of the Government of India's philosophy[2] this is the term used in this study. There are huge uncertainties in the way climate change will directly and indirectly impact agricultural and food systems, and related vulnerabilities. Building resilience now is central to preparing for future changes. The notion of resilience enables examining together various domains – biophysical (ecosystems), economic, social and institutional – and scales of operation[3]. CRA is a holistic approach to the problems of food security, climate resilience and climate mitigation. It is an integrated approach suited to meeting the food security, demographic and climate challenges that confront the world at large.

What is CRA?

CRA overlaps with the concepts of sustainable agriculture and disaster risk reduction, and some of its techniques, such as rainwater harvesting, have been practiced for centuries. What is different about CRA is its emphasis on climate risks. While all activities under CRA are likely also to represent sustainable agriculture practices, vice versa may not be the case. It is not a 'one size fits all' set of practices. In any specific location, its form is defined by the context and associated priorities[4] . CRA involves developing technologies, policies and institutions, mobilizing investments and bringing all these into alignment in pursuit of three pillars as described below in the diagram[5]:

1 Food and Agriculture Organization of the United Nations (2013). Climate-smart agriculture sourcebook. Rome
2 See Government of India's NICRA, National Initiative on Climate Resilient Agriculture
3 Building Resilience for Adaptation to Climate Change in the Agriculture Sector. Proceedings of a Joint FAO/OECD Workshop April 2012. http://www.fao.org/docrep/017/i3084e/i3084e.pdf
4 http://www.actiononclimate.today/act-on-knowledge/climate-smart-agriculture-and-the-need-to-scale-up/#_ftn2 http://www.fao.org/docrep/018/i3325e/i3325e00.pdf
5 http://www.fao.org/docrep/018/i3325e/i3325e00.pdf

Figure 1. The three pillars of CRA

Increasing adaptive capacity, Pillar 2, is thus central to CRA. Climate change threats can be reduced by increasing the adaptive capacity of farmers as well as increasing resilience and resource use efficiency in agricultural production systems[6].

Crucial CRA Actions

Governments and partners seeking to implement CRA can undertake a range of actions to provide the foundation for effective policies, programmes and projects. Four major types of actions are generally considered to be essential[7]:

1. Review and expand the evidence base. Knowledge and data are vital in identifying agricultural strategies for reducing vulnerability that integrate necessary adaptation and mitigation;
2. Build policy frameworks. Building policy frameworks to support implementation at scale;
3. Strengthening institutions. Strengthening national and local institutions to enable farmer management of climate risks and adoption of context-suitable agricultural practices, technologies and systems;
4. Leveraging finance. Enhancing financing options to support implementation, linking climate and agricultural finance.

CRA in South Asia

As a region, South Asia has one of the world's highest incidences of food insecurity and poverty. Climate, population growth and agricultural investment trends combine to exacerbate the situation. Recent assessments suggest that by 2050, South Asian rice production is set to fall by 14%, wheat production by up to 49% and maize production by up to 19%[8]. At the same time, the South Asian rural population is expected to peak in the next 20 years[9]. In South Asia, as in other parts of the world, examples of good CRA practice are showing what can be achieved, and there are a growing number of success stories.

Other success stories

The World Bank Group (WBG) aims to deliver CSA through all its operations, increasing its focus on adaptation and resilience[10]. It screens all its projects for climate risks, and supports client countries to implement their Nationally Determined Contributions (NDCs) in the agriculture sector. The WBG quotes successful examples of CSA in its projects in Mexico. Morocco, Senegal, and Uruguay. It also supports African farmers in the Evergreen Agriculture programme which promotes minimal use of costly fertilizers; in Zambia maize yields tripled when grown under Faidherbia trees[11].

In Uganda, use of more efficient water-management technologies such as advanced drip irrigation and solar irrigation have proved effective approaches to adapt to climate change. Scientists are using beneficial microbes to strengthen plant resilience to increased drought, diseases and pests brought on by climate change. Farmers are also actively participating in the collection of climate-related data[12]. In New Mexico an organic dairy farmer responded to increasing drought by transitioning to zero-tillage to save water[13].

6 www.nature.com/nclimate/journal/v4/n12/full/nclimate2437.htm

7 https://ccafs.cgiar.org/climate-smart-agriculture-0#.WQmWQ1N95AZ

8 Nelson, G.C., M.W. Rosegrant, J. Koo, R. Robertson, T. Sulser, T. Zhu, C. Ringler, S. Msangi, A. Palazzo, M. Batka, M. Magalhaes, R. Valmonte-Santos, M. Ewing and D. Lee (2009). Climate Change: Impact on Agriculture and Costs of Adaptation. Washington: International Food Policy Research Institute.

9 IFAD (2011) cited in Food and Agriculture Organization of the United Nations, the Consultative Group for International Agricultural Research and the Research Program on Agriculture, Climate Change and Food Security (n.d.). Knowledge on Climate Smart Agriculture: Questions and Answers.

10 http://www.worldbank.org/en/topic/agriculture/brief/foster-climate-smart-agriculture

11 http://www.worldbank.org/en/news/feature/2013/03/18/an-evergreen-revolution-cuts-fertilizer-costs-for-africa-s-farms

12 https://farmingfirst.org/tag/climate-smart-agriculture/

13 http://blogs.edf.org/growingreturns/2014/09/25/what-is-climate-smart-agriculture/

There are by now many other case histories on record where CSA/CRA has had an impact. The list is growing, and suggests that the approach is comprehensive and sound. A series of success stories of climate smart agriculture in action, has been released by the Technical Centre for Agricultural and Rural Cooperation (CTA) and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) to demonstrate the varied ways climate smart agriculture can take shape[14].

National focus

The Prime Minister's National Action Plan on climate change has identified agriculture as one of the eight national missions[15]. Recognizing the vulnerability faced by India and the disproportionate impacts of the risks posed by climate change to the nation, the Indian Council of Agricultural Research constituted the National Initiative on Climate Resilient Agriculture (NICRA) in February 2011. NICRA actions are multi-stage and strategic in addressing climate risks. The initiative promotes strategic research on core areas, technology demonstration for coping with current variability, capacity building and financing of critical research gaps. The interventions are layered and focus on four modules; natural resources, crop production, livestock and fisheries and institutional interventions. Drought-prone districts of Chhattisgarh are covered under the technology demonstration component of the programme.

The Pardhan Mantri Krishi Sinchayee Yojana (PMKSY)[16] Program to promote efficient irrigation practices and improve water use efficiency; the Integrated Watershed Management Program (IWMP)[17] on natural resources conservation; as well as India's Intended Nationally Determined Contribution (INDC) as presented to the COP21 in Paris to address the adverse effects of climate change are earmarked as priority flagship programs by the national government.

Individual initiatives from multi-lateral and bilateral development agencies such as World Bank, SDC, NORAD, GIZ and the Embassy of Netherlands also promote actions that are in line with the government priorities for climate resilient agriculture in India. The Consultative Group for International Agricultural Research (CGIAR) working with national agricultural research centres are engaged in developing location-specific crop varieties that are resistant to climate variability. The $10 billion Green Climate Fund[18] has identified climate-resilient agriculture as one of its five investment priorities. The Bill and Melinda Gates Foundation[19] also allocates approximately $100 million per year to agricultural research centres.

Climate Resilient agriculture practices for Chhattisgarh

Interventions / Climate risk management:

Looking into the regional climate change studies in Chhattisgarh state, some policy interventions have been documented which are as follows. Looking into the discussion held, an attempt has been made to list adaptation and mitigation strategies which can be applied under field conditions as model testing for its implementation at wider scales. This will also help in adopting and developing risk management strategy.

(i) Rainwater harvesting

* Farm Ponds

* Percolation tanks

14 https://farmingfirst.org/tag/climate-smart-agriculture-success-stories-from-farming-communities-around-the-world/
15 https://www.gktoday.in/what-are-the-8-missions-of-indias-national-action-plan-on-climate-change/
16 http://pmksy.gov.in/
17 http://iwmp.telangana.gov.in/
18 http://www.greenclimate.fund/home
19 https://www.gatesfoundation.org/Where-We-Work/India-Office

* Nala Bandhan

* Check dams

* Dug wells

(ii) Introduction of Pressure Irrigation:

* Drip irrigation
* Sprinkler
* Pipe irrigation

Model of indigenous Micro irrigation system for use of conserved water of dug wells

(iii) Moisture conservation techniques:

* Use of plasticulture
* Contour bunding
* Staggered trenches
* Gabien structures
* Soil mulch/ straw mulche

(iv) Crop/ cropping system management :

* Early duration rice
* Drought resistant varieties
* Crop diversification
* Broadbed furrow system

(v) Farming system approach

* Dependancy on allied enterprises
* Different components of farming system viz, animals, dairy, poultry, fisheries, lac cultivation, honeybee and mushroom etc.

(vi) Use of Farm Mechanization in agriculture

* Use of mechanization for crop establishment, interculture, harvesting etc.
* Custom hiring approach for completing weather sensitive farming operations in time

(vii) Strengthening of real time agro-advisory dissemination

(viii) Technological interventions

* Dry line sowing
*Chemical weed control
* Mechanized crop establishment
* Ridge furrow for dryland crops
* Selection of crops and varieties

(ix) Weather based crop insurance for different crops

(x) Development of assured irrigation sources

* Tubewells/ Dugwells

(xi) Employment generation through entrepreneurship development.

(xii) Capacity building through training programmes at village level and exposure visits.

Further an attempt has been made under NICRA-AICRPAM project to document the varieties which are suitable for cultivation in different sets of abiotic stress.

List of varieties of rice crop with biotic stress tolerance in different agro-climatic zones of Chhattisgarh

(Name of the state : Chhattisgarh state)						
Names of varieties recommended for						
	Delayed monsoon	Drought tolerance	Flooding/ submergence tolerance	Heat tolerance	Cold tolerance	Source of seed availability
Agroclimate zone I (Chhattisgarh Plains zone)	Vanprabha, Indira Rajeshwari, Indira Sona, Aditya, Danteshwari	Poornima, Tulsi, Kranti, Indira BaraniDhan -1, Samleshwari, Annada, Aditya, Kalinga-3	Jaldubi Baleshwari, Mahamaya	Karma Mahsuri	-N/a-	IGKV seed farm and C.G. Rajya Beej avam Krishi Vikas Nigam
Agroclimate zone II (Northern Hills)	Indira Rajeshwari, Vanprabha, Indira Sona	Poornima, Tulsi, Kranti, Indira Barani-1,Samleshwari, Annada, Aditya,Kalinga-3	Jaldubi Baleshwari, Mahamaya	Karma Mahsuri	-N/a-	IGKV seed farm and C.G. Rajya Beej avam Krishi Vikas Nigam
Agroclimaticzone III (Bastar plateau)	Vanprabha, Annada, Aditya, Samleshwari, Indira Sona	Pradhan, Lalu Chanda, Satka Vandana, Poornima	Jaldubi Baleshwari, Mahamaya		-N/a-	IGKV seed farm and C.G. Rajya Beej avam Krishi Vikas Nigam

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur

Case study-

Field Model of Soil Conservation Structures Constructed with Local Materials was conducted through BRSM College of Agricultural Engineering & Technology and Research Station, Mungeli (Chhattisgarh). Soil Erosion is a major problem in Mungeli district and other parts of the state. The soil losses are more than the permissible limit of 02 tonne/hectare from the cultivated land. The conservation of soil and water both are important for realizing the full potential of the crop, by conserving these two natural resources. The soil and water conservation structure are more effective than vegetative measures for this purpose. Dry spell is a frequent phenomenon in the region, therefore 1-3 supplemental irrigations are needed to rice and other crops, otherwise drastic reduction in crop yields have long repercussion in terms of wide spread drought and consequent migration from the region. To overcome these problems, for demonstration purpose, to the students and farmers, a demonstration unit was setup, depicting various soil conservation structures such as gabion, boulder checks, gunny bag check dam, vegetative dams etc. 06 soil and water conservation structures were established in the natural drain to arrest soil loss and storage of rain water for subsequent irrigation if needed. These structures were made from local available materials and used materials. These structures are suitable for cultivated land with 1-3% slope. These structures are very cost effective as these are made from locally available and waste materials found almost in every farm. Since these structures are long lasting (10 years life), the tangible and intangible benefits accrued from these structures are manifold and on an average the cost of such structures are recouped within 5 years. Besides these, the ground water recharge and saving of valuable fertile soil particles are other intangible benefits to the concerned farmer and the community as whole. Watershed program implemented in the state is using these technology to improve soil health and water status in the farmers field.

Session-3

Soil and Water Conservation with Reference to Climate Change

The consequences of climate change could be variation in temporal and spatial water availability (Surface Water as well as ground water), frequent occurrence of flood and drought (Intensity, Frequency and Magnitude), higher glacier retreat rates, reduction in snow precipitation, sea level rise (sea water intrusion in coastal areas) etc. Global warming is leading to change in climate. As temperature increases so does the process of evaporation. In addition the moisture holding capacity of the atmosphere increases with temperature. For every 1oC increase in global temperatures there is a 7% increase in the moisture holding capacity of the atmosphere. Now, rainfall intensity should increase at same rate as increases in atmosphere moisture (7% / degree C), hence; more moisture in the atmosphere ultimately leads to changes in rainfall patterns (http://www.waterandclimatechange.eu/evaporation). More rain is expected over high-latitude land areas while less over equatorial regions. Tropics and subtropics regions are expected to receive less runoff. This coincides with the existing water stress in tropical and subtropical regions. Overall less frequent but more intense floods and droughts will occur, which will lead to water shortage. In Chhattisgarh, the climate in many districts is becoming semi-arid. In general the state is moving from a wet to dry climate (Department of Agrometeorology, IGKV). The situation may put additional pressure on already overexploited aquifers due to want of irrigation water. One of the solutions to these problems is Storage (Ground water or Surface water) through adoption of soil and water conservation measures. Government has taken suitable measures by creating series of anicuts and check dams in the nallahs and rivulets. Another solution could be the wetland conservation and its judicious management.

Climate change is also responsible for extreme weather events, which is creating environmental hazards, accelerated rate of soil erosion, and also threatening the agricultural production. Increase in soil erosion rates will reduce productivity. Climate change, in addition to the ever bursting population threatens the food security and presents one of the biggest challenges before agriculture. Looking to the alarming situation Indian Council of Agricultural Research (ICAR) has launched a major network project, National Initiative on Climate Resilient Agriculture (NICRA) during February 2011 to undertake strategic research on adaptation and mitigation, fill critical research gaps, and demonstrate technologies on farmers' fields to cope with current climate variability and capacity building of different stakeholders. Interventions under NICRA leading to Soil and Water Conservation are in-situ moisture conservation, biomass mulching, residue incorporation instead of burning, brown (Animal) and green (Plant) manuring, water harvesting and recycling for supplemental irrigation, improved drainage in flood prone areas, conservation tillage, artificial ground water recharge and water saving irrigation methods.

Current estimate of soil loss in the country is around 5000 M tons yr-1. This will account for loss of millions of rupees when converted in terms of nutrient. Now, with more intense floods due to climate change this estimate is further going to increase and agriculture situation going to worsen. Additionally, climate change can increase the potential for higher erosion rates, which is also of concern because erosion has been reported to lower agricultural productivity by 10% to 20% (Quine and Zhang 2002; Cruse and Herndel 2009). Since there is direct relationship between soil and water conservation practices and agriculture productivity, it is confirmed that without the application of appropriate soil and water conservation measures, it will not be possible to increase the agriculture productivity to feed the growing population. Solution lies in the soil and water conservation measures; which can be broadly classified based on land slope as agronomical/biological measures and engineering/mechanical measures. In agronomical measures (when slope is less than 2 percent) efforts are made to conserve soil by crop rotation, inter cropping, mixed cropping etc. The vegetative measures may include use of cover crops, diversification in cropping systems, shift from annual crop to perennial crops, use of organic soil amendments (brown and green manure), grazing field management etc. Climate change scenario will call for change in the practices to mitigate the adverse effects. It is a proven fact that soil function improves with soil carbon and soil carbon sequestration is beneficial for the environment as a whole. Carbon sequestration is important in climate change adaptation efforts as it is directly related to agriculture productivity.

In engineering/mechanical measures, suitable structures are designed and constructed at suitable sites utilizing locally available materials. These structures could be temporary or permanent depending upon the slope to be stabilized for having a check on soil erosion and water harvesting. The design consists of hydrologic design, hydraulic design and structural design. Hydrologic design is carried out by considering a rational recurrence interval (R.I.) of a particular magnitude-frequency-duration of rainfall. Based on that hydrologic design the peak flood and time to peak to be handled by the structure is ascertained. Now, with changing climate scenario, more intense floods are being expected. This may call for higher recurrence interval than the standard to mitigate the consequences of climate change. Higher recurrence interval will lead to have hydraulic and structural design on higher side for additional factor of safety. With enhanced dimensions and strength, the cost of soil and water conservation is definitely going to increase. On the other hand, in hilly areas the life of existing bench terraces and other structures is also going to be shortened as it will not be able to accommodate more intense precipitation. This establishes the fact that climate change affects development and development affects the climate.

The challenges of climate change mitigation and adaptation can be met by maximizing soil and water conservation. This will also enable to develop sustainable systems. Soil and water conservation needs for climate change mitigation and adaption includes prevention of soil erosion, creation of irrigation infrastructure, adoption of modern irrigation practices for increasing irrigation efficiencies, soil and crops management to increase water-use efficiencies, diversification of cropping systems, developing drought-tolerant crop varieties, developing secondary storage at farmers field (Small farm reservoir), resynchronization of agricultural operations matching with the shifts in rainy season, carbon sequestration, awareness and valuation of agricultural produce with their respective water and carbon footprint and precision agriculture. To conclude, a sound scientific approach incorporating the concepts of agronomy, soil science and soil water conservation is needed to build and maintain sustainable agricultural production systems.

Case studies-

1. Low cost Mulching for Badi Cultivation

Mulching is a layer of any material applied to the surface of soil. The material may be paddy straw, stones, pebbles, plastic sheets etc. placed on the ground around plants to moderate the temperature, suppress weed growth, retain soil moisture, and prevent freezing of roots. Despite the problems of decomposition and dumping, plastic mulch has proven its merits over the other. Hence, it is most commonly used and costs ranges from 6 to 16 per square meter. This cost is a big constraint for small and marginal farmers. As a result many small and marginal farmers, growing vegetables under Badi cultivation are not using plastic mulching.

On the hand, due to widespread applications of plastic in all walks of life, every day tons of plastic waste is produced. There is an urgent need to arrest expansion of plastic. What every individual can do is refuse, reduce and reuse. Food materials are often sold in plastic bags of different micron thickness. Can we utilize the big size bags (60cm x 90cm) for some useful purpose? Yes, used plastic bags like wheat flour bag, rice bags, fertilizer bags, cement bags etc. have been utilized for making mulching rolls. Experiments were conducted in the year 2015-16 (Rabi marigold) and 2016-17 (summer okra) and found encouraging results. Further, the experiment is going on for evaluating the performance in Rabi Onion during the year 2017-18. The experiment is being conducted at department of Soil and Water Engineering, FAE, IGKV, Raipur with the aim to prepare mulch sheet from used plastic materials and to evaluate their performance in terms of change in micro-climate for rabi onion crop. In this experiment, 8 types of mulching condition have been used i.e. black polythene mulch, silver polythene mulch, wheat flour bag mulch, rice bag mulch, fertilizer/cement bag mulch, paddy straw mulch, soil mulch and without mulch(control) under the same level of irrigation (100% of ETC) with three replications. Observations of Yield, Labor requirement, Soil Moisture Content at different depth, soil temperature, Weed control Merits and demerits are taken up. The issues of creating efficient and uniform holes in the mulch have also been covered by improvising a low cost frame and using common tools. Sequential picturesque presentation of the whole process and methodology has also been shown.

General observation of soil temperature, soil moisture and weed restriction has shown enthusiastic results with cost varying from 3 to 4 per square meter including the labour cost. Small and marginal farmers who are reluctant to adopt mulching due to want of extra investment, may adopt with little efforts and contribution towards environment.

Collection of used plastic bags

Sorting

Cleaning

Cutting

Fixing

Mulching frame

Wrapping in frame

Use of tools

Mulching roll with uniform holes

Different types of mulch roll

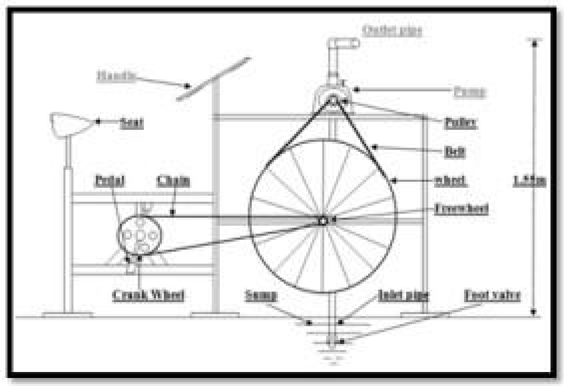
Laying of mulch in field

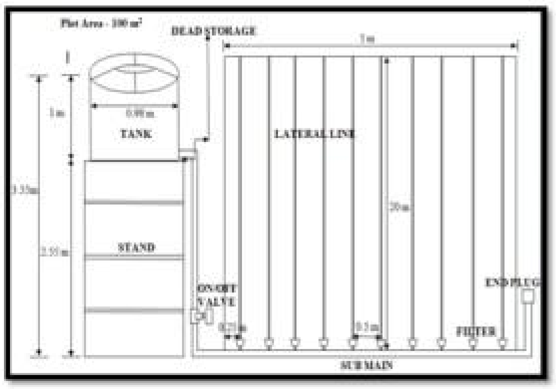
Onion crop with different mulches

2. Development of an environment and health linked human powered pedal operated low lift pumping system for operating gravity drip system of irrigation

Problem statement: Operating a gravity Drip system of irrigation without electricity or diesel engine power, Low lift pumping in remote and inaccessible locations, Water harvesting and lifting water for ODF villages/schools

Description: Human powered pedal operated low lift pumping system, equipped with sensors on time, speed, distance; calorie and pulse observation is developed and tested. The mechanism works in exercising mode (Health friendly) and capable of liftingdeveloping maximum 1625 RPM for operating a 1 hp centrifugal pump of size 25mm × 25 mm without electric motor. With this RPM the pumping system can lift water (Harvested) @ 2230 lph under a maximum suction head of 3.85 m and 0.65 m delivery head or @ 1800 lph under a maximum delivery head of 2.25 m and 1.0 m delivery head without using electricity or diesel engine power (Environment friendly). The water is used for operating a gravity fed drip system of irrigation and catering to the need of kitchen garden.





Applicability/Situations: The developed system can be installed near a water harvesting tank in all the gardens with open gym, in all schools with “PoshanVatika”, in all the hostels and human power of youth can be utilized efficiently for some useful work. It has got number of house hold application also as the pump can be operated with ease and without electricity. Environment and health friendly pumping system can also be used for lifting harvested water near hand pumps in villages, to overhead tank and play some role in open defecation free villages. The system can also be utilized in sprinkling water to the nearby field from an elevated canal without using electricity.

Session-4

Integrated Farming System –effective approach to cope up with climate change

The human population of India has increased to 1210.2 million at a growth rate of 1.76 per cent in 2011 over 2001 (1028.7 million) and is estimated to increase further to 1530 million by 2030 (Census of India, 2011). On the other hand, our national food grain production for past 3-4 years is hovering around 234 million tonnes. This means, per capita food grain production is only about 193 kg per year. Simultaneously, the demand for high-value commodities such as; fruits, vegetables, livestock products, fish, poultry etc., is increasing faster than food grains. Livestock has traditionally been an integral part of farmers' household, as it plays an important role not only in the farm production but also in augmenting rural economy and in recycling of farm wastes. India's current livestock population is 510.6 million (with 191.2 million cattle and 102.4 million buffalo) and estimates indicate that milk production will also increase substantially, from present 108.5 million tonnes to 175 million tones by 2030 (Indian Livestock Census, 2003). However, situation with respect to feed and fodder availability may further worsen, which is already facing a shortfall of concentrate (63%), green fodder (62%) and dry fodder (22%). The poultry, 571.1 million in number, produces about 55.64 billion eggs and 1401 thousand tonnes of meat, and present production of beef, buffalo meat, sheep meat, goat meat, pork and poultry meat is 1462, 1443, 232, 470, 612 and 1401 thousand tonnes as against a demand of 1460, 3250, 600, 850, 770 and 3930 thousand tonnes, respectively. National scenario with respect to farm size is also not very promising the average size of the landholding has declined to 1.21 ha during 2009-10 from 2.30 ha in 1970-71, If this trend continues, the average size of holding in India would be mere 0.68 ha in 2020, and would be further reduced to a low of 0.32 ha in 2030 (Agricultural Statistics at a Glance, 2009). Declining size of landholdings without any alternative income augmenting opportunity is resulting in fall of farm income, and causing agrarian distress. In view of serious limitations of horizontal expansion of land for agriculture, only alternative left is vertical expansion through various farm enterprises requiring less space and time but give high productivity and ensuring periodic income especially for the small and marginal farmers. However, under the changing scenario a paradigm shift in research is inevitable with more focus towards small and marginal holders in farming systems perspective.

Integrated farming system refers to agricultural systems that integrate livestock and crop production or integrate fish and livestock and may sometimes be known as integrated bio-systems. In this system an inter-related set of enterprises used so that the "waste" from one component becomes an input for another part of the system, which reduces cost and improves production and/or income. IFS also ensure overall increase in productivity for thewhole agricultural systems and preserving the resource base and maintaining high environmental quality.

Principles of Farming System

- Minimization of risk
- Recycling of wastes and residues
- Integration of two or more enterprises
- Optimum utilization of all resources
- Maximum productivity and profitability
- Nutritional security
- Ecological balance
- Generation of employment potential efficiency
- Use of end products from one enterprise as input in other enterprise

Integrated Farming Systems Models, IGKV, Raipur

Integrated farming system research model has been started from the year 2010-11 with cropping system, horticultural system, fishery and poultry enterprises. From the year 2012-13, dairy component, Vermicompost and biogas units have also been taken under operation in addition to the aforesaid components.

Objectives

The situations of prevailing farming system and socio-economic conditions of the farmers call for the use of dynamic and innovative approaches to get maximum productivity and net realization from a farming system.

- To develop region specific IFS model including with crop-horti- dairy-fishery and other enterprises
- To enhance the productivity and profitability of small and marginal farmers' households through IFS approach
- To improve the livelihood and nutritional security through diversification approach.

Income generated from IFS research model:

Integrated farming system research model has been started from the year 2010-11 with cropping system, horticultural system, fishery and poultry enterprises. From the year 2012-13, dairy component, vermicompost units, biogas units have also been taken under operation in addition to the aforesaid components. A gross income of Rs 5,36,649/ha was generated from the entire IFS Research model area which is more in terms of gross return over previous year income i.e. 2015-16 from different component/enterprises. The net income of Rs 278689/- was achieved from different component/enterprises of Integrated Farming System.

Table 2: Gross income generated from IFS research model developed at IGKV, Raipur during last seven years

Enterprises/units	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Cropping systems							
Crop component	50453	59720	59,640	89721	119699	88535	129987
Horticulture							
Vegetables	13685	20225	17415	20050	34061	93174	117816
Papaya plantation	-	-	-	4000	4200	9405	18366
Supporting enterprises							
Dairy	-	-	60800	64583	100495	40696	113512
Poultry	-	9764	13,876	18910	15600	35233	84230
Fishery	8099	9975	2600	1800	5000	4500	11200
Mushroom	-	-	-	1362	1600	3600	5600
Vermicompost	-	-	-	12000	20000	20000	42000
Pigeon pea on pond dykes	1125	2500	2250	3360	2400	5840	2880
Biogas unit	-	-	-	5040	6000	10000	10000
Others	1587	-	-	-	-	722	1058
Total	**74,949**	**1,02,184**	**1,56,581**	**2,20,826**	**3,09,055**	**3,11,705**	**5,36,649**

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur

The gross income of 1.0 ha developed IFS model has been increased with year due to integration of more enterprises or components like dairy component, vermi-compost and biogas unitsin year 2013.

Production, Input-Output and Economics of IFS research model

In view of serious limitations of horizontal expansion of land for agriculture, only alternative left is vertical expansion through various farm enterprises requiring less space and time but give high productivity and ensuring periodic income especially for the small and marginal farmers.

Table 4: Component wise performance of IFS model during 2016-17

Components	Cost (Rs)	Gross return (Rs)	Net return (Rs)
Crop component (Agro + Horti)	77010.00	247803.00	170793
Bund plantation	8072.00	18366.00	10294
Dairy	85507.00	113512.00	28005
Poultry	41200.00	84230.00	43030
Fishery-	4762.00	14080.00	9318
Mushroom-	1500.00	5600.00	4100
Vermicompost	12548.00	42000.00	29452
Goatry	27360.00	1058.00	-26302
Biogas	-	10000.00	10000.00
Total	**257959.00**	**536647.00**	**278688.00**

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur

Income/cash flow round the year

Unlike conventional single enterprise crop activity where the income is expected only at the time of disposal of economic produce after several months depending upon the duration of the crop, the IFS enables cash flow round the year by way of sale of products from different enterprises viz., eggs from poultry, milk from dairy, fish from fisheries, silkworm cocoons from sericulture, honey from apiculture etc. This not only enhances the purchasing power of the farmer but also provides an opportunity to invest in improved technologies for enhanced production.

Employment Generation by IFS system

Various farm enterprises viz., crop +livestock or any other allied enterprise in the farming system would increase labour requirement significantly and would help solve the problem of under employment. An IFS provides enough scope to employ family labour round the year.The employment generation increased to 467 man days/ha/year by integrating various component as compare to cropping alone (123.15 man days/ha/year) during 2016-17. Integration of other components with cropping increases the labour requirement and thus provides scope to employ family labour round the year without much lean and peak demand for labour.

Table 5: Employment generated from IFS research model developed at IGKV, Raipur during 2016

Enterprise- wise Employment Generated (Man days)						Total	Total Value
Crops	Dairy	Hort.	Goat	Poultry	Others (Please specify)	Man Days	@ Rs./Man Day
123.15	180	25	86	26	26 (Fish Mushroom, vermicompost etc.)	467.15	Rs 107445/- @ Rs.230/-

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur

Residue Recycling by IFS system

Soil health, a key factor for sustainability is getting deteriorated and polluted due to faulty agricultural management practices viz., excessive use of inorganic fertilizers, pesticides, herbicides, high intensity irrigation etc. In farming system, organic supplementation through effective use of manures and waste recycling is done, thus providing an opportunity to sustain potentiality of production base for much longer time. Nutrients play key role in increasing agricultural production but now a day's the cost of fertilizers and other agro-inputs tremendously increased so the cost of cultivation is becoming constraints for small and marginal farmers. Efficient utilization of this costly input is the need of the time. Integration of different system components and recycling of by-products and farm wastes has been practiced in farming system. Total 76460 kg farm waste of Rs. 74284.00 value was recycled from 1.0 ha IFS model, IGKV, Raipur during 2016-17.

Farm Enterprises and related products used for recycling within the system	Total products recycled (Kg /Lit / No.) with their market value in parenthesis (Rs.)
Crops straw (kg)	14070 (@Rs 1.0/-Rs. 14070)
Green fodder (kg)	24173 (@ Rs 0.5/-Rs. 12087)
Crop residue (kg)(N%-0.60)	978(9.78 kg N, Rs 127.14/-)
Cowdung** Urine	37239 + 15400 (Rs. 6000/year as biogas and 21 tonnes of vermicompost @ Rs 2/kg (Rs. 42000)
Total	**76460 kg and 15400 litre (Rs. 74284/-)**

Source : Indira Gandhi Krishi Vishwavidalaya, Raipur

Impact Of IFS Model

Under region specific integrated farming systems model of 1.0 ha cropping system, horticulture system, fishery, poultry, dairy, goatry, vermicompost and mushroom components were under operation during 2016-17 at IGKV, Raipur. A gross income of Rs. 536647/-, was generated from IFS research model with income of Rs. 247803/- through cropping system, Rs 18366/- by horticultural cropping system, Rs. 240800/- by dairy unit, Rs. 14080/- from fishery and rest of Rs 15600/- from the other enterprises and total net return of Rs. 278689/- was achieved from the 1.0 ha model with employment generation of 467 man days.

Session-5

Women in Agriculture and climate change

It is estimated that, rural women are responsible for production of more than 55 per cent food grains and comprise 67 per cent of total agricultural labour force (Shivaram, FAO 1988). A recent estimation by FAO (2011) showed that women agricultural labour consists of 43 per cent of total world agricultural labour force. The role of women in agriculture varies from country to country. Asian women contribute to about 50 per cent of the food productionIn India, according to census 2011 among male workers, other workers constituted a major proportion i.e. 47.20 per cent of total workers. Similarly, among female workers, agricultural labourers constituted a major fraction i.e. 55.21 per cent of total workers.

Eighty per cent of Chhattisgarh's population is dependent on agriculture for its livelihood. Of the 37.46 lakh farmer households, 76% fall under the small and marginal category[20] , 33% of the farmer families are STs and 12% SCs. Small and marginal farmers cultivate 38% of the cropped area but constitute 75% of the State's cultivators. While it is a commonly known fact that women are involved in farming, disaggregated data on women farmers is rarely collected.

The Chhattisgarh State Action Plan on Climate Change(CSAPCC) recognizes that women and marginal farmers could be disproportionately affected by the impacts of climate change and the resulting vagaries of nature. Responsibility of adaptation falls on their shoulders including finding alternate ways to feed their families[21] . Because of customary laws restricting women's property and land rights, it becomes difficult for them to access credit and agricultural extension services and schemes which target land owners only. The CSAPCC also states that in a sector largely dominated by men, women farmers face a lot of difficulty in accessing inputs, extension services and subsidies for taking up agriculture as a livelihood option.

Women's contribution to agriculture, whether it is in subsistence farming or commercial agriculture, when measured in number of tasks performed and time spent is greater than that of men. Depending on the region and crops, women's contributions vary but they provide crucial labour from planting to harvesting and post-harvest operations. Despite working hard, spending longer hours and crucial contribution to agricultural production, their role has not been acknowledged. They are paid less or even left as unpaid workers. When there is a mention of a farmer, immediately the picture of a male farmer comes to our mind and not that of a female farmer whose contribution to the sector is high.

Table 4.1: Share of Farm Women in Agricultural Operation

Activity	Involvement (%)
Land Preparation	32
Seed cleaning and Sowing	80
Inter Cultivation Activities	86
Harvesting, Winnowing, Dying, Cleaning and Storage	84

Source: National Commission for Women, New Delhi Report (2005)

The above table shows that women are largely involved in inter cultivation activities (86%), Harvesting etc. (84%) and in seed cleaning and sowing activities (80%). Much of these agricultural works are by nature physically demanding, involving long periods of standing, stooping, bending, and carrying out repetitive movements in awkward body positions. Even when technological change has brought about a reduction in the physical drudgery of agricultural work, it has introduced new risks, notably associated with the use of sophisticated machinery and the intensive use of chemicals often without appropriate safety measures,

20 Annual Administrative Report 2017-18, Government of Chhattisgarh, Department of Agriculture and Biotechnology.
21 State Action Plan on Climate Change. Govt. of Chhattisgarh, March 2014

information and training. The demand for agricultural women labour in India fluctuates according to the seasons according to different regions and this is reflected in the nature of the workforce. Hours of work tend to be extremely long during planting and harvesting. Men agriculture workers tend to use the machineries whereas women who are not trained, resort to tedious and labour intensive agricultural methods.

Table 4.2: Type of Activities Performed by Women Agricultural Labour

Activities	Average Hours/Minute
Domestic Activities	7.55
Agriculture and Allied Activities	7
Sleep	6.5
Rest and Recreation	2.15
Total	**23.2**

Source: National Commission of Women, New Delhi Report (2005)

The table shows average time spent by women worker in household activities, agricultural activities and other activities.The role performed by men and women in agriculture is more or less defined. However, in the context of changing climate and adversities the role need to redefine in order to sustain the agriculture productivity.

Gender Empowerment to ensure climate resilient agriculture

1 .Access to Resource

Men's and women's access to and control over agricultural resources is often unequal. Many of these resources are essential for adaptation to climate change. Taking women's persistent lack of access to and control over resources into consideration is thus essential when supporting adaptation strategies to improve women's access to resources, and achieve gains in agriculture and food security in the context of climate change adaptation.

Key questions include:

- What are men's and women's resources for coping with climate change?
- Do women and men access climate information that they use in responding to climate risks? In what form? Do they use this information?
- What are the formal and informal institutions that supply men and women with the resources needed for adapting, such as information, financial support and technological inputs?
- Do men and women have access to labour markets for earning an income in times of need?
- Are men and women able to access the resources they need (e.g. cash and land) when they need them?
- Who owns and controls as opposite who uses the agricultural resources in the household? Specify land, seeds, manure, livestock, pest control systems and/or other resources.
- What are men's and women's individual food security status in times of crisis? Are they equally capable of accessing the resources they need to meet their food security requirements?

2. Including Gender in Agricultural Value Chain

In recent years, trade liberalization, globalization, technological advancement and other major trends have brought important changes to agricultural and food systems. These changes have yielded positive results, such as opening up new markets and creating successful linkages between producers and markets. However, they have also created new challenges for rural actors in gaining access to and benefitting from local, national and global markets (FAO, 2013c). Women in particular experience more difficulties compared to men in accessing productive resources, and in participating in and benefitting equally from agri-food value chains. Women make up 43 percent of the agricultural labour force and are profoundly involved in the production of food and cash crops worldwide, as well as in fishery, forestry and livestock. This "gender gap" represents a missed opportunity to secure sustainable development for the agricultural sector as well as improved food security and nutrition for all (FAO, 2011).

Major comparative studies have already established that improvements in gender equality and economic growth can be mutually reinforcing, while gender inequalities tend to be costly and inefficient (World Bank, 2001; World Bank, IFAD and FAO, 2009). Closing the "gender gap" in agriculture can result in major production gains: the FAO report on The State of Food and Agriculture 2010-2011 determined that women's yields could grow by 20–30 percent if the gender gap in accessing agricultural inputs were closed, an increase that could raise total agricultural output in developing countries by 2.5–4 percent, which could in turn reduce the number of food insecure people in the world by 12–17 percent (FAO, 2011). Within this context, integrating gender considerations into the development of agri-food value chains is not only necessary from a human rights perspective; it is also a prerequisite to ensuring sustainable growth in areas of intervention.

Gender relations are a primary component of the social and economic context that shapes Value Chain(VC) functioning at all levels, determining factors ranging from the types of jobs that are available to men and women, to differences in remuneration and the qualitative nature of individuals' productive roles inthe VC (e.g. time use, adoption of labour-saving technologies, and participation in decision-making). Gender relations are also deeply affected by the economic shifts inherent in VC improvement. For example, depending on the nature of the intervention and of the specific value chain, expanding women's productive participation may lead to an increase or a decrease in their access to and control over income (Rubin and Manfre, 2014). Similarly, changes in men's productive roles and earning capacity may also lead to shifts in the balance of decision making power at household and community levels. Finally, it is worth noting that gender considerations are relevant to issues of environmental sustainability in value chains. Women are usually responsible for the collection of food, fuel and water, as well as the production of subsistence crops in the household division of labour, but they also tend to have less access to key technologies and information (such as irrigation or training on drought mitigation techniques) that can increase their resilience in the face of environmental changes. They are therefore disproportionately affected by shifts in natural resource availability, but also ideally positioned to act as agents of change in relation to natural resource management (UN Women Watch).

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