Uttarakhand Climate Responsive Rainfed Farming Project
(UCRRFP)

Project Implementation Plan

Submitted To:
Project Director, UCRRFP,
Watershed Management Directorate
Indira Nagar Forest Colony,
Dehradun, Uttarakhand PIN-248006

Submitted by:
Ernst & Young LLP

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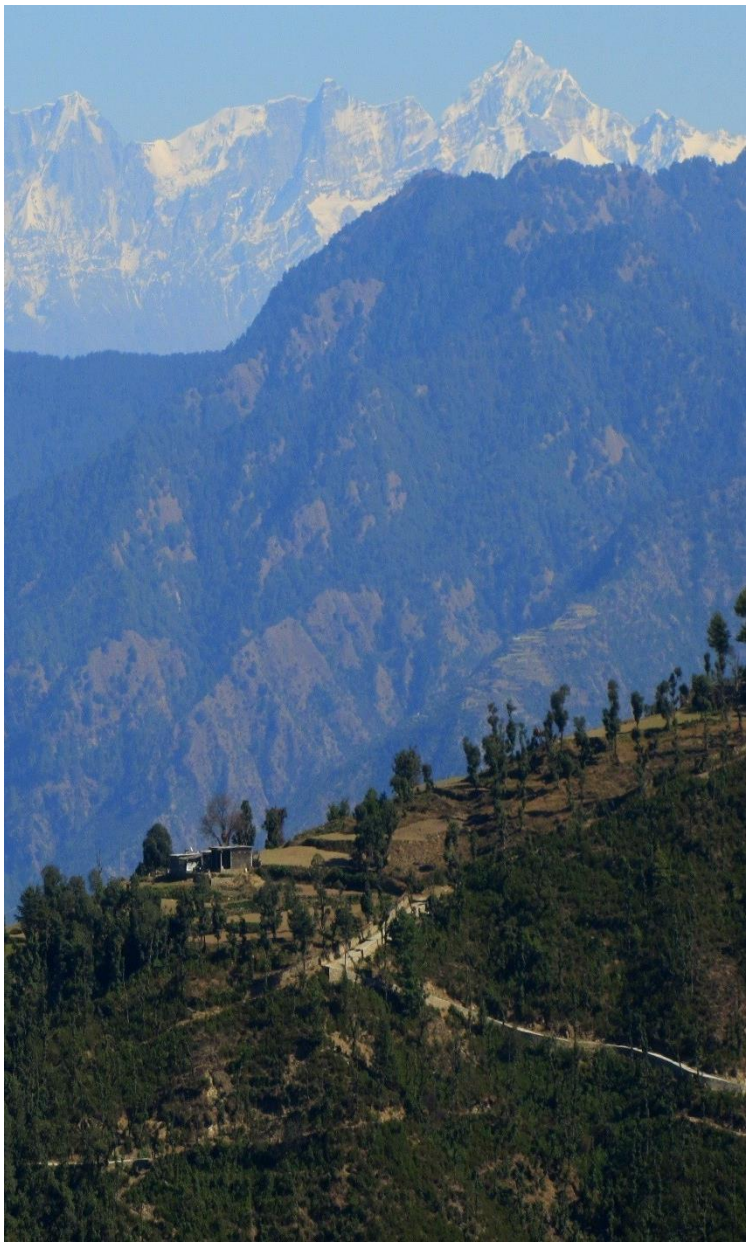
Abbreviations

AA	Accounts Assistant
AAP	Annual Action Plan
ABGC	Agribusiness Growth Centre
ADS	Agri Digital Service
ADSS	Agricultural Decision Support System
AE	Agri-Entrepreneurs
AEZ	Agri Export Zone
AG	Auditor General
AOA	Articles of Association
APMC	Agriculture Produce Marketing Committee
AWD	Alternate Wetting and Drying
BOD	Board of Directors
CA	Charted Accountant
CAAA	Controller of Aid, Accounts and Audit
CAG	Controller and Auditor General
CAGR	Compound Annual Growth Rate
CBO	Community Based Organization
CF	Continuous Flooding
CHC	Custom Hiring Centre
CM	Chief Minister (Helpline)
CMSS	Community Managed Seed System
CPP	Cultural Property Plan
CSA	Climate Resilient Agriculture
CWB	Crop Water Budgeting
DBT	Direct Benefit Transfer
DCC	District Coordination Committee
DD	Deputy Director
DDO	Drawing and Disbursing Authority
DEA	Department of Economic Affair
DOLR	Department of Land Resources
DPMU	District Project Management Unit
DSS	Decision Support System
EC	Eddy Covariance
EDP	Enterprise Development Program
EOI	Expression of Interest
EPI	Expert Preparedness Index
ESCP	Environment and Social Commitment Plan
ESF	Environment and Social Framework
ESHS	Environment and Social Health Standards
ESM	Environment and Social Management
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Standards
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FFS	Farmer Field School
FIG	Farmer Interest Group
FIU	Field Implementation Units
FNGO	Field Non-Governmental Organization
FPC	Farmer Producer Company

FPO	Farmer Producer Organization
GAP	Gender Action Plan
GDP	Gross Domestic Product
GHG	Green House Gas
GIS	Geographical Information System
GMO	Genetically Modified Organism
GOI	Government of India
GP	Gram Panchayat
GPRP	Gram Panchayat Resilient Plan
GRM	Grievance Redressal Mechanism
GSDP	Gross State Domestic Product
GSVA	Gross State Value Aided
HOD	Head of Department
HPC	High Power Committee
ICT	Information and Communication Technology
IGA	Income Generation Activity
IMD	Indian Meteorological Department
INM	Integrated Nutrient Management
INMP	Integrated Nutrient Management Plan
IOT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
IPMP	Integrated Pest Management Plan
IPPF	Indigenous People's Planning Framework
ISRO	Indian Space Research Organization
IT	Information Technology
IUFR	Interim Unaudited Financial Report
KPI	Key Performance Indicator
KVK	Krishi Vigyan Kendra
LDPE	Low Density Polyethylene
LMP	Labour Management Plan / Procedure
M&E	Monitoring and Evaluation
MDT	Multi-Disciplinary Team
MEL	Monitoring Evaluation and Learning
MIS	Management Information System
MOA	Memorandum of Association
MOES	Ministry of Earth Sciences
MORD	Ministry of Rural Development
MOU	Memorandum of Understanding
MT	Metric Ton
MTR	Mid-Term Review
NHP	National Habitat Plan
NIC	National Informatics Centre
NICRA	National Innovations on Climate Resilient Agriculture
NRM	Natural Resource Management
O&M	Operation and Maintenance
OGD	Open Government Data
ONDC	Open Network for Digital Commerce
PAD	Project Appraisal Document
PD	Project Director
PDO	Project Development Objective
PET	Potential Evapotranspiration
PHM	Participatory Hydrological Monitoring / Post-Harvest Management
PIP	Project Implementation Plan
PMFME	Pradhan Mantri Formalisation of Micro Food Processing Enterprises
PMU	Project Management Unit
PNGO	Partner Non-Governmental Organization
POP	Package of Practices

PPDO	Project Procurement Development Objectives
PRA	Participatory Rural Appraisal
PRI	Panchayati Raj Institution
PSC	Project Steering Committee
RFP	Request for Proposal
RPF	Resettlement Policy Framework
RS	Remote Sensing
RVC	Revenue Village Committee
SC	Scheduled Caste
SEP	Stakeholder Engagement Plan
SMP	Spring Shed Management Plan
SMS	Short Message Service
SNA	Single Nodal Account
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
ST	Scheduled Tribe
STEP	Systematic Tracking of Exchanges in Procurement
TA	Technical Agency / Assistance
TOR	Terms of Reference
TOT	Training of Trainers
UCRRFP	Uttarakhand Climate Responsive Rainfed Farming Project
UDWDP	Uttarakhand Decentralised Watershed Development Project
UHMB	Uttarakhand Horticulture Marketing Board
UKUMP	Uttarakhand Krishi Utpadan Mandi Parishad
VRA	Variable Rate Application
WHO	World Health Organization
WMD	Watershed Management Directorate
WMP	Waste Management Plan
WP	Water Productivity
WWMC	Water and Watershed Management Committee

Chapter 1



Introduction

Chapter One: Introduction

1.1 State Overview:

The State is having a geographical area of 53,483 sq. km, of which 93% is mountainous and 71% is forest area, Uttarakhand, positioned between 30°43' N to 31°27' N and 79°34' E to 81°02' E, is demarcated by the river Tons in the northwest from Himachal Pradesh and the river Kali in the east from Nepal. Its boundaries are defined by the greater Himalayas to the north, serving as the international border with China, while the southern foothills meet Uttar Pradesh. This region, nestled centrally within the Himalayan expanse, acts as a transition between the pre-humid eastern and the dry to sub-humid western Himalaya.

Designated as the 27th state of India on November 9 of 2000, Uttarakhand sustains a population primarily reliant on agriculture, with approximately 70% engaged in this sector. Despite its importance, only 14.02% of the reported area is under cultivation, with more than 55.0% of cultivated land being rainfed. The state exhibits a cropping intensity of 160.6%, although landholdings remain small and fragmented. In the hills, the average landholding measures around 0.68 hectares, divided into numerous patches, while the plains witness an average of 1.77 hectares per holding[1].

Uttarakhand has a total of 7.66 lakh ha. cultivated area in which 4.21 lakh ha. area is rainfed. Considering the magnitude of the problems, the Uttarakhand Govt. has taken up watershed-based planning and development approach. A total of about 8 catchments, 26 watersheds, 116 sub watersheds and 1,164 micro-watersheds (MWS) have been identified in the state, which are being taken up for regeneration and sustainable development, in phased manner in 8 selected districts of Uttarakhand.

Agriculture is an important sector supporting the State economy, with a contribution of around 23.4% to the State Domestic Product (GDP)[2]. The net irrigated area in the State is 3.45 lakh ha. out of which 85.83% are in plains and 14.17% are in hills[3]. The geographical attributes and climatic conditions of the State are ideal to produce temperate and sub-tropical fruit crops. The availability of irrigated land makes it beneficial to cultivate more than just staple crops. The State has the unique advantage of producing off-

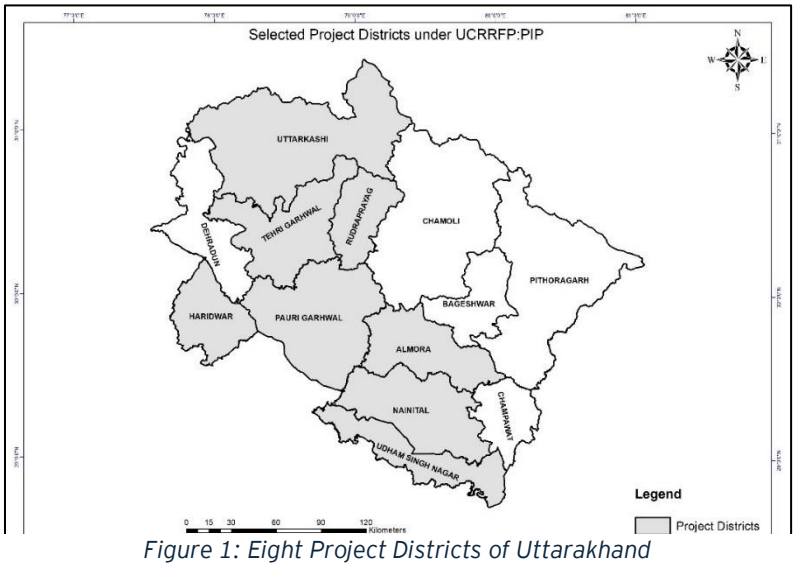


Figure 1: Eight Project Districts of Uttarakhand

[1] http://pmksywd.uk.gov.in/3-Preliminary%20Project%20Report/PPR_10-11.pdf
[2] State Horticulture Mission| Govt of Uttarakhand
[3] Ibid

season vegetables in hilly areas, which commands good prices in the market. In the year 2020-21, the land under cultivation in terms of Gross Sown Area amounted to 997 thousand hectares, while the Net Sown Area accounted for 621 thousand hectares.[4]

The Gross State Domestic Product (GSDP) of Uttarakhand for 2022-23 (at current prices) is projected to be Rs 3,02,620.68 crore. This is a growth of 11% over the revised estimate of GSDP for 2021-22 (Rs 2,72,159.48 crore) at current price. The Compound Annual Growth Rate (CAGR) of agriculture during 2011-23 is around 6.64%. Contribution of agriculture and allied sector is gradually increasing from 87.73% in the year 2011-12 to 93.15% in 2022-23. A distinct rise in livestock in the state (9.02%) and a good rise in forestry and fishery sectors is leading to the growth of primary sector in the state. Secondary sector remains the main employment provider in the state with around half of the working population in this sector. In 2022-23, the secondary sector contributed 48.61 percent to the state's GSVA at current prices, followed by the tertiary sector (40.09 per cent) and the primary sector (11.30 per cent).

At a CAGR of 10.95 percent, the tertiary sector has been the fastest growing among the three sectors from 2011-12 to 2022-23. The growth has been driven by trade, transport, storage, communication & services related to broadcasting and other services. The secondary sector grew at a CAGR* of 8.58 percent between 2011-12 and 2022-23. This was driven by manufacturing, construction and electricity, gas & water supply. The primary sector grew at a CAGR* of 7.17 percent between 2011-12 and 2022-23. Gross State Value Added by economic activity at current basic prices for agriculture, forestry and fishing is Rs 30,24,191 lakhs. Manufacturing sector is of great importance for Uttarakhand's economy. The manufacturing GVA in the organized secondary sector is 77.30 percent, which is much more than the corresponding national average. For the past five years, the secondary sector has CAGR which is as a whole has been 13.53 percent per annum. There is a disconcerting issue that relates to the declining share of the industry in the GSDP. It is seen that the sector declined from 53.13 percent in 2011-12 to an estimated 48.61 percent in 2022-123. Uttarakhand is a middle-income state with an average per capita annual income of INR 2,61,173.

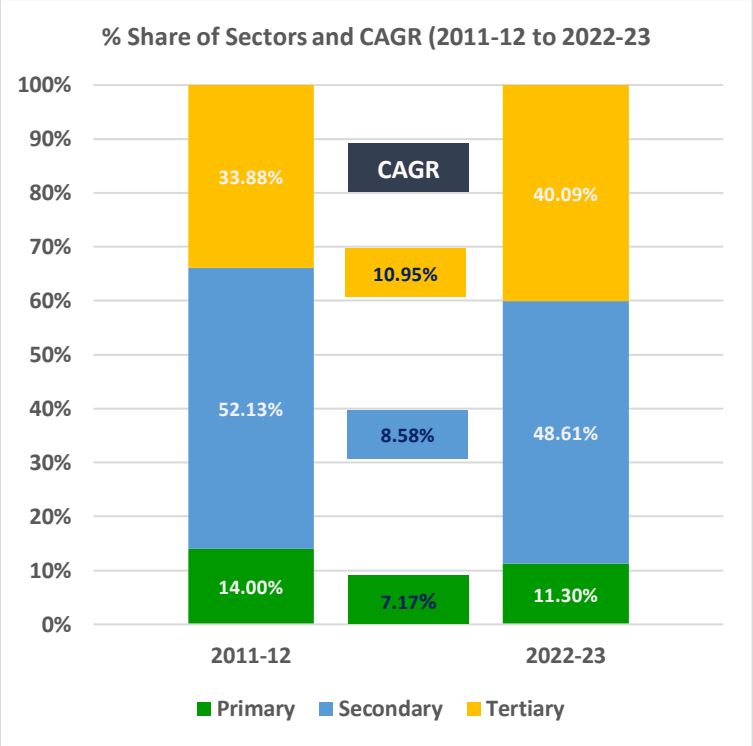


Figure 2: Share of Primary, Secondary, & Tertiary Sectors to GSDP

The government has observed appreciable growth in terms of the target of getting inclusive growth with imperative execution in both development and welfare sectors. In 2022-23, the Gross State Domestic Product (GSDP) grew at the rate of 10.07 percent. (Refer *annexure*).

[4] RBI| Handbook of Statistics on Indian States

During 2011-23, the fishing and aquaculture sector had Compound Annual Growth Rate (CAGR) of 17.06 percent. The mining and quarrying sector decreased marginally from 12.27 percent in 2011-12 to 6.85 percent in 2022-23. The contribution of construction sector varies from 15.65 percent in 2011-12 to 18.42 percent in 2022-23. The industries sector observed Compound Annual Growth Rate (CAGR) of 13.53 percent. The annual growth of the services sector expanded from 33.88 percent in 2012-13 to 40.09 percent in 2022-23. During 2011-17, the Compound Annual Growth Rate was 8.9 percent.

1.2 Demographic Features:

The population of Uttarakhand, as per 2011 census is 1,00,862,92 out of which 51,37,773 are male and 49,48,519 are female with a sex ratio of 963. The population density for Uttarakhand is 189 persons per square kilo meter (km), as against 159 persons per square km at all India level in 2011. The literacy rate of the State was 78.82 percent in 2011.

The district of Haridwar and Udham Singh Nagar are having the maximum population as compared to all other districts. Haridwar is having the maximum rural population and maximum population density per sq. km. The percentage of district population to State population in Haridwar is 18.74 which are higher than the other districts. The percentage of urban population to the total population in the State is 30.23 percent and the percentage of rural population to the total population in the State is 69.77%. Districts like Rudraprayag and Uttarkashi have highest percentage of rural population whereas districts like Nainital and Haridwar have good percentage of rural population. Almora, Rudraprayag, Pauri Garhwal, and Tehri Garhwal have good sex ratio as compared to other districts. The population density per sq. km reflects increasing to 189 (year 2011) from 159 (year 2001) indicates population growth, i.e., about 18.87 percent.

Uttarakhand had 15.80 lakhs cultivators, 4.03 lakh agricultural laborers, and 49 lakhs of working out of 68.50 lakh total workers in 2011 census. The Population Census 2011 shows that the State has more percentage of main working population in rural region (69.58%) than in urban region (30.42%). It can be observed that the rural region forms major part of the main cultivator population (98.30%) and main agricultural labourer population (91.21%). According to Population Census 2011, the State has a greater number of marginal cultivator population in rural regions (99.24%) than in urban region (0.76%). Similarly, the marginal other workers population in rural area (84.78%) is higher than the urban area (15.22%) of the state. The annual growth rate of the population in Uttarakhand from 2001 to 2011 is 18.81% (refer *annexure*).

Table 1: Population of Project Districts, Census 2011.

Project District	Districts Population in ('000 No)					Percentage to Total Population		Sex Ratio (No. of Females per '000 males)			Population Density Per Sq. Km		District Population to State Population in %
	M	F	T	R	U	R	U	R	U	T	2001	2011	%
Haridwar	1,005	885	1,890	1,197	693	63.34%	36.66%	889	866	880	612	801	18.74%
Udham Singh Nagar	859	790	1,649	1,062	587	64.42%	35.58%	930	903	920	424	649	16.35%
Nainital	494	461	955	583	372	61.06%	38.94%	948	912	934	198	225	9.46%
Pauri Garhwal	327	360	687	575	113	83.60%	16.40%	1,144	917	1,103	129	129	6.81%
Almora	291	331	623	560	62	89.99%	10.01%	1,177	848	1,139	205	198	6.17%
Tehri Garhwal	298	321	619	549	70	88.67%	11.33%	1,116	817	1,077	148	170	6.14%
Uttarkashi	169	161	330	306	24	92.64%	7.36%	968	838	958	37	41	3.27%
Rudraprayag	115	128	242	232	10	95.90%	4.10%	1,137	697	1,114	120	122	2.40%
Uttarakhand	**5138**	**499**	**10,086**	**7,037**	**3,049**	**69.77%**	**30.23%**	**1,000**	**884**	**963**	**159**	**189**	**100.00%**

Note: M: Male, F: Female, T: Total, R: Rural, U: Urban

1.3 Climatic Features:

Uttarakhand exhibits a diverse climatic profile due to its distinct regions—the hilly terrain and the smaller plain areas—each influencing the weather differently. The northern part, nestled within the Himalayas, experiences varied conditions. Above 4,880 meters, temperatures remain consistently below freezing, with perpetual snow cover. The eastern Himalayan slopes receive heavy rainfall, while the western side is comparatively drier. Summers across most of Uttarakhand are generally pleasant, yet certain areas like U. S. Nagar, Haridwar, and Rishikesh can soar to 40°C, causing discomfort due to humidity. Summer spans from April to June. Winters are harsh, witnessing frequent snowfalls in places like Chamoli, Rudraprayag, Pithoragarh, and Uttarkashi, with temperatures ranging from below zero to around 15°C. Winter lasts from October to February. Monsoons prevail from July to September, with temperatures ranging from 15°C to 25°C across most areas, accounting for 90% of the annual rainfall. This period is often regarded as one of Uttarakhand's most enjoyable seasons.

Throughout the year, the state experiences distinct seasons: winter from December to February, followed by the pre-monsoon or hot weather from March to May. June to September marks the southwest monsoon, and October and November bring the post-monsoon season. The state is geographically split into two regions: the Garhwal region in the west comprising Chamoli, Dehradun, Hardwar, Pauri Garhwal, Rudraprayag, Tehri Garhwal, and Uttarkashi districts, and the Kumaun region in the east consisting of Almora, Bageshwar, Champawat, Nainital, Pithoragarh, and Udham Singh Nagar districts.

Different climate patterns, as per Koppen's classification based on precipitation and temperature, categorize various areas within the state[5]. For instance:

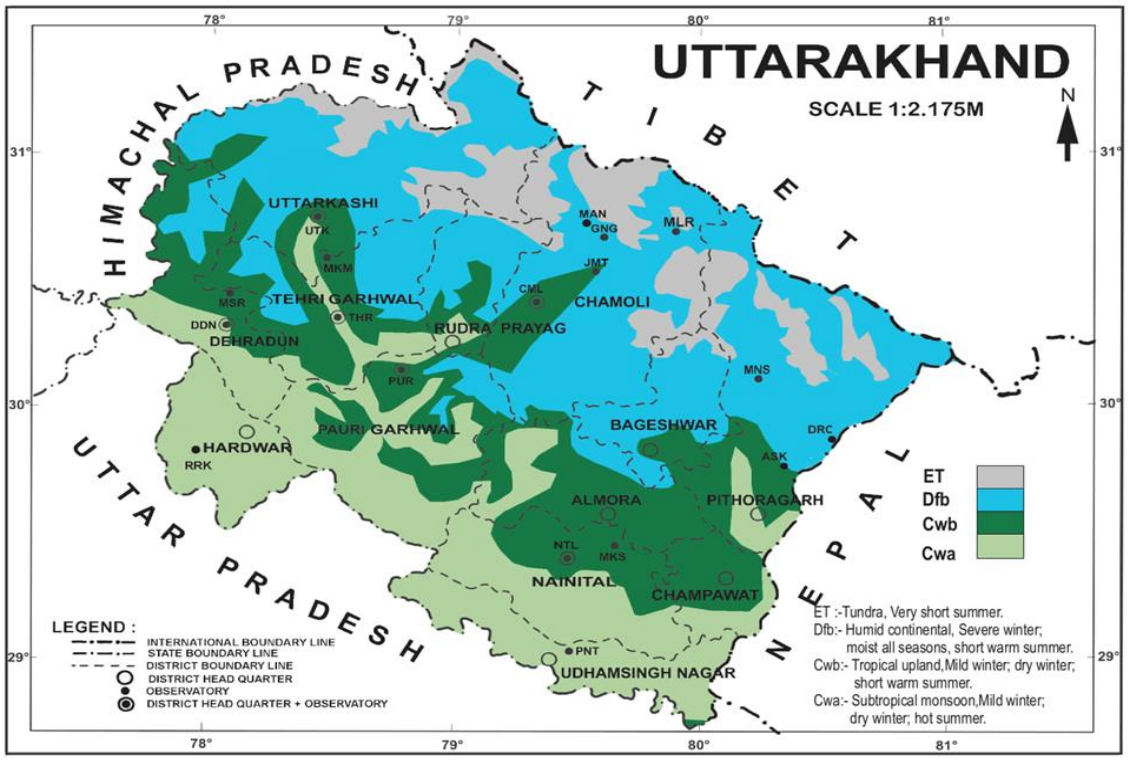


Figure 3: Climatic Classification of Uttarakhand

[5] https://imdpune.gov.in/li brary/public/Climate%20of%20Uttarakhand.pdf

1. Haridwar, Udham Singh Nagar, and parts of Nainital, Bageshwar, Champawat, Almora, Dehradun, Pithoragarh, Tehri Garhwal, Pauri Garhwal, Rudraprayag, and Uttarkashi fall under the subtropical monsoon category, characterized by mild and dry winters and hot summers (Cwa).

2. Some parts of Chamoli, Almora, Dehradun, Nainital, Uttarkashi, Pithoragarh, Rudraprayag, Bageshwar, Champawat, Pauri Garhwal, and Tehri Garhwal fall under the tropical upland category, experiencing mild winters, dry winters, and short warm summers (Cwb).

3. High-altitude areas of Almora, Bageshwar, Chamoli, Dehradun, Pauri Garhwal, Pithoragarh,

4. Rudraprayag, Tehri Garhwal, and Uttarkashi come under the humid continental type, characterized by severe winters, moisture throughout the season, and brief warm summers (Dfb).

5. The peaks in Bageshwar, Chamoli, Pithoragarh, Rudraprayag, Tehri Garhwal, and Uttarkashi districts fall under the Tundra climate, experiencing very short summers (ET).

The agriculture sector of the State frequently suffers from natural calamities like landslides, flash floods, and avalanches due to its mountainous terrain and proximity to the Himalayas which generously influence production and profitability of horticulture. These disasters set off an endless loop of financial effects starting with yield disappointment, joblessness, erosion of assets, diminish in pay, intensifying of living conditions, poor sustenance, and, in this way, diminished hazard absorptive limit, which thus enhance the vulnerability of the poor to another calamity. The state has different agro-climatic conditions, slopes, and height. Details of Physiographic Zones and farming situations in the state are as under:

Table 2: Agroclimatic Zone of Uttarakhand[6]

S. N	Zone	Farming situation	Soil	Rainfall (mm/year)	Districts	Principal farm produces and Livestock
1	Zone A up to 1000m	Tarai irrigated	Alluvial	1400	U.S. Nagar, Haridwar	Rice, wheat, sugarcane, lentil, chickpea, rapeseed mustard, mango, Litchi, guava, peach and plums. Livestock: Buffalo and cattle
		Bhabar Irrigated	Alluvial mixed with boulders and shingles	1400	Nainital, Dehradun and Pauri Garhwal	Rice, wheat, sugarcane, rapeseed mustard, potato, lentil, mango, guava, and litchi. Livestock: Buffalo and cattle
		Irrigated lower hills (600-1000m)	Alluvial sandy soil	2000-2400	Champawat, Pauri Garhwal, Dehradun, Nainital, Tehri Garhwal	Rice, Wheat, onion, chilly, peas, potato, radish, cauliflower, pulses, oilseeds, soybean, mango, guava, plums and peaches. Livestock: Buffalo and cattle
		Rain-fed lower hills (600-1000m)	Residual sandy loam	2000-2400	Champawat, Nainital, Pauri Garhwal, Dehradun, Tehri	finger millet, Maize, rice, wheat, pulses, mango, guava, plums, and peaches.

[6] https://shm.uk.gov.in/pages/display/6-state-profile

					Garhwal, Bageshwar	Livestock: Buffalo, cattle, and goat
2.	Zone B 1000-1500m	Mid hills south aspect (1000-1500 m)	Sandy loam	1200-1300	Champawat, Nainital, Almora, Dehradun, Tehri Garhwal, Bageshwar	Rice, finger millet, wheat, potato, tomato, peas, cole crops, pulses, peach and plums. Livestock: Cattle, sheep & goat
3	Zone C 1500-2400m	High hills (1500-2400 m)	Red to dark	1200-2500	Pithoragarh, Almora, Chamoli, Bageshwar	Amaranth, finger millet, French-beans, Cole crops, potato, peas, peaches, plums, pear, apple and stone fruits. Livestock: Cattle, sheep, and goat
4.	Zone D >2400m	Very High hills	Red to dark Black clay	1300	Pithoragarh, Chamoli and Uttarkashi	Amaranth, buckwheat, peas, Cole crops, apple, and potato. Livestock: Sheep & goat

1.3.1 Rainfall

The state receives 70% of rainfall during the southwest monsoon, 15% in the pre-monsoon season, 11% in winter, and 4% in the post-monsoon period. Rainfall in the state primarily occurs due to low-pressure areas and monsoon depressions originating in the Bay of Bengal during the southwest monsoon. These depressions often traverse inland, moving northwest or west over the state, occasionally reaching the hilly districts. Interactions between the monsoon system and extra-tropical systems like western disturbances can lead to heavy rainfall at times. While rainfall may decrease in the plain districts during the monsoon season, heavy rain in hilly areas can cause river floods.

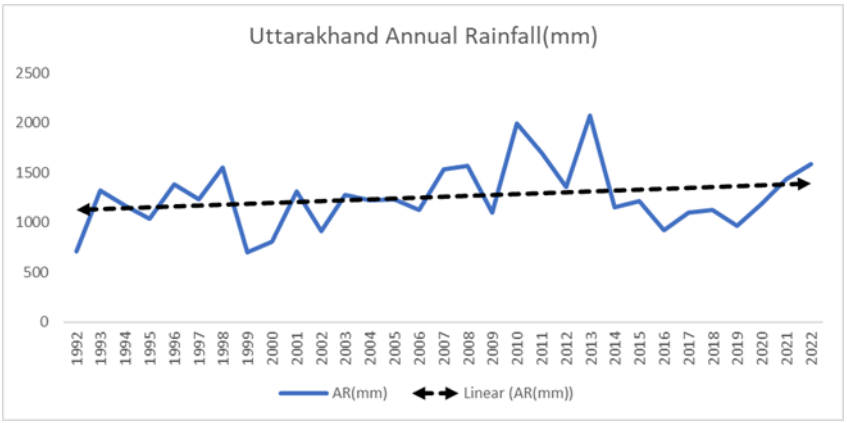


Figure 4: Annual Rainfall of Uttarakhand-30 yrs.

The remaining rainfall occurs in winter and early summer, associated with the passage of western disturbances across northern India. Winter precipitation in the northern districts often manifests as snowfall. July and August stand out as the wettest months, accounting for nearly 53% of the annual rainfall. Notably, two rainfall minima are observed in April and November. Following April, rainfall gradually increases until June, then sharply rises in July before rapidly decreasing after the southwest monsoon withdrawal by the last week of September. Pre-monsoon precipitation is mostly linked to thunderstorms.

The Monthly rainfall data (mm) of 8 selected districts of Uttarakhand were collected from the India Water Portal of India Meteorological Department (IMD) for the period 1992–2022 with 'Homogeneous Indian Monthly Rainfall Data Sets' which is one of the most authentic meteorological data in India.

Table 3: Rainfall Statistics of Project Districts, 2022

SN	District	Geographical Area (sq.km)	Normal Rainfall (mm)	Actual Average Rainfall (mm) 2022	Deviation from normal (mm)	Deviation (%) from normal
1	Almora	3,144	1,179.6	1,179.0	-0.6	-0.05
2	Haridwar	2,360	1,054.5	1,153.1	98.6	9.35
3	Nainital	4,251	1,831.2	1,495.2	-336.0	-18.35
4	Pauri Garhwal	5,329	1,538.9	1,101.5	-437.4	-28.42
5	Rudraprayag	1,984	2,118.4	1,830.2	-288.2	-13.60
6	Tehri Garhwal	3,642	1,251.9	1,380.6	128.7	10.28
7	Udham Singh Nagar	2,542	1,372.1	1,673.1	301.0	21.94
8	Uttarkashi	8,016	1,758.0	1,414.9	-343.1	-19.52
	Uttarakhand	**53,483**	**1,569.7**	**1,588.2**	**18.5**	**1.18**

Source: IMD, Pune

The table outlines Uttarakhand's district-wise rainfall for 2022, comparing actual averages with expected values. Almora nearly matched its anticipated 1179.6mm rainfall with a slight deviation of -0.6mm, while Haridwar exceeded expectations by 9.35%, receiving 1153.1mm against 1054.5mm. However, Nainital (-18.35%) and Pauri Garhwal (-28.42%) faced significant deficits, receiving 1495.2mm and 1101.5mm against expected values of 1831.2mm and 1538.9mm, respectively. Tehri Garhwal saw a positive deviation of 10.28%, recording 1380.6mm compared to the expected 1251.9mm, while Udham Singh Nagar had a surplus of 21.94%, receiving 1673.1mm against 1372.1mm. Uttarkashi experienced a -19.52% deviation, getting 1414.9mm instead of the anticipated 1758.0mm. Overall, Uttarakhand recorded 1588.2mm of rainfall against the expected 1569.7mm, marking a slight deviation of 1.18%, showcasing the diverse rainfall patterns across the state. The overall trend indicates a gradual increase in annual rainfall over the years in Uttarakhand. The State witnessed higher rainfall in the years 1997, 2001, 2010, and 2013; while there are years with markedly lower rainfall like in 1999, 2000, 2002, 2015, and 2018, indicating dry periods *(refer annexure)*.

1.3.2 Temperature:

The state lies in the mountainous region except for some plain areas in the districts along the southern boundary of the state. The temperatures in the state, therefore, vary considerably from place to place in the state accordingly elevation, location, slope and topography. The temperature starts to rise from March and steadily rises till it reaches its peak in May to the middle of June, when the mean maximum temperature in southern parts and valleys of the state is at about 34°C to 38°C and mean minimum temperature is at about 20°C to 24°C. At places at about 2 km altitude mean maximum and mean minimum temperatures are around 23 - 24°C and 15°C respectively. On individual days maximum temperature rises to 42°C in the valleys and southern part of the state and 30°C at stations at about 2 km elevation. The highest maximum temperature on record at any individual station was 47.4°C at Roorkee observatory on 22nd May 1978.

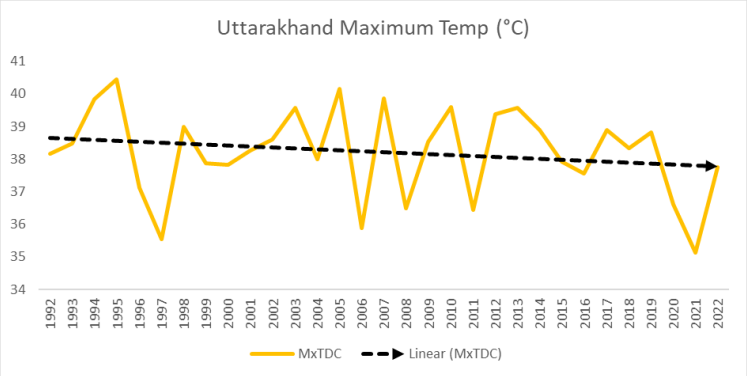


Figure 5: Maximum Temperature (last 30 yrs.)

Maximum temperatures over the past 30 years in Uttarakhand show a gradual decrease. Despite the variability, the overall trend indicates a slight decrease in maximum temperatures. This suggests potential shifts in climatic conditions or other environmental factors affecting the region. Several years exhibit notably high maximum temperatures, such as 1995, 1997, 2006, and 2012, indicating periods of extreme heat. Conversely, years like 1998, 2005, 2015, and 2021 experience lower maximum temperatures, indicating relatively cooler periods.

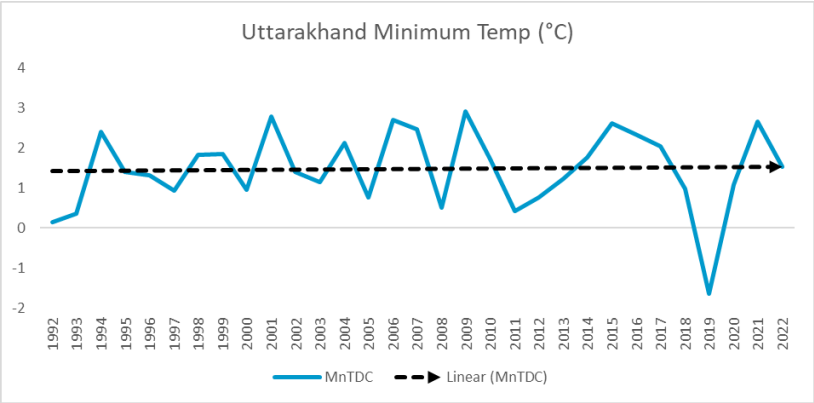


Figure 6: Minimum Temperature (last 30 yrs.)

However, in contrast to the maximum temperature, the minimum temperature over the past 30 years in Uttarakhand has shown little to no significant long-term change. 2020 experienced a sharp drop in minimum temperature, while other years, 2007 and 2013, had higher minimum temperatures.

1.4 Economy:

Uttarakhand is one of the fastest growing states in India thanks to the massive growth in capital investment arising from conducive industrial policy and generous tax benefits. Uttarakhand, since its formation in 2000, has showcased a distinctive economic trajectory. Initially, from 2001 to the early 2010s, the state struggled to match the national growth averages. Its annual average growth rate hovered around 6.5 percent during this period, slightly trailing the all-India average of 7-8 percent. This indicated a gap of around 1.5 percentage points from the national average, primarily due to the challenges of establishing infrastructure and industries in its hilly terrain.

However, a notable shift occurred in the latter half of the 2010s. From around 2015 onwards, Uttarakhand's growth trajectory witnessed a significant acceleration. The state's economy surged, registering an impressive growth rate surpassing 9 percent annually, outpacing the national average growth rate of 7-8 percent. This remarkable surge propelled Uttarakhand into a category of rapidly growing economies within the country.

The agricultural sector witnessed a fluctuating pattern, showing a gradual decline from 12.28% in 2011-12 to 9.95% in 2015-16, followed by a recovery trend till 2019-20 at 10.46%, only to slightly dip in subsequent years. Crops, constituting a significant part of agriculture, experienced a consistent decrease, dropping from 7.05% to 5.07% during 2011-22. Contrarily, the manufacturing sector demonstrated relative stability, maintaining a range between 36.50% to 41.07% from 2012-13 to 2018-19 before slightly ascending to 36.09% in 2022-23.

A noteworthy trend was observed in the construction sector, which exhibited intermittent fluctuations yet generally remained within a close range, varying from 7.57% in 2012-13 to 8.96% in 2022-23. The trade, repair, hotels, and restaurants sector underwent a significant surge from 11.01% in 2011-12 to a peak of 16.51% in 2019-20, followed by a substantial decline in subsequent years, reaching 13.62% in 2022-23. This was predominantly attributed to shifts within trade and repair services, accounting for a major part of this sector. Moreover, the transport, storage, communication, and services related to

broadcasting displayed slight fluctuations over the years, with notable increments in communication-related services from 4.23% in 2011-12 to 4.74% in 2022-23.

Overall, while certain sectors like agriculture witnessed fluctuations, others such as manufacturing and construction maintained relative stability, with trade experiencing a notable peak followed by a decline. These variations reflect the dynamic nature of Uttarakhand's economic activities, influenced by both internal dynamics and external factors impacting the state's economic growth trajectory.

Over the past years, Uttarakhand's economic sectors have experienced significant fluctuations in growth rates. The Gross State Domestic Product (GSDP) across various sectors in the economy has exhibited noteworthy variations over the years. In the primary sector, agriculture, forestry, and fishing displayed substantial growth, especially in agriculture which saw an impressive 14.92% surge in 2019-20. However, the growth rates fluctuated in specific segments like crops, experiencing a dip in 2013-14 (-6.07%) but recovering steadily to reach 6.00% in 2022-23.

Livestock and forestry exhibited consistent growth trends, albeit with slight fluctuations. Forestry and logging notably volatile, showing swings from -8.57% in 2014-15 to a substantial 25.47% in 2019-20. The primary sector saw intermittent fluctuations, maintaining a growth trend overall, with notable spikes in certain years, such as a 12.22% growth in 2017-18.

Conversely, the mining and quarrying sector experienced erratic changes, with a staggering 42.02% growth in 2013-14 but significant downturns in subsequent years, notably in 2018-19 (-19.21%) and 2019-20 (-26.92%), followed by a slight upturn in 2022-23 (0.22%). Manufacturing demonstrated steady growth, with occasional peaks, such as a substantial 15.93% rise in 2021-22, indicating potential expansions in industrial production. In services, trade, repair, hotels, and restaurants experienced fluctuations, marked by a substantial dip in 2020-21 (-27.06%) but a subsequent recovery to 17.94% in 2022-23.

Transport and communication services displayed mixed trends, with sectors like air transport showcasing extreme fluctuations - a notable 79.70% decline in 2018-19 but a subsequent increase of 48.23% in 2021-22. Public administration showcased volatility with a significant 34.81% rise in 2013-14 followed by fluctuating growth rates in subsequent years.

These variations in economic sectors showcase the dynamic nature of the state's economy, marked by sector-specific challenges, policy interventions, and market dynamics impacting growth trajectories.

Table 4: GSVA by Economic Activity (% share) at Current Basic Prices

SN	Economy Activity	Percentage Share											
		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
1.	Agriculture, forestry, and fishing	12.28	12.42	11.32	10.71	9.95	9.42	9.57	9.32	10.46	11.67	10.56	10.53
1.1	Crops	7.05	7.29	6.09	5.73	5.10	4.77	5.07	4.72	5.30	5.75	5.07	4.83
1.2	Livestock	2.66	2.54	2.52	2.66	2.75	2.73	2.67	2.76	2.81	2.84	2.61	2.59
1.3	Forestry and logging	2.54	2.56	2.67	2.28	2.07	1.89	1.80	1.82	2.33	3.05	2.86	3.07
1.4	Fishing and aquaculture	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03
2.	Mining and quarrying	1.72	1.66	2.54	1.57	1.24	1.41	1.51	1.60	1.28	1.01	0.86	0.77
	Primary	**14.00**	**14.08**	**13.86**	**12.28**	**11.19**	**10.83**	**11.08**	**10.92**	**11.74**	**12.68**	**11.42**	**11.30**
3.	Manufacturing	40.29	41.07	39.00	39.04	38.94	39.10	37.92	36.50	34.66	35.01	35.99	36.09
4.	Electricity, gas, water supply & other utility services	3.67	3.36	2.69	2.87	3.40	3.22	3.33	3.35	3.32	3.46	3.46	3.56
5.	Construction	8.16	7.57	8.91	8.62	8.03	7.88	7.95	8.38	8.06	7.87	8.28	8.96

	Secondary	52.13	52.01	50.59	50.52	50.37	50.20	49.20	48.22	46.04	46.34	47.73	48.61
6.	Trade, repair, hotels and restaurants	11.01	11.38	11.57	11.88	12.46	13.50	14.24	15.69	16.51	13.04	13.74	13.62
6.1	Trade & repair services	9.36	9.85	10.22	10.57	11.07	12.09	12.82	14.13	14.97	12.40	13.16	13.08
6.2	Hotels & restaurants	1.65	1.54	1.35	1.31	1.39	1.41	1.42	1.56	1.54	0.64	0.57	0.53
7.	Transport, storage, communication & services related to broadcasting	6.39	6.56	6.70	7.09	7.82	7.23	6.18	6.17	6.83	7.44	6.83	6.49
7.1	Railways	0.13	0.13	0.12	0.15	0.16	0.16	0.15	0.15	0.20	0.22	0.22	0.22
7.2	Road transport	2.02	2.10	2.06	2.04	2.03	2.04	1.98	2.04	2.04	1.76	1.60	1.49
7.3	Water transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.4	Air transport	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.02	0.04	0.03	0.03	0.03
7.5	Services incidental to transport	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.02	0.05	0.01	0.01	0.01
7.6	Storage	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00
7.7	Communication & services related to broadcasting	4.23	4.31	4.50	4.88	5.60	4.94	3.97	3.94	4.50	5.41	4.97	4.74
8.	Financial services	2.71	2.59	2.57	2.67	2.74	2.52	2.65	2.77	2.88	3.46	3.36	3.45
9.	Real estate, ownership of dwelling & professional services	5.44	5.42	5.30	5.41	5.16	5.07	5.04	5.19	5.20	5.34	5.15	4.93
10.	Public administration	3.73	2.55	3.47	4.05	4.07	4.22	4.70	4.24	3.78	4.35	4.28	4.09
11.	Other services	4.60	5.41	5.93	6.09	6.19	6.44	6.92	6.79	7.00	7.35	7.49	7.51
	Tertiary	**33.88**	**33.91**	**35.54**	**37.19**	**38.44**	**38.97**	**39.73**	**40.86**	**42.22**	**40.98**	**40.85**	**40.09**
12.	**TOTAL GSVA at basic prices**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Ministry of Statistics & Programme Implementation, GOI; GSVA: Gross State Value Added

1.5 Agriculture:

Spanning 5.35 million hectares, Uttarakhand's terrain is primarily characterized by hilly landscapes, constituting about 86% of its total area, while the remaining 14% comprises plains. This topographical layout limits cultivable land to a mere 14%, shaping the livelihoods of its inhabitants. Agriculture, which engages roughly 70% of the population, is a cornerstone, despite cultivated land accounting for only 14.02% of the reported area, with over 55.0% relying on rainfed cultivation. The average land holding sizes reflect the disparity between regions, i.e., around 0.68 hectares in hills and approximately 1.77 hectares in plains. The recorded agricultural landholdings of 747,320 hectares are largely fragmented, with over 74.78% comprising holdings smaller than one hectare. Small and marginal farmers collectively own a staggering 91.67% of these landholdings in the state.

The forest area covers 64.79% of the total area, but satellite imagery indicates a green cover of only 44%. The net sown area represents slightly over 13% of the total reported area, showcasing variations across districts. Irrigation covers about 12% of agricultural land, predominantly utilized for cultivating cereals, fodder, and certain vegetables.

The state's economy heavily reliant on agriculture faces challenges due to underdeveloped secondary and tertiary sectors, exacerbated by the difficult accessibility and vulnerability of mountainous regions. Although agriculture sustains nearly 70% of the population, its contribution to the GDP/NDDP is a modest 37.5%, resulting in inadequate income levels and instability. Moreover, this subsistence-oriented nature leads to significant male out-migration, leaving behind households led by women, amplifying the significance of women's roles in the household economy.

Uttarakhand's main agriculture products are rice, wheat, cereals, pulses, oilseeds, sugarcane, vegetables, spices, potato, fruits, etc. The agriculture sector in Uttarakhand experienced a 1.6% growth in 2023-24, rebounding from a 2.4% contraction in 2022-23. The Terai and Bhabar regions of the state are highly fertile, yielding cereals in quantities that exceed the state's demand. In contrast, millets and pulses are primarily cultivated in the hilly areas.

In Uttarakhand, specific districts stand out as major producers for various crops, shaping the state's agricultural landscape. Nainital holds prominence in the fruits sector, being a significant producer of mangoes, pears, and peaches. Additionally, it leads in litchi

production and contributes notably to tomato cultivation. Almora is a leading national producer of plums, apricots, and walnuts. Uttarkashi ranks third in apple production within Uttarakhand. Champawat is the third-largest cinnamon producer. Haridwar excels in vegetable farming, ranking in the top 10 for capsicum and leading in mushroom production. Udham Singh Nagar, Dehradun, and Tehri Garhwal are notable for their significant production of potatoes, peas, cauliflower, onions, brinjals, cabbages, and okra, enhancing Uttarakhand's diverse agricultural output.

Table 5: Crop wise major producing districts in Uttarakhand

Crop type	Ranking – National (N)/ State (S)	Major Producing Districts
Fruits		
Mango	Majority production in fruits sector (S)	Nainital
Pear	3rd largest producer (N)	Nainital
Peach	largest producer (N)	Nainital
Plum	largest producer (N)	Almora
Apricot	largest producer (N)	Almora
Litchi	Among top 10 producers (N)	Nainital
Apples	3rd largest producer (N)	Uttarkashi
Walnut	2nd largest producer (N)	Almora
Spices		
Cinnamon	3rd largest producer (N)	Champawat
Fenugreek	6th largest producer (N)	
Vegetables		
Capsicum	Among top 10 producers (N)	Haridwar
Mushroom	Leading Producer (N)	Haridwar
Potato		Udham Singh Nagar
Cauliflower		Dehradun
Tomato	Majority production in Vegetables sector (S)	Nainital
Onion		Tehri Garhwal
Brinjal		Haridwar
Pea		Udham Singh Nagar
Cabbage		Haridwar
Okra		Haridwar
Cereals		Udham Singh Nagar
Small Millets	2nd largest producer (N)	Tehri Garhwal
Paddy	Among top 20 producers (N)	Udham Singh Nagar

Source: Ministry of Food Processing Industry, GoI

1.5.1 Cultivated Area and Production:

The major crops grown in Uttarakhand are Paddy, Wheat, and Millet, etc. The detail table of all crops growing in project hilly and plain districts wise data is given in Annexure. In the section, a total overview of various crops is being discussed and the total crop area and production data w.r.t the state as well as the hilly and plain districts is given in table 11-13 below.

(A) Paddy:

The decadal data for Uttarakhand state from 2011-12 to 2021-22 reveals an interesting relationship between area under cultivation and crop production. Despite a gradual decline in cultivated area from 275,000 hectares in 2011-12 to 253,000 hectares in 2021-22, there is a notable increase in crop production. Beginning at 590,000 tons in 2011-12, production steadily rises to 709,000 tons by 2021-22. This suggests a trend of improving agricultural productivity, wherein farmers are achieving higher yields from a decreasing land area. Factors contributing to this phenomenon could include technological advancements, adoption of efficient farming practices, and possibly favorable climatic conditions. The data indicates a shift towards more efficient land utilization and potentially higher crop yields per unit of land in Uttarakhand over the analyzed period.

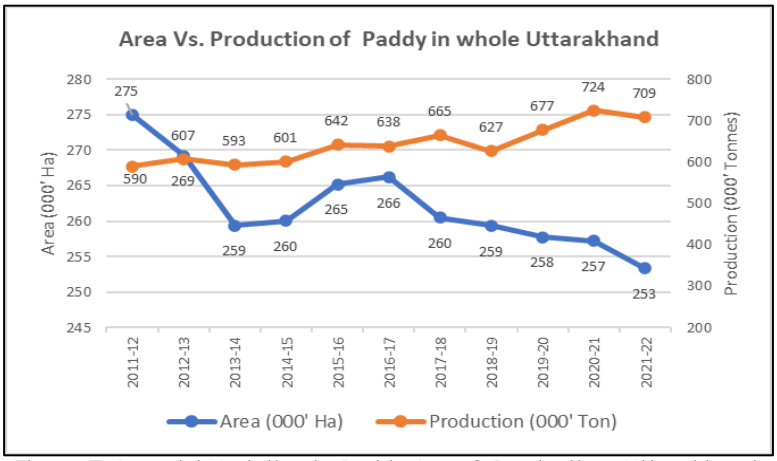


Figure 7: Decadal Variation in Paddy Area & Production; Uttarakhand

In the **hilly districts**, covering rugged terrain and often posing challenges to farming, the data reveals a consistent pattern. Over the analysed period, there's a discernible decline in the area under cultivation, decreasing from 80,000 hectares in 2011-12 to 55,000 hectares in 2021-22. However, this reduction in cultivated land is juxtaposed with an intriguing increase in crop production. As the area available for cultivation has decreased, crop production has likewise declined, dropping from 125,000 tons in 2011-12 to 113,000 tons in 2021-22. These patterns likely stem from various challenges, including land fragmentation, restricted accessibility, and environmental limitations, all of which affect agricultural operations in the hilly regions. Among the hilly districts only in Nainital paddy has been grown in both kharif and summer season and in kharif in all other districts (*Annexure*)

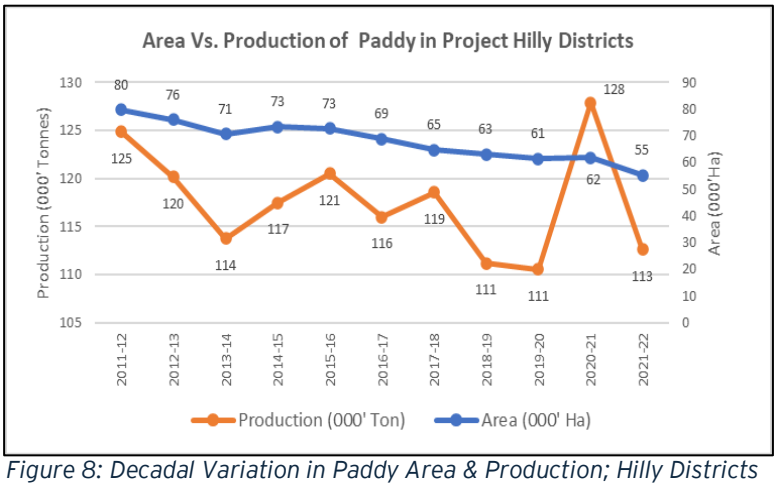


Figure 8: Decadal Variation in Paddy Area & Production; Hilly Districts

Conversely, in the **plain districts** characterized by relatively flat terrain, there's a different narrative unfolding. Here, the cultivated area has remained relatively stable over the years, with minor fluctuations. From 131,000 hectares in 2011-12, it has marginally increased to

145,000 hectares by 2021-22. Interestingly, crop production in these districts has showcased a significant upward trajectory. Starting at 371,000 tons in 2011-12, it has surged impressively to 510,000 tons in 2021-22, indicating a commendable boost in agricultural output. In the two plain districts, i.e., Haridwar and US Nagar (the summer paddy is grown only in US Nagar.), Paddy has been cultivated in both kharif and summer season (*Annexure*).

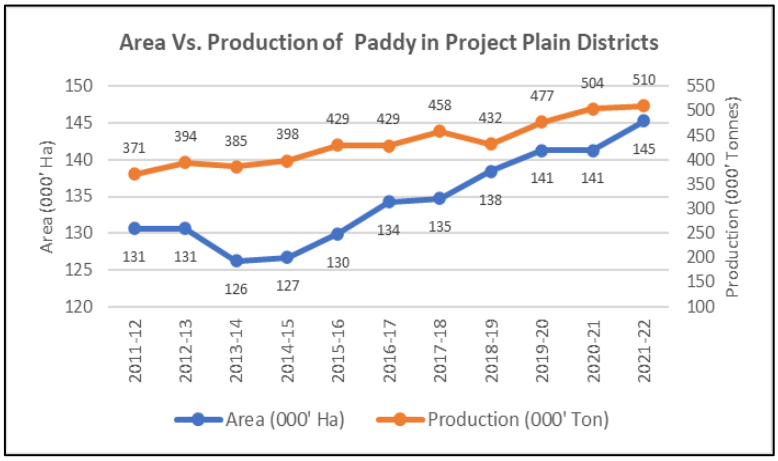


Figure 9: Decadal Variation in Paddy Area & Production; Plain

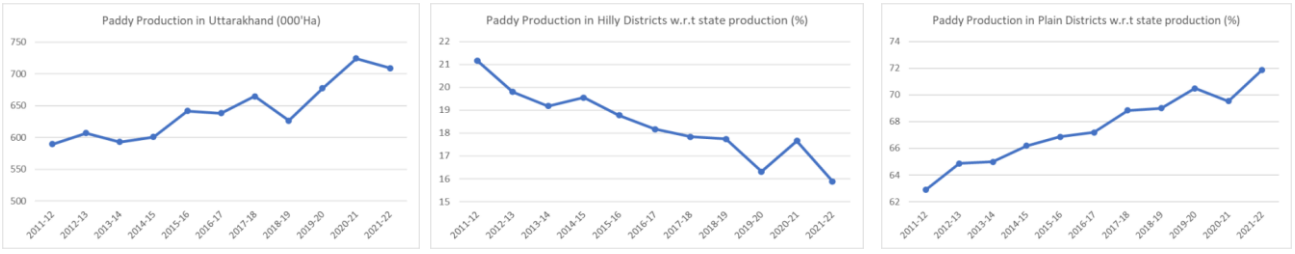


Figure 11: Paddy Area in Hilly and Plain Districts

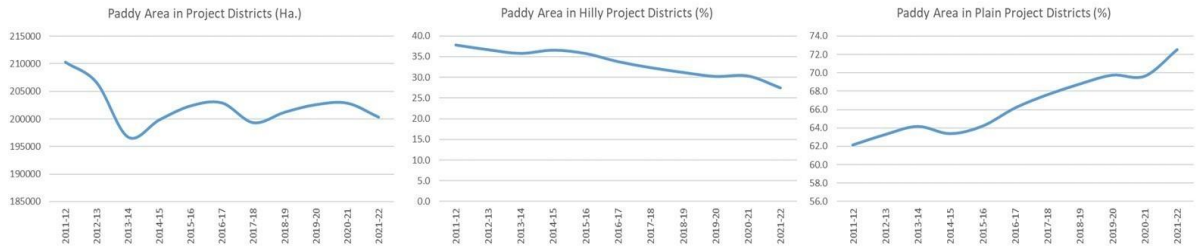


Figure 10: Paddy Production in Hilly and Plain Districts

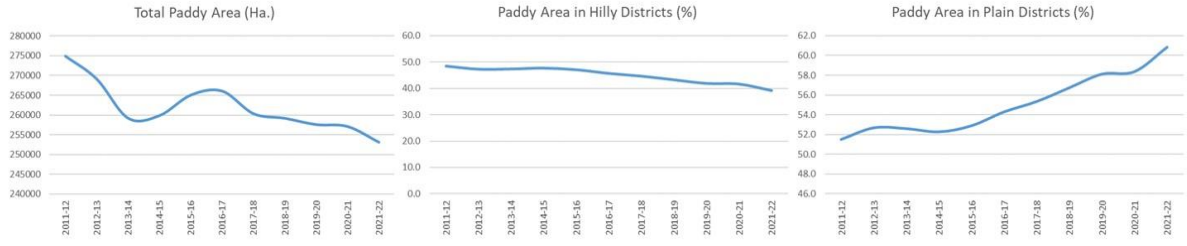


Figure 12: Paddy Area in Hilly and Plain Districts, Uttarakhand

(B) Wheat:

The decadal data for **Uttarakhand** state spanning from 2011-12 to 2021-22 unveils an intriguing correlation between the area under cultivation and crop production. Despite witnessing a gradual decline in cultivated area from 356,000 hectares in 2011-12 to 285,000 hectares in 2021-22, there is a noticeable uptick in crop production. Starting at

865,000 tons in 2011-12, the production steadily ascends to 862,000 tons by 2021-22. This trend indicates a significant improvement in agricultural productivity, suggesting that farmers are achieving higher yields from a diminishing land area. Factors contributing to this phenomenon may include technological advancements, adoption of efficient farming practices, and possibly favourable climatic conditions. The data underscores a shift towards more efficient land utilization and potentially higher crop yields per unit of land in Uttarakhand over the decadal period.

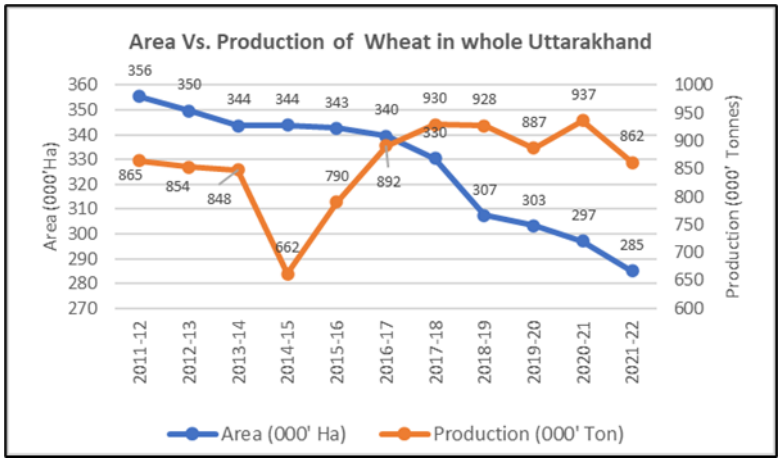


Figure 13: Decadal Variation in Wheat Area & Production; Uttarakhand

In the hilly districts, a noticeable downward trend in both wheat cultivated area and wheat production over the analysed period. The cultivated area in these districts has experienced a consistent decline, decreasing from 132,000 hectares in 2011-12 to 79,000 hectares in 2021-22. Similarly, crop production has followed a similar trajectory, dropping from 203,000 tons to 178,000 tons during the same period. These trends may reflect challenges such as land fragmentation, limited accessibility, and environmental constraints that impact agricultural activities in the hilly regions.

In the plain districts where the topography is relatively flat and more conducive to farming, a different narrative unfolds. Despite minor fluctuations, the cultivated area in these districts has remained relatively stable, with marginal changes observed over the years. From 142,000 hectares in 2011-12, it has hovered around 147,000 hectares by 2021-22. In stark contrast to the hilly regions, wheat production in the plains has exhibited significant fluctuations but generally shows a more resilient trend. Starting at 526,000 tons in 2011-

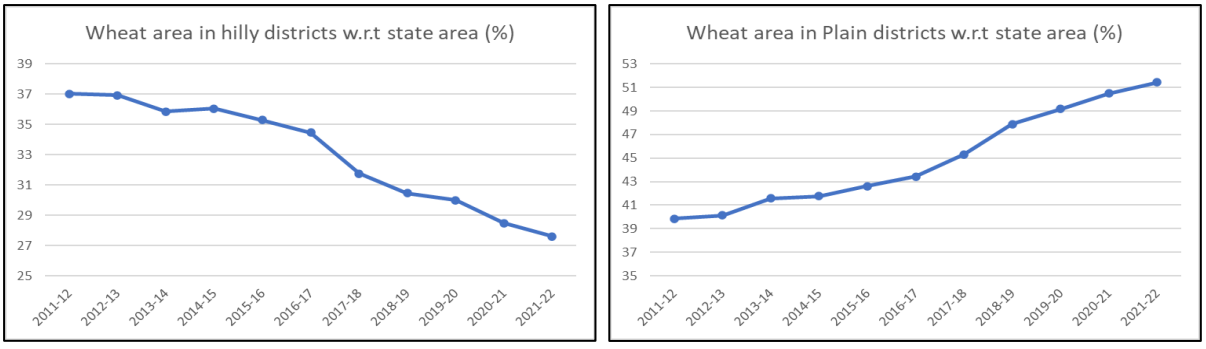


Figure 15: Wheat Area in Hilly and Plain Districts

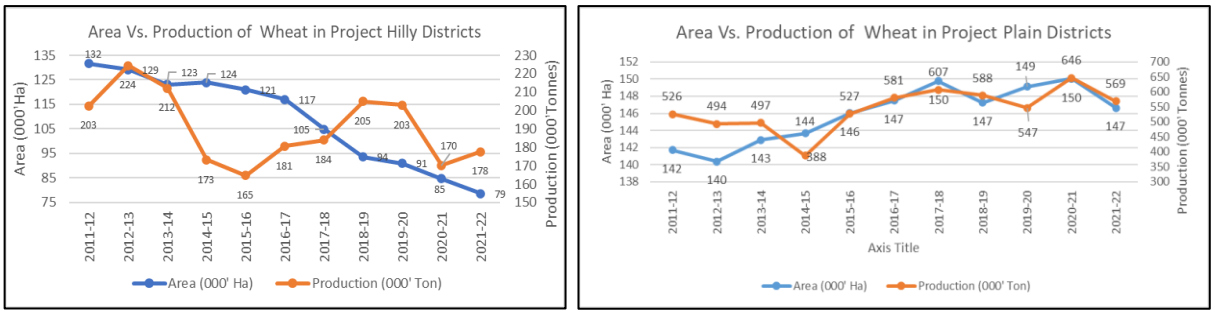


Figure 14: Decadal variation in Wheat Area & Production; Hilly & Plain Districts

12, it experienced fluctuations but ended at 569,000 tons in 2021-22, showcasing a certain degree of stability and capacity for productivity even amidst variability.

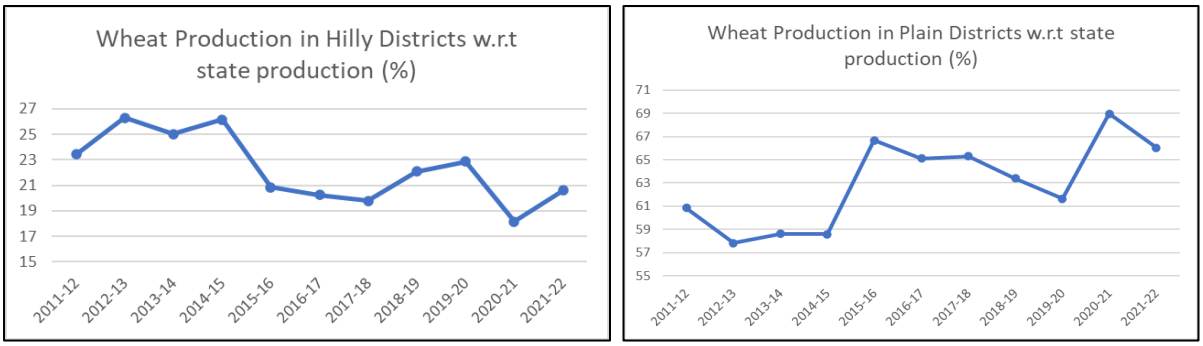


Figure 16: Wheat Production in Hilly and Plain Districts

(C) Millet:

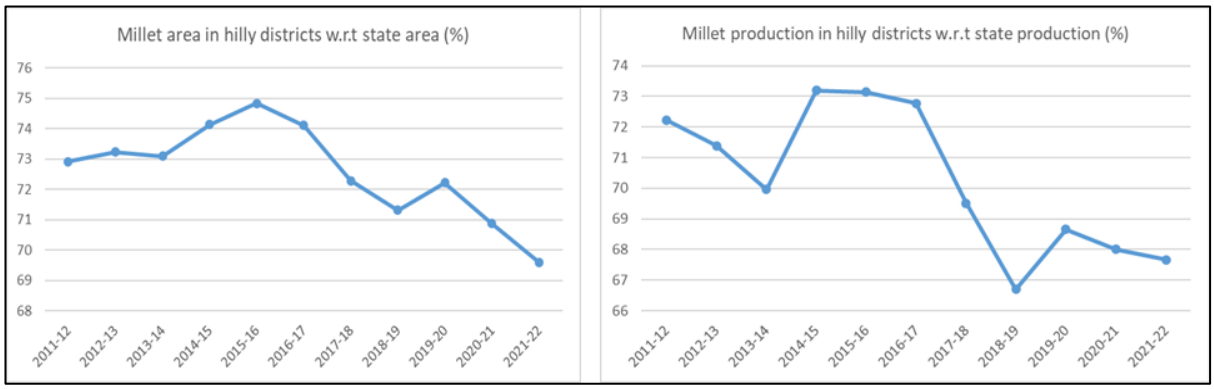


Figure 17: Millet Production in Hilly and Plain Districts

The data from 2011-12 to 2021-22 for Uttarakhand demonstrates a noteworthy relationship between the area under cultivation and Millet production. While the cultivated area has gradually decreased from 115,000 hectares in 2011-12 to 78,000 hectares in 2021-22, the production has shown varying trends. Initially, from 2011-12 to 2014-15, despite a slight decrease in cultivated area, production remained relatively stable, indicating consistent productivity. However, from 2015-16 onwards, although the area continued to decline, the production remained somewhat constant, implying improved productivity per unit of land. Notably, in 2016-17, there was a significant increase in production despite a slight increase in the cultivated area, suggesting enhanced efficiency or favourable conditions. Subsequently, from 2017-18 to 2021-22, both area and production exhibited a declining trend, possibly indicating challenges or shifts in agricultural practices. Overall, while there's a decreasing trend in cultivated area, the data suggests fluctuations in production, indicating the dynamic nature of agricultural productivity in Uttarakhand over the analysed period.

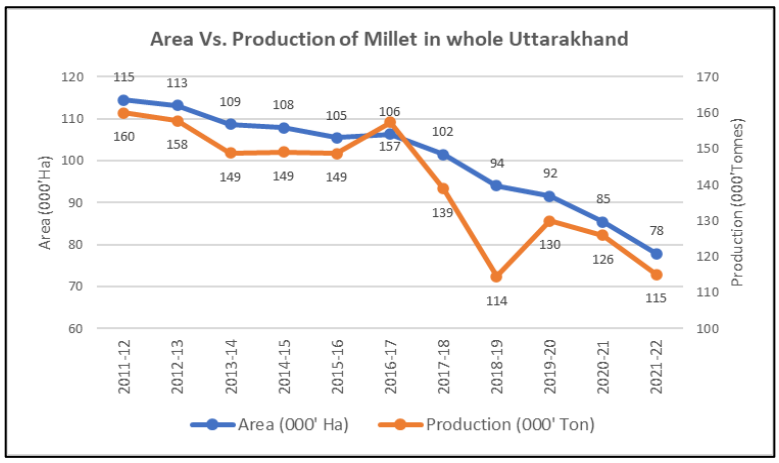


Figure 18: Decadal Variation in Millet Area & Production; Uttarakhand

In the **hilly districts** of Uttarakhand, there's a noticeable downward trend observed in both Millet cultivated area and crop production over the past 10 years. The cultivated area in these districts has experienced a consistent decline, decreasing from 84,000 hectares in 2011-12 to 54,000 hectares in 2021-22. Similarly, crop production has followed a similar trajectory, dropping from 116,000 tons to 78,000 tons during the same period. These trends may reflect challenges such as land fragmentation, limited accessibility, and environmental constraints that impact agricultural activities in the hilly regions. It's crucial to highlight that Millet cultivation primarily occurs in hilly districts, as reflected by the provided percentage of Millet area in hilly districts. Additionally, it's important to note that Millet is not typically cultivated in plain districts, contributing to the unique agricultural landscape of hilly regions.

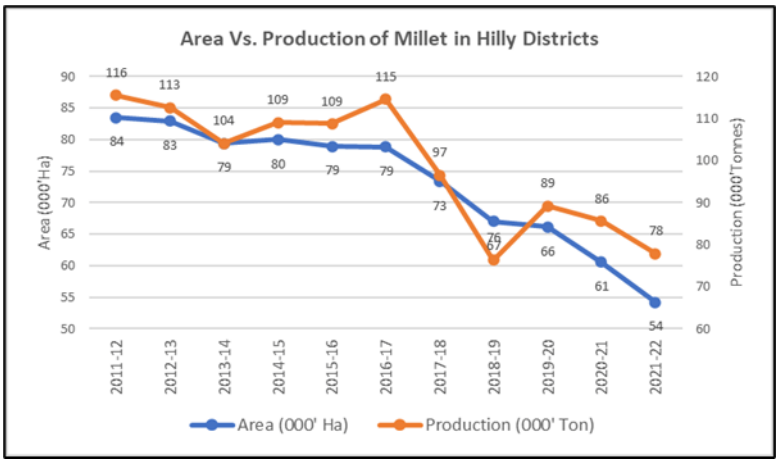


Figure 19: Decadal Variation in Millet Area & Production; Hilly Districts

(D) Pulses:

In Uttarakhand state, the relationship between cultivated area and pulses production shows fluctuations over the years. From 2011-12 to 2021-22, the cultivated area varies, reaching its peak at 55,000 hectares in 2019-20 and its lowest point at 46,000 hectares in 2011-12. Similarly, crop production experiences fluctuations, with the highest production of 53,000 tons in 2019-20 and the lowest of 37,000 tons in 2011-12. Despite some variation, the data suggests a general upward trend in both area and production over the last 10-11 years, with occasional fluctuations possibly influenced by factors such as climatic conditions, agricultural policies, and technological advancements.

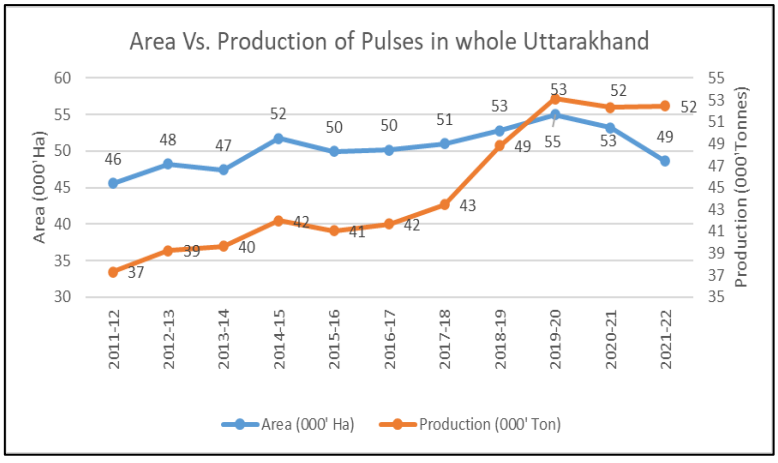


Figure 20: Decadal Variation in Pulses Area & Production; Uttarakhand

In the hilly districts of Uttarakhand, covering rugged terrain and often posing challenges to farming, the data reveals a consistent pattern for pulses cultivation. Over the last 10 years, there's a discernible increase in the area under pulses cultivation, decreasing from 27,000 hectares in 2011-12 to 30,000 hectares in 2021-22. However, this reduction in cultivated land is juxtaposed with an intriguing increase in pulses production. Despite the diminishing area, pulses production has shown resilience, climbing from 22,000 tons in 2011-12 to 32,000 tons in 2021-22. This trend suggests a notable enhancement in agricultural productivity per unit of land for pulses in the hilly regions of Uttarakhand.

Conversely, in the plains of Uttarakhand characterized by relatively flat terrain, a different narrative unfolds for pulses cultivation. Here, the cultivated area has remained relatively

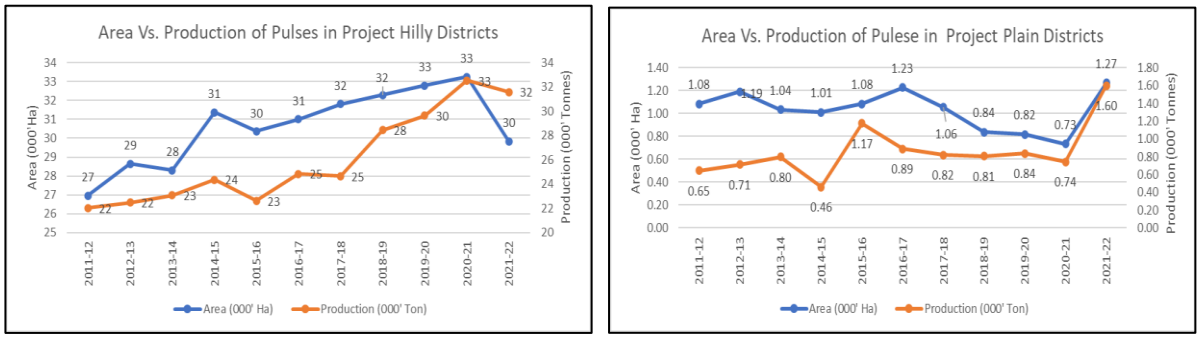


Figure 21: Decadal Variation in Pulses Area & Production; Hilly & Plain Districts

stable over the years, with minor fluctuations. Starting at 1.08 thousand hectares in 2011-12, it increased to 1.27 thousand hectares by 2021-22. Interestingly, pulses production in these districts has showcased a significant upward trajectory. Beginning at 650 tons in 2011-12, it has surged impressively to 1600 tons in 2021-22, indicating a commendable boost in Millet agricultural output.

(E) Foodgrains:

The agricultural data for **Uttarakhand** from 2011-12 to 2021-22 presents an insightful perspective on the relationship between cultivated area and foodgrain production over the years. Beginning with an area of 901,000 hectares and a production of 1,797,000 tons in 2011-12, there's a notable fluctuation observed in both parameters throughout the analysed period. The cultivated area experiences a gradual decline, reaching 746,000 hectares by 2021-22, while foodgrain production shows fluctuations but generally maintains a level close to the initial values, culminating at 1,882,000 tons in the last recorded year. This data highlights the complex interplay between agricultural practices, environmental factors, and economic dynamics within Uttarakhand, underscoring the need for adaptive strategies to ensure sustainable agricultural growth amidst evolving challenges.

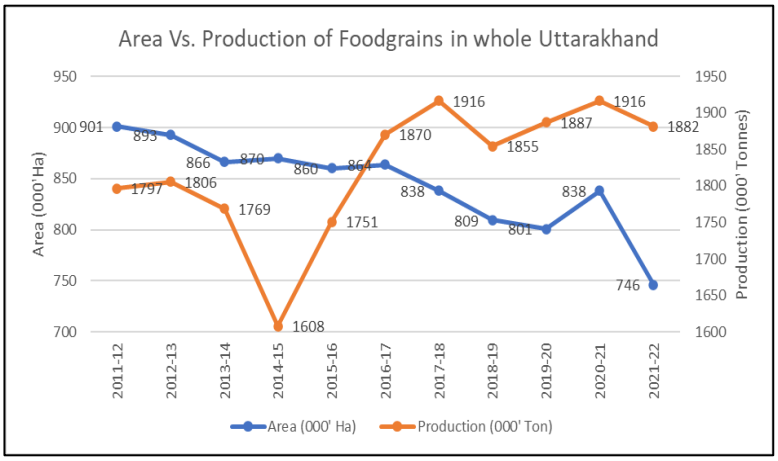


Figure 22: Decadal Variation in Foodgrains Area & Production; Uttarakhand

In the hilly districts of Uttarakhand, the relationship between cultivated area and foodgrain production over the last decade displays a notable pattern. Beginning from 2011-12 to 2021-22, the cultivated area experiences fluctuations, reaching its peak at 400,000 hectares in 2011-12 and its lowest point at 274,000 hectares in 2021-22. Correspondingly, foodgrain production also fluctuates, with the highest production of 566,000 tons recorded in 2011-12 and the lowest of 493,000 tons in 2021-22. Notably, there's a discernible trend of decreasing cultivated area and production in recent years, potentially reflecting challenges such as land fragmentation or environmental factors impacting agricultural activities in the hilly regions.

In the plain districts of Uttarakhand, the relationship between cultivated area and foodgrain production reveals a consistent trend in last 10 years. Beginning from 2011-12 to 2021-22, the cultivated area remains relatively stable, with minor fluctuations, ranging from 271,000 hectares to 294,000 hectares. Correspondingly, foodgrain production exhibits a gradual increase over the years, with the highest production of 1,083,000 tons recorded in 2021-22 and the lowest of 787,000 tons in 2014-15. Notably, there's a discernible trend of increasing production despite minor fluctuations in cultivated area, indicating efficient agricultural practices and potential improvements in productivity in the plain regions of Uttarakhand.

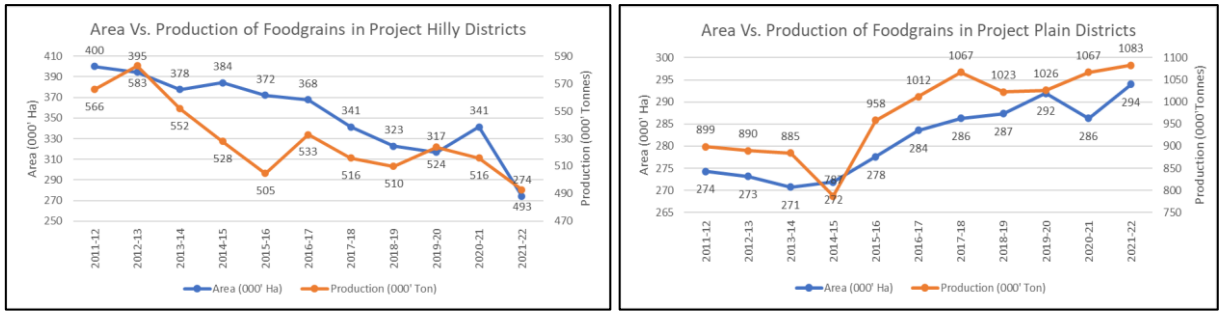


Figure 23: Decadal Variation in Foodgrains Area & Production; Hilly & Plain Districts

(F) Oilseeds:

In Uttarakhand, the cultivation and production of oilseeds exhibit a dynamic relationship over the years. From 2011-12 to 2021-22, the cultivated area fluctuates between 23,100 hectares to 28,300 hectares, while production ranges from 22,200 tons to 33,600 tons. These variations suggest shifting agricultural practices and potential influences from factors such as climatic conditions and market dynamics.

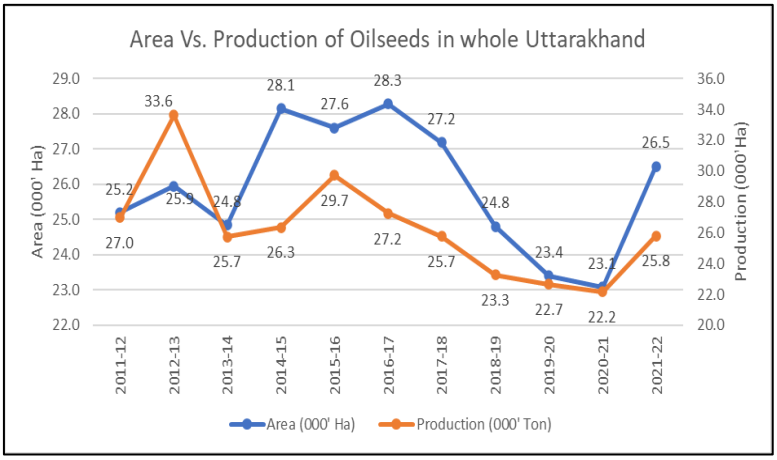


Figure 24: Decadal Variation in Oilseeds Area & Production; Uttarakhand.

In the hilly districts, characterized by challenging terrain and environmental conditions, both the cultivated area and production of oilseeds exhibit a declining trend. From 2011-12 to 2021-22, the cultivated area in these districts decreases marginally from 12100 hectares to 12200 hectares. However, there is a slight increase in production from 9600 tons to 11500 tons during the same period, indicating some resilience in oilseed farming despite challenges.

In the plain districts of Uttarakhand, the cultivation and production of oilseeds follow a distinctive trend over the years. From 2011-12 to 2021-22, there's a discernible pattern of

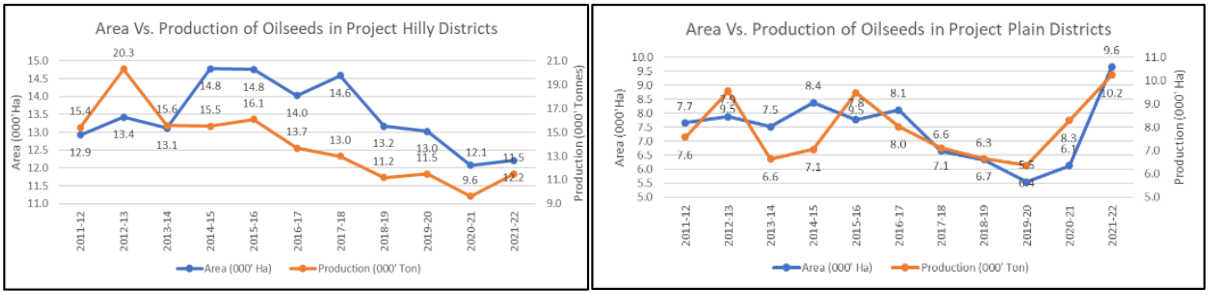


Figure 25: Decadal Variation in Oilseeds Area & Production; Hilly & Plain Districts

fluctuating cultivation area and steadily increasing production levels. The cultivated area experiences minor fluctuations, with a peak of 9600 hectares recorded in 2021-22. This suggests a certain degree of stability in oilseed cultivation practices in the plain districts. Despite occasional fluctuations, the overall trend indicates a consistent effort to maintain oilseed cultivation in these regions. Conversely, oilseed production showcases a noteworthy upward trajectory, steadily rising from 7100 tons in 2014-15 to 10200 tons in 2021-22. This indicates significant progress and improvement in oilseed farming practices, potentially attributed to advancements in agricultural techniques, access to better quality seeds, and enhanced irrigation methods.

(G) Sugarcane:

The data on sugarcane cultivation in Uttarakhand from 2011-12 to 2021-22 reveals interesting trends in both area and production. While the cultivated area remains relatively stable, fluctuating between 90,000 and 106,000 hectares over the years, sugarcane production demonstrates a notable increase. Beginning at 6,348,000 tons in 2011-12, production gradually rises, reaching 8,438,000 tons by 2021-22. This indicates a significant improvement in productivity per unit of land, showcasing advancements in agricultural practices, and possibly favourable climatic conditions. Despite challenges, such as terrain constraints and environmental factors, the data reflects a positive trajectory in sugarcane cultivation and production in Uttarakhand over the last 10 years, highlighting the resilience and adaptability of the agricultural sector in the region.

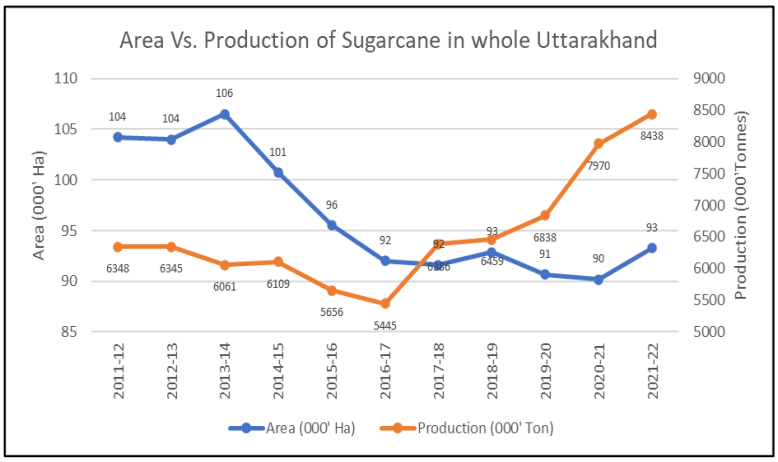


Figure 26: Decadal Variation in Sugarcane Area & Production; Uttarakhand

In the hilly districts, sugarcane cultivation area experiences a gradual decline, decreasing from 4000 hectares in 2011-12 to 2300 hectares in 2021-22. This reduction in cultivated area is mirrored in production, which also shows a declining trend, falling from 245.0 thousand tons to 189.8 thousand tons during the same period. Despite fluctuations, these figures suggest a notable decrease in both sugarcane cultivation and production in the hilly regions, potentially influenced by terrain challenges and environmental factors.

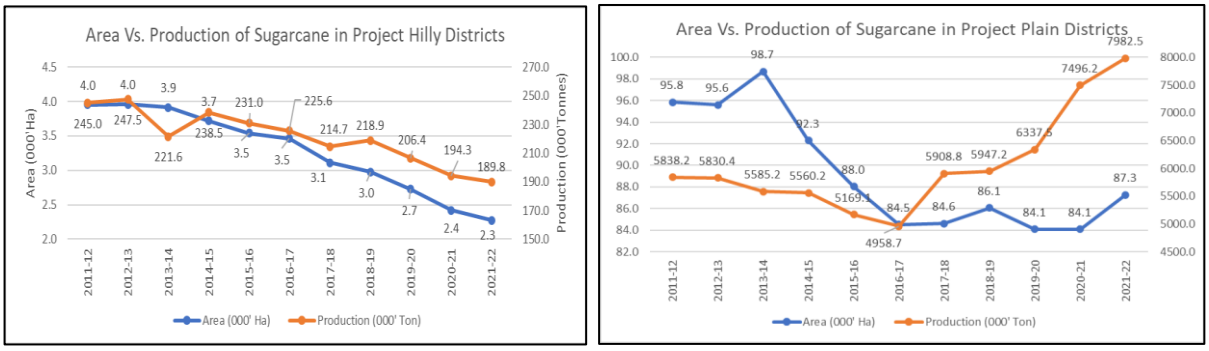


Figure 27: Decadal Variation in Sugarcane Area & Production; Hilly & Plain Districts

Conversely, in the plain districts, the data presents a contrasting picture. Here, the cultivated area and production of sugarcane exhibit fluctuations but generally show an upward trajectory. The cultivated area ranges from 84.5 thousand hectares to 98.7 thousand hectares, while production varies from 4,958.7 thousand tons to 7,982.5 thousand tons since last 10 years. This indicates a relatively stable or increasing trend in sugarcane cultivation and production in the plains, potentially driven by favourable agricultural conditions and enhanced farming practices.

1.5.2 Average Crop Yield:

The detail table of yield in kg/ha of the all crops growing in project hilly and plain districts wise data is given in Annexure. In the section, a total overview of various crops is being discussed and the total crop yield data w.r.t the state as well as the hilly and plain districts is given in table 14-16 below.

(A) Paddy:

The average yield (kg/ha) of paddy in Uttarakhand, categorized into hilly districts and plain districts, spanning from the agricultural year 2011-12 to 2021-22. Over the years, there have been fluctuations in average yields across different regions. In 2011-12, the average paddy yield in Uttarakhand stood at 1877 kg/ha, with hilly districts producing slightly lower at 1603 kg/ha compared to plain districts, which yielded 2470 kg/ha. However, this trend evolved over the following years. From 2012-13 to 2014-15, there was a gradual increase in yields across all regions, with hilly districts showing a consistent rise. Notably, in 2015-16, there was a significant spike in average yields across all regions, with Uttarakhand recording an average yield of 2803 kg/ha. From 2016-17 to

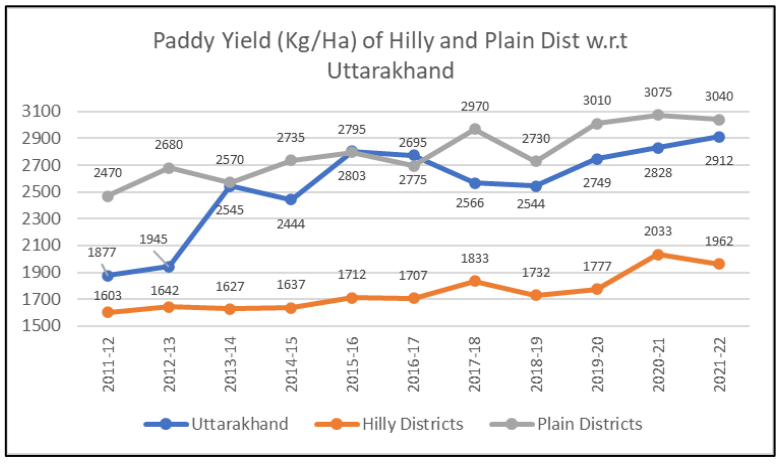


Figure 28 Average Paddy Yield; Uttarakhand

2018-19, there was relative stability in average paddy yields, with minor fluctuations observed. However, it's worth mentioning that hilly districts consistently maintained a slightly lower average yield compared to plain districts during this period. The year 2019-20 saw another notable increase in average paddy yields across all regions, with Uttarakhand recording a yield of 2749 kg/ha. This trend continued into 2020-21 and 2021-22, with further improvements observed in average yields, especially in hilly districts where there was a significant increase.

(B) Wheat:

The average yield of wheat in the project districts as well in Uttarakhand offers a comprehensive view of the average yield of wheat in Uttarakhand, spanning from 2011-12 to 2021-22. This breakdown allows for a more nuanced understanding of agricultural productivity across different terrains within the state. In 2011-12, the average yield across Uttarakhand stood at 1873 kg/ha. Hilly districts generally exhibited lower yields compared to plain districts, with yields ranging from 1590 kg/ha to 3455 kg/ha in the same year. However, over the years, there have been fluctuations and notable shifts in yield patterns. For instance, in 2014-15, there was a significant drop in yield across all regions, attributed to various factors such as adverse weather conditions or agricultural practices. Nevertheless, the subsequent years witnessed a recovery and even surpassing of previous yield levels, particularly noticeable in 2017-18 and 2018-19. Analyzing the most recent data from 2021-22, the average yield for Uttarakhand stands at 2305 kg/ha. While there has been a general upward trend in yield over the years, it's crucial to acknowledge the disparities between hilly and plain districts. Despite this, both regions have shown improvements in yield over the years, indicating resilience and adaptability within the agricultural sector.

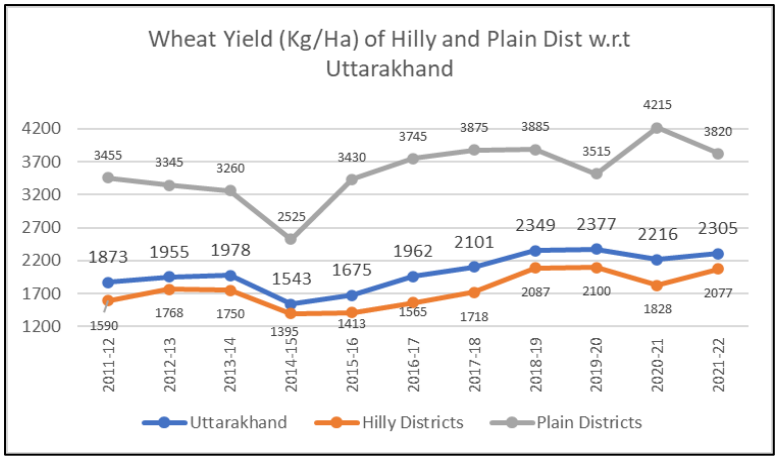


Figure 29: Average Wheat Yield; Uttarakhand

(C) Millet:

The average yield of Millet Uttarakhand, with a specific focus on comparing yields between Uttarakhand as a whole and its hilly districts, as Millet is not cultivated in plain districts. Millet is a staple crop known for its nutritional value and resilience to adverse growing conditions, making it in particularly important in regions like Uttarakhand. Across the years from 2011-12 to 2021-22, the average yield of Millet in Uttarakhand fluctuated within a relatively narrow range, with variations observed between the overall

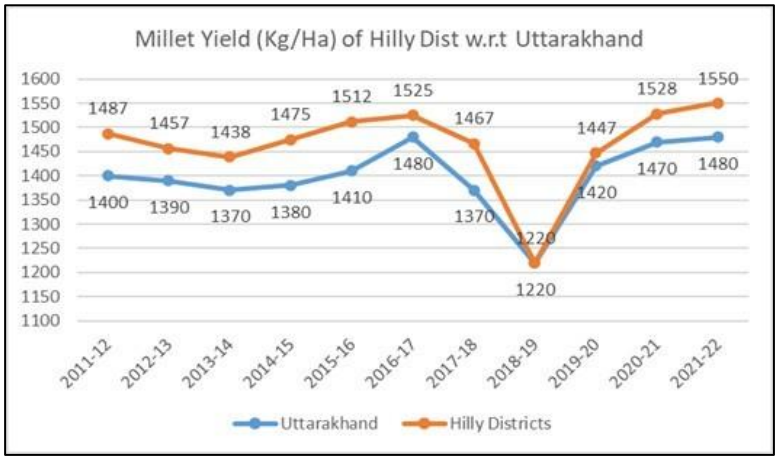


Figure 30: Average Millet Yield; Uttarakhand.

state and its hilly districts. It's noteworthy that Millet cultivation is predominantly concentrated in hilly regions, as indicated by the absence of data for plain districts. In 2011-12, the average yield of Millet in Uttarakhand was 1400 kg/ha, with hilly districts showing a slightly higher yield at 1487 kg/ha. Over the subsequent years, there were minor fluctuations in yield, with occasional peaks and dips. Notably, in 2018-19, there was a significant decrease in both overall state yield and hilly district yield, dropping to 1220 kg/ha. However, this trend reversed in the following years, with yields gradually increasing and even surpassing previous levels in some instances. The year 2021-22 indicates an average yield of 1480 kg/ha for Uttarakhand as a whole, with hilly districts showing a slightly higher yield of 1550 kg/ha. This suggests a relatively stable performance of Millet cultivation in the region, with yields maintaining a consistent level over the years.

(D) Pulses:

The average yield of pulses in Uttarakhand, with a further breakdown into hilly and plain districts, spanning from 2011-12 to 2021-22. Pulses are essential crops in agriculture, providing a significant source of protein and nutrients, especially in regions like Uttarakhand. In 2011-12, the average yield of pulses in Uttarakhand stood at 768 kg/ha. Hilly districts generally exhibited higher yields compared to plain districts, with yields ranging from 595 kg/ha to 800 kg/ha in the same year. Over the subsequent years, there were fluctuations in yield, with occasional peaks and dips. Notably, in 2014-15, there was a significant drop in yield across all regions, particularly evident in plain districts. This could be attributed to various factors such as weather conditions, pest infestations, or agricultural practices. However, yields gradually recovered and even surpassed previous levels in the following years. Whereas, average yield of pulses in 2021-22 indicates an average yield of 1070 kg/ha for Uttarakhand as a whole. Hilly districts continue to show higher yields compared to plain districts, although both regions have experienced improvements in yield over the years. The variations in yield could be influenced by factors such as soil quality, climatic conditions, access to irrigation, adoption of improved varieties, and agricultural practices.

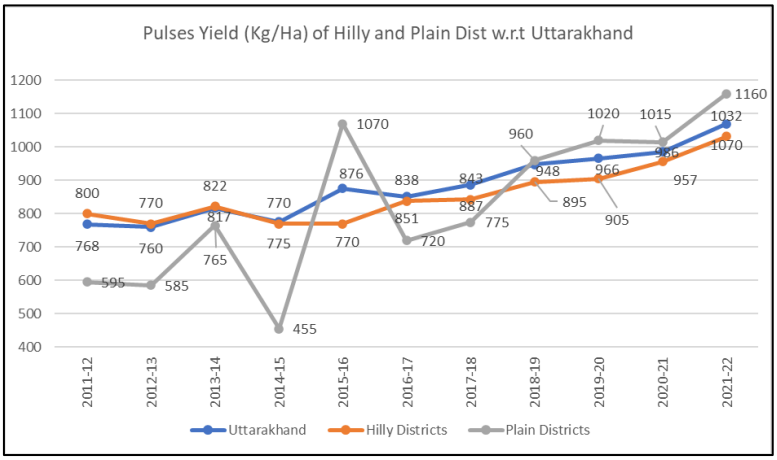


Figure 31: Average Pulses Yield; Uttarakhand.

(E) Foodgrains:

The decadal average yield data analysis indicate a consistent upward trajectory in the average yield of pulses across Uttarakhand. This positive trend is evident in both hilly and plain districts, although there are variations in yield levels between these regions. In 2011-12, the average yield of pulses in Uttarakhand stood at 1723 kg/ha, with hilly districts exhibiting slightly lower yields compared to plain districts. However, over the subsequent years, there was a noticeable increase in yield, with occasional fluctuations. In 2014-15, there was a notable decrease in yield across all regions, potentially attributed to various factors such as adverse weather conditions, pest outbreaks, or agricultural practices. The most recent data from 2021-22 indicates an average yield of 2060 kg/ha for Uttarakhand as a whole. Interestingly, hilly districts have caught up and shown comparable yields to plain districts in recent years, reflecting improvements in agricultural practices and possibly better adaptation to local conditions.

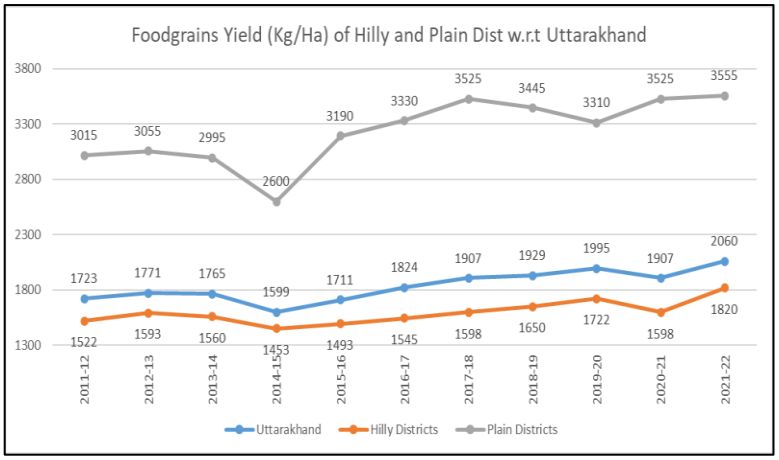


Figure 32: Average Foodgrains Yield; Uttarakhand.

(F) Oilseeds:

The provided data presents the average yield of oilseeds (measured in kilograms per hectare) in Uttarakhand, with a breakdown into hilly districts and plain districts, covering the period from 2011-12 to 2021-22. Oilseeds are essential crops as they are a primary source of vegetable oils, which are vital for cooking, industrial purposes, and as components of various products. Analyzing the trends over the specified period, it's evident that the average yield of oilseeds in Uttarakhand has experienced fluctuations, with varying performance between hilly and plain districts. In 2011-12, the average yield of oilseeds in Uttarakhand stood at 873 kg/ha, with plain districts exhibiting higher yields compared to hilly districts. However, there have been fluctuations in yield over the years, with occasional peaks and dips observed across all regions. Notably, in 2014-15, there was a significant decrease in yield across all regions, potentially due to adverse weather conditions, pest infestations, or other agricultural factors. The most recent data from 2021-22 indicates an average yield of 848 kg/ha for Uttarakhand as a whole. Interestingly, hilly districts have shown a slight increase in yield compared to previous years, narrowing the gap with plain districts.

From 2015-16 onwards, there has been a noticeable distinction in the average yield of oilseeds between hilly and plain districts in Uttarakhand. In hilly districts, which typically have rugged terrain and limited access to resources, the average yield of oilseeds has demonstrated resilience despite challenges. For instance, in hilly districts, the average yield in 2015-16 stood at 782 kg/ha, and it steadily increased to 780 kg/ha by 2021-22. This suggests a modest but consistent improvement in yield over the years, highlighting the resilience of farmers despite challenging conditions.

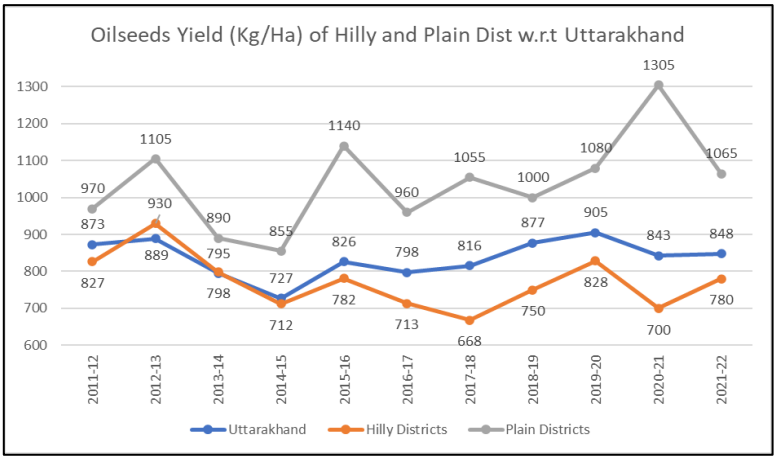


Figure 33: Average Oilseeds Yield; Uttarakhand.

Conversely, in plain districts where agricultural land is more accessible and resources are relatively abundant, the average yield of oilseeds has exhibited more variability. For instance, in plain districts, the average yield in 2015-16 was 1140 kg/ha, but it fluctuated

over the years, reaching 1305 kg/ha in 2020-21 before decreasing to 1065 kg/ha in 2021-22.

(G) Sugarcane:

Comparing the average sugarcane yield across Uttarakhand, hilly districts, and plain districts reveals intriguing insights into the productivity trends over the last 10 years. In Uttarakhand as a whole, the average sugarcane yield has shown fluctuations, with notable peaks and dips observed over the years. From 2011-12 to 2021-22, the average yield ranged from 56,920 kg/ha to 90,470 kg/ha, showcasing significant variability. In hilly districts, despite rugged terrain and potential limitations in resources, the average sugarcane yield has generally been comparable to or slightly higher than the state average. While fluctuations were observed, particularly in the early years, there has been a trend of consistent improvement. From 2017-18 onwards, hilly districts consistently showed higher yields compared to the state average, reaching 83,400 kg/ha in 2021-22. Conversely, in plain districts where agricultural land is more accessible and resources may be relatively abundant, the average sugarcane yield has been consistently higher than both the state average and hilly districts. Plain districts consistently exhibited the highest yields throughout the years, peaking at 88,380 kg/ha in 2020-21.

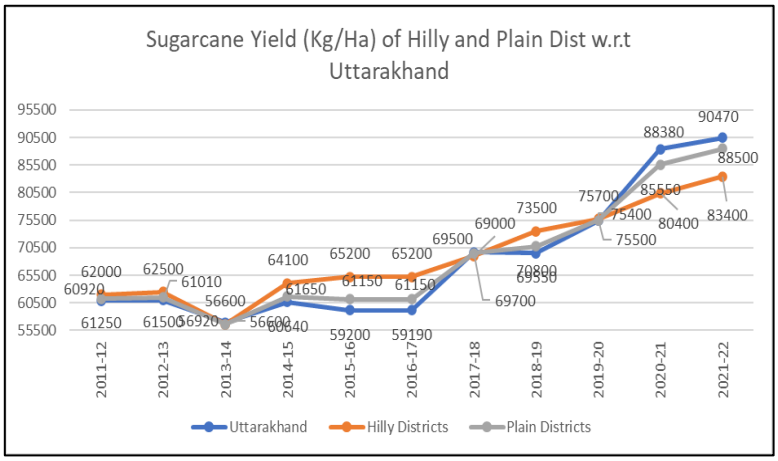


Figure 34: Average Sugarcane Yield; Uttarakhand

1.5.3 Vegetable Cultivation:

Uttarakhand is a key supplier of off-season vegetables to the North Indian market. Farmers have adjusted their cropping calendars to meet market demand, with tomatoes, potatoes, and peas thriving. Other widely grown OSVs include cauliflower, capsicum, cabbage, and beans. Over the span of 6 years, Uttarakhand's vegetable cultivation landscape exhibited nuanced shifts and notable trends. Peas cultivation witnessed a consistent rise in area, expanding from 12.58 thousand hectares to 11.56 thousand hectares, paralleled by a steady in production from 87.81 thousand tonnes to 81.51 thousand tonnes. Radish cultivation remained relatively stable, maintaining an area between 4.90 to 4.15 thousand hectares and production increases from 55.68 to 60.85 thousand tonnes till 2020-21 and then decreased drastically in the recent year to 37.16 thousand tonnes. Bean cultivation displayed a gradual expansion in area, reaching 6.19 thousand hectares, with production scaling from 40.21 thousand tonnes to 42.28

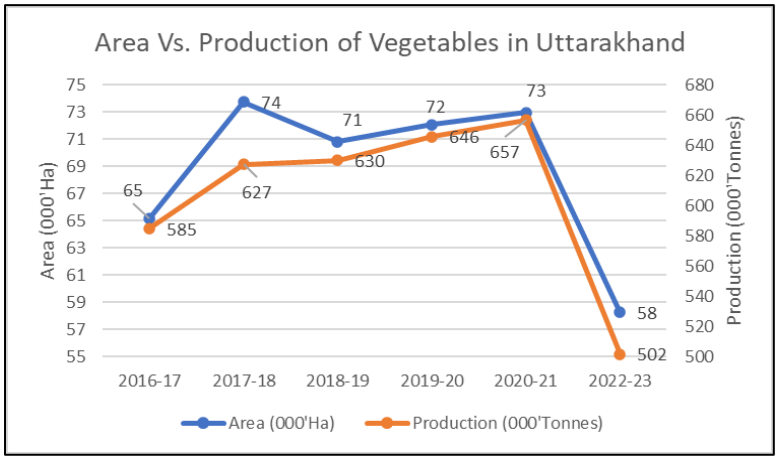


Figure 35: Variation in Vegetable area & Production; Uttarakhand

thousand tonnes till the year 2021-21, and then followed the similar result as other vegetables to decline drastically in 2022-23 to 23.25 thousand tonnes. Cabbage, cauliflower, onion, capsicum, okra, tomato, brinjal, and other vegetables showcased similar trend as peas, radish and bean in both cultivation area and production. Collectively, the total vegetable cultivation area increased from 65.20 thousand hectares to 72.96 thousand hectares till 2021-21. Additionally, potato cultivation, although separately categorized, also saw a slight uptick in both area (from 26.04 to 17.08 thousand hectares) and production (from 360.37 to 183.92 thousand tonnes). These trends signify a generally positive trajectory in vegetable cultivation, emphasizing incremental growth in both cultivated area and production, reflecting the agricultural sector's adaptability and efforts to meet demand while enhancing yield across various vegetable categories in Uttarakhand.

The detail table of area and productions of the all vegetable growing in project hilly and plain districts wise data is given in Annexure. In the section, a total overview of different vegetables is being discussed and the total vegetable data w.r.t the state as well as the hilly and plain districts is given in table 17-19 below.

Over the span of six years, the vegetable cultivation landscape in Uttarakhand's hilly and plain districts depicted varied trends and nuanced shifts. Total vegetable cultivation showed a consistent increase in area, expanding from 30.88 to 30.14 thousand hectares in hilly districts and from 12.36 to 14.10 thousand hectares in plain districts, paralleled by a steady rise in production from 243.54 to 192.47 thousand tonnes in hilly districts and from 156.26 to 201.73 thousand tonnes in plain districts. Radish cultivation remained relatively stable, maintaining an area between 2.43 to 2.17 thousand hectares in hilly districts and from 0.42 to 0.55 thousand hectares in plain districts, with production fluctuating from 27.60 to 17.67 thousand tonnes in hilly districts and from 5.06 to 8.19 thousand tonnes in plain districts till 2020-21 and then decreased drastically in the recent year to 8.19 thousand tonnes. Bean cultivation displayed a gradual expansion in area, reaching 3.14 thousand hectares in hilly districts and from 0.31 to 1.22 thousand hectares in plain districts, with production scaling from 19.31 to 11.79 thousand tonnes in hilly districts and from 2.95 to 2.94 thousand tonnes in plain districts till the year 2021-21, and then followed the similar result as other vegetables to decline drastically in 2022-23 to 11.79 and 2.94 thousand tonnes, respectively. Cabbage, cauliflower, onion, capsicum, okra, tomato, brinjal, and other vegetables showcased similar trends as peas, radish, and beans in both cultivation area and production across hilly and plain districts.

Collectively, the total vegetable cultivation area increased from 42.46 to 44.24 thousand hectares in hilly districts and from 16.72 to 17.46 thousand hectares in plain districts till 2021-21. Additionally, potato cultivation saw a slight uptick in both area (from 12.10 to 8.61 thousand hectares in hilly districts and from 4.36 to 3.71 thousand hectares in plain districts) and production (from 181.05 to 72.88 thousand tonnes in hilly districts and from 95.05 to 74.37 thousand tonnes in plain districts). These trends signify a generally positive trajectory in vegetable cultivation, emphasizing incremental growth in both cultivated area and production, reflecting the agricultural sector's adaptability and efforts to meet demand while enhancing yield across various vegetable categories in Uttarakhand's hilly and plain districts.

1.5.4 Fruits and Flowers:

(A) Fruits: Across the years spanning from 2016-17 to 2022-23, Uttarakhand's fruit cultivation sector underwent varied shifts in both cultivation area and production. The region showcased consistency in certain fruit categories while witnessing nuanced changes in others. Apple cultivation remained relatively stable with an average cultivation area of 25,500 hectares, fluctuating only marginally across the years, while its production maintained an average of 62,060 tonnes in 2016-17 and peaked at 64,880 tonnes in 2020-21. Similarly, *Nashpati* (Pears) cultivation displayed a modest increase in area from 13090 hectares to 13,250 hectares, yet its production exhibited a declining trend, starting at 79.75 thousand tonnes and falling to 73.78 thousand tonnes by 2020-21. Conversely, Peach cultivation experienced a slight rise in area, reaching 8,280 hectares, but its production declined from 58.09 to 52.86 thousand tonnes over the same period. Plum cultivation witnessed minor area expansions and gradual production declines, while Apricot cultivation remained relatively stable in both area (ranging from 7,990 to 8,070 hectares) and production (fluctuating around 28,000 tonnes). These trends reflect the nuanced dynamics within Uttarakhand's fruit cultivation sector, showcasing stability in some fruits' cultivation areas alongside fluctuations in their production outputs over the specified years.

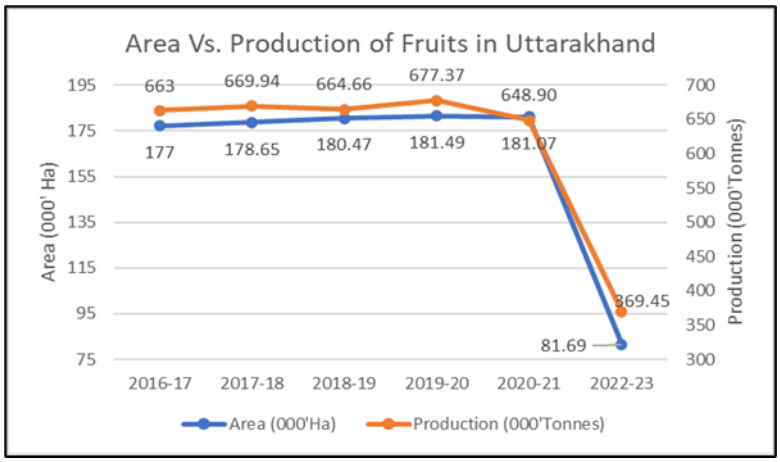


Figure 36 Variation in Fruits Area & Production; Uttarakhand

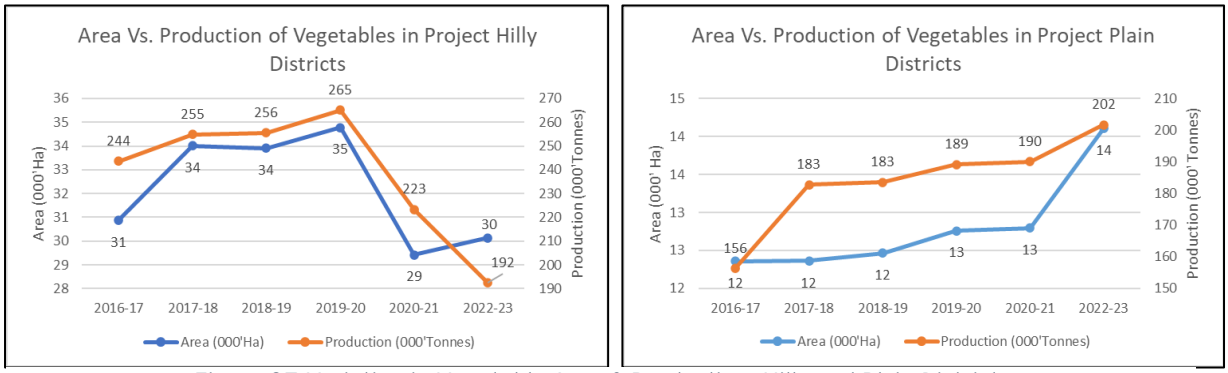


Figure 37 Variation in Vegetable Area & Production; Hilly and Plain Districts

The detail table of area and productions of the all fruits and flowers growing in project hilly and plain districts wise data is given in Annexure. In the section, a total overview of different fruits and flowers is being discussed and the total vegetable data w.r.t the state as well as the hilly and plain districts is given in tables below.

Table 6: Area and Production of Fruits; Uttarakhand

Area in Thousand Ha. and Production in Thousand Tonnes												
Type	2016-17		2017-18		2018-19		2019-20		2020-21		2022-23	
	A	P	A	P	A	P	A	P	A	P	A	P
Fruits												
Apple	25.20	62.06	25.32	58.66	25.68	57.75	25.79	62.09	25.98	64.88	9.42	37.17
Pears (Nashpati)	13.09	79.57	13.14	79.80	13.19	77.25	13.23	78.12	13.25	73.78	1.63	6.52
Peach (Aadoo)	7.94	58.09	8.11	58.99	8.19	58.49	8.26	58.80	8.28	52.90	5.52	36.24
Plum (Pulam)	8.90	36.25	8.95	36.47	8.99	36.20	9.03	36.45	9.08	34.84	2.63	12.62
Apricot (Khumanee)	7.99	28.28	8.03	28.43	8.07	28.03	8.09	28.32	8.07	25.62	2.30	8.76
Walnut	17.37	20.47	17.55	21.17	17.62	20.05	17.73	20.37	17.76	18.93	5.68	9.68
Citrus	21.28	88.90	21.49	91.33	21.61	90.92	21.74	91.18	21.75	86.85	9.99	36.91
Mango	36.42	150.14	36.48	152.71	36.77	154.03	36.91	156.79	36.60	150.67	21.05	113.41
Litchi	10.39	24.02	10.50	24.27	10.61	24.26	10.70	24.64	10.72	24.72	5.22	19.07
Amla	1.29	2.39	1.33	2.65	1.40	2.43	1.43	2.46	1.00	2.39	0.99	3.92
Guava	3.43	19.34	3.62	20.37	3.98	20.10	4.10	21.17	4.15	21.75	4.69	37.70
Total Fruits	**177.32**	**662.85**	**178.65**	**669.94**	**180.47**	**664.66**	**181.49**	**677.37**	**181.07**	**648.90**	**81.69**	**369.45**

Table 7: Area and Production of Fruits; Hilly Districts

Area in Thousand Ha. and Production in Thousand Tonnes												
Type	2016-17		2017-18		2018-19		2019-20		2020-21		2022-23	
	A	P	A	P	A	P	A	P	A	P	A	P
Fruits												
Apple	17.11	29.94	17.14	44.12	17.43	43.67	17.49	48.00	17.60	50.78	7.48	26.23
Pears (Nashpati)	8.82	56.71	8.84	56.74	8.88	56.19	8.91	57.09	8.91	52.90	2.58	26.23
Peach (Aadoo)	5.06	50.50	5.19	50.68	5.23	50.43	5.27	50.70	5.29	44.75	3.98	31.65
Plum (Pulam)	6.23	32.21	6.25	32.25	6.28	31.98	6.30	32.22	6.32	30.60	2.02	11.33
Apricot (Khumanee)	5.56	24.65	5.57	24.67	5.59	24.29	5.59	24.57	5.60	22.42	1.88	7.85
Walnut	11.47	12.92	11.59	13.43	11.62	12.35	11.70	12.68	11.73	11.23	3.68	7.22
Citrus	10.25	47.12	10.39	48.45	10.47	48.34	10.54	48.56	10.57	19.24	5.23	20.14
Mango	14.63	73.58	16.25	77.38	14.80	75.55	14.89	75.69	14.94	74.02	7.13	40.38
Litchi	2.38	9.84	2.42	9.77	2.22	9.40	2.49	9.74	2.51	9.73	2.05	8.79
Amla	0.28	1.10	0.29	1.31	0.32	1.11	0.33	1.11	0.47	0.96	0.52	2.84
Guava	0.77	3.48	0.79	3.54	0.83	3.35	0.85	3.64	0.80	3.62	1.15	5.99
Total Fruits	**95.17**	**381.09**	**95.79**	**380.58**	**93.52**	**324.02**	**97.10**	**387.64**	**97.44**	**366.18**	**42.77**	**199.70**

Note: A: Area and P: Production; (Area in 000' ha. and Production in 000' T)

Table 8: Area & Production of Fruits; Plain Districts

Area in Thousand Ha. and Production in Thousand Tonnes												
Type	2016-17		2017-18		2018-19		2019-20		2020-21		2022-23	
	A	P	A	P	A	P	A	P	A	P	A	P
Fruits												
Apple	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pears (Nashpati)	0.00	0.00	0.21	2.41	0.21	1.97	0.21	1.92	0.20	1.78	0.01	0.09
Peach (Aadoo)	0.00	0.00	0.16	0.75	0.17	0.68	0.17	0.71	0.18	0.72	0.08	0.31
Citrus	1.68	7.74	1.69	8.63	1.70	7.41	1.70	7.43	1.70	7.28	0.64	3.05
Mango	9.43	57.36	9.65	58.12	9.80	58.91	9.82	61.48	9.47	57.03	8.33	51.63
Litchi	3.15	6.62	3.18	6.65	3.23	6.66	3.27	7.01	3.26	7.09	1.79	6.86
Amla	0.20	0.71	0.20	0.72	0.20	0.70	0.21	0.72	0.19	0.67	0.05	0.23
Guava	1.58	13.41	1.70	14.33	2.00	14.23	2.08	15.00	2.10	15.59	2.58	28.80
Total Fruits	**22.95**	**152.10**	**23.35**	**153.92**	**23.89**	**153.71**	**24.06**	**158.31**	**23.70**	**152.13**	**14.53**	**98.17**

In the hilly districts, apple cultivation remained relatively stable with a consistent cultivation area, ranging from 17.11 to 17.60 thousand hectares. Its production fluctuated marginally between 26.23 to 50.78 thousand tonnes, peaking in 2020-21 before experiencing a significant decline to 7.48 thousand tonnes in 2022-23. Similarly, pears (Nashpati) cultivation maintained a steady area around 8.82 to 8.91 thousand hectares, with production ranging from 26.23 to 57.09 thousand tonnes, witnessing a decline to 26.23 thousand tonnes in 2022-23. Peach (Aadoo) cultivation displayed a slight increase in area, reaching 5.29 thousand hectares, but production declined from 44.75 to 31.65 thousand tonnes over the same period. Plum (Pulam) cultivation witnessed minor area expansions and gradual production declines, while Apricot (Khumanee) cultivation remained relatively

stable in both area and production, fluctuating around 5.56 to 5.60 thousand hectares in area and approximately 22.42 to 24.67 thousand tonnes in production. These trends reflected nuanced dynamics within Uttarakhand's fruit cultivation sector, showcasing stability in some fruits' cultivation areas alongside fluctuations in their production outputs over the specified years.

Conversely, in the plain districts, the cultivation landscape displayed different dynamics. While apple cultivation was not reported in the data provided for the plain districts, pears (Nashpati) cultivation witnessed slight fluctuations in both area and production, with a gradual decline in both metrics, reaching 0.01 thousand hectares in area and 0.09 thousand tonnes in production in 2022-23. Peach (Aadoo) cultivation showed a minor increase in both area and production, reaching 0.08 thousand hectares in area and 0.31 thousand tonnes in production in 2022-23. Citrus cultivation exhibited a slight decline in area and production in 2022-23 compared to previous years. Mango cultivation displayed fluctuations in both area and production, with a decline in both metrics in 2022-23. Litchi cultivation also witnessed minor fluctuations, with a slight decrease in both area and production in 2022-23. Amla and guava cultivation showed similar trends, with minor fluctuations in both area and production.

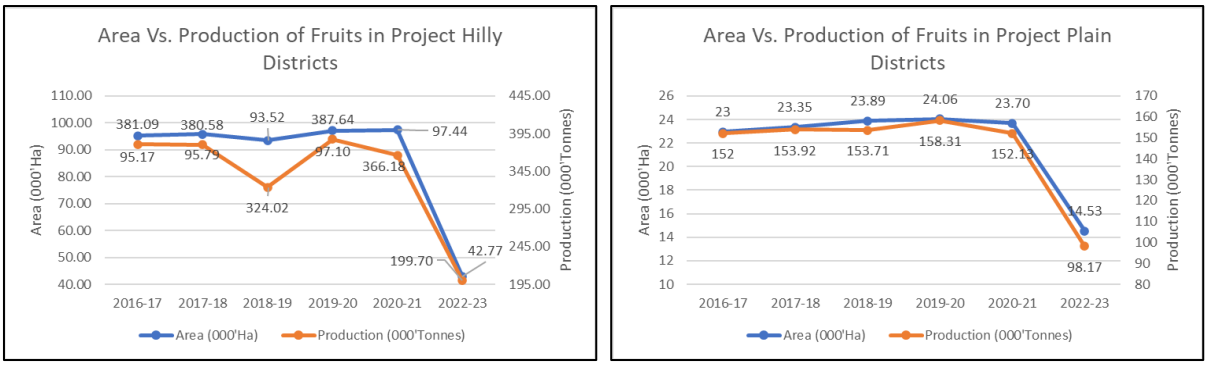


Figure 38: Variation in Fruits Area & Production; Hilly & Plain Districts

(B) Flowers: From 2016-17 to 2020-21, Uttarakhand's floral cultivation landscape experienced fluctuations in both cultivation area and production across various flower varieties. Gerbera cultivation remained relatively stable with a consistent cultivation area of approximately 0.10 to 0.11 thousand hectares, showing fluctuations in production, starting at 950 to 1,110 tonnes in 2019-20 before dropping to 910 tonnes in 2020-21. Carnation cultivation sustained a consistent area of around 0.02 thousand hectares, while its production remained relatively stable, fluctuating between 120 to 130 tonnes. Gladiolus exhibited minor variations in both area and production, with the area increasing slightly from 0.29 to 0.31 thousand hectares and production ranging from 440 to 650 tonnes over the years. Marigold, a significant floral crop, showcased a gradual rise in both area and production, expanding from 0.78 to 0.86

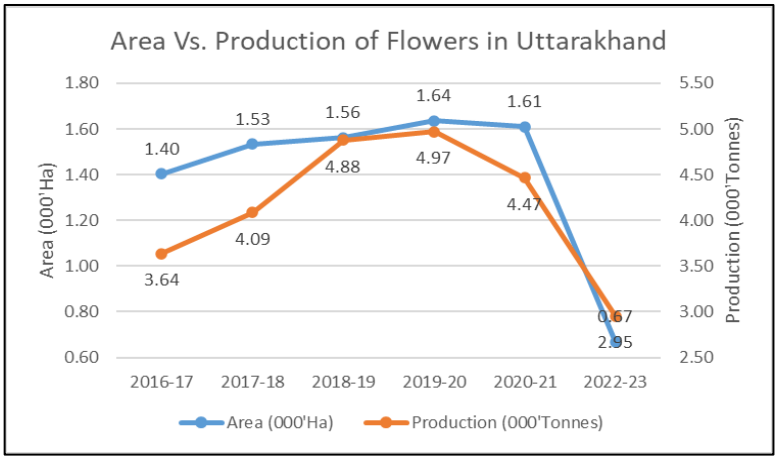


Figure 39: Variation in Flower Area & Production; Uttarakhand

thousand hectares and from 1,780 to 2,680 tonnes, respectively. Roses experienced a minor increase in area from 0.11 to 0.16 thousand hectares while maintaining production levels between 170 to 220 tonnes. Tuberose and other flowers maintained consistent cultivation areas around 0.02 thousand hectares and exhibited stable production values.

As of the current year 2022-23, there have been further changes in floral cultivation in Uttarakhand. Gerbera cultivation area has notably decreased to 0.05 thousand hectares with production reduced to 490 tonnes. Carnation cultivation area remained at 0.02 thousand hectares with a slight increase in production to 50 tonnes. Gladiolus cultivation area has decreased to 0.06 thousand hectares with a production of 90 tonnes. Marigold continues to maintain a significant cultivation area of 0.34 thousand hectares with a production of 1,890 tonnes. Roses have a cultivation area of 0.11 thousand hectares with a production of 210 tonnes. Tuberose cultivation area remained the same at 0.0003 thousand hectares with a production of 3 tonnes.

Table 9: Area & Production of Flowers; Uttarakhand

Area in Thousand Ha. and Production in Thousand Tonnes												
Type	2016-17		2017-18		2018-19		2019-20		2020-21		2022-23	
	A	P	A	P	A	P	A	P	A	P	A	P
Flowers												
Gerbera	0.10	0.95	0.10	0.98	0.11	1.07	0.11	1.11	0.11	0.91	0.05	0.49
Carnation	0.02	0.12	0.02	0.12	0.02	0.13	0.02	0.13	0.02	0.05	0.00	0.02
Gladiolus	0.29	0.48	0.28	0.44	0.28	0.64	0.32	0.65	0.31	0.47	0.06	0.09
Lilium	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.00	0.01
Marigold	0.78	1.78	0.83	2.17	0.84	2.64	0.86	2.67	0.86	2.68	0.34	1.89
Rose	0.11	0.17	0.16	0.22	0.15	0.21	0.15	0.22	0.16	0.17	0.11	0.21
Tuberose (Rajanigandha)	0.017	0.033	0.017	0.019	0.017	0.018	0.018	0.019	0.018	0.020	0.0003	0.003
Total Flowers	**1.40**	**3.64**	**1.53**	**4.09**	**1.56**	**4.88**	**1.64**	**4.97**	**1.61**	**4.47**	**0.67**	**2.95**

Note: A: Area and P: Production (Area in 000' ha. and Production in 000' T)

Table 10: Area & Production of Flowers; Hilly Districts

Area in Thousand Ha. and Production in Thousand Tonnes												
Type	2016-17		2017-18		2018-19		2019-20		2020-21		2022-23	
	A	P	A	P	A	P	A	P	A	P	A	P
Fruits												
Gerbera	0.01	0.25	0.01	0.25	0.01	0.25	0.01	0.25	0.01	0.02	0.01	0.04
Carnation	0.00	0.10	0.00	0.10	0.00	0.10	0.00	0.10	0.00	0.03	0.00	0.01
Gladiolus	0.054	0.076	0.048	0.086	0.047	0.236	0.103	0.208	0.076	0.073	0.010	0.019
Lilium	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.00	0.00
Marigold	0.11	0.42	0.15	0.47	0.15	0.47	0.17	0.48	0.16	0.45	0.08	0.41
Rose	0.02	0.08	0.07	0.14	0.06	0.12	0.06	0.12	0.02	0.04	0.04	0.15
Tuberose (Rajanigandha)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0030
Total Flowers	**0.23**	**0.96**	**0.34**	**1.12**	**0.33**	**1.24**	**0.38**	**1.27**	**0.35**	**0.68**	**0.19**	**0.73**

Table 11: Area & Production of Flowers; Plain Districts

Area in Thousand Ha. and Production in Thousand Tonnes												
Type	2016-17		2017-18		2018-19		2019-20		2020-21		2022-23	
	A	P	A	P	A	P	A	P	A	P	A	P
Fruits												
Gerbera	0.05	0.67	0.05	0.70	0.05	0.79	0.06	0.84	0.06	0.87	0.03	0.44
Carnation	0.000	0.000	0.005	0.002	0.005	0.010	0.005	0.011	0.005	0.010	0.000	0.000
Gladiolus	0.18	0.34	0.17	0.28	0.18	0.33	0.14	0.29	0.18	0.33	0.04	0.07
Lilium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Marigold	0.53	0.85	0.53	1.16	0.54	1.63	0.54	1.64	0.54	1.68	0.18	1.34
Rose	0.08	0.07	0.08	0.07	0.08	0.09	0.08	0.09	0.09	0.10	0.04	0.05
Tuberose (Rajanigandha)	0.01	0.03	0.01	0.04	0.01	0.01	0.01	0.01	0.01	0.02	0.00	0.00
Total Flowers	**0.89**	**2.02**	**0.94**	**2.28**	**0.92**	**2.92**	**1.00**	**3.00**	**0.94**	**3.09**	**0.27**	**2.03**

In the hilly districts, flower cultivation presents a mixed picture marked by challenges and limitations. Gerbera cultivation, for instance, experienced a continual decline in both area and production over the years, with the area decreasing from 0.01 thousand hectares in 2016-17 to 0.01 thousand hectares in 2022-23, accompanied by a decrease in production

from 0.25 to 0.04 thousand tonnes during the same period. This trend indicates perhaps the constraints posed by the rugged terrain and harsher climatic conditions on cultivation. Carnation cultivation remains marginal, with minimal fluctuations and negligible production throughout the period, suggesting the limited suitability of hilly terrains for this particular flower variety. Gladiolus cultivation, while showcasing fluctuating trends, witnessed a significant drop in both area and production in 2022-23, reflecting the vulnerability of hilly regions to environmental factors.

Flowers cultivation in plain districts showcases a more promising outlook characterized by stability and growth. Gerbera cultivation, for instance, exhibits a steady increase in both area and production, with the area expanding from 0.05 thousand hectares in 2016-17 to 0.03 thousand hectares in 2022-23, accompanied by a rise in production from 0.67 to 0.44 thousand tonnes during the same period. This indicates the favourable conditions of the flatlands for this particular flower variety. Similarly, Carnation cultivation demonstrates a relatively stable growth trend, with slight fluctuations but an overall upward trajectory in both area and production, indicating the adaptability of plain districts to support diverse floral crops. Gladiolus cultivation shows consistent growth patterns, with both area and production steadily incrementing over the years, showcasing the resilience and potential of plain districts to sustain floral cultivation efforts.

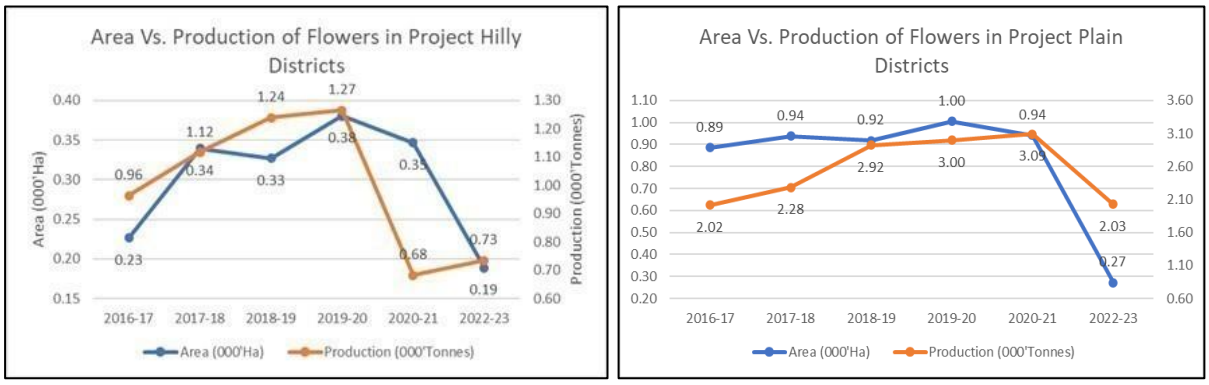


Figure 40: Variation in Flowers Area & Production; Hilly & Plain Districts

1.5.5 Spices:

Over the span of years from 2016-17 to 2022-23, Uttarakhand has consistently showcased a progressive trend in the cultivation and production of spices. Turmeric cultivation area and production have witnessed steady growth, with the area expanding from 1.48 thousand hectares in 2016-17 to 1.79 thousand hectares in 2020-21, accompanied by a rise in production from 12.65 to 15.20 thousand metric tons during the same period. In 2022-23, there was a notable surge in both area and production, with the cultivation area increasing to 3.15 thousand hectares and production reaching 28.16 thousand metric tons, indicating a significant boost in turmeric cultivation. Similarly, chilly, coriander, fenugreek, garlic, ginger, cardamom, and other spices have experienced

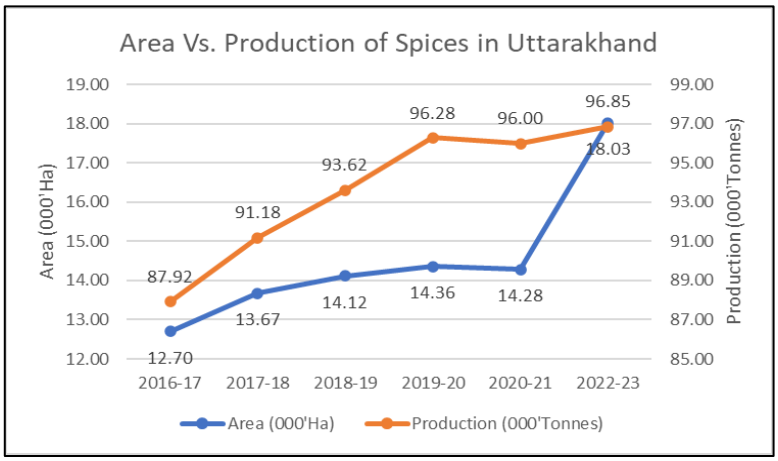


Figure 41: Variation in Spices Area & Production; Uttarakhand

an upward trajectory in both cultivation area and production rates over the years. For instance, chilly cultivation has maintained an area ranging from 2.75 to 2.85 thousand hectares and production between 8.86 to 9.63 thousand metric tons. In 2022-23, there was a considerable increase in chilly cultivation area and production, with the area expanding to 3.72 thousand hectares and production rising to 10.74 thousand metric tons. Ginger, a prominent spice, displayed consistent growth in both cultivation area and production, expanding from 4.47 thousand hectares and 47.11 thousand metric tons in 2016-17 to 5.17 thousand hectares and 50.05 thousand metric tons in 2020-21. However, in 2022-23, there was a slight decline in both area and production, with the cultivation area decreasing to 4.60 thousand hectares and production declining to 33.38 thousand metric tons.

The detail table of area and productions of the all fruits and flowers growing in project hilly and plain districts wise data is given in the Annexure.

Table 12: Area & Production of Spices; Uttarakhand

Area in Thousand Ha. and Production in Thousand Tonnes												
Type	2016-17		2017-18		2018-19		2019-20		2020-21		2022-23	
	A	P	A	P	A	P	A	P	A	P	A	P
Spices												
Turmeric	1.48	12.65	1.57	13.03	1.72	14.18	1.77	14.75	1.79	15.20	3.15	28.16
Chilly	2.75	8.86	2.76	9.16	2.80	9.47	2.85	9.63	2.75	9.33	3.72	10.74
Coriander	1.24	3.37	1.36	3.64	1.43	4.06	1.46	4.15	1.39	3.93	1.85	3.47
Fenugreek	0.58	3.32	0.65	3.30	0.66	3.70	0.69	3.85	0.66	3.63	0.86	2.86
Garlic	1.70	10.70	1.95	10.64	2.00	11.05	2.09	11.44	1.92	11.27	2.95	14.25
Ginger	4.47	47.11	4.52	48.03	4.91	48.47	5.06	49.69	5.17	50.05	4.60	33.38
Cardamom	0.058	0.070	0.063	0.072	0.075	0.527	0.067	0.078	0.085	0.090	0.049	0.037
Total Spices	**12.70**	**87.92**	**13.67**	**91.18**	**14.12**	**93.62**	**14.36**	**96.28**	**14.28**	**96.00**	**18.03**	**96.85**

Note: A: Area and P: Production; (Area in 000' ha. and Production in 000' MT)

Table 13: Area & Production of Spices; Hilly Districts

Area in Thousand Ha. and Production in Thousand Tonnes												
Type	2016-17		2017-18		2018-19		2019-20		2020-21		2022-23	
	A	P	A	P	A	P	A	P	A	P	A	P
Spices												
Turmeric	0.74	5.52	0.80	6.35	0.88	6.46	0.91	6.63	0.91	6.93	1.70	14.24
Chilly	1.55	3.96	1.76	4.59	1.78	4.81	1.82	4.91	1.71	4.59	2.54	5.66
Coriander	0.69	1.59	0.80	1.92	0.85	2.24	0.86	2.27	0.78	2.02	2.13	1.64
Fenugreek	0.17	0.73	0.23	0.77	0.22	1.08	0.24	1.13	0.20	0.84	0.43	1.43
Garlic	0.78	3.73	1.01	3.99	1.03	4.29	1.11	4.76	0.93	4.21	1.57	6.09
Ginger	2.71	27.48	2.98	28.10	3.05	28.41	3.17	28.97	3.27	29.27	2.50	17.03
Cardamom	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.04	0.02
Total Spices	**7.01**	**43.19**	**7.86**	**46.25**	**8.07**	**47.88**	**8.37**	**49.00**	**8.03**	**48.35**	**10.08**	**46.99**

Table 14: Area & Production of Spices; Plain Districts

Area in Thousand Ha. and Production in Thousand Tonnes												
Type	2016-17		2017-18		2018-19		2019-20		2020-21		2022-23	
	A	P	A	P	A	P	A	P	A	P	A	P
Spices												
Turmeric	0.28	2.65	0.29	2.78	0.30	2.84	0.32	3.22	0.33	3.31	0.53	7.65
Chilly	0.527	3.425	0.462	3.173	0.473	3.235	0.482	3.286	0.483	3.292	0.379	1.797
Coriander	0.26	1.00	0.26	0.90	0.27	0.97	0.28	1.03	0.29	1.04	0.28	0.21
Fenugreek	0.19	1.52	0.19	1.42	0.20	1.48	0.21	1.58	0.93	1.01	0.20	0.80
Garlic	0.35	3.53	0.36	3.14	0.37	3.20	0.38	3.38	0.38	3.42	0.48	3.46
Ginger	0.61	6.78	0.61	6.55	0.62	6.60	0.64	7.13	0.64	7.12	0.35	3.94
Cardamom	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Total Spices	**2.33**	**19.25**	**2.33**	**19.19**	**2.43**	**19.70**	**2.50**	**21.03**	**2.54**	**21.17**	**2.46**	**20.51**

In the realm of spice cultivation in hilly and plain districts spanning from 2016-17 to 2022-23, both regions showcased distinct yet consistent patterns. In **hilly districts**, the cultivation area remained relatively steady, ranging from 7.01 to 10.08 thousand hectares, while production rates fluctuated slightly, reaching 46.99 thousand metric tons in 2022-23. Notably, turmeric cultivation in hilly districts displayed a significant surge in both area and production, peaking at 1.70 thousand hectares and 14.24 thousand metric tons

respectively in 2022-23. Chilly, coriander, fenugreek, garlic, and ginger also exhibited consistent growth in cultivation area and production rates over the years. Conversely, in plain districts, the cultivation area ranged from 2.33 to 2.54 thousand hectares, with production rates fluctuating between 19.19 to 21.17 thousand metric tons. Turmeric cultivation in plain districts notably surged in both area and production, reaching 0.53 thousand hectares and 7.65 thousand metric tons respectively in 2022-23. Similar to hilly districts, other spices like chilly, coriander, fenugreek, garlic, and ginger demonstrated steady growth in both cultivation area and production rates. Overall, both hilly and plain districts portrayed a consistent dedication to spice cultivation, with minor variations in cultivation area and stable production rates observed across the specified timeframe.

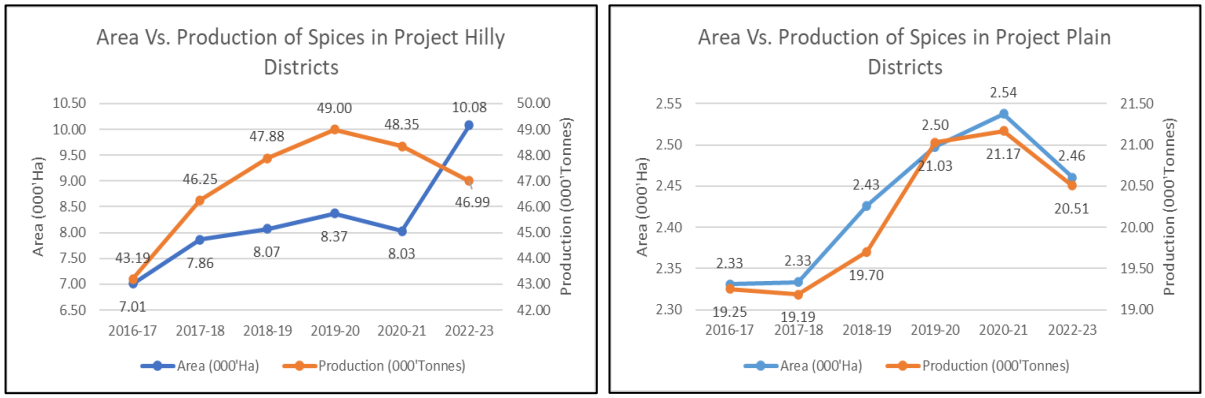


Figure 42: Variation in Spices Area & Production; Hilly & Plain Districts

1.5.6 Yield of Vegetables, Fruits, Flowers, and Spices:

The table presents the yield rates of vegetables, flowers, fruits and spices in Uttarakhand spanning from 2013-14 to the projected figures for 2022-23. Over this period, several

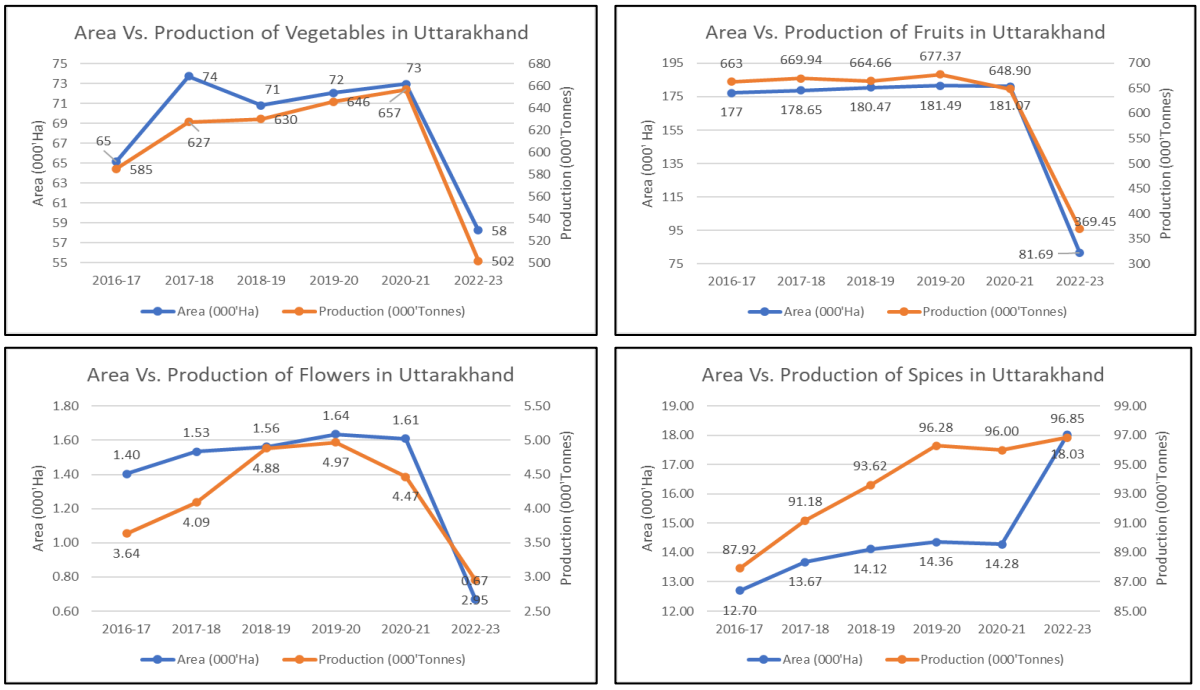


Figure 43: Area & Production of Vegetables, Fruits, Flowers & Spices; Uttarakhand

trends and fluctuations emerge across different crops. In terms of rice cultivation, the yield rate initially showed a steady rise from 2289 kg/ha in 2013-14 to 2814 kg/ha in 2019-20, signifying progressive agricultural practices. However, there was a slight decrease projected for 2020-21 and 2021-22, settling at 2786 kg/ha and 2556 kg/ha, respectively.

Wheat cultivation exhibited fluctuations, with significant variations year to year. After a dip in 2014-15, wheat yields saw consistent growth until 2021-22, reaching 2974 kg/ha, indicating efforts to improve wheat productivity. Coarse cereals showed fluctuations but generally maintained a relatively stable yield rate, with a projected increase in 2022-23 to 1584 kg/ha. Pulses demonstrated a slight increase in yield rates over the years, peaking at 1076 kg/ha in 2021-22. However, the total foodgrains yield mirrored the trend in pulses, reflecting a similar growth pattern. Oilseeds showcased fluctuations but have been relatively steady around 942-1100 kg/ha over recent years. Sugarcane, while not displaying significant year-to-year changes, consistently maintained a high yield rate, projected at 80,000 kg/ha from 2019-20 onwards, indicating stability in sugarcane production. Overall, these trends suggest varying degrees of stability and growth in yield rates for different principal crops, reflecting the agricultural landscape's dynamism and the efforts toward enhancing crop productivity in Uttarakhand.

Table 15: Average Yield of Vegetables, Fruits, Flowers, & Spices, Uttarakhand

Avg. Yield in Kg/Ha						
Type	2016-17	2017-18	2018-19	2019-20	2020-21	2022-23
Vegetables	8971	8506	8897	8958	9000	8612
Fruits	3740	3750	3680	3730	3584	4520
Flowers	2592	2667	3123	3040	2774	4413
Spices	6900	5670	6630	6620	6722	5370

Source: State Horticulture Mission Govt. of Uttarakhand

Table 16: Average Yield of Vegetables, Fruits, Flowers, & Spices; Hilly Districts

Avg. Yield in Kg/Ha						
Type	2016-17	2017-18	2018-19	2019-20	2020-21	2022-23
Vegetables	7318	7356	7357	7421	7140	5840
Fruits	3847	3816	3263	3860	3656	4127
Flowers	3980	3893	4204	4078	3021	2748
Spices	5514	5635	5733	5716	5737	4111

Source: State Horticulture Mission Govt. of Uttarakhand

Table 17: Average Yield of Vegetables, Fruits, Flowers, & Spices; Plain Districts

Avg. Yield in Kg/Ha						
Type	2016-17	2017-18	2018-19	2019-20	2020-21	2022-23
Vegetables	13105	16155	16114	16220	16237	14873
Fruits	6725	6685	6520	6620	6370	6628
Flowers	2375	2721	3748	2974	3936	7799
Spices	8264	8228	8124	8416	8340	8331

Source: State Horticulture Mission Govt. of Uttarakhand

In examining the average yield of various agricultural products such as vegetables, fruits, flowers, and spices across hilly and plain districts, discernible patterns emerge. In hilly districts, the average yield of vegetables remained relatively stable, fluctuating between 7,318 to 7,421 kg/ha from 2016-17 to 2019-20, before experiencing a notable decline to 5,840 kg/ha in 2022-23. Contrastingly, in plain districts, vegetable yields exhibited a consistent upward trend, starting at 13,105 kg/ha in 2016-17 and peaking at 16,237 kg/ha in 2020-21 and 14,873 kg/ha in 2023-23. Similarly, fruit yields in hilly districts fluctuated over the years, ranging from 3,263 to 3,860 kg/ha, with a notable increase to 4,127 kg/ha in 2022-23. In plain districts, fruit yields showcased a more stable trend, fluctuating between 6,720 to 6,628 kg/ha across the same period. Flower yields in hilly districts fluctuated considerably, with a peak of 4,204 kg/ha in 2018-19, followed by a decline to 2,748 kg/ha in 2022-23. Conversely, plain districts witnessed a notable increase in flower yields, rising from 2,375 kg/ha in 2016-17 to a peak of 7,799 kg/ha in 2022-23. Spice yields in hilly districts ranged from 5,514 to 5,737 kg/ha, with a significant decline to 4,111 kg/ha in 2022-23, whereas in plain districts, spice yields remained relatively stable, fluctuating between 8,264 to 8,340 kg/ha over the specified period. These trends

underscore the varying agricultural productivity levels between hilly and plain districts, with plain districts generally exhibiting higher average yields across different agricultural products.

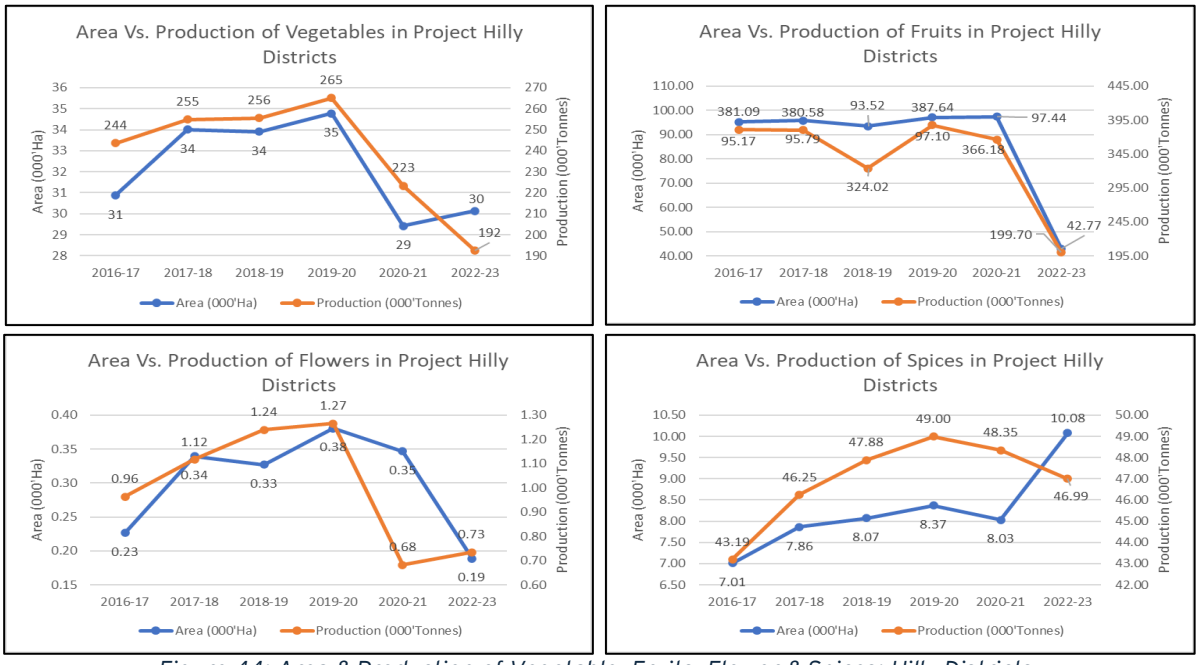


Figure 44: Area & Production of Vegetable, Fruits, Flower & Spices; Hilly Districts

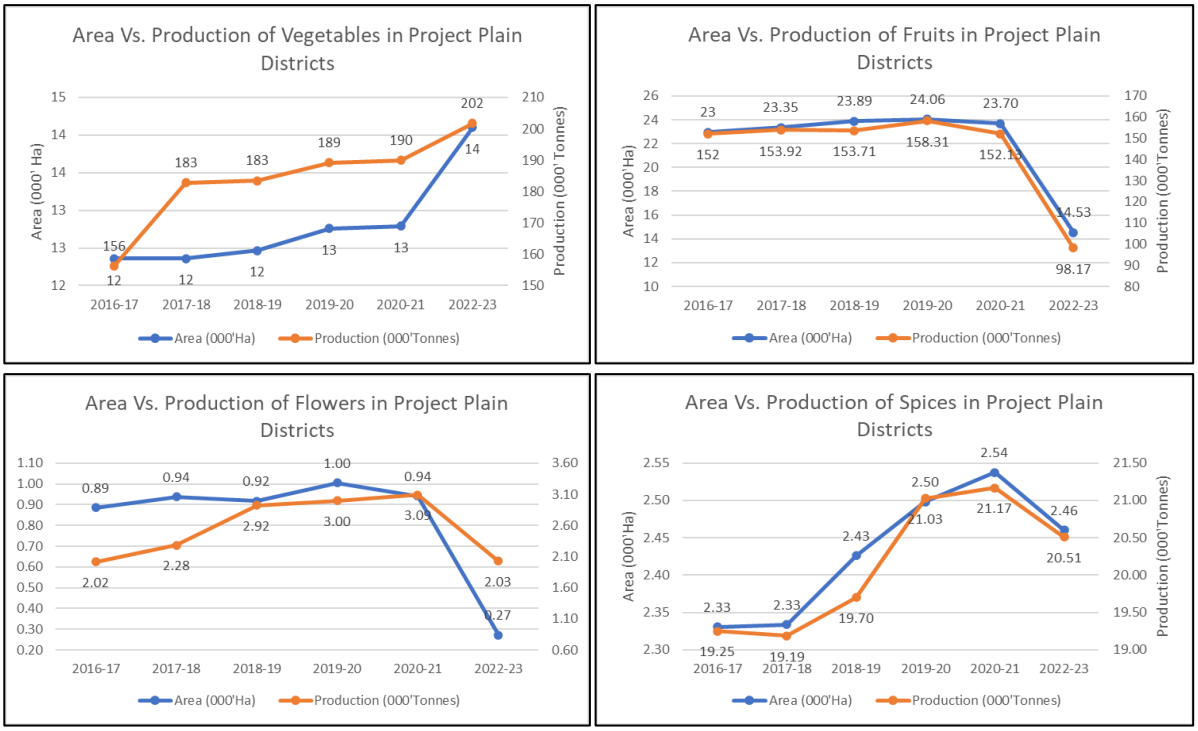


Figure 45: Area & Production of Vegetables, Fruits, Flowers. & Spices; Plain Districts

1.5.7 Cropping Intensity:

The snapshot of Uttarakhand's agricultural landscape from 2011-12 to 2020-21, reflects decrease in net sown area from 714 in 2011-12 to 621 in 2020-21 along with gross cropped area, from 1132 in 2011-12 to 997 in 2020-21. The cropping intensity has been fluctuating between 155 to 161 percent.

Table 18: Cropping Intensity; Uttarakhand (Area in 000' ha)

Years	Gross Sown Area	Net sown area	Cropping intensity (%)
2011-12	1132	714	158.5
2012-13	1124	706	159.2
2013-14	1099	701	156.8
2014-15	1097	700	156.7
2015-16	1083	698	155
2016-17	1082	691	156.7
2017-18	1060	673	157.4
2018-19	1029	648	158.9
2019-20	1024	638	160.5
2020-21	997	621	160.6

Source: Reserve Bank of India - Handbook of Statistics on Indian States (rbi.org.in)

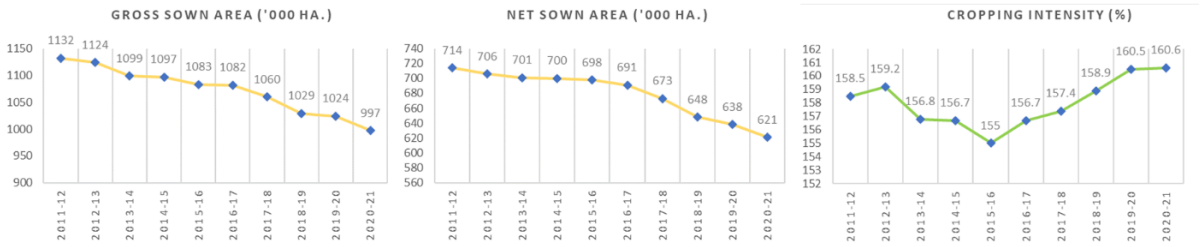


Figure 46: Gross Sown Area, Net Sown Area, and Cropping Intensity

1.5.8 Irrigated Area:

The gross and net irrigated area reflects gradual decrease from 2012-13 and further increase towards 2020-21. The gross irrigated area has decreased from 555 thousand hectares in 2011-12 to 546 thousand hectares in 2020-21, while the net irrigated area has decreased from 339 thousand hectares to 322 thousand hectares. On the other hand, gross irrigated area to gross sown area and net irrigated area to net sown area reflects a positive growth trend.

Table 19: Irrigated Area

Years	Gross Irrigated Area ('000 Ha.)	Net Irrigated Area ('000 Ha.)
2011-12	555	339
2012-13	554	338
2013-14	544	328
2014-15	542	330
2015-16	541	330
2016-17	542	329
2017-18	543	329
2018-19	540	323
2019-20	539	317
2020-21	546	322

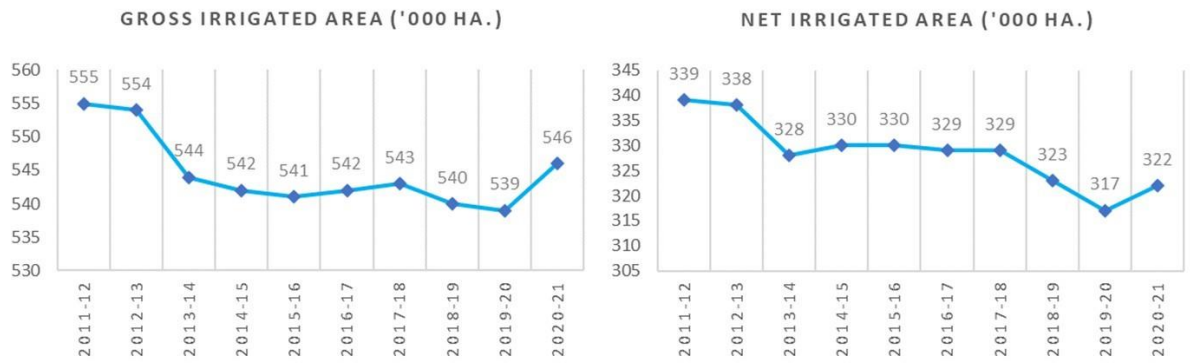


Figure 47: Gross and Net Irrigated Area

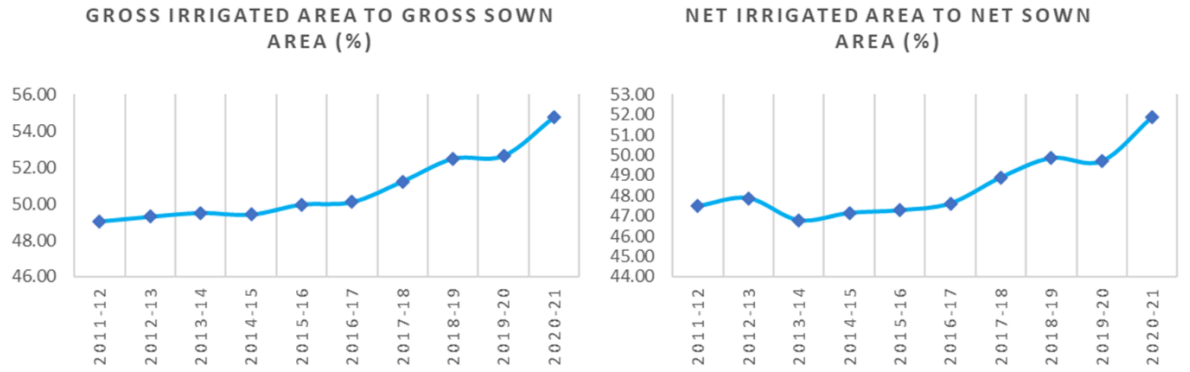


Figure 48: Irrigated Area to Sown Area

1.5.9 Challenges in Agriculture and Allied Sectors:

In the current scenario, agriculture and allied sectors have been facing serious challenges, such as[7]:

- Small and fragmented landholdings;
- Inconsistent and uneven rainfall patterns lead to uncertainty in cropping cycles, affecting crop yield and quality;
- Low and stagnant productivity of several crops;
- Deterioration of soil health leading to land degradation and loss of productive upper layer of soil (topsoil) due to heavy rain.
- Poor adoption levels of new technology/risk minimization/mitigation;
- Lack of mechanization & timely input supply;
- Lack of irrigation facility in hilly regions/rainfed agricultural regions;
- Lack of efficient utilization of resources-water.
- Low skill up gradation & poor access to technology and market information.
- Low levels of value addition & poor supply chain;
- Lack of quality planting materials in fruit crops;
- Mono cropping practice;
- Less effective / non-existence of farmer's association (FIG/FPO);
- Crop damaged by wildlife;
- Barren lands due to migration.

Rainfed agriculture yields are often limited by deficient soil fertility that comes as a result of nutrient depletion, loss of organic matter, and other forms of soil degradation.

[7] Declining agriculture in Garhwal Himalaya: Major drivers and implications (Sati and Kumar, 2023)

Table 20: Addressing Challenges; Strategy & Technological Overview

Challenges/ Issues	Strategy to Overcome	Technology / Activity
Low and stagnant productivity (Land Productivity)	Enhancing water retention capacity of watersheds; Promoting sustainable land management practices. Promoting integrated Water shed and spring shed management	1. Soil and moisture conservation techniques; 2. Afforestation and reforestation; 3. Promoting agroforestry; 4. Promoting contour farming; 5. Promoting gully plugging and stream bank stabilization.
Climate Risk to Agricultural Production System	Enhancing resilience to climate change impacts;	1. Drought-tolerant crop & varieties; 2. Flood control measures; 3. Community-based adaptation plans; 4. Watershed development plans (GPRP); 5.Integrated watershed management projects; 6. Improving spring yield; 7. Technology adoption; 8. Water harvesting and its efficient use; 9. Promoting water conservation practices; 10. Facilitate weather-based crop advisory.
Deterioration of water quality	Minimizing pollution sources; Promoting sustainable water management practices.	1. Waste management practices; 2. Afforestation and reforestation;
Lack of efficient utilization of water resources	Promoting water use efficiency; Enhancing water availability.	1. Micro-irrigation (drip/sprinkler etc.); 2. Water harvesting techniques; 3. Watershed restoration and conservation; 4. Spring-shed management; 5. Moisture conservation (mulching etc.).
Soil Degradation	Crop Rotation, Cover Cropping, and Green Manure Practices	1. Implementation of crop rotation; 2. Cover cropping; 3. Green manure practices; 4. Conservation of topsoil; 5. Use of compost / FYM
Low Crop Productivity	Promote Agroecological Practices, Crop Diversification, and Integrated Farming Systems	1.Introduce Climate-Resilient Crop & Varieties, 2. Integrated climate resilient farming system 3. Participatory watershed management 4. Promotion precision farming techniques; 5. Soil health management
Pest and Diseases	Integrated Pest Management (IPM), Resistant Crop Varieties, Biological Controls	1.Monitoring pest occurrence & advisory to farmers; 2.Early disease detection technologies; 3,Use of IPM / IPNM;
Yield Stability	Diversification of Crop Varieties, Inter-cropping Methods	1. Improved climate resilient crop & varieties; 2. Promotion of resilient seed in cluster basis; 3.Climate-Resilient Crop Breeding; 4. Short duration varieties; 5. IT based real time soil, moisture, nutrient, and pest management.

Lack of institutional coordination and stakeholder participation	Strengthening institutional coordination; Enhancing stakeholder participation.	1. Watershed management committees; 2. FIG / FPO promotion; 3. Capacity building programs; 4. Awareness campaigns; 5. Public-private partnerships; 6. Coordination with State & National level knowledge institutions.

1.6 Animal Husbandry:

Animal Husbandry is related with sustained employment, Income Generating Activities (IGA) and livelihoods of rural people / farming communities. It is a crucial component of the state's rural economy. Livestock are an essential part of the farming system and a key source of livelihood for over 70% of rural households in the state, with these households earning more than a third of their income from livestock. The livestock census 2019 shows that the total population of the livestock in the state is 96.78 lacs including poultry. As per 20th livestock census 2019, Uttarakhand has 18.52 lakhs cattle, 8.66 lakhs buffaloes, 2.84 lakhs sheep, 13.71 lakhs goats, and 50 lakhs poultry. Uttarakhand ranks 10th in per-capita availability of livestock which is higher than the national average with highest per-capita availability in Punjab. Uttarakhand ranks 12th in annual growth rate of egg production, 4th in annual growth rate of meat production (Animal Husbandry Statistics, 2022-23).

The livestock census in Uttarakhand reveals a diverse distribution of animals across districts. The total cattle count stands at approximately 12.75 lakhs, with Haridwar leading in crossbred cattle and Tehri Garhwal boasting the highest number of indigenous cattle, each surpassing 10 lakhs. Buffaloes total around 8.66 lakhs, with Udham Singh Nagar having the highest count of crossbred buffaloes (15.29 lakhs) and Pauri Garhwal leading in indigenous buffaloes (3.01 lakhs). Sheep population records around 0.76 lakhs, showcasing Uttarkashi as the highest district, while goats tally up to 2.08 lakhs, with Tehri Garhwal taking the lead. Interestingly, pigs have a lower count at around 0.76 lakhs in the state. These figures highlight the significant presence of various livestock in specific districts, emphasizing the diverse agricultural landscape of Uttarakhand. -

In Uttarakhand, the livestock population varies significantly between hilly and plain districts. In hilly regions, indigenous sheep constitute 33% of the total state livestock population, with crossbred sheep at 93%, goats at 47%, and poultry at 6%. Contrastingly, in plain districts, indigenous sheep make up 3% of the state livestock population, crossbred sheep 1%, goats 6%, and poultry a significant 78%. These differences highlight the diverse agricultural practices across the state.

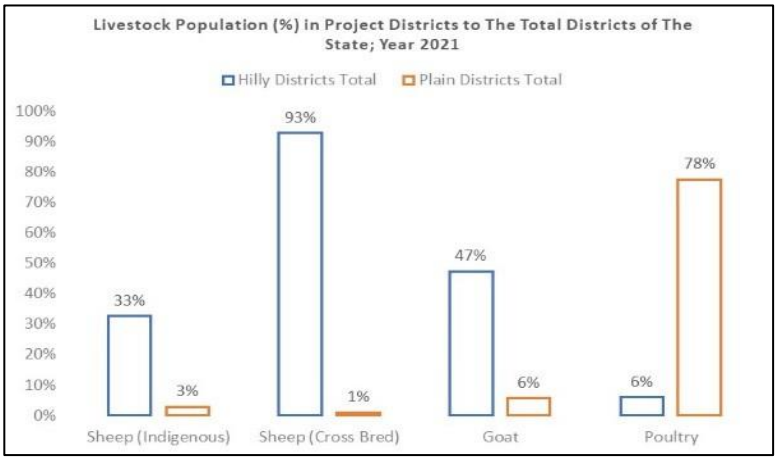


Figure 49: Livestock Population (%) of Total

Table 21: Animal Population in Hilly Districts

20th Livestock Census- 2019									
Hilly Districts	Cattle		Buffalo	Sheep		Goat	Pig		Poultry
	Indigenous	Cross Bred		Indigenous	Cross Bred		Indigenous	Cross Bred	
Almora	132038	17042	77444	2186	0	185319	351	8	10910
Haridwar	63728	115667	214480	4209	488	26594	3856	2273	18479
Nainital	101009	75497	77759	825	3	66213	383	396	42183
Pauri Garhwal	20899	235412	30076	13159	117	142816	1085	7	17602
Rudraprayag	2960	71277	31115	12265	819	28363	44	0	12256
Tehri Garhwal	80833	5529	79394	8176	21145	126944	420	203	23562
Udham Singh Nagar	63311	103038	152911	1759	309	51014	1753	4277	1518654
Uttarkashi	82991	22488	25945	31606	48743	100882	151	118	14099
State Total	1275303	576820	866318	208256	76359	1371971	9544	8115	1981073

Source: 20th Livestock Census- 2020-21

Table 22: Animal Population in Plain Districts

20th Livestock Census- 2019									
Plain Districts	Cattle		Buffalo	Sheep		Goat	Pig		Poultry
	Indigenous	Cross Bred		Indigenous	Cross Bred		Indigenous	Cross Bred	
Haridwar	63728	115667	214480	4209	488	26594	3856	2273	0
Udham Singh Nagar	63311	103038	152911	1759	309	51014	1753	4277	0
State Total	1275303	576820	866318	208256	76359	1371971	9544	8115	1981073

Source: Statistical Diary, 2020-21; 20th Livestock Census, 2020-21

Table 23: Animal Health Care in Project Districts

Name of the District	No. of Hospitals and Dispensaries (2020-21)	No. of Livestock Aid Centres (2020-21)
Almora	37	172
Haridwar	16	86
Nainital	28	204
Pauri Garhwal	40	199
Rudraprayag	15	83
Tehri Garhwal	38	155
Udham Singh Nagar	22	172
Uttarkashi	25	121
Uttarakhand (Total)	**329**	**1690**

From the above table, district Pauri Garhwal and Tehri Garhwal are having the maximum number of hospitals and dispensaries. Nainital and Pauri Garhwal have maximum number of livestock aid centres. Apart from these districts, Almora, US Nagar, Uttarkashi also have good number of hospitals, dispensaries as well as livestock aid centres, while Haridwar has the lowest number of hospital and dispensaries as well as livestock aid centres.

In Uttarakhand, Haridwar leads in milk production with 375.01 thousand MT, while Rudraprayag has the lowest at 42.89 thousand MT. Udham Singh Nagar stands out for egg production with 3622.15 lakh, whereas Nainital has the lowest at 98.85 lakh. Tehri Garhwal records the lowest meat (Sheep, Goat, Pig) production at 0.65 TMT, while Pauri Garhwal leads with 18.10 TMT. Uttarkashi excels in wool production at 131.91 thousand kg, whereas

Nainital shows no wool production. Over 80% of women households in the state are involving in the livestock management and rearing, while majority of the farmers are associated with farming activities.

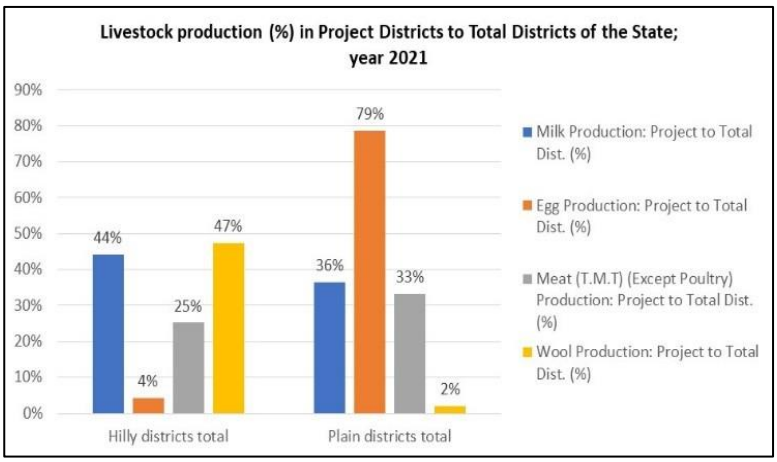


Figure 50: Livestock Production in Hilly & Plain (% of Total)

Table 24: Production of Milk, Egg, Meat and Wool in Hilly Districts

Hilly Districts	Production (2020-21)			
	Milk ('000 MT)	Egg (Lakh No.)	Meat (T.M.T) (Except Poultry)	Wool ('000 Kg)
Almora	118.4	20.6	10.5	3.5
Haridwar	375.0	41.2	7.6	5.9
Pauri Garhwal	98.9	37.4	18.1	16.1
Rudraprayag	42.9	24.5	4.7	17.0
Tehri Garhwal	98.7	50.1	0.6	32.0
Uttarkashi	59.2	28.5	5.3	131.9

Table 25: Production of Milk, Egg, Meat & Wool in Plain Districts

Plain Districts	Production (2020-21)			
	Milk ('000 MT)	Egg (Lakh No.)	Meat (T.M.T) (Except Poultry)	Wool ('000 Kg)
Haridwar	375.0	41.2	7.6	5.9
Udham Singh Nagar	281.0	3622.1	54.3	2.6

Over the years in Uttarakhand, the trends in key livestock and poultry products have seen varying patterns. Milk production peaked at 1844.97 thousand MT in 2019-20, marking the highest, while 2020-21 witnessed a slight decline to 1797.45 thousand MT. Conversely, meat production saw a decrease from 29.45 thousand MT in 2017-18 to 18.58 thousand MT in 2020-21, reflecting a significant drop. Egg production steadily increased, hitting a high of 4924.1 lakhs in 2020-21, showcasing consistent growth. Wool production remained relatively stable, fluctuating between 436.01 thousand kg (2020-21) and 564.07 thousand kg (2017-18). The per capita availability of these resources demonstrated slight variations annually, with 2017-18 marking the highest for milk, meat, eggs, and wool.

When comparing livestock production between Uttarakhand's hilly and plain districts relative to the state's total, distinct patterns emerge. Hilly districts contribute 44% of the state's milk production, surpassing plain districts which account for 36%. In egg production, however, plain districts stand out significantly, contributing 79% of the state's total compared to a mere 4% from hilly regions. Meat production, excluding poultry, sees plain districts leading slightly with 33% contribution, while hilly areas contribute 25%. Notably, wool production heavily favours hilly districts, contributing 47% to the state's total compared to a minimal 2% from plain districts. These disparities highlight the diverse agricultural landscapes and practices between Uttarakhand's hilly and plain regions.

Table 26: Trend in Production of Milk, Meat, Egg & Wool; Uttarakhand

Year	Production of milk (thousand MT)	Per capita Availability of Milk (lts/day)	Production of meat (thousand MT)	Per capita Availability of meat (Kg./annum)	Production of eggs (in Lakhs)	Per capita Availability of eggs (nos/annum)	Production of wool (thousand kg)	Per capita Availability of wool (kg/annum)
2014-15	1565.35	155	26.03	2.58	3697.4	37	468.93	0.046
2015-16	1655.73	164	27.60	2.74	3906.5	39	513.33	0.051
2016-17	1692.42	168	28.40	2.82	4119.1	41	538.25	0.053
2017-18	1741.68	173	29.45	2.92	4297.6	43	564.07	0.056
2018-19	1791.96	178	29.19	2.89	4531.8	45	551.98	0.055
2019-20	1844.97	183	25.26	2.50	4786.3	47	496.69	0.049
2020-21	1797.45	178	18.58	1.84	4924.1	49	436.01	0.043

1.7 Watershed:

Watershed management is one of the most important options that can provide a constructive framework to address the challenges in rainfed areas in the following ways:

- Improving the recharge of local aquifers and improving downstream water flows.
- Helping farmers better manage surface and groundwater resources.
- Increasing vegetative cover and decreasing soil erosion.
- Increasing agricultural productivity.
- Supporting farmers to adapt to climatic change; and
- Ensuring improved livelihoods for people.
- Carbon Storage[8]

Watershed management approaches have shifted from a centralized, supply-oriented method to one that embraces community participation, aiming to collaborate closely with local populations as partners. This new model integrates interventions for soil and water conservation with support for rural livelihoods. The Watershed Development Component, funded by both Central and State Governments at a 90:10 ratio, serves as a pivotal element in the Government of India's backing for watershed development. It is anticipated to cover approximately 55 million hectares across 29 states by 2027, marking the culmination of the 14th Five Year Plan. Despite being the second-largest watershed program globally, trailing only China, the current results fall short of the potential achievements. Uttarakhand encompasses approximately 1,164 micro-watersheds across 13 districts and 95 blocks, covering 53.4 lakh hectares. With an untreatable area of 10.89 lakh hectares, it underscores the comprehensive scale of watershed management efforts in the region.

Table 27: Total No. of MWS (approx.) in Uttarakhand

All amounts (in Rs Lakhs) And All Area in Lakh Ha.						
SN	State Name	Total no. of Districts	Total no. of Blocks	Total no. of Micro-watersheds	Total geographical area	Total untreatable area*
1	Uttarakhand	13	95	1164	53.4	10.89

Source: Department of Land Resources, Ministry of Rural Development

In Uttarakhand, a total of about 8 catchments, 26 watersheds, 116 sub watersheds and 1,164 micro-watersheds (MWS) are mapped, excluding Haridwar District[9]. A separate

[8] Watersheds with intact natural land cover and healthy soil resources can sequester carbon, thereby offsetting greenhouse gas emissions (https://www.epa.gov/hwp/benefits-healthy-watersheds#:~:text=Some%20healthy%20watershed%20ecosystem%20services,Carbon%20storage%20opportunities.)

[9] http://wmduk.gov.in/wmd.html

Directorates- Watershed Management Directorate (WMD) has been established as a nodal agency for coordination, monitoring, and implementation of integrated watershed development programmes in the state. Among the 537 untreated ones, 124 are situated above 3,200 meters, characterized by snow-clad landscapes, rocky terrains, and dense forests within State Forest Department jurisdictions. These areas, vulnerable to landslides due to steep slopes, face environmental degradation from high tourist and pilgrim footfall. Specialized interventions are necessary for these high-altitude zones.

Additionally, among the 409 MWS below 3,200 meters, covering around 18.11 lakh hectares, along with an extra 1,20,000 hectares from Haridwar, a total of 102 MWS (spanning 2.03 lakh hectares) have been earmarked for initial treatment under the Integrated Watershed Management Programme (IWMP). District-specific criteria guide the selection process, and these areas are open for convergence with other developmental schemes, inviting projects from various departments such as Forest, Agriculture, and Rural Development.

Table 28: Number of Water Bodies

No. of water bodies			
State	**Rural**	**Urban**	**Total**
Uttarakhand	2,970	126	3,096
India (Total)	23,55,055	69,485	24,24,540

Source: First Census of Water Bodies, 2017-18

The following is the list of projects initiated under the Watershed Management Department since 2004.

Table 29: List of WMD Projects in Uttarakhand

S. N	Name of the Project	Implementation Period	Project Districts	Project Area (km^2)	No. of Watersheds	Cost (Cr)	Beneficiary Benefitted	
							Households	Population
1.	Uttarakhand Decentralized Watershed Development Project (UDWDP)Phase-I (GRAMYA)	September 2004-2012	Dehradun, Terhri, Uttarkashi, Pauri Garhwal, Rudraprayag, Chamoli, Bageshwar, Champawt, Pithoragarh, Almora, Nainital,	2348	76	488.20	51,000	258,000
2.	UDWDP	2009- August 2013	Uttarkashi, Nainital, and Bageshwar	608	20	37.60		
3.	Integrated Livelihood Support Project (ILSP)	2012-December 2021	Pauri Garhwal, Nainital, Champawat	702	22	282.19	22,420	107,211
4.	Pradhan Mantri Krishi Sinchayee Yojna WD (erst while IWMP)	2011-March 2022	Dehradun, Uttarkashi, Pauri Garhwal, Rudraprayag, Chamoli, Bageshwar, Champawat, Pithoragarh, Almora,	4266	182	147.26	206,109	1,170,204

			Nainital, US Nagar, Haridwar					
5.	Uttarakhand Decentralized Watershed Development Project (UDWDP) Phase-II (GRAMYA)		Dehradun, Uttarkashi, Pauri Garhwal, Rudraprayag, Tehri Garhwal, Bageshwar, , Pithoragarh, Almora	2638.37	82	754.36	66352	300,000

Table 30: Water Conservation Measures

State	Water Conservation and Rainwater Harvesting (No.)	Renovation of Traditional Water Bodies (No.)	Reuse and Recharge Structures (No.)	Watershed Development (No.)	Intensive Afforestation (Ha.)	Treated Wastewater Used (in KLD)
Uttarakhand	13781	3514	2246	29374	21873937	1502
India (Total)	897320	161171	582772	1075214	783281353	8549334

Source: Status Report under National Water Mission, Ministry of Jal Shakti[10]

1.8 Agribusiness:

Uttarakhand state has 26 principal market yards, 31 sub-market yards and 27 weekly markets for marketing of agricultural produce. The Government of Uttarakhand had adopted an agricultural policy for the state in the year 2018 for bringing commercialization in the field of Agriculture. The objectives of the policy are as below.

- To increase the income of farmers;
- To provide better pricing facilities in the market for the farmers surplus production;
- To provide better business opportunities in the market of food processing;
- To encourage precision agriculture farming in the state;
- To encourage crop substitution particularly in uplands and medium lands;
- To focus on horticultural crops including dry land horticulture;
- To focus on small ruminants, poultry, and fisheries to augment the income of the farmers;
- To encourage modern farming system approach;
- To encourage organic farming;
- To enhance water, use efficiency through peoples' participation;
- To increase access to credit for small and marginal farmers;
- To facilitate appropriate market linkages for agricultural produce;
- To improve the marketing facilities and access to market information;
- To declare the local community crops having their own Minimum Assured Price value;
- To implement integrated watershed development programs in watershed areas for Natural Resource Management (NRM), increased crop production as well as on-farm and non-farm income;
- To create appropriate institutions / facilities to undertake regulatory, enforcement and quality assurance activities matching to the emergent needs;
- To focus more on water conservation practices in irrigation practices through sprinkler system and drip irrigation system;
- To provide Minimum Assured Price for the local farmers crops.

[10] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1911226

Apart from the above, under these projects several important aspects shall be covered to strengthening then agribusiness sector in the project districts as below;

- Strengthening agri-marketing systems through farmers' federations and value addition services.
- Developing carbon-neutral end-to-end supply chains in agriculture logistics.
- Establishing Agri Business Growth centres in remote areas for agri-enterprise hubs.
- Providing nonfarm-based livelihood initiatives to marginalised households in project villages for inclusiveness and equity.

The Growth Centre Scheme in Uttarakhand, launched in 2018, focuses on establishing growth centres in specific rural areas to promote niche local products and services at a national and international level. Uttarakhand's diverse agro-geo climatic zones and natural resources offer potential in various sectors like flowers, horticulture, textiles, and industrial infrastructure. However, challenges in commercial cultivation, quality standardization, and market linkages hinder the growth of MSMEs, particularly in specialized products.

The scheme aims to bridge these gaps by setting up growth centres in remote areas witnessing high youth out-migration. By adopting a cluster-based approach inspired by the Ministry of Micro and Small Enterprises' Cluster Development Programme, these centres will provide common infrastructure for enterprises producing similar products. The focus will be on establishing export-oriented units, boosting local economies, and creating income opportunities to curb youth migration.

Through empowering entrepreneurs, farmers, and artisans, the scheme intends to improve product-specific value chains, enhance productivity, and diversify outputs. It emphasizes skill development, infrastructure enhancement, and rural-urban linkages to catalyse employment and reduce poverty. The state government plans to support these initiatives by developing infrastructure, institutions, capacity building, and facilitating marketing efforts. The Growth Centre Scheme in Uttarakhand aims to uplift rural economies, leverage local advantages, and foster economic activities to achieve poverty reduction and shared prosperity in the state.

The Agri-Business Growth Centre lays the groundwork for a comprehensive strategy aimed at nurturing agricultural development and economic progress in rural or distant regions. It acts as a consolidated platform, amalgamating essential components pivotal for advancing agricultural methods, fostering entrepreneurship, and enhancing community well-being. While a few agribusiness growth centres are already operational in the state, this initiative aims to expand further, reinforcing and fortifying this sector. Here are some of the existing agribusiness growth centres in Uttarakhand:

- Agri Business Growth Centre-Khyarshi Thatud, Tehri Garwhal
- Agri Business Growth Centre-Thano Raipur, Dehradun
- Agri-Business Growth Centre Faliyat Almora
- Agri Business Growth Centre- Shama Kapkot, Bageshwar
- Agri Business Growth Centre -Simarakhal Pauri
- Agri Business Growth Centre-Amotha Guth Patisain, Pauri Garhwal
- Agri Business Growth Centre-Punha, Vikas Nagar
- Agri Business Growth Centre-Purola, Uttarkashi
- Agri Business Growth Centre-Nachni, Pithoragarh

Further, Uttarakhand Food Processing Policy is having the vision "to increase the flow of investments in the sector across the value chain from farm to market, increase self-life and reduce wastage of farm produce".

1. The policy specifies the objectives and strategy in the following manner.
2. To provide fiscal & non-fiscal incentives to encourage value addition.
3. To provide fiscal incentives to the technical / professional institutions and existing entrepreneurs to promote product / process innovations and R&D
4. To facilitate development of common infrastructure near the existing food processing clusters.
5. To promote setting up of Cold Chains, Cold Storages & Primary Processing Centres.
6. To organize need based skill development programmes.
7. To provide Single window clearance system with a clear timeline for project approvals and guidance.
8. To facilitate Online system for submission of application forms for various clearances and tracking of the application.
9. To set up Development of Agri Export Zones (AEZ) for food processing industries in the state.
10. To Set up of common facility centres in identified clusters.
11. To set up Exclusive industrial clusters/parks for food processing industries at strategic locations of Uttarakhand state.

1.9 Green House Gas Emission:

In India, agriculture holds a crucial position in the economy, making up approximately 20% of the national gross domestic product and offering a source of livelihood for nearly two-thirds of the population. But it plays a significant role in the greenhouse effect by releasing and utilizing greenhouse gases like methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2). Methane is generated in the soil through the microbial breakdown of organic matter in anaerobic conditions, with submerged rice fields being a key source of methane production.[11]

Submerged rice fields have the potential to generate methane (CH_4), with factors like prolonged submergence, higher organic carbon content, and the application of organic manure in puddled soil intensifying CH_4 emissions. Additionally, burning crop residues contributes to the global methane budget. Enteric fermentation in ruminants is another significant source of CH_4 emissions. Natural processes in soils, specifically nitrification and denitrification, lead to the production of nitrous oxide. Nitrification, the aerobic microbial oxidation of ammonium to nitrate, and denitrification, the anaerobic microbial reduction of nitrate to nitrogen gas (N_2), contribute to nitrous oxide release. The availability of inorganic nitrogen in soil, influenced by human-induced inputs like synthetic or organic fertilizers, manure, crop residues, sewage sludge, and changes in land use, plays a crucial role in these processes.

In agriculture, carbon dioxide production primarily stems from soil management practices, such as tillage, which induces gas emission through the biological decomposition of soil organic matter. Tillage disrupts soil aggregates, enhances oxygen supply, and exposes organic material surfaces, promoting their decomposition. The use of fuel in agricultural operations, the burning of crop residues, and the carbon dioxide produced during the manufacturing of farm implements, fertilizers, and pesticides are additional sources of carbon dioxide emissions.

[11] Pathak, Dr Surendra & Bhatia, Arti & Jain, Niveta. (2014). Greenhouse Gas Emission from Indian Agriculture: Trends, Mitigation and Policy Needs Enter title.

Between 2005-2015 in India, crop residue burning contributed to total emissions of 5.06 to 6.16 MtCO2e annually. Specifically, emissions from rice burning ranged from 1.87 to 2.22 MtCO2e, wheat from 1.32 to 1.73 Gg/yr, maize from 0.14 to 0.21 Gg/yr, cotton from 0.05 to 0.10 Gg/yr, sugarcane from 1.27 to 1.69 Gg/yr, jute at 0.02 Gg/yr consistently, rapeseed & mustard from 0.10 to 0.12 Gg/yr, groundnut from 0.06 to 0.10 Gg/yr, and millets from 0.14 to 0.19 Gg/yr. Overall, these figures highlight the varying contributions of different crops to methane and nitrous oxide emissions during this period.

Table 31: GHG Emission from Crop Residue Burning; India (2005-2015)

Total Emissions from Crop Residue Burning (CH_4+N_2O) $MtCO_2e$ - AR2	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Rice ($MtCO_2e$)	1.87	1.93	2.01	2.07	1.99	1.99	2.12	2.24	2.24	2.20	2.22
Wheat (Gg/Yr)	1.32	1.40	1.46	1.53	1.52	1.61	1.73	1.72	1.74	1.57	1.63
Maize (Gg/Yr)	0.14	0.14	0.17	0.19	0.17	0.19	0.21	0.21	0.23	0.23	0.21
Cotton (Gg/Yr)	0.05	0.06	0.07	0.07	0.07	0.09	0.10	0.10	0.10	0.10	0.09
Sugarcane (Gg/Yr)	1.27	1.58	1.64	1.41	1.36	1.55	1.67	1.62	1.64	1.69	1.66
Jute (Gg/Yr)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Rapeseed & Mustard (Gg/Yr)	0.12	0.12	0.10	0.11	0.11	0.12	0.11	0.12	0.12	0.10	0.10
Groundnut (Gg/Yr)	0.09	0.06	0.09	0.09	0.07	0.09	0.08	0.06	0.10	0.09	0.08
Millets (Millet+ Small Millet+ Bajra+ Sorghum) (Gg/Yr)	0.17	0.17	0.19	0.18	0.15	0.18	0.18	0.16	0.16	0.16	0.14
Total Emissions from Residue Burning (AR2) ($MtCO_2e$)	**5.06**	**5.49**	**5.75**	**5.66**	**5.46**	**5.84**	**6.22**	**6.25**	**6.35**	**6.17**	**6.16**

Source: https://www.ghgplatform-india.org/

From 2010-11 to 2016-17, India's agricultural sector witnessed distinct fluctuations in greenhouse gas emissions across several crucial categories. Enteric Fermentation, a significant contributor stemming from livestock digestion, exhibited a modest rise in emissions from 227 $MtCO_2e$ in 2010-11 to a peak of 227.16 $MtCO_2e$ in 2014-15, followed by a gradual decline to 222.66 $MtCO_2e$ by 2016-17. Manure Management, despite a minimal footprint in 2010-11 at 2.77 $MtCO_2e$, experienced a sharp increase to 28.10 $MtCO_2e$ by 2014-15, stabilizing around 27 $MtCO_2e$ in subsequent years. Rice Cultivation, a pivotal agricultural practice, remained relatively consistent, fluctuating between 70 and 73 $MtCO_2e$ annually throughout the period. Agricultural Crop Residue and Emissions from Soils displayed slight fluctuations, with Crop Residue emissions rising from 7.92 $MtCO_2e$ in 2010-11 to 8.84 $MtCO_2e$ in 2016-17, whereas Soil Emissions saw a gradual decline from 81.08 $MtCO_2e$ in 2010-11 to 77.78 $MtCO_2e$ in 2016-17. Overall, these diverse categories collectively contributed to an average of approximately 409 $MtCO_2e$ annually, showcasing the nuanced dynamics and varied trends in greenhouse gas emissions within Indian agriculture over the seven-year period.

Uttarakhand's net greenhouse gas emissions are 11.83 $MtCO_2e$, which make up 0.40% of India's emissions at 2952.87 $MtCO_2e$. India's per capita emissions average 2.24 tCO_2e per person, while Uttarakhand's per capita emissions are 1.07 tCO_2e per person.[12]

[12] Trend Analysis of GHG Emissions of UTTARAKHAND (2015-2018)

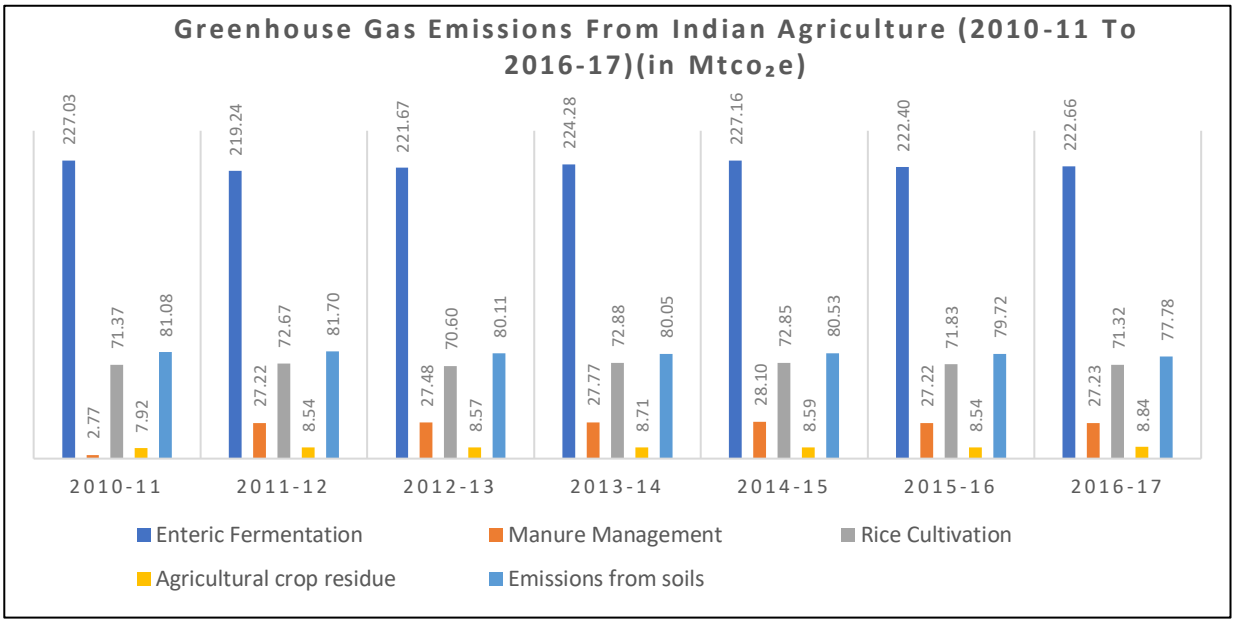


Figure 51: Trends in Agricultural Emissions Categories ($MtCO_2e$) in India

In Uttarakhand, examining the greenhouse gas emissions attributable to agricultural practices from 2005-06 to 2015-16 reveals key contributors and trends. Rice cultivation consistently accounted for an average of 0.45 $MtCO_2e$ annually, remaining relatively stable across the years. Simultaneously, biomass burning in croplands associated with various crops—wheat, sugarcane, cotton, groundnuts, maize, millets, rapeseed, and mustard—contributed cumulatively to emissions, averaging around 0.03 $MtCO_2e$ per year. The collective emissions from these activities peaked at approximately 0.53 $MtCO_2e$ in the early years and gradually decreased to around 0.44 $MtCO_2e$ by 2015-16. This data underscores the significance of rice cultivation and biomass burning practices in shaping Uttarakhand's agricultural emissions, depicting both consistent patterns and a marginal decline in overall emissions over the studied decade.

Table 32: GHG Emissions from Uttarakhand Agriculture by Crop Type and Practices

Crop Type	Agricultural practices	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Rice	Rice Cultivation	0.48	0.46	0.45	0.45	0.43	0.44	0.42	0.40	0.39	0.39	0.39
Rice	Biomass Burning in Cropland	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total		0.50	0.47	0.47	0.47	0.45	0.45	0.44	0.41	0.40	0.40	0.41
Wheat	Biomass Burning in Cropland	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sugarcane	Biomass Burning in Cropland	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Cotton	Biomass Burning in Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Groundnuts	Biomass Burning in Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maize	Biomass Burning in Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Millets	Biomass Burning in Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rapeseed and Mustard	Biomass Burning in Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Emission		0.53	0.51	0.51	0.51	0.48	0.49	0.48	0.46	0.44	0.44	0.44

Note: Emission in $MtCO_2e$

From 2005 to 2018, Uttarakhand experienced a compounded annual growth rate (CAGR) of 1.30%, with emissions climbing from 9.99 Mt CO_2e to 11.83 Mt CO_2e. Throughout this period, the Energy sector consistently emerged as the primary contributor to the state's greenhouse gas emissions. Notably, there was a peak in overall emissions in 2014, reaching 17.55 Mt CO_2e. Between 2014 and 2016, there was a noticeable decline in net GHG emissions, mainly due to reduced emissions from the Industrial Processes and Product Use (IPPU) sector, coupled with increased removals from Agriculture, Forestry, and Other Land Use (AFOLU). Despite a subsequent increase in overall emissions post-2016, particularly from the Energy sector, this rise was insufficient to fully offset the decline observed between 2014 and 2016.

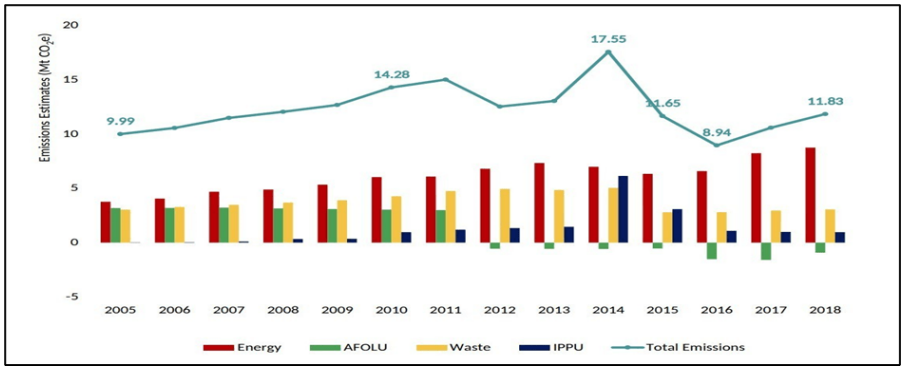


Figure 52 Per Capita Net GHG Emission of Uttarakhand & India (2005 to 2018)

Uttarakhand consistently had lower per capita emissions compared to India, as depicted in Figure. Despite reaching a peak in 2014, Uttarakhand's per capita emissions witnessed a slight decrease at a CAGR of 0.20%, dropping from 1.10 t CO_2e/capita in 2005 to 1.07 t CO_2e/capita in 2018. This trend differed from India's per capita emissions trend, which experienced a growth at a CAGR of approximately 3.41% between 2005 and 2018.

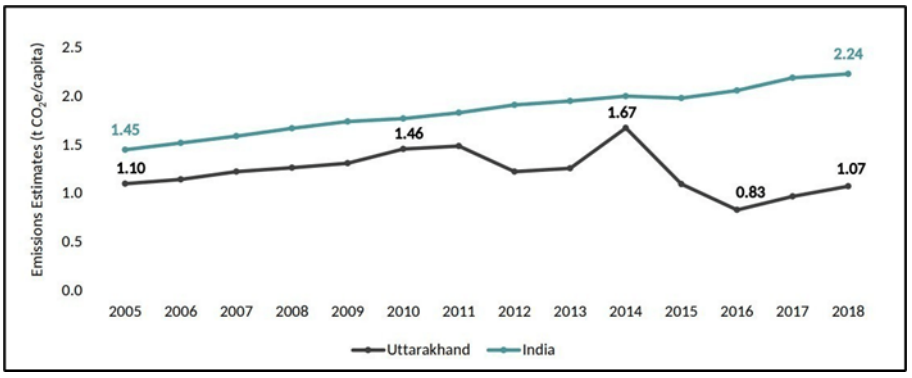


Figure 53 GHG Emission Estimates of Uttarakhand (2005 to 2018); Source: GHG Platform, India

Under the purview of Agriculture, Forestry, and Other Land Use (AFOLU), emissions delineate key contributors. Enteric Fermentation has the highest emission of 1.86 MT CO_2e with 72% of share, Manure management at 0.18 Mt CO_2e (7%) and agricultural soils at 0.41 Mt CO_2e (16%) emerge as significant contributors. Biomass burning in cropland and forestland records 0.06 Mt CO_2e (2%), while rice cultivation tallies 0.07 Mt CO_2e (3%). These statistics underscore the pivotal role of sustainable practices within AFOLU sectors to mitigate emissions and foster environmental balance.

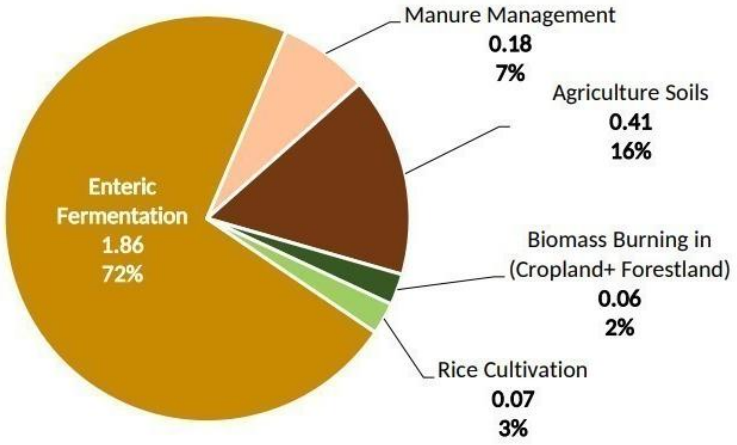


Figure 54: AFOLU Emissions (Mt CO2e) in Uttarakhand (2018)

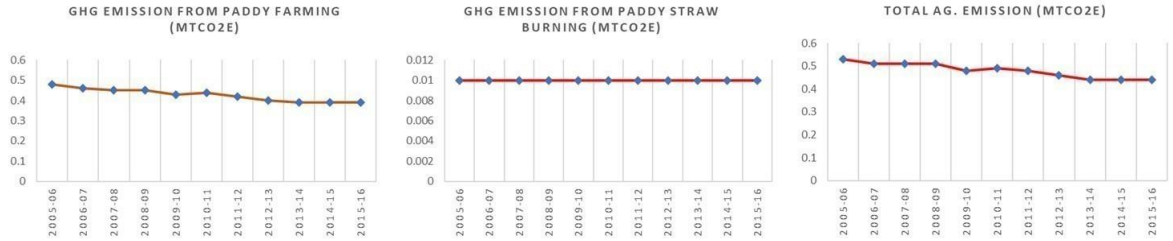


Figure 55: GHG Emission from Paddy and Straw Burning

Reduction in AFOLU GHG emission can be attributed to reduction in net sown area & gross cropped area, increased area under vegetable, fruit crops and other crops. GHG reduction in paddy is also attributed to reduction in paddy area in Kharif.

Overall, paddy area in hilly districts reflects decreasing trend whereas it reflects increasing in plain districts of the State. The pattern remains same in project districts. Looking at the current growth in paddy area, it can be assumed that GHG emission from paddy fields are expected to rise in coming days. The project intends to address the emerging issue amicably through different measures, like [1] promotion of appropriate package of practices and technologies, [2] climate resilient seed variety promotion, [3] irrigation management, [4] crop diversification in suitable land parcels, [5] promotion of organic farming, [6] fertiliser management using INM principles, [7] use of renewable energy-based water lifting devices, and [8] periodic measurement of emission and promotion of in-situ strategies for emission reduction.

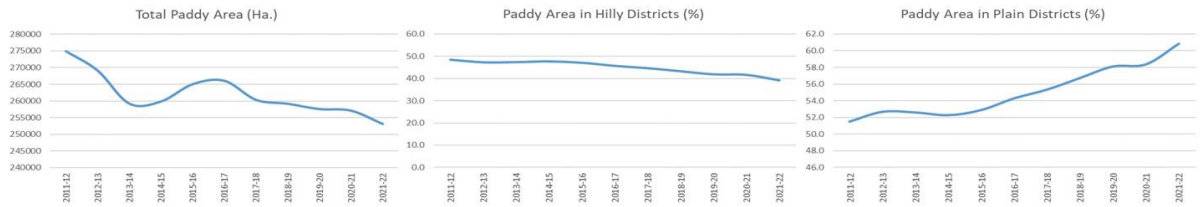


Figure 56: Paddy Area in Hilly & Plain Area, Uttarakhand

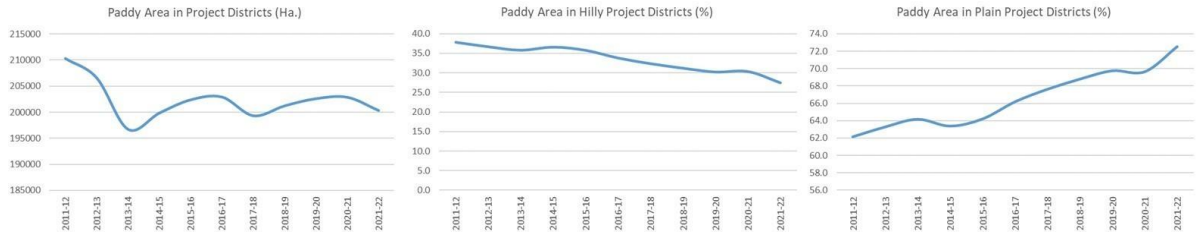


Figure 57: Paddy Area in Project Districts, Hilly & Plain Area

The primary sources of greenhouse gas (GHG) emissions in the livestock sector stem predominantly from enteric fermentation (39.1 percent), feed production (46.7 percent), and manure management (9.7 percent). According to the FAO[13], broader adoption of established best practices and technologies in livestock rearing has the potential to reduce GHG emissions from the sector by up to 30 percent.

In Uttarakhand, the emissions stemming from livestock activities, particularly through enteric fermentation and manure management practices, form a significant portion of the region's greenhouse gas outputs. The detailed breakdown of emissions across different animal types and agricultural practices showcases the intricate role of each in shaping the emissions landscape.

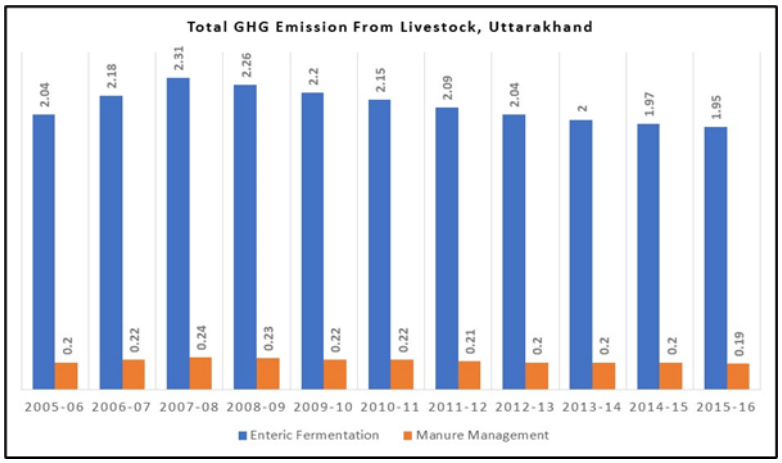


Figure 58: Total GHG emission from Livestock

Buffaloes engaged in dairy production exhibited a substantial emissions footprint, releasing around 0.51 $MtCO_2e$ in 2015-16 alone. Similarly, indigenous cattle, especially in non-dairy roles, contributed significantly, emitting approximately 0.43 $MtCO_2e$ in the same year. These findings underscore the substantial impact of specific livestock categories on the emissions profile due to their digestive processes.

Additionally, the management of manure from livestock presents a noteworthy contribution to emissions. Practices such as manure handling from indigenous cattle and crossbred cattle collectively accounted for about 0.28 $MtCO_2e$ in 2015-16. This aspect emphasizes that beyond digestion, waste management in agriculture significantly influences greenhouse gas emissions. The collective emissions from diverse livestock activities culminated in a total of approximately 2.14 $MtCO_2e$ by 2015-16, showcasing the cumulative effect of these practices over the years. This data emphasizes the critical role of sustainable livestock management practices to curtail emissions and promote environmental sustainability in Uttarakhand. Efforts directed at optimizing livestock-related activities and waste management can significantly mitigate the region's greenhouse gas output, fostering a more sustainable agricultural sector.

[13] FAO. (2016). Livestock and climate change. Retrieved from www.fao.org/climate- change

Chapter 2

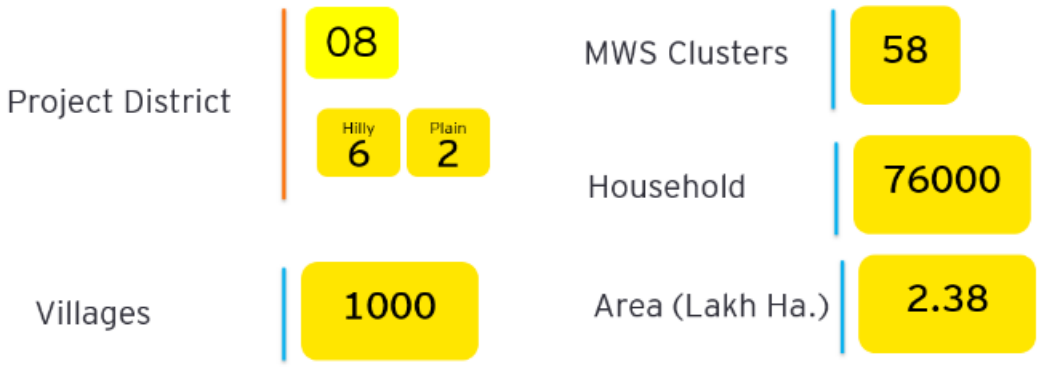
About the Project

Chapter Two: About the Project

The Uttarakhand Climate Responsive Rain-fed Farming Project (UCRRFP) will be undertaken by the Watershed Management Directorate (WMD) in Uttarakhand. Its primary aim is to enhance the resilience of production systems in specific micro-watersheds across the region, making mountain farming more competitive, profitable, and less susceptible to adverse climate conditions. This initiative spans six years, scheduled to operate from 2023 to 2029, with a total cost of USD 138.05 million. The funding breakdown includes USD 96.20 million from the IBRD, USD 34.19 million from the State Government, and USD 7.66 million from beneficiaries[14].

Given Uttarakhand's topography, agriculture heavily relies on rainfall and faces vulnerability to varying weather conditions. Adapting to these changes swiftly is crucial to sustain and increase agricultural yields amidst a rapidly evolving climate. To achieve this, there's a need to transition towards production systems that optimize productivity, resource utilization, stability in output, and resilience against short- and long-term climate fluctuations.

The UCRRFP targets six hilly districts and two plain districts in Uttarakhand, encompassing 1,000 villages and 58 micro village clusters. Its focus is to enhance food security while simultaneously reducing emissions from farming practices through the implementation of more efficient and resilient agricultural methods.



2.1 Project Development Objective:

The Project Development Objective is "Improve production system resilience to make mountain farming emission competitive and profitable in selected micro-watersheds of Uttarakhand". The project targets reducing GHG emission in pilot plots, enhancing production system resilience, improving spring shed discharge, and boosting profitability through optimal crop yields. By implementing improved practices, benchmarking productivity, increasing water discharge rate of spring-sheds, and optimizing water use, the project aims to promote sustainable agriculture while ensuring economic viability.

[14] Project Appraisal Document (PAD), World Bank, January 30, 2024.

2.2 Project Design Framework:

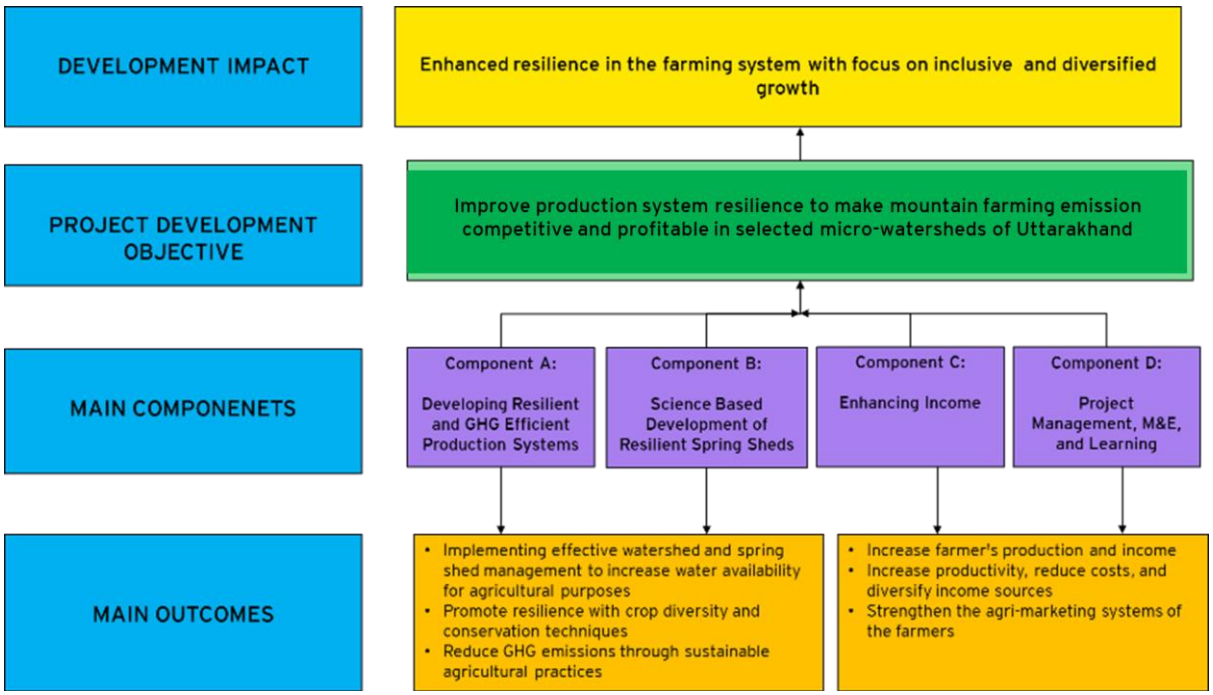


Figure 59: Project Design Framework; UCRRFP.

Overview of Project Interventions, Outputs and Outcomes

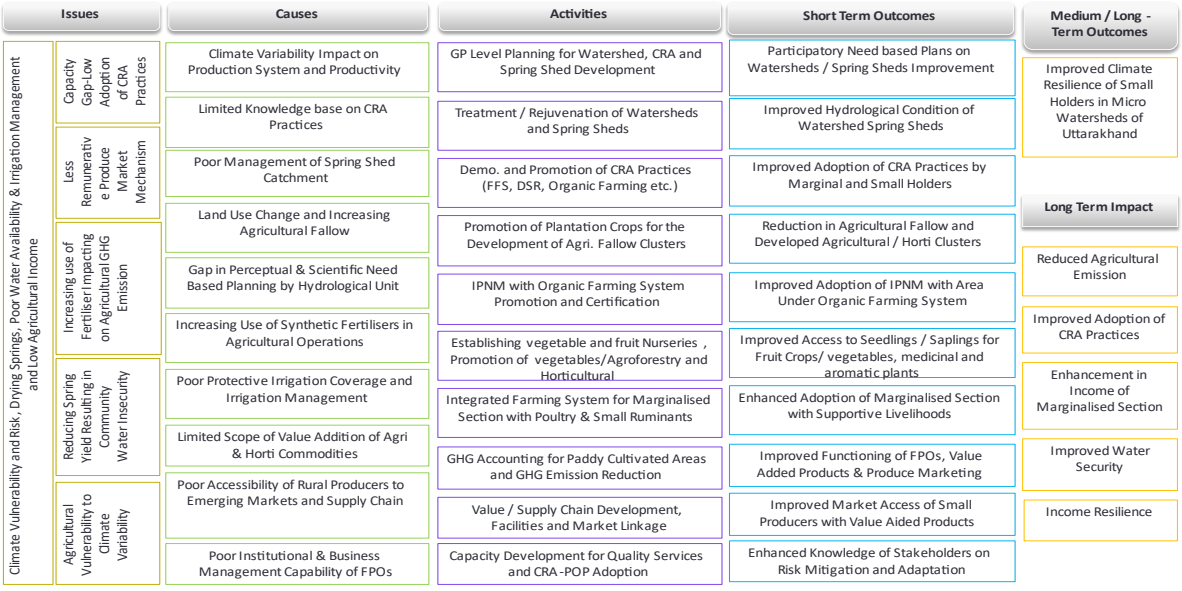
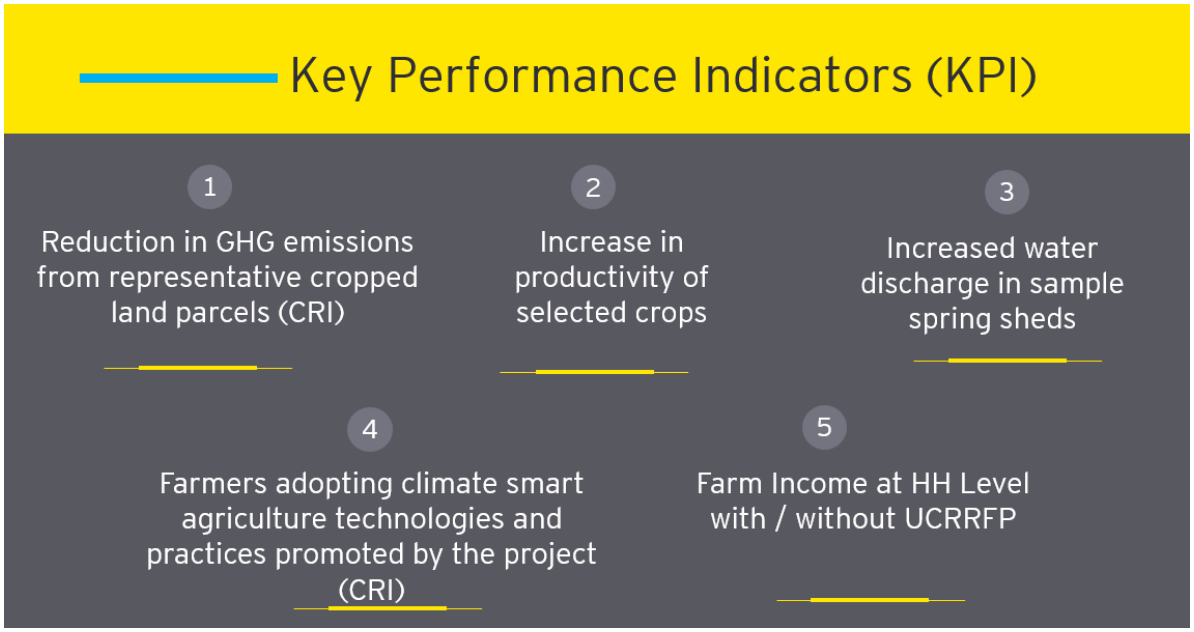


Figure 60: Project Intervention Overview

2.3 Key Performance Indicators:

The following Key Performance Indicators (KPI) are proposed for measuring the core outcomes of the project:



Theory of Change

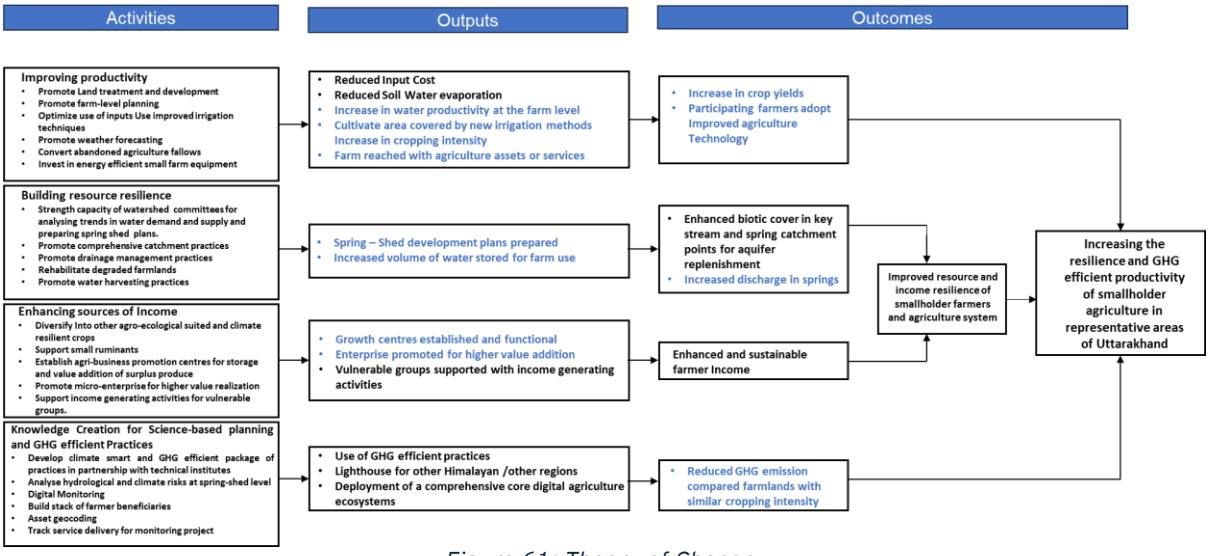


Figure 61: Theory of Change

2.4 Project Beneficiary:

Project beneficiaries include small and marginal farmers, producer organizations (POs), and other Agri-entrepreneurs (AEs). Targeted investments will be undertaken to address climate change mitigation and adaptation strategies as well as benefit of other marginalised groups like, women farmers, community farmers/cultivators of different land holding categories, FIGs etc.

2.5 Project Components:

The project envisages to intensify and diversify agricultural production and adopting technology, enhance climate resilient watershed management and improve water productivity in selected village clusters of Uttarakhand. Further, to improve the market share of the produces at producer end, the project intends to promote / strengthen supply

chain and value chain of agricultural and horticultural produces using Farmer Producer Organizations (FPOs).

The project has four components to achieve the Project Development Objective (PDO). The project components and sub-components are discussed below. The fifth component of the project (Contingent Emergency Response Component) is the non-budgeted component.

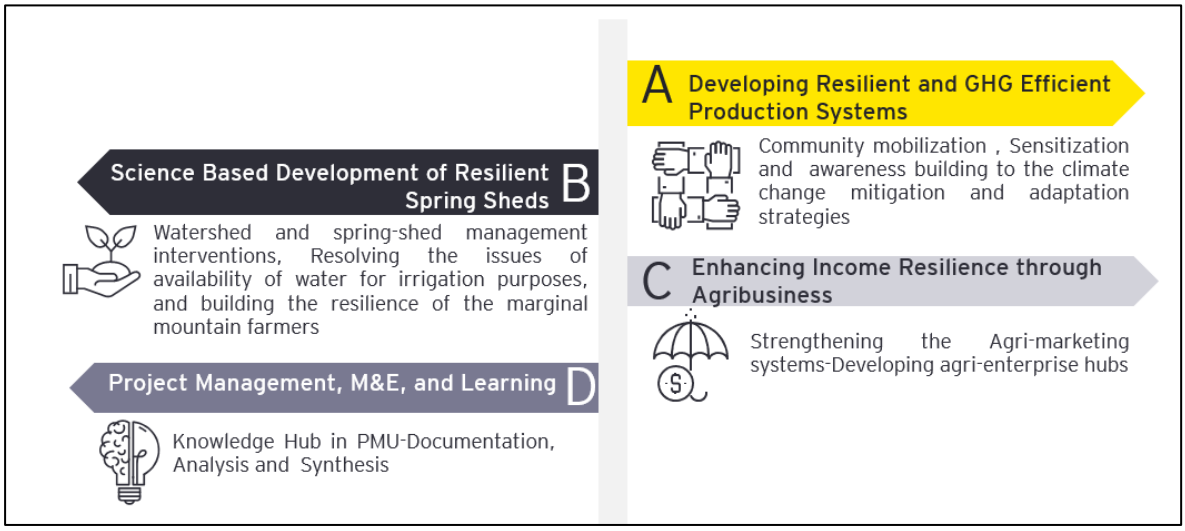


Figure 62: Project Components

2.5.1 Component A: Developing Resilient and GHG-efficient Production Systems:

The objective of the component is to improve productivity through land treatment and development, while simultaneously enhancing fertilizer efficiency, water productivity, and mitigating greenhouse gas emissions. The component establishes the groundwork for the project to transition cultivation towards an optimal input usage pattern, resulting in lower input costs and increased average income for farmers.

Within this component, priority will be placed on expanding controlled irrigation coverage, encouraging protected cultivation, recultivation of fallow lands, fostering agricultural diversification, and bolstering farmer's income through varied livelihood options. Utilizing a landscape approach grounded in land-use capability, the project will furnish high-quality inputs and implement early warning advisory systems to facilitate the adoption of ecologically sensitive and diversified production systems.

A decision support system for Climate-Smart Agriculture (CSA), grounded in evidence, will be established through strong partnerships with leading scientific entities, both within the state and at the national level. These collaborative partnerships will generate knowledge products through co-creation processes, frequently involving pilot communities. Additionally, they will create a digital data repository comprising advisories, tools, analytics, and data management solutions to facilitate on-the-ground implementation, bridging the gap between laboratory research and practical field application.

2.5.2 Component B: Science- based Development of Resilience Spring Sheds:

To build climate resilient watersheds with the support of participating communities, watershed and spring-shed management interventions shall be carried out. These initiatives would help in resolving the issues of availability of water for irrigation purposes which is critical for building the resilience of the marginal mountain farmers whose farming is totally rain-fed.

The aim of this component is to enhance the efficiency of spring-sheds by implementing extensive catchment treatment measures, enhancing the quantity and reliability of spring flows through drainage management, and augmenting water storage capacity for agricultural use through the construction of farm ponds. The harvesting structures in participatory planning for spring-shed development that will empower watershed committees to deepen their grasp of science-based spring-shed hydrology. This process will enable them to identify and cultivate representative sites for project interventions, with a particular focus on critical springs.

Additionally, the project will facilitate the installation of water harvesting and storage infrastructure and establish channels for gravity-based distribution at the farm level.

To increase productivity, the project will provide both technical and farming inputs to the farmers in agriculture, horticulture, and allied sectors (fishery & livestock with small ruminants). In the endeavour to make farmers climate resilient, farming systems shall be promoted, organic farming, integrated pest management, integrated nutrient management and protected farming systems shall be developed. In the process the project will support interventions that reduce greenhouse gas emissions from farming systems.

Hence, under this component, depending upon the activities, the project will promote resilient parameters of a watershed / spring-shed considering water availability, efficient irrigation system promotion, irrigation regulation and management, water conservation mechanisms etc. Taking lessons from similar interventions under other projects in similar geographical conditions (like NICRA interventions), the project will promote climate resilient agricultural practices, intensive / semi-intensive farming models, exploring agriculture-horticulture options, mixed / inter-cropping etc., based on its feasibility. Reducing cost of cultivation through natural farming / organic farming, promotion of carbon farming models, achieving nutrient use efficiency etc. will also be the points of intervention under the component.

2.5.3 Component C: Enhancing Income Resilience:

The foremost goal of the project is to bolster the economic resilience of farmers, with special focus on mountain communities. To achieve this, the project will invest in fortifying the agricultural marketing systems. This involves uniting farmers into federations, offering value-added services, establishing comprehensive supply chains, and ensuring less carbon intensive / carbon-neutral logistics for agricultural products. The initiative also aims to foster the growth of agricultural enterprises by establishing Agri Business Growth Centres in remote regions. To promote inclusivity and fairness, the project will extend non-agricultural livelihood opportunities to marginalised households within the project villages.

Therefore, As stipulated under the component, income resilience can be achieved through the promotion of remunerative market linkage through collective approach. The project intervention would be in line with the expected outcomes, i.e., strategies and processes of product collectivization, farmer association or FPO promotion mechanisms, product specific cluster development, support through processing intervention, market linkage through e-marketing portals (like E-NAM) etc. The project will also support in commodity specific supply chain improvement and management aspects, along with logistics management. With reference to the baseline, the project will also look at key livelihood support mechanisms that can benefit to the identified marginalised households in the project area.

2.5.4 Component D: Project Management, Monitoring & Evaluation, and Learning:

Supported by a consortium, the project aims to establish a knowledge hub within the Project Management Unit (PMU). This hub will analyse, synthesize, and document diverse methods, practices, and strategies essential for optimizing natural resource usage, reducing greenhouse gas emissions, fostering resilient integrated farming systems, and improving marketing inputs.

Furthermore, the project will focus on augmenting the expertise of staff within the Watershed Management Department (WMD) and across departments. This effort aims to integrate climate-resilient approaches effectively at the local level. Additionally, this component encompasses overseeing the institutional framework, coordination, monitoring, evaluation, and overall project management under the purview of the PMU.

2.6 Geographical Coverage:

The project will cover 8 districts in the state with intensive focus for agricultural development and climate resilient watersheds / spring-sheds. The framed project activities will be implemented over a period of six years in a phased manner.

Table 33: Geographical Coverage

SN	Project District	No. of Blocks	No. of Project Blocks	No. of GPs	No. of Project GPs	No. of Project Revenue Villages	No. of Watersheds
1	Almora	11	2	1160	101	194	58
2	Haridwar	6	1	306	11	25	
3	Nainital	8	2	479	77	180	
4	Pauri Garhwal	15	1	1174	74	181	
5	Rudra Prayag	3	2	336	82	154	
6	Tehri Garhwal	9	2	1035	86	150	
7	Udham Singh Nagar	7	1	376	11	19	
8	Uttarkashi	6	2	508	73	97	
	Total	**65**	**13**	**5374**	**515**	**1000**	

2.7 Project Implementation Arrangement:

The UCRRFP is based on joint relationship among three entities: (i) village communities and GPs; (ii) WMD; and (iii) Consortia of Science Based Research Institutes. All these three stakeholders will fulfil their respective roles and responsibilities for the project to be successful. Specifically, the roles of each entity are:

Table 34 Implementation Arrangements for UCRRFP:PIP

Agency	Function	Composition
Village Community and GP	• The Gram Panchayat (GP-WWMC) is the primary implementation agency of activities undertaken for Watershed Treatment • Responsible for planning and executing project activities within their respective areas. • Oversee the project's on-ground implementation at the grassroots level.	Pradhan (Head) of the villages, Up-Pradhans, representatives of SHGs, Yuva Mandals, WUAs, etc.

Agency	Function	Composition
Watershed Management Directorate	• Facilitates overall coordination and aids village communities and GPs. • Staff and representatives from the Watershed Management Department (WMD) actively collaborate with village communities and Gram Panchayats (GPs) throughout project execution. • Their support aims to ensure alignment with the overarching objectives and strategies of the department. • They work closely with local entities to facilitate and assist in the successful implementation of the project.	▸ Headed by Project Director ▸ Dy. Directors ▸ Finance Expert (CA) ▸ Field Implementation Units along with multi-disciplinary team 5-6 full time staff (from relevant disciplines like agriculture, soil conservation like agriculture, horticulture, livestock, irrigation etc), Social, Watershed and GIS expert, MIS, and other experts
Consortia of Science Based Research	Conducts scientific studies on various critical aspects related to the project's goals: • Study key indicators: • Technical support for reduction in greenhouse gas emissions • Suggest measures to increase discharge in spring-sheds. • Productivity measurements encompassing biomass. • Technical inputs for hydrological parameters within micro-watersheds Offers valuable scientific insights and methodologies for: • Precise data collection • Thorough analysis • Informed decision-making throughout the project duration	Research institutes identified to support the project across different components.

The Gram Panchayat (GP) serves as the primary body responsible for executing watershed / spring-shed treatment activities. GPs will receive comprehensive information about the allocated budget for their specific project period, termed as the 'Budget Envelope'. Within this financial framework, GPs will devise a three-year "Work Plan". Before commencing the formulation of the Gram Panchayat Resilient Plan (GPRP) and Spring-shed Development Plans, the project will conduct capacity-building exercises for relevant GP members, the general body, and its sub-committees. Implementation and procurement related to the GPRP and Spring-shed Development Plan will be carried out by the GP itself or delegated to various village-level institutions operating within the GP. Additional specifics are available in the operational manual of the UCCRFP.

2.8 Project Financing:

The total cost of the project estimated to be USD 138.05 million, of which World Bank will finance USD 96.20 million and Government will finance USD 34.19 million of the total cost of the project.

Table 35: Project Financing

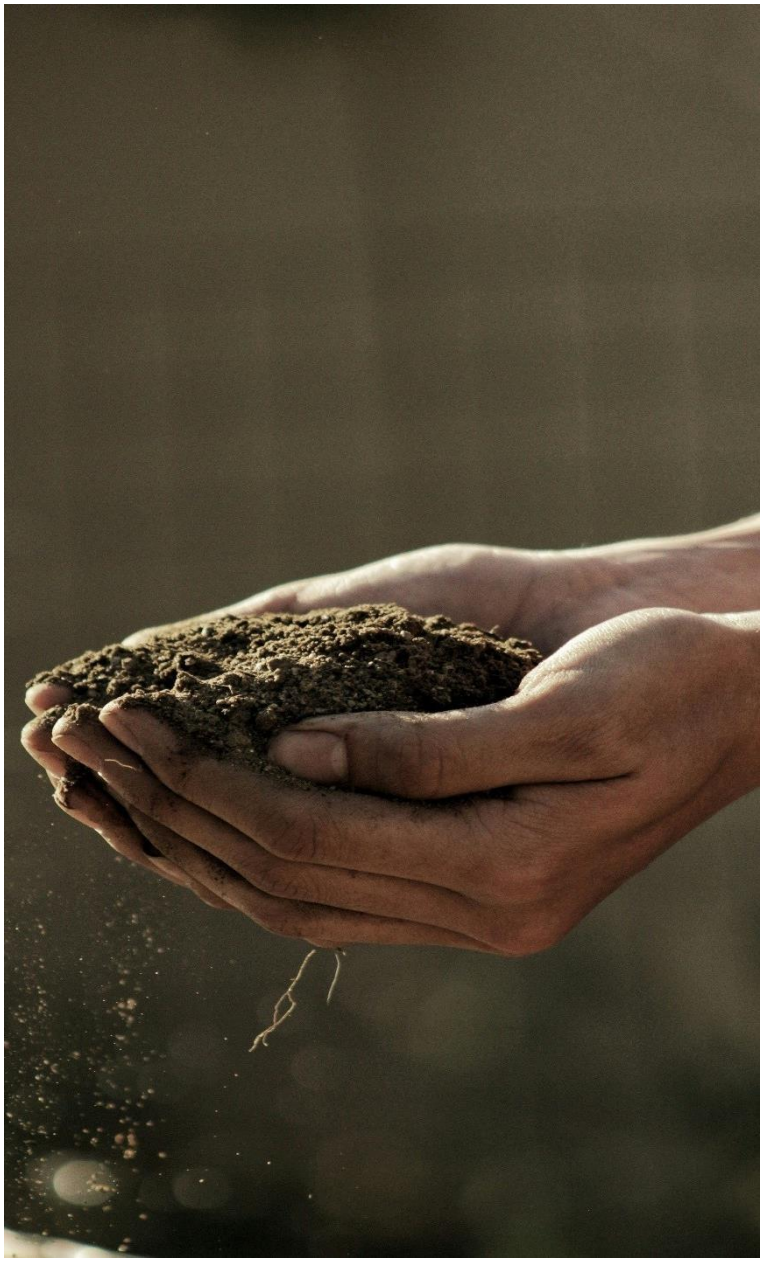
Project Components	Project cost (USD)	World Bank Financing (USD)	State Government (USD)	Beneficiary Share (USD)
Developing Resilient and GHG Efficient Production Systems	46.83	36.31	5.88	4.64
Science-Based Development of Resilient Spring-sheds	62.71	43.24	16.88	2.58
Enhancing Income Resilience through Agribusiness and Entrepreneurship	14.77	11.82	2.52	0.43
Project Management, Monitoring & Evaluation, and Learning	13.72	4.81	8.90	-
Contingent Emergency Response	0.00	0.00	0.00	0.00
Total Project Cost	138.05	96.20	34.19	7.66
Total financing required	138.05	96.20	34.19	7.66

2.9 Experience of WMD in Similar Interventions:

The Watershed Management Directorate is the anchoring and nodal agency to implement the World Bank supported UCRRFP project. The Directorate is having adequate learning and experience in implementing externally aided projects in watershed and NRM sector. The earlier experience of the WMD in implementing integrated watershed-based approach found to be encouraging and supportive to the people not only in restoring and enhancing ecosystem services, but also enhancing their income by strengthening agribusiness support mechanisms through individual and collective approach. Experience and learning have been across sectors, from agriculture to inclusive growth. Earlier interventions not only helped farmers from agricultural investments; marginalized groups / individuals were also integrated to the off-farm and non-farm activities for livelihood. Benefits of investment, that resulted with higher production and productivity of agricultural and horticultural commodities, were linked to the market through designed support mechanisms.

While benefitting, these projects have also helped to develop in-depth understanding on key emerging challenges due to climate variability in agriculture sector, scopes that are emerging to enhance the income of the producers, the critical gaps that have been hindering in realizing remunerative return to the farmers, need of crop diversification and livelihood support to be more resilient, need of production system resilience through scientific approach and practices and over and above need to enhance the rate of adoption of such practices. The UCRRFP is designed, based on such learning from earlier projects to enhance climate resilience of people and production system.

Chapter 3



Component A: Developing Resilient and GHG Efficient Production Systems

Chapter Three: Component A: Developing Resilient and GHG Efficient Production Systems

The broad objectives of the project in the agriculture sector (agriculture and horticulture) are: (i) reduce methane emission from low land paddy without compromising with productivity; (ii) facilitate improved adoption of agricultural technology and package of practices for climate resilience, (iii) enhance crop productivity through technology promotion; and (iv) promote agribusiness through supply chain management and value chain improvement. In the above context, the project plans to take up agriculture, horticulture, and other interventions with the following specific objectives:

Intervention Objectives:

1. Reducing methane emission from low land paddy;
2. Promote climate resilient technology and package of practices;
3. Improve productivity of crops by supporting with improved climate resilient seed varieties,
4. Minimize the risk by improving crop/cropping system diversification;
5. Promote on-farm water use efficiency techniques;
6. By promoting integrated farming system;
7. Agribusiness and market linkage for remunerative return.

3.1 Supporting Climate Smart & Diversified Production Protocols: (Sub-Com A1):

Promotion and adoption of CSA practices is the core focus of this sub-component. The project under this sub-component will support farm planning and mobilization of farmers and their association / federation and support them to adopt practices that are climate resilient and GHG efficient. For improving climate resilience of agriculture and improved adoption of CSA, this sub-component will support in identifying, accessing, and implementing the most suitable practices. The farmers can make use of weather forecast (provisioning weather forecast in convergence with ongoing government initiatives) to plan agricultural activities.

Adoption of CRA practices and improvement in cropping intensity require irrigation provision. The project will support farmers / FIG / FPO in providing controlled irrigation through various means to improve gross crop area. Along with this the project will also support farmers for protective cultivation, converting abandoned agricultural fallows to crop land, promoting diversification of agriculture, and supplementing incomes of farmers through livestock support (including small ruminants). Wherever feasible and based on the interest of the farmers, integrated farming system will be supported. The project will also help the farmers in accessing quality inputs and deploy early warning advisory systems to ensure adoption of ecologically sensitive and diversified production system.

While provisioning irrigation will be one of the focuses of the project by using available and potential sources, it will also support farmers in improving water use efficiency. Improved efficiency in water use will support the farmers to irrigate more area and hence enhancement in gross cropped area and cropping intensity. For improved resilience,

promotion of suitable seed varieties will be taken up by the project. While the project will support in productivity enhancement of selected crops, for the benefit of the nature and local environment, the project will pilot methane (CH4) emission reduction protocols in lowland paddy (selected land parcels / plots). This pilot initiative will be supported by the consortium partner/s. Further the project will help farmers in accessing small farm equipment to minimise the cost of cultivation and improve timely operation of farm activities.

3.1.1 Augmentation of Water Availability & Efficiency:

Unavailability of required irrigation has been a constraint for the farmers. The hilly terrain geography further restricts scope of irrigation as lifting water to a higher altitude has been a problem. To make agriculture more productive, taking up intensive / semi-intensive farming, improving gross cropped area, and enhancing cropping intensity, it becomes essential to improve scope of irrigation and covering more area under irrigation. Hence, to improve resilience and bringing in more area under irrigation, the project will invest in irrigation improvement.

The Project Appraisal Document (PAD) reflects that the project will have focused attention to bring more areas under controlled irrigation, promote water use efficiency, improve spring shed yield and conservation of water for irrigation. Accordingly, the project plan reflects to support farmers / FIGs / FPOs to take up solar based water lifting device, construction of water harvesting / storing structures, promotion of micro irrigation and taking up soil moisture conservation through mulching.

Table 36: Interventions for Augmentation of Water Availability & Efficiency

Project Intervention	Specific Activities
Demonstration and Adoption of Water Harvesting Interventions	Village level Solar water lifting schemes
	Small Solar water lifting pumps for individual farmers
	Low-cost water harvesting / irrigation Tanks
	LDPE Tanks
	Prefabricated Water Harvesting Tanks
Demonstration and Adoption of Interventions to improve Water use efficiency in production systems.	Establishment of farm level crop intelligence system in crop clusters including crop water budgeting
	Drip irrigation system for fruit orchards
	Drip irrigation system for vegetable cultivation
	Demonstration of Sprinkler irrigation systems
	Demonstration of mulching technologies

3.1.1.1 Water Harvesting and Storage:

To improve water availability for irrigation, the project will support in constructing irrigation tanks for storage / harvesting water. The construction of tanks will include LDPE (Low Density Polyethylene) as well as water harvesting tanks. The water harvesting and storage structures will be utilised, with the support of lifting device, to irrigate crop land at different altitude. Initially, it will be taken up on demonstration mode at the project villages (villages having inadequate irrigation as identified during assessment and planning). The project will also invest in promoting adoption of such practice by supporting individual farmers. In adoption promotion, a part of the cost will be supported by the interested beneficiary. The operation and maintenance cost will be the responsibility of the concerned beneficiary.

Though the project area is having different water sources like stream, wells etc., farmers have been facing difficulty in irrigating their fields due to lack of pumping mechanism to the

land that are in a higher altitude. In this context, solar pump emerges as the reliable, eco-friendly, low cost and sustainable power source of irrigation. Promoting solar pump sets will reduce the dependency on grid supplied electricity, there by reduces the cost of irrigation. Secondly, it will be supportive to improve the irrigated area by which farmers can take up Rabi crop and can provide protective irrigation during Kharif.

Objectives	*Advantages with Solar Pump sets*
▸ Improve water storage and enhancing irrigation coverage with the support of solar pumps that runs with alternative source of energy; ▸ Promoting eco-friendly irrigate to increase irrigation potential and cropping intensity; ▸ To promote solar energy in areas where electricity is un-served or underserved.	▸ No fuel cost, more economical than diesel pump sets in the long run; ▸ Environment friendly; ▸ Maintenance is low and affordable; ▸ Timely irrigation provision, increases area under irrigation; ▸ Providing critical irrigation in rainfed areas; ▸ Use of renewable energy for water pumping will not contribute to GHG emission.

Project Assistance:

Solar pump sets of required capacity, will be supported as per the assessed need (feasibility based), to eligible farmer / farmer groups, following support norm of the Govt. In case of requirement and based on the need of the local farmers, the project may take appropriate decision to support more than one FIG / FPO in a village / locality with solar pump, condition to extension of support to member farmers in the village / locality.

Key Guiding Principles

- The project will conduct surface and ground water assessment in the project locations to understand water availability and its adequacy for providing irrigation;
- Areas with shallow water table, water reservoirs, and stream flow as assessed by the project will only be supported with solar pumping system;
- The given pump sets should be primarily utilized for irrigation purpose;
- Project will give subsidized pump sets to farmer / FIGs;
- Individual farmer can access the benefit through the farmer's group;
- The concerned farmer's group / FIG will install the pump in the common water source to benefit farmers having land in the area;
- The farmer's group will prepare irrigation schedule to irrigate land of different farmers in a time bound manner;
- Equal opportunity would be provided to the farmers belonging to SC/ST category and women farmers;
- Farmer's group / FIG can generate revenue from users for providing irrigation;
- Individual farmer / household will be supported with solar pump;
- Demonstration of water harvesting interventions will be done for adoption;
- No maintenance cost will be provided by the project;
- Contribution of farmer / FIG / FPO will be upfront and it will be deposited in user's account for future O&M.

Role and Responsibilities:

WWMC: Finalization of area to be irrigated through solar pumps, selection of farmer / farmers group as per the set criteria for project support, monitoring water utilization by the supported farmers and create awareness for water conservation and its management.

Unit Office: Will provide project support as per the finalized list of farmer / farmer group, based on the assessment findings. Officials of unit office will monitor water utilization during different cropping seasons for specific crop types and record additional area put under irrigation.

DPMU: DPMU will conduct periodic monitoring of the intervention, review the use of solar pumping system, monitor the benefits in terms of irrigation improvement, enhancement in gross cropped area and cropping intensity; assess the ground water status periodically and discuss during review meeting, if any such issues are there for amicable solution.

PMU: The officials of PMU will conduct periodic monitoring to the project locations, assess the project benefits, discuss with the farmers, and document the learning cases for wider dissemination. PMU will also take up periodic assessment of ground water status in collaboration with consortium institutions / partners.

3.1.1.2 Promote Water Use Efficiency and Water Productivity:

Water Use Efficiency (WUE) is the percentage of water supplied to the plant that is effectively taken up by the plant, i.e., water is not / less lost to drainage or evaporation. So, WUE is the ratio of total amount of water used to the total amount of water applied. Water productivity (WP) normally refers to crop production in relation to total water consumed. The water productivity plays a crucial role in modern agriculture which aims to increase yield per unit of water used, both under rainfed and irrigated conditions.

3.1.1.2.1 Crop Water Budgeting:

The objective of Crop Water Budgeting (CWB) is to shift the focus from supply side to demand side management. The CWB will provide the community with required knowledge for social regulation on water management. CWB will be performed by data collected through the Participatory Hydrological Monitoring (PHM) initiative in the watershed to enable the community to understand water availability from all sources in different cropping seasons. This would enable them to plan for appropriate crops to ensure irrigation in Kharif and augment the water availability in Rabi season. The CWB will be performed by accounting for the crop water requirement and hydrological data (i.e., rainfall, groundwater recharge and extraction, and surface water availability). The crop water requirement will be computed by accounting for crop acreage and their respective crop water requirements. The farmers will be sensitized to change their cropping pattern according to the water balance.

Crop Water Budgeting (CWB) also serves as a crucial tool for optimizing cropping intensity, promoting crop diversification, and enhancing productivity and efficiency in agriculture. By meticulously analysing water availability and demands across different stages of the cropping cycle, CWB empowers farmers to make well-informed decisions concerning irrigation scheduling and crop selection. This meticulous planning enables farmers to maximize land use by efficiently utilizing available water resources, thereby facilitating the cultivation of multiple crops within a single season. Moreover, CWB facilitates crop

diversification by identifying crops that are most suitable for varying levels of water availability, thus reducing dependency on water-intensive crops. Through these measures, CWB contributes significantly to boosting overall productivity and efficiency in agricultural systems while fostering sustainable farming practices.

Crop Planning: Crop planning will be done before each cropping season by WWMC / farmer groups, with the support of the project. All the farmers will participate in the crop planning exercise, organised by the WWMC, and facilitated by the project team. Each farmer in the watershed will indicate the extent of area and crops to be cultivated in specific cropping season. The field team of the project will aggregate the crop plans and arrive at the crop water requirement. This will lead to the crop water budgeting exercise.

Piloting Crop-Water Budgeting: The crop water budgeting, taking both surface and groundwater into account, will be taken up on a pilot basis in the first year of the project in selected watersheds, based on certain parameters like geo-hydrology, cultivated area, crops cultivated, water availability etc. In case of requirement, support of consortium institutions will be accessed to facilitate the process. The findings of the piloting can be scaled up in all the project watersheds from the second year onwards.

Capacity Building: The farmers will be oriented on participatory irrigation management principles and their role in water resource management. Based on the project needs and sustainability of the process, farmers will be oriented with refresher courses. The capacity building process should be more practical/field oriented with demonstration and linking with the field reality.

Audio-Visual Display: The audio-visual displays can be used to make the farmers / community understand the concept, crop water budgeting, water conservation, rainwater harvesting and water productivity etc.

Promoting Water Use Efficiency through the Project

1. **In Water Conservation**

- **Irrigation water efficiency**- a paradigm shift from the less efficient flood system of irrigation to alternative wetting and drying.
- **Demonstration and adaptation of water harvesting interventions**- Village level Solar water lifting schemes, low-cost water harvesting/ irrigation tanks, LDPE tanks, prefabricated water harvesting tanks.

2. **In Production System**

- Establishment of farm level crop intelligence system in crop clusters including crop water budgeting
- Demonstration and adoption of drip irrigation system for fruit orchards, vegetable cultivation.
- Demonstration and adoption of sprinkler irrigation systems and mulching technologies

3.1.1.2.2 Water Productivity:

Crop water productivity (WP) is the amount of crop produced with a unit amount of water. The primary objective of this activity is to promote physical water productivity, i.e., mass of production to the amount of water consumed ('crop per drop') by which the small and marginal farmers can have economic water productivity, i.e., value derived per unit of water used. Further, this project approach will support in achieving greater irrigation coverage at the micro watershed level, in terms of area coverage.

Calculation of WP requires the measurement of crop produced and the amount of water applied from all sources (rainfall, surface water and ground water). The project will measure application of water from all sources and with these inputs, the consortium partners will support in computing WP.

1. Water productivity to be assessed and computed at the end of each cropping season;
2. Water productivity will be assessed for major crop categories;
3. Maintaining water use data (surface and groundwater) for crop production by the WC;
4. Crop cutting, as per procedure, would be conducted to estimate production / productivity;
5. The WWMC/ farmers/ committee should maintain production figures by crop type.

Promoting Water Productivity through the Project

- **Use of sensors-**
  A. For soil moisture- will accurately measure soil moisture, allowing for precise determination of irrigation needs and reducing water waste. It will prevent both under and over-irrigation.
  B. For weather-Temperature and humidity sensors enable farmers to identify optimal planting conditions for different crops, ensuring timely planting.
- **Real-time sensor data-** Data on soil moisture, nutrient levels, insect infestation, and crop health will be delivered to beneficiaries via an ICT platform, enabling informed decisions on irrigation, fertilizers, and pest control.

The spheres of intervention will include catchment and command area treatment of micro watershed, including rainwater harvesting, spring water harvesting & management, and construction of group- based bore well.

The project proposes to enhance water productivity which will be achieved either by (1) increasing the yield of the crops for each unit of water transpired, (2) reducing the outflows / losses, or (3) enhancing the effective use of water. The first option refers to the need for improving crop yield; the second one intends to increase the beneficial use (water uptake - transpiration) of water supply against the non-beneficial losses (evaporation); the third aims to utilize efficiently the water resources. All these options will lead to the improvement of the on-farm management aspects of crop growth, through the application of the best crop management practices which will permit to use less water for irrigation, decrease evaporation losses, allow better pest control, minimize energy consumption, and improve soil conditions.

3.1.1.2.3 Crop and Technology Adoption:

Based on crop water balance, farmers shall adjust the crops and the extent of area to be cultivated. They will also adopt various water saving technologies to optimize available water, considering equity and productivity. The farmers, based on crop water balance, would take up water saving irrigation and other climate resilient technologies, such as:

- Micro-irrigation (drip and sprinklers);
- Plastic mulches and tunnels;
- Improved soil moisture retention sub-surface barriers;
- Alternative wetting and drying for rice;
- Multi-cropping systems;
- Proper shade management - humidity and moisture stress on crops;

- Organic farming;
- Irrigation scheduling / planning.

3.1.1.2.4 Micro Irrigation (Drip / Sprinkler Irrigation)

Use of micro irrigation (drip / sprinkler) reduces water footprint, improves water use efficiency and support in bringing more area under irrigation. The project will promote such systems in the project villages / clusters on demand basis, following the existing government norms. Promotion of micro irrigation system would be helpful to save water up to 50 percent which can be utilised for irrigating more area and improve cropping intensity.

Objective:

The overall objective of demonstration of micro irrigation and promotion of its adoption is to improve water use efficiency, reduce loss of water due to flood irrigation, and increase the irrigated area with the help of micro irrigation system.

Benefits of Drip Irrigation

- Requires very low pressure;
- Since irrigation is provided in the vicinity of the tubing installation, any weed seeds there do not receive water and dies;
- Since soil moisture is kept in control, soil erosion is reduced;
- Targeted fertilizer is provided resulting in reduced use of fertilizer, reduced cost of input and reduced loss of fertiliser;
- Improvement in seed germination.

Project Assistance:

The project will support the intervention as per the existing norms of the Government. The project will take up demonstration with selected farmers / FIGs where others can see the benefits and learn the technical aspects. The project will also support to farmers who are interested in adopting the practice in their field.

Key Guiding Principles:

- Beneficiaries will be identified by the concerned WWMC / FIG / FPO for finalization at the unit office level. Unit office will verify the list, visit to the proposed site, discuss with the concerned applicant, and assess the feasibility;
- Conducting feasibility assessment of the proposed site/s, including available water sources, availability of water lifting system, water storage system (overhead tank);
- Project assistance will be as per the approved government norms;
- The beneficiary of the micro irrigation will also be supported for other agricultural and horticultural activities to ensure that the concerned household / FIG / FPO strengthen its operation, adopt / utilize the learning, and sustain the process;
- Micro irrigation will be promoted for field crops as well as for fruit and vegetable crops;
- Operation and maintenance of micro irrigation system will be the sole responsibility of the concerned farmer / FIG / FPO;
- The beneficiary farmers will be trained on operation and maintenance of the micro irrigation system;
- The micro irrigation system can be procured by the beneficiary directly from the empanelled suppliers. The empanelled supplier will be paid by the project following the financial norm of the project. In case of requirement, based on the request of the beneficiary, project will also facilitate in linking the supplier with the beneficiary;
- The supplier of micro irrigation system will be contracted for providing on time services to farmers, based on received complain.

Beneficiaries would be trained on the use of micro irrigation (drip / spring) system and key precautionary measures to be taken to ensure that the system functions properly. Specific aspects to be taken care of by the beneficiaries for proper functioning of the drip are:

1. Protecting the tubes from harsh sun which can damage the tube;
2. Regular check of tubes as without proper filtering, mineral deposit tends to build up and clog the tubes;
3. Maintaining and monitoring pressure as pipes and fittings can blowout during pressure fluctuations. Pressure reducing valves are required to ensure water pressure is low enough to avoid blowouts which cause dirt to enter lines.

Role and Responsibilities:

Community Organizations (WWMC / FIG / FPO):

1. Community consultation, awareness creation and identification of beneficiary;
2. Selection and finalization of interested farmers for micro irrigation;
3. Prepare a detail list of beneficiaries and its submission to the unit office;
4. Preliminary assessment of scope;
5. Appraising officials of the unit office from time to time on progress;
6. Mobilize and organize meetings / trainings with the support of project officials;
7. Providing required information to the unit office.

Field Implementation Unit:
The unit office will support community organizations (WWMC / FIG / FPO) in the following areas;

1. Assessment of current application of micro irrigation, area coverage and crops under micro irrigation and farmers adopting such practice;
2. Review the recommendations of the WWMC / FIG / FPO for assistance and discuss with the stakeholders;
3. Conducting physical verification of the suggested sites and feasibility assessment;
4. Educating farmers on importance of micro irrigation and its benefits;
5. Conducting training / orientation for beneficiaries;
6. Providing guidance / technical support as per the plan;
7. Assessment of use of micro irrigation in the project area, including area coverage;
8. Periodic visit to the field, consultation with farmers and assessing the benefits;
9. Documentation of learning and its dissemination.
10. Submission of progress / output report to DPMU as per requirement;

DPMU:

1. Periodic monitoring / physical observation of the use of micro irrigation;
2. Discussion with the beneficiary farmers on current water use, increment in irrigated area etc.;
3. Assess the benefits harvested by the beneficiary through micro irrigation;
4. Discuss with officials of the Field Implementation Unit on progress of activity;
5. Documenting learning lessons and preparing case studies;
6. Preparing monitoring report and share with PMU for reference.

PMU:

1. Prepare guidelines for implementation of the activity, looking at the scope;
2. Periodic monitoring, including visit to the farmer's field, consultation with farmer on micro irrigation use, area under micro irrigation, increment in irrigated area etc.;
3. Consultation with DPMU / Unit Office on progress of the activity and review of records;
4. Assess the environmental and economic benefit of the activity;
5. Providing required guidance for improving the investment outcomes;
6. Document the learning lessons and dissemination.

3.1.1.2.5 Mulching:

Mulching is one of the important soil management practices which will be promoted by the project involving individual as well as collective of farmers. Farmers will be oriented and demonstrated on mulching using crop residues like straw, leaves, and other materials like polythene films to conserve soil moisture and to control the weed growth.

Advantage of Promoting Mulching:

- Keeping soil cool in day; warm at night hours;
- Reducing surface run-off;
- Adding humus to the soil;
- Preventing soil erosion;
- Protection to fruits from falling on the soil (since they fall on the mulches);
- Absorption of more rainwater and hence reduce irrigation frequency;
- Less water footprint.

3.1.2 Climate Resilient Agriculture Production Systems:

The project will promote climate resilient agriculture / horticulture production system by making investment in a range of activities. The project will demonstrate various CRA practices and will provide adoption support to the farmers / FIGs / FPOs. There will be focused intervention to develop agricultural fallows to agricultural / horticultural farms, demonstration of CRA practices through FFS, promote vermicompost, diversification of crops, supporting farmers for organic farming, promoting protected cultivation etc. The activities planned for execution will support in improving resilience in agriculture / horticulture production system, reducing GHG emission, improving cropping intensity and bringing more area under irrigation.

Table 37: Proposed Interventions for Climate Resilient Agriculture Production

Particulars	Proposed Activities
Conversion of hitherto agricultural fallows for agriculture purposes	Development of fallow land cluster of FIGs for agriculture purposes
	Fencing of the cluster land parcel
	Terrace development
	Irrigation facility for the cluster land parcel
	Support for climate resilient package of practices for two years
Demonstration of High Yielding Agricultural Crops through farmer field school (FFS)	Demonstration of Rabi agriculture crops at Cluster level
	Demonstration of Kharif agriculture crops at Cluster level
	Demonstration of Zaid agriculture crops at Cluster level

Demonstration of Climate Resilient Package of Practices (PoP) in Agriculture through (FFS)	Demonstration of Seed Production of Rabi Crops
	Demonstration of Seed Production of Kharif Crops
	Demonstration of Seed Production of Zaid Crops
Demonstration of Climate Resilient and Low Emission small farm equipment and tools.	Demonstration of Climate Resilient and Low Emission small farm equipment and tools
	Demonstration Support for setting up of Low Tunnel
	Demonstration support for Poly Tunnels
Adoption Support for Vermi Compost and Bio Compost	Adoption support for vermicompost mother unit
	Adoption support for vermicompost
	Adoption support for bio compost
Support for Organic Certification	Hiring of TA for organic certification
	Support for Organic Crop Production
Adoption Support to FIGs and FFs for high yielding agriculture crops and climate resilient PoP	Adoption Support for Rabi agriculture crops
	Adoption Support for Kharif agriculture crops
	Adoption Support for Zaid agriculture crops

3.1.2.1 Converting Abandon Agricultural Fallow:

There is growing concern about farmers leaving certain portion of their cultivable land fallow for years due to various reasons. Gradual increase in fallow land has been impacting upon agricultural production. Over the years, the fallow land percentage to total has increased from 1,59,609 ha. in 2017-18 to 2,05,261 ha in 2021-22[15]. To make use of these cultivable fallow land and converting it to an economic asset with carbon sequestration potential, the project intends to promote agricultural / horticultural crops, fruit crops, agroforestry / farm forestry in these areas with the direct involvement of the concerned farmers / FIGs / FPOs.

Objective:

- To recultivate the fallow land;
- Enhance income of the farmers through appropriate utilization of cultivable fallow;
- Improve carbon sequestration through agriculture, horticulture / fruit crops etc.;
- Demonstration and promotion of adoption of CSA practices.

Project Approach and Guiding Principles:

- The project will identify cultivable fallow land (adopting participatory approach / PRA methodology) during the cluster level planning and aggregate total land to be recultivated. Number of households associated with identified patches of fallow land will also be mapped;
- Detail plan for each land parcel will be prepared for reclamation of fallow land in consultation with the concerned farmer/farmer's families;
- A prior mutual consent of the farmers will be taken for the development of fallow lands. Minimum of 05 families will work collectively for the consolidated scattered patch of abandoned land;
- Farmer group / FIG / FPO may also be associated in the process, based on their interest and consent;

[15] Directorate of Economics and Statistics, MOA&FA, GOI

- The project will invest in providing technical and related other inputs based on the assessed requirement to the concerned households. Labour, watch & ward, and maintenance expenses to be incurred by the concerned beneficiary household/s;
- Beneficiary contribution may also be mobilised, as per the need, in shape of cash or kind or both, based on the suitability of the beneficiary household/s;
- Project will also invest in recultivating such fallow land which are under common possession. The project will invest in such land parcels, as per the requirement and based on the prepared plan;
- Project will also invest in demonstration and adoption of the technologies and other activities;
- As the project envisages to promote orchards, based on the willingness of the farmers in such lands, scope of carbon financing will also be explored, aggregating the abandoned lands at the cluster level.

Role and Responsibilities:

Table 38: Role and Responsibilities; Agricultural Fallow Land Development

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC / FIG	Participate in planning process
		Identify and propose land parcels to be recultivated
		Prepare list of interested farmers to be covered
		Suggest to unit office with farmer details and area
2	Field Implementation Unit	Facilitate village / cluster level planning;
		Verification of suggested sites to authenticate
		Verify the documents submitted by WWMC
		Submit verified list and observation report to DPMU
		Support the farmers in recultivating verified land
3	District Project Management Unit (DPMU)	Review & verify documents submitted
		Visit to sample areas for verifications
		Support the unit office to execute the activity
		Maintain MIS & GIS mapping of plots (pre-post)
		Prepare consolidated report and submit it to PMU
		Document learnings and sharing with PMU
4	Project Management Unit (PMU)	Issuing guidelines for fallow land reclamation
		Review the documents submitted by the DPMU
		Field visits and consultation with stakeholders
		Provide required technical inputs and guidance
		Periodic review of MIS / GIS and monitoring

3.1.2.2 Capacity Building through Farmer Field School:

Farmer Field School (FFS) is an informal education system conducted by the farmers on their own fields. Farmers were organized, trained, and facilitated to learn basic crop management (pest & nutrient management) skills and educate them to take right decision. It is a research based, season long, two-way interactive learning system between the farmers and the facilitator (extension staff / scientist). The participatory approach adopted to disseminate and fine tune the location specific production technology based on available resources with farmers in such a way that, adoption rate becomes high. Project proposes to promote Integrated Crop Management (ICM) practices through Farmer's Field Schools- cum-demonstrations approach which is a very effective means of transferring ICM / IPM / INM

technology to the farmers' field. Project proposes to conduct FFS on IPM and INM in need-based crops among the prioritized crops viz., rice, pulses, millets, and vegetables only.

Objective:

- To involve farmers and strengthen their role in research and extension;
- To increase farmer's knowledge and skills in improved crop management practices particularly INM and IPM practices;
- Improve adoption of technology / practices through demonstrations and learning sessions.

Approach & Strategy:

Farmer's Field School will provide opportunities for learning by doing. It is a season long programme which will be organized in farmer's field by meeting two to three times in a cropping It is season long so that it covers all the different developmental stages of the crop and their related management practices. Farmers themselves conduct a research study and compare the results with the adjacent neighbour control field. In each Farmer's Field School, around 15-20 farmers for 2-3 times depending upon the crop duration, during the entire cropping season, starting from land preparation to post harvest technology will get learning exposure. Women farmers would also be included in FFS. The unit office will execute the entire process with the support of technical institutions of the consortium.

Farmers will be trained on Integrated crop management practices from sowing to harvest by giving special emphasis on the Integrated Pest Management (pest and disease surveillance, their habit and habitat, nature of damage, time of occurrence, life cycle, control measure, including method and result demonstration of seed treatment & bio-control agents, adverse effects of injudicious pesticide use etc) and Integrated Nutrient Management (Soil sampling, soil testing-soil health cards, identifying soil related problems, soil test based nutrient recommendations, soil nutrients, fertilizers & manures, various bio-fertilizer usage, seed treatment/soil inoculation with biofertilizers, calculating nutrient requirement/dose, identifying nutrient deficiency based on symptoms produced and corrective measures etc.).

Selection of Village:

- Before selecting the village, situation analysis of the village would be carried out to assess area under cultivation of selected crop, no. of farmers cultivating, pest problems and pesticide usage in previous crops, soil problems and fertilizers usage in previous crop, status of irrigation facilities, social and economic status of the farmers, women farmer population, assessing approachability etc. to enable village selection;
- Easy approachable village, assured season long irrigation facility would be preferred;
- Villages having maximum pest problems and high pesticide/fertilizer to be preferred;
- Village should have good acreage of the area under selected crop. At-least 30-50 farmers in the village / cluster should be interested to grow the crop chosen;
- Willingness of farmers associated with FIG / FPO to take up demonstrations.

Selection of Farmers for Demonstration:

- Farmers who are willing to provide critical resources (land / water / labour / any other input not supported by the project);
- She / he should be a progressive farmer and member of the concerned FPO/FIG;
- The list of farmers would cover socio-economically backward / SC / ST / small & marginal farmers / women farmers of the watershed cluster under demonstration;
- Farmers cultivating other's land on share cropping or on leased-in basis are also eligible;
- The identified plot for demonstration should be easily approachable.

Key Guiding Principles:

1. The FFS will be conducted for specified crop among the prioritized crops in the watershed cluster. As the FFS is crop specific, depending on the demand and farmers interest, there may be more than one FFS in a project cluster / village;
2. In each of the project cluster, FFS will be conducted on 4 most potential crops among the prioritized crop list at its maximum and conducted for 3 subsequent years in different locations;
3. Crop specific and location specific, climate resilient crop management practices (seed, cropping system, agronomic practices, INM and IPM practices etc.) will be demonstrated in the farmers' field. Other field adjacent to demonstration field will be taken as control field for comparison of results. The crop and variety / technology selected for demonstration should be based on the need and preference of the farmers;
4. Crop wise technologies to be demonstrated will be packaged by the DPMU, with the support of PMU and technical partners, with the involvement of unit office personnel;
5. Entire cost of running FFS that included both demonstration cost and training classes will be borne by the project. Farmers have to contribute land, water, labour and day to day supervision;
6. Demonstration will be carried out preferably in area with assured irrigation facility;
7. In cases, where demonstrations are carried out, it will not restrict any farmer from other villages / non-project area to learn from demonstration. All farmers, including farmers from the nearby villages, irrespective of holding size, should be allowed to participate in the farmer's field day by which they would be benefited by visiting the demonstration plots;
8. The demonstrations may be conducted in cluster approach of at least 0.1-0.5 ha as per the availability of land. The size of control plot in adjacent area within the same farmers or neighbour farmer should be of same size as that of demonstration plot;
9. Prior to demonstration, situation analysis should be conducted to assess the existing level of adoption of different technologies and crop productivity;
10. All the important farm operations should be carried out by the demonstrating farmers under the close supervision of officials of the project (unit office level);
11. A display board mentioning about the key details of the variety / technology demonstrated should be erected at the demonstrated plot;
12. Farmers will be taken to the demonstration site to assess the crop growth, pest incidence etc. and discuss the same to arrive at a decision to tackle the problems;
13. At maturity, just before harvesting, "Field Day" may be organized where farmers from neighbouring villages and extension workers are invited. A farmer-scientist interaction session would be organized on the event. On the field day, crop yield in

1m^2 plot to be done in front of farmers, covering both demonstration and control plot/s.

Role and Responsibilities:

Table 39: Role & Responsibilities; FFS

SN	Implementing and Support Entities	Role and Responsibility
1	WWMC / FIG / FPO	1. Consultation with farmers on FFS and its benefit details; 2. Selection of beneficiaries as per the set criteria (accessibility, land holding, irrigation provision etc.) in consultation with unit office; 3. Preparing a list of selected farmers and submission of list to unit office; 4. Encouraging other farmers to visit the FFS and learn about application of practices / technologies.
2	Field Implementation Unit	1. Review the list of farmers prepared and submitted by the WWMC / FIG / FPO; 2. Consultation with the WWMC / FIG / FPO and selected farmers on FFS, implementation mechanism etc. 3. Orientation to the selected farmers; 4. Prepare detail plan for technology and input support at different stages of crop growth; 5. Providing input and technical support as per the plan; 6. Periodic visit to the field by technical staff and guiding the farmers; 7. Facilitate in organizing "field day" and orienting farmers on practices / interventions taken up; 8. Documentation of learning and its dissemination.
3	District Project Management Unit (DPMU)	1. Periodic monitoring to the FFS sites; 2. Discussion with the farmer involved in demonstration / FFS; 3. Assess the package of practices adopted and its benefits; 4. Preparation of monitoring report and its sharing with PMU.
4	Project Management Unit (PMU)	1. Periodic monitoring of the demonstration sites; 2. Consultation with farmers and officials of DPMU / unit office; 3. Assess the benefit of the FFS by consulting the beneficiary and other farmers; 4. Document the learning lessons and dissemination.

3.1.2.3 Multiplication of Climate Resilience Crop Varieties (Seed Production):

Adaptation and mitigation strategies including use of climate resilient crops and varieties for different regions are most essential for agriculture to successfully cope with climate variability (NICRA, 2019). Improved agricultural practices have the potential to enhance climate change adaptation (Venkateswarlu et al., 2011; Aggarwal et. al., 2018). Natural resource management practices for adverse climatic conditions aid in enhancing resilience under variable climate and extreme events. In this process of developing and promoting crop varieties with tolerance to abiotic stresses like drought, heat, submergence for the target areas is of great significance. Availability of climate resilient seed varieties along with required quantity and quality need to be available to the farmers for sustaining the production system. Farmers require varieties that produce a satisfactory yield when subjected to stress conditions but also have a high productivity potential under favourable

conditions. Different climate resilient crop varieties suggested for the State under different crop categories are as below (NICRA).

Table 40: Suitable Crop Varieties for Uttarakhand

Crop	Varieties	Source of Seed Availability
Rice	Pant Dhan 16, Barani, Dhan-1, Aditya, Kalinga-3	GBPUA&T, Pantnagar; IGKV, Jabalpur
	Vivek Dhan-154	BAU, Sabour
	DRR Dhan 44 (IET 22081)	IIRR, Hyderabad
	VNR-2111 PLUS (IET 24075) (VNR 212)	VNR Seeds Pvt. Ltd., Raipur
	VL Dhan 39, 206,16, 163	ICAR-VPKAS, Almora
Wheat	UP1109, UP2572	GBPUA&T, Pantnagar
	WH 1142	CCSHAU, Hisar
	VL Gehun 401,404,421, 616,719	ICAR-VPKAS, Almora
KODO Millet	PRM-1	Hill Campus, GBPUA&T, College of Forestry, Ranichauri - VARSHA
Barley	VL Barley 56	ICAR-VPKAS, Almora
	VL Barley 85	ICAR-VPKAS, Almora
	VL Jau 118	ICAR-VPKAS, Almora
Maize	Vivek Hybrid 9 (FH 3077)	ICAR-VPKAS, Almora
	Vivek Hybrid 5	ICAR-VPKAS, Almora
	VL Makka 42	ICAR-VPKAS, Almora
Finger Millet	VL Mandua 315, 324, 347	ICAR-VPKAS, Almora
Barnyard Millet	VL Madira 8, 29, 21	ICAR-VPKAS, Almora
Buckwheat	VL Ugal 7	ICAR-VPKAS, Almora
Amaranthus	VL Chua 44, VL Chua 110	ICAR-VPKAS, Almora
Lentil	VL Masoor 126, VL Masoor 129	
Horse gram	VL Gahat 8	ICAR-VPKAS, Almora
	VL Gahat 10	ICAR-VPKAS, Almora
Onion	VL Piaz 67	ICAR-VPKAS, Almora
	VL Piaz 3	ICAR-VPKAS, Almora
Short duration Crop Varieties		
Rice	DRR Dhan 44 (IET 22081)	IIRR, Hyderabad
	VNR-2111 PLUS (IET 24075) (VNR 212)	VNR Seeds Pvt. Ltd., Raipur
Chickpea	JG11	JNKVV, Jabalpur
Crop Varieties Suitable for Cultivation under Delayed Monsoon		
Rice	Govind	GBPUA&T, Pantnagar
	PR 113	PAU, Ludhiana
Rice bean	UP C 9202	GBPUA&T, Pantnagar
	UPC 628	GBPUA&T, Pantnagar
Crop Varieties Suitable for Cultivation under Heat Stress		
Wheat	WH 1124	CCSHAU, Hisar
	DBW 173	ICAR-IIWBR, Karnal, Haryana
Chickpea	Pant G 186	GBPUA&T, Pantnagar
Brassica (Rapeseed & Mustard)	Pant Rai 19, Pant Rai 20	GBPUA&T, Pantnagar
Cold Stress		
Rice	Pant Dhan 11	Pantnagar
Barley	BHS352	IARI, Shimla
Chickpea	PDG 4	GBPUA&T, Pantnagar
Crop Varieties Suitable for Cultivation under Flooding or Submergence		
Wheat	UP 2338, UP 2425, UP 2526, UP 2565	GBPUA&T, Pantnagar
Maize	Pragati	GBPUA&T, Pantnagar

Sugarcane	Co 8371, Co TI 88322, Co 99006, Co 0124, Co 0237 and Co 0239	SBI, Coimbatore
	CoLK 09204 (Ikshu-3)	IISR, Lucknow

Strategies for Ensuring Access to Resilient Crop Varieties:

The changing climate is a major obstacle in sustaining agricultural productivity especially for small and marginal farmers. Ensuring the supply of quality seeds of climate resilient crop varieties along with adoption of suitable technologies is essential to make agriculture more sustainable in a climate change situation. Rainfed agriculture, which is more Marginalised to climate variability, needs a robust decentralized seed system that can provide quality seed of diverse crops and varieties at affordable prices at right time to improve productivity. This will aid in buffering contingencies of climate risks such as repeat sowing in case of crop failure. There is also a need to ensure conservation of the local agrobiodiversity which has inbuilt tolerance to various stresses.

In case of early season stress, the loss of standing crop at initial growth stages could be compensated by re-sowing immediately. However, there may not be sufficient seed left with the farmer for re-sowing. Moreover, it would be difficult for the public and private seed sectors to meet the demand of seeds to farmers specially those residing farther from seed source. To overcome such a situation, development of community seed banks may be useful as a contingency measure to meet local seed demand. It is necessary to ensure quality of farm saved seeds for enhancing crop productivity. The need to replenish diversity in agricultural systems will encourage farming communities to build up community seed banks. This facilitates the revival and distribution of traditional and stress-tolerant crops and varieties. Various aspects of seed production, seed distribution and storage conditions to be improved and strengthened at the farmers' level under a community-based seed system by making a cluster of villages or block as a seed village to cater the quality seed requirement of specified area.

The project intends to promote climate resilient seed variety in village / village clusters. Therefore, required quantities of quality seeds of climate resilient crop varieties need to be made available to farmers for sustaining the production system and meeting the increasing demand for food grains. Further, climate variability may be a major setback in coming days to sustaining agricultural productivity, especially to small and marginal farming communities, where loss of a single crop can lead to food scarcity at the household level. The loss of a standing crop due to the impact of adverse climatic conditions at the initial stage could be compensated by re-sowing immediately, provided seed is available with the farmer. To support farmers in providing climate resilient crop varieties, the project will introduce seed production under the "seed village" concept.

The project strategy involves building the capacity of farmers for seed production in their own village on the seed village concept, and certified seed thus produced will be procured by state seed corporation or directly by farmers. The seed thus procured by seed corporation will be cleaned, further processed, tested, and supplied to the same farmers in the same seed village at a subsidized price. This will ensure timely availability of the required quantity of quality seeds at a low price. The entire cost of seed production will be borne by the project.

Objectives of Seed Production:

- To promote production and distribution of quality seeds, that are climate resilient, for better adaptation, improving production and productivity;
- To arrange local supply of quality seeds of climate resilient crop varieties.

The following seed production programmes will be taken-up under the project.

i. Production of climate resilient seed varieties recommended by the technical institutions / consortium partner;
ii. Crops, tentatively selected for seed production are paddy, millets, and pulses;
iii. Multiplication of seeds (certified seeds) in seed village program;
iv. Certification of seed by Community Managed Seeds Systems (CMSS).

Project Approach and Guiding Principles:

- Selected farmers and FIGs / FPOs, based on their expressed interest, will be supported for seed production;
- All the farmers who have been covered under varietal replacement and seed replacement will be facilitated for enrolment under crop insurance through convergence with existing government schemes;
- Seed production activity for major crops will be taken up in a participatory mode. Major crops tentatively selected for seed production are paddy, pulses, and millets. The selection of a particular crops and crop varieties for seed production will be done in consultation with scientists from consortium partners;
- The foundation and certified seed production will be undertaken through the cluster area approach in assured irrigation supply blocks;
- The seed thus produced will be supplied to all categories of farmers at a subsidized rate;
- The project will assist in establishing high-yielding fruit nurseries.

Training & Capacity Building of Farmers:

Training will be given on seed production and seed technology to the identified farmers for the seed crops grown in the seed villages for technological empowerment of farmers. Total duration of the training will be of 3 days for each batch of 25 participants.

Training Topics
Sowing practices, seed treatment, and other agronomic practices.
Maintenance of seed plots, plant protection measures, maturity status and harvesting methods.
Seed cleaning, grading, seed treating, bagging and storage aspects, seed sampling and sending to seed testing laboratory for analysis.

3.1.2.4 Promotion of Poly Tunnel:

Polytunnels, like polyhouses, are naturally ventilated protected structures. The tubular structures purposely constructed for developing planting materials, farming vegetables, flowers, and other selected crops. Polytunnels are largely constructed in hilly and temperate regions mainly to control the temperature. The project will support selected farmers for erecting low tunnels and poly tunnels on demonstration basis for learning and wider adoption.

***Low tunnels**: These protected structures are less than 1 m in height, constructed with conventional polyethylene or polyvinyl chloride or ethylene-vinyl acetate. Management strategies and/or cultural practices (if required) are done from outside. These structures are suitable for low-height crops.*

***High tunnels**: Unlike low tunnels, these structures provide a walk-in facility to the growers and cultural practices can be done easily inside the tunnel. These tunnels are suitable for moderate-height or even tall crops.*

The tunnel/s will help farmers to take up high value and/or offseason vegetables like tomato, capsicum, cucumber, beans, leafy vegetables; flowers; fruits like strawberry, herbs, etc. It will support the producers to have higher income than the conventional farming. This initiative under the scope of the project will not only enhance the income of the farmers, but also improve resilience to agricultural production system. It will increase crop yield, extend the growing season, protect the crops from pest and disease, and reduce water footprint.

As the project intends to demonstrate the benefits of poly tunnel base farming for wider adoption, it is essential to select farmers that have required patch of land for installing tunnels, willingness for operation and maintenance of the tunnels, interest for adopting package of practices that are rendered for different crops, and over and above support other farmers to visit to the site for learning. Apart from project investment in the poly tunnel structure, the farmers will be trained on its operation and maintenance, tunnel-based cropping system, package of practices to be followed etc.

3.1.2.5 Farm Mechanization:

Timely access to farm machinery from sowing to harvesting is an important component of adaptation strategy to deal with climatic variability and scarce agricultural labour force. The sowing window in rain-fed areas most of the time is very short and at the same time small farmers' access to farm machinery is poor. As a result, many farmers are not able to sow the crop on time, hence they incur significant yield losses. Lack of access to improved implements and farmers' inability to procure improved implements are some of the reasons for non-adoption of improved agronomic practices or technology that involve mechanization. Therefore, the project plans to provide improved implements through "Custom Hiring Centre". The custom hiring centers/s will be established at project cluster level and/or at the proposed growth center level, based on feasibility. The WWMC or the local FIG / FPO will manage the center and provide farm implements on hiring basis to the aspirants.

Advantages of Custom Hiring Centres

- Providing access to small and marginal farmers to farm machineries;
- Facilitates timeliness in farm operations and efficient use of inputs;
- Promotes adoption of climate resilient practices and technologies by farmers because of availability of appropriate machines at reasonable hiring charges;
- Facilitates crop residue recycling and prevents burning of residues;
- Reduction in cost of cultivation;

Objective of Custom Hiring Centre (CHC):

The overall objective of establishing custom hiring center at the village / village clusters, covering project villages, is to improve the farm mechanization rate by making available farm equipment at the local level for enhanced farm production and productivity. Specific objectives of promoting CHCs are;

1. Improving area under farm mechanization and reducing manual labour dependency;
2. Improve efficiency in terms of output per unit of time invested in farmyards; and
3. Drudgery reduction of farmers in general, and women farmers in particular.

Approach and Strategy:

Under this activity, the project will establish CHCs and support for procuring farm implements by which small and marginal farmers can avail of these benefits by paying nominal hiring charges. It will enable small and marginal farmers to take up farm operations on time. The CHCs will meet the agricultural operations from sowing to harvest. Such CHCs will be established on cluster approach to cover approximately 100 ha.

Machinery and implements will be supported as per the need of the local farmers. The machineries may include seed drills, multi crop planters, power weeders, threshers, power tillers, sprayers, solar pump sets, line marker and other need-based small farm implements. The project will also support in procuring crop specific (paddy crop) relevant machinery such as drum seeders, seed drills, transplanters, combined harvesters, etc. These are some of the important farm implements and machines which will be available at the custom hiring center. However, before the procurement of machineries, there will be consultation with the local WWMC / FIG on their requirement and area specific demand for different machineries.

A committee of farmers will be nominated by the WWMC / FIG / FPO to manage the custom hiring center. Based on the feasibility and considering the capacity of the WWMC / FIG / FPO, CHC management may be delegated to them. It will help these local institutions to generate revenues and manage / maintain the CHCs smoothly. The rates for hiring the machines / implements are to be decided by the concerned WWMC / FIG / FPO. Every farmer in the village / cluster can hire the machines from these centers on a 'first come first serve' basis. The modalities of utilizing custom hiring center will be decided by the committee members themselves and amended from time to time as per the local situation and needs. The organization / institution having the CHC management responsibility will use the revenue generated from hiring for repair and maintenance of machinery and implements.

Key Guiding Principles:

1. Custom hiring centers will be established in appropriate growth centers and/or in the selected village village clusters within the project area only;
2. Priority will be given to the villages having low farm power availability and large area under small and marginal holdings;
3. Each custom hiring center will have small crop-specific machinery suitable for local requirement for mechanized farming under small and marginal holdings;
4. The following parameters may be chosen for selection of village for setting up of custom hiring centers (in case of cluster mode):
    a. Low ratio of farm power availability;
    b. Low number of tractor population;
    c. Small & marginal operational holdings;
    d. Less productivity of food grains but potential to enhance productivity.
5. Unit office will identify/invite applications from WWMC / FIG / FPOs to set up CHCs;
6. Available government land / GP land, without any encroachment / legal litigation will be utilized for setting-up of CHC infrastructure. In case of establishment of CHC in growth centers, identified and feasible growth centers, having required

infrastructure will be used for CHC establishment. There would not be any private land acquisition for CHC infrastructure construction;

7. The concerned WWMC / FIG / FPO may also provide land for establishing CHC, if they have land in their name which is free from any litigation;
8. The CHCs shall have farm machineries that are women farmer / women agricultural workforce friendly.

Role and Responsibilities:

Table 41: Role and Responsibility, Farm Mechanization

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC / FIG / FPO	1. Selection of area for establishment of CHC along with officials of unit office; 2. Applying to unit officer for the establishment of CHC; 3. Submission of required documents, including land records for CHC establishment; 4. Discussing / suggesting unit officer on priority list of machineries / equipment; 5. Prepare a business plan / revenue model that is implementable; 6. Taking steps for credit linkage with financial institutions (if credit is required after project support); 7. Construction of sheds / CHC unit; 8. Finalizing the hiring cost of different machineries in consultation with Field Implementation Unit; 9. Scheduling requirement of farmers (farm machinery based) and renting out machineries; 10. Collection of rental charges from the farmers and depositing in bank account; 11. Timely maintenance of the assets / machineries from the generated revenue; 12. Reporting the performance of the CHC to unit office.
2	Field Implementation Unit	1. Assessment of current farm mechanization status in the project area; 2. Discussion with WWMC / FIG / FPO on establishment of CHC; 3. Capacity and feasibility assessment of WWMC / FIG / FPO for project support; 4. Finalization of area for establishment of CHC as per the assessment; 5. Review & verification of land record before establishing CHC; 6. Submission of all plan proposals to DPMU for review and approval 7. Handing over farm machineries / equipment to the concerned WWMC / FIG / FPO; 8. Facilitate in preparing business plan; 9. Orientation to WWMC / FIG / FPO on operation, management, and maintenance of the CHC; 10. Documentation of learning lessons.
3	District Project Management Unit (DPMU)	1. Review the proposals submitted by the unit offices; 2. Examine feasibility of he proposed units on sample basis; 3. Procurement of farm machineries / equipment and handing over to unit office; 4. Developing standard operating procedures for the CHCs; 5. Periodic monitoring and review the revenue generation and financial management;

4	Project Management Unit (PMU)	1. Support DPMU in procurement of certified farm machineries as per the Govt. guidelines; 2. Review the physical and financial progress of the activity; 3. Periodic monitoring and discussion with the farmer / WWMC / FIG / FPO on benefits of CHC; 4. Assessment of area increment under farm mechanization during Kharif / Rabi, reduction in cost of cultivation, reduction of drudgery, reduction in manual labour dependency etc.; 5. Assessment of accessibility of farm machineries by women farmers, tribal farmers, marginal and small farmers; 6. Documentation and dissemination of learned lessons;

3.1.2.6 Vermicompost:

Vermicompost has been proved to be one of the environmentally suitable waste management methods, and having edge over conventional disposal strategies such as burning, landfill etc. to convert waste into value added products. The quality of the manure depends on the quality of the waste material. Almost all types of biologically degradable and decomposable organic waste such as animal dung, agricultural waste, kitchen waste, waste from mushroom cultivation etc. are utilized in vermicomposting. In the way of promoting organic farming, reduce cost of cultivation, minimize nitrogen emission / GHG emission from agriculture field; project will support the producers to establish vermicompost pits.

Objectives:

- To convert organic waste into useful manure for soil application;
- To discourage the crop residue burning process as a means of organic waste management;
- To enrich the soils and improve the soil health with compost application;
- To reduce the cost of fertilizer application and support in INM / IPNM.

Benefits of Vermicomposting:

- Vermicomposting is compatible with sound environmental principles that value conservation of resources and sustainable practices;
- Vermicomposting is faster, produces fewer odours and produces a superior product;
- Huge quantities of farm organic waste can be handled easily;
- Soil gets all the essential nutrients;
- Increases microorganism population in the soil;
- Contains plant useful hormones and antibiotics;
- Plants can resist pest attack to a higher degree;
- It increases rate of germination, plant growth and crop yield;
- Support in improving fruit quality;
- Compost when applied to soil increases soil's water holding capacity;
- Improves soil aeration.

Beneficiary Selection:

1. Farmers / beneficiaries within the project area including their association/s are to be selected as per the existing government selection norms /criteria;
2. Preference will be given to farmers of small and marginal households;
3. Willingness of the farmer to operate and manage the pit;
4. Farmer willing to adopt organic farming with reduction in use of synthetic inputs;

5. The beneficiary should be able to provide required raw material for vermicomposting;

Role and Responsibilities:

Community Organizations (WWMC / FIG / FPO):

1. Community consultation and identification of beneficiary farmers;
2. Selection and finalization of interested farmers for vermicompost;
3. Prepare a detail list of farmers and its submission to unit office;
4. Monitor the activities periodically;
5. Facilitate organizing meetings, training, orientation with unit office;
6. Appraising unit office from time to time on progress and coverage.

Field Implementation Unit:

1. Review of beneficiary list and detail proposition of WWMC / FIG / FPO;
2. Assessing the feasibility and consult with the proposed beneficiaries;
3. Finalizing list of farmers for project support;
4. Extending financial and technical support to selected farmers;
5. Orientation / training of farmers on vermicomposting and its field application;
6. Assessment of use of vermicompost and farmers involved in producing vermicompost;
7. Periodic visit to the vermicompost units, consultation with farmers and assessing the benefits;
8. Preparing learning documents, including case studies;
9. Submission of progress / output report to PMU periodically.

DPMU:

1. Review of documents submitted by field implementation units;
2. Periodic monitoring of vermicompost units and physical observation of its utilization;
3. Discussion with the beneficiary farmers involved in the activity;
4. Assess the benefits harvested by the beneficiary through vermicompost;
5. Preparing monitoring report and its sharing in PMU;
6. Assessment of current production and use of vermicompost;
7. Support unit office in preparing detail plan for project support;
8. Support unit office in training / orientation to the beneficiaries on vermicomposting;
9. Providing guidance / technical support as per the plan;
10. Periodic visit to the field by technical staff, guiding the farmers and assessing progress;
11. Preparing and submitting monitoring report to PMU on periodic basis.

PMU:

1. Preparing guidelines for implementation of the activity
2. Consultation with DPMU and unit office on progress of the activities and review of records;
3. Periodic monitoring, including field visit and consultation with beneficiary farmers;
4. Assess the environmental and economic benefit of the activity and reduction in cost of inputs;
5. Providing required guidance to DPMU and unit office;
6. Document the learning lessons and dissemination.

3.1.2.7 Organic Farming and Certification:

Excessive use of chemical fertilizers and pesticides as a mean of intensive cultivation to boost up food production causes considerable damages to soil health and the environment. Organic products are grown under a system without the use of synthetic (also referred as chemical) fertilizer and pesticide with an environmentally and socially responsible approach. This is a method of farming that preserves the reproductive and regenerative capacity of the soil, good plant nutrition, and sound soil management, and produces nutritious food. Uttarakhand is bestowed with potential to produce all varieties of organic products due to its agroclimatic conditions. In different parts of the State, the inherited tradition of organic farming / minimal use of synthetic fertilizer & pesticides is an added advantage. This creates an opportunity for the organic producers to tap the market which is growing steadily in the domestic and international arena.

Organic farming is a production system which avoids or largely excludes the use of synthetic fertiliser and pesticides. This system entirely relies on crop rotation, crop residues, animal manures, legumes, green manures, off-farm organic wastes, biofertilizers, mechanical cultivation etc. and aspects of biological pest control to maintain soil productivity and tilth to supply nutrients and to control insects, weeds, and other pests. Looking at the environmental benefits organic farming (which is also referred as biological farming / regenerative farming / sustainable farming / ecofriendly farming etc.), along with its cost effectiveness and premium price of the produce; the project will extend support to farmers and their collectives for demonstration and adoption of organic farming. Some selected progressive farmers and their collectives will be supported for demonstration.

Essential Features

- Use of organic manures like FYM, compost, vermicompost etc.;
- Use of biofertilizers;
- Use of green manures and grain legumes.
- Non-chemical weed management.
- Use of bio control agents in the control of crop pests.

As the project intends to promote environment friendly production system, organic farming will be a part of overall agricultural / horticultural intervention. The interested farmers / farmer associations (FIGs / FPOs) will be supported for organic farming in terms of inputs, technical knowhow, demonstrations, capacity building and in-situ guidance and hand holding. All the interested farmers will be orientated on organic farming system and procedures, key requirements of organic farming, package of practices to be followed / adopted for organic farming, and organic certification process.

There is an exponentially growing global demand for organic produce. This will fetch high profits for farmers who undertake organic farming practices. Organic certification serves as an object of assurance for consumers who prefer chemical-free produce. Looking at the profitability and from environmental perspective, the project intends to promote organic farming and its certification access the project districts, based on its feasibility and interest of the farmers and their associations.

The APEDA, Ministry of Commerce & Industries, Government of India is implementing the National Program for Organic Production (NPOP). The program involves the accreditation of Certification Bodies, standards for organic production, promotion of organic farming and marketing. In India, these standards or requirements are set forth mainly by two agencies, i.e., [1] NPOP: National Program for Organic Production; and [2] PGS-India: Participatory Guarantee System of India. These agencies construct the standards that each applicant for organic certification must abide by to be conferred with the certification. The NPOP is a central government

body that regulates the certification process and other aspects of organic farming. In contrast, the PGS (Participatory Guarantee System) is a "guarantee system" that ensures the participation of stakeholders in the certification process.

The project will facilitate organic certification following defined steps, such as selection of certifying agency, application and documentation, inspection and evaluation, compliance and correction, decision for certification, and annual review and renewal. The project will support the interested farmers / farmer's association in educating them on the organic certification process and key requirements. Special awareness drive / consultation meetings will be organized with the farmers / FIGs / FPOs to mobilize them for organic production and certification.

Registration for organic certification can be done by [1] Individual Farmer: a farmer who is the legal owner of a particular piece of land, can apply for the organic certification; [2] Group of Farmers: an association of farmers, two or more farmers can apply as per the prescribed guidelines; and [3] Corporate bodies: it mainly refers to the association of farmers who come together to register as a corporate body. They can produce, process, and sell organic produce having an office setup to monitor the activities.

Key Certification Requirements:

- ***Conversion**: The land that was used for conventional agricultural practices must undergo a conversion to organic practices. This includes the prohibition of synthetic chemicals and Genetically Modified Organisms (GMOs).*
- ***Land**: The land should be free from any kind of restricted substances and should maintain buffer zones to prevent contamination from non-organic sources.*
- ***Agricultural inputs**: Organic seeds, organic fertilizers, and organic plant protection substances should be used on the farm. The use of GMOs or any chemical fertilizer or pesticide will compromise the certification.*
- ***Farm records**: Records / documents of all the activities occurring on the farm like seeds used, fertilizers used, irrigation time, etc.*
- ***Management plan**: Farmers should maintain a management plan outlining all the activities that are to be done on the organic farm. It serves as the blueprint of all activities on the farm.*
- ***Labelling**: After successful completion of the certification process, the certified farmers can use the Indian Organic logo on their products. However, the use of this logo in labelling and packaging should comply with the NPOP standards of packaging and labelling.*
- ***Post-Certification**: the certified organic producers must continue to abide by the rules and regulations of NPOP to maintain their certification. They must undergo periodic inspections of their land to update their status. In case of any misconduct, the certification will be suspended or revoked.*

To facilitate organic certification process, the project will engage a Technical Agency (TA) who will support in organic certification process. The agency is expected to be well versed with the prescribed standards and steps of certification. The agency will be responsible for selection of certifying agency (in consultation with the PMU-UCRRFP), documentation and application submission for organic certification, facilitate inspection and evaluation with the support of FIG / FPO and PMU / DPMU, address compliances required from time to time and guide the FIG / FPO in annual review and renewal of certificate.

3.1.3 Climate Resilient Horticulture Production System:

The project will invest in strengthening horticulture production system in the project villages / clusters along with agriculture production system. A range of activities will be taken up for improving resilience which includes demonstrations of package of practices for different horticultural crops, rendering adoption support, establishing nursery for fruit crops, orchard development, promotion of protected cultivation etc.

Table 42: Interventions under Climate Resilient Horticulture Production System

Particulars	Activities
Conversion of hitherto agricultural fallows for horticulture purposes	Development of fallow land cluster of FIGs for horticulture purposes
	Fencing of the cluster land parcel
	Terrace development
	Irrigation facility for the cluster land parcel
	Support for climate resilient package of practices (two years)
Support for setting up of high yielding fruit nurseries	Support for setting up of high yielding fruit nurseries
Demonstration of High Yielding vegetable Crops through farmer field school (FFS)	Demonstration of Vegetable crops and Climate Resilient PoP at Cluster level
	Demonstration of floriculture crops and Climate Resilient PoP at Cluster level
	Demonstration of spices crops and Climate Resilient PoP at Cluster level
	Demonstration of medicinal and aromatic crops/plants and Climate Resilient PoP at cluster level
Demonstration of Climate Resilient Package of Practices (PoP) in Horticulture through (FFS)	Setting up of Fruit Orchards
	Setting up of High-Density Fruit Orchard
Adoption Support to FIGs and FFs for high yielding Vegetables crops and climate resilient PoP	Adoption Support for Vegetable crops and Climate Resilient PoP
	Adoption Support for Floriculture crops and Climate Resilient PoP
	Adoption Support for Spices crops and Climate Resilient PoP
	Adoption Support for Medicinal and Aromatic crops and Climate Resilient PoP
Adoption Support to FIGs/Farmers for setting up of Horticulture fruit orchards	Adoption Support to FIGs/ farmers for setting up of Horticulture fruit orchards
	Setting up of High-Density Fruit Orchard
Support for other horticulture interventions- Bee Keeping, Sericulture, Mushroom etc.	Support for Bee Keeping
	Support for Sericulture
	Support for Mushroom cultivation
Demonstration support for Precision agriculture interventions	Demonstration Support for setting up of Hitech Protected Cultivation
	Demonstration Support for setting up Poly Houses

Adoption support for Precision agriculture interventions	Adoption Support for setting up of Hitech Protected Cultivation
	Adoption Support for setting up Poly House Clusters

3.1.3.1 Development of Fallow Land through Horticulture:

As discussed, there has been abandoned agricultural fallow land which is having the potential to be developed for agricultural and horticultural purposes. Apart from use of land of this category for agricultural purposes, horticultural activities will also be taken up to make such land productive again. Required land development will be taken up in the fallow land along with fencing, terrace development, creation of irrigation facility for horticultural crops etc. Horticultural intervention in fallow land will be taken up involving FIG / FPO who express their interest to watch and ward and managing it. The project will extend required land development and input support for specific period and after that the concerned FIG / FPO will manage it and use the benefit for growth of the organization and its member. The fruit nurseries to be promoted under the project will be supportive in providing good quality planting materials for development of orchard in such land. The agribusiness promotion initiatives, including growth center/s will be linked to the horticulture production system through digital platform so that it becomes easier for the FIGs / FPOs to venture into new market opportunities.

3.1.3.2 Demonstration of Horticultural Crops through FFS:

The project will demonstrate climate resilient practices not only for agricultural crops, but also for horticultural crops. Demonstrations will be taken up through FFS (FFS model as per the current practice by the Govt. and technical inputs of consortium partners), involving individual farmers / FIGs / FPOs. Demonstrations will cover high yielding vegetable crops, floriculture, spice crops and medicinal & aromatic plants. The demonstrations will be helpful for the local producers to learn and adopt. The project will also support interested farmers for adoption of such horticultural crops and related climate resilient package of practices. The responsibility of managing the farm, providing labour and watch and ward of the crops lies with the concerned interested farmers / FIGs / FPOs. Like agriculture production system, horticulture production system will be linked to growth centers and agribusiness initiatives through digital platform.

3.1.3.3 Development of Fruit Nurseries:

Availability of quality planting material is crucial for success of commercial horticulture. This necessitates having a network of horticultural nurseries which conform to Model Nursery Standards in terms of infrastructure, quality of seed and planting materials and adoption of nursery management practices. Looking at the emerging need for fruit crops, it is realized that fruit nurseries should be promoted under the project to meet the demand. Secondly, as the project intends to reclaim abandoned fallow land, improve income of the farmers through crop diversification and promote fruit orchards; nurseries will help in supplying quality planting materials to the farmers on timely basis and as per the required quantity. Establishing nurseries will minimize external dependency (including dependency on other States), reduce the cost of procurement, and ensure availability of seedling / planting materials.

The fruit nurseries will be developed in association with existing or aspiring private entities who are interested in establishing nurseries. The project will select nursery developers and extend its support financially and technically for production of quality planting materials. The supported nursery owner will give priority to the project and its beneficiaries in supplying quality seedlings / planting materials with a rate / unit cost as fixed mutually by the project authority and the nursery owner. As the project will invest in fruit nursery

development, it is expected that the beneficiary farmers will avail seedlings / planting materials in lesser cost than the actual market price. The project will ensure that Uttarakhand Fruit Nurseries (Regulation) Rules, 2021, is adhered to in the process.

3.1.3.4 Support for Fruit Orchard:

The project will support individual farmers / FIGs / FPOs in establishing fruit orchard / high density fruit orchard in project area. The fruit nursery to be promoted / supported under the project will be linked to these orchards in terms of supplying quality planning materials. The project will support selected farmers / FIGs / FPOs on demonstration basis for development of orchard. Apart from financial support, the project will also render technical support, including selection of proper location and site, planting system, and planting distance, choosing the varieties, and providing in-situ guidance to ensure maximum production. Orchard can be promoted in abandoned agricultural fallow land or in a patch of land that is suitable for orchard develop and farmer / FIG / FPO express their willingness. If required facilities are not available in the identified location, like irrigation, fence around the site etc. project will invest in creating such facilities with the support of concerned beneficiary. Before selection of site for establishing a new orchard, certain aspects would be examined, like [1] suitability of soil, its fertility, the nature of sub-soil and soil depth; [2] proper drainage system in the site (no water stagnation during rainy season); [3] source of irrigation; [4] transportation facility in the nearby area; [5] suitability of climatic condition for growing fruit orchards.

Preliminary operations: After selecting the suitable location and site, preliminary operations will be taken up like clearing tree stumps, shrubs and other weedy growth, deep ploughing and removing big roots, manuring, terracing depending upon the topography of the land, land levelling within the terraces etc.

Lay out of Orchard: Layout plan will be prepared aiming at providing maximum number of trees per hectare, adequate space for proper development of the trees and ensuring convenience in orchard cultural practices. The system of layout can be [1] vertical row planting pattern and [2] alternate row planting pattern.

High Density Planting System: High Density Planting (HDP) of fruit trees, i.e., planting at a closer spacing with the sole objective of obtaining maximum productivity per unit area without sacrificing quality, will also be taken up in suitable cases with specific fruit plants. High Density Planting will have certain advantages like [1] early cropping and higher yields for a long time, [2] reduced labour cost, and [3] improved fruit quality.

Planting Season: The season of planting may vary with different fruits depending upon the local conditions. Planting will be taken up either in monsoon (June - August), and/or in spring (February - March). Monsoon season is considered to be most suitable for planting fruit trees like citrus, mango, sapota and guava. If the trees are planted early in the rainy season, they soon establish themselves and grow vigorously. Required technical guidance for orchard development (planting method, plant spacing, orchard management etc.) will be rendered by the experts of the project to the beneficiaries.

Mixed Cropping: Based on the feasibility and technical specification, certain seasonal / perennial crops can be grown in the alley spaces of the main perennial crops. The main advantage is the effective utilization of available area and increase in the net income of the farm per unit area.

Intercropping: If the trees are properly spaced, there is considerable land which will not be used by the permanent trees for several years (in case of In new orchards). Similarly, in the case of some long duration horticultural crops like tapioca, turmeric, ginger and banana, some area between adjacent plants will be remaining unoccupied by the main crop for few months. It creates an opportunity for the grower to get additional return from this vacant land especially when the grower is getting no return in the early periods. The beneficiaries will be encouraged to grow economic crop/s in alley spaces of the fruit trees in the first few years or in the unoccupied spaces of the long duration crop in the early periods for higher return. Vegetables are normally considered most suitable inter crops. But whatever may be the intercrop grown, it would be kept well away from the main fruit trees and irrigated independently. The intercropping would be stopped when trees occupy the entire orchard space. Thereafter, green manuring or cover cropping may only be practiced.

Some important principles to be followed while growing intercrops are;

- Inter crops should not occupy the area where the roots of the fruit trees are concentrated.
- Soil fertility should be maintained or improved when intercrops are grown.
- Water requirements of the intercrops should not clash with those of the main fruit trees. The intercrop may require an irrigation at a time when it would be detrimental to the trees.
- Intercrops should be selected with reference to their effect on soil moisture. The intercrops selected should not exhaust the soil water and nutrients and should not demand more water than is allowed for fruit trees.

Table 43: Recommended Intercrops for some Important Horticultural Crops

Crop	Age	Intercrop
Mango	Up to 7 years	Leguminous vegetables, Papaya (filler)
Grapes	Up to 8 months	Snake gourd or bitter gourd in pandal
Apple, pears	Up to 5 years	Potato, Cabbage
Banana	Up to 4 months	Sunhemp, onion
Tapioca	Up to 3 months	Onion, beans, lab-lab, black gram
Turmeric	Up to 3 months	Small onion, coriander
Arecanut	Up to 10 years	Pineapple
Coconut	Up to 3 years	Banana, tapioca, vegetables
***Source*: TANU**		

3.1.3.5 Promotion of Protected Cultivation:

Protected cultivation practices can be defined as a cropping technique wherein the microclimate surrounding the plant body is controlled partially or fully as per the requirement of the crop grown during their period of growth. Looking at the increasing population, climate variability, decreasing land holdings, increasing pressure on natural resources, modern technologies of crop production like protected cultivation seems a necessity. Protected cultivation not only provides high water and nutrient use efficiency but also improves the quality, increases productivity and favourable market price to the growers. Protective cultivation enables the farmers to fetch a good income in off-seasons. Further, it is safe to raise vegetable nursery for off season vegetable production under protective cultivation, especially under adverse weather conditions. In this context, it is proposed to promote protected cultivation in a big way. Among the various protected cultivation techniques, it is proposed to promote poly houses / green houses and shade net cultivation techniques. The project will promote protected cultivation in the project clusters / villages.

Beneficiary Selection Criteria:

1. Farmers / beneficiaries are to be selected as per the existing government selection norms / criteria;
2. WWMC / FIG / FPO will identify such beneficiaries and project support will be routed;
3. The farmer should have provision for irrigation;
4. Project will give priority to progressive farmers in different holding categories, including women farmers;

Project Assistance:

The project will support the intervention as per the existing and approved norms. Other Govt. schemes of similar nature may also be referred.

Implementation Process:

1. This activity will be demand driven, based on the interest of the farmer and willingness to abide by the guidelines;
2. Project team in consultation with FIGS/FPOs/community and with the support of local CBOs, will identify the beneficiaries at the village level and the list of beneficiaries will be verified by the unit office before providing project assistance;
3. The identified beneficiaries will apply to the project, through WWMC, for assistance in the prescribed format, along with certified copies of all land-related documents;
4. Project assistance will be credited directly to the bank a/c of the beneficiary, based on the work progress, as assessed by WWMC, and verified by unit office;
5. The beneficiary can procure goods / items from the agencies empanelled with the department. The vendor can be paid directly by the project following the financial norms;
6. Required technical support for the installation of poly house / shed net will be provided by the concerned supply agency with the technical guidance of the unit office;
7. The assistance will be on a one-time basis;
8. Beneficiary availing the benefits will also have to pay his/her share;
9. If there is potential in a village and farmers / FIG / FPO are interested, project will support in establishment of polyhouse in the village and developing it into a hub with a cluster of polyhouses for exotic variety of crops;
10. Scaling up of already existing polyhouse can also be taken up;
11. Capacity building for the project supported beneficiaries on operation and management of protected cultivation structures, feasible crops to be grown, adoption of technologies in protected cultivation, developing nurseries, etc.;
12. Maintenance of the structure will be the responsibility of the farmer / beneficiary.

Role and Responsibilities:

Table 44: Role and Responsibilities: Protected Farming

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC / FIG / FPO	Community consultation, awareness creation
		identification of beneficiary farmers
		Selection and finalization of interested farmers
		Submit list of farmers to unit office
		Appraising DPMU from time to time on progress

2	Field Implementation Unit	Assessment of current scenario in the project area
		Review the list of farmers, submitted by the WWMC
		Consultation with WWMC / FIG / FPO / farmers
		Prepare detail plan for project support
		Submitting the compiled list to DPMU for support
		Training to farmers on protected cultivation
		Providing guidance / technical support
		Guiding the farmers and assessing progress
		Documentation of learning and its dissemination
3	District Project Management Unit	Monitoring / physical observation of structures
		Discussion with the beneficiary farmers
		Assess the benefits of protected farming system
		Learning documentation and reporting to PMU
4	Project Management Unit (PMU)	Consultation with farmer on protected farming
		Assessing crops grown, production, productivity etc.
		Periodic monitoring, including visit to the farmer's field
		Consultation with DPMU / unit office on progress
		Assess the economic benefit of the activity
		Providing required guidance for investment outcomes
		Document the learning lessons and dissemination
5	Technical Institutions (Consortium)	Providing necessary guidance as per the need
		Conduct training for progressive farmers, if needed
		Provide modules by crop types for polyhouse cultivation

3.1.3.6 Other Horticulture Interventions:

3.1.3.6.1 Bee Keeping:

Beekeeping is an environment friendly activity that support in providing employment and income. Beekeeping is a low investment sector having the potential to offer additional income to the farmers Beekeeping plays a vital role in the livelihoods of the rural communities in different ways like [1] it is an income generating activity; [2] provides food and medicine - value of honey and other hive products are relatively costly; [3] it supports agricultural activities through cross pollination and increase in yield of crops; [4] it provides supplementary income to farmers etc. To harness the economic and environmental benefits, the project proposes to promote bee keeping, involving individual farmers / FIGs / FPOs through demonstration and rendering adoption support. Wherever required, project may collaborate with other agencies for marketing and value addition.

3.1.3.6.2 Sericulture:

Silk is one of the natural textile fibres widely used by people at the national level. There is increasing demand on silk both at national and international level due to its eco-friendly nature. Sericulture includes plantation of the host plant, rearing of the silkworms, and extraction of the silk yarn from the cocoon, weaving of the fabric and marketing. The cocoon production, reeling of yarn and weaving of fabric provide livelihood to people. There are 4 types of silk cultivated in India such as Mulberry (Bombyx mori), Tasar (Antheraea paphia), Eri (Samia ricini) & Muga.

Uttarakhand is the only state producing all four kinds of cocoon viz Mulberry, Oak Tasar, Muga and Eri. Climatic condition of the state is suitable for silk sector with conducive temperature and relative moisture. In view of the increasing demand and to provide employment and supplementary source of income, the project will support selected households who are currently involved in sericulture or households who express their interest to take up sericulture. The project will provide both technical and financial support to the selected beneficiaries in project locations.

3.1.3.6.3 Mushroom Cultivation:

Mushroom farming is one of the most potent sources of subsidiary income generation for small and landless farmers. It is a labour-intensive but environmentally beneficial and a successful agribusiness. As mushroom farming does not require large cultivable area and may be grown vertically in a little space, it gives an edge over shrinking land holding size in recent years. Mushroom farming is having the potential of generating employment and a steady source of income. It requires minimal cash, less technical skills, and is feasible to produce on a small scale in an indoor environment, with a good return on investment. Women can cultivate mushrooms in their homes, similar to poultry raising, with little capital.

Uttarakhand produces mainly three species of mushroom-Button, Oyster and Milky Mushroom. Button Mushroom contributes the largest share, i.e., 80 percent, followed by Oyster (12-13 percent), and Milky mushroom (7-8 percent). Mushroom production in Uttarakhand state was 12,395 tonnes annually in which the contribution of Garhwal and Kumaon region was 10,685 and 1,710 tonnes, respectively[16].

Uttarakhand faces various adverse climatic conditions and natural calamities. In view of the scope for mushroom cultivation that can provide a sustainable livelihood support to people engaged in agriculture and other sectors, the project will support rural households and farmer associations in mushroom farming. The project will demonstrate mushroom farming and provide adoption support to the interested farmers / FIGs / FPOs. The members to be involved will be trained on technical aspects of mushroom farming and in-situ guidance will be provided with market linkage support through ABGC.

Role and Responsibilities:

Table 45: Role and Responsibilities: Other Horticultural Activities

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC / FIG / FPO	Identification of beneficiary farmers
		Selection and finalization of interested farmers
		Consultation with interested farmers
		Submit list of farmers to unit office
		Appraising FIU from time to time on progress
2	Field Implementation Unit	Assessment of current scenario in the project area
		Review the list of farmers, submitted by the WWMC
		Consultation with WWMC / FIG / FPO / farmers
		Prepare detail plan for project support
		Submitting the compiled list to DPMU for support
		Training to farmers on bee keeping, sericulture etc.
		Providing guidance / technical support
		Periodic monitoring and assessing progress
		Maintaining database and updating MIS
		Documentation of learning and its dissemination

[16] The Pharma Innovation Journal 2022; SP-11(9): 1043-1048;

3	District Project Management Unit	Support to FIU in planning and execution
		Facilitate capacity building events
		Periodic monitoring & beneficiary consultations
		Assess the benefits
		Learning documentation and reporting to PMU
4	Project Management Unit (PMU)	Prepare guidelines in consultation with DPMU/FIU
		Review of physical & financial progress
		Periodic field monitoring & beneficiary meeting
		Assess the economic benefit of the activity
		Providing required guidance to DPMU/FIU
		Consult with consortium partners, if required
5	Technical Institutions (Consortium)	Providing guidance as per the need
		Facilitate capacity building of beneficiaries
		Assess benefits based on per PMU request

3.1.4 Support for Climate Resilient Production System:

(Diversify Livelihood-Support Small Ruminants)

In Uttarakhand, agriculture, animal husbandry, and forestry are interconnected components of the overall farming system. Together, agriculture and animal husbandry contribute two-thirds of the net domestic output from commodity-producing sectors in the region. Small and marginal farmers in Uttarakhand heavily rely on the livestock sector, not only for milk and draft power but also for supplementary income through by-products. Additionally, women play a significant role in livestock activities, including gathering fodder, maintaining sheds, milking cattle, and processing milk products. Furthermore, research indicates that women in Uttarakhand, as in many regions of India, face challenges such as restricted ownership of agricultural land and limited access to agricultural credit and information[17].

Table 46: Interventions to Support Climate Resilient Production System

Particulars	Activities
Natural Breeding Centre / Hatcheries for Small Ruminants / Poultry / Fisheries	Natural Breeding centre for Goatry
	Setting up of Hatcheries for Poultry
	Setting up of Hatcheries for Fisheries
Demonstration for Commercial Goat / Poultry / Fisheries Farming	Demonstration of commercial goat farming
	Demonstration of commercial poultry farming
	Demonstration of commercial fish farming
Adoption Support for Commercial Goat / Poultry / Fisheries Farming	Adoption support for commercial goat farming
	Adoption support for commercial poultry farming
	Adoption support for commercial fish farming
Feed and Fodder Support and Technologies	Feed and Fodder support and technologies
	Demonstration support for promoting of Feed which lower GHG emission in ruminants
	Adoption support for promoting of Feed which lower GHG emission in ruminants

[17] Preparatory Survey on Uttarakhand Integrated Horticulture Development Project (UKIHDP), JICA

Health Care Veterinary Camps	Health Care Veterinary Camps

Small ruminants and poultry are well integrated into the production system and overall livelihood of rural communities. Small ruminants and poultry not only contribute to food and nutritional security at the household level, also generate income and employment. They also play a greater role in agricultural waste management. In the context of climate change, integrated production and management system appears to be a promising adaptation package for stabilizing livelihood of the household. Supporting marginal and small farmers, including landless for rearing of small ruminant and poultry not only diversify livelihood, will also bring resilience in the production system. Fisheries can become an intervention in hills as rainbow trout, cold water fish is becoming popular. In project villages / clusters having water holding structures / water bodies, will be utilised for fishery promotion and harvest the potential for additional income. With the presence of spring sheds and various water holding structures in the project area, fisheries hold significant promise.

Project Approach and Guiding Principles:

- Preparing criteria for selection of households at watershed villages;
- Households with prior experience in livestock rearing may also be supported as it's a cost intensive activity, beneficiaries with prior experience will have higher adoption;
- Consultation with households and mapping their interest for small ruminants / poultry and fisheries as a part of integrated farming system;
- Financial support to the beneficiary through DBT, following govt. subsidy norms;
- Selected beneficiary will purchase small ruminants / poultry and fisheries by his/her own from market, preferably from agencies empanelled with Govt.;
- The interested beneficiary will contribute, in shape of cash or kind, including shouldering operation and management responsibility of the unit;
- A detail business plan will be prepared for each unit to be supported under the project to understand the commercial viability;
- Orientation / training of beneficiaries on management of small ruminants / poultry and fisheries;
- Support to natural breeding centres, hatcheries for poultry and fisheries;
- Demonstration and adoption of commercial goat farming, poultry, and fish farming;
- The project will also support in feed and fodder support and technologies;
- Demonstration and adoption for promoting of feed which lower GHG emission in ruminants;
- Preliminary health check-up of small ruminants / poultry, before purchasing;
- Animal disease surveillance and linking with Animal Husbandry Department for health care management.

***Note:** *: Beneficiary will purchase small ruminants / poultry and fisheries by his/her own, directly from market and/or from govt./govt. authorised selected empanelled vendors. Preference will be given to empanelled govt. vendors. Either to the farmers if he has capacity and knowledge to buy, and project can support on farmers' satisfactory report, the project will give directly.*

To promote livestock based integrated farming (small ruminants and birds) system, the project will adopt two-fold strategy. The project will extend support to strengthen the breeding centres of the goat, poultry hatcheries and fish hatcheries for required production and supporting the goat firms, poultry firms and fish farms to take up rearing of goat, poultry, and fish farming on commercial basis. The breeding centres / hatcheries will be operationally linked to the commercial goat / poultry / fish farming units for supply quality seed / breed. Support to commercials firms (goat rearing, poultry, and fish farming units)

will be on demonstrative in nature for learning and adoption of others. The project will also extend technical and financial support to the farmers / farmer federations who express their interest to adopt livestock based integrated farming system.

Role and Responsibility:

Table 47: Role & Responsibility for Small Ruminant Support

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC	Selection of beneficiary as per community listing
		Compile & prepare list of beneficiaries after selection
		Submit the beneficiary list to unit office
		Monitor the activity & project support
		Disease surveillance & support from Animal Husbandry Department
2	Field Implementation Unit	Facilitate village / watershed cluster level planning
		Verification of WWMC suggested list of beneficiaries
		Submit verified list to DPMU
		Extend support to finalised beneficiaries
		Extension of livestock management
		Orientation / training to beneficiaries on health care
3	District Project Management Unit (DPMU)	Review & verify documents submitted
		Visit to sample villages & households
		Support the unit office to execute the activity
		Maintain MIS & GIS mapping of households
		Prepare consolidated report and submit it to PMU
		Collaborate with animal husbandry dept.
		Disease surveillance and support
		Document learnings and sharing with PMU
4	Project Management Unit (PMU)	Issuing guidelines for beneficiary selection
		Review the documents submitted by the DPMU
		Field visits and consultation with stakeholders
		Provide required technical inputs and guidance
		Periodic review and monitoring
5	Technical Institutions (Consortium)	Suggest on reclamation models (type of plantation crops)
		Periodic field visit and guiding DPMU & unit office team
		Assessing coverage using geo-spatial RS images
		Roles will include suggesting successful models, establishing value chains akin to those in Uttarakhand, and providing SOPs for small ruminants, poultry, and fisheries.
		Participate in consultation meetings, as per the need

3.1.5 Crop Diversification and Demonstration:

Technology demonstration is one of the most promising extension methodologies to promote new crops / varieties / production technology amongst the farmers. Demonstrations will be conducted in farmers' fields under the technical guidance of the project personnel and collaborating institutions. Training to farmers, including

demonstration and extension support would be the key approach. Field days will also be organised at demonstration sites, inviting scientists, farmers of the village / cluster for learning and adoption. Farmer-scientists interaction on the field day will further make it more effective in transfer of technology. Participating farmers, after learning the technical know-how of new technology, can also serve as local extension agents and assists in dissemination of technology. Demonstrations would also be helpful in generating data on factors contributing higher adoption of CSA practices, crop yields, and constraints of production under various farming situations.

Table 48: Activity for Crop Diversification & Demonstration

Particulars	Activities
Mitigation Interventions in Paddy Cultivated Lands to Reduce GHG Emissions.	Demonstration of DSR Technique
	Demonstration for diversification of Paddy area
	Demonstration of Farm mechanization
Adoption Interventions in Paddy Cultivated Lands to Reduce GHG Emissions.	Adoption of DSR Technique
	Adoption for diversification of Paddy area
	Adoption of Farm mechanization

Selection of Farmers for Demonstration:

1. Farmers who are willing to provide critical resources (land/water/labour, any input not supported by the project);
2. She / he should be a progressive farmer and member of the concerned FIG / FPO;
3. Preference should be given for proportionate coverage of socio-economically backward / SC / ST / small & marginal farmers/women farmers under demonstration;
4. Farmers cultivating other's land on share cropping or on leased-in basis will also be eligible;
5. The identified plot for demonstration should be easily approachable by other farmers & extension workers;

Project Support:

1. Project will provide inputs support to the selected farmers for technology demonstration;
2. Hand holding support and on-field technical guidance will be rendered throughout the demonstration period;
3. Imparting training on the aspects relevant to demonstrated theme;
4. Conducting field days along with farmer-scientist interaction in the field.

Beneficiary Contribution:

1. Farmer to share land, water, labour, and any other inputs not supported by the project;
2. Day to day supervision of the demonstration site;
3. Timely taking of crop management practices like weeding, pest and disease management, fertilizer application etc. as advised by the agricultural scientists / experts.

Approach & Strategy for Technology Demonstration:

Frontline Demonstration approach will be followed to demonstrate crops / varieties / technology with respect to prioritized crops grown in the area, along with full package of

practices. Selected farmer's field would be utilized to demonstrate the potentiality of the technologies to participating farmers. The approach would encompass training, capacity building and demonstrations as an integral system. The project will adopt participatory approach from planning to implementation. Project will encourage women farmers to get involved in the demonstrations.

The area specific crop and stress tolerant varieties of the prioritized crops or any other improved technology to be demonstrated would be identified by PMU / DPMU in consultation with the scientists of consortium partner institutions, and Agriculture Dept. Agriculture experts at the unit offices and DPMU will play an important role in supervision and facilitation of the overall process. Agriculture experts from consortium partners, agriculture expert from the project along with scientists from local KVK would provide on-field technical guidance. At field level, the demonstrations may be established with all logistics, exclusively by the village level extension worker. The project will play the role of a facilitator, in terms of providing required inputs, other logistics and bringing in coordination with other institutions.

Key Guiding Principles:

1. Demonstration will be taken up in watershed villages in a cluster mode; (a cluster will constitute of minimum 5 families)
2. The beneficiaries will gain significantly in cluster mode, with better market prices and marketing opportunities.
3. Entire cost of demonstration, except land, water and labour cost will be funded by the project. Farmer will contribute land, water, labour, and day to day supervision;
4. In cases, where demonstrations are carried out, it will not restrict any farmer from adjacent area to learn from demonstration;
5. The site of demonstrations should be at a place of easy accessibility and at central point;
6. Technology demonstrations will be carried out for different crops in selected locations;
7. For better and visible impact, the demonstrations may be conducted in cluster approach. The size of plot at individual farmers should be between 0.4 ha. to 1.0 ha.;
8. Other equal size plots of the demonstrating farmers or the equal size plot of neighboring farmers in the same farming situation should be considered as control plots for comparison of the results;
9. Prior to demonstration, an assessment should be conducted to assess the existing level of adoption of different technologies and crop productivity;
10. Orientation training will be organized for all the participating farmers / persons about all aspects of demonstration (variety/ technologies);
11. All the important farm operations would be carried out by the demonstrating farmers under the close supervision of officials of dept. and under the guidance of scientist;
12. A display board mentioning about the key details of the variety/technology demonstrated would be erected at the demonstrated plot;
13. Farmers will be taken to the demonstration sites at least thrice; once at the beginning (sowing), once in the mid of the crop season and the at maturity / harvest time;
14. At maturity, just before harvesting, two "Field Day" may be organized where farmers and extension workers are invited. A farmer-scientist interaction session would be organized on the event. On the Field Day, crop yield in $1m^2$ plot to be done in front of farmers, covering both demonstration and control plot/s;

Roles and Responsibilities:

WWMC / FIG / FPO: Selection of beneficiaries as per the set criteria in consultation with officials of unit office. A list of selected farmers will be prepared by the WWMC and will be submitted to the project authority for demonstration support.

Unit Office: The office of Unit Officer will be involved in scrutiny of the list of the beneficiaries as prepared by WWMC / FIG / FPO, consult with the selected beneficiaries, and render project related support for demonstration.

Technical Agencies / Consortium Members: Technical support agencies / consortium members will extend required guidance and technical support in technology demonstration. They will support the farmers in adopting appropriate technologies in the demonstration fields.

DPMU: DPMU will monitor the demonstration activities, consult with the farmers involved in demonstration, and prepare monitoring reports.

PMU: The agriculture expert of PMU will monitor the demonstration activities from time to time, consult with DPMU / Unit Office on progress of demonstrations, visit the demonstration sites and discuss with farmers, document the learning cases, dissemination / sharing the learning with other stakeholders.

3.1.5.1 Promotion of CSA Practices:

The IPCC sixth assessment report defines climate resilience as the capacity of social, economic and ecosystems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity, and structure as well as biodiversity in case of ecosystems while also maintaining the capacity for adaptation, learning and transformation. In general, climate resilience considered to be the ability to recover from, or to mitigate vulnerability to climate-related shocks (floods, droughts etc.). It is a process that strengthens the ability of all to mitigate vulnerability to risks from, and adapt to changing patterns in, climate hazards and variability[18]. Climate resilient agriculture also referred as an approach that includes sustainability, using existing natural resources through crop and livestock production systems to achieve long term higher productivity and farm incomes under climate variabilities.

CSA means the incorporation of adaptation, mitigation and other practices in agriculture which increases the capacity of the system to respond to various climate related disturbances by resisting damage and recovering quickly. Such perturbations and disturbances can include events such as drought, flooding, heat/cold wave, erratic rainfall pattern, long dry spells, insect or pest population explosions and other perceived threats caused by changing climate. In short it is the ability of the system to bounce back. Climate smart agriculture includes an in-built property in the system for the recognition of a threat that needs to be responded to, and the degree of effectiveness of the response. CSA will essentially involve judicious and improved management of natural resources viz., land, water, soil, and genetic resources through adoption of best practices[19].

[18] Climate Smart Agriculture (CSA) (also referred as climate resilient agriculture, CRA) is a set of agricultural practices and technologies which simultaneously boost productivity, enhance resilience and reduce GHG emissions (https://www.worldbank.org/en/topic/climate-smart-agriculture).
[19] https://naas.org.in/Policy%20Papers/policy%2065.pdf

Objectives:

The overall objective of promoting CSA practices is to enable farmers in general, and marginal & small holders in particular, to cope with climate variability, minimise agricultural emission, increase agricultural productivity in the longer run and moving ahead in achieving income resilience in village clusters of the project.

With reference to the principles of climate resilience, the project will promote and support the farmers in adopting climate resilient agricultural practices, based on agroecological zone and crop type. List of different practices to be promoted, based on the feasibility and suitability, are listed below in the matrix.

Table 49: CSA Technologies & Agronomic Practices

Agric. Technology Agri. Practice	Main resilience feature and contribution to the climate agenda	Main agronomic benefits expected	Potential triple-win impact under UCRRFP	Yield improvement due to climate resilient intervention[20]
Improved seed varieties	Adaptation to adverse climate conditions through use of climate-smart seed varieties (short maturity duration, stress-tolerant) Demonstration of high yielding rabi/kharif/zaid crops at the cluster. Demonstration of seed production of rabi/kharif/zaid crops	Reduces risk of major crop losses due to adverse weather. Helps preserve crop mix even with late onset of monsoon.	Increased crop productivity Improved water use efficiency	In mid-hills (<1,000 mm): short-duration, stress-tolerant (biotic/abiotic) varieties Millets: 20% Wheat: 20%
In-situ soil and moisture conservation	Enhanced capacity to manage water run-off and surface drainage to protect against soil erosion following high intensity precipitation.	Collects run-off from the catchment to improve soil moisture on the cropped area. Encourages controlled surface drainage. Reduces soil erosion and nutrient losses.	Increased crop productivity Enhanced soil health Improved water security	Improvement in fodder availability. increased crop productivity

[20] Ch. Srinivasa Rao, K.A. Gopinath, J.V.N.S. Prasad, Prasanna kumar, A.K. Singh (2016): *Climate Resilient Villages for Sustainable Food Security in Tropical India: Concept, Process, Technologies, Institutions, and Impacts.* In: Advances in Agronomy, Vol.140, by Donald L. Sparks, ed. (2016)

Agric. Technology Agri. Practice	Main resilience feature and contribution to the climate agenda	Main agronomic benefits expected	Potential triple-win impact under UCRRFP	Yield improvement due to climate resilient intervention[20]
Organic Farming Practices	Organic practices that strengthen farming systems for carbon sequestration	Encourages moisture storage in the soil profile. Provides a better drained and more easily cultivated soil.	Increased crop productivity Enhanced soil health Improved water security	Reduction in input costs, increased profitability, and optimum productivity.
Intercropping/ Mixed Cropping	Climate-risk management strategy to help farmer cope with adverse climate events that may have a different impact on 2 or more crops grown simultaneously on the same plot. Demonstration and adoption of Vegetable crops, floriculture, species, medicinal, aromatic crops and Climate Resilient PoP at Cluster level	Reduces likelihood of total crop failure due to adverse weather. Crop diversification benefits (biological, financial) Ensures optimum use of soil moisture and nutrients. Helps with effective pest management.	Increased crop productivity Enhanced soil health Improved water security	Crop diversification ensures buffering against biotic and abiotic stress ensuring economic resilience.
Integrated Pest and Nutrient Management	Enhanced absorptive capacity of the farming system to manage pest infestations and soil nutrient deficiency induced by high levels of humidity (pests) or prolonged droughts (nutrient deficiency).	Reduces nutrient deficiencies. Mitigates soil salinity. Reduces infestations. Reduces crop losses. Reduces use of chemical pesticides. Improves crop quality.	Increased crop productivity Enhanced soil health	Reduces input cost, increases productivity, and returns across the project area.

Agric. Technology Agri. Practice	Main resilience feature and contribution to the climate agenda	Main agronomic benefits expected	Potential triple-win impact under UCRRFP	Yield improvement due to climate resilient intervention[20]
Mulching/Soil Cover	Enhanced adaptive capacity of the farming system to cope with extreme temperature and high intensity rainfalls. Improved in-situ soil moisture content. Carbon sequestration through decomposition of organic mulch Demonstration of mulching technologies	Reduces evaporation and increases soil water retention. Insulates soil by providing a buffer from heat. Provides valuable nutrients and organic matter as the mulch breaks down. Inhibits the germination of weed seeds.	Increased crop productivity Improved water use efficiency. Enhanced soil health	Reduced evaporation will result in increased moisture availability for crop productivity.
Minimum Tillage	Improved farming system's adaptive capacity to cope with moisture stress, soil and nutrient losses. Carbon sequestration through incorporation of crop residues into the soil	Improves soil organic matter content and carbon sequestration. Reduces soil erosion. Slows down water runoff and improves water availability	Enhanced soil health Improved water security	Reduction in input costs; improvement in soil health

Agric. Technology Agri. Practice	Main resilience feature and contribution to the climate agenda	Main agronomic benefits expected	Potential triple-win impact under UCRRFP	Yield improvement due to climate resilient intervention[20]
Protected cultivation	Enhanced transformative capacity of farmers to cope with climate variability through their partial or total control of microclimate. Demonstration and adoption support for setting up poly houses. Demonstration and adoption support for setting up Hitech Protected Cultivation	Cultivation of high-value crops in controlled environment More efficient use of inputs (including water) Effective control of pests and diseases Higher seed germination rate	Increased crop productivity Improved water use efficiency	Improved water-use efficiency and water productivity
Micro irrigation systems (drip, sprinkler) and farm ponds	On-farm water availability through enhanced storage capacity of surface water to cope with late monsoon rains and/or dry spells; increased water productivity and 'more crop per drop'; Small Solar water lifting pumps for individual farmers; Low-cost water harvesting/ irrigation tanks; Drip irrigation system for fruit orchards and vegetable cultivation; Demonstration of sprinkler irrigation systems	Increases rainwater harvesting and optimum use of harvested water. Helps overcome moisture stress during critical stages through supplemental irrigation.	Improved water use efficiency. Increased crop productivity	In mid hills farm pond; sprinkler, drip irrigation.
Efficient Conveyance of Irrigation Water	Use of HDPE pipes in distribution system, Solar submersible pump for lifting of Water from downstream LDPE tanks and prefabricated water harvesting tanks. Establishment of farm level crop intelligence system in crop clusters including crop water budgeting	Optimum utilisation of available water for irrigation (Water budgeting)	Reduces seepage and increased water Use Efficiency	Efficient Water utilisation for increased productivity

Agric. Technology Agri. Practice	Main resilience feature and contribution to the climate agenda	Main agronomic benefits expected	Potential triple-win impact under UCRRFP	Yield improvement due to climate resilient intervention[20]
Direct Seeding Rice (DSR)[21]	Introduction of suitable short-duration varieties for both lowland and uplands, including agronomic practices. Demonstration and adoption of DSR technique Demonstration and adoption for diversification of paddy area	Reducing water footprints without reduction in crop yield.	Improvement in soil health, reduction in methane emission.	Reduced water footprints, timely sowing of rabi crop.

Note: This is the list of practices that can be promoted under the scope of the project. However, all practices may not be suitable for all agroclimatic conditions. Hence, depending on agroclimatic conditions, POP will be finalised in consultation with technical institutions / consortium partners.

Project Approach and Guiding Principles:

1. Mapping of current practices, including traditional practices, adopted by the farmers for different crops and its analysis to understand relevance of the adopted package of practices from climate resilient perspective.
2. Collaborating with farmers and consortium partners, we'll assess current practices and develop tailored Production Optimization Plans (POPs) suitable for local agroclimatic conditions and crops.
3. Capacity building of officials / experts / staff of PMU, DPMU and unit office;
4. Prepare a detail CSA promotion plan by project district / village clusters in consultation with WWMC, FIG and farmers;
5. The CSA promotion plan would capture area to be covered (ha.), farmers to be covered (no.), POP to be promoted for specific crops, phasing of project inputs etc.;
6. Promote POP at the village clusters through institutional mechanism of the project;
7. Collaborate with concerned line departments and consortia;
8. Educate farmers through awareness camps, sensitization meetings, trainings, visual display. and distribution of IEC materials;
9. Conduct demonstrations, organise FFS and provide in-situ guidance to the farmers;
10. Introduction of climate based advisory system for different crops /different agriculture practices, animal husbandry to the beneficiaries;
11. Tracking adoption of promoted package of practices by the farmers with geo-tagging of plot.

Role and Responsibilities:

Table 50: Role and Responsibilities for Promotion of CSA Practices

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC / FIG	Organizing / Conducting meetings with farmers
		Coordinate with farmers and unit office
		Support Field Implementation Unit in awareness creation

[21] Nayak, AK et al (2022), Carbon and water footprint of rice, wheat and maize crop production in India. Pedosphere, 32.

2	Field Implementation Unit	Awareness and sensitization on CSA practices
		Periodic consultation with local KVK and other institutions
		Providing hand holding and in-situ guidance & support
		Extension supports to farmers-crop based
		Conducting demonstrations and implementation of farming system/ FFS
		Prepare project database on inputs, coverage etc.
		Appraising and reporting to DPMU
3	District Project Management Unit (DPMU)	Finalize package of practices in consultation with PMU
		Coordinate with technical institutions of consortium
		Guide unit office from time to time
		Monitoring and supervision of project inputs
		Tracking physical and financial progress using MIS
		Prepare and submit periodic progress report to PMU
4	Project Management Unit (PMU)	Consultation with technical institutions of the consortium
		Prepare package of practices for different crops
		Guide DPMU and unit office in CSA practices
		Capacity building of DPMU and unit office
		Tracking physical and financial progress using MIS
		Periodic monitoring and technical / managerial support
5	Technical Institutions (Consortium)	Consult with PMU / DPMU from time to time
		Prepare POP based on agroclimatic zone & crop
		Support in implementation of POP
		In-situ guidance based on PMU / DPMU request
		Provide capacity building inputs on POP
		Conduct visits to sample sites and providing guidance

3.1.5.2 Farmers Training on Climate Resilient Agricultural Practices:

Capacity building of farmers on Climate Resilient Agricultural Practices is key for sustaining interventions under UCRRFP. Project will take required capacity building measures for the farmers in the watershed villages for adoption and replication of climate resilient package of practices. Training modules on climate resilient practices will be developed to impart training to the farmers. Along with the farmers, the associated project personnel / staff / experts would also be given training so that their learning can percolate down to the farmers during field orientations, guidance, and awareness initiatives.

Objective:

1. To impart knowledge to farmers on climate change, its impact on agriculture, feasible adaptation strategies to climate variability and mitigation measures of climate change
2. To equip farmers, irrespective of their holding category, on climate resilient agricultural practices
3. To strengthen the knowledge base of farmers through practical demonstration, sharing research findings and learnings from national and international practices

Project Assistance:

The project will bear the entire cost of training and capacity building of farmers / other stakeholders, as per the project design.

Key Guiding Principles:

1. Project village / cluster will be considered as the unit;
2. Capacity building of farmers will cover training, exposure, hand holding, escorting etc. as per the identified capacity building needs;
3. Key capacity requirements, as per the capacity need assessment will be identified before finalizing capacity building plan. Training modules would be developed, encompassing the identified thematic areas for capacity building;
4. Separate capacity building plan would be developed for women and tribal farmers, if required;
5. Capacity building measures will be taken up in a phased manner, keeping in mind the agricultural season and engagement of farmers;
6. Based on the need of the women farmers, trainings may be organized locally, at the village level or in a suitable place which is easily approachable by the women farmers;
7. Training on climate resilient technologies, package of practices specific to crop types, IPNM, IPM, agro-enterprise promotion etc. may be taken up, if so, identified as a capacity building need;
8. Necessary training modules / manuals / IEC materials would be designed and circulated to farmers;
9. As a part of capacity building, field demonstrations and in-situ guidance will be provided along with exposure to some of the demonstration sites.

Role and Responsibilities:

Table 51: Role & Responsibilities; Capacity Building

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC / FIG / FPO	1. Mobilizing farmers to participate in the CNA process; 2. Discuss with unit office from time to time on capacity building initiatives; 3. Participate in capacity building program; 4. Create awareness among farmers and follow-up for adoption of climate resilient practices;
2	Field Implementation Unit	1. Consultation with the farmers on their current agricultural practices (crop specific); 2. Conducting Capacity Need Assessment (CNA) of the farmers; 3. Identifying capacity gap through CNA by different land holding categories; 4. Designing a capacity building framework / plan on climate resilient agricultural practices for the farmers, based on the identified gap and taking in to account the agro-climatic condition of the area; 5. Preparing a detail report on CNA, including capacity building plan and finalizing with DPMU; 6. Preparing modules / manuals for capacity building of the farmers; 7. Piloting the modules / manuals and its adoption for capacity building;

		8. Finalization of resource persons, and if required, taking support of DPMU / SPMU 9. Organizing capacity building program as per the finalized capacity building framework / plan; 10. Follow-up of the capacity building inputs and organizing refresher courses, if required; 11. Educate, aware and motivate farmers to adopt climate resilient practices.
3	District Project Management Unit (DPMU)	1. Participate in capacity building program and observe / witness the approach and process adopted for capacity building of farmers; 2. Suggest, if any modification required in capacity building approach or process adopted or delivery methodology; 3. Prepare monitoring report on capacity building and share with PMU.
4	Project Management Unit (PMU)	1. Designing the capacity need assessment tool/s and its modification, if any, after piloting; 2. Designing capacity building framework / plan; 3. Finalization of CNA report and issuing required guidelines for conducting capacity building events; 4. Designing modules / manuals as per the identified capacity gaps; 5. Participate in piloting of the modules / manuals and making necessary correction / change in the modules / manuals; 6. Monitoring capacity building events and suggest, if any modification is required in delivery mechanism / methodology, capacity building approach or related aspects; 7. Document capacity building learning (in terms of adoption of practices by the farmers) and its dissemination.

3.1.5.3 GHG Emission Reduction in Paddy:

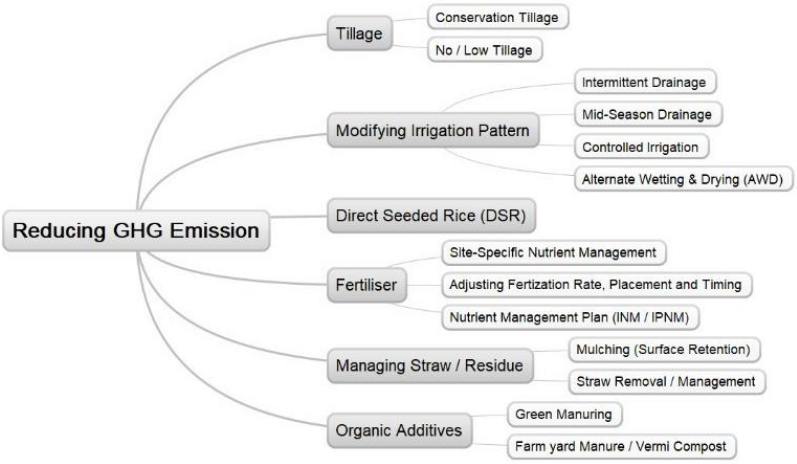
Promoting climate resilience in agriculture sector has been the focus of the project. Looking at the geo-morphological situation of the State, total area covered under paddy is about 39.16 percent in hilly districts with total production of 24.85 percent of total paddy production of the State. Whereas area covered under paddy in plains is 60.84 percent of the total paddy area that produce 75.15 percent of total paddy production[22]. Of the 8 project districts, 27.48 percent of the total paddy area are in 6 hilly districts and remaining 72.52 percent paddy area in 2 plain districts[23]. In view of emission potential of paddy fields, the project intents not only to promote package of practices that reduce emission from paddy fields, but also the project will monitor in-situ GHG emission on pilot basis, with the involvement of technical institutions of the consortium. Periodic measurement of emission from paddy fields will further support in strengthening interventions that would help in minimizing emission with increased adoption of relevant package of practices.

Key reasons for assessing and measuring emission in paddy field is related to unscientific does of fertiliser use, less use of soil parameters for soil health improvement, standing water in the paddy field, less adoption of precision farming protocols etc. Hence GHG emission measurement and its tracking would be supportive to the farmers to adopt package of practices that reduce GHG emission, without compromising crop productivity.

[22] Directorate of Economic & Statistics, DA&FW, MoA&FW, GOI, 2021-22
[23] Directorate of Economic & Statistics, DA&FW, MoA&FW, GOI, 2021-22

Strategies for Reducing GHG Emission:

The project will adopt multi-prong strategies for reduction of GHG emission from crop lands, more particularly from paddy fields. Better irrigation management with land levelling (laser levelling of land), and Alternate Wetting and Drying (AWD) in place of Continuous Flooding (CF) will reduce emission of CH4. The project will promote scientific management practices in four critical areas, i.e., [1] water / irrigation management, [2] fertiliser (organic / synthetic) management (fertiliser efficiency through prevision farming), [3] crop diversification (pulses and millet promotion) in suitable land parcel (particularly in medium and up land), with crop and varietal selection (short duration paddy, agro forestry / farm forestry), and [4] promotion of scientific agronomic practices. Apart from this, soil management and improving Soil Organic Carbon (SOC) will be an integral part of the project intervention. All these aspects are discussed in different sections which are objectively linked to GHG emission reduction. Emission of GHGs in rice fields can be reduced by modifying irrigation pattern and tillage permutations, managing organic additives and fertilizer inputs, and selecting cropping regime.



Modifying Irrigation Pattern:

Water management during rice production is one of the key factors controlling GHG emission. Several water management options like distinct drainage periods in mid-season, alternate wetting and drying of the soil, intermittent irrigation, and controlled irrigation support to minimize GHG emissions as compared with traditional flooded rice and can be opted as a practice under varying soil and climatic conditions without lowering crop yields. Mid-season drainage / a short-term drainage will encompass a distinct period of interrupted irrigation during the crop growth phase. Reducing the amount of applied water, i.e., net decrease in water will ultimately reduce CH4 emissions.

Alternate Wetting and Drying:

Alternate wetting and drying are the periodic drying and reflooding of the rice field. In contrast to mid-season drainage, the time intervals between dry and wet conditions appear to be too short to facilitate the shift from aerobic to anaerobic soil conditions. Alternate wetting and drying will result in a significant reduction of CH4 emission, but N2O emission from this system varies in a broad range. Optimal irrigation according to the crop physiological characteristics at different growth stages can limit the frequency of alternate dry and wet conditions leading to less N2O production and emissions.

Intermittent Drainage:

Intermittent drainage will involve a repetition of free drainage and irrigation. It will improve the advantage of ameliorating soil oxidative conditions by enhancing root activity, higher soil bearing capacity, and will ultimately minimise water inputs that result in anaerobic conditions. It will enhance diffusion of oxygen into the soil, increase the aerobic area and reducing the CH4 production.

Controlled Irrigation:
Controlled irrigation has reported to minimize net GHG emission with respect to transplanted flooded rice, which the project will promote in selected areas. Soil in controlled irrigated paddy fields will remain dry (60–80 %) during the rice growing season without flooding.

Tillage Permutations:
Tillage has a pronounced bearing on GHG emissions in rice fields originating primarily to alteration in soil properties (soil porosity, soil temperature, soil moisture, etc.) and biochemical processes. Soil disturbance caused by tillage can increase emissions by aerating the soil and mechanically breaking down soil aggregates, causing the release of protected organic fractions. When soils are tilled, it accelerates oxidation of soil C pool to CO2 by improving soil aeration, increasing contact between crop residues and soil, and exposing aggregate-protected SOM to microbial attack. Reducing tillage and soil disturbance in rice-based cropping systems could lead to less GHG emissions. Project will attempt to promote managed / low tillage with proper awareness to farmers.

Straw / Residues Management:
Crop production inevitably leads to the production of huge amounts of straw/residues that are typically left in the field. As the organic manure application is gradually decreasing, rice soils largely depend upon straw recycling to overcome carbon losses caused by soil cultivation and harvesting of crop. Burning of straw generates large amounts of GHGs and adversely affects air quality. CH4 emission rates are very sensitive to the mode of straw management into the soil. Scientists report that CH4 emission rate is higher from fresh rice straw with respect to off-crop season incorporation in paddy fields. The project will promote abandoning straw application to rice fields as an effective measure for GHG reduction as because straw removal decreased the emission of GHG as compared with straw incorporation.

Fertilizer Management:
Fertilizer management is a critical component for reducing environmental impacts of rice fields. Fertilizers applied to soil are not always efficiently used. Enhancing the fertilizer use efficiency can reduce GHG emissions especially N2O. Practices that improve fertilizer use efficiency and decrease GHG emission will include precise adjustment of application rates according to crop needs, using nitrification inhibitors or slow-release fertilizers, adjusting application timing, and selecting appropriate fertiliser, precise placement of fertilizers into the soil, avoiding over applications, or eliminating N applications where possible (based on soil test). Adjusting fertilization and matching N supply with demand and adjusting N and phosphorus levels to meet the crop requirements will benefit the crop yield while controlling GHG emissions.

GHG Measurement:
Anthropogenic activities release greenhouse gases into the atmosphere causing climate change and results in effects to ecosystems functioning. For effective mitigation of anthropogenic emission of Greenhouse gases, it is important to know the current level of GHG emission with certain precision and initiating remedial measures accordingly. For the measurement of GHGs emission, project will use chamber techniques. The consortium partner/s in consultation with the PMU-UCRRFP will take up GHG measurement in selected crop lands. Closed chamber technique is most popularly used in which, emissions of gases from soil are usually determined by closed chamber placed over the soil surface, which restricts the volume of air exchange across the covered surface. In case, if the project feels

the requirement, micrometeorological method (Eddy covariance flux tower) may also be used to continuously measure the vertical concentration gradients of the gases.

Chamber Method: For decades, until the eddy covariance (EC) technique has become the standard technique to estimate net carbon dioxide (CO2) exchange (Aubinet et al., 2012), chamber measurements have been the prevailing technique to monitor the CO2 exchange between the atmosphere and soil, plant organs or complete ecosystems (Livingston and Hutchinson, 1995; Pumpanen et al., 2004; Wohlfahrt et al., 2005; Acosta et al., 2013). In the case of methane (CH4) and nitrous oxide (N2O), for which fast and precise analysers have only been developed very recently and are more expensive than fast CO2 sensors, chambers still provide the majority of information and are the most commonly used flux measurement method (Denmead, 2008). CO2, CH4 and N2O are the three greenhouse gases (GHGs) which are most commonly monitored using the chamber method.

Chamber measurements are relatively simple to operate, and they are important tools in situations where the EC technique cannot be applied. Furthermore, they are useful to determine the spatial heterogeneity of fluxes of GHGs, to partition the net fluxes of CO2 into their components (respiration and gross primary production), as well as to offer supporting data for the gap-filling of the EC data. Even though the manual chamber measurements allow to investigate the inter-annual variations of soil GHGs and the influence of environmental factors on them during the growing season, they may not be consistent throughout the year and may miss specific weather events; such as wet or dry conditions. Automated chambers have the great advantage of being able to measure continuously for long periods, regardless of the weather and time of day. The use of automated systems for GHG efflux allows accurate measurements, minimal disturbance of the soil surface, and high-resolution datasets for extended periods of time (Korkiakoski et al., 2017).

Project Intervention:

The project will monitor GHG emission from agricultural fields / crop lands, in both high land and low land areas of intervention districts of the State, focusing on paddy area. The project will implement chamber-based flux monitoring mechanism, at least thrice in each cropping season (planting, flowering and before harvesting), covering both paddy and non-paddy fields. The consortium partner institution/s will play an important role in monitoring GHG emission in crop lands.

Table 52: Role & Responsibilities for Emission Measurement

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC	Identify suitable land for installing chamber
		Support in chamber installation
		Periodic checks of sites & physical verification
		Report to unit office periodically about site status
2	Field Implementation Unit	Identification support in installing chambers
		Keeping recording
3	District Project Management Unit (DPMU)	Periodic verification of installed sites
		Support in installation of chambers for flux monitoring
		Coordinate with PMU and technical institutions
4	Project Management Unit (PMU)	Coordinate with technical institutions (consortium)
		Prepare plan for measurement (annual / seasonal)
		Review of report of technical institution

		Plan for GHG emission reduction as per observations
5	Technical Institutions (Consortium)	Technical guidance on chamber installation
		Orientation to project officials on measurement
		Analysis of collected measurement data
		Laboratory testing of chambers for flux analysis
		Submit report to PMU on observations of experiment
		Orientation to PMU/DPMU on scientific dimensions

3.2 Building Consortium and Digital Platform: (Sub-Com A2):

3.2.1 Consortium of Technical Institutions:

Project of this nature requires technological application and scientific approach to execute the framed activities, more particularly for preparing GHG inventory at the project level, planning and management of spring sheds, developing resilience protocols in farm sector, and bringing in innovations and its piloting. To meet technical requirements, the project will collaborate with technical institutions of National and international repute and will form a consortium of these institutions. These technical institutions will be finalised by the project who will render their expert service and technical inputs from time to time, as per the need. The project will sign Memorandum of Understanding (MOU) with the selected institutions for specific technical inputs. The technical institutions shortlisted by the PMU for collaboration are as below.

Table 53: Consortium Partners and Project Support

SN	Technical Institutions	Type of Support
1	Indian Council of Forestry Research & Education / FRI, Dehradun, Uttarakhand (ICFRE)	▸ Technological inputs, assessment, and monitoring support for forest species for reclamation of agricultural fallow land; ▸ Assessing carbon sequestration for plantation crops / areas covered under forest species; ▸ Carbon Sequestration Methodology and Estimation.
2	Indian Institute of Soil and Water Conservation, Dehradun, Uttarakhand (IISWC, ICAR)	▸ Recommend soil nutrient management, package of practices for different crops by soil type, soil quality improvement and soil amendment measures; ▸ Field assessment and providing technical support to implementing entities; ▸ Carbon Sequestration Methodology and Estimation.
3	Indian Institute of Remote Sensing (IIRS), Dehradun, Uttarakhand	▸ Inputs on cropping area, cultivable fallow land, mapping changing scenario based on satellite imagery; ▸ Periodic tracking of changing cropping scenario in the project area, land covered under different crops etc.; ▸ Provide required information to PMU, based on satellite imagery analysis.; ▸ Carbon Sequestration Methodology and Estimation.
4	Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora (VPKAS), Dehradun (ICAR Institution)	▸ Developing crop specific package of practices for adoption; ▸ Support / guidance in identifying appropriate agricultural technology for hilly and plain areas. ▸ Periodic monitoring and technical support to achieve climate resilience in agriculture; ▸ Guidance to project team from time to time as per the need.
5	G.B Pant University of Agriculture and Technology (GBPUA&T), Pantnagar, Uttarakhand	▸ Support in providing climate resilient seed varieties; ▸ Technical support, as per the need on different interventions in agriculture and horticulture.
6	National Institute of Hydrology (NIH), Roorkee, Uttarakhand	▸ Geo-hydrological mapping of watersheds and spring sheds; ▸ Technical support in watershed and spring shed development and management.
7	Indian Institute of Technology (IIT), Roorkee, Uttarakhand	▸ Geo-hydrological mapping of watersheds and spring sheds;

SN	Technical Institutions	Type of Support
		▸ Technical support in watershed and spring shed development and management.
8	National Rice Research Institute (NRRI), Cuttack, Odisha (ICAR Institution)	▸ Support in designing GHG emission reduction strategies; ▸ Measuring GHG emission and technical guidance to the project team on GHG inventory.
9	Indian Institute of Science (IISc), Karnataka	Support in irrigation management guidance, treatment of spring sheds / watersheds, crop water budgeting principles, and in GHG inventory preparation and tracking.
10	Central Institute of Temperate Horticulture (CITH), Srinagar, J&K	Support in supplying planting materials, technical inputs for horticultural crop management and building technical knowhow of the project officials.
11	Indian Agriculture Research Institute (IARI), Pusa, New Delhi	Technical guidance on climate resilient agriculture and strategy for GHG emission reduction from paddy fields.
12	YS Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh	▸ Support in rendering package of practices and horticultural technology; ▸ Guidance and support for plantation crops and other horticulture promotion initiatives of the project.
13	National Centre for Organic & Natural Farming (NOCNF), Ghaziabad, Uttar Pradesh	▸ Provide inputs on organic farming and detail package of practices; ▸ Periodic visit to project locations, as per the need and providing capacity building inputs to the farmers and their organization.
14	Indian Veterinary Research Institute (IVRI), Izzatnagar, Bareilly, Uttar Pradesh	▸ Providing guidance on management of small ruminants / poultry and fisheries; ▸ Facilitate in developing required guidelines and IEC materials; ▸ Animal disease surveillance and inputs for animal health management.
15	Dr. R.S Tolia Uttarakhand Academy of Administration (ATI), Nainital, Uttarakhand	▸ Providing capacity building inputs to the project stakeholders ▸ Support in training modules / manual / reference materials. ▸ Facilitate training of project officials / staff.

***Note**: Other technical institutions will be incorporated in the consortium based on the requirement of the project.*

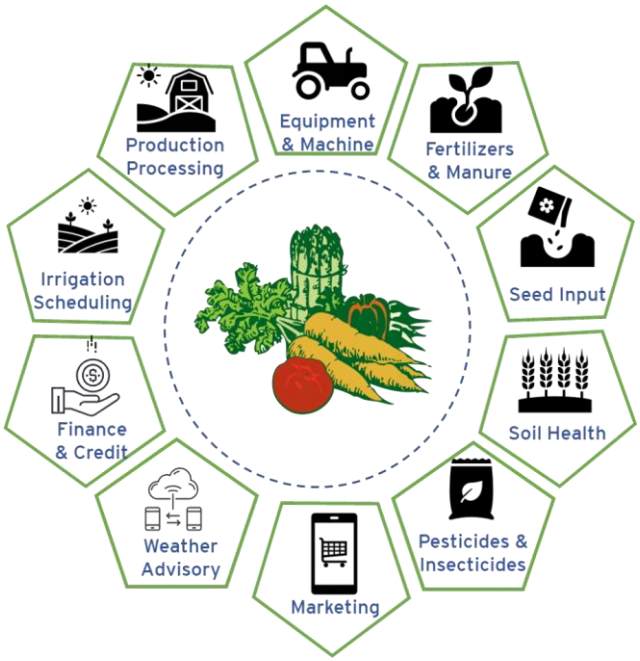
In the way of rendering their support and services, selected technical institutions will also be helpful in building in-house capacity of the officials / staff of the WMD and the constituted PMU, DPMU and Unit offices.

3.2.2 Digital Platform for Agriculture:

Digital technologies, such as the Internet of Things (IoT) and machine learning (ML) techniques offer new opportunities for agriculture. These technologies involve data sharing, homogenization, editability, reprogram ability, and distribution. Digital agriculture[24], will be a tool that digitally collect, store, analyse, and share electronic data and/or information in agriculture. Digital agriculture is expected to impact the entire agri-food value chain. Digital platform will involve e-commerce platforms, e-extension services, farm machinery rental, etc. Apart from this, the proposed platform will also capture project specific information / data with inbuilt MIS and GIS platform. Digital technology has the potential to revolutionize and streamline agricultural practices in rural India[25]. It empowers farmers with timely and valuable insights, enabling them to adopt optimal practices and efficiently manage their farms. This approach minimizes losses and maximizes profits for farmers.

[24] Digital agriculture also referred as smart farming or e-agriculture.
[25] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1847506

Digital agriculture will encompass a wide range of technologies, most of which have multiple applications along the agricultural value chain. These technologies would include cloud computing, digital communication technology, digital platforms, such as e-commerce platforms, digital information system, agro-advisory app, precision agriculture technologies (like soil sensors), advance imaging technology (like satellite and drone imagery to look at fertility gradients and moisture gradients), internet of things etc. Digital agriculture would also address the challenges of agricultural emission, making the agricultural value chain more efficient, equitable, and environmentally sustainable.

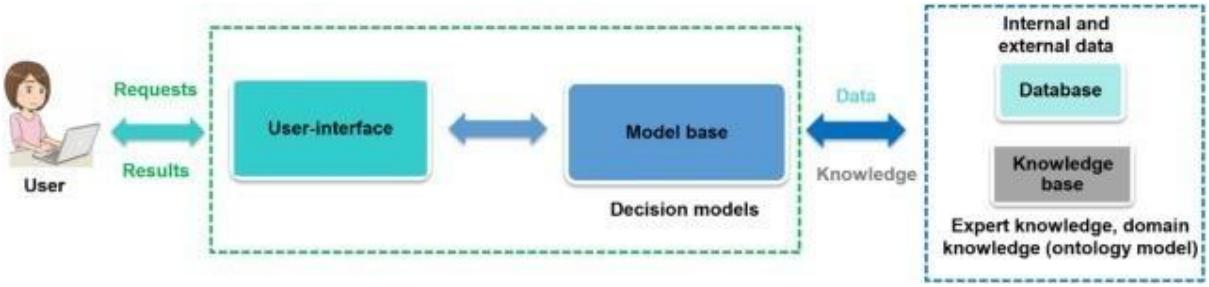


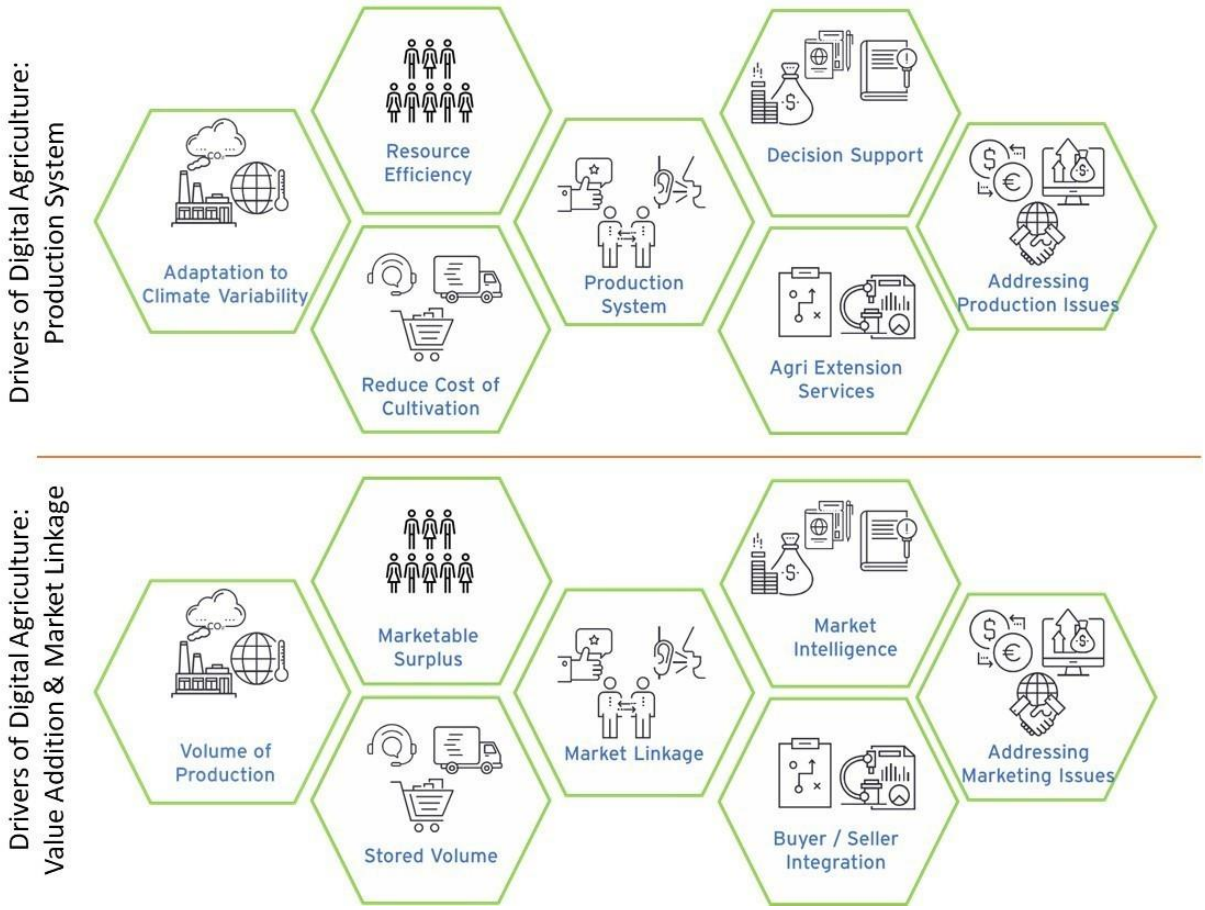
Digital Agriculture is "ICT (Information and Communication Technologies) and data ecosystems to support the development and delivery of information on time, providing targeted information and services to make farming profitable and sustainable. In the context of the project, digital agriculture would support the stakeholders in two ways, i.e., [1] data driven production system support, and [2] e-commerce. In data driven production support system, digital agriculture would bring in weather advisory, precision agriculture, crop disease management, irrigation scheduling, e-extension services, crop yield mapping, and overall crop production advisory. In e-commerce, it will include post-harvest storage, market linkage, and supply chain management.

The production support system would include providing information and solution for [1] crop management, [2] irrigation management, [3] water and environment management, [4] soil management, [5] farm management, [6] weed management, [7] crop quality management, [8] pest and disease management, and [9] harvest / yield mapping.

Agricultural Decision Support Systems (ADSS):

Digital agriculture will be a part of decision support system (DSS) that will support decision-making to specific demands and problems by providing operational answers to stakeholders and potential users based on useful information extracted from raw data, documents, personal knowledge, and/or models. The ADSS will be data-driven, model-driven, communication-driven, document-driven, and knowledge-driven. General architecture of an ADSS, consisting of four fundamental components, is presented in the figure.





Provisioning Services under Digital Agriculture:

In the face of growing demands and environmental concerns, digital agriculture is emerging as a game-changer, offering a diverse range of services to empower farmers and transform the agricultural landscape. In the project, the services will encompass a spectrum of technologies and tools that bridge the gap between traditional farming practices and the power of digital solutions.

Precision Agriculture:

Utilizing sensors, satellite imagery, and data analytics, farmers/ beneficiaries will gain real-time insights into their fields, enabling them to make informed decisions regarding resource allocation, irrigation, and pest control, ultimately leading to increased efficiency and productivity. It will help the beneficiaries to precisely tailor the application of resources, ensuring crops and soil receive the optimal inputs for their health and productivity. The beneficiaries will get timely information through mobile apps related to the weather forecasts, irrigation, at what stage the fertilizers and based on the soil type what type and quantity of fertilizers need to be added to the crop. The real-time information through sensors will reach the beneficiaries through ICT platform on the soil moisture and nutrient levels, insect infestation and crop health. This will help the beneficiaries to utilize this data to make informed decisions regarding the timing and application of irrigation, fertilizers, and pest control measures.

Farm Management Platforms:

Mobile apps and online platforms will provide access to market information, weather forecasts, agricultural advisories, and financial services, streamlining farm operations, improving risk management, and fostering financial inclusion. These platforms will cater all

the necessary needs of the beneficiaries by providing the decision support. The platform will analyse the input data (data accessed through different sources either in the form of a picture or some other information) and provide them with valuable insights and recommendations on the crop selection, planting schedule, timely irrigation, usage of accurate fertilizers and pest management. The beneficiaries can also effectively manage their agricultural inputs.

E-commerce and Market Access:

Bypassing traditional intermediaries, farmers can connect directly with consumers through online marketplaces, gaining access to wider markets and potentially capturing a larger share of the profits. It will play a crucial role as the beneficiaries will have an increased market reach, thereby they can easily identify the vendors/buyers and sell their produce at a better price, earning higher profit. The beneficiary will not save the time and money, he/she will be assured of the selling if their produce at the market price only.

Knowledge Sharing and Collaboration:

Online communities, forums, and e-learning modules create opportunities for farmers to connect with experts, share knowledge, and collaborate on problem-solving, fostering a collaborative and knowledge-driven agricultural ecosystem. This will help beneficiaries to obtain expert guidance, utilize effective strategies, and access technical knowledge regarding crop management, pest control, soil health, and various other agricultural aspects. The beneficiaries will get hands on information on advanced farming system and technologies from pre- to post- harvesting crop management. Ask the Expert, created through ICT platform will directly connect the beneficiaries to the experts.

Sustainability and Traceability:

Digital tools promote sustainable practices like precision irrigation and soil health monitoring, while blockchain technology facilitates food traceability, building consumer trust and potentially fetching premium prices. It will help the beneficiaries in electing optimal crops, hybrid seeds, and resource-efficient farming methods. Furthermore, it enhances farming productivity and precision, aiding farmers in developing seasonal forecasting models.

Services to the Farmer:

Digital agriculture will provide a plethora of services to the farmers. Beneficiaries can easily connect with Custom Hiring Centres (CHCs) or nearby vendors to fulfil their requirements for farm equipment and machinery. By simply uploading soil testing reports, beneficiaries can receive recommendations on the type of fertilizers to use and suitable crops to grow on their farms.

Weather Forecasting and Advisory Services will play a pivotal role in empowering farmers with crucial information for decision-making. Utilizing advanced technologies like sensors, satellites, and weather stations, data regarding weather patterns will be. The advisory services will be delivered through mobile applications, SMS, or voice calls, and offer personalized recommendations to the beneficiaries regarding optimal planting times, irrigation scheduling, pest, and disease management, and more. The integration of digital weather solutions into farming practices significantly contributes to improved yield outcomes and profitability for farmers[26].

[26]AgriTech Weather Solutions (https://tracextech.com/climate-resilience-in-agriculture/#:~:text=Agritech%2C%20which%20incorporates%20cutting%2Dedge,analytics%2C%20and%20smart%20irrigation%20systems.

Precision farming will utilize data from soil analysis, weather monitoring, and yield prediction to optimize resource usage and maximize yield[27]. Farm management tools will assist with record keeping, financial management, and resource optimization, leading to improved efficiency. Market access and information services will connect the beneficiaries directly to consumers and provide valuable insights on pricing, demand, and farm-to-consumer opportunities[28]. Additionally, access to finance and insurance through online platforms facilitates easier access to loans and protects against unforeseen risks[29]. Finally, extension services and training that will be delivered online, providing farmers with access to expert advice, virtual consultations, and research findings, enhancing their knowledge and skills[30].

Services to the Agribusiness / Agri Entrepreneurs:

The competitiveness and operations in agribusiness can be enhanced through the digital agriculture. Different entities associated with agribusiness can connect with the producer / FIG / FPO and collect the required quantity of produce directly from the stock.

Digital solutions will play a crucial role in supporting agribusinesses and agri-entrepreneurs in the project districts. Supply chain management services like farm traceability, logistics optimization, inventory management, and post-harvest solutions will enhance efficiency and transparency throughout the agricultural value chain[31]. Input optimization and procurement platforms will provide access to online marketplaces for farm inputs, price comparison tools, and quality control mechanisms, ensuring efficient and cost-effective procurement. Financial services tailored to agribusinesses include trade finance, risk management tools, and access to investment opportunities, will promote financial stability and growth. Market analysis and research services will offer valuable insights through consumer data, market intelligence reports, and trend forecasting, enabling informed business decisions[32]. The agri-marketing and promotion tools, including digital marketing platforms, brand building applications, and access to online marketplaces, will also facilitate effective marketing strategies and market reach in the 8 districts.

Services to the Trader / Aggregators:

Marketplace Platforms serve as essential facilitators for traders and aggregators in connecting buyers and sellers within the agricultural ecosystem. Through robust e-commerce infrastructure, these platforms offer a seamless trading experience, enabling stakeholders to transact online efficiently. Integrated payment gateways ensure secure and hassle-free transactions, instilling trust, and confidence among users. Furthermore, rating and review systems foster transparency and accountability, empowering stakeholders to make informed decisions. Meanwhile, logistics and transportation solutions optimize the movement of agricultural commodities, leveraging route optimization algorithms and fleet management technologies to ensure timely and cost-effective deliveries. By embracing digital marketplace platforms and logistics solutions, traders and aggregators can unlock new opportunities for market expansion and operational efficiency, driving growth and profitability in the agricultural value chain.

Digital technologies significantly benefit traders and aggregators in the agricultural sector. Market intelligence and price discovery are facilitated through real-time price information, online auction platforms, and demand forecasting tools, enabling informed buying and

[27] https://en.wikipedia.org/wiki/Precision_agriculture
[28] https://collaboration.worldbank.org/content/sites/collaboration-for-development/en/groups/digital-and-data-driven-agriculture-cop.html
[29] www.researchgate.net/publication/352743054_Digital_Inclusion_of_Farmers_and_Rural_Hinterland_The_Case_of_Digital_India
[30] https://www.fao.org/documents/card/en/c/ca8199en
[31] https://agtechfinder.com/
[32] https://www.sciencedirect.com/science/article/abs/pii/B9780323905503000126

selling decisions[33]. Logistics and post-harvest management services such as cold chain solutions, transportation optimization tools, and access to storage facilities ensure efficient and cost-effective product handling and storage. Quality control and traceability are enhanced through blockchain technology for food tracking, digital certification of products, and quality testing services, building trust and transparency in the market[34]. Risk management tools like price risk management platforms, weather insurance, and market trend information help mitigate potential risks and ensure business continuity. Additionally, access to financial services including trade finance solutions, working capital, and payment processing platforms simplifies financial operations and facilitates smooth business transactions.

Services to Others:

Research and Development (R&D) support in digital agriculture is instrumental in advancing scientific knowledge and innovation within the sector. In the context of the project (UCRRFP), data sharing platforms will provide collaborative space for the project to access and exchange valuable agricultural datasets, linking with different research institutions / agricultural universities etc. and share the learning with project target mass.

Digital agriculture will extend its benefits beyond traditional stakeholders, offering services that contribute to the overall well-being of the agricultural ecosystem. Policy and regulatory support will utilize data-driven insights to inform policy decisions and create e-governance platforms for farmers, facilitating access to government schemes and simplifying administrative processes (Dhaliwal, 2021)[35]. Research and development will be amplified through data collection and analysis platforms, collaboration tools for researchers, and access to agricultural research findings, fostering innovation and knowledge sharing in the sector. Finally, environmental monitoring and sustainability initiatives will promote responsible agricultural practices by monitoring soil health, water usage, and carbon footprints, contributing to environmental conservation and a more sustainable future for agriculture.

Broad Interventions for Digitization of Agriculture:

The agricultural sector is undergoing a period of rapid transformation, driven by external impacts from climate change, demographic, migratory flows, and uneven economic growth. In this context, digitization will be a helpful asset of agriculture sector to increase crop yields while contributing to the fight against climate change in the project. Although the farmer of the project districts will remain at the heart of agricultural data collection, they will also be the recipient of agricultural advisory and market solutions.

Being a hilly state, Uttarakhand has diverse agroclimatic conditions and hence different agricultural practices and diversified cropping system. Digital agriculture through a unified platform can provide a range of services and solution that meets the requirement of farmers living in different agroclimatic zones. Digital agriculture can improve the general livelihoods of poor rural families by reducing cost of farming, linking the producers to the market for remunerative return and providing overall decision support for making agriculture remunerative.

The project will harness the power of digital technologies in agriculture, providing digital solutions to transform agriculture and agribusiness. The project aims to pilot and scale up digital technologies to strengthen agricultural interventions, empower farming households,

[33] Data-driven Digital Agriculture: Knowledge and Learning Platform: The World Bank Group
[34] https://www.farmprogress.com/technology/startup-digitizes-data-for-better-use
[35] Dhaliwal, Amandeep. (2021). Digital Inclusion of Farmers and Rural Hinterland: The Case of Digital India. 10.1007/978-3-030-79454-5_9.

and support agricultural enterprises. For transforming agriculture and making use of digital platforms accessible and available, the project will collaborate with NIC, technology solution providing institution/s and related agencies. Digitization and digital platform will support in developing agricultural strategies, help rationalizing resources (financial and human) and holistically address ICT requirement for the agriculture sector in a more efficient manner. Such strategies would also be helpful to improve the livelihoods of rural communities.

To promote scientific agriculture, the project will develop required database, integrated applications, and platforms to support the producers, agricultural entrepreneurs and the agencies who are associated with them. These digital services would increase access to useful data, information, maps, and statistics. The project will prepare a cloud based Agri-Digital Service (ADS) platform to disseminate information on agriculture and scale up agricultural services for smallholders, by providing them digital agriculture advisories fostering digital inclusion. The tools and platform will enable evidence-based decision-making, provide weather advisory, improve agricultural production, and strengthen early warning system. The geospatial technologies and agricultural data will create a unique opportunity to find new ways of accessing data-driven solutions.

Activity 1: Data Requirement Mapping for Digital Agriculture and its Source:

The project location data will be collected from both primary and secondary sources. Field data collection will be conducted using designated data collection tools or through Participatory Rural Appraisal (PRA) exercises. The socio-economic data and resource mapping of the beneficiaries will be done through primary sources and will be collected from the project area. The climatic data and geospatial data for the project area will be collected from the secondary sources like Indian Meteorological Department (IMD), Indian Space Research Organisation (ISRO), and the Ministry of Earth Sciences (MoES provide geospatial and climatic data collected through satellites, weather stations, and other monitoring systems). The project will also access open data portals like Bhuvan portal and Open Government Data (OGD) platform to avail wide range of geospatial and climatic datasets for different project districts / sub-district.

Table 54: Data Requirement for Digital Agriculture Promotion

SN	Description	Data Category: (S: Static D: Dynamic)	Data form: (SP: Spatial NS: Non-spatial)	Availability: (R: Readily Available, C: to be collected in project cycle)	Stages of Project Cycle: IN: Inception, IM: Implementation, MT: Mid-term ET (End term)	Frequency
A	**Developing Resilient and GHG Efficient Production Systems**					
A1	*Supporting Climate Smart and Diversified Production Protocols*					
	Project block mapping	S	SP	R	IN	Once
	GP member database	S	NS	R	IN	Once
	Project Functionary Database	S	NS	R	IN	Once
	Land use database	D	SP	C	IN	Annual
	Crop Database	D	NS	C	IM	Seasonal
	Livestock database	D	NS	C	IM	Annual
	Field Demonstration database	D	NS	C	IM	Annual

SN	Description	Data Category: (S: Static D: Dynamic)	Data form: (SP: Spatial NS: Non-spatial)	Availability: (R: Readily Available, C: to be collected in project cycle)	Stages of Project Cycle: IN: Inception, IM: Implementation, MT: Mid-term ET (End term)	Frequency
A2	*Building Consortia and Digital Platform for Evidence-based Decision Support*					
	Geo-coded asset database	D	SP	C	IM	Annual
	Beneficiary database	D	NS	C	IM	Quarterly
	Beneficiary level land parcel database	S	SP	C	IM	Once
	Farmer Database	D	NS	C	IM	Annual
	Farm input -seeds database	D	NS	C	IM	Seasonal
	Farm-input-fertilizer database	D	NS	C	IM	Seasonal
	Farm-input -irrigation database	D	NS	C	IM	Seasonal
B	**Science-Based Development of Resilient Spring-sheds**					
B1	*Participatory Planning for Spring-shed Development*					
	Spring inventory	D	NS	C	IM	Annual
	Ground water database	D	NS	C	IM	Seasonal
	Climate Information - temperature, precipitation, frost and heat)	D	NS	C	IM	Realtime, forecasted once
B2	*Enhancing Spring shed Hydrology and Water Storage*					
	Para hydrologist database	D	NS	R	IN	Seasonal
	SMC measures	D	SP+NS	C	IM	Annual
	Hydrology database	D	SP+NS	C	IM	Annual
C	**Enhancing Income Resilience through Agribusiness and Entrepreneurship**					
C1	*Supporting Agribusiness Promotion Centres*					
	FIG database	D	NS	C	IM	Half yearly
	FPO database	S	NS	C	IM	Half yearly
	Market Intelligence	D	NS	C	IM	Realtime

SN	Description	Data Category: (S: Static D: Dynamic)	Data form: (SP: Spatial NS: Non-spatial)	Availability: (R: Readily Available, C: to be collected in project cycle)	Stages of Project Cycle: IN: Inception, IM: Implementation, MT: Mid-term ET (End term)	Frequency
C2	*Micro- Enterprise Development*					
	Business Plans	D	NS	C	IM	Quarterly
C3	*Income Generation Support for Marginalised Groups*					
	DBT data base	D	NS	C	IM	Realtime
D	**Project Management, Monitoring & Evaluation, and Learning**					
	Social media analytics	D	NS	C	IM	Realtime
	Capacity Building Database-events	D	NS	C	IM	Monthly
	Project Management System	D	NS	C	IM	Recurrent
	KPI dashboard	D	SP+NS	C	IM	Recurrent
	Grievance system	D	NS	C	IM	Recurrent

***Note**: Data requirement is mapped as per current assessment. Data integration with existing platforms will support in further data access across the project components.*

The project will use both primary and secondary data, collected from different sources. Primary data such as village demographic features, land holding parcel, crop yield, beneficiary details, beneficiary coverage etc. will be gathered from primary sources. Secondary data will include, rainfall, temperature, humidity, geospatial / RS data, market information, weather forecast etc. The collected baseline data will go through period changes (some on monthly basis and some on cropping season basis), based on the project inputs and intervention of different activities.

All primary data will be collected from village clusters / village / household level, whereas secondary information will be collected either through linking with the existing sites /

platform or feeding data after its collection from different sources. A detail matrix of data required, and its availability is presented for reference. However, most of the data that is currently available will serve as the baseline, which will be periodically updated as per the requirement. The project will develop a SOP (standard operating procedure) for frequency of capturing data and updating database.

Activity 2: Development of Applications:

For the collection of primary data an app will be developed having scope for collecting geo-spatial information, capturing farmer's response, and geotagging of infrastructure and facilities. The application may be administered during the local planning process (watershed planning, spring shed planning and livelihood planning) and the data will be simultaneously uploaded in the centralized server thereby reducing data redundancy.

Activity 3: Architectural Designing:

The raw or primary data collected with the help of integrate backend services, will be simultaneously uploaded in the centralized server at the head office in the Dehradun. The centralized storage facilitates efficient management and organization of the data, ensuring that it is readily available for various purposes such as decision-making, reporting, and sharing with relevant stakeholders. Once collected, the data will be sent to a centralized system for processing, aiding in the development of a decision support system for the project. The collected data will also enable all stakeholders involved in the project cycle to easily access the data of any beneficiary at any point and monitor progress. The central server or the cloud computing will process data input from different sources (land record data, climatic data, crop, irrigation, soil moisture in form, baseline data) and interface through app for query raising and solutions.

Activity 4: Developing a Region-based ICT Hub:

The areas with different agro-climatic and agro-ecological differences with wide variety of cropping pattern which demands for different agricultural information hubs for each of the areas. Information for crops of one area cannot cater the need of other area. For that purpose, different ICT resource centres at DPMU level will be established to provide local-specific information regarding agriculture and allied fields in the project districts. These ICT hubs will help in keeping the beneficiaries up-to-dated on the agroecosystem like in case the beneficiary needs any equipment or machines, he/she can connect directly to the Custom Hiring Centres (CHC) or the nearby vendor through mobile apps. Farmer can also get all the updates regarding seed and fertilizer suppliers, information on crop cycle stages, soil testing, timely weather advisory, etc.

Activity 5: Involving Stakeholders in Information Gathering:

For developing the ICT information hubs, the participation of local people is very much needed because the local people know their needs, problems, strengths, weakness, opportunities, and threats. So, the involvement of local people will be essential for information gathering regarding agricultural and marketing problems. The ICT will help farmers by connecting them to the online marketplaces where beneficiary can list their produce and vendors can browse and purchase directly, through mobile applications, the beneficiary can also upload information about their produce, including quantity, quality, and pricing, while vendors can place orders and arrange for delivery or pickup directly. The platform will also help the beneficiaries for sharing relevant information, such as market prices, demand trends, and best practices.

Activity 6: Integration of Digital Agriculture Platform with Existing Ones:

Agricultural markets are real or virtual meeting places where buyers, sellers and intermediaries meet to exchange commodities between seller and buyer (Reddy, 2018)[36]. In the exchange process, sellers, buyers, and intermediaries face many counter-party risks, like delivery failures, substandard quality, and delay in payments. There is various digital agriculture platform which is benefiting and giving services to the various aspects of agriculture. The Ministry of Agriculture & Farmers Welfare has developed major digital applications to boost technology adoption among farmers. The project will harness the potentiality of these initiatives by linking / integrating with existing digital platforms. Some of the platforms that have potential for linkage are annexed for reference. However, the PMU will examine the contextual relevance of these platforms and expected benefits to fulfil project objectives before integration.

Addressing Key Requirements:

Digital farming merges precision farming and smart farming through the deployment of intelligent software and hardware systems to enhance efficiency, sustainability, and profitability in the agricultural sector. It can be accomplished by installing network-connected 'smart' devices as components of the Internet of Things (IoT), or through software as a service (SaaS) based agricultural technology. The following are some of the breakdowns if the requirements:

Data Collection through Sensors:

Real-time data gathered by sensors on soil moisture, nutrient levels, temperature, humidity, and crop health serves as the basis for subsequent analysis and decision-making. The project will install such sensors in the project areas, based on locational suitability assessment. Looking at the risks associated in open field farming, the project may take up installation of such instruments in selected protected conditions.

Communication Networks:

Dependable communication networks, encompassing both cellular and satellite connections, are crucial for transmitting sensor-collected field data to central processing systems. The project will assess current communication networking and strengthen the capacity of the project implementing entities (DPMU and unit office).

Geographic Information Systems (GIS):

GIS software consolidates spatial data from diverse sources such as satellite imagery, sensor data, and field boundaries, enabling visualization and analysis of agricultural activities and resource management. Required software and standardized applications will be installed at different project implementation levels, based on the assessment of the PMU-UCRRFP.

Precision Farming Technologies:

This involves employing a range of tools and techniques utilizing data from sensors, drones, and other sources to develop tailored strategies for irrigation, fertilization, and pest management, maximizing resource efficiency and reducing wastage. For example, the precision irrigation tools will help farmers in improving water efficiency. The project will deploy required tools and technologies, after assessing the needs.

Using Artificial Intelligence (AI) and Analytics:

AI algorithms are essential for analysing large datasets sourced from diverse channels for decision support. They will be supportive in pattern recognition, trend prediction, and offering farmers data-driven suggestions to enhance operational efficiency. As developing

[36] Reddy, A. (2018). Electronic national agricultural markets: the way forward. Current Science, 115(5).

and deploying such a system is time and cost intensive, the project may take up AI enabled services in a later stage, based on the progress made in this direction in the initial years.

Internet of Things (IoT):

Integrating diverse devices and sensors via the internet will facilitate real-time data collection and monitoring, promoting automation and supporting / regulating agricultural processes. As discussed, the project will support in installing IOTs and related instruments for seamless data capturing and its analysis.

Agricultural Decision Support Systems (ADSS):

Agricultural Decision Support Systems (ADSS) will encompass software tools that amalgamate diverse technologies and data sources to furnish farmers with real-time recommendations, enhancing decision-making and farm performance optimization. For the purpose, required analytics will be a part of the overall ADSS to provide decision support to different stakeholders.

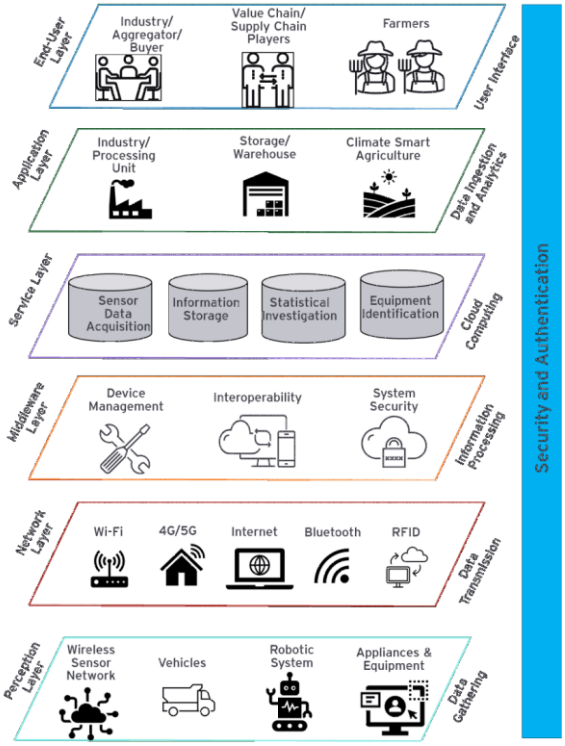


Figure 63: Six-layered architecture of Internet of Technology

3.2.2.1 Technical Management:

Interoperability:

Data from various sources like farmlands, buyers, suppliers, and warehouses may vary in format, making integration complex. Ensuring data interoperability is crucial to maximize the value of this dispersed data. Additionally, cross-technology communication will be used to enhance system interoperability.

Device Standardization:
Standardizing devices for smart farming applications resolves interoperability issues across devices, applications, and systems. This may necessitate replacing or upgrading pre-existing hardware alongside introducing new hardware at various project locations.

Data Quality:
High-quality data is crucial for meaningful results, alongside ensuring data security, storage, and accessibility. The project will implement a decentralized data acquisition and management system, gathering relevant data from farm fields using sensor-based models, satellite imagery, UAVs, and manual collection methods for basic data such as farming households and landholding patterns.

Hardware implementation:
Deploying smart agricultural setups in open fields faces challenges due to exposure to environmental conditions like heavy rainfall and extreme temperatures. The project will implement robust casing and protection measures to ensure durability and resilience against such conditions.

Adequate Power Sources:
Typically, the wireless devices deployed at farms that operate consistently may require power back up support. A suitable energy supply and management mechanism will be devised to provide energy backup support. The IOTs that require minimum energy for effective operation will be given emphasis in the project.

Reliability:
The reliability of devices, as well as corresponding software applications, is important as these IoT devices need to gather and transfer data for decision. Unreliable sensing, processing, and transmission can provide false monitoring data and hence erroneous reporting eventually impact upon the performance of agricultural system. Hence, reliability of the instruments will be checked as per the govt. approved standards.

Robust Wireless Architectures:
The project will invest in establishing robust and fault-tolerant wireless architectures with appropriate location of sensor nodes, antenna height, network topology, and communication protocols that requiring minimum maintenance.

Piloting and Scaling Up:
The project will initially pilot, at least in the initial year/s of implementation with limited number of IOT devices, machinery, and sensors. Based on the pilot observations, it can be increased gradually from second year onwards, covering all the project area by the fifth year of project execution.

User Interfaces:
Complex user interfaces of agricultural applications and devices may hinder adoption of smart farming practices. Hence, improving the user interface by making it user friendly with multimodal feedback will allow a larger section to use it to perform different agricultural operations.

Participation of Beneficiary / Target Mass:

Stakeholder engagement is vital for the success of agricultural digitization. Smart technologies can address farmers' issues, from production advice to market connections. Stakeholders must share challenges for targeted project support and provide data inputs regularly for decision support systems.

Associated Costs with Smart Systems:

The costs associated with the adoption of smart technologies and systems usually involve deployment, operating, and maintenance costs. The deployment costs of smart systems are usually very high as they involve; [1] hardware installation, [2] human resource deployment, [3] cost of software development, [4] station infrastructure etc. Likewise, to facilitate data processing, management of IoT devices and equipment, and information sharing, centralized networks and software packages is required, which ultimately increases the operating costs. To ensure the adequate operations of the smart system, occasional maintenance is also required. The project will have all the required provisions to ensure that the digital ecosystem functions appropriately meeting the basic objective of providing solutions to the identified issues linked to the project development objective. The project may pilot digital ecosystem development in selected areas and scale up gradually to other project sites.

Bridging Digital Divide:

One factor that may impact upon digitization of the agriculture is the lack of knowledge of digital technologies and their applications. Majority of the farmers may not be having required understanding and knowledge about the significance of digital technologies, how to implement and use them, and which technology is suitable for their farm and meets their requirements. Hence, the project will educate the farmers about modern farming technologies and use of digital agriculture systems. Initial hand holding support may also be helpful for the users in the project area.

Connectivity and Infrastructure:

Looking at the geographical situation of the project area, it is evident that network connectivity and associated infrastructure will be a challenge for full-fledged execution of digital agriculture ecosystem. However, project will take required measures in consultation and convergence with different other Govt. departments / service providers for effectiveness of the digital agriculture. In cases, where insufficient connectivity infrastructure persists and that limits access to advanced digital tools, project will attempt to access required data from heterogenous sources an provide valuable and actionable insights to the users.

Data Management and Sharing:

The project related data, may require sharing with different private sector entities and individuals, such as FPCs, farmers, WWMC etc. The project will devise appropriate policies for managing and sharing data with requisite safeguards, with those requiring the same for beneficial purposes. The project will provide guidelines on what types / categories of data can be open, what kind of data needs specific permission to access and what type of data can be shared to a specific category of users. The project will develop data management and sharing policies / guidelines to ensure that specific user can access relevant data only that are permissible as per the guidelines.

Capacity Building Training on ICT:

All the officials / experts / staff associated with the project will be trained on the digital agriculture and its functional dimensions. A detail training and operational module will be developed and provided to DPMU and unit offices by the PMU. The training would cover data capturing mechanism, data input system, data analysis, operation of different apps, report generation etc. Training will be organised in a decentralised mode at the DPMU level and one exclusive training for the officials / staff of the PMU. Initially, hand holding support will be provided by the developer (if any external agency is going to be associated in the process), at least for a period of one year to make acquaint all the project stakeholders on use and applicability of the platform.

Implementation Mechanism-Role and Responsibility:

Though, the project will develop digital ecosystem, it requires appropriate architectural governance and management. An important aspect of the implementation framework is establishing an institutional mechanism for the implementation and sustenance of the initiative. The PMU at the central is the obvious choice to take up the overall responsibility with required capabilities to handle the responsibility. In case of requirement, the project will build required capabilities of the PMU, including technical, domain, and program management capabilities.

The digital agriculture implementation mechanism[37] represents the crucial implementation path which refers to a structured, step-by-step process that guides in adopting and integrating various digital agriculture components into the farm operations and agribusiness promotion. The scope of an implementation path would encompass identifying the most appropriate digital technologies and solutions, planning their adoption, and (along with the Smart Ag Optimize Methodology) managing their successful integration into the project related aspects (production system and agribusiness) and decision-making processes.

Needs Assessment and Resource Evaluation:

Before embarking on the implementation of digital agriculture initiatives, it is crucial to conduct a thorough need assessment and evaluate available resources. This will involve understanding the specific challenges faced by farmers in the project districts, such as access to markets, information, and technology, as well as assessing existing infrastructure, including internet connectivity and mobile phone penetration rates.

Selection of Digital Tools:

Based on the needs assessment and resource evaluation, appropriate digital tools will be selected to address the identified challenges. These tools will include mobile applications, IoT sensors, drones, weather stations, GIS software, and blockchain technology. Each tool will be chosen based on its relevance to the local context and its potential to deliver meaningful impact.

Data Collection:

Data Collection solutions in digital agriculture will involve gathering various types of data related to crop, soil, weather, and other field conditions. These solutions will employ various tools and technologies such as yield monitors (tools that collect data on crop yields during

[37] Digital agriculture solutions can be broadly categorized into Data Collection, Decision Support, and Data-Driven Equipment and Input Adjustment. These categories work together to help farmers collect valuable data, analyse it for actionable insights, and implement precise and data-driven adjustments to optimize farm operations and achieve their desired goals.

harvest), soil sensors / monitors (data on soil properties, including nutrients, moisture, and pH levels), and remote sensing (satellites, aerial imagery from drones, and ground-based sensors) to collect valuable data that will be used to make informed decisions on the farm of the project districts. On field data such as topography, soil surveys, and weather conditions etc. will be gathered. This information is crucial for understanding agriculture planning, providing production support, weather advisory etc. that could impact crop growth. Some solutions in this category include topographical mapping tools, weather stations, and soil survey databases. Data Collection will be the foundation for effective decision-making and enabling farmers to monitor and assess their farm's performance in real-time.

Decision Support (DS):

Decision support solutions will help farmers/ beneficiaries or the project team to analyse the collected data and generate actionable insights. These systems will provide visualizations such as yield maps, soil maps, weed or pest maps, trends, and areas of improvement. Furthermore, decision support solutions will be utilized to predict crop yields, pest and disease outbreaks, and weather patterns. By leveraging these insights, farmers/ beneficiaries of the project districts can make better decisions to optimize production processes, manage inventories, and mitigate risks.

Table 55: Role and Responsibilities

Project Level	Stakeholder Category	Expected Role in Digital Agri.
Project Village / WS Cluster	Farming Households Marginalized Households	Provide required data; Support in ground truthing; Raising advisory needs; Access project benefits.
	FIGs / FPOs / Growth Centres	Provide commodity stock data; Access market price information; Linkage with buyers / markets.
	WWMC	Ground level facilitation support; Maintaining local database; Data input to unit office.
	Local GP	Provide scheme specific data; Provide infrastructure data; Data on GP level services.
	Local Aggregators / Traders	Placing requirement / demand; Access stock information; Access price information; Place stock request.
	Community Facilitators	Collection of ground level data; Georeferencing land / assets; Feeding data to unit office.
Implementation Entities	Project Unit Offices (UO)	Collection of relevant data; Georeferencing land / assets; Data base development (MIS/GIS); Periodic data updating; Data review and authentication.
	District Project Management Unit (DPMU)	Review project database; Coordinate with unit offices; Support in bridging data gap; Provide DPMU level inputs; Generate reports.
	Project Management Unit (PMU)	Assess operational needs; Establish operational mechanism; Issue operational guidelines; Developing required applications; Data integration;

		Linkage with other platforms; Issuing advisory; Issuing market information; Monitoring and tracking; Coordinate with DPMU / UO; Capacity building of DPMU / UO; Generate reports.
Consortium Partners	Technical Institutions	Analyzing data; Data driven decision support;

Expected Benefits of Digital Agriculture:

Digital agriculture will encompass a diverse range of technologies and practices aimed at improving various aspects of agricultural production, management, and sustainability through the integration of digital tools and data analytics (Ray et al., 2021)[38]. These advancements are expected to significantly impact the agricultural sector, offering numerous benefits across the entire value chain of the project districts.

Table 56: Expected Benefits of Digital Agriculture

Benefits	Description
Adaptation to Climate Change:	Weather advisory set up will be implemented for Climate-smart digital agriculture practices, such as precision irrigation, weather-resilient cropping systems, and flood / drought-tolerant crop varieties. It will help farmers to adapt to the impacts of climate change, such as extreme weather events, water scarcity, and shifting growing seasons. By building resilience and adaptive capacity, digital agriculture contributes to the long-term sustainability of food production systems.
Enhanced Efficiency and Productivity:	Precision farming techniques, employing sensors, drones, and data-driven decision-making tools, will be employed in the project to empower farmers regarding target inputs like water, fertilizers, and pesticides, optimizing resource allocation and minimizing waste. This approach will significantly be improved both efficiency and productivity of the beneficiaries of the project, as demonstrated by Bronson et al. (2017)[39] who reported an average yield increase of 12% and a 15% reduction in water usage through precision irrigation practices.
Reduced Costs and Enhanced Sustainability:	Implementation of digital agriculture will help in promoting the sustainable practices by enabling the precise application of inputs, reducing chemical dependency, minimizing soil erosion, and conserving water resources in the project area. This will help in timely advisory to the beneficiaries on the crop monitoring, and detail on farming systems will help in the reduction of beneficiaries input cost.
Risk Mitigation and Improved Decision-Making:	Advanced analytics and predictive modelling tools will leverage historical data, weather forecasts, and algorithms to help farmers / aggregators / buyers assess and mitigate risks associated with weather variability, pests, diseases, and market fluctuations and will empower them to make informed decisions, minimizing production risks and optimizing resource allocation, as confirmed by Luo et al. (2020)[40] who found that integrating weather forecasts with irrigation management resulted in a 20% reduction in water usage without compromising crop yield.
Traceability and Quality Assurance:	Digital solutions like blockchain technology, RFID tags, and other tracking mechanisms will be used in the project to enable improved traceability and transparency throughout the agricultural supply chain. This will foster consumer confidence by ensuring food safety, quality, and compliance with regulatory standards.
Market Access and Value Addition:	Digital platforms will empower farmers / aggregators / agri enterprises to access new markets and explore value-added opportunities by producing / aggregating high value crops, organic products, or niche commodities tailored to specific consumer preferences in the project district as suggested by Mondelaers et al., 2020[41]. Linkage of E-commerce platforms, direct marketing channels, and digital marketplaces will enable farmers to

[38] Ray, D., Srivastava, A. K., Bhattacharya, S., Kumar, N., & Pandey, S. C. (2021). Smart agriculture: Current state and future research directions. Computers and Electronics in Agriculture, 189, 106322.
[39] Bronson, K. (2017). The economic benefits of precision agriculture. Choices, 32(3), 10-15
[40] Luo, Y., Li, S., Wang, J., & Tang, H. (2020). Integration of weather forecast with irrigation management for high-yielding maize production in arid regions. Agricultural Water Management, 237, 106228.
[41] Mondelaers, K., Van Den Berg, M. A., & Verhoef, P. C. (2020). Psychological and behavioral decision making of green consumption. Current Opinion in Food Science, 38, 121-127.

	bypass traditional intermediaries, capturing a larger share of the value from their produce.
Knowledge Sharing and Collaboration:	Digital platforms, mobile applications, and online forums facilitating knowledge sharing, collaboration, and networking among farmers, research institutes (including consortium partners), extension agents, and other stakeholders will be implemented in this project. Online "Ask the expert tab / link" will be created to directly link the beneficiaries to the respective experts, which will foster collective problem-solving, accelerate innovation, and empower agricultural communities and other stakeholders to address common challenges and issues.
Empowering Smallholder Farmers:	Digital solutions, accessible through mobile technology, will offer significant potential to empower smallholder farmers, by providing access to market information, financial services, agronomic advice, and weather forecasts by bridging information gaps and reducing transaction costs, digital solutions can improve their productivity, incomes, and livelihoods.

Monitoring Mechanism:

Monitoring digital agriculture in project villages in Uttarakhand will be achieved through a combination of technology-enabled solutions and on-the-ground assessments as follow.

A. Remote Sensing and GIS Mapping:

Utilize satellite imagery and Geographic Information Systems (GIS) to monitor land use, crop health, and changes in agricultural practices in the hilly and plain project districts. This can provide valuable insights into crop growth patterns, soil health, and the impact of interventions.

B. Internet of Things (IoT) Sensors:

Installation of IoT sensors in key locations to collect real-time data on temperature, humidity, rainfall, and soil moisture, etc of the project districts. This information can help farmers make informed decisions about irrigation, planting, and crop protection.

C. Mobile Applications:

Develop mobile applications tailored to the needs of farmers in the project districts of Uttarakhand. These apps can provide access to weather forecasts, market prices, extension support service etc. Additionally, they can facilitate communication between farmers and extension workers.

D. Agricultural Drones:

Employment of drones equipped with multispectral cameras to monitor crop health, detect pests and diseases, and assess the effectiveness of various agricultural practices in the districts. Drones can cover large areas quickly and provide high-resolution imagery for detailed analysis.

E. Blockchain Technology:

Implementation of blockchain-based systems to track the production and supply chain of agricultural products in the targeted districts of Uttarakhand. This will help ensure transparency, traceability, and fair pricing for farmers / beneficiaries while reducing the risk of fraud and counterfeiting.

F. Feedback Mechanisms:

Feedback mechanisms will be gathered input from farmers and other stakeholders about their experiences with digital agriculture technologies. This feedback will inform future interventions and ensure that solutions are tailored to the needs and preferences of end-users.

By implementing these strategies, digital agriculture can be effectively monitored and evaluated in project villages in Uttarakhand, leading to improved productivity, resilience, and livelihoods for smallholder farmers.

Policy and Regulatory Environment:

The conducive govt. policy and regulatory framework would be supportive in bringing in and spreading up of digital agriculture. However, addressing data ownership and addressing data privacy and security would be in the fore front. As the project will invest in developing required infrastructure for collection, analysis and sharing data to benefit different stakeholders, the ownership of data will remain with the Watershed Management Directorate, Government of Uttarakhand. The project will also take all the required measures, in line with the Govt. act / policy, to ensure data privacy and security.

3.2.3 Development of Knowledge Hub in WMD:

The project is having a strong scientific base to pilot climate resilience and promotion of climate resilience practices. The GHG measurement, spring shed development, NRM based interventions in a watershed approach, digitizing agriculture etc. are some of the critical aspects that the project has planned to take up. Hence. It becomes essential to develop the institutional capacity of WMD to manage the project interventions in a desirable manner. To equip itself to deal with the challenging requirements, WMD will establish a knowledge hub at the PMU level where experts / consultants from different disciplines (internal from Govt. system and from open sources) will be engaged to support in execution of key project activities. A laboratory will be established at the PMU level, well equipped with required instruments, that will deliver weather advisory services to the farmers. It will support farmers to plan their farm operations, including irrigation scheduling. A demonstration unit will also be established at the PMU level on climate resilient practices for learning of different stakeholders. The knowledge hub will have specific documentation cell to document implementation learning and its dissemination, including climate resilient practices and technologies for wider adoption. Different learning documents, IEC materials, audio-visuals will be developed and distributed, including use of e-platform/s as a part of the knowledge sharing and practice promotion strategy.

Table 57: Knowledge Hub in WMD

SN	Key Activities of Knowledge Hub in WMD
1	Engagement of consultants at PMU.
2	Setting up of demonstration unit for climate resilient practices at PMU.
3	Setting up of a lab for provision of weather and other advisory services.
4	Documentation and dissemination through pamphlets / wall paintings / brochures / publications / books etc of Climate Resilient practices and technologies.
5	Audio Visuals/Short films on Climate Resilient practices and technologies.
6	Documentation and dissemination of Climate Resilient practices and technologies through e-platforms.

3.2.4 Development of ICT Infrastructure:

The project will make use of evidence-based decision support system using digital platform/s. Under this sub-component, required ICT infrastructures will be developed at PMU and DPMU level for DSS. Required hardware will be installed and software will be developed for real time monitoring of project progress and tracking GHG emission. The ICT infrastructure will also be supportive in developing different communication materials and audiovisuals for learning (*refer digital agriculture for details*).

Table 58: Developing ICT Platform

Particulars	Activities
Development of ICT platform for Dissemination of Project Learning	Development of ICT infrastructure in PMU / DPMU
	Development of software for various portal / dashboard
	Setting up of monitoring systems for GHG emissions
	Setting up of monitoring systems for real time project progress mapping
	Developing learning documents (procuring consultancy services)
	Development of audiovisual and communication materials

3.2.5 Capacity Development of Stakeholders / Line Departments:

As discussed in different sections / sub-sections, the project will help in developing capacity of different stakeholders associated with the implementation of the project at different levels. The community organizations such as WWMC, FIGs, FPOs, DNSS etc. will be supported for developing capacity on various aspects of the project, like climate resilience package of practices, INM / IPNM / IPM, organic farming, protected cultivation, micro irrigation, crop diversification, crop water budgeting, micro-enterprise management, livestock management, agribusiness etc. Capacity development measure under the project would cover not only training, but also workshops, exposure visits, demonstrations, hand holding and escorting support to the stakeholders at the village / cluster level.

Table 59: Capacity Building of Stakeholders / Line Departments

Particular	Activities
Capacity building training for project stakeholders	Village level workshops
	Field implementation unit level workshops
	Workshops at DPMU level
	Special workshops
	Training at village level
	Training at DMPU level
	Training at PMU level
	State level training
	Trainings conducted by State and Govt of India level Institutes
District level workshops for officials of the line departments	District level workshops for officials of the line departments at DPMU level
Exposure visits of project stakeholders	Exposure visits of stakeholders within state
	Exposure visits of stakeholders outside state
	Exposure visits of staff within state
	Exposure visits of staff outside state
	International Exposure visits
State level workshops and seminars	Workshops at PMU/State level
	Workshops with line departments and research institutes / universities / consortia members etc. at State level
	Seminars at PMU/State level
National level workshops	National level workshops
Note: *The project will organise special training for the officials / staff of PMU, DPMU and FIU on digital agriculture, related software operation, GIS application, MIS, and related IT aspects.*	

Apart from capacity development of primary stakeholders, the project will also support in capacity development of project implementing entities like PMU, DPMUs, Field Implementation Units and associated line departments on project aspects. Different seminar and workshops will be organized from district to National level on various themes linked to the project. Experts and institutions will be invited for presentation and discussion on project themes.

The project will develop annual capacity development plan and schedule / calendar of execution for different stakeholders. Different learning materials, training modules, audio-visuals along with documents prepared by the knowledge hub / documentation cell of the PMU will also be utilized for capacity development.

Table 60: Role and Responsibilities; Capacity Building

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC / FIG	Suggesting capacity development needs
		Support of unit office in organizing events
		Mobilize people / actively participate in programs
2	Field Implementation Unit	Assess capacity needs of different stakeholders
		Prepare capacity development plan & calendar
		Organise capacity building events
		Follow-up of adoption of inputs
		Organize refresher courses
		Organizing exposure of primary stakeholders
		Document events / training report preparation
3	District Project Management Unit	Support FIU in preparing capacity building calendar
		Support in providing resource person/s
		Support PMU in preparing learning materials
		Monitor capacity development events & adoption
		Preparing dist. level capacity building calendar
		Organise dist. level trainings / workshops / seminars
		Organize exposure of dist. officials / stakeholders
4	Project Management Unit	Prepare annual capacity building calendar / schedule
		Prepare training modules, manuals, IEC materials etc.
		Support DPMU & FIU in capacity building activities
		Organize State and National level workshops / seminars
		Organise State & National level exposure programs
		Coordinate with other institutions for capacity building
		Document capacity building events & dissemination
5	Consortium / Other Institutions	Support PMU in preparing training modules / manuals
		Provide resource persons as per the requirement
		Participate in workshops / seminars
		Support PMU / DPMU in overall capacity building events

Chapter 4

Component B: Science Based Development of Resilient Spring Sheds

Chapter Four: Component B:
Science Based Development of Resilient Spring Sheds:

The Himalayan region is blessed with many springs. But unfortunately, these vital resources are under stress due to climate variability, seismic activity and changing land-use practices (deforestation, urbanization, etc.). Increasing need of water for the growing population, modern industrial practices and intense agricultural activities have increased the demand for groundwater resources. This has had an impact on groundwater resources and spring flows, leading to a decline in spring discharge or even drying up of springs, affecting the lives of millions of people dependent on them[42].

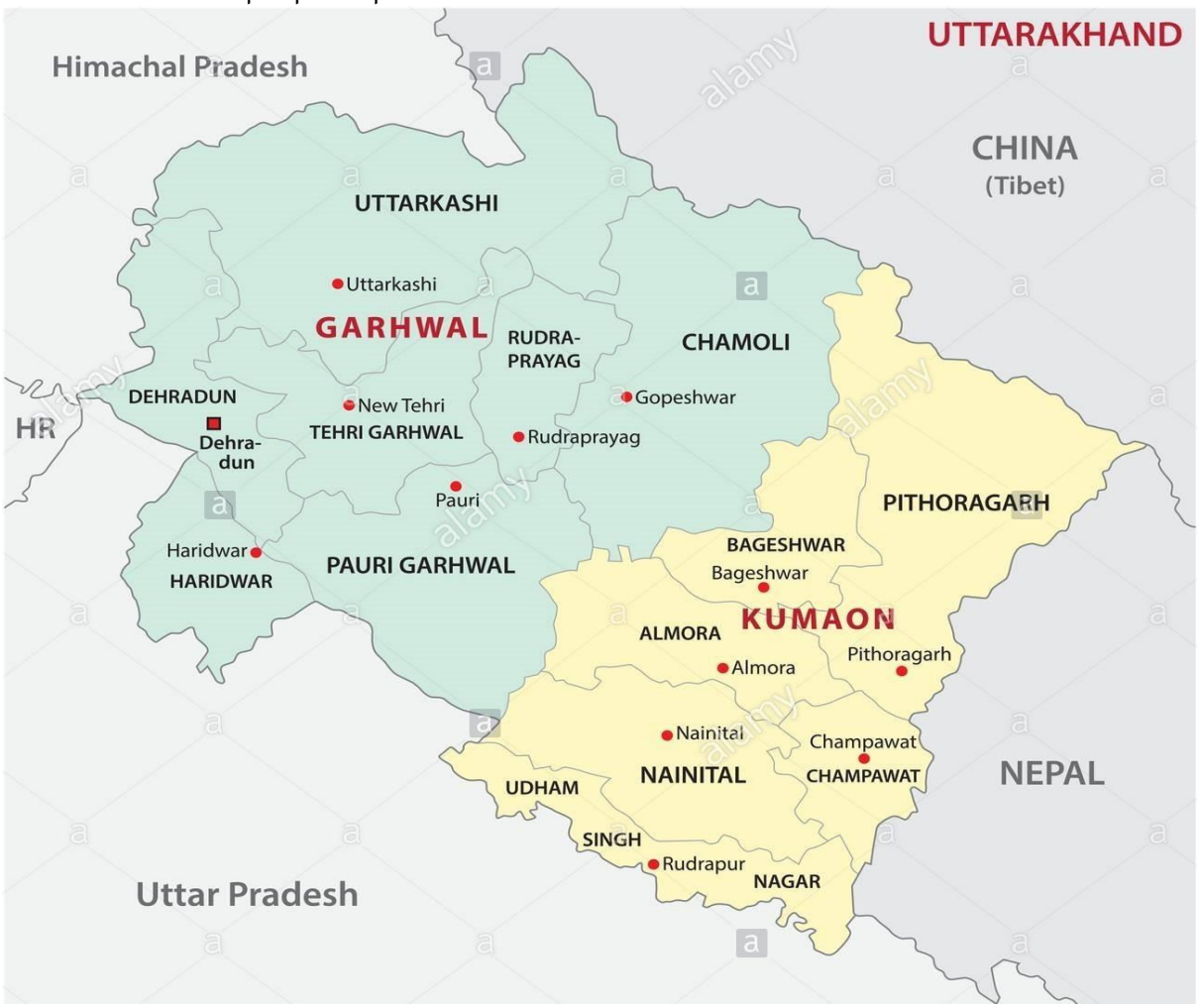
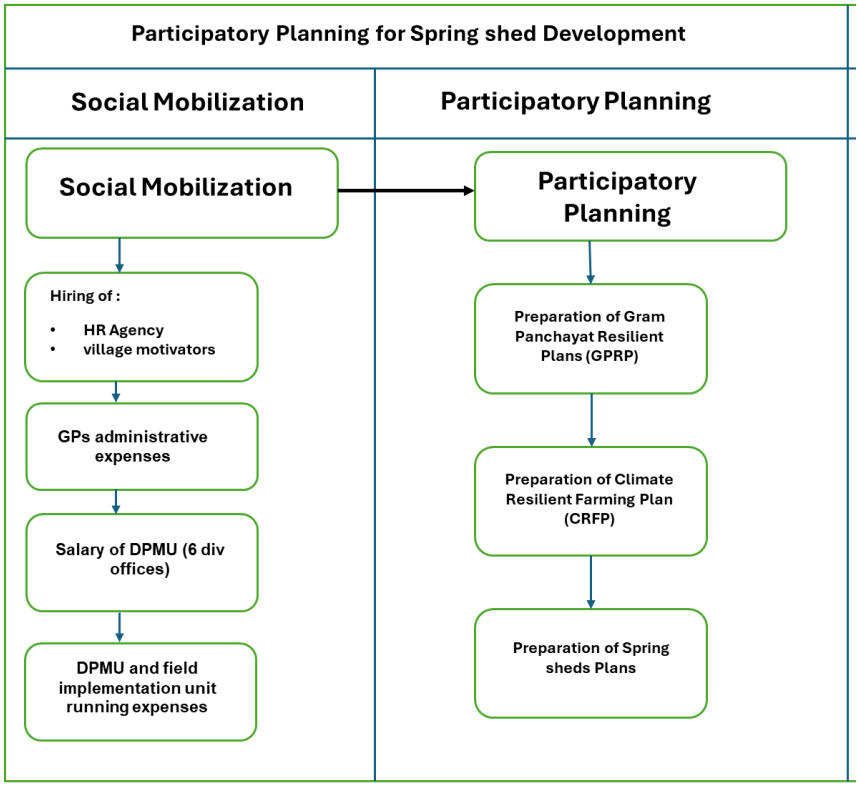


Figure 64: Map of Uttarakhand with Regions

Reduction of spring discharge is experienced as a common phenomenon across the Himalayan region, with evidence of springs drying up completely[43]. Despite the key role of springs in water security, sustainable development of these resources is not given due importance in the Himalayan region. There is a dearth of scientific knowledge on Himalayan springs despite the high dependency of people on these resources and their increasing sensitivity to various factors (NITI Aayog, 2018). There is a need for a scientific approach to address the issue of spring water depletion, along with efforts to protect springs to help ensure water security, biodiversity, and ecosystem sustainability.

[42] Khadka K., et al., Spring-shed Management: An approach to revive Drying Springs in the Himalayas.
[43] (Negi & Joshi, 2002; Tambe et al., 2012; Valdiya & Bartarya, 1989)

During the monsoon season, there is abundant water for the communities in the Himalayan region[44]. However, during the dry period, water scarcity is a common problem, exacerbated by changing precipitation patterns attributed to climate change[45]. In the Himalayas, groundwater is mostly replenished by precipitation, although in some locations snow and glacier melt waters are also important[46]. The idea of constructing ponds in the upstream to increase spring discharge or rejuvenate the springs below has gained momentum in recent times (Sharma et al., 2016). To enhance spring discharge, it is necessary to improve the efficiency of the replenishment process (Bouwer, 2002). At the level of the individual spring, this can be achieved if the area where precipitation directly recharges the spring's groundwater aquifer can be identified (Tambe et al., 2012). Once the recharge area is identified, various vegetative and structural measures can be applied to improve the infiltration of precipitation in this zone.



People residing in mountain regions have been depending upon springs. Revival of this traditional source of water is extremely important for the region's sustainable growth. At the national level, a gross estimate of nearly 200 million people depends upon spring across the Himalayas, Western Ghats, Eastern Ghats, Aravalli, and other such mountain ranges. It implies that more than 15% of India's population depends on spring water (Niti Ayog).

Spring-Sheds:

In the mountain regions, groundwater naturally discharges in the form of springs, which occur where a water bearing layer (perched aquifer) intersects with a hill slope and groundwater seeps. Spring shed is the unit of land where rain falls (recharge area), and then emerges at discharge points of the spring. It is the natural unit for revival and management of spring. Spring-sheds differ from watersheds because the source of spring is determined by aquifer characteristics (underground geology and rock structure) and not surface topography. A spring shed consists of the entire hydrological catchment area that contributes water to a spring. It covers (a) recharge zones (b) groundwater flow paths (c) and the springs. On the other hand, watershed encompasses the units of the land surface that drain water to a common point through a system of interconnected stream channels called the drainage network.

[44] Khadka K., et al., Spring-shed Management: An approach to revive Drying Springs in the Himalayas.
[45] (Gentle & Maraseni, 2012; Malla, 2008; Merz et al., 2003; Tiwari & Joshi, 2015)
[46] (Andermann et al., 2012; Mukherjee et al., 2015)

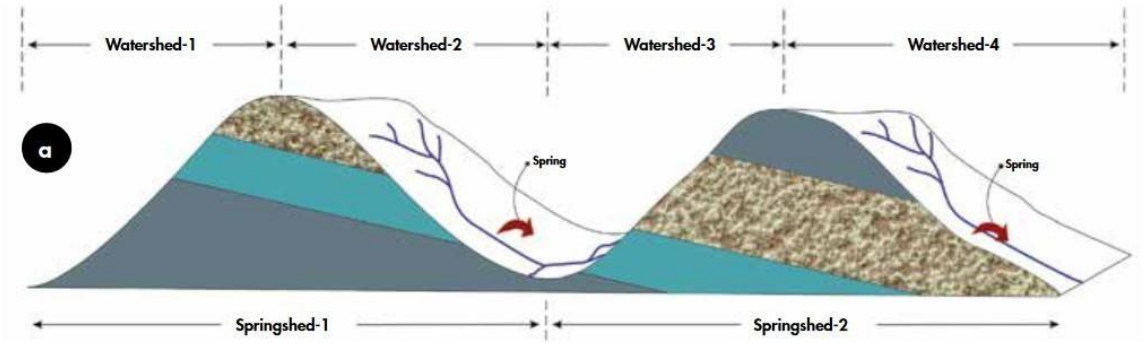


Figure 65 Spring shed and watershed delineation.
Source: Spring shed Manual by ICIMOD (ICIMOD Manual 2018/4)

There are different kinds of spring sheds, i.e., [1] Depression springs, [2] Contact springs, [3] Fracture springs, [4] Fault springs, and [5] Karst springs. Springs are also classified based on its order and volume of discharge[47]. *Classification based on the order of springs*[48]: this is based on the volume of flow based on the unit of time.

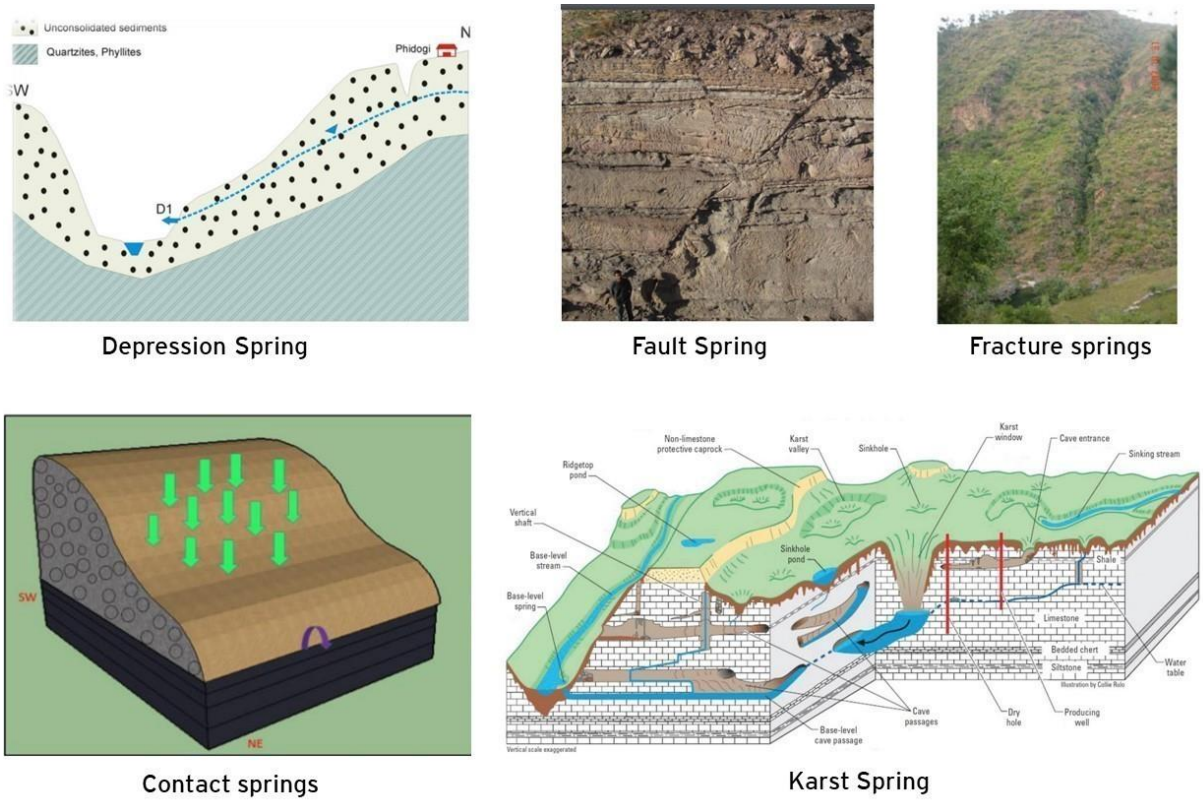


Figure 66: Types of Springs
(Figure Source: Sharma S.; Spring Hydrology; Science Based Approach for Spring shed Management)

Fracture Springs: Fracture springs occur because of permeable fracture zones appearing in low permeability rocks. Movement of groundwater is mainly through the fractures which tap both shallow and deep aquifers. Springs are formed where these fractures intersect the land surface	**Contact Springs**: Contact springs emerge at places where relatively permeable rocks overlie rocks of low permeability. A lithological contact is usually marked by a line of springs. Such springs are usually associated with perched aquifers in mountains.

[47] Meinzer (1927) and Alfaro and Wallace (1994)
[48] Meinzer (1927) and Alfaro and Wallace (1994)

Depression Spring: Formed at topographic lows and formed when water table reaches the surface due to topographic undulations. It creates a local flow system, and a spring is formed at the local discharge zone.	**Fault Spring:** Faulting may also give rise to conditions favourable for spring formation as groundwater (at depth) under hydrostatic pressure (such as in confined aquifers) can move up along such faults. An impermeable rock unit may be brought in contact with an unconfined aquifer due to faulting.
Karst Spring: It is normally observed in mountainous region with limestones. Springs in limestone terrains can be interconnected to topographic depressions caused by sinkholes – depressions in the ground surface cause due to the dissolving of limestones below. Water moves through the cavities, channels, conduits, and other openings developed in limestones.	

Table 61: Spring Magnitude and Flow Category (Meinzer, 1923[49]; Nisa and Umar, 2024[50])

Spring Magnitude	Flow
1st	>10 m^3/s
2nd	1-10 m^3/s
3rd	0.1-1 m^3/s
4th	10-100 l/s
5th	1-10 l/s
6th	0.1-1 l/s
7th	10-100 ml/s
8th	<10 ml/s

Spring-Sheds in Uttarakhand:

Variability in the climate, especially erratic rainfall pattern, ecological degradation, change in land use and land cover, infrastructural development etc. have been posing pressures on mountain aquifer systems, resulting in reduction of spring yield and/or dying of springs across the mountain regions. Hence, it becomes important to rejuvenate the springs through appropriate scientific management practices. The NHI Roorkee has suggested around 60,000 spring-sheds present in the state and mapping of the same has only been limited to 6207 (Approx.) (SAARA, 2024, Ministry of Jal Shakti, 2024[51]). Still large numbers of spring-sheds are yet to be mapped in Uttarakhand (Jal Shakti Mantralya). As the intervention districts are having a significant number of springs, the project has planned to invest in spring rejuvenation to meet water demand of the locals.

Climate Change and Spring Vulnerability:

The springs are impacted by the climate change and land use change. The sensitivity of the springs due to climate change relates to extent of snow melt (related to warming), rainfall pattern, and evapotranspiration. Amongst the springs, Karst spring aquifers[52] are most vulnerable to climate change. Future climate scenarios for the region indicates high surface-runoff and occurrence of extreme events such as floods, glacial lake outbursts, and landslides. These events, apart from the enhanced anthropogenic action triggering changed land use, can affect the flow and water quality of springs.

The objective of the component is to improve spring shed efficiency by investing in (i) undertaking comprehensive catchment treatment around spring sheds; (ii) improving quantity and stability of spring flows through drainage management; and (iii) increased volume of water stored for farm use in farm ponds. With technical inputs from consortia partners, this component will support enhanced participatory micro-watershed planning,

[49] Meinzer O E 1923 Outline of groundwater hydrology, with definitions; US Geol. Surv. Water Supply Paper 494 48-56

[50] Nisa, F.U., Umar, R. Spring water system classifications and their methods of study: An overview of the current status and future perspectives. J Earth Syst Sci 133, 10 (2024). https://doi.org/10.1007/s12040-023-02218-7

[51] https://www.niti.gov.in/sites/default/files/2021-12/ResourceBook-on-SpringshedManagement.pdf

[52] Panwar, S. Vulnerability of Himalayan springs to climate change and anthropogenic impact: a review. *J. Mt. Sci.* 17, 117–132 (2020). https://doi.org/10.1007/s11629-018-5308-4

incorporating spring shed treatment; rehabilitation of degraded common land; and water harvesting/storage from improved spring flows. It will enhance water supply and reliability, ensuring more timely input with water budgeting for each crop, for improved farm productivity under Component A. A plan will be developed for each of the selected vulnerable spring sheds, considering climate trends, during early stages of implementation that will provide a roadmap for the implementation of project activities and investment priorities (*Ref. Project Appraisal Document*).

4.1 Participatory Planning for Spring-Shed Development (Sub-Com B1):

With the objective of improving resilience in the project villages / GPs, the project will prepare [1] Gram Panchayat Resilience Plan (GPRP), [2] Climate Resilient Farming Plan (CRFP), and [3] Spring Shed Management Plan (SMP). All these plans will be prepared in a participatory manner, involving project stakeholders, like villagers in general, community-based organizations (WWMC, RVC, FIG, FPO, etc.), technical institutions, and other stakeholders. Following PRA methods and tools, key challenges and prioritised solutions will be mapped for intervention (interventions in alignment with project frame). The plans to be prepared under this sub-component will be linked to the intervention framework of component A and component C.

4.1.1 Social Mobilization:

To make the planning participatory, social mobilization will be the initial work where villagers will be provided with required information on the objective of planning and its relevance in the context of the project. For mobilizing people, village level motivators will be engaged by the project. The motivators will be selected jointly by the WWMC and unit office following certain fixed criteria, like understanding of the locality, educational background, relation with villagers / locals etc. The selected motivators will aware and educate the people on the project and planning process. For effective discharge of responsibility, the selected motivators will be trained by the unit office on different aspects of the project, planning process, expected output of the planning, utilization of plan output for project intervention etc.

Role and Responsibilities:

Table 62 Role and Responsibilities for Social Mobilization

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC	Discussion with Unit Office on planning aspects
		Select village motivators with officials of unit office
		Participate in the orientation of motivators
		Organize awareness meetings / workshops
		Support motivators in community mobilization
		Prepare database and submit to unit office
2	Field Implementation Unit	Initial consultation with WWMC / villagers / stakeholders
		Finalise selection criteria for motivators
		Selecting motivators along with WWMC
		Prepare orientation plan for motivators
		Conduct orientation training of motivations
		Documenting orientation & preparing training report
		Support motivators & WWMC for awareness
		Maintain database of motivators
		Sharing progress report with DPMU
3	District Project Management Unit (DPMU)	Support Field Implementation Unit in all aspects
		Participate in orientation of motivators
		Participate in awareness camps / meetings

		Monitor awareness activities
		Reporting to PMU on progress & performance
4	Project Management Unit (PMU)	Support DPMUs and FIU
		Progress review and guidance to DPMU / FIU
		Periodic monitoring and review
5	Technical Institutions (Consortium)	Support to PMU / DPMU as per the requirement

4.1.2 Participatory Planning:

The GPRP will be based on watershed principles with focus on natural resource management within a hydrological boundary. The successful planning, preparation and implementation of any community driven activity or project depend on the effective participation of the community itself and social mobilization plays an important role in ensuring it. The proposed project puts special emphasis on social mobilization for which following steps would be taken up at different levels.

Preparatory Work by the Project:

WMD staff at unit office and DPMU level will do initial preparatory work before initiating planning. Key activities to be taken up as a part of the preparatory work are as below.

- Communication and information packages for GPs and village communities will be prepared;
- Training / orientation of project functionaries (WMD, MDTs, FNGOs, PNGOs) on the PDO of the project; the processes, roles and responsibilities of each project entity, and stakeholders;
- Training of project functionaries in preparing GPRP, with reference to project documents / guidelines / Govt. communications etc.;
- The PMU-UCRRFP will facilitate in accessing support of consortium partners / technical institutions on identified key aspects of watershed level planning, such as geo-hydrological planning, catchment treatment measures (SMC by gradient) etc. In case of requirement, PMU-UCRRFP may engage an external institution of State and National repute to impart training / conducting orientation of project personnel on watershed planning.

Orienting Villagers on Project:

Based on the planning requirement, project field personnel will utilize various communication tools to educate and orient communities on need of the planning, key aspects that are to be looked in to in the planning and coming out with feasible and implementable options in line with the project mandate and overall implementation framework.

- Providing basic information on the project and bringing consensus among villagers and GP to participate in the process;
- Signing of MOU with the concerned GP on GP's willingness to participate in the project as per the project design and implementation framework;
- Social mobilization and conducting PRA exercises at village / GP / cluster level;
- Use of communication tools such as printed materials, audio-visuals, folk performances to create awareness among the community about watershed management, concept of community-driven and process-led development, concept of ownership, and details of its contribution to the project;
- Provide project brief to the GP / WWMC/DNSS and different community organizations for their learning and reference;

Constitution of Water & Watershed Management Committee (WWMC):

Based on the consultation with the local GP, status of WWMC will be assessed about their existence and functioning. In case of need for organization / reorganization, formation of WWMC will be facilitated by the project with the direct association of the GP and its members. Constitution of the WWMC will be in line with the provisions of State Act and Rule.

- The Water and Watershed Management Committee (WWMC), including the chairperson will be constituted as a committee of GP under the chairmanship of Gram Pradhan for every selected GP in the project area;
- The WWMC will consist of at least one ward member from every revenue village in the GP. Of these ward members, at least one woman, one OBC and one SC/ST ward member will be included in WWMC as members;
- One female ward member of the WWMC will be nominated by the GP as a co-signatory to operate project account with Gram Pradhan;
- If Gram Pradhan is a woman; a male ward member of WWMC may be nominated as co- signatory to operate the project account;
- WWMC will take up and assist in mobilization of villages, lead the entire process of planning, preparation & implementation of GPRP and ensure the strict compliance of ESCP in project formulation and implementation;
- WWMC will support in selection of beneficiaries, implementation of project activities and ensure inclusion and equity parameters in project execution;
- In case, if the committee is entrusted with procurement of goods, works and non-consulting services, procurement guidelines of the project will be adhered to;
- The committee will submit physical and financial report, in the prescribed format/s to the project on timely basis;
- It will ensure the audit of GP annual accounts on a timely basis and submit the audit report to the project.

Formation of Revenue Village Committee (RVC):

The RVC will be established by the WWMC after signing the Memorandum of Understanding (MOU) with WMD.

- The WWMC, in collaboration with the project team, will facilitate the establishment of Revenue Village Committees (RVCs) through open meetings at each revenue village level, comprising 7-11 members;
- The RVC will be headed by Gram Pradhan or Ward member belonging to the concerned revenue village;
- Gram Pradhan will head the RVC of that revenue village in which he/she is a voter, or he/she may nominate any ward member as chairperson of that revenue village;
- In revenue villages with multiple ward members, villagers will nominate a chairperson for the RVC through consensus during an open meeting. The remaining ward members will automatically become members of the RVC;
- At least 50% members The RVC should be Women voters from respective Revenue Village;
- To ensure a fair representation of SC/ST population, at least one male and one female belonging to SC/ST should be the members of RVC;
- The RVC will have a woman secretary, which will be selected by the members of the RVC or in the general meeting of the revenue village. If the chairperson of the RVC is a woman, then a male member can be nominated as secretary;

- The bank account of the RVC will be operated by the joint signatures of the chairperson and secretary;
- The RVC will be the day-to-day operating and decision-making body of the Revenue Village;
- RVC will primarily be a consultative committee which will be used for implementation of the project activities;
- RVC will help in facilitating community's participation, identifying the priorities, planning and implementation of the project at revenue level;
- Project implementing entities will help the community in understanding role and responsibility of the RVC vis-à-vis that of its GP and Water & Watershed Management Committee (WWMC);
- RVC, UGs and individuals will, themselves or with the help of the Accounts Assistant (AA), maintain their books of accounts and records for all funds received and expenditures incurred under the project.

Formation of Users Groups:

The formation of Users Groups will occur collaboratively between WWMC and MDT following the identification of community assets to be established.

- User groups will be formed after identification of community assets to be created under GPRP.
- These groups will act as implementers of the project activities and will also be responsible for use and maintenance of the assets.
- They will also create funds for future Operation and Maintenance of the assets created after project withdrawal.

Capacity Building Activities

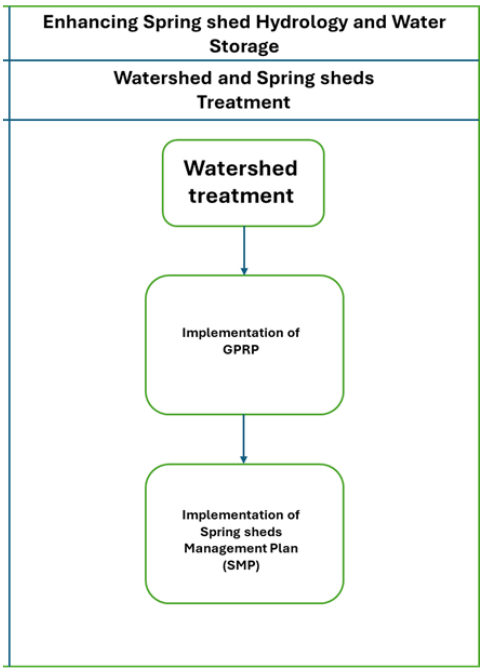
- Sensitization and training of project staff (WMD and PNGOs) and GPs to facilitate the implementation of a community driven watershed project;
- Comprehensive information, training and capacity building of individuals and CBOs in the village communities to participate effectively in the project;
- Training of project staff, GPs and RVCs on the rules and regulations of the project including ESMF and Financial and Procurement Guidelines;
- Training of AA to provide services to the GP;
- Training of VM to motivate and mobilize village communities.

4.1.2.1 Gram Panchayat Resilient Plan (GPRP):

The project will prepare Gram Panchayat (GP) specific climate resilient plan, termed as GPRP in a participatory and consultative manner with a scientific base. The plan will objectively look at rehabilitation / restoration of natural resource base of the watershed along with its improvement for stabilizing and augmenting ecosystem services, and overall socio-economic development of the local community. The GPRP would be a dynamic document and every year it is reviewed by the Gram Sabha. The plan will adhere to the overall objective of watershed development and its management in a sustainable basis with the active participation of local community and governance structure/s.

The GPRP will provide an analytical integrated framework for the development of micro watersheds / cluster of watersheds and villages / GPs falling under the watershed within the project jurisdiction. The plan will encompass required development and management efforts for the restoration & improvement of water sources, improve water availability, restoration of degraded areas and to protect / improve overall natural base for climate resilience. The

project recognizes that not all the watersheds planned for coverage under the project are threatened or impaired to the same degree. In many cases watershed stakeholders have also expressed their interest to develop and implement watershed plans for maintaining & improving the natural resource base and minimise expected degradation in future through various measures. While steps for resilient planning and implementation would be same for all the GPs, the plan and development strategies may vary depending upon local priorities and need for resilience.



Step 1. Building Collaboration and Partnerships:

The first step in the watershed planning process would be to build partnerships with local GP, community level organizations, and other local stakeholders. Collaboration and partnering with the locals will provide insights to the local issues, challenges people face, solutions that they visualise and perceived to be adopted, and solutions that are more acceptable and feasible to implement. Association of local stakeholders in the planning process will help in setting watershed development objectives based on common concerns and will be supportive in developing a set of activities and monitorable indicators. Association of local community in the planning process will also be helpful to identify their capacity needs and develop an effective information sharing mechanism. Stakeholder involvement will also increase the probability of long-term sustenance of the interventions, bringing ownership along with mobilizing their contribution for the implementation of activities.

Conducting Public Outreach:

Awareness and Information / educational activities will be initiated at the outset of the planning effort to familiarize the stakeholders on the objective of such planning, outline the planning process, and enlisting stakeholders for their active participation. Public outreach and mobilization initiative will make the local stakeholders understand the importance of the planning and how their involvement will shape up the future interventions and management of the project in the longer run.

Identify Key Stakeholders:

The project will identify key stakeholders at the village and GP level who can contribute to the process in terms of providing information, suggest key interventions, participate in decision making, support in intervention framing etc. To make stakeholders involvement more productive and meaningful, the project will educate and aware them on the benefits of the intervention and how these benefits can be harvested through their participation.

Identify Issues of Concern:

It is important for the identified stakeholders to assist in identifying issues of concern in the village / cluster of villages / GP. The local GP and community organizations may have a historical perspective on problems in the area and a sense of whether conditions are improving or deteriorating. These issues will help to shape the overall objective of GPRP and determining what information is needed to accurately define and address the concerns. This will also help in determining the geographic scope of the plan (different geo-hydrological interventions).

Setting Planning Objective:

A fundamental step in the partnership-building process is to ask stakeholders to list their long-term objectives for improving climate resilience. The objectives may undergo through a refinement / redefining process during the planning to represent acceptable and shared objectives. Objectives with measurable targets and indicators will be developed and finalised with the stakeholders.

Step 2. Understanding Resilient Perspective:

Understanding of the local problem/s will be the basis for developing plan and devising effective management strategies to meet the objective. Analysing the situation, backed by scientific data, would help to focus upon key climate resilient measures and required management efforts. Based on the analysis of the situation, GPRP plan would broadly include [1] identification of causes for the current situation, [2] potential measures that would help in addressing the causes, and [3] sustenance of the interventions in the long run.

- Mapping data requirement for preparing plan and data sources;
- Collection of GPRP specific required information / data;
- Identifying data gap and devising strategy to bridge the gap;
- Preparing a watershed inventory;
- Collecting additional data if needed (primary and secondary sources);
- Analysing data objectively;
- Identifying causes that impact the natural resource base in a GP.

Gathering Data and Creating Inventory:

To understand the situation of the village / cluster, required data will be listed out along with its source of availability. Both primary and secondary data would be used to analyse situation for better understanding of the GPRP. Different categories of data will be considered for situation analysis and understanding of climate resilience perspectives, i.e., [1] physical and natural features (hydrology, topography, soil type etc.), [2] land use and land cover (land type, different uses of land, forest cover, agricultural land, fallow land etc.), [3] demographic situation (able bodied persons, sex ratio, social composition, total population, marginalised section etc.), [4] people's engagement and dependency on natural resource base on seasonal / annual basis (engagement in different sectors, duration of engagement in agricultural activities, lean period, forest dependency etc.), and [5] available water resources and its condition (irrigation by sources, irrigated area etc.).

Information / data would be collected not only from government sources, but also using information technology (satellite-based imagery and extracted data), GP level information, earlier studies, and local community.

Data Analysis:

Once, required data / information is collected, it will be analysed to understand the current situation. Analysis of data will also pave the way to address the identified issues, like depletion of natural resource base, drying up of spring, etc. through appropriate measures to improve resilience.

Identifying Causes to be Addressed:

Together with the inputs from stakeholders and their local knowledge of village / area, analysed data would help to understand the problems and its causes. Transact walk and reconnaissance survey would further help to identify critical areas (like degraded area) to focus upon and to give priority to conservation practice implementation.

Step 3. Setting Objectives and Identifying Solutions:

After characterization and quantification of the problems at the village / GP level, objective of promoting climate resilience will be defined with measurable targets and indicators. Accordingly, management practices will be determined for the identified critical areas to achieve the objectives.

- Setting overall development and management objectives;
- Developing targets and indicators;
- Identifying critical areas;
- Developing management measures to achieve objectives.

Developing Indicators/Targets:

The project will develop indicators and targets to quantitatively measure whether the investment is meeting its objectives. Earlier set indicators with the stakeholders to determine achievement from climate resilience perspective can be refined to measure implementation. When developing indicators and targets, interim milestones will be finalised that will measure the implementation of activities, including the costs associated with those activities. The project will have environmental indicators to measure the current conditions and help to identify the stressors.

Step 4. Designing Implementation Program:

Once the objectives and indicators are finalised, implementation schedule will be prepared. Implementation program will be designed, detailing how plan for improving climate resilience will be implemented.

- Developing an implementation schedule;
- Developing interim milestones to track implementation of management measures;
- Developing criteria to measure progress toward meeting resilience objectives;
- Developing monitoring mechanism and aspects to monitor;
- Developing information and education aspects for stakeholders;
- Developing evaluation process;
- Identifying technical and financial assistance needed to implement plan;
- Assigning responsibility for reviewing and revising the plan.

Step 5: Implementing the Plan:

The prepared plan will be implemented following the road map developed. Individual activities will be implemented in a coordinated manner, involving project officials, GP, local community, and technical institutions.

Monitoring:

As a part of the development and execution of the plan, monitoring mechanism will be in place to track and evaluate the effectiveness of the implementation efforts. Monitoring will cover activities that are implemented, process of implementation of plan, stakeholder association in implementation, implementation of activities as per the schedule, etc. Key inputs and outputs will be monitored periodically to ascertain that activities are implemented as per the plan. Periodic tests will be conducted for soil moisture, soil organic carbon, water quality etc.

Preparation of GPRP:

To improve system resilience at the GP level, feasible and implementable plan will be prepared by the revenue villages. The plan will be need based to address the identified issues and challenges. The plan will have different vegetative and mechanical measures required for catchment stabilization, improving soil moisture regime, harvesting run-off and its effective use in irrigation and community purposes, treatment of drainage line in feasible cases, construction of irrigation channel / irrigation pipelines (sub-surface or above surface) etc. Moving ahead, the plan will also include, promotion of bio-compost (if needed), vermicompost, developing grazing land through fodder plantation, afforestation, and treatment of degraded area.

Use of Participatory Tools (PRA Tools):

Participatory Rural Appraisal (PRA) method will be followed for preparing GPRP, apart from analysis of available secondary data and satellite imagery. Before initiating the exercise, key areas of investigation / exploration will be finalised that align with the project objective. The tools to be used will be finalised as per the key areas of investigation / exploration. The team, to be assigned to facilitate the planning, would conduct transact walk, FGD with community members in different groups to understand their opinion, specific FGD with women members, prioritize the issues and solutions using scoring and ranking method / priority grid method, prepare social and resource maps, Venn diagram on institutional existence and important institutions as per their current role, wealth / wellbeing ranking using card-sorting method, crop calendar of the area (integrating irrigation), seasonal vulnerability matrix, constraint and opportunity matrix, trend analysis for specific parameters (ex. spring shed discharge, rainfall, temperature, pest attack, etc.), a perspective map of the village etc.

Table 63: Selected PRA Tools and its Objective

SN	PRA Tool	Objective
1	Brainstorming	The main purpose of brainstorming sessions is to enhance the creativity of a group, using their collective insight to solutions of a problem.
2	Focus Group Discussion (FGD)	It helps in understanding perceptions of different groups / people, their opinions, beliefs and attitudes to the issue/s and their understanding of the solution that can be helpful in solving the issue.
3	Priority Grid	The tool provides a rational and structured approach to derive the priorities and building consensus for priority-based intervention across sectors.
4	Transects / Maps	It is a visual tool that helps in mapping the area as per the transect walk, and maps provide a sound qualitative picture of the situation.
5	Resource Mapping	It helps in understanding resource distribution, use and access to resource, and availability of key resources at the village / GP level. Wealth ranking observations can be superimposed to the map.
6	Crop Calendar	Crop Calendars present the pattern of activities related to the production, harvesting and marketing of specified crops. This participatory tool provides scope to explore constraints and opportunities for increasing production, improving gross cropped area etc.
7	Constraints Analysis	Constraints analysis is a methodology for mapping a critical path of actions required to create an enabling environment for sustainable livelihood systems.
8	Opportunity Matrix	Opportunity matrix helps in rephrasing each identified constraint into positive desirable conditions and detailing the opportunities for innovation and change.
9	Stakeholder Analysis	Stakeholder analysis provides scope for the identification and assessment of the degree of influence which individuals, groups and institutions may have on project interventions.

Figure 67 Flowchart of Human resource development in the project

10	Venn Diagrams	Venn Diagram illustrates relationships among CBOs / groups and are also useful in understanding their importance in the community and potential conflicts between different stakeholder groups.
11	Gender Analysis	Gender analysis aims to integrate women in the development process and to achieve equity, by taking due account of the differences in women and men in different aspects like engagement, land holding, livestock under possession, women headed households etc. It helps to identify social and economic inequity between men and women. Understanding of the situation can be applied in planning and service delivery.
12	Trend Analysis	Trend analysis is employed to identify current and future situation of a particular phenomenon. This process may involve comparing past and current crop productivity levels, cost of production, soil fertility, income levels, rainfall, temperature, irrigation coverage, etc.
13	Wealth Ranking	Wealth ranking helps in determining socio-economic well-being of the households, within the given context. The information generated by the wealth ranking exercise helps in the stratification of resources endowed vis a vis disadvantaged.
14	Social Map	The focus here to understand habitation patterns and the nature of housing and social infrastructure: roads, drainage systems, schools, drinking water facilities, irrigation sources etc.
15	Transect Walk	This can be used to explore the spatial dimensions of people's realities. It has been popularly used for natural resource management. It provides a cross sectional representation of the different agroecological zones and their comparison against certain parameters including topography, land type, land usage, ownership, access, soil type, soil fertility, vegetation, crops, problems, opportunities and solutions.

(A) Development of Revenue Village Plan (RVP):

Each revenue village falling under the watershed will develop a comprehensive plan, based on the technical inputs from the project. Key interventions will be identified and prioritised by the villagers that meets the requirement of the project.

- Each revenue village will prepare its own plan, i.e., Revenue Village Plan (RVP)", with technical inputs from the project;
- Plans so prepared by different revenue villages under a GP will be consolidated and integrated into the GPRP;
- Every member of the RVC will have equal chance to express their opinions regarding interventions that can be beneficial for watershed development and management.
- The RVP will adhere to the ESCP of the project and other guiding documents.

The RVC must ensure that [1] the plan is in accordance with the PDO of the project and contribute to the KPI and result indicators, [2] promoting and strengthening social equity with regard to accessing project benefits, [3] following inclusive parameters while accessing project benefits, i.e., inclusion of women, marginalised section, SC/ST and tribal/transhumant population. The RVP, so prepared will be submitted to the WWMC for consolidation.

(B) Development of GPRP:

The development of GPRP involves collaboration between WWMC, Gram Panchayat, and project team. Upon receiving RVC Proposals from all Revenue Villages, the WWMC will consolidate them to formulate the Gram Panchayat Resilient Plan (GPRP), facilitated by the project team. The WWMC will be responsible for ensuring GPRP compliance with the project ESCP. Further, the WWMC will ensure proposed expenditures do not surpass the allocated budget, making modifications if necessary. The GPRP will include a phased plan for the implementation of activities with a withdrawal strategy in the final year. The WWMC will

present the GPRP to the Gram Sabha for discussion and approval. The approved GPRP, will be placed to Field Implementation Unit and concerned DD for review and approval.

(C) Review and Appraisal of GPRP:

DPD would conduct a comprehensive review and appraisal of the approved GPRP from WWMC promptly upon receipt.

- The DPD office will evaluate the GPRPs according to the guidelines outlined in the Project Operation Manual;
- If the GPRP aligns with the budget allocation and ESCP guidelines, it will receive approval;
- GPRPs exceeding budget limits or diverging from ESCP guidelines will be sent back to the GP with noted observations for restructuring;
- The WWMC will review these observations and make necessary adjustments to the GPRP, potentially seeking approval from the Gram Sabha if required;
- The finalized GPRP will be resubmitted to DPD for final approval;
- GPs are obligated to adhere to ESCP within the project;
- It should be noted that WMD funding will not be allocated to activities listed as prohibited within the project.

(D) Use of GIS & MIS in Planning:

WWMC, project team, and the GIS and MIS Cell utilize GIS and MIS in planning through the development of a database following the approval of GPRP. All the interventions will be geotagged in Real Time Monitoring in various tools/applications.

- All information generated during PRA exercises for GPRP preparation will be captured by the MIS cell in uniform format to create project baseline database;
- The land base activities such as community assets, proposed plantation areas, fodder and orchard development etc. will be captured using GPS to develop GIS. A GIS map of each GPRP would be prepared by the DPD and Geo referenced on the project maps in the GIS cell at WMD level. In case of any change or deviation, DPD will take prior approval of the PMU-WMD;
- Process monitoring and onsite monitoring of GPRP implementation using GIS tools will be carried out by M&E cell of WMD and external M&E agency.

(E) Payment to GP:

Drawing limits to Gram Panchayat (GP) for the Development Project (GPRP) by DD will be given after the final approval of GPRP by the Gram Panchayat and submission of the Annual Work Plan (AWP).

- After approval of GPRP, signing of 2nd MOU between GP and WMD will be taken place;
- The WWMC shall prepare a detailed Annual Work Plan (AWP) for the first year based on approved GPRP. This will contain details of activities to be funded and implemented, Implementers, beneficiaries and their contribution, and the cost to be incurred on each activity.

(F) Allocation of Funds to GP As Budget Envelop:

To plan and prepare the Gram Panchayat Resilient Plan (GPRP) at GP level, each GP will receive drawing limits from the project in the form of a budget envelope, determined by a formula with 65% weightage to area and 35% weightage to population, subject to maximum and minimum caps.

Activities (prioritised) under GPRP of a GP, will be prepared based on the allocated budget envelope and in accordance with the formula provided above. The plan will consist of activities that are to be implemented within the GP's jurisdiction.

Formula for Allocation of Funds to GPs

$R_m = \{0.65(R)A_m/A + 0.35(R)P_m/P\} + R_{mnrm} + R_{admn}$

Where;

R_m is the total Fund allocation to a particular GP in Rupees

R is the total Fund for allocation to all GPs under the project

A_m is the geographical area of a GP in Hectare

A is the total geographical area of all the GPs under the project.

P_m is population of a GP

P is the total population of all GPs under the project

R_{mnrm} is the amount for treatment of inter-GP spaces to be allocated to a GP.

R_{admn} is a fixed amount for administrative expenses to a GP.

Note :1 There will be a minimum and maximum ceiling for R_m.

Note :2 The amount indicated within { } may be indicated to GP in form of Budget

(G) Capacity Development: Village Level Training Calendar:

Capacity building as a long-term continual process of development that involves all stakeholders; associated with the process. The objectives of capacity building of watershed committees are [1] human resource development, [2] organization development, and [3] develop and strengthen cooperation between organisations and networks for knowledge exchange. Process to be followed in capacity building are:

1. Identifying capacity requirements-capacity building need assessment;
2. Developing suitable curricula and methodology for capacity building;
3. Preparing capacity building action plan;
4. Implementation of capacity building plan (inhouse / classroom, exposure, and demo.);
5. Monitoring utilization of capacity building inputs;
6. Organizing refresher courses, based on requirement.
7. Development of a Knowledge Hub in WMD
8. Engagement of Consultants at PMU
9. Setting up of demonstration unit for climate resilient practices at PMU
10. Setting up of a lab for provision of weather and other advisory services
11. Documentation and dissemination of Climate Resilient practices and technologies
12. Audio Visuals/Short films on Climate Resilient practices and technologies

A comprehensive capacity building action plan will be designed, comprising [1] types of trainings to be organized during different periods & under phases for the entire project period, [2] finalizing contents of trainings, [3] duration of trainings, [4] level of trainings to be organized, i.e., State / District / GP / village clusters / Village, [5] list of trainees / stakeholders to be trained, [6] effective monitoring & follow up of CB activities.

Guiding Principles:

1. Capacity building would not be restricted to classroom training;
2. It would cover exposure, learn from field visits and from experience of others;

3. Capacity building would be individual and organizational need-based;
4. It would be a continuous process with refresher courses;
5. Providing required hand holding and escorting support;
6. Based on the feasibility, project may follow TOT approach for capacity building.

Apart from identified needs, some project specific themes would be covered in the capacity building. Specific themes (indicative) that would be covered under capacity building are as below.

1. Assessment of natural resource base & its status / services;
2. Preparing GPRP / CRFP / spring shed plan;
3. Spring shed management principles;
4. Irrigation regulation and management;
5. Crop water budgeting / irrigation scheduling;
6. Book-keeping;
7. Monitoring, learning and documentation.

(H) Developing Annual Calendar for Capacity Building:

The project will develop annual capacity building calendar for different stakeholders. The calendar will contain curriculum brief and modules to be covered under each curriculum along with month of organization of capacity building program. The courses and modules to be covered will be as per the project requirement and identified capacity needs of the stakeholders.

Table 64: Capacity Building Calendar (Illustrative)

Stakeholder	Course Title	Module	Content	Methodology	Module Duration	Month of Organization
1.						
2.						
3.						
4.						
5.						

4.1.2.2 Preparation of Spring-Shed Management Plan:

The broad objective of rejuvenating spring sheds in the project districts is to improve ecosystem services and ensuring water security for the locals. Management of spring sheds in a participatory manner will improve drinking water security and water availability for irrigation in the mountain regions. The project approach for rejuvenation of spring shed will be three-fold, i.e., [1] preparing spring-shed development plans, [2] execution of the plan, and [3] monitoring the interventions. The participatory project approach would entail inclusion criteria, focusing on spring users, women members, and marginalised section.

Key Steps for Spring-Shed Planning:

The project will follow below discussed approach for spring-shed development planning, in accordance with the NITI Aayog guidelines. The spring-shed development planning will adhere to key planning components and planning aspects discussed in this section which is in line with the prescription of NITI Aayog.

Spring shed Management: Steps for Preparation of Hydrogeological Technical Report[53]:

- Spring Inventory and Geotagging of Springs
- Hydrogeological Survey and mapping of spring shed
- Planning and implementation for treatment measures in the recharge area with the help of community

[53] Sharma S.; Spring Hydrogeology: Science based Approach for Spring shed Management.

▸ Setting up monitoring system for periodic spring discharge measurement

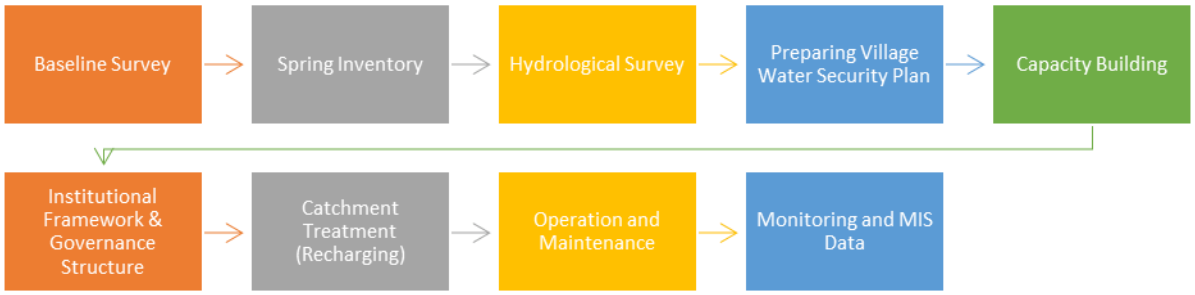


Figure 67 Steps for spring shed planning

The spring-shed planning and management approach would use hydrogeology to map spring sheds. The identified potential areas will be targeted for augmentation of recharge and protection. Normally, the spring-shed of a particular spring is an area from recharge to discharge point of the spring, including aquifer, which can be in one or multiple watersheds. To understand the spread of the spring-shed, spring shed mapping will be done through a field survey of springs with their coordinates and identification of rock type and structures around the spring. Discharge, rainfall, and water quality will be measured for the identified springs during the survey. A hydro-geological layout will be prepared which will serve as the basis for identifying the spring shed (recharge zone, discharge zone, aquifer). Once the spring shed is delineated, plans will be prepared for ground water recharge and protection of spring shed.

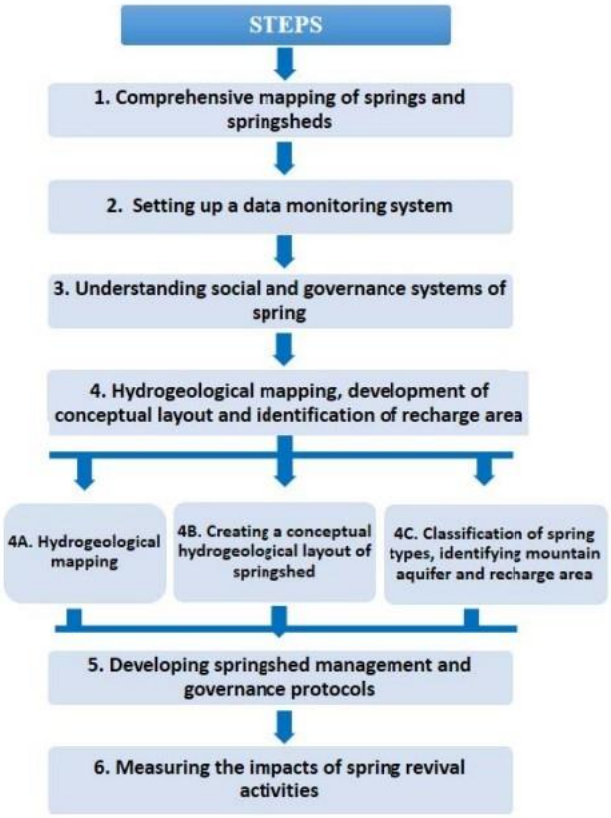


Figure 68: Six Step Protocol for Spring Revival and Spring-Shed Management
Source: Six-Step protocol for spring revival and spring shed management in the Himalayan region (Shrestha et al., 2018)

Table 65: Step wise Methods for Spring Shed Development

Activities	Objective	Required Equipment	Expected Outcome
Spring Discharge Measurement	Measuring current spring discharge	A bucket whose volume is known and stopwatch	Spring Hydrograph
Rainfall Measurement	To measure rainfall	Rain Gauge	Spring Hydrograph
Water Quality Assessment	Water Quality Monitoring	Tracer, on spot water quality testing	Water quality report
Preparing Baseline	Baseline survey	Formats, structured tool	Village water resource map, demand and supply map, map of vulnerable springs
Hydrological mapping	Collect hydrological data from field	GPS, Brunton, Clinometer, Hammer, Google Earth and Sketch Up software	Hydrological conceptual layout and spring site cross section
Designing recharge interventions and management protocols	Physical and biological measures, social fencing, and behavioural change	Tool for community mobilization experts as SARAR kit	Spring recharge and protocols for spring shed management
Impact assessment of spring shed works	Measurement of benefits of spring shed works with other socio-economic aspects	A bucket whose volume is known and stopwatch, Tracer, on spot water quality testing, formats, structured tools	Improvement in water availability / water quality.

Spring Prioritization for Monitoring:

Spring inventory making is cumbersome and a costly process, hence prioritisation is required in the project for long term monitoring of the springs. The following criteria can be used for the identification of springs, adaptation planning and long-term monitoring.

- Springs that have recently shown a significant decrease in discharge;
- Springs with seasonal or perennial water quality issues;
- Springs on which significant number of households depend for drinking throughout the year;
- Springs used for irrigation, more particularly in Rabi;
- Springs on which marginalized communities and disadvantaged groups depend and co-managed by community (with pre-existing committees, presence of CBOs);
- Springs with special cultural significance.

Data Requirement for Planning:

- Spring specific coordinates for inventory and GIS mapping;
- Geo-morphological characteristics like slope (%), LULC, soil type, rock type etc.
- Rainfall (time series data);
- Spring discharge / yield (seasonal);
- Water quality;
- Socio-economic data like household dependency, dependency purpose etc.
- Water demand Vs water availability (spring & other sources).

Preparation of Plan:

A detail spring-shed management plan will be prepared, encompassing type of measures (mechanical, vegetative) to be taken in different identified, mapped, and prioritized spring-shed area. The plan would also include [1] treatment area protection measures, [2] participation of local community, [3] operation and maintenance (if required), and [4] monitoring mechanism. A spring-shed treatment plan matrix is presented for reference which will be suitably adopted during the planning.

Table 66: Spring Shed Management Plan

SN	Site Name	Geo Reference	Treatment Area (Ha.)	Mechanical Measures			Vegetative measures	
				CCT	SCT	Other Measures	No. of Plants (Fruit / Non-Fruit)	No. of Fodder Plants
1								
2								
3								
4								
5								

Note: CCT: Continuous Contour Trenches, SCT: Staggered Contour Trenches

Spring-Shed Management: Principles & Practices:

The project will invest in regenerating / recharging groundwater through various engineering, vegetative and social measures in the spring recharge area. Key principles to be followed and interventions to be taken up to improve spring-shed hydrology is presented in the matrix along with expected benefits.

Principles:	Practices:	Benefits of Management:
▸ Increase time of concentration ▸ Increase infiltration ▸ Reduce soil erosion ▸ Improve water quality ▸ Promote equitable water sharing	▸ Trenching (SCT and CCT) ▸ Treatment of Drainage Channels ▸ Small Check Dams/Gully Plugs ▸ Vegetative Measures ▸ Social Fencing	▸ Increase in base flow ▸ Reduction in lean flow period ▸ Higher plant survival rate ▸ Increase in biomass production ▸ Increased fodder availability ▸ Household water security ▸ Improved water quality ▸ Increased downstream storage

Spring-shed Management Protocols:

- Ownership of recharge area of springs and benefit sharing;
- Planting of fruit and non-fruit bearing trees and grass along with trenches in the recharge area;
- Sharing norm of fruits, fuel wood and fodder with landowner and user group, apart from increased spring water supply;
- Community imposed self-regulations – Prohibiting (a) open defecation, (b) open grazing, and (c) green felling in the recharge area;
- Prioritising water demand (irrigation), irrigation scheduling and supply regulation;
- Community based monitoring and decentralised decision making.

Impact and Results Framework:

In line with the objective of rejuvenating the spring-sheds, monitoring of the intervention will look at key impacts across the project districts. Key impacts to be monitored are [1] spring productivity, [2] economic impact, [3] social impact, and [4] intervention

sustainability. Key monitoring indicators and means of verification by impact area is presented in the matrix.

Table 67: Impact and Result Framework

Key Impacts	Monitoring Indicators	Means of Verification (MOV)
Spring Productivity	Spring discharge	Change in spring yield (t_1-t_0) (record based)
	Water quality	Change in water quality (t_1-t_0) (record based)
	Soil moisture	Soil moisture index (t_1-t_0)
	Biomass productivity	Biomass assessment (t_1-t_0)
	Soil erosion	Soil map / Sediment storage (t_1-t_0)
Economic Impact	Drinking water availability	HH water availability (t_1-t_0)
	Water availability for irrigation	Area irrigated (t_1-t_0)
	Fodder availability	Household surveys (t_1-t_0)
Social Impact	Reduction in drudgery of women	Women reporting drudgery reduction
	Household water security	Reduction in water scarcity period
	Social inclusion	Women participation in WWMC/ DNSS and water accessed by marginalised section
Intervention Sustainability	No. of trained community members / WWMC in spring shed management.	Impact assessment of trainings
	No. of DNSS formed (around spring shed) and capacitated.	Assessment of Dhara-Naula Sanrakshan Samiti and their role
	WWMC / DNSS association in periodic monitoring and support.	Assessment of WWMC and their role
	Roadmap for sustaining interventions and future operation & Maintenance.	Plan document and action mapping

Spring-Shed Governance:

- Like watershed committee, Dhara Nala *Sangrakhayan Samiti* (DNSS) around the spring would be formed, comprising members with due representation of different social groups from different socio-economic categories, with a focus on women. The *samiti* (*Dhara Nala Sangrakhayan Samiti*) will be responsible for springs and recharge area management. The *samiti* (*Dhara-Naula Sanrakshan Samiti*) may be a part of the local watershed management committee;

- This *samiti* will be a technical committee under the PRI system and would have written rules/by laws and regulations for spring water management, and penalties for violations of rules vetted duly by *gram sabha* resolution;

- A spring shed management would be established with a nominal monetary contribution of the members. This is important to ensure that the recurrent costs for maintenance and management of springs and recharge structures can be covered in a sustainable manner;

- Spring discharge and water quality would be monitored periodically to assess the impact of spring shed management protocols;

- A seasonal water balance, aligning with cropping season, will be calculated based on spring discharge and rainfall data to facilitate equitable distribution of spring water.

Spring-Shed Resilience:
Impact of these measures can determine the resilience of the springs and effectiveness of adaptation measures in reducing the vulnerability. Key elements to consider for spring shed in determining their resilience:

- Increment in spring discharge, especially in post-monsoon period;
- Duration of spring water availability in comparison to pre-project situation;
- Improvement in spring water quality, thereby reducing health risks;
- Management of spring water promotes equitable access; and
- Increment in area irrigated by springs / adequate spring water availability, wherever it is used for agricultural purposes;
- Better protected and managed recharge areas;
- Agricultural and allied livelihood opportunities without risking spring sheds;

4.1.2.3 Preparation of Climate Resilient Farming Plan (CRFP):

Following the same participatory process, Climate Resilient Farming Plan (CRFP) will be prepared at village / GP level, The CRFP is a strategic document to help farmers adapt to climate change and minimize its impact on agricultural and horticultural production. The plan aims to implement sustainable farming practices that are resilient to the adverse effects of climate change, thereby ensuring food security and the livelihood of farmers. The CRFP will be linked to agriculture and horticulture production system to benefit the producers and their associations.

Guiding Principles:

- Engage local communities and farmers in the planning process;
- Study data on local climate patterns, soil conditions, and existing farming practices;
- Stakeholder meetings with local authorities, and agricultural experts;
- Identify vulnerabilities of farming systems to climate change;
- Assess the potential impact of climate risks on crop yields, soil health, and water availability;
- Promote crop diversification to minimise risk;
- Implement soil conservation and efficient water management techniques;
- Integrate agroforestry practices to improve soil fertility and reduce erosion;
- Encourage conducive climate-smart agricultural practices;
- Capacity building of farmers on climate-resilient techniques;
- Demonstration of CRA practices through FFS for learning and adoption;
- Aligning CRFP with National & State policies and climate adaptation strategies;
- Aligning agriculture and horticulture production system with CRFP.

Role and Responsibilities:

Table 68 Role and Responsibilities for Planning & Implementation

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC / DNSS / FIG / FPO	Consulting with farmers / villagers
		Support in awareness, and sensitization
		Mobilize people and facilitate local level planning
		Document local planning process
		Support in implementing activities
		Reporting to Unit Office
2	Field Implementation Unit	Prepare schedule for planning

		Orientation to planning team on methods, tools etc.
		Developing planning tools, piloting tools & finalizing
		Mobilize people with the support of CBOs
		Conducting awareness / sensitization meetings
		Preparing village / GP level planning
		Plan consolidation and budget framing
		Participatory implementation of planned activities
		Conducting monitoring and review
		Submit periodic reports to DPMU
3	District Project Management Unit (DPMU)	Support FIU in planning and implementation
		Plan consolidation and budget finalization
		Monitoring during planning & implementation
		Periodic review of physical and financial progress
		Reporting to PMU on progress & performance
4	Project Management Unit (PMU)	Issuing guidelines for planning & implementation
		Support DPMU & FIU in planning & Implementation
		Participate in sample villages / GP during planning
		Consolidate DPMU level plans
		Guiding DPMU and Field Implementation Units
		Tracking physical and financial progress using MIS
		Periodic monitoring and technical / managerial support
5	Technical Institutions (Consortium)	Consult with PMU / DPMU from time to time
		Technical support for GPRP / Spring shed plan
		Technical support during implementation (need based)
		Visit to sample locations and providing guidance

4.2 Enhancing Spring Shed Hydrology and Water Storage (Sub-Com B2):

4.2.1 Implementation of Spring Shed Management Plan:

The management of spring sheds and adaptation plan includes both structural and non-structural measures. There will be a proper water budgeting for the identified springs considering both demand and supply side issues. The broad structural and non-structural measures that can be taken up as per the geo-morphological characteristic are summarised below.

Structural Measures	Non-structural Measures
• *Shallow dugout ponds (avoid where there is slope movement, subsidence, land sliding, or gullying which may affect the area below; where the valley side of the pond is not sufficiently stable to hold standing water; at the toe of a slope, where the pond may increase the instability of the slope; and close to a cliff, where slope-failure may occur due to seepage or water pressure).* • *Continuous or staggered contour trenches* • *Semi-circular bunds or eyebrow pits (with grass, fodder, fruit, or non-fruit species plantation)* • *Triangular Pits* • *Stone bunds* • *Check-dams*	• Keeping the recharge area and spring surrounding clear of open defecation, garbage, solid waste, and others; • Construction of a spring box to prevent surface water flowing directly into the spring; • No construction of toilets in demarcated recharge area or near springs; • No application of chemicals (fertilizers, pesticides) in the recharge area or near the spring; replace with eco-friendly methods like composting, integrated pest management and traps; • No cutting of trees in the demarcated 'Protection and Recharge' area; • Keeping the area around the spring clean and green; • Afforestation with the plants having good water holding capacity. (Broad Leaf Plants).
Vegetative measures • *Hedge growing;* • *Palisades (live check dams);* • *Brush layering.*	**Agronomic measures** • Organic mulching, • Vermicompost, • Minimum tillage

4.2.2 Protocols for Spring-Shed Recharge:

- Making recharge area free from waste disposal and defecation to prevent groundwater contamination;
- Preventing application of synthetic fertilizers, pesticides in the recharge area or near the spring;
- Adoption of Natural / eco-friendly farming methods in the recharge area;
- Demarcate recharge area with signage, hedges / vegetative boundary, plantation etc.;
- Preventing tree felling in the demarcated 'Protection and Recharge' area;
- Community watch and ward of recharge area, catchment treatment and water quality monitoring;
- Formation and strengthening of water users / DNSS around the spring shed.

4.2.3 Creation of Water Storage Structures:

Based on the spring shed plan, the project will invest in rejuvenation of the spring sheds. It is expected that the rejuvenation measures will improve the yield of the springs which can be utilised for agriculture and domestic use purposes. So, the project will invest in spring water storage structures in most feasible and suitable places to harvest spring run-off and

utilise in irrigation. The storage structures will be used to pump water using different means including solar pumping system to irrigate additional area. Wherever feasible, gravity-based farm-level distribution channels will be constructed to facilitate irrigation. Availability of spring water is expected to enhance cropping intensity, improve resilience in agriculture production system and additional income to the farmers.

The storage structures will be created taking in to account the water requirement (agricultural and other uses) and yield of the springs. To assess water requirement, water budgeting exercise will be conducted in the project villages / clusters in a participatory manner. The operation and maintenance of the storage structures will be the responsibility of the farmers getting benefit due to creation of such structures. A token amount will be collected from each benefitting household after each agriculture season, and it will be deposited in the bank account as corpus fund for future operation and maintenance. The irrigation potential of the storage structures, as determined based on the water budgeting, can be enhanced further with the use of micro irrigation systems by the farmers.

The project will also support the implementation of water harvesting and storage structures and build channels for gravity-based farm-level distribution. This includes field channels and farm ponds as appropriate in the area. Actual volume of water stored and variability in supply and distribution will be monitored in a participatory manner. A comprehensive water budgeting exercise will complement the spring shed plans. Further, the water budgeting exercise at spring shed level will also include hydrological analyses and evapotranspiration of prevailing cropping pattern. The project will make realistic assessment of demand-side and supply-side hydrology to quantify possible water use in relation to dependable spring flows in each spring shed, hence giving due attention to sustainability, and encouraging water use efficiency. Keeping this in view, in-flow hydrology management will be backed by institutional strengthening and capacity building of stakeholders. Benefits from expected increase in biotic cover in terms of above ground and soil carbon will be monitored, to assess contribution to carbon sequestration.

4.2.4 Capacity Building of Dhara Nala Sanrakshan Samiti (DNSS):

The project will support in capacity building of Dhara Nala Sanrakshan Samiti (DNSS) for Spring shed Management as follows:

- Conduct workshops and training sessions on spring shed management techniques.
- Provide training on skills such as mapping, data collection, and analysis.
- Organize awareness programs to educate the community about spring shed management.
- Develop and distribute educational materials like pamphlets and posters.
- Facilitate exchange programs with other successful spring shed management committees.
- Host regular workshops and seminars with experts.
- Identify and secure funding opportunities from government schemes.
- Involve the community in the planning and decision-making process.
- Encourage community members to participate in volunteer programs for spring shed conservation.
- Engage hydrologists, geologists, and other experts for technical assistance.
- Set up a system for regular monitoring of spring discharge and water quality.
- Strengthen the organizational capacity of DNSS through governance training and leadership development.
- Train DNSS members on how to advocate for supportive policies and regulations.

- Educate DNSS members on sustainable agricultural and land-use practices.
- Promote the adoption of soil and water conservation techniques within the spring shed area.

Role and Responsibilities:

Table 69 Role and Responsibilities for Plan Implementation (GPRP, CRFP & SMP)

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC / DNSS / FIG / FPO	Consulting with farmers / villagers
		Coordinate with local CBOs (DNSS, FIG, FPO etc.)
		Support in implementing planned activities
		Monitoring implementation of activities
		Reporting to Unit Office
2	Field Implementation Unit	Preparing implementation schedule
		Executing activities in collaboration with CBOs
		Capacity building / orientation of stakeholders
		Conducting monitoring and review
		Documentation of learning
		Update data in MIS
		Submit periodic reports to DPMU
3	District Project Management Unit (DPMU)	Support FIU in implementation of activities
		Monitoring implementation progress
		Support FIU in capacity bulding
		Periodic review of physical and financial progress
		Review and managing data input in MIS & GIS
		Reporting to PMU on progress & performance
4	Project Management Unit (PMU)	Issuing guidelines for implementation
		Support DPMU & FIU in Implementation of activities
		Guiding DPMU and Field Implementation Units
		Tracking physical and financial progress
		Periodic monitoring and technical / managerial support
5	Technical Institutions (Consortium)	Technical support for implementation (need based)
		Visit to sample locations and providing guidance
		Conducting thematic study as per the need of PMU

Chapter 5

Component C: Enhancing Income

Chapter Five: Component C: Enhancing Income Resilience:

In Export Preparedness Index 2022 (EPI, 2022), Uttarakhand ranked 9 among the States and 1 in category rank. Udham Singh Nagar has been the highest exporting district in the State (2021-22). In export promotion policy, the State is having a score of 99.52, 55.44 in export ecosystem, 49.76 in business ecosystem, and 38.29 in export performance. According to the report (EPI, 2022), The best-performing Himalayan state of Uttarakhand has scored 59.13 in the index. Registering a total export value of over US$ 1.9 Billion, the state primarily exports Zinc products, pharmaceutical products, and gold Jewellery. In terms of business ecosystem, Uttarakhand has dedicated pharma parks, no power deficit, decent storage facilities, and air cargo terminals to boost connectivity, thus overcoming its geographical disadvantages. The state has registered a significant increase over the previous year in FDI inflow. The state can take measures to strengthen its business environment coupled with its solid policy ecosystem will reflect in its export performance.

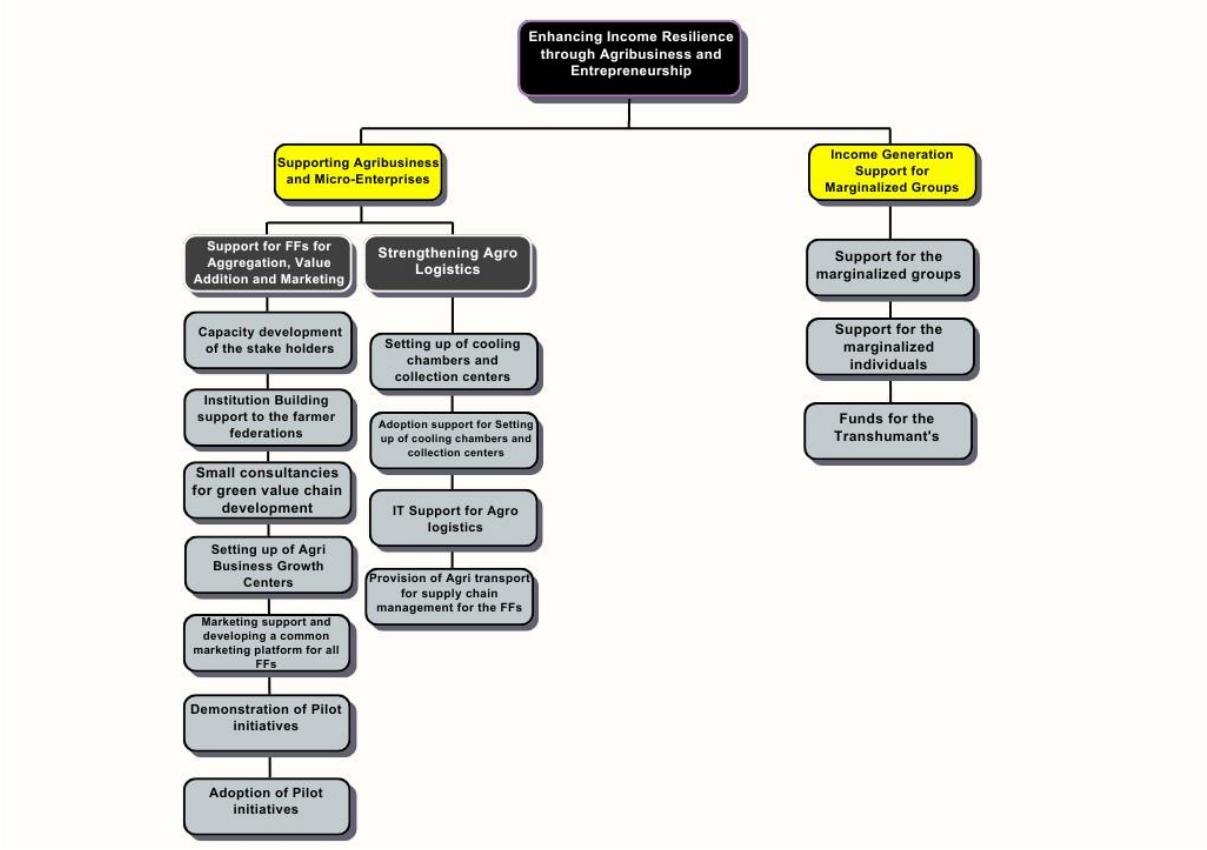


Figure 69 Process of income enhancement.

5.1 Agribusiness and Micro-Enterprises (Sub-Com C1):

To harness agribusiness potential of the project districts, it would be essential to identify key products and markets which will provide opportunities for the agri-enterprises to grow and achieve economies of scale. The State has significant comparative advantage in agricultural / horticultural products, which can be further strengthened by promoting agribusiness.

This sub-component aims to enhance the profitability for the farmers by improving their access to markets through collective approach. The project will promote / strengthen FIGs and FPOs, as the base at village and cluster of villages. This component will help the farmers to realize a greater return to their products through value chain improvement and supply chain management. The project will take up different measures, based on the requirement of the farmers to improve the value chain of horticultural and agricultural crops in different project locations. The project interventions will aim to provide the primary producers and entrepreneurs an enhanced remunerative return.

The Government of Uttarakhand has been providing high priority to agriculture and allied sectors. Considerable efforts have been made to strengthen agriculture, horticulture and livestock sectors in terms of productivity improvement, infrastructure, knowledge, IT applications, market intelligence, linkages, credit and financial arrangement. To improve agricultural income of the farmers, particularly small and marginal farmers, there is a need to create appropriate ecosystem in the project districts. Experience indicates that organization of farmers that are financially robust, adopt business model and well integration of technology, research, markets, banks, and other infrastructure facilities could provide enormous economic benefits to its members.

Objectives:
The overall objective of this component is to enhance farm income through forward market linkages and backward support systems. The objective is to harness the potential of enhancing value addition of selected farm produces by creation of required infrastructure, facility & services. For improved market access and value addition of the commodities, Farmer Producer Organizations (FPOs) / Farmer Interest Group (FIG) will be associated. The specific objectives of promoting agribusiness are;

1. Improve market linkage through collectivization and product aggregation;
2. To improve return to farmers and its organization (FIG / FPO) through value addition;
3. Improve accessibility of farmer's collectives to agribusiness services;
4. Strengthen post-harvest management and supply chain through infrastructures, facility & services.

Project Approach

1. For the promotion of agribusiness activities and making it a profitable venture for the marginal and small farmers, the project will strengthen the supply chain for selected horticultural / agricultural crops along with establishing and strengthening agribusiness growth centres in suitable locations based on the marketable surplus created in the project area. It will be helpful to the farmers to sell their products directly in the market for a remunerative return.
2. For improved post-harvest management, emphasis will be given for establishment of agribusiness growth centres with required facilities.
3. Farmer Interest Groups (FIGs) / Farmer Producer Organizations (FPOs) shall be promoted and encouraged for association in agribusiness activities (suitable activities), based on their potentiality.
4. For strengthening and improving access to market, the FIGs / FPOs / ABGCs will be tied up with national market through e-NAM / ONDC / other markets. It will help the farmers to sell their produce at the national level with a remunerative price.

5. Market information, more particularly the commodity specific price of different markets will be made available to the farmers / FIGs / FPOs periodically. It will help them to sell their produce in a better price. It will also be helpful to minimize distress sale of the commodities.

Activities

To achieve the objectives of the component, following activities and sub-activities shall be carried out.

Table 70: Key Activities for Agribusiness Promotion

SN	Activities
A	**Support for FFs for Aggregation, Value Addition and Marketing**
A.1	Capacity development of the stakeholders
A.2	Institution building support to the farmer federations
A.3	Small consultancies for green value chain development
A.4	Setting up of Agri Business Growth Centres
A.5	Marketing support and developing a common marketing platform for all FFs
A.6	Demonstration of Pilot initiatives
A.7	Adoption of Pilot initiatives
B	**Strengthening Agro Logistics**
B.1	Setting up of cooling chambers and collection centres
B.2	Adoption support for Setting up of cooling chambers and collection centres
B.3	IT Support for Agro logistics
B.4	Provision of Agri transport for supply chain management for the FFs
B.5	Setting up of Godowns/Shops near the marketing Hubs

5.1.1 Support for FFs for Aggregation, Value Addition and Marketing:

5.1.1.1 Promotion & Strengthening of FIGs and FFs:

Promotion and strengthening of producer organizations (FIGs / FPOs) has emerged as one of the effective pathways to address the challenges of agriculture sector. The collective approach helps in improving access to technology, inputs, and markets. The project will not only focus on enhancement of production but also its market connectivity, which also resonates with the overarching strategy of inclusive market-oriented development. The project envisages that while there will be growth in production in project villages / clusters due to quality inputs and services, it will also require to be connected to remunerative markets. In this direction, FIGs / FPOs as collective of producers, can play a role in maintaining supply chain and value addition of the produces.

The objective of promoting FIGs / FPO is to organize farmers into a collective to improve their bargaining strength in the market. They will be owned and governed by the shareholder farmers / members. A FIG will be formed by the interested producers. They can undertake activities related to production, harvesting, procurement, aggregation, grading, pooling, marketing, processing, etc., of agricultural / horticultural / livestock produce. The FIG / FPO will have democratic governance process where each producer or member has equal voting right irrespective of the number of shareholdings.

***Note**: Farmers within the project clusters will be mobilised into Farmers Interest Groups (FIGs) based on their specific activities or commodities they produce.*

Guiding Principles

- New FIGs / FPOs will be promoted where such institutions do not exist in project areas / clusters (based on the assessment). Existing government guidelines will be referred for promoting FIG / FPO;
- The focus would be to promote FIG / FPOs along with a commodity value chain (agricultural / horticultural / livestock), wherever feasible;
- They will be assisted by the project in preparation of a comprehensive business plan;
- The plan will focus on various aspects of aggregation, market linkage, value addition, etc.;
- Synergy with project activities will be built in areas like seed production, nursery raising, input buying and selling, packaging, and selling of value-added products etc.;
- The project will help the FIGs / FPOs to access institutional credit and resources from different sources;
- Helping the FIGs / FPOs to adopt transparency and accountability norms in their operation and improving institutional governance practices;

The FIGs / FPOs to be promoted / strengthened, could be federated in the later stage for higher impact. The FIGs / FPOs are expected to overcome the constraints of farmers imposed by the small size of their individual farms by leveraging the collective strength and bargaining power to access financial and non-financial inputs, services, and technologies to enhance their income, reduce costs of input purchases along with transaction costs, and create opportunities for involvement in value addition including processing, distribution, and marketing. The FIGs / FPOs will be promoted initially at the village / village clusters and can be federated in the later stage at the block and district level depending upon the needs of the producers.

1. Looking at the geographical situation of project area and commodity specific needs, the number of members in FIG / FPO could vary. Business model can be prepared accordingly along with shareholding norm.
2. Once the FIGs are federated, the project will decide on the legal status of the entity to take up commercial activities;
3. Increasing benefits to the members (enhancing income through technology and knowledge infusion, higher productivity and business services like input distribution, output marketing, value addition, etc.) is the fundamental requirement / purpose for promoting and strengthening FIGs / FPOs.
4. The FIGs / FPOs will function as a business entity with a detailed business plan as well as share capital from all the members;
5. FIGs / FPOs will be established in the context of the existing and emerging market opportunities. Based on a systematic assessment of market potential, business plans of FIGs / FPOs will be developed;
6. The timeline for promotion and sustainable establishment of an FIG / FPO is expected to vary but shall be for a minimum period of 3 years;
7. On-going Government efforts would be consolidated and further strengthened by converging necessary support systems at the district and sub-district level;
8. The FIGs / FPOs will focus on (a) improving productivity through improved extension services; (b) use of appropriate technology and knowledge systems; (c) creating infrastructure facilities for improved efficiency in pre-harvest and post-harvest production systems; (d) reduce cost of production; and (e) creating business opportunities that generate higher incomes.

9. The FIGs / FPOs may also be involved in different project activities that support in production enhancement, adoption of climate resilient practices, establishing & managing post-harvest management structures etc.

Process of Promotion of FIG / FPO & Strengthening:

1. Identification of potential production clusters (commodity specific) through commodity specific assessment, covering one or more villages in a cluster. The production clusters may be beyond the geographical territory of one village;
2. Assessment of market and marketable surplus that can be generated;
3. Identification of potential commodity specific value addition scope and its market demand;
4. Awareness and sensitization of farmers on FIG / FPO and its benefits;
5. Collectivization of farmers into FIG and federating them to FPO;
6. Mobilization of membership fees / share capital from the members;
7. Preparation of byelaw and completing other formalities like PAN card, bank account opening etc.;
8. Registration of FPO;
9. Capacity Building of FIG / FPO on business planning and preparation of business plan;
10. Rendering required support and services for aggregation, value addition, and market penetration;
11. Facilitate establishing post-harvest and market infrastructure;
12. Linking FIGs / FPOs to market agencies or with other FIGs / FPOs for value addition and marketing.

Table 71: Process of FIG / FPO Promotion:

SN	Process	Details
1	Farmer sensitization	Farmers would be sensitized at the village level through sensitization meeting. It involves all categories of farmers at the village level.
2	Selection of Farmers	Farmers would be selected, based on their interest to get associated in the process.
3	FIG Formation	Farmer Interest Groups (FIGs) would be formed within a geographical area for effective operation and management. Existing FIGs may be strengthened and prepared for federating to FPO.
4	Share Capital Mobilization	Mobilization of share capital from the members and issuance of share. Share capital generation would be guided for investment in business operations.
5	FPO Formation	Farmer Producer Organization (FPO) formation process will be initiated with selection / election / nomination of Board of Directors.
6	FPO Registration	All the statutory requirements for incorporation of FPOs to be complied like attainment of Digital Signature Certificate (DSC), PAN, Director Identification (DIN), Name approval, Memorandum of Association (MOA) & Articles of Association (AOA) for registration.
7	Capacity Building	Capacity building of each FIG / FPO on identified areas that enhances their ability in business promotion. Capacity building program would be taken up for the Board of Directors and CEO of the FPOs. They would also be exposed to similar initiatives taken elsewhere within the country.

Farmer producer organisations can be formed by federating small farmer's groups at the cluster level, depending upon the activity or commodity produced by them.

Table 72: FPO Promotion Purpose, Process and Performance

Purpose of FPO formation	Process of FPO formation	Performance indicators of FPO
• Reaping the benefit of economies of scale through aggregation inputs, output, and various processes • Reduce the transaction costs in a significant way, improving profit margin and incomes of rural households; • Effectively address the capital and credit constraints faced by smallholders; • Help small holders to manage risk and uncertainties through collective efforts in production, marketing, and post-harvest value addition.	**Pre-formation Stage** • Identification of uniform cluster • Farmer sensitization / awareness; • Organization of Farmer Interest Groups and educate them about the activity and intended benefit; • Collection of share money; **Formation Stage** • Membership drive and formalizing the management structure; • FPO incorporation documentation and registration • Capacity building of FPOs functionaries. **Implementation of Business Plans** • Actual operation of production, value addition, marketing, etc.; • Regulatory approval for the activities (if needed), e.g., selling of fertilizers or agro-chemicals.	• Increased employment opportunities; • Improved income level of farmers; • Reduction in cost of input procurement / production cost; • Enhancement in social status; • Linkage effects of agriculture and non-agriculture sectors; • Increment in farmer's share of consumer price; • Benefit of collaboration and convergence; • Improvement in accessibility to various institutions; • Improvement in health, education, and overall well-being.

Stages of FPO Development

There would be six stages of development like (1) Pre-promotion assessment; (2) Mobilization and capacity building; (3) Pre-formation stage of FPO; (4) FPO formation and registration; (5) Business planning and its implementation and (6) post-project sustainability (phasing out).

Table 73: Stages of FPO Development

Stages of Project Development	Key Activities
Stage 1: Pre-promotion assessment	1. Baseline on volume, value, and market access; 2. Identification of product specific clusters; 3. Feasibility analysis; 4. Project implementation plan.
Stage 2: Mobilization and Capacity Building	1. Village meetings, sensitization, and awareness; 2. Identification of potential farmers for FPO; 3. Handholding support for productivity increase; 4. Identify value proposition-commodity specific; 5. Exposure visits of farmers for learning & adoption.
Stage 3: Pre-formation stage of FPO/Collective and preparation of FPOs	1. Demonstration conducted on improved agriculture practices; 2. Start-up shareholders campaign; 3. Identification of training needs & imparting training to promoters of FPO;

business plan through CIG level exercise	4. CIGs meeting & orientation, scoping, vision building exercise & exposure visit of farmers; 5. Generate crop-wise household information with surplus, deficit and gap exist; 6. FPO forming process initiated.
Stage 4: FPO formation and Registration	1. Initiation of statutory process required for formation of FPO like attainment of PAN, DIN of Directors, etc.; 2. Stabilize new surplus production system and farmers; 3. Finalizing list of CIG members willing to join FPOs and start share money collection; 4. Membership drive continues and farming of Byelaws / MoA / AoA, incorporation of FPO; 5. Training of members and promoters on FPOs; 6. Registration of FPO.
Stage 5: Business plan Preparation and implementation	Preparation of business plan based on business feasibility assessment and implementation of business plan of FPO.
Stage 6: Phasing out	Preparation of detail phasing out plan and develop systems for post-project sustainability

Key Functions of FPOs

The following are the key functions of the FPO:

1. Engage in mobilizing member by conducting a systematic membership drive;
2. Mobilizing share capital and issuing share to the members;
3. Assessment of marketable surplus and market demand;
4. Product aggregation, value addition and market tie-up;
5. Develop business plan and its approval by the Board of Directors (BoDs);
6. Accessing credit and grant funds from different sources;
7. Implementing the business plan;
8. Addressing statutory requirements (tax return etc.) and ensure legal compliances- Audit / Tax payments / Accounting and Finance Management / MIS / Board Meeting / Getting license for taking up business etc.;
9. Adopt new technologies for processing, value addition and marketing;
10. Addressing compliance / requirement of promoting agencies (reports etc.);
11. Conduct / organize capacity building for its members;
12. Branding, certification, and marketing of value-added commodities;
13. Collaboration and convergence with various relevant institutions/organizations.

Table 74: Services by FIG / FPO

SN	Services by FIG / FPO	Details of Services
1	Input Supply Services	The FIG / FPO may provide low cost and quality inputs to member farmers. It will supply fertilizers, pesticides, seeds through its licensed store and provide farm equipment and machineries through custom hiring centre.
2	Technical Services	The FIG / FPO will promote best package of practices for climate resilient agriculture, maintain marketing information system, diversifying and raising levels of knowledge and skills in agricultural production and post-harvest processing that adds value to products.
3	Procurement Services	The FIG / FPO will procure agriculture produce from its member farmers, if so required; will arrange storage, value addition and packaging.
4	Marketing Services	The FIG / FPO will do the direct marketing after procurement of agricultural produce. This will enable members to save in terms of time, transaction costs, weighing losses, distress sales, price fluctuations, transportation, quality maintenance etc.

5	Financial Services	The FIG / FPO will attempt to access credit to meet financial requirement of its members. Attempt will also be made by the FIG / FPO to access resources through convergence mode.
6	Networking Services	Making channels of information (e.g. about product specifications, market prices) and other business services accessible to the members; facilitating linkages with financial institutions, building linkages of producers, processors, traders, and consumers, facilitating linkages with government program etc.

Involvement of FPO in Strengthening Value Chain

Strengthening emerging value chain entails viable investment in product aggregation, handling, transformation, and marketing (e.g. collection centres, grading and packing units, cold storage facilities, ICT-based market information systems). The FIGs / FPOs are expected to offer a variety of services to its members, such as input supply, technical services, product aggregation, processing & marketing etc. The FIG / FPO will facilitate linkages between farmers, processor, traders, and retailers to coordinate supply and demand and to access key business development services such as market information, input suppliers, and transport services. Based on the emerging needs, the FIG / FPO will keep on adding new services from time to time.

Post-Harvest Management

The FIGs / FPOs will take up, with the support of the project, certain primary processing operations like cleaning, drying, grading, polishing, milling, etc., before produce is sold to the trader or processor. With the project support, the FIGs / FPOs will adopt appropriate post-harvest technologies for cost effectiveness and maintaining required quality and marketability of the produce by value addition. Primary processing by the FIGs / FPOs can potentially get more remunerative price and profits by enhancing quality.

Establishing Backward and Forward Linkages

Input suppliers including information, would form part of backward linkages for FIGs / FPOs. The project will facilitate in establishing such linkages with different entities (high quality planting material, good quality fertilizers, extension services, technical knowhow on production etc.). Similarly, project support system will also enable FIGs / FPOs to establish forward linkages with wholesalers, retailers, or food processors, so that FPOs/CIGs retain a higher share of value of the commodity.

Promotion of Collective Marketing

It has been observed that producers engaged in aggregation models have a better bargaining power in the market and are able to get a higher price for their produce as compared to conventional models of agricultural marketing where produces are sold in small quantities. This holds more significance for small and marginal farmers due to the prospect of resource pooling and benefitting from higher scale of production, cluster-based commodity specialization and minimization of input costs.

Capacity Building:

The project will support capacity building of different stakeholders (FPOs, FIG, officials etc.), as per the identified needs. Capacity building measures will be taken up based on the mapping of required vs existing knowledge and skill base of different category of stakeholders. The inputs will be designed objectively and in accordance with the identified needs to bridge the gaps. A detail capacity building schedule will be prepared, encompassing identified themes. Capacity building measures would be in different forms like workshop for FPOs, training of FPO members, organizing exposure visits, extending hand holding support etc. Trainings will not be limited to classroom lectures, rather it would also cover practical

demonstrations on various aspects. Follow-up measures would be taken to promote adoption / application of the rendered inputs. In case of requirement, refresher courses will be provided to farmer's collectives and its members.

Capacity building exercises would comprise of a combination of activities such as workshops, training, exposure visits, and certification courses (management development programs). Capacity building of FIGs / FPO would have two broad aspects, i.e., business understanding development and technical knowhow. Management related training provided to FPO members would include management aspects such as business management, marketing, costing etc. This will enable the members to understand the functioning of their FIG / FPO as well as decision making process based on scientific assessment of various factors. Technical knowledge will be imparted to the members which would include topics such as production enhancement, climate resilient agricultural practices, post-harvest handling, food processing, input management, etc.

All members of the FFS will receive training on the benefits of business development, joint marketing, and market-driven production. To educate farmers about market opportunities and encourage creative thinking, exposure visits will be arranged. These visits can also provide valuable insights from other farmers who are already engaged in collective actions for produce marketing and market-oriented production villages. This could help them appreciate the advantages and requisites of collective actions in agriculture, both in production and marketing to maximize returns.

Table 75: Capacity Development of FIG / FPO

Capacity Development of the Stakeholders	
Workshops for FPO formation	• Organizing decentralised workshops with producers at village / clusters / block level to sensitize farmers on FIG / FPO and its beneficial dimensions; • Objectives of the workshop/s would be raising awareness about FPO benefits, understanding FPO formation steps, nurturing leadership skills, and providing necessary knowledge and skills.
Training of FPO members:	• Identifying specific training needs of FPOs and its members, • Designing training curriculum / schedule to address the identified training needs; • Orginizing thematic trainings on beneficial topics in alignment to project objectives, like agricultural production system, climate resilient agriculture, livestock management practices, supply chain management, value addition etc.; including FPO governance system, financial management, negotiation skills, and business planning etc. • Comprehensive training modules would be developed in simple language tailored to FPO members' educational backgrounds. • Trainers with expertise in identified areas would be selected, including successful farmers, agricultural experts, and professionals; • Training sessions would be planned and scheduled at the convenience of FPO members, avoiding information overload; • Trainers would conduct interactive sessions involving discussions, demonstrations, role-plays, and hands-on activities; • Practical demonstrations would be arranged for first hand learning experiences. • Progress of training sessions would be regularly monitored and evaluated based on feedback; • Refresher trainings will also be organised periodically for the FPOs; • Records of all training programs, including attendance, materials used, feedback, assessments, etc. would be maintained;

Exposure Visits of FPO members	• Identification of potential learning cases / demonstrated success cases by the project for exposure of FPOs; • Preparing detail schedule of visit, mapping key learning areas, and assessing its importance for the project; • Field visits to successful FPOs for firsthand learning experiences. • Discussions with FPO members to share learnings and observations (peer learning process); • Support and monitor application of learning by the FPOs & follow-up actions.

Institution Building Support to FIGs / FPOs:

Table 76: Institution Building Support:

Institution Building Support to the Farmer Federations	
Human Resource (HR) Support	• The project will support the FPOs with qualified professionals to handhold the FPO functions, guide them in their business ventures, facilitate in supply chain / value chain activities, and fostering linkages with different entities. • It will help organize regular training programs to enhance the skills of FPO members and staff.
Support for Institutional Strengthening	• Continuous training and education for members and management; • Direct financial support and assistance in resource mobilization; • Technical advice and support in operational areas; • Facilitate / support in good governance practices; • Assistance with legal and regulatory compliance; • Facilitate networking with other stakeholders; • Support in strategic planning and goal setting; • Leadership mentoring for enhanced management skills; • Establishment of performance indicators and monitoring systems; • Optimization of information management processes.
Support for Professional Services	• Financial management support including accounting, tax consulting, risk assessment, auditing, and financial planning; • Assistance with legal compliance, contract law, dispute resolution, and agricultural laws and regulations • Technological support for data management, digital applications, and communication platforms • Expert advice on strategic planning, operational efficiency, market research, and leadership development • HR assistance with recruitment, training, retention strategies, performance management, and labour law compliance • Professional support for marketing strategies, branding, and public relations • Training in leadership, financial management, and farming techniques • R&D services for market trends, customer behaviour, and innovative product development • Assistance with quality standards, certifications, and hygiene regulations • Optimization of supply chain management, warehousing, distribution, and logistics • Building partnerships with government agencies (Consortia partners) for professional services support.

Role and Responsibilities:

Table 77 Role and Responsibilities for FIG / FPO Promotion & Strengthening

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC	Awareness / sensitization (meetings / workshops)
		Identification of potential farmers / producers
		Organizing farmers to FIG with the support of Unit Office
		Finalizing operational modalities with Unit Office
		Preparing database of famers, their produces etc.
		Periodic updating of profile of FIG
		Reporting to Unit Office
2	Field Implementation Unit	Formation of FIG (if not existing)
		Federating FIGs to FPO
		Prepare capacity building plan for FIG / FPO
		Conduct capacity building of FIG / FPO
		Support in preparing business plan
		Facilitate integration of FIG/FPO with ABGC
		Periodic monitoring & guidance to FIG / FPO
		Maintain / update database (MIS) of FIG / FPO
		Periodic reporting to DPMU on functioning
3	District Project Management Unit (DPMU)	Support Field Implementation Unit in all aspects
		Support unit office in preparing business plan
		Facilitate capacity building of FIG / FPO
		Support in networking, market linkage and branding
		Conduct periodic assessment of FIG / FPO functioning
		Reporting to PMU on progress & performance
4	Project Management Unit (PMU)	Support DPMUs in related activities
		Facilitate linkage with State and National Markets
		Preparing capacity building plan for FIG / FPO
		Participate in capacity building
		Facilitate product branding
		Provide guidance to DPMU & Field Implementation Unit
		Tracking physical and financial progress using MIS
		Periodic monitoring and technical / managerial support
5	Technical Institutions (Consortium)	Guidance as per the implementation requirement
		Consultation with FIG / FPO to assess challenges
		Support to PMU / DPMU to address the challenges
		Conduct specific assessments, if required

5.1.1.2 Green Value Chain Development:

The green value chain approach refers to the full range of coordinated value-adding activities that produce raw agricultural materials and transform them into particular food products that are sold to final consumers and disposed of after use, in a manner that is profitable throughout, has broad-based benefits for society, and aims to reduce the environmental footprint (FAO, 2014). The environmental component of sustainable food value chains looks at the greening of food value chains and how this can contribute to the reduction of the environmental footprint as a result of food chain processes, operations and transactions, and importantly seeks to provide preventive strategies to increase the efficiencies and effectiveness of natural resources as well as impacts on natural life cycles, the climate and so forth. Such strategies relate to carbon and water footprints, as well as food waste and loss prevention, soil, ecosystem services and biodiversity conservation.

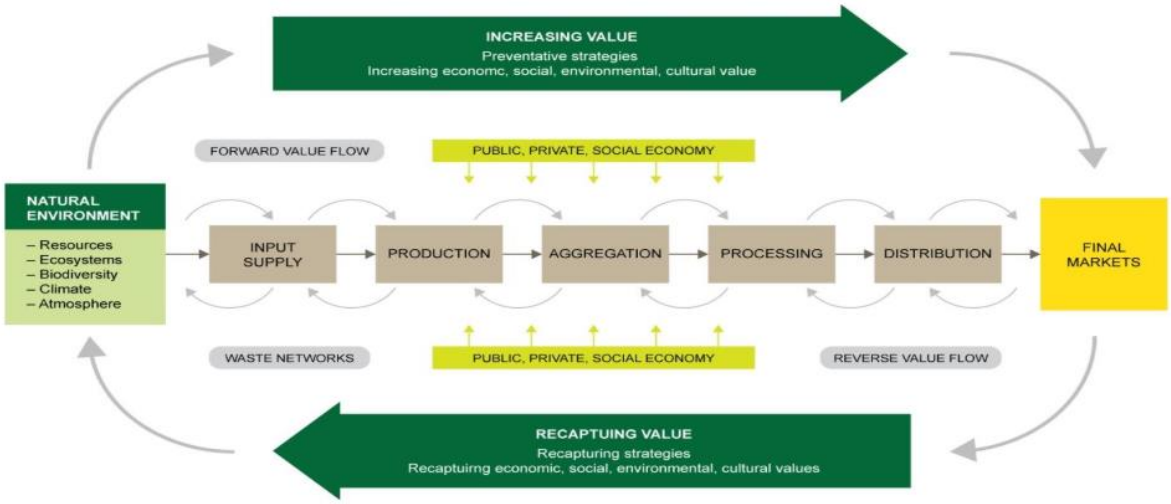


Figure 70: Green Value Chain Development Framework, FAO

The green food value chain concept is defined as a food chain that provides value at each stage, proactively reducing the usage of the natural environment, (natural resources, ecosystem services and biodiversity), so as to diminish or mitigate adverse impacts, or even have positive impacts, while considering disposal and recycling patterns of generated waste, to recapture value at every stage of the food value chain and thus further reduce environmental impact.

As the project intends to promote green value chain, it will access services of consulting agencies to identify the scope and prepare a detail plan for green value chain development. The project will support Farmer Producer Organizations (FIGs / FPOs) in developing less carbon emitting green value chain. This initiative aims to enhance FPOs' capabilities in sustainable agricultural practices, green technology, and resource management through comprehensive training and strategic partnerships. By identifying and addressing the specific needs of their clients, FPOs can offer tailored solutions that promote sustainability and efficiency.

- Training FIGs / FPOs in sustainable agricultural practices, green technology, and resource management;
- Partnering with experts in green technology to provide essential technical guidance;
- Identifying needs to offer solutions for farmers, FIGs / FPOs, and agribusiness units;
- Offering services such as training programs, green technology implementation, and regulatory compliance advisory;
- Leveraging local networks for green value chain;
- Ensuring continuous learning and adaptation to new technologies;
- Monitoring and evaluating green value chain development initiatives and its overall outcome;
- Incorporating green value chain development interventions in the business plan to ensure financial sustainability.

Supply and Value Chain Analysis:

Agri-food system requires transformation looking at the emerging market demand and value to the consumers and margin to the producers, especially marginal and small farmers. In agricultural commodities, adequate focus is required regarding processing, value addition and marketing of agricultural commodities in all the segments of the supply chain. The traditional way of food production and marketing is to be replaced with practices that are

more remunerative to the small producers and which can be realized through a coordinated mechanism across different players of the chain, i.e., farmers, processors, traders, and other stakeholders in the value chain. Demand for high-value commodities like fruits and vegetables is growing and producers are trying to diversify their production systems accordingly. On the other hand, demands of the consumers are changing towards quality of food commodities and convenient food systems (frozen, pre-cut, pre-cooked and ready-to-eat items). So, it is required that current production, processing, and distribution systems are to adapt such changes. Steps that are necessary are to be taken up by which existing supply chain is strengthened further and value addition activities are taken up locally in an enterprise mode.

Organization of agriculture along the value-chain framework has been conceived as one of the strategies to bring more efficiency in the agricultural sector in the project districts. There has been an increasing emphasis on the development of efficient agricultural value chains at the national level to improve the income of the farmers. Based on national and state perspectives, the project also intends to promote and support supply chain and value chain improvement in agriculture and horticultural commodities. However, there are certain apprehensions about the capability of smallholders to take up supply chain and value chain management system efficiently. For this purpose, the project intends to improve the capacity of producers and their organisations / associations (FPO etc.), apart from promotional support, by which they can take up such activities for better return. It is expected that improvement in value chain and supply chain management systems will improve linkages between buyers and small farmers in the project districts, which would be beneficial for the smallholders.

Objectives of the Supply and Value Chain Analysis:

The key objectives of supply chain and value chain analysis are to understand the current system of management practices, stakeholders involved in the process at different stages, identify current bottlenecks and opportunities for improving the supply and value chain in specific agricultural commodities. The analysis will be helpful to develop commodity specific strategies for improvement in agriculture and horticulture.

Identifying Issues of Importance and Building Strategy:

The supply chain and value chain require increasing vertical coordination among different players. Establishing successful coordination in the value chain has a significant impact on cost reduction and farm-income enhancement as well as resulting in positive externalities. The project will promote / support necessary conditions for the development of successful value chains and improve supply chain for specific project supported agricultural and horticultural commodities. The supply / value chain will be helpful to identify the following aspects so that the project can take up appropriate activities for specific commodities.

1. Opportunities and challenges for strengthening value chains in the agricultural and horticultural commodities (specific project promoted commodities).
2. Analyse the scope of supply / value chain improvement that can address the issue of marginal and small agricultural producers and help to improve their income and livelihood;
3. Institutional and policy reforms needed to ensure inclusiveness of the resource-poor farmers in agricultural value chains;
4. Requirement of technology, policy, and infrastructural facilities in the development of commodity specific value chain;
5. Identifying the enabling factors for establishing linkages between farmers and other stakeholders in the value chain;

6. Identifying scope of promoting / strengthening farmer's organization / co-operative to enhance their bargaining power to deal with other stakeholders in the value chain;
7. Identifying the externalities (social, economic, and environmental) in the commodity specific value chains;
8. Required conditions that would encourage a successful public-private partnership;
9. Technological challenges and use of modern ICTs in improving supply / value chain;
10. Strategy to deal with price volatility so that the supply chains work efficiently, and farmers are less or not affected by high price fluctuations;
11. Documenting lessons from various success stories and failures in the area of agriculture to draw implications for the future;
12. Identifying most efficient pathways for scaling up of successful value chains across different agricultural and horticultural commodities in project clusters / districts.

Commodities for Analysis:

The supply and value chain analysis will be taken up for the commodities that the project is promoting within its scope of interventions. The commodities to be taken up for analysis are:

1. Millets
2. Pulses (Red Bram, Black Gram & Bengal Gram)
3. Horticultural commodities (fruits and vegetables)

The supply chain and value chain analysis will be the prerequisite to take up agribusiness activities, which will be done involving farmer groups / FPOs. It will be done by DPMU and watershed cluster level units of WMD, supported by PMU.

5.1.1.3 Supporting Agribusiness Growth Centre:

The project will support in establishing Agribusiness Growth Centres (ABGCs) in selected districts / aggregated clusters that will support in backward and forward linkage. In establishing and making it operational, the project will adhere to the followings.

Guiding Principles:

- Before establishing ABGC, there will be assessment of production and marketable surplus of specific commodities to understand the viability of the centre in the longer run;
- Current value chain and supply chain of agricultural and horticultural commodities would be assessed, along with potential for accessing other markets and scope of value addition;
- Spatial planning, based on commodity in-flow and outflow easiness.
- Selection of point of establishment that is easily accessible for the producers, traders, suppliers etc.;
- Availability of required communication and transportation facility;
- Plan for infrastructural requirement, based on the assessed scope, and preparation of detail investment plan;
- A detail business plan (at least for a period of 10 years) with projected cash inflow and outflow;
- Human resource plan for operation and management of the centre;
- Preparing governance / management plan and operational guidelines for the centres;
- Fulfilling required legal and reporting requirements, as per Govt. guidelines / norms;
- Branding/Marketing of the ABGC.

Key Functions of the ABGC:

The ABGCs will provide direct support to the farmers in terms of inputs for production of agricultural and horticultural commodities. It will also serve as aggregation point where farmers / FPOs can aggregate their produce along with primary screening, cleaning, and gradation. The centre will have facility for primary and secondary processing of selected commodities that are produced in volume and available for value addition. The centre will be integrated with other business networks and IT enabled platforms to access price information and e-marketing. The proposed Custom Hiring Centre (CHC) may also operate from ABGC, based on the operational feasibility.

Role and Responsibilities:

Table 78 Role and Responsibilities for ABGC

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC /DNSS/ FIG	Consulting with farmers on products
		Assessing marketable surplus (commodity specific)
		Updating information on marketable surplus
		Reporting to Unit Office
2	Field Implementation Unit	Conducting value and supply chain assessment
		Assessing feasibility of establishing ABGC
		Support DPMU in preparing business plan
		Facilitate integration of FIG/FPO with ABGC
		Capacity building of FIG/FPO managing ABGC
		Periodic monitoring & maintaining database
		Submit assessment reports to DPMU
		Periodic reporting to DPMU on ABGC functioning
3	District Project Management Unit (DPMU)	Support Field Implementation Unit in all respects
		Preparing ABGC business plan
		Assessing ABGC performance
		Support in market linkage and branding
		Reporting to PMU on ABGC progress & performance
4	Project Management Unit (PMU)	Support DPMU in ABGC business planning
		Facilitate linkage with State and National Markets
		Facilitate product branding
		Consultation with technical institutions on PHM
		Guiding DPMU and Field Implementation Unit
		Tracking physical and financial progress using MIS
		Periodic monitoring and technical / managerial support
5	Technical Institutions (Consortium)	Consult with PMU / DPMU from time to time
		Provide technical support to PMU / DPMU
		Conduct visits to ABGC and providing guidance

5.1.1.4 Marketing Support and Developing a Common Marketing Platform:

The project will support in creating a unified, recognizable brand (GRAMYA brand may be used), including a shared logo, slogan, and colour scheme. A comprehensive marketing campaign will promote this brand through various channels. By sharing resources like content writers and graphic designers, costs will be reduced, and quality maintained. Training and support will be provided for implementing marketing strategies, including social media tutorials and brand guidelines. A system will track marketing effectiveness, and regular meetings will review performance and plan future initiatives, increasing visibility and support FIGs / FPOs. The FIGs / FPOs will be integrated to the digital platform of the project

for marketing of produces. Along with this, E-marketing support will also be provided through existing platforms like E-NAM and ONDC portals through registration and integration.

Agriculture Marketing Infrastructure in the State:

For marketing of agricultural produces, Government has established Uttarakhand Krishi Utpadan Mandi Parishad (UKUMP), which is the nodal agency for agricultural marketing in the state. UKUMP has created state-wide network for marketing of agricultural produce with 25 principal market yards, 31 sub-market yards and 27 weekly markets. To ensure marketing of horticulture produce, 18 separate marketing yards have been established in the state. The state also has set-up 3 farmer- consumer markets. For horticultural crops, Uttarakhand Horticulture Marketing Board (UHMB) is established to assist farmers in marketing of horticulture produces. The benefit can be gained by fixing MSP for different crops.

Status of APMC Act:

The state government has amended the APMC Act, in line with Model Act 2003. The amended Act facilitates setting up of private markets, farmer consumer markets, reduced fee on perishable horticulture produce, contract farming, e NAM for e-trading etc.

Status of Food Processing Industry in Uttarakhand:

State Govt. has taken initiatives to establish Four Agri Export Zones (AEZs) under the AEZ scheme of Government of India for litchi, floriculture, herbs and medicinal plants, and basmati rice. Two mega food parks have been set up under Mega Food Parks Scheme of Ministry of Food Processing Industries. The state is having several small and medium food processing units. Currently, the state is having 512 food processing industries, of which 109 are non-horticulture-based units and 403 are horticulture-based units. The State is having 17 cold storages and 3 controlled atmosphere (CA) storages with capacity of 59,900 MT[54]. The Government of India has launched PMFME scheme for supporting microenterprises.

The Government of Uttarakhand has been providing high priority to agriculture and allied sectors. Considerable efforts have been made to strengthen agriculture and horticulture sector in terms of new technology, productivity improvement, infrastructure, knowledge, IT applications, market intelligence, linkages, credit, and financial arrangement. To support farmers in fetching a better return of their produces, particularly small and marginal farmers, there is a need to create appropriate ecosystem at project clusters and at the State. Looking at the potential, the project has identified certain commodities, i.e., paddy, millets, and horticultural crops for providing necessary support for value addition and market linkage.

5.1.1.5 Support for Brand Development, Packaging, and Market Intelligence:

Effective brand development, innovative packaging, and robust market intelligence are crucial for the success of agribusiness activities. These elements ensure that farmers can not only grow and harvest high-quality crops but also sell their products in a competitive market. By establishing a strong brand identity, utilizing attractive and functional packaging, and leveraging market data to make informed decisions, the FIGs / FPOs can significantly enhance their market presence, increase sales, and build customer loyalty. This comprehensive support framework of the project will empower the farmers and their collectives to achieve long-term sustainability and growth.

[54] Department of Horticulture, Govt. of Uttarakhand

Objectives:
The overall objective of this investment is product branding and its market positioning for the value-added products. Providing market related information like product demand, price etc. to the producers and their associations (FIGs / FPOs) will also be a part of the support mechanism.

1. To create a strong brand identity of the product;
2. To improve packaging design with cost-effective packaging;
3. Remunerative return to the FIGs / FPOs based on market information system.

Project Approach:

This component aims at enhancing profitability for the farmers by improving their access to markets through bringing-in producers and consumers closer for locally produced goods. The project will invest to achieve this by enhancing market penetration and developing alternate marketing channels which improve farm level post-harvest management and value addition. The project will capitalise on existing network of producers / farmer producer organizations (FPOs), wherever feasible. This component will help the farmers to realise a greater return to their products through value chain improvement and supply chain management. The project will take up different measures, based on the requirement of the farmers to improve the value chain of horticultural and agricultural crops in different project locations. The activities framed under the sub-component will be implemented by WMD directly through its district and cluster level set-ups. The project will attempt to foster convergence with other relevant schemes / programs of the Government to benefit the target mass.

1. For the promotion of agribusiness activities and making it a profitable venture for the marginal and small farmers, the project will strengthen the supply chain for selected agricultural and horticultural crops based on the marketable surplus created in the project clusters. It will be helpful to the farmers and their organizations to sell their products directly in the market (including e-marketing).

2. For improved post-harvest management, emphasis shall be given for strengthening / establishment of integrated pack houses and low-cost storage structures/cold storage.

3. Farmer Producer Organisations FPOs shall be encouraged for association in agribusiness activities (suitable activities), based on their potentiality.

4. For strengthening and improving access to market, the regulated and private markets will be tied up with national market through e-NAM / ONDC and other marketing portals. It will help the farmers to sell their produce at the national level with a remunerative price. The project will facilitate in establishing and strengthening necessary infrastructural requirements in the selected clusters for storage and produce marketing.

5. Market information, more particularly the commodity specific price of different markets will be made available to the farmers / FPOs periodically. It will help the farmers / FPOs to sell their produce in a better price. It will minimize the distress sale of the commodities.

Digital Agribusiness:

Digital solutions will play a crucial role in supporting agribusinesses in the project districts. The project envisages to promote digital agriculture that support the producers, marketing entities and related other stakeholders. An IT driven information dissemination and decision

support system will be developed that would support agribusiness activities and overall agricultural interventions. With its support, the producers can easily connect with market that they consider remunerative. The digital platform will enhance competitiveness and operations in agribusiness. Different entities associated with agribusiness will be connect with the producer / FIG / FPO and collect the required quantity of produce directly from the stock.

Promotion of agribusiness through digital platform will strengthen supply chain management like logistics optimization, inventory management, market information accessibility etc. The procurement platform will provide access to online marketplaces for price comparison. The agri-marketing and promotion tools, including digital marketing platforms and access to online marketplaces will facilitate effective marketing strategies and market reach in the project districts. The platform will also support the traders / aggregators to establish connection with different sellers / buyers.

Agribusiness will be a part of the overall digital agriculture architecture of the project. The project will develop required database, integrate applications, and platforms to support the producers, FIGs / FPOs and the agencies for product value addition and marketing. The producers, including their associations, will be registered & linked with detail information on specific commodities, unit price of the available commodities, quality of the available commodities etc. (*refer digital agriculture section for details*).

Role and Responsibilities:

Table 79 Role and Responsibilities for Branding, Packaging and Marketing

Implementing & Support Entities	Role and Responsibility
FIG / FPO	▸ Organizing trainings / workshops with the support of Unit office / DPMU and other stakeholders; ▸ Discuss with members periodically and strategize for better market penetration; ▸ Taking up branding and packaging with the member farmers; ▸ Seeking required support from unit office / DPMU to strengthen its operation; ▸ Periodic consultation with unit office and progress reporting.
Field Implementation Unit	▸ Conducting value and supply chain assessment; ▸ Support FIGs / FPOs in branding, packaging, accessing market information, support in registration in digital platform; ▸ Capacity building of FIGs / FPOs and monitoring application of inputs; ▸ Support FIGs / FPOs in business planning and market linkages; ▸ Submit progress reports to DPMU; ▸ Periodic reporting to DPMU on branding and marketing functioning.
District Project Management Unit (DPMU)	▸ Support Field Implementation Units in all respects; ▸ Coordinate branding efforts; ▸ Oversee packaging initiatives;

	▸ Support in market linkage and brand positioning; ▸ Analyze and report on district-level market trends and Facilitate information flow; ▸ Reporting to PMU on progress & performance
Project Management Unit (PMU)	▸ Support DPMU in branding, packaging, and business planning; ▸ Organize workshops for brand positioning and development; ▸ Conduct market research on consumer preferences (commodity specific) and inputs to DPMU and unit offices; ▸ Facilitate linkage with State and National Markets; ▸ Develop overall brand positioning strategy; ▸ Support in developing packaging guidelines and standards; ▸ Analyse market trends and regulatory requirements and supporting DPMUs / Unit Offices accordingly; ▸ Tracking physical and financial progress using MIS / digital platform; ▸ Periodic monitoring and technical / managerial support.
Technical Institutions (Consortium)	▸ Consult with PMU / DPMU from time to time; ▸ Provide technical support to PMU / DPMU on brand positioning, brand promotion and market penetration; ▸ Conduct visits to FPO / FIG / agribusiness units / growth centres and providing guidance

5.1.1.6 Demonstration of Pilot Initiatives and Adoption:

Project investment and initiatives in agribusiness promotion through FIG / FPO, including value addition, and demonstration of business strategies will be initially in a pilot scale with selected FIGs / FPOs across the project districts. These pilot initiatives will also be learning centres for other FIGs / FPOs of the project area who can visit and understand the benefits of the project approach. Based on their learning, some of the FIGs / FPOs may express their interest to adopt such measures. In such cases, the project will extend financial and technical support to the interested FIGs / FPOs in specific aspects.

Role and Responsibilities:

Level	Roles and Responsibilities
PMU (Project Management Unit)	Planning, resource allocation, policy and execution support, facilitate State / National level networking, overall coordination and management, monitoring and evaluation.
DPMU (District Project Management Unit)	Providing implementation support to unit offices, coordination among stakeholders, monitoring of activities and progress reporting.
Consortia Partner	Providing expertise and technology, facilitate capacity building of FIG / FPO, and supporting implementation, conducting thematic studies.
Field Implementation Unit (FIU)	Executing pilot projects on the ground, providing direct support to FIG / FPO, collecting data, and reporting progress.
FIG / FPO	Engaging local farmers, facilitating community involvement, ensuring adoption of practices, and providing feedback.

5.1.2 Strengthening Agro Logistics:

The agricultural sector, particularly in hilly area has been facing challenges of value addition and logistics. While increasing income of producers has been the objective, enhancing supply chain of agricultural / horticultural commodities is important. Hence, establishing agro processing / value addition supportive infrastructure and logistics management becomes crucial. The hilly areas having logistics challenges is to be addressed in a planned manner. The production collection centres will be established in suitable and feasible places, cooling chamber facility will be created for storage and shelf-life improvement and strengthening energy efficient transportation mechanisms. By improving logistical systems and processes, agricultural businesses can overcome many of the problems they are facing now. This can help them to reduce costs, improve efficiency, and better serve the market.

Some of the challenges that will be tackled to streamline the efficiency of agricultural business are [1] addressing transportation difficulty of distant located villages / villages in a remote area with poor or no road network which makes getting products from the farm to market difficult, [2] providing market information, such as price information, consumer demand, and supply constraints, etc. for efficient logistics management, and [3] creating infrastructural facility to reduce waste of agricultural / horticultural products.

Optimizing Logistics For Agri-Business Development:

Improving the efficiency of agricultural logistics is a critical aspect of creating a more sustainable supply chain system. Some of the important ways to optimize logistics for agriculture / horticulture under the project are:

- Using advanced data analytics through digital platform and advisory to understand supply chain performance and requirement;
- Implementing multiple supply chain optimization strategies, including digital technology and automation that covers stock monitoring, availability of marketable surplus of commodities, demand vs supply gap bridging etc.;
- Improving efficiencies through transportation planning, inventory management, and distribution techniques that minimize costs, optimize delivery time (reducing delays), and maintain timing in receiving products and/or services;
- Optimize logistical operations through better coordination between FIGs / FPOs such as product aggregation, storage of product, channelizing products to different markets and transportation management.

Looking at the challenges in availability and management of agro logistics in hilly areas, the project will support in promoting and strengthening agro logistics, including post-harvest management infrastructures like cooling chambers, collection centres, processing units etc. It will enhance supply chain management, ensuring energy-efficient and climate-resilient transportation, grading & packaging centres for value addition, and godowns/shops near marketing hubs. For efficient transportation of commodities in hilly areas, the project will also explore the scope of gravity-based ropeway system in collaboration with FIGs / FPOs / other stakeholders.

Project Approach and Guiding Principles:

- Conducting scoping study and identifying critical areas that require agro logistic improvement and management support;
- Preparing detail business plan by type of project investment, including management plan;

- Extending support as per the plan for agro logistics / post-harvest management structures;
- Provisioning IT support for agro logistics management as a part of digital agriculture.

Role and Responsibilities:

Level	Role and Responsibility
WWMC / FIG / FPO	▸ Identifying critical gaps in agro logistics and proposing to field implementation unit to improve the condition with project support; ▸ Support in implementation of agro logistic facilities; ▸ Preparing business plan for agro logistics supported under the project; ▸ Periodic review of use of agro logistics and its benefits; ▸ Oversee alignment of intervention with business needs; ▸ Tracking business plan realization and managing financials of agro logistic. **Note**: agro logistic would cover a range of post-harvest and value chain development units, such as collection / aggregation centre; cooling chamber; godown / storage structure; cleaning, grading, and packaging unit; primary / secondary processing unit; transportation facility including rope-way based solutions etc.
Field Implementation Unit (FIU)	▸ Conduct feasibility assessment of proposed agro logistic; ▸ Support FIG / FPO in preparing business plan; ▸ Support in implementation of feasible agro logistic support unit/s; ▸ Training and handholding support to FIG / FPO in agro logistic management; ▸ Coordinate with FIGs / FPOs involved in agro logistic management; ▸ Periodic monitoring and review of functionality of the units; ▸ Accessing required support from DPMU, PMU and consortium members; ▸ Preparing progress report and its submission to DPMU periodically.
DPMU	▸ Support Field Implementation Units in feasibility assessment and business planning; ▸ Support FIUs in establishing agro logistic support units; ▸ Conducting periodic monitoring of established units and assess management system; ▸ Coordinate with associated stakeholders and market entities at the district level to establish linkage with the established units; ▸ Linking agro logistics units with digital platform for improved accessibility; ▸ Preparing / consolidating progress report and appraising to PMU on periodic basis.
PMU	▸ Prepare operation and management guidelines for agro logistics; ▸ Prepare project level plan and allocating resources; ▸ Technical and managerial support to DPMU and FIUs; ▸ Periodic monitoring and assessing performance of the established units; ▸ Review of reports submitted by DPMUs and supporting in resolving issues, if any;

	▸ Capacity building of DPMUs and FIUs in planning and agro logistic management.
Consortium Partners	▸ Providing techno managerial support, wherever required based on the need of the project; ▸ Support in assessing performance of the established agro logistic units; ▸ Consult with PMU and DPMU and providing technical support and ideas on implementation of smart technologies.

5.2 Income Generating Support for Marginalised Groups: (Sub-Com C2):

Multidimensional poverty in Uttarakhand has decreased by 8 percent during the last 5 years of the National Family Health Survey of 2015-16 and 2019-21[55]. As per the report, 8,15,247 people have come out of the poverty line in Uttarakhand (according to the population of 2011 census). The number of people living in multidimensional poverty in Uttarakhand has dropped from 17.67 percent to 9.67 percent between 2015-16 and 2019-21. Multidimensional poverty of rural areas of Uttarakhand decreased by 11.03 percent. In 2015-16, 21.87 percent were poor, which decreased to 10.84 in 2019-21. There is less poverty in the urban areas of the state than in the villages. Between 2015-16 and 2019, multidimensional poverty in cities fell from 9.89 percent to 7 percent. Maximum 16.18 percent of people came out of the poverty line in Almora district. Uttarkashi in second place with 14.74 percent people come out of poverty. Champawat district with a decline of 12.82 percent stood at the third place, Bageshwar district at the fourth place with a decline of 12.49 percent. Apart from these, 11.72 percent in Udham Singh Nagar district, 11.60 percent in Tehri Garhwal, 9.96 percent in Chamoli, 8.77 percent in Rudraprayag, 8.41 percent in Haridwar, 7.48 percent in Pithoragarh, 3.86 percent in Dehradun, 3.31 percent in Nainital and 3.01 percent in Pauri Garhwal district poor were decreased.

Table 80: Distribution of Rural HH by Monthly Income of Highest Earning Member

District	< Rs. 5,000	Rs. 5,000 to Rs. 10,000	>= Rs. 10,000
Uttarkashi	80.10	9.05	10.84
Chamoli	60.07	24.21	15.72
Rudra Prayag	53.74	31.32	14.94
Tehri Garhwal	70.94	19.47	9.59
Dehradun	48.95	23.95	27.10
Pauri Garhwal	59.17	23.87	16.96
Pithoragarh	62.83	19.78	17.39
Bageshwar	66.37	20.99	12.64
Almora	73.30	16.24	10.47
Champawat	73.12	14.03	12.85
Nainital	61.78	20.9	17.31
Udham Singh Nagar	65.02	22.24	12.74
Hardwar	62.56	27	10.44
State Total	**63.41**	**21.86**	**14.72**
All India	**74.52**	**17.18**	**8.25**

***Source**: Socio-economic Caste Census, 2011.*

The Socio-economic Caste Census-2011 (rural) reveals that highest of 80 percent of rural households in Uttarkashi having monthly income less than Rs. 5,000 of their highest earning members. Other districts with such low income of rural households are Almora, Champawat and Tehri Garhwal. The lowest proportion of such rural households was in Dehradun and Rudraprayag districts. While Dehradun district has the advantage of urbanization as well as tourism, Rudraprayag district has the advantage of tourism. As compared to India, the proportion of low earning member households is significantly lower in Uttarakhand. Similarly, the proportion of rural households with a highest monthly income range of more than Rs. 10,000 was almost double in Uttarakhand as compared to the national average. The proportion of such high-income rural households significantly varies across districts of the state with Dehradun on the top (27 percent) and Tehri Garhwal at the bottom (9.59 percent).

[55] The Multidimensional Poverty Index Report, NITI Aayog, July 17, 2023,

5.2.1 Support for Marginalized Groups and Individuals
(Non-Farm based livelihood options for the Marginalized Groups)

For greater inclusion and to address the livelihood needs of the rural marginalised section, the project will support such households, selected by the community, who are not expected to be benefitted directly from the major farm related project investments. The support is primarily intended to reduce vulnerability and improve their resilience to climate variability impacts.

Project Approach:
The project will facilitate selection of marginalised households in project villages / village clusters with the participation of local community. The project will finance small-scale income generating activities to the identified individual households or their groups for different livelihood activities. The project will also provide skill and business management training to the supported households. The project will support the marginalised households with a maximum of 50 percent of the financing need, not exceeding Rs. 40,000. The project will develop specific guidelines to support Marginalised groups along with payment modalities. – The wealth ranking exercise will be carried out to study and classify the economic status of households within the community in a participatory manner, following PRA principles. The exercise will involve local community members in identifying and ranking households based on their perceived wealth and socio-economic status. During the wealth ranking exercise, the identification of marginalised household will be based on specific criteria like [1] landless or having less than 5 nails (0.10 ha.) of land, [2] socially marginalised such as widow, disabled, SC/ST, women, etc., [3] household not having any specific reliable source of income for major part of the year etc.

Entrepreneurship Development Program (EDP):
After selection of Income Generating Activity (IGA), EDP training will be imparted to the marginalised groups / individual beneficiary. EDP will cover skill Training and Exposure program.

Guiding Principles:

- Organizing awareness and sensitization drive at the project clusters / villages to make people understand the objective of selection of marginalised households and selection process.
- Marginalized households will be selected based on certain parameters like current source of livelihood, multidimensional deprivation, current level of income, women headed households etc. The parameters will be finalised by the PMU in consultation with ground force of the project.
- The local GP will be involved in the selection process along with local community and community- based organizations.
- The selected marginalised households will apply for project support to the local project office with a detail business plan for the livelihood activity they want to pursue. The ground force of the project will support the interested households in developing feasible and implementable business plan.

- The project may render financial support in trenches, not exceeding 3, depending upon the amount of support.
- Financial support to the marginalised households will be rendered through DBT, directly to the bank account of the target household.
- The scope of support would also cover skill base development of educated youths in different trades of interest and supporting them financially to establish their unit.
- A group of targeted households, with similar livelihood activity, will be trained / oriented on operation and management aspects of the involved enterprise / supported business.
- An individual/ group shall be ready to participate in Entrepreneur Development Programme (EDP) prior to taking up IGA.
- Wherever feasible, the project will render market linkage support, based on the volume of production.
- The project will prepare guidelines to ensure use of project support by the target households objectively,

The project will support the inclusion of marginalized (including women headed) and landless households, who will not directly benefit from the major farm related project investments in Component B, to bridge the economic gap and bring about overall prosperity of the community in the project areas. The approach was implemented successfully under UDWDP II, with strong take up, many livelihoods' activities with good returns. The project will finance small-scale income generating activities for such groups against basic business proposals developed with the assistance of field level staff or locally recruited consultants. The project support will be channelised by the district offices directly to the accounts of the beneficiaries in Marginalised households after appraisal by the state office. The project will also provide skill and business management training to the beneficiaries in the concerned support categories / livelihood area.

Project Support:

The project will support the marginalized group for the enhancement of their income through different livelihood options. The project will have two-fold approach for livelihood improvement of the marginal section, i.e., [1] individual approach where individual households will be supported for feasible livelihood option/s as per the identified need, and [2] group approach where village level community organizations or a group of people from the project village / GP / project cluster will be supported with different business enterprises. A list of potential livelihood interventions for the marginalised section is presented in the matrix, as per the initial assessment.

Table 81: List of Identified Potential IGA for Individual / Group

Sl. No.	Individual Livelihood Support Activities	Sl. No.	Group Livelihood Support Activities
1	Black Smithy	1	Band Party/Cultural Group
2	Carpentry	2	Tent house
3	Cobbler	3	Fruit preservation/ pickle making
4	Barber	4	Fibre Works
5	Tailoring	5	Handicraft
6	Beekeeping	6	Mushroom Cultivation

7	Shops (for technical works)	7	Fisheries
8	Poultry	8	Tailoring
9	Goat Rearing	9	Goat Rearing Unit
10	Artisan	10	Others
11	Processing Units (Wheat / Spices)		
12	Plumber/ Electrician		
13	Gharat Operation		
14	Others		

5.2.2 Support for the Transhumant:

Along with livelihood strengthening support to the marginalized households, the project will also support transhumant in terms of providing first-aid kit for animals, concentrate cattle feed, tents etc. A tentative list of support that can be provisioned for transhumant is presented in the matrix. However, based on the need of the transhumant, additional other support/s may also be rendered under the project. The details of transhumant in the project covered area has been given in Table below.

Table 82: Details of the Transhumance in WMD Project Area

Name of the Division	Name of the Nomad Group	Season	From	To	Animal Type	Animal No.	HH	Population	Project Location Area
Uttarkashi	Van Gujjar	Sum	Apr	August	Cow, Horse, Buffalo	164	4	57	Brahamkhal, Dunda/Pipli
	Sheep/Goad Herder	Whole Year	Jan	Dec	Sheep, Goat, Horse	13505	93	101	
Rudraprayag	Van Gujjar	Sum	Apr	Sep/Oct	Cow, Horse, Buffalo	2518	22	121	Listwalta, maikhanda, dharpudi, lastar
	Goad Herder	Sum	Mar / Apr	Sep/Oct	Goat	2105	4	18	khankara, Rudraprayag
Pauri	Van Gujjar	Sum	Mar	October	Small Ruminant	3000	20	85	Farsadi/Syunsi/ Maithanadhaar

Table 83: Project Support to Transhumant

Project Support to transhumant:

- Organizing human health camp
- Organizing veterinary health camps
- Distribution of tarpaulin sheets/ poly- sheets for young born calves;
- Distribution of tents for human-beings;
- Distribution of feed tubs;
- Distribution of blankets;
- Distribution of first aid kits for human-beings;
- Distribution of first aid kits for animals;
- Distribution of concentrate animal Feed;
- Distribution of solar lantern;
- Distribution of portable water storage cans/canisters

Role and Responsibilities:

Table 84: Role and Responsibilities: IGA for Marginalised

SN	Implementing & Support Entities	Role and Responsibility
1	WWMC / RVC	Consultation with villagers / conducting village meetings
		Identification of marginalized households
		Review and verification of documents of households
		Mapping households with prioritized need
		Finalize list of households and submission to Unit Office
2	Field Implementation Unit	Visit to project villages / GPs and consultation
		Verification of list of selected households
		Technical & managerial support to WWMC / RVC
		Maintain required documents
		Conduct periodic monitoring and assess benefits
		Report to DPMU on progress and benefits
3	District Project Management Unit	Support Field Office in finalizing list of beneficiaries
		Orientation of officials / staff of field office
		Monitoring to assess project benefits
		Maintain MIS and periodic tracking and updating
		Reporting to PMU on progress & benefits
4	Project Management Unit (PMU)	Issuing specific guidelines for project support
		Setting physical and financial targets
		Periodic assessment of progress & project benefits
		Conduct monitoring and support DPMU / Field Office
		Tracking physical and financial progress using MIS

Chapter 6

Component D: Project Management, M&E, and Learning

Chapter Six: Project Management, M&E, and Learning: Component D:

The project of this nature requires effective coordination at all levels, i.e., from village to the decision makers at the PMU level. For effective implementation of the project, a Project Management Unit (PMU) has been established at the State level and District Project Management Units (DPMU) with implementation and fund flow arrangement at project districts. The PMU, headed by the Project Director, consist of a multi-disciplinary team of experts. The PMU would take up coordination functions with DPMUs, Regional Project Offices and Field Implementation Units.

6.1 Objective:

The key objective of this component is to ensure smooth implementation of project activities, as well as monitoring of, and learning from project processes and outputs.

Specific objectives:

- Setting up, supporting and capacity building of officials / staff at all project levels (PMU, DPMU, Unit Office etc.) in line with the capacity requirement of the project components;
- Monitoring, evaluation, and promotion of learning culture at all levels;
- Set-up of ICT Infrastructure Developing a web-enabled MIS for tracking of progress;
- Documentation of project processes and experience, and its dissemination to the wider development community for cross-learning and sharing;
- Hiring services of an external M&E agency for the duration of the project to support the PMU in creating a feed-back loop for objective oriented intervention;
- Providing support for emerging needs and innovations during implementation; and
- Networking, collaboration, and coordination with consortium institutions / partner organizations, external professional agencies, and the World Bank.

6.2 Institutional Arrangement:

For effective implementation of project activities, institutional arrangement will be made at different project levels (State to village / clusters). Project governance mechanism at different levels shall be as follows:

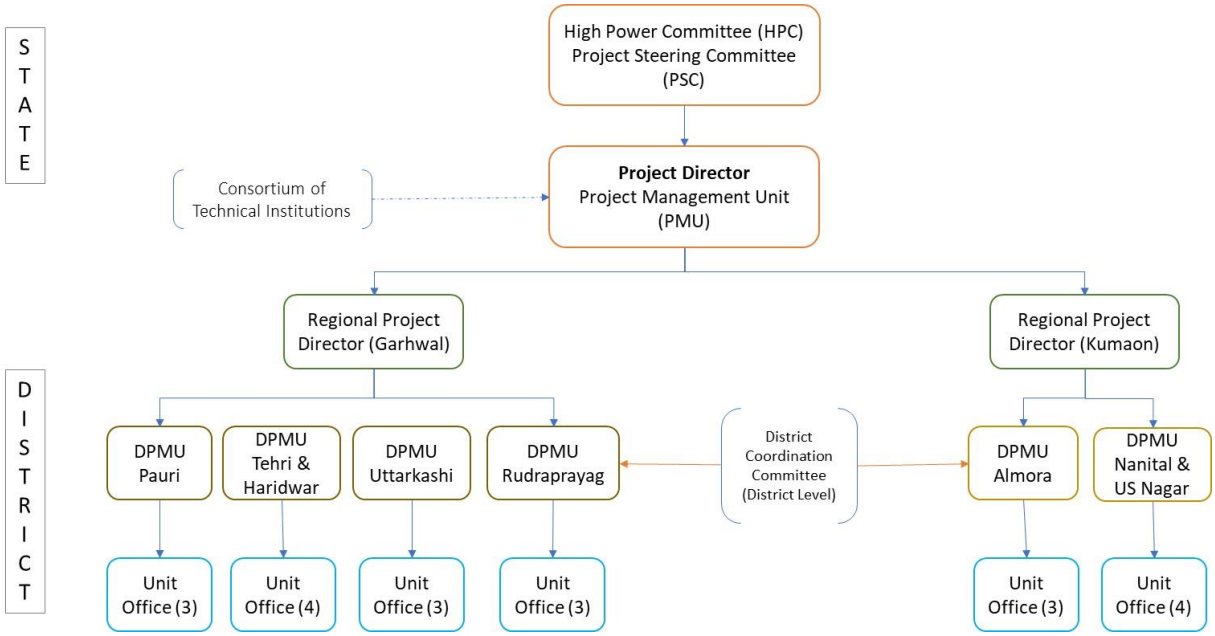


Figure 71: Project Implementation Structure

Table 85: Institutional Arrangements and Their Key Functions

Level	Institution	Location	Vested Authority	Key Functions
State	High Power Committee / Steering Committee	Dehradun	Chairperson of HPC / SC	1. Overall policy guidance; 2. Support in Planning; 3. Inter dept. coordination / Convergence; 4. Approvals to proposals (as per GO[56]) 5. Review & approval of work plan and budget
State	PMU	Dehradun	Project Director (PD)	1. Project Planning and Management; 2. Coordination with technical institutions / consortium members, other Depts., and key stakeholders; 3. Rendering Technical and Financial Support to DPMUs; 4. Providing guidance to DPMU and Unit Offices; 5. Monitoring, Learning and Documentation; 6. Developing capacity building strategies; 7. Ensuring the implementation of the ESS / ESCP; 8. Financial accounting and management. 9. Conducting procurement of goods, works and services for the project as per the laid-out procedures. 10. Maintaining web portal, project MIS and documentation 11. Grievance redressal;
Region	RPMU	Garhwal & Kumaon	Regional Project Director	1. Coordination with DPMU and PMU 2. Facilitate project implementation.

[56] Govt. GO. No. 86/XXVII (7)36/2010-11/2019 dated 08 March 2023

				3. Monitoring and supervising financial and physical progress and inspection
District	DPMU	8 Districts	Deputy Director (DD)	1. Preparing district level plan as per the approved project framework; 2. Implementation of project activities; 3. Coordination with PMU RPMU and Unit Offices 4. Coordination with technical institutions (consortium members) as per the guidance of the PMU and with other agencies; 5. Guidance to unit offices 6. Project Progress Review; 7. Accounting and book-keeping; 8. Procurement as per the procurement plan; 9. Ensure implementation of ESS / ESCP; 10. Project monitoring and supervision; 11. Grievance redressal 12. Reporting and documentation.
Cluster	Field Implementation Unit (FIU)	Village clusters	Unit Officer	1. Local level planning as per the overall project plan; 2. Execution of project activities, including selection of target mass, preparing GP level plans etc. 3. Coordination with GP, WWMC, FIGs, FPOs and other local level institutions; 4. Grievance redressal / conflict resolution. 5. Coordination with DPMU 6. Reporting and documentation 7. Project monitoring and database development
GP	WWMC	GP	President of WWMC	1. Support in implementation of project activities; 2. Monitoring the quality of works / activities taken up under the project; 3. Mobilize community, facilitate in planning, address grievances, coordinate with unit office and participate / support in implementation.

6.3 Staffing Arrangement:

For the execution of the project in line with the designed framework, the project has made exclusive staff arrangement at different operational and functional levels. Staff positioning and their number, as per the approval of the Government is presented below.

6.3.1 Project Management Unit (PMU):

The PMU will have staff / officials in three categories, i.e., [1] technical resources who will be directly from different Govt. depts. Who will join the project either on deputation or on service transfer basis, apart from the own existing staff of WMD (16 resources); [2] ministerial / other staff of WMD (73 resources); and [3] contractual (14 resources) / outsources staff through service providers (23 resources). Total staff strength of the PMU,

including all categories, would be 126 of which 89 resources (technical and ministerial) would be from Govt. sources (existing and deputation / service transfer).

The PMU will comprise of technical resources from different disciplines to guide and support the project components. There will be Joint Directors (3 nos.), Deputy Directors (3 Nos.), Asst. Engineer (Civil), Junior Engineer, Senior Finance and Accounts Officer, Asst. Finance and Account Officer, and Additional Statistical Officer (3 nos.).

Apart from Government resources, the project will also employ key experts, sourced from open market on contractual basis. They are the thematic experts who will support the technical team of the project in project delivery. The project will also have outsourced personnel for data entry and performing support functions, apart from Ministerial staff.

Table 86: Role & Responsibilities of PMU Officials

SN	Human Resources	Number	Role & Responsibility
A	**Technical Team (Excluding PD-UCRRFP)**		
A1	Joint Director, Climate Change & Consortia Coordinator	01	Planning & Coordination with Consortia Members; Tracking Climate Change Parameters (GHG); Guidance to DPMU on GHG Reduction Interventions; Capacity Building Inputs to Project Team; Prepare reports on GHG and Climate Change.
A2	Joint Director, ICT	01	Identify ICT Needs of the Project; Giving ICT Edge to the Project Components; Guiding in Development of ICT based Platforms; Reporting on ICT Progress.
A3	Joint Director, Enterprise Development	01	Assessing Scope for Enterprise Development; Facilitate Enterprise Promotion Activities; Coordinate with Financial & Technical Institutions; Mobilising Skill Base from Different Sources; Guidance & Capacity Building Support; Reporting on Progress in Enterprise Promotion.
A4	Deputy Director, Capacity Development & Knowledge Management	01	Capacity Need Assessment by Project Components Designing Need Based Capacity Building Plans Organizing & Coordinating Capacity Building Events Documenting Project Learnings Guidance to the Team to Capture Field Learning Preparing Knowledge Products for Dissemination Organizing Knowledge Sharing Events
A5	Deputy Director, Operation & Implementation	01	Overseeing Project Operation and Implementation Providing Necessary Guidance to the Teams Reporting on Overall Project Progress
A6	Deputy Director, Monitoring & Evaluation	01	Preparing M&E Plan for the Project by Component Guiding & Coordinating with External M&E Agency Review of M&E Reports and Feedback
A7	Assistant Engineer (Civil)	01	Drawing and Designing Civil Works; Monitoring Civil Constructions & Quality Check; Assessing ESS / ESCP Implementation; Providing Guidance to the Field Team.
A8	Junior Engineer	01	Support Asst. Engineer in Civil Works
A9	Senior Finance & Accounts Officer	01	Maintaining Accounts / Financial Records Tracking Financial Progress Report to Project Director on Financial Matters
A10	Assistant Finance & Accounts Officer	01	Review / Scrutiny of Bills / Vouchers Reporting to Senior Finance & Accounts Officer
A11	Additional Statistical Officer	03	Framing Data Requirement for Analysis

			Support in Collection of Project Related Data Performing Statistical Analysis Preparing Reports
	Sub-Total	**16**	
B	**Contractual (From Open Market)**		
B1	Project Manager: Operation & Implementation	01	Support Dy. Director in Project Operation and Implementation Providing Necessary Guidance to the Teams Reporting on Overall Project Progress
B2	GHG Emission Expert	01	Assessing GHG Emission Periodically; Analysis of Emission Factors as per the Protocol; Tracking & Analysis of Data Gathered from Flux Tower; Prepare Report on GHG Emission; Prepare GHG Inventory and its Tracking; Support in Coordinating with Consortia Members; Capacity Building of Team on GHG Assessment.
B3	Climate Change Expert	01	Preparing Plans to Address Climate Change; Tracking Climate Change Parameters; Support in Implementation of ESS / ESCP; Support to DPMU for Resilient Practice Promotion; Capacity Building Inputs to Project Team; Prepare reports on Climate Change Aspects.
B4	Expert, Climate Resilient Agricultural Practices	01	Preparing Plans for CSA Practice Promotion; Periodic Assessment on Adoption of Practices; Support in Implementation of INM / IPM / ESS / ESCP; Support to DPMU for Resilient Practice Promotion; Capacity Building Inputs to Project Team; Prepare Reports on Adoption of CSA Practices.
B5	Agri-Marketing Expert	01	Conduct Market Assessment & Potential Mapping; Conduct Supply Chain / Value Chain Assessment; Meeting and Coordination with Market Players; Organize Trainings for Producers / FPOs; Periodic Assessment of Marketable Surplus; Facilitate Market Linkage; Identify Scope for Value Chain Promotion; Support FPOs in Preparing Business Plan; Support DPMU in Agri-Marketing; Prepare Periodic Report on Agri-Marketing Progress; Support Joint Director, Enterprise Development.
B6	Agri-Marketing Expert (Junior)	02	Support Agri-Marketing Expert & Joint Director.
B7	Social & Institutional Development Expert	01	Conduct Assessment of Community Organizations; Support in Implementation of ESS / ESCP; Prepare Plan as per GAP and Transhumant Plan for Inclusion Prepare Capacity Building Plan for CBOs Facilitate Capacity Building of Stakeholders
B8	Enterprise Development Expert	01	Support Joint Director, Enterprise Development; Assessing Scope for Enterprise Development; Facilitate Enterprise Promotion Activities; Coordinate with Financial & Technical Institutions; Mobilising Skill Base from Different Sources; Guidance & Capacity Building Support; Reporting on Progress in Enterprise Promotion.
B9	ICT Expert	01	Support Joint Director, ITC in Identify ICT Needs of the Project; Giving ICT Edge to the Project Components; Development of ICT based Platforms; Reporting on ICT Progress.
B10	MIS Expert	01	Review and Maintain MIS Database Prepare MIS Reports

			Provide Information / Data Support to Team
B11	GIS Expert	01	Prepare Data Driven GIS Maps Analysis of Satellite Imagery
B12	Knowledge Management Expert	01	Develop Knowledge Products Capture Field Learning Prepare Learning Cases / Documents Support Dy. Director in Knowledge Management Facilitate Knowledge Dissemination Events
B13	Audit Manager & Procurement Expert	01	Prepare Bid Documents for Procurement Getting Bid Documents Reviewed Inviting Bids / Advertisement Scrutiny of Bids and Preparing Report Support Procurement Committee Support in Audit Function of the Project
	Sub-Total	**14**	
C	**Outsourced**		
C1	MIS / Data Entry Operator, Office Asst. & Support Staff	23	Support in Data Entry and Extending Required Support
	Sub-Total	**23**	
	Total	**126**	

6.3.2 District Project Management Unit (DPMU):

The project will have six DPMUs to execute the project in 8 selected districts. For Tehri & Haridwar, there will be one DPMU, and one DPMU for Nainital and US Nagar. Apart from this, all other districts will have one DPMU. The DPMUs will be headed by Deputy Director who will discharge his/her responsibility through a team of officials / staff / experts. Each DPMU will have human resource strength of 21-25, comprising of technical resources from Govt. sources (deputation and/or service transfer, 5 nos.), technical resources from open markets (contractual, 4 nos.), ministerial staff (8 nos.), and outsourced resources (4 nos.).

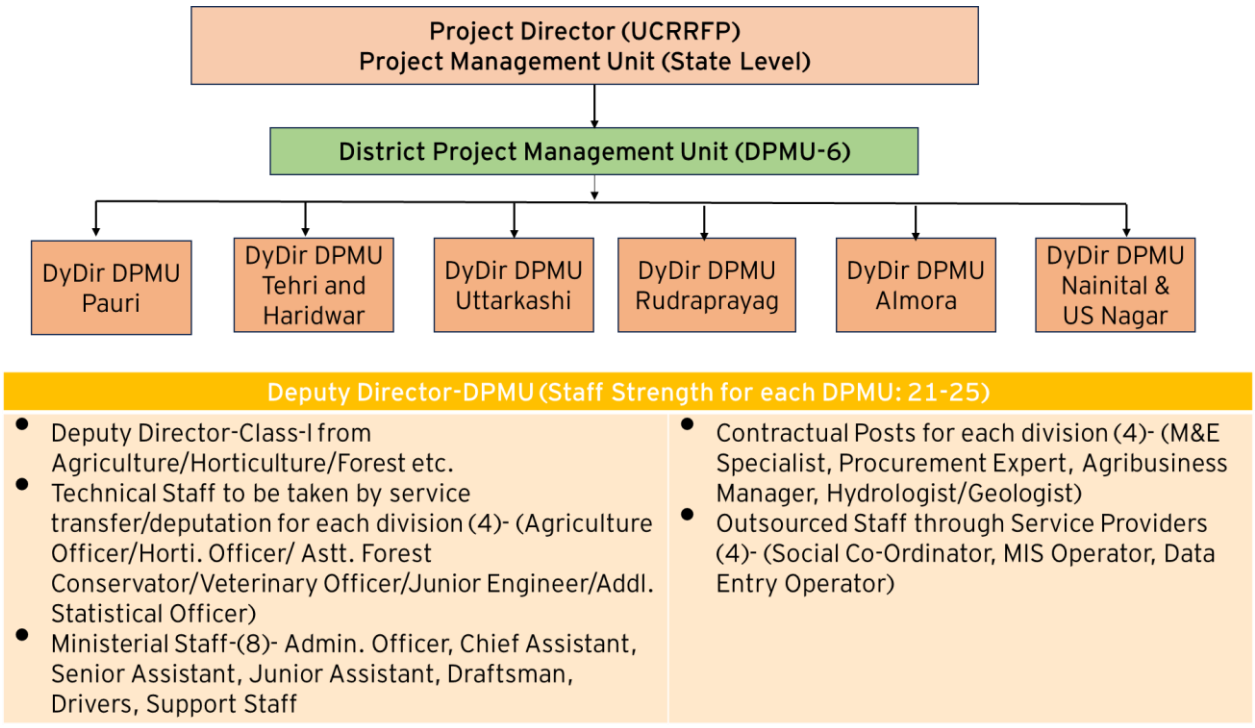


Figure 72: Organisational Structure of DPMU

6.3.3 Field Implementation Units (FIU):

The project will have 20 FIUs and each IU will be headed by Unit Officer. Each FIU will have human resource strength of 15-17. Each FIU will be equipped with a Multi-Disciplinary Team (MDT), comprising of technical resources from Govt. sources (deputation and/or service transfer, 7 nos.), and outsourced resources (8 nos.). Each MDT will comprise of officials from agriculture, horticulture, forestry, and support staff. The outsourced resources will comprise of junior engineer (civil), social practitioners, agribusiness coordinator, MIS operator, data entry operator, and project associate.

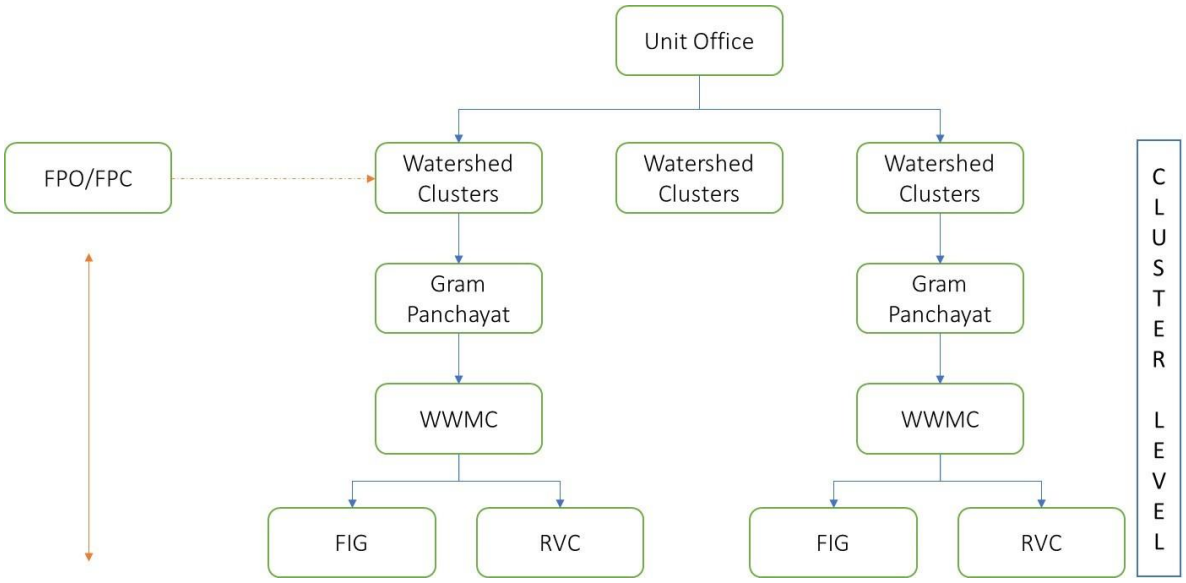


Figure 73: Implementation Structure; Unit Office and Below

6.4 Monitoring, Evaluation, and Learning:

Key objective of Monitoring, Evaluation, and Learning (MEL) system is to monitor the results of investment in various sub-components and components of the project, assess the investment effectiveness and enhance the learning of key stakeholders during the process through a constructive feedback loop. MEL system will monitor key processes during implementation as well as the outputs and outcomes of the project. Results based management framework has been adopted to develop the MEL system for the Project.

Monitoring, Evaluation and Learning

MEL includes:

- Facilitation in results-based management by integrating focus on outputs and outcomes and planning and defining the activities and their phasing;
- Understand the effects of development interventions and the progress in comparison to the baseline situation through evaluation and impact assessment;
- Setting up a system for baseline data collection, analysis and preparing baseline of the project;
- Activity monitoring with reference to baseline indicators to understand effects of project interventions and track the progress made in comparison to the baseline data;
- Setting up of standardized learning and evaluation process for stakeholders at the state, district, and cluster level and dissemination of learning from the development process for use by the stakeholders as well as wider community;
- Conduct implementation audit, monitoring, tracking, impact, and outcome analysis, and provide technical and capacity building support to the implementing entities.

The project's M&E system will have primary focus on empowering the community members by facilitating the participatory monitoring and evaluation having a major thrust on self-monitoring tools and methodologies. Learning will be at various levels and will be generated through participatory methodologies in data collection, data sharing through joint reviews, theme-based studies, and process documentation. It will be a continuous process during the life of the project.

Table 87: MEL Process

MEL Component	Type of Monitoring	Methodology	Who will Lead this component	Who will use this information
Participatory monitoring at cluster level	Self-rating by CBOs / FIGs / FPOs	Participatory Assessment	Concerned CBO with the Support of FIU	FIU, DPMU and External M&E agency
Quality monitoring of works	Civil works quality monitoring	Random site selection and quality monitoring checking.	Civil Engineer	FIU, DPMU
MIS & GIS	Periodic tracking of data and information	Finance linked monitoring of inputs, reports on inputs against the annual action plans standard formats prepared output information collected through reporting formats based on the strategic result monitoring framework web enabled system to facilitate data entry and access to information at various level.	SPU with support from DPMU & FIU.	PMU and DPMU for progress monitoring and management decision making, reporting
Field Visit based monitoring	Six Monthly	Cluster level progress review and field assessment	M&E Agency and DPMU with the support of PMU	DPMU and PMU
Participatory Assessment		Quantified participatory assessment methodology	Officer for scheduling	
		Sequence and process monitoring	An external M&E agency	Project team to understand the status and sequencing of events
		Six monthly processes will be taken by SPU and DPMU to understand the progress and process of work based on MIS and GIS report after the field visits mentioned above. The indicators of results monitoring framework as well as Input Output monitoring will be used.	SPU and DPMU, SOs, MEL resource person and World Bank team will participate in two events per annum.	SPU, DPMU and World Bank.
Periodic review and tracking	Field survey and tracking of identified clusters and households	Cluster level assessment and Household level survey of identified poor households to understand the impact of intervention of poverty	PMU MEL team with support from an external M&E agency	PMU, DPMU and World Bank.
Theme based studies	Issue and theme-based studies	Themes based on project cycle and issues emerged from the results of on-going MEL.	DPMU	PMU and DPMU

Baseline	Baseline study	Participatory baseline development, adopting mix method in the first year of the project	External M&E Agency	SPU for its use in monitoring and comparing changes through results monitoring framework
Evaluation	Mid Term	Midterm review and learning of achievements of the project, constraints, gaps to achieve the objectives. Review of strategies for implementation through field assessment, sample. Household surveys, analysis of project MIS and consultative workshops	External M&E agency	PMU, DPMU and World Bank to plan for mid-course corrections and finalizing future implementatio n strategies
	Impact Evaluation	At the end of the project to assess changes with respect to baseline situation, and overall project Impact.	External M&E agency	PMU and World Bank

District Coordination Committee:
This committee will be formed in each project district for the purpose of effective implementation of World Bank funded Uttarakhand Climate Responsive Rainfed Farming Project (UCRRFP) under Watershed Management Directorate by ensuring coordination among the concerned line departments, enhancing public support and participation, monitoring of activities, and evaluation of progress.

Monitoring at State Level:
Vide G.O no. 89/XXVII (7)36/2010-11/2019 of Uttarakhand Government regarding establishment of High-Power Committee for approval, implementation and monitoring of Externally Aided Projects, Project Director UCRRFP is granted right to perform in financial capacity equivalent to Head of Department. High Power Committee will monitor the progress of project from time to time.

Physical verification of Project Activities:
Physical verification of fixed assets shall be conducted by authorized Project staff at each accounting centre at regular intervals. The Physical Verification shall be done on the basis of Fixed Assets register. Discrepancies observed shall be recorded in the Fixed Asset Register itself and a separate report along with comments of the concerned officer shall be submitted to the Unit / DPMU / PMU.

MDT	**100% of assigned work**
JE Unit	100% for Cemented Structure, Irrigation Structure, and Irrigation related activities, 25% of kaccha structure activities
Unit Officer	50% of all activities
JE Division	20% of all activities
SDO/ACF/Agri/ Horti/Other Officers	20% of all activities
DPD	10% of all activities
PMU Level	05% of all activities of all divisions

6.4.1 Participatory Monitoring, Evaluation and Learning:
The project will facilitate participatory MEL process where the beneficiaries and village / cluster level organizations will participate and render their views / opinion on different aspects of project interventions. Community level organizations will be associated actively in monitoring the quality of interventions, process adopted to execute different activities,

suggest for required improvement as per the local situation, and support in adoption of learning. For participatory MEL, community-based organizations / other local stakeholders will be oriented, apart from capacity building on institutional development & management. Some of the participatory monitoring techniques to be adopted are: FPO self-assessment / rating, beneficiary self-assessment, and GP / WWMC feedback mechanism. The project's M&E system will have primary focus on empowering the community members by facilitating the participatory monitoring and evaluation having a major thrust on self-monitoring tools and methodologies. Learning will be at various levels and will be generated through participatory methodologies in data collection, data sharing through joint reviews, theme-based studies, and process documentation. It will be a continuous process during the life of the project.

Participatory MEL will provide scope for learning, improving the quality of intervention through collective action and bringing in transparency and accountability. Participatory MEL exercise will enable the stakeholders to understand different aspects of the project implementation and key benefits expected. Participatory MEL will also create scope for cross learning through exposure visits, sharing of knowledge, and solution to issues.

Internal Monitoring System

The project will have internal monitoring system through the PMU, DPMUs and Field Unit Offices. The internal monitoring system will be regular / continuous in nature, which will cover both physical and financial monitoring. The internal monitoring mechanism will encompass different stakeholders of the project, including GP / WWMC / RVC. Field level execution of different activities in accordance with the guidelines, adherence to project timeline, physical progress of the planned activities, association of beneficiaries / community organizations in execution of activities etc. will be monitored regularly by the Field Unit Offices. The Field Unit Offices will submit their project progress report to the concerned DPMU as per the stipulated timeframe.

The DPMUs will monitor the physical and financial progress of DPMU level activities on regular basis, along with activities of Field Unit Offices. Periodic visit to project villages / clusters, interaction with officials / staff of Unit Offices, interaction with beneficiaries / community organizations etc. will be the part of internal monitoring procedures of the DPMUs. DPMUs will share their observation report to the PMU on periodic basis, as specified in the project. Apart from DPMUs, the District Coordination Committee (DCC) and Zilla Parishad in the respective project districts will also monitor the project periodically.

With reference to MIS and based on the reports received from DPMUs, PMU will also conduct periodic monitoring to assess the project progress in both physical and financial front. PMU will discuss on various aspects of the project implementation with the DPMUs, Unit Offices and other stakeholders. PMU officials will also visit to project villages and interact with the beneficiaries / community organizations as a part of the monitoring procedure. The PMU will also take up real time monitoring of project interventions using IT solutions. The monitoring team of the PMU will share their observation report with the PD-UCRRFP for information and required action/s.

The project has constituted a consortium of technical institutions to provide technical support to the project on different aspects. They will also monitor and evaluate key project interventions on periodic basis and provide technical guidance, like GHG emission measurement and tracking, spring-shed yield monitoring, benefits of adoption of climate

resilient package of practices etc. The technical institutions, who are part of the consortium, will submit their observation report to the PMU for required measures.

Apart from Unit Offices, DPMUs and PMU; the high-power committee / steering committee, will also monitor physical and financial progress of the project periodically. Apart from approving project plan / proposal / budget, the committee will also help in providing policy guidance / support, addressing challenges / issues and other matters of importance that will be placed by the project for the consideration of the committee.

External Monitoring:

The PMU of the project will be supported by an external M&E agency, which will [1] support the PMU in developing project database and MIS, [b] will conduct baseline study for the project, (c) will undertake process monitoring to generate project cycle reports (six monthly), and (d) undertake impact evaluations (mid-term and end of the project). The process studies will provide the program a mechanism to rapidly identify areas in implementation requiring course correction in advance of the mid-term review to inform adjustments in operational design and align with the strategic objectives as outlined in the PDO.

Key responsibilities of external M&E agency shall be as follows:

- To conduct baseline study and prepare baseline of the project;
- Integrate the baseline data with project result indicators and project MIS to generate project cycle reports (concurrently every six month);
- To undertake Midterm Review (MTR) (after 3rd year of the project implementation) to help the PMU in deciding whether there is a need for mid-course correction;
- Conducting end line review and measuring project result indicators;

***Note**: The details of indicators that to be tracked by the project with inputs from external M&E agency and to be reported from time to time has been included in the project result framework.*

Apart from external M&E of the project with the support of external agency, the project would also undertake issue and theme-based studies, based on the project requirement/s. These themes / issues are likely to relate to implementation processes, identification of implementation challenges, and estimation of project outcomes / impact in specific areas like GHG emission, spring-shed yield, climate change adaptation benefits etc.

Key Deliverables by the Agency

The following deliverables are to be provided to project by contracted external M&E agency and select service providers.

Table 88 Key Aspects of external M&E

Key ML&E Output	Description	Periodicity
Baseline Study	Ex-ante baseline study to populate the baseline value in result framework	At the beginning of the project implementation stage (1st year of the Project)
Concurrent monitoring to generate project cycle report	The scope of concurrent monitoring exercise to be undertaken by the external M&E agency are; (i) up-to-date physical progress data compared to annual and end-project targets (project level data support by the	Every six months

	PMU); (ii) comparison of project performance vis-a-vis the annual and end-project targets; (iii) mapping project output on periodic basis, (iv) mapping project result indicators with respect to the baseline values (v) key learning and challenges.	
Theme based studies	The multi-disciplinary interventions under the project create a need of in-depth understanding of key project aspects during the project cycle. Considering this need, the project will conduct theme-based studies to gain a better understanding of the processes and outcomes. These studies will directly contribute to the results / outcomes as well as unveil newer dimensions of the project. Some of the theme-based studies may be conducted by specialized agencies who are part of the consortium, and some can be undertaken by external agencies, as per the requirement.	As per the need of the project and part of the project cycle
Process documentation	Some of the key processes to be tracked during the implementation for learning, i.e., adoption of inclusion principles in the project execution, environmental safeguard measures, community organization strengthening, promotion of CRA practices etc.	Yearly (on key learning)
Mid-term review	Mid Term Review will help to identify persisting challenges and outline corrective actions to ensure that the project is on track to achieve maximum results by its completion. The MTR would include an impact assessment of the project to date, and focus on procedures, implementation processes and recommend adjustments in the project design and / or implementation arrangements to overcome identified issues / challenges.	After 3rd year of the project implementation
End-term Review	The final assessment will focus on understanding the outcomes of project interventions and effect of the same on the target population and compare these with the baseline situation to assess the effectiveness of the project in terms of physical infrastructure development, socio-economic changes, environmental impacts as well as institutional strengthening. The Final Assessment would be a comprehensive overall impact assessment including quantitative and qualitative assessment of progress against project development objective. The end-term review will also look at sustainability of project outcomes and future course of action.	After the 6th year of the project

Project Monitoring and Review by World Bank:

The World Bank will monitor the project progress periodically and extend technical support. The expert team of World Bank will conduct implementation support mission once in six months where project activities, implementation mechanism and overall physical & financial progress of the project will be discussed. The World Bank team will also provide required inputs to the project to strengthen project implementation.

The operational responsibility for planning and coordinating MEL activities would rest with the state level Project Management Unit (PMU). The data and information would be consolidated and managed by the PMU at the State and District Project Management Unit (DPMU).

Table 89: Internal and External Monitoring System

Internal Monitoring System	External Monitoring System
• High Power Committee • State Project Management Unit • District Project Management Unit • Field Unit Office • WWMC / CBOs • Consortium of Technical Institutions	• External Monitoring Agency • World Bank

The management of the MIS & Web MIS will be the responsibility of DPMU-MEL staff. Computerization support will be provided at each division office, where the primary data entry will be done by a data entry operator. Project MIS development will be taken up by MIS Expert and if required, support of a professional agency will be hired for the purpose. The MIS will provide information for project management as per the project cycle. The web enabled MIS/GIS will facilitate use of information at various levels. Data compilation and feedback to the users will be coordinated by the DPMU-MEL staff through joint reviews and DLIC interactions.

Quarterly and Six-monthly reviews will be undertaken by the state and district MEL teams together prior to the joint review by the World Bank Supervision Mission. The PMU will constitute teams of two or three members from among PMU Experts and PMU members who will undertake field visits every month. Each PMU team will visit at least two districts every month and cover about 5-6 villages. The PMU teams will coordinate visits with implementing line departments whenever possible. Each team will visit one or two villages per day. After the field visits, the team will report to the District Project Director about the progress of work and implementation issues. Considering the project phasing and sampling proposed, these teams will visit each district twice a year. Supplementation of the MEL teams with subject matter specialists will facilitate integration and comprehensive review of project activities at the village / cluster level. It will also facilitate the specific subject review based on field visits by the subject specialist.

An External Monitoring & Evaluation Agency will be involved in undertaking concurrent monitoring as well as half-yearly, midterm and end project impact assessment on a sample basis. The Agency will develop the sampling methodology and field visit plan in consultation with the M&E Specialist and will be approved by the PMU. External monitoring will focus on understanding the progress on outcomes/results of project interventions and their effect on the participating families in the village / cluster. Along with the regular data collection, the agency will be involved in undertaking process monitoring, assessment of sequencing of activities as per the project cycle phasing and household surveys. Review of the capacity building interventions, institution building processes, and CBO performance assessment will also form part of the concurrent monitoring as a component of reviewing the project support systems and enabling environment. The regular monitoring of the project activities will include monitoring of progress on indicators specified in the Social and Environmental Management Framework. The External M&E agency would also monitor the implementation activities under ESMF. During mid-term and end project audits, specific focus would be required on resettlement plan, tribal development plan, dam safety measures, cultural property plan, gender action plans, and INM/IPM plans.

The external M&E agency will undertake detailed monitoring of a selected set of households from beginning to end of the project to understand the impact of project interventions on, inter alia: (a) production patterns and incomes; (b) access to and efficiency in use of water resources; (c) skill formation as well as (management) capacity for community resource management; (d) distribution of benefits across various categories of land holders and

different socio-economic groups. The methodology as well as sample selection for this analysis will be agreed in advance with the PMU.

6.4.2 Capacity Building for MEL:

The MEL process would require active participation of different stakeholders, i.e., from project villages to state level officials. The processes being technical and specialized, wherein various tools will be used for capturing, analysing, reporting, monitoring and dissemination data, information, and knowledge, it is required that the persons involved in it have requisite competency and skills. Capacity building interventions for MEL will cover training programmes on overall approach of MEL, result based management, participatory monitoring and learning, process monitoring etc. The orientation trainings will be provided to all key staff members of the PMU, DPMU and Field Implementation Units. Specific skill trainings on various tools on participatory MEL, ICT driven web enabled MIS, etc. will be provided specifically to the MEL and MIS staff to cater to the project needs. Major focus of capacity building on MEL will be laid on creating and facilitating mechanisms and instruments promoting analysis of data gathered, generating learning's from MEL processes, and promoting two-way information flow. For dissemination of learning, theme-based workshops will be organised from time to time.

It is envisioned that the Monitoring, Evaluation, and Learning (MEL) system for this project would require active participation from different stakeholders at different levels of project implementation. The processes for MEL being technical and specialized, wherein various tools will be used for capturing, analysing, reporting, monitoring and dissemination data, information, and knowledge, it is required that the persons involved in it have requisite competency and skills. Capacity building interventions for MEL will cover training program on overall approach of MEL, result based management, participatory monitoring and learning, process monitoring etc. The orientation trainings will be provided to all staff members. The specific skill trainings such as various tools on participatory MEL, ICT driven web enabled MIS, etc. will be provided specifically to the MEL and MIS staff to cater to the project needs. Major focus of capacity building on MEL will be laid on creating and facilitating mechanisms and instruments promoting analysis of data gathered, generating learning's from MEL processes & event, and promoting two-way information flow. The learning and dissemination component of MEL will require theme-based workshops, experience sharing by other agencies at state and national levels.

Table 90: Training and Workshops for MEL

Stakeholders	Training / Orientation	Refresher Course	MIS	Review	Participatory Monitoring and Learning
PMU Level	√	√	√	√	√
DPMU Level	√	√	√	√	√
FIU Level	√	√	√	√	√
GP / WWMC	√	√	√	√	√
FIG / FPO / RVC	√	√		√	√

Table 91: Training and Workshops for MEL

Stakeholders	Six monthly Reviews	MIS	Participatory Monitoring and Learning	Baseline and impact assessments
PMU Level	Orientation	Training	Orientation	Workshop
DPMU Level	Orientation	Training	Orientation	Workshop
FIU Level	Training	Training	Orientation	Workshop
GP / WWMC	Orientation	Training	Training	Workshop
FIG / FPO / RVC	Orientation		Exposure visit, training	Workshop

6.4.3 Implementation Arrangements:

The operational responsibility for planning and coordinating MEL activities would rest with the state level Project Management Unit (PMU). The data and information would be consolidated and managed by PMU at state and District Project Management Unit (DPMU) at district level.

The management of MIS will be the responsibility of PMU and DPMU-MEL staff. Computerization support will be provided at each unit office, where the primary data entry will be done by a data entry operator. Project MIS development will be taken up by ICT-MIS Expert. The web enabled MIS/GIS will facilitate use of information at various levels.

An external agency will be involved to support the PMU in M&E of the project. The Agency will develop the sampling methodology and field visit plan in consultation with the PMU. Along with regular data collection, the agency will be involved in undertaking process monitoring and household surveys. The external M&E agency will undertake monitoring of selected set of households from the beginning to the end of the project to understand the impact of project interventions as per the result framework of the project. The external M&E agency will share the methodology with the PMU prior to conducting assessments.

6.4.4 MIS/ICT:

MIS/ICT will be an important tool for project management. It will cover primarily the input and output monitoring. The input monitoring will be linked to financial performance. The project will develop a system for monitoring of inputs, its timeliness, and adequacy. Standard reports on inputs against the annual action plans will be produced and used by the project teams to assess progress.

The output information will be collected through reporting formats, to be prepared by the MEL team of PMU based on the strategic result-based monitoring framework. The data collection responsibility for this information will rest with the FIU. Performance targets will be finalized for each of the activities as part of the annual action planning workshop. Progress and variances against these will be tracked by the MIS. Review meetings of DPMU and PMU will focus on understanding the reasons of variance and map support requirements.

6.4.5 Development of Database

A comprehensive geo-referenced database of village / clusters will be developed across the project districts. The database will focus on developing and updating geo-spatial information on soil moisture, catchment treatment area, vegetation index. spring shed status etc. It will provide an overall status and coverage of irrigation through springs and other minor irrigation sources. Along with this, a farmer's database will also be prepared by watershed / spring shed / project location, along with project inputs, its utilization and benefits will be mapped in the database. All created infrastructures will be geotagged, and geo referred. This database will act as a monitoring and activity tracking instrument.

6.4.6 Baseline Survey

Socio-economic situation and development parameters (as per the project result indicators) at the watershed level may not be similar across the project districts. It is imperative to understand the prevailing situation at the village / clusters before the implementation of the project. For the purpose, a baseline survey will be conducted to understand the socio-economic and environment related situation in the project area, thereby providing scope for coming up with baseline indicators which would be used for assessing the augmentation in

the results of the indicators, project intervention related impact influence and spread the project's best practices. The study will be conducted on sample watersheds, representing different agroclimatic zones.

6.4.7 Concurrent Monitoring:

Field level implementation would be independently monitored by the external M&E agency. This will be done by selecting a sub-set of village / clusters within each major clusters. Concurrent monitoring will be conducted in every six months. These reviews will focus on understanding the critical developments as well as the progress of performance indicators. The progress reports available at DPMU, and unit office level will be used to understand overall progress. Based on the assessment, the external M&E agency will submit monitoring report to the PMU.

6.4.8 Periodic Benefit Tracking (Longitudinal Study):

The impact of the project will be assessed through a longitudinal study of sample watersheds and households. The longitudinal study will focus on detail understanding of progress and changes in the identified watersheds in accordance with the result framework indicators. Household information on different project interventions will be collected six monthly to monitor these watersheds and gain understanding of overall project results. The households in these watersheds will be tracked over the entire project duration.

6.4.9 Thematic Studies:

Considering the need, the project would undertake thematic studies in selected areas to gain a better understanding of the situation. The themes will be selected considering the contemporary importance, such as adoption of CSA practices, GHG emission, ecosystem services etc.

6.4.10 Impact Assessment:

Two full-scale impact evaluation studies will be conducted, i.e., "mid-term review" in the mid of the project life cycle and "end-line" assessment at the end of the project period. The mid-term review will help to assess the progress, examine the relevance of the project design, and identify areas of critically that have bearing on the project. Accordingly, it will be supportive for mid-course correction in scope of project and its design. The end-line study will focus on understanding the outcomes of interventions in line with the result indicators, effect on the target population in comparison to the baseline situation, socio-economic changes induced by the project, and overall objective (PDO and intermediate) that is achieved in line with the theory of change.

6.4.11 Financial Management:

Financial Management System:

Efficient and effective financial management system is important for the success of the project. It includes proper planning, budgeting, accounting, financial reporting, internal control, auditing, funds disbursement and physical performance of the project. It aims at managing the project resources properly for achieving the project objectives. The financial management system of the project would revolve around the basic principles that all financial transactions are made in accordance with the established procedures of the project in a transparent manner and are duly accounted, for future review and audit.

Objective:

The primary objectives of financial management system in the project are (a) to ensure smooth flow of funds to different levels / executing entities so that there are no delays in

the implementation of activities, (b) all financial transactions are as per rules and procedures and in line with the norms of the project, (c) all such transactions are duly accounted for in the prescribed manner and (d) all payments due to be made to any service providers are done in efficient, speedy and transparent manner. Since the implementation arrangement for the project is at different levels, it is important that there is a coherence in book-keeping, accounting policy, adopted procedures, transactions, audit, procurement, financial reporting, project monitoring etc. aligned with the agreed norms between World Bank and Government. In this regard, a Financial Manual is prepared for the financial management of the project with the objective of guiding all the project implementing entities at different levels. The financial management of the project aims at producing real time, relevant and reliable financial information, that would allow the project executives to plan and implement the project, monitor compliance with agreed procedures, and guide the project progress towards the set objectives. Some of the important objectives of the Financial Management Framework of the project are:

1. Efficient use of resources-proper and need-based flow of funds;
2. Efficient accounting system;
3. Insuring the use of IT for reliable, relevant, real time and online financial reporting system;
4. Proper and useful utilization of fund;
5. Compliance of applicable rules and laws;
6. Establishment of accounting and responsibility;
7. Proper forecasting and budgeting;
8. Timely alarm for financial problem;
9. Timely preparation and submission of disbursement report;
10. Financial evaluation of the project both - pre and post;
11. Ensuring sufficient fund availability for the project;
12. Use of IT in financial management and procurement.

Salient Features of the Financial Management System:
The financial management system would encompass the followings;

- Planning and Budgeting
- Fund Flow Management
- Accounting
- Delegation of Power
- Reporting
- Audit
- Financial Management at different levels

6.4.12 Environment and Social Management Audits:

Two audits will be undertaken by the external M&E agency during the project period to assess the implementation of Environment and Social Standards (ESS) and Environment and Social Commitment Plan (ESCP). These audits will focus on understanding the implementation and outcomes of the environmental and social management measures proposed in various stages of project cycle and changes that have occurred in the project villages with respect to major concerns identified during the assessment. These audits will be undertaken twice ,i.e., at the "mid-term" and at the "end-line" of project cycle.

6.5 Environmental and Social Standards:

6.5.1 Specific Plans and Frameworks under ESF:

Based on the World Bank Environment and Social Framework (ESF) that have been triggered by the proposed project, specific plans have been developed. Detailed Plans and Frameworks are in Annexures. The outlines of these plans and frameworks are summarized below:

1. **Integrated Nutrient Management Plan (INMP):** The aim of Integrated Nutrient Management (INM) is to apply balanced nutrient, as per soil and plant requirement to increase crop productivity and preserve soil productivity. INM aims at optimal use of nutrient sources on a cropping-system. This encourages farmers to focus on long-term planning and make greater consideration for environmental impacts.

2. **Integrated Pest Management Plan (IPMP):** IPM is a holistic approach to sustainable agriculture that focuses on managing insects, weeds, and diseases through a combination of cultural, physical, biological, and chemical methods that are cost effective, environmentally sound and socially acceptable. This includes the responsible use of crop protection and plant biotech products. The goal of Integrated Pest Management (IPM) is to identify, prevent, and eliminate conditions that could promote or sustain a pest population in a food production and storage system.

3. **Cultural Property Plan (CPP, ESS 8):** CPP aims to preserve and protect cultural heritage by avoiding, minimizing, or mitigating the adverse impacts that project might cause to cultural heritage. In addition, the project can play a role in promoting awareness on conservation of cultural heritage.

4. **Natural Habitat Plan (NHP, ESS 6):** The conservation of natural habitats, like other measures that protect and enhance the environment, is essential for long-term sustainable development. The NHP lays down precautionary approaches to natural resource management that help ensure opportunities for environmentally sustainable development.

5. **Resettlement Policy Framework (RPF, ESS 5):** The project does not anticipate any land acquisition to implement project activities. The infrastructures to be created under the project (agribusiness and other infrastructures) will be in the land parcel that is made available by the GP or donated by the farmer and/or their group.

6. **Transhumant Plan (ESS 7):** Social assessment indicates that some of the sub-project areas are inhabited by tribal people. Hence Transhumant Plan is prepared with the objective of ensuring that tribals are adequately and fully consulted prior and during the course of the project; receive benefits equal to their population proportion: are provided with special assistance as per laws and policies because of their marginalization and receive adequate protection against any adverse impact on their cultural identity.

7. **Gender Action Plan (GAP):** Women comprise nearly 50.0 percent of the population of the state. They play an important role in the economic and social life of households and communities. Their role in agricultural and allied sectors has been significant. In this context, GAP is prepared to address concerns related to gender-based inclusion and equity. The objective of GAP is to ensure that the project is able to serve

women's strategic and practical needs. The plan aims to ensure that women are given an opportunity to participate in the project and are represented in key planning and management structures.

6.5.2 Environment and Social Commitment Plan (ESCP):

6.5.2.1 Organizational Structure:

WMD will establish PMU, DPMUs, and FIU with qualified staff from different disciplines, in line with the project requirement. The human resources would include Climate Change Expert, GHG Emissions Expert, Climate Resilient Agri-practices Expert, Environment Expert and Social and Institutional Expert at PMU level. Social Coordinators will be engaged at DPMUs and three Social Facilitators at FIUs to support management of E&S risks. The project may also engage short term consultants, if required, within the PMU at state level, who will support, monitor, and report on the implementation/compliance of the ESSs. At the district and block levels, designated staff members will handle the responsibilities. The human resources will be trained on ESS and ESCP to discharge their responsibilities.

6.5.2.2 Environmental and Social Instruments:

The project will implement suggested measures as per the ESMF. The proposed sub-projects described in the exclusion list set out in the ESMF shall be ineligible to receive financing under the project. A "community operations manual" will be prepared, which will include "code of conduct" for workers and will also focus on specific measures, including grievance mechanism, regular supervision, monitoring, and feedback, to mitigate the risks. The project will execute laid out Labour Management Procedures, Indigenous Peoples Planning Framework (IPPF), and GAP in the suggested lines.

6.5.2.3 Management of Contractors:

Incorporate the relevant aspect of ESCP, including inter alia, the relevant E&S instruments, the LMP, and code of conduct into the ESHS specifications of the procurement documents and contracts with contractors and supervising firms. Thereafter, ensure that the contactors and supervising firm comply and sub-contractors to comply with the ESHS specifications of their respective contracts.

6.5.2.4 Technical Assistance:

Ensure that the consultancies, studies, capacity building, training, and any other technical assistance activities under the project are carried out in accordance with terms of reference and consistent with the ESSs.

6.5.2.5 Labour and Working Conditions (ESS 2):

Labour Management Procedures:

The project will adhere to and implement the Labour Management Procedures (LMP), duly incorporating the ESS2 provisions, including, inter alia, provisions on working conditions, labour camp management, payment of minimum wages, occupational health and safety (including use of personal protective equipment, and emergency preparedness and response), code of conduct (relating to ESHS), prohibition of forced labour and child labour, grievance arrangements for project workers, method of engaging with community workers, key roles and responsibilities related to LMP implementation and applicable requirements for contractors, subcontractors, supervising firms and primary suppliers in line with World Bank ESSs and applicable national and state labour regulations.

Grievance Redressal Mechanism for Project Workers:

The project will use existing grievance redressal mechanisms, aware workers, and different other stakeholders on GRM, in line with LMP and in accordance with ESS 2. Applicable

national & state labour laws, regulations, and specific legislations on construction workers will be followed.

6.5.2.6 Resource Efficiency, Pollution Prevention, and Management (ESS 3):

Construction Material Sourcing Plan:
Adopt and implement construction material sourcing plan as a part of the site-specific ESMP for post-harvest structures.

Hazardous and Non-Hazardous Waste Management Plan:
Site specific ESMPs would include Construction and Demolition Wastes and Solid Waste Management Plans. In the design of the infrastructure, during construction, and at the operational stage; waste management plan will be adhered to. Waste Management Plan (WMP), including management of liquid and solid wastes, for value addition and processing units, will be followed in line with ESS 3.

Demobilization and Restoration Plan:
Site specific ESMPs to include Demobilization and Site Restoration Plan, as applicable.

Integrated Pest Management (IPM) Plan and Integrated Nutrient Management (INM) Plan:
Crop specific Integrated Pest Management Plan (IPM) will be prepared to reduce use of pesticides and mitigate adverse environmental impacts, arising out of its unscientific application. Project will not promote or support use of WHO and Government of India banned pesticides. The project will also prepare an Integrated Nutrient Management (INM) Plan and encourage the target farmers for its adoption to maintain soil health and plant nutrient supply.

6.5.2.7 Community Health and Safety (ESS 4):
Adopt and implement community health and safety measures included in the ESMPs and the community operations manual.

6.5.2.8 Land Acquisition (ESS 5):
No land is envisaged to be acquired for project purposes. The government or public land to be used, as advised by Gram Panchayat, will be free of encroachment and other encumbrances. The identified land parcel will be free from restrictions to access, traditional customary rights, legal disputes, etc. Project will take up screening, physical verification, and vetting of the land parcel to ensure that identified land is not private land and is free of encroachment and other encumbrances.

6.5.2.9 Biodiversity Risks and Impacts (ESS 6):
The project does not envisage any negative impact of the interventions on local biodiversity. However, based on screening observations, site specific ESM, and in accordance with ESS 6, required preventive measures will be taken to ensure that local biodiversity is not impacted negatively.

6.5.2.10 Indigenous Peoples/ Traditional Local Communities (ESS 7):
In accordance with ESS7, project will implement Indigenous Peoples Planning Framework (IPPF), following key principles like inclusion, and equity.

6.5.2.11 Cultural Heritage (ESS 8): Chance Finds:
In case, if any cultural heritage is observed during implementation, project will take all necessary measures, including finding alternatives, avoiding the site for any project specific

activities that may impact the heritage etc. The project will implement "chance finds" procedures, as part of the ESMF and ESMPs.

6.5.2.12 Stakeholder Engagement and Information Disclosure (ESS 10):

In line with ESS 10, the project will implement Stakeholder Engagement Plan (SEP). Project will consult with the stakeholders from time to time, will seek their opinion / views, engage them in planning process, provide them with required / need based project specific information and involve them in different stages of project planning, execution, and management.

6.5.2.13 Capacity Support:

Capacity building measures will be taken up for different stakeholders based on the identified needs. It would include ESSs and ESCP of the project, apart from component specific themes.

6.6 Financial Management System:

Efficient and effective financial management system is important for the success of the project. It includes proper planning, budgeting, accounting, financial reporting, internal control, auditing, funds disbursement and physical performance of the project. It aims at managing the project resources properly for achieving the project objectives. The financial management system of the project would revolve around the basic principles that all financial transactions are made in accordance with the established procedures of the project in a transparent manner and are duly accounted, for future review and audit.

Objective:

The primary objectives of financial management system in the project are (a) to ensure smooth flow of funds to different levels / executing entities so that there are no delays in the implementation of activities, (b) all financial transactions are as per rules and procedures and in line with the norms of the project, (c) all such transactions are duly accounted for in the prescribed manner and (d) all payments due to be made to any service providers are done in efficient, speedy and transparent manner. Since the implementation arrangement for the project is at different levels, it is important that there is a coherence in book-keeping, accounting policy, adopted procedures, transactions, audit, procurement, financial reporting, project monitoring etc. aligned with the agreed norms between World Bank and Government. In this regard, a Financial Manual is prepared for the financial management of the project with the objective of guiding all the project implementing entities at different levels. The financial management of the project aims at producing real time, relevant and reliable financial information, that would allow the project executives to plan and implement the project, monitor compliance with agreed procedures, and guide the project progress towards the set objectives. Some of the important objectives of the Financial Management Framework of the project are:

1. Efficient use of resources-proper and need-based flow of funds;
2. Efficient accounting system;
3. Insuring the use of IT for reliable, relevant, real time and online financial reporting system;
4. Proper and useful utilization of fund;
5. Compliance of applicable rules and laws;
6. Establishment of accounting and responsibility;
7. Proper forecasting and budgeting;
8. Timely alarm for financial problem;
9. Timely preparation and submission of disbursement report;

10. Financial evaluation of the project both - pre and post;
11. Ensuring sufficient fund availability for the project;
12. Use of IT in financial management and procurement.

Salient Features of the Financial Management System:
The financial management system would encompass the followings;

- Planning and Budgeting;
- Fund Flow Management;
- Accounting;
- Delegation of Power;
- Reporting;
- Audit;
- Financial Management at different levels.

Project Director, UCRRFP will prepare and submit the annual budget to the department based on action plan and estimates of DPMUs. The physical and financial plan will be placed before High Power Committee / Steering Committee for approval. Based on the approval of the plan and allocation made thereby, State treasury will transfer funds, 50.0 percent of the annual planned budget, to the account of Head of Department (HOD). A Single Nodal Account (SNA) will be opened in a Nationalised bank with wide outreach in the project area. The nodal account will be linked with other project specific accounts opened at Regional PDs and DPMU. On receiving funds, HOD will transfer the funds to SNA so that payments can be cleared smoothly through the SNA and linked accounts.

Salient Features of the Proposed Funds Flow Arrangement:

- No parking of funds as the expenditure will be shown only after payment is made;
- Payment limit for Drawing and Disbursing Officer (DDO);
- Payment limit of a DDO can be slashed and allocated to other DDO in case of poor utilization;
- Interest earned in SNA will be deposited back in the State head;
- The project will prepare its own payment software and link it with SNA;
- Avoid unspent fund availability in GP account;
- Real time monitoring of expenditure and financial progress;
- Dashboard for monitoring physical and financial progress.

To make payment to the targeted beneficiaries at village / GP / watershed cluster level, the concerned WWMC will generate demand note, appropriately signed by the signatories, will be placed at the concerned bank branch for release of payment. After examination, bank will remit the requested amount in the bank account of the concerned beneficiary.

6.6.1 Funding Sources:

The project will be funded by the World Bank and the Government of Uttarakhand based on predetermined funding pattern. The project will also mobilise contribution from the beneficiaries for selected interventions (in cash, kind, or both). Funds of the World Bank will be routed through the Central Government.

6.6.2 Flow of Funds:

The flow of funds related to the project would be as below:

- Fund Flow from the World Bank to State Government via Central Government;
- Fund Flow from the State Government to WMD HOD A/C;
- Fund Flow from WMD HOD A/c to PD UCRRFP in Single Nodal A/C;
- Drawing limits from the WMD to the PD and DD;
- Drawing limits from DD to GP;
- Beneficiary contribution by community to the GP.

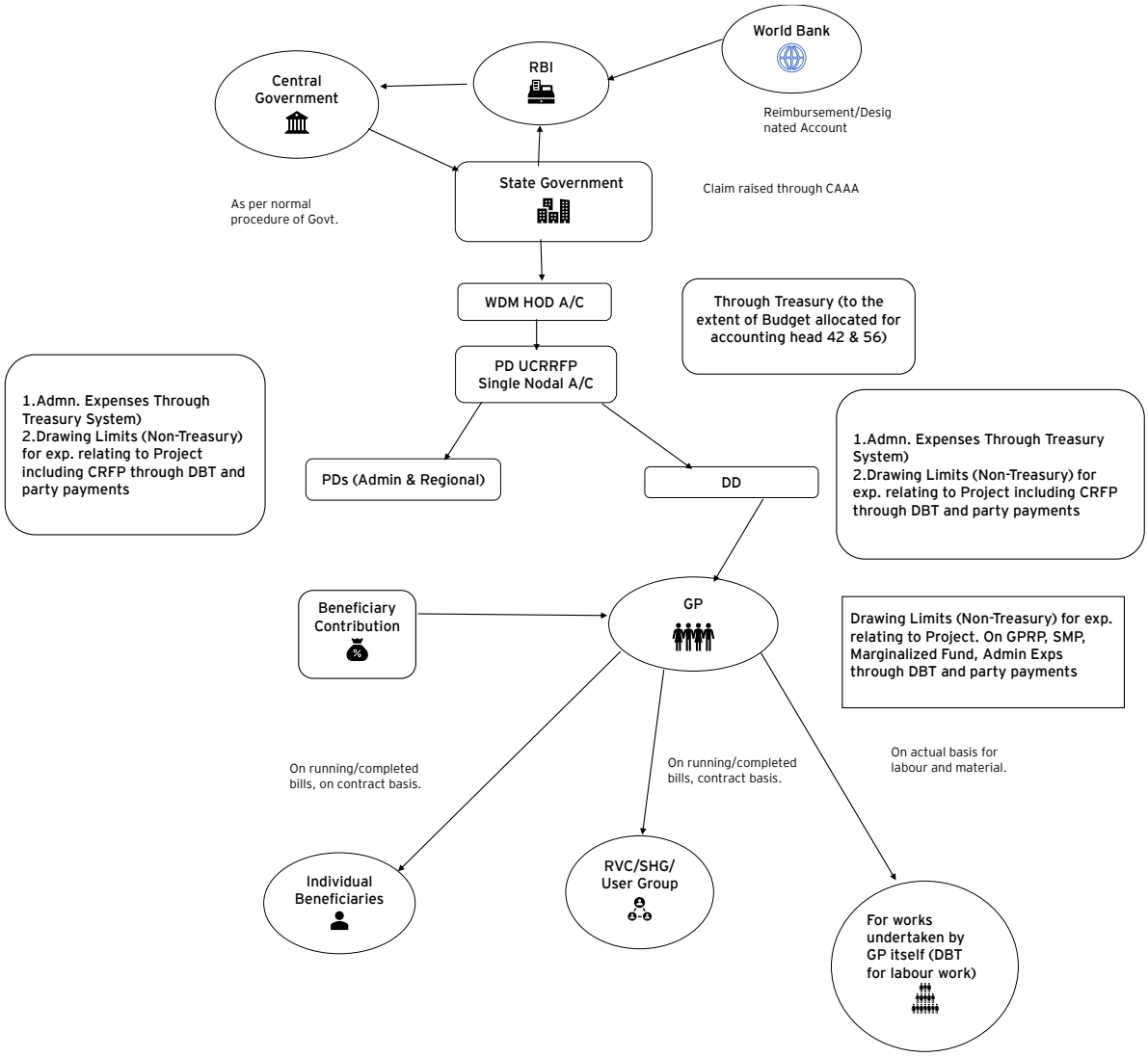


Figure 74: Overview of Funds Flow Arrangement

6.6.3 Funding by The World Bank (Reimbursement):

Under the proposed arrangement of UCRRFP, the World Bank shall provide loan/credit to the Central Government for financing the developmental activities under this Project. The World Bank shall provide funds to the project by depositing money in the designated account in RBI for the project.

6.6.3.1 Designated Account (DA):

The DA is a revolving account in which World Bank deposits funds. These funds are to be used exclusively to cover the Bank's share of the eligible expenditure of the project. The DA is opened by the Government of India with the Reserve Bank of India. This account is maintained separately for each World Bank funded project in convertible foreign exchange. The DA would be operated in accordance with the Bank's operational policies. The project will submit withdrawal applications to CAA & A in DEA for onward disbursement of funds by Bank in designated account.

6.6.3.2 Operation of the Designated Account:

The DA is operated by the Controller of Aid, Accounts and Audit (CAAA), Department of Economic Affairs, Ministry of Finance, Government of India. Based on the amount of claim raised on the World Bank in respect of the expenditure incurred on the project (as per the reimbursement claim filed by implementing agencies), the CAAA will issue advice to the Reserve Bank of India to transfer the amount claimed from the DA to the State through ACA releases.

6.6.3.3 Interim Unaudited Financial Report (IUFR) based Disbursements:

Disbursements from the Bank will be made based on reports (monthly/quarterly Interim unaudited financial reports) submitted by the project. These Interim Unaudited Financial Reports (IUFRs) would reflect the actual expenditure incurred under different project components. Any advances to any agency or others given by the project would be separately shown in the IUFRs and would not be eligible to be claimed.

The Bank will finance actual expenditure that is made on project components as reported in the IUFR. All expenditures reported in the IUFR will be subject to confirmation / certification by the annual audit reports. Any discrepancies between the expenditure reported by the annual audited IUFRs and those reported in the annual audit reports will be adjusted in subsequent disbursements.

All expenditure done by GPs will be treated as eligible expenditures for replenishment. Supporting documentation for the replenishment would be in the form of a simple summary statement providing details of the expenditure done by GPs e.g., approved value of GPRP and Spring-shed Management plans, sanctions made, current expenditure, and cumulative expenditure.

The WMD will compile the financial information from all its management constituent agencies and prepare reimbursement claims on a monthly basis. The WMD will also be responsible for submission of the withdrawal applications to GoI/CAA&A for onward submission to the Bank for replenishment of the special account or reimbursement.

Under the system of monthly reimbursement of expenditure, a month-wise IUFR shall be prepared at the DDO level. These statements shall be consolidated for the project as a whole. The method of preparation of IUFR has been dealt with in detail on Chapter 07 of 'Accounting System including Internal Control'.

6.6.4 Funding by the State Government:

Initially the expenditure will be met out of the funds disbursed by the State Government which later be reimbursed by the World Bank. The amount of funds to be disbursed by the State Government will be limited to its budgetary allocation for the project.

6.6.4.1 Budgetary Allocation:

The State Government shall provide initial funds to the Watershed Management Directorate for the execution of the project. The funding by the State Government to the project would be made through allocation of funds in its annual budget under the specific account head and physical transfer of funds to the Single Nodal A/c opened by WMD for the Project. However, it shall honour and transfer the payments relating to the project to the extent of budgetary allocation. Hence, the budgetary allocation would indicate the State Government funds committed for the project in that particular year.

6.6.4.2 Funding by WMD to PD and DD

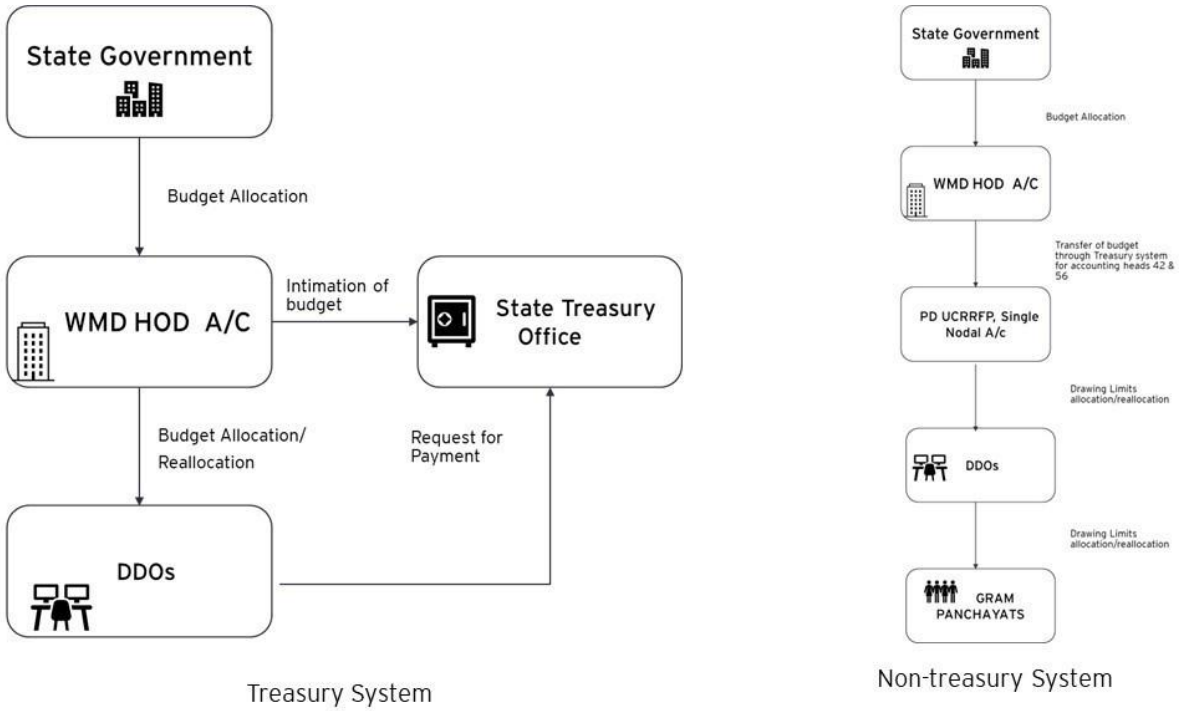


Figure 75: Funds Flow from State Government to WMD HOD & DDOs

Based on the annual budgetary allocation to the project, the Watershed Management Directorate (WMD), being the controlling office of the project in the state, shall make further budgetary allocation to various PDs (PD Admin & Regional PDs) and DDs (Divisions) and provide them with drawing limits against the Single Nodal A/c maintained at WMD level. The WMD may also reallocate the drawing limits among the PDs and DDs during the year, based on their actual utilization against estimated fund requirements.

6.6.4.3 System to Release Funds:

The funds shall be made available to the DDOs (PDs & DDs) through [1] Treasury System, and [2] non-treasury system.

Treasury System for Accounting Heads (other than 42 & 56):

Under this system, the payment will be made by the State Treasury Office, for expenses incurred by the DDOs. For each payment, the concerned DDO will send a request to the State

Treasury Office supported duly with approved bills of expenditure. Under the treasury system, the DPD/PD does not have any sub-disbursers working under it.

Non-treasury System (Drawing Limits to DDOs) for Accounting Heads (42 & 56):

Under non-treasury system of making payments, the DDOs have the authority to make payments drawing payment orders on behalf of the State Government as per the drawing limits provided to them. The WMD office shall release quarterly / monthly drawing limits to DDOs based on demand as per the Annual Action Plan (AAP).

On release of Drawing Limits, the DDOs will have the authority to draw payment orders to meet expenditure incurred by them under the accounting head 42- Misc. Department Expenditure & 56 – General Grant (General- Non-Salary). The payments made from this Child Account will reflect in the Single Nodal Account maintained at WMD level. For all other expenditure, DDOs will follow the Treasury System.

6.6.4.4 Flow of Funds from DD to GP:

The concerned DD will sub-divide the drawing limit given to him / her for implementation among the Gram Panchayats (GPs) under it. Gram Panchayats will process all its activities and payments through the project MIS and generate a payment order and make payments under the accounting head 56 – General Grant (General-Non-Salary). The payments made from these child accounts will directly reflect in the Single Nodal Account maintained at WMD level. Unit office staff will facilitate all processes on project MIS for Gram Panchayats under it. Summary and details of expenditure made by each Gram Panchayat shall be reflected in the reports generated by the project MIS in various formats.

6.6.5 Beneficiary Contribution:

The beneficiaries are the individuals / group of individuals who would benefit from the developmental activities undertaken in the project. The beneficiary contribution to the project (as discussed in the subsequent paragraphs) would be received directly by the Gram Panchayats that is undertaking the developmental activity. The contribution from the beneficiaries can be in any of the form, i.e., [1] contribution-in-cash, [2] contribution-in-kind, and [3] labour contribution, and [4] material contribution. The financial policies and accounting concepts governing the beneficiaries' contribution are included in the Financial Manual for reference.

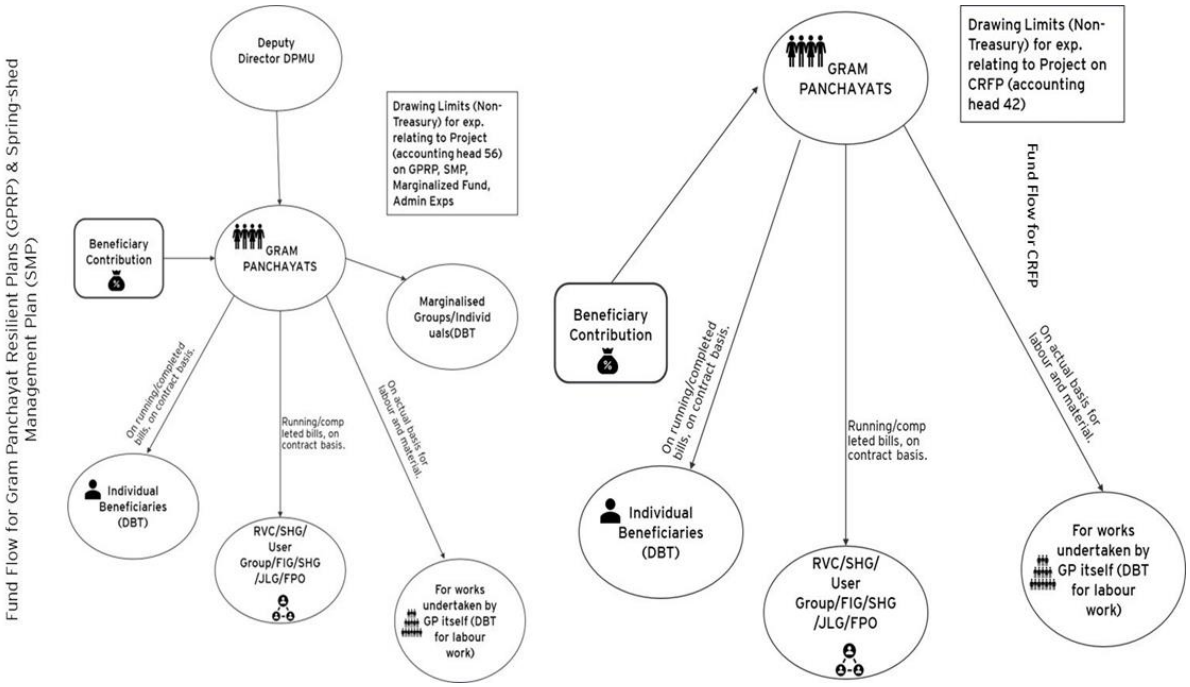


Figure 76: Fund Flow for GPRP, SMP and CRFP

6.7 Audit Arrangement:

The A.G., Uttarakhand in course of their regular audit, may be advised to look at project expenditures. Apart from this, a Chartered Accountant (CA) firm will also audit the accounts of the project as per the law.

6.7.1 Internal Audit:

The project will appoint a CA / CA firm to undertake internal audit of the project on a quarterly basis. The internal audit will cover the PMU and all project offices. The report of the internal audit will be placed before the Project Director, UCRRFP. If so required, the Project Director will place the audit observations before the HPC / PSC for information. The internal auditors will submit their report within 45 days of completion of audit at the end of each quarter.

6.7.2 External Audit:

Through the State Principal Accountant General, the CAG will conduct the external audit of the project related expend incurred at the departmental level. Statements of expenditures at all project levels will be submitted to the State AG by 30th of June each year to allow adequate time for the audit, which will be conducted in accordance with the terms of reference agreed by the CAG for audit of the project. Audit reports will be submitted within six months of the end of each financial year.

The project will engage a firm of chartered accountants to conduct the annual statutory audit as per the agreed TOR. Annual audit report will be submitted to the World Bank within nine months of the close of each financial year.

6.8 Internal Control:

Segregation of Responsibilities:
The role and responsibility of accounts staff, procurement staff & drawing and disbursing officer would be segregated, and one person cannot hold two responsibilities. All SNA linked bank accounts shall be operated by signature of two persons.

Verification by Project Director:
Random visits of Project Director / delegated PMU official to DPMU / Unit Office to review and monitor progress in operation. Real time monitoring of expenditure by the Project Director and guidance to the team.

Surprise Cash Check:
If cash in hand is available for day-to-day operation, will be checked at least once in a month in a random basis. The Project Director at PMU and Dy. Director at the DPMU will carry out such checks.

Physical Verification of Stock:
All stocks and assets of the project will be physically verified at least once in a year by a committee of three persons nominated by the Project Director at PMU. The report of the physically verification will be submitted to the Project Director for information.

6.9 Project Procurement:

6.9.1 Procurement Objective:
The Project Procurement Development Objectives (PPDO) are (1) to ensure procurement efficiency and value for money, (2) to ensure appropriate market participation, and (3) placing the risk with party best able to manage the risk and minimizing risk of supplier failure and/or incompetence.

6.9.2 Procurement Policy:
Procurement of all goods, works, and services will be carried out in accordance with the World Bank's Procurement Framework. The details pertaining to procedures and methods to be followed for procurement are detailed in the procurement manual. In case of any contradiction between the Banks procurement guidelines and project / state guidelines for procurement, the Bank's guidelines will supersede.

6.9.3 Methods of Procurement:

Goods and Works and Non-Consulting Services:
The following are the usual methods of procurement of goods and works to be adopted in the Project:

a) Request for Proposal;
b) Request for Bids;
c) Request for Quotations;
d) Direct Selection;
e) Framework Agreement;
f) Force Account;

Consultancy Services:

The following are the usual methods of procurement to be adopted in the project for consultancy services.

a) Quality and Cost based selection;
b) Fixed budget-based selection;
c) Least cost-based selection;
d) Quality based selection / consultant's quality-based selection;
e) Direct selection.

6.9.4 Procurement Plan:

Procurement plan/ schedules including the description of goods, works and services to be procured along with their value and consistent with technically and administratively approved estimate, are required to be prepared for each project year, in accordance with the budgetary provision. The actual procurement is to follow the approved plans.

During preparation of the procurement plans, packaging should be appropriately done. Items of similar nature, which can be supplied by the same set of firms, should be packaged together to achieve economies of scale. Aggregate value of total package will form the basis for determining the procurement method as well as the review requirement of the World Bank.

The PMU will prepare a tentative procurement plan for the first 18 months based on the projected activities. The procurement plan will include description of goods, works and non-consultant and consultant services to be procured (year-wise over the implementation period) along with their values which are consistent with technically and administratively approved cost estimates and milestones for all procurement activities. List of goods, works, and services to be procured under the project year-wise, with estimated cost and method of procurement have been mentioned in the manual in accordance with the format specified by the Bank. The Procurement Plan including their updates shall set forth at a minimum the following:

1. A brief description of goods, works and non-consulting / consulting services required for the project for which procurement action is to take place/ invitation for proposals are to be issued during the period;
2. The proposed methods of procurement / selection as permitted under the financing agreement;
3. The Bank review requirement and thresholds;
4. The time schedule for key procurement activities;
5. Any provision for the application of domestic preference in case of goods & works procurement in international competition;
6. Any other information that the Bank may reasonably require.

6.9.5 Procurement Agencies at Different Levels:

State Level (PMU):

All the consultancy services, related to the project components, will be procured by the PMU at the State level. All major procurements will be done through e-procurement by PMU.

District Level (DPMU):
At district level the major procurement will be activity specific like agricultural inputs, civil works, books and records, office articles etc. Dy. Director at the district level, with prior approval from the Project Director and with reference to the procurement manual, can procure such goods, works, and required services. The officials of the DPMUs will be trained by the procurement specialist at the PMU on World Bank procurement guidelines, project procurement manual, and basic record keeping for the procurement activities and the tendering procedures. Unit level expenses will be borne by DPMU.

6.9.6 Procurement Risk Mitigation Plan:
The Procurement Manual has been prepared to provide clarity on procurement process and to ensure consistency. It describes all the steps in the procurement procedures, i.e., preparation of bid documents / RFP, evaluation reports, pre-bid minutes, bid opening minutes, contract information, checklists etc. All the DPMU's will send their annual procurement plans to State Procurement Cell (PMU) for review and vetting. Subsequently State procurement cell shall ensure it updating in the STEP system for Bank clearance. The Bank clearance and coordination with DPMU's shall be the responsibility of the State procurement cell / unit in the PMU. The procurement cells at State level will constantly guide the DPMU's procurement cells and periodically carry out review at the offices of the implementing units and provide guidance about all procurement aspects including record maintenance. It will also be equipped with trained personnel, who will maintain the procurement MIS and train the personnel involved in the procurement at DPMU level, as needed. State level Procurement cell will provide guidance to all DPMU's, to ensure that all records regarding procurement activities under the project are kept in an indexed and safe manner and will be readily available for the Bank review.

6.9.6.1 Procurement Manual:
The project has prepared a "procurement manual" to provide clarity on procurement process and to ensure consistency. It describes all the steps in procurement procedures, i.e., preparation of bid documents (EOI / RFP), evaluation of bids, pre-bid meeting, bid opening principles, contract information, checklists etc.

6.9.6.2 Procurement Plan:
All the associated implementation units (DPMUs and Unit Offices) will submit their annual procurement plans to State procurement cell for review and vetting. Subsequently State procurement cell shall ensure it's updating in STEP system for Bank clearance. Obtaining Bank clearance shall be the responsibility of State Procurement Cell of PMU.

6.9.6.3 Procurement Trainings:
The PMU will arrange procurement trainings with the support of procurement experts for the officials operating at DPMU and unit office level.

6.9.6.4 State level Procurement Cell:
The procurement cells at State level will guide the DPMUs / Unit offices regarding all procurement aspects including record maintenance. It will also be equipped with trained personnel, who will maintain the procurement MIS and train the personnel involved in the procurement at different project levels. PMU will also periodically carry out reviews to access any further guidance required related to procurement aspects.

6.9.6.5 Disclosure Policy:

The PMU will ensure public disclosure as required under the Bank Regulations and State Government Policy.

6.9.6.6 Procurement Grievance Redressal:

To deal with the complaints from bidders, contractors, suppliers, consultants, and public at large, the existing complaint handling mechanism will be utilised. The complaint handling mechanism will be integrated with the project website. Immediate action will be initiated on receipt of complaints to redress the grievances as per the stipulated guidelines of the Government. All complaints will be registered and handled at a level higher than that of the level at which the procurement process is being undertaken and the allegations made in the complaints will be thoroughly enquired into and if found correct, appropriate remedial measures will be taken by the concerned authority.

6.10 Grievance Redressal Mechanism:

The project will utilise the existing grievance redressal mechanism, i.e., from the GP level to State level in agreement with ESS 10. Attempt will be made to address the grievances in a time bound manner. All the grievances will be recorded and tracked by the appropriate authority. The project will have the mechanism for receiving, registering and amicable settlement of grievances using both on-line and off-line options.

Existing GRM channels will be used for grievance redressal. The GRM channels will be publicized, maintained, and operated as an accessible grievance mechanism, to receive and facilitate resolution of concerns and grievances in relation to the project, promptly and effectively in a transparent manner that is culturally appropriate and readily accessible to all project-affected parties/stakeholders at no cost and without retribution, including concerns and grievances filed anonymously in a manner consistent with ESS 10. The grievance mechanism shall be equipped to receive, register, and facilitate the redressal mechanism.

6.10.1 Toll Free Number for Grievance Redressal:

The project will utilise existing toll-free number for receiving grievances and its timely redressal. Any member, having any grievance related to the project can use the toll-free number and communicate with the appropriate authority of the project. After reviewing the details of his/her grievances and field facts, appropriate authority will communicate to the concerned person and solve his/her grievance. The existing help line of the WMD may also be used for grievance redressal.

6.10.2 IT based Grievance Redressal Mechanism:

The project will extensively use existing IT platform (CP Gram and CM Helpline Portal) for receiving grievances, its processing and addressing the issue. Any person having any grievance related to the project can use the IT platform to share his / her grievance to the appropriate project authority for amicable solution. The decision, made by the appropriate authority, based on available facts and figures will be communicated back to the concerned person using the same platform.

6.10.3 Recording of Grievances and its Dispose-off:

At every stage the grievances received, number of grievances addressed, time consumed for decision making would be documented. In case of IT based grievance redressal mechanism or use of toll-free number, such aspects will be electronically recorded for future review.

6.10.4 Addressing Grievances of Service Providers:

The grievances of service providers, procured as per the World Bank Procurement Guidelines and resource agencies partnering with PMU through MoU will be governed as per their contract conditions and condition of the MoU. Any grievance raised by the service provide will be attempted for amicable resolution through mutual consultation and agreement.

6.11 Result Indicators:

PDO Indicators by PDO Outcomes

		Baseline	Period 1	Period 2	Closing Period
	Improved resilience of smallholder farmers and agriculture system				
	Increase in discharge in sample springs (Percentage)				
		Feb/2024	Feb/2026	Feb/2028	Feb/2030
		0	5	10	20
	Farmers adopting improved agricultural technology (Number) [CRI]				
		Feb/2024	Feb/2026	Feb/2028	Feb/2030
		0	10000	20000	40000
	Ø Farmers adopting improved agricultural technology - Female (Number) [CRI]				
		0	4000	8000	16000
	Ø Farmers adopting improved agricultural technology - male (Number) [CRI]				
		0	6000	12000	24000
	Improving productivity of key agriculture commodities in target areas				
	Increase in crop yield of selected crops (Percentage)				
		Feb/2024			Feb/2030
		0			20
	Relative reduction of GHG emission in sample areas against control areas				
	Reduction in GHG emissions from representative cropped land parcels (measured in Kg CO_2eq/ ha) (Number)				
		Feb/2024			Feb/2030
		0			5
	Enhanced farm income				
	Increase in farm income due to project interventions (Percentage)				
		Feb/2024	Feb/2026	Feb/2028	Feb/2030
		0	10	20	30

Intermediate Indicators by Components

		Baseline	Period 1	Period 2	Closing Period
	Component A: Developing Resilient and GHG-efficient Production Systems				
	Cultivable area covered by new irrigation methods (Hectare (Ha))				
		Feb/2024	Feb/2028		Feb/2030
		0	10000		20000
	Increase in water productivity at farm level (Percentage)				
		Feb/2024	Feb/2028		Feb/2030
		0	10		30
	Increase in cropping intensity (Percentage)				
		Feb/2024			Feb/2030
		120			170
	Farmers reached with agricultural assets or services (Number) CRI				
		Feb/2024			Feb/2030
		0			70000
	ØFarmers reached with agricultural assets or services - Female (Number) CRI				
		0			28000
	Component B: Science-based Development of Resilient Spring sheds				
	Participatory and science-based spring shed plans developed (Number)				
		Feb/2024			Feb/2030
		0			500
	Increase in water harvesting (or storage) capacity (Cubic Meter(m^3))				
		Feb/2024	Feb/2026	Feb/2028	Feb/2030
		0	10000	50000	50000
	Component C: Enhancing Income Resilience through Agribusiness and Entrepreneurship				
	Number of new Growth Centres established and functional (Number)				
		Feb/2024	Feb/2028		Feb/2030
		0	4		8
	Number of enterprises supported by the project (Number)				
		Feb/2024			Feb/2030
		0			20
	Component D: Project Management, Monitoring & Evaluation, and Learning				
	Registered grievances related to the project that are addressed (Percentage)				
		Feb/2024			Feb/2030
		0			90