Scaling Out Climate-Smart Agriculture for Resilient Farming IN BEED DISTRICT OF MAHARASHTRA

2021

Scaling Out Climate-Smart Agriculture for Resilient Farming

IN BEED DISTRICT OF MAHARASHTRA

Project Report

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2021

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ICAR-ATARI's and ICAR-KVK's, India
IWMI, CCAFS

ABSTRACT

Climate-smart agriculture (CSA) is an important approach towards minimizing impacts due to climate risks and maintaining agricultural growth. This report aims to contribute towards building a national strategy for scaling out climate resilient agricultural practices and technologies by synthesizing cumulative knowledge, experiences, and learnings gained by ICAR, CCAFS, and CG Centre's Programs in climate risk management. The report presents district level adaptation plan for resilient farming in the Beed district of Maharashtra. The process consisted of characterization of climatic risks followed by identification and prioritization of CSA technologies and practices and identifying scaling up opportunities through the convergence of government policies and programs.

Drought, heat wave, dry spells, and deficit rainfall are frequently occurring climate risks in the district with severe impact on rainfed cropping system. For the identification and prioritization of CSA technologies, all potential technologies are first categorized into six main categories of water-smart, energy-smart, nutrient-smart, carbon-smart, weather-smart and knowledge-smart. Thereafter, district specific suitable CSA technologies are identified following a participatory approach through stakeholder's workshop. The identified technologies are evaluated and prioritized for implementation feasibility, acceptability, adoption barriers, synergy with government plans, incentive mechanisms and key institutions. Total estimate budget of Rs. 387.0 Crore will be required for implementing these technologies in the district. The convergence of resources from relevant government schemes/projects for mobilizing funds for prioritized CSA technologies has been proposed. The process and results provided here are intended to assist decision makers to prioritize investments for CSA interventions to build resilient farming in the district.

KEYWORDS

Climate-smart agriculture; climatic risks characterization, CSA practices, prioritization, stakeholder's consultation, convergence

ACKNOWLEDGEMENTS

This work was implemented as part of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), which is carried out with support from the CGIAR Trust Fund and through bilateral funding agreements.

This project report has been generated through collective efforts of many. We acknowledge the support provided by ICAR- Agricultural Extension, ICAR- Natural Resource Management divisions and ICAR- CRIDA, Hyderabad. The authors would like to thank Krishi Vigyan Kendra, Beed and ICAR-ATARI, Pune for the field work and data collection. The team would also like to express humble gratitude towards all the stakeholder's who participated in technology prioritization workshop arranged at Ambajogai, Beed.

MESSAGE

रविंद्र जगताप, भा.प्र.से.
जिल्हाधिकारी तथा जिल्हादंडाधिकारी
बीड

Ravindra Jagtap I.A.S.
COLLECTOR & DISTRICT MAGISTRATE
BEED.

सत्यमेव जयते
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No-2021/MISC/8070 Date -22.3.2021

To,

Senior Scientist & Head
Krishi Vigyan Kendra, Ambajogai
Beed 1 (MH)

As it has been informed by the KVK, Beed-1 regarding implementation of the project entitled **"Strengthening Capacity in Indiafor Scaling-up Climate-Smart Agriculture Technologies, Practices and Services"**by its collaborative agencies i.e. ICAR, IWMI, CGIAR Research program on CCAFS, New Delhi.

Beed district (Maharashtra) is selected under ICAR-ATARI, zone VIII and project is being implemented through Krishi Vigyan Kendra, Ambajogai, Beed-1.

As an outcome of the project, the report on **"Scaling Out Climate-Smart Agriculture for Resilient Farming in Beed district of Maharashtra"** is prepared. The developed district climate adaptation plan forresilient agriculture will assist in streamlining investments being made in agriculture, water and rural development sectors from various sources.

After going through the report I find it very useful to the farmers of the district and we will be happy to be a part of this process with support from district line departments under the guidance and facilitation of KVK, Ambajogai, Beed-1, nearby ICAR Institutions and CGIAR Centre's.

It is my great pleasure to forward the results of this study to the farmers of the district.

OFFICE OF THE COLLECTOR
सत्यमेव जयते
BEED.

(Ravindra Jagtap)
Collector Beed

TABLE OF CONTENTS

ACRONYMS

CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CRIDA	ICAR-Central Research Institute for Dryland Agriculture
CSA	Climate-Smart Agriculture
CSA-IF	Climate-Smart Agriculture technology Implementation Feasibility index
CSA-PI	Climate-Smart Agriculture technology Performance Index
CSV	Climate-Smart Village
CSV R4D	Climate-Smart Village - Research for Development
FYM	Farm Yard Manure
ICAR	Indian Council of Agricultural Research
ICAR-ATARI	ICAR-Agricultural Technology Application Research Institute
ICT	Information and Communication Technologies
IWMI	International Water Management Institute
KVK	Krishi Vigyan Kendra
MIDH	Mission for Integrated Development of Horticulture
NMSA	National Mission for Sustainable Agriculture
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
RADP	Rainfed Area Development Program
RKVY	Rashtriya Krishi Vikas Yojana
SAU	State Agriculture University
WBCIS	Weather Based Crop Insurance Scheme

Executive Summary

Climate-smart agriculture (CSA) is an approach for transforming agriculture under the new realities of climate change. It aims to increase productivity, enhance resilience, and where possible, reduce/remove greenhouse gases (GHGs) emissions. CSA is imperative to adapt to climate change and ensure sustainable production and food security. A collaborative project of ICAR and CG centers “Strengthening Capacity in India for Scaling-up Climate-Smart Agriculture Technologies, Practices and Services” aims to contribute towards a national strategy for synthesizing cumulative knowledge, experiences and lessons gained by ICAR, CCAFS and CG Centre’s Programs in climate risk management. This is to guide investments being made by the government and donors in scaling out climate resilient agricultural practices and technologies at the developmental scale in vulnerable agro-ecologies of India. This report is the outcome of this collaborative effort and outlines the process for developing a comprehensive district climate smart agriculture plan for resilient agriculture for Beed district of Maharashtra. The process consisted of characterization of climatic risks followed by identification and prioritization of CSA technologies and practices, and identifying scaling up opportunities through the convergence of government policies and programs.

Climate risks characterization identified drought, heat wave, dry spell and deficit rainfall as the main climate risks occurring frequently in the district with severe impact on rainfed cropping system. Drought and heat wave primarily occur in Rabi and summer season, respectively. These climatic risks negatively impact cropping system with crop losses, reduction in yields, flower drop, moisture stress and crop damages. To overcome these risks, climate-smart agricultural technologies play a crucial role.

Potential CSA technologies for the district are categorized into six main categories of water-smart, energy-smart, nutrient-smart, carbon-smart, weather-smart and knowledge-smart which cover agricultural production systems. Thereafter, participatory approach through stakeholder’s workshop is used to identify the district specific suitable CSA technologies. Identified list of technology is then evaluated for implementation feasibility, acceptability, adoption barriers, synergy with government plans, incentive mechanisms and key institutions. The main prioritized technologies under different categories in Beed district are- water smart: raised bed planting for vegetables, aquifer recharge shaft and wells, irrigation scheduling, drip irrigation, broad bed and furrow planting for crops, farm bunding, sprinkler irrigation, mulching, farm ponds; energy smart: zero tillage, solar pump; nutrient smart: intercropping with legumes, use of farm yard manure and vermi-compost, Integrated Plant Nutrient Management (IPNM); carbon smart: crop residue incorporation, concentrate feeding for livestock; weather smart: Information and Communication Technologies (ICT); knowledge smart: fodder bank, short duration crop varieties, crop diversification

Potential CSA technologies for the district are categorized into six main categories of water-smart, energy-smart, nutrient-smart, carbon-smart, weather-smart and knowledge-smart which cover agricultural production systems.

with fruit and vegetable and stress tolerant breeds. The evidence on technologies from existing trials in the district show that significant gains in terms of increased production and benefit-cost ratio can be achieved. However, not all prioritized interventions evidence could be collected reflecting the gap in implementation or research on field which needs to be gathered either from similar agro-ecological zones or field trials.

The implementation of CSA technologies requires financial support. Investment needed for scaling prioritized technologies is estimated using certain assumptions (such as number of villages, and crop area to be covered, number of farmers to be trained) including proposed government and farmer's contribution based on existing support pattern for these interventions in the district. The total budget estimated for implementing district level climate adaptation plan is Rs. 387/- Cr. and would need government support of Rs. 168.8/- Cr. In Beed district, the funds available through different existing government schemes are only 30% (50.0 Cr.) of the total estimated budget. Thus, additional budget of Rs. 134.3/- Cr. is needed for implementing climate adaptation plan. Therefore, convergence matrix is prepared by linking the prioritized CSA technologies with relevant government schemes. This convergence matrix plays a vital role in identifying source(s) of investment required for implementing CSA technologies.

Report also briefly outlines the institutional arrangement required for implementing CSA plan and effectively carry out the convergence. Developed district climate adaptation plan for resilient agriculture can help streamline investments being made in agriculture, water and rural development sectors from various sources to enhance resilience and sustainable development under changing climate scenario. The process and framework for developing district climate resilient agriculture plan presented in the report would provide a guidance for developing and scaling out evidence based, participatory and integrated climate adaptation plan for other districts.

Report also briefly outlines the institutional arrangement required for implementing CSA plan and effectively carry out the convergence.

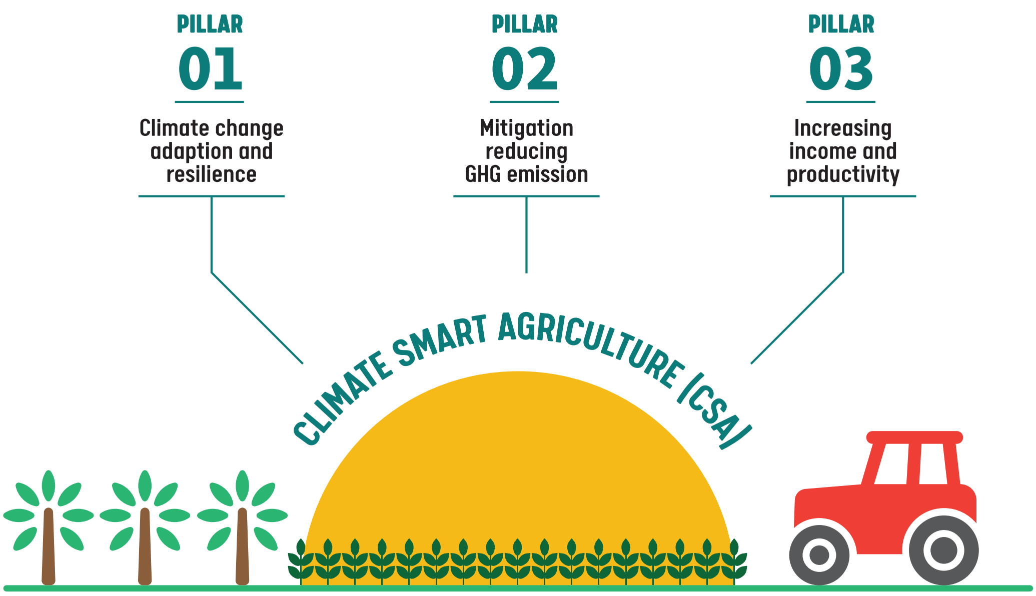
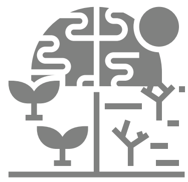


Figure 1 Three pillars of Climate Smart Agriculture (CSA)

1. PROJECT BACKGROUND

Maintaining agricultural growth while minimizing climate risks and shocks is crucial to building a resilient food production system and livelihood security as well as meeting development goals in vulnerable areas. Climate-smart agriculture (CSA) aims to increase sustainable agricultural production by building climate resilience, increasing adaptive capacity, and wherever possible, reduce GHG emissions. Without adaptation, climate change may depress growth in global agriculture yields up to 30 % by 2050 (GCA, 2019).

Agriculture sector is critical for Indian economy contributing to ~ 15 % to gross domestic product (GDP) and employing around 50% of the people either as vocation or as workers. Climate change in the rainfed areas of India could reduce annual agricultural income by up to 20-25 % (India Economic Survey, 2017-18). Rising temperatures and changing monsoon rainfall patterns associated with climate change could shave off 2.8 % of India's GDP and depress the living standards of nearly half its population by 2050 (World Bank, 2018). At the same time, agriculture sector contributes about 19.6% of India's total GHG emissions, as per 2014 estimates (WRI CAIT 4.0, 2017, FAOSTAT, 2018).



There is an urgent need for building resilience of Indian agriculture to climate change. Climate-smart agriculture is an important approach towards minimizing climate change impacts and building sustainable food systems.

Thus, there is an urgent need for building resilience of Indian agriculture to climate change. Climate-smart agriculture is an important approach towards minimizing climate change impacts and building sustainable food systems. CSA provides the framework within which synergies among adaptation, mitigation, and improved food security for small-scale farmers can be identified, developed, and disseminated (Andrieu et al., 2019). The CSA approach pursues the triple objectives of sustainably increasing/ stabilizing productivity and incomes, adapting to climate change and reducing greenhouse gas emissions where possible (FAO, 2012). CSA contributes to several sustainable development goals (SDGs) such as poverty reduction, zero hunger, climate action, affordable and clean energy and partnership for the goals.

CSA technologies help cope up with climate change impact on agriculture by achieving goals of adaptation, mitigation and resilience. These technologies vary with location and hence, identification of area specific technologies for resilient farming is a necessity as well as a challenge. Integrated learnings through policy dialogues, stakeholder consultations, training and capacity development have potential to promote local, need based, incremental and transformative adaptation options and for expanding resilient agriculture.

This report outlines the process of developing district level adaptation plan for resilient farming as part of the project "Strengthening Capacity in India for Scaling-up

Climate-Smart Agriculture Technologies, Practices and Services” by ICAR, CCAFS and CG Centre’s. The project aims to contribute towards building a national strategy for scaling out climate resilient agricultural practices and technologies by synthesizing cumulative knowledge, experiences and learnings gained in climate risk management. This is to guide investments being made by the government and donors at the developmental scale in India. The project also aims to strengthen the capacities of stakeholders at the state and national level by providing a knowledge platform generating awareness for potential scaling up opportunities in India.

As part of the project, in the first phase 11 vulnerable districts, one each from 11 Agricultural Technology Application Research Institute (ATARI) zones are identified for developing district climate adaptation plan for resilient agriculture. The report presents district level Climate Adaptation Plan for Resilient Farming for Beed district in Maharashtra state.

2. METHODOLOGY AND FRAMEWORK

Development of CSA plan involves four main stages, i) climate risk characterization to find out the key climatic risks that occur in a district and their impact on crop production, ii) CSA technology identification, iii) CSA technology prioritization and its validation through consultation with district stakeholders and iv) developing investment, convergence and institutional framework for scaling up the CSA technologies. The different steps within these four phases for developing district climate adaptation plan for resilient farming are given in Figure 2.

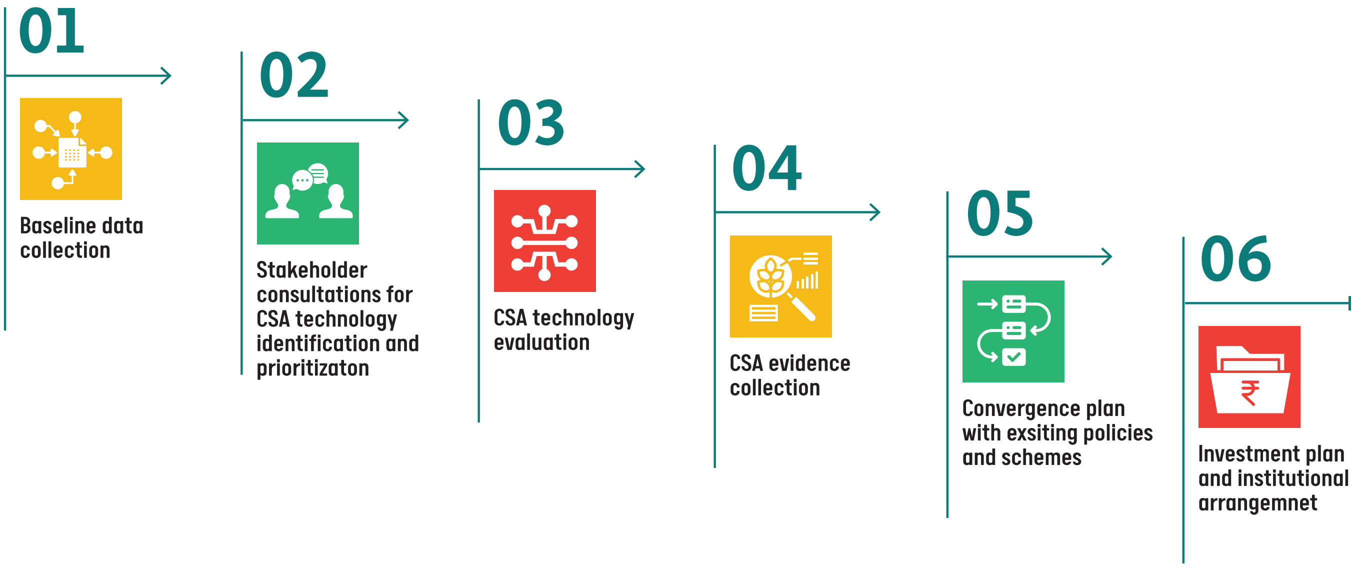
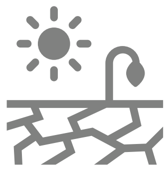


Figure 2 Procedure adopted for preperation of CSA district level plan

Baseline data collection involves collecting area specific hydrological, agricultural, soil, livestock, fishery and socio-economic data. This data helps to support the analysis and decision making process. Climate risk characterization involves the identification of different risks by analyzing rainfall and temperature data. Identification of risk is necessary to know occurrence of major climatic risks and their impact on production systems' viz. crop, livestock, fisheries etc. The next step is stakeholders' consultations for CSA technology identification and prioritization. Stakeholders' consultation provides a platform to identify area specific CSA technologies and subjecting them to CSA prioritization framework. CSA technology prioritization framework assesses technologies based on several criteria such as productivity, income, resilience,



Identification of risk is necessary to know occurrence of major climatic risks and their impact on production systems' viz. crop, livestock, fisheries etc.

implementation feasibility, incentive mechanisms needed, adoption barriers and key institutions. Based on this, top performing technologies satisfying multiple criteria are selected. CSA evidence collection process involves the collection of evidence on performance or effectiveness of selected best technologies on various aspects of CSA. Thereafter, information of existing government schemes and policies is gathered for planning convergence of resources from various schemes/programs. Developing a convergence plan involves identification of opportunities for linkage of selected technologies with existing government schemes and assessing the need for making additional budget arrangements for implementing CSA plan. Investment plan and institutional arrangements involve specifying the detailed year-wise implementation plan with phasing of activities and budget for uniform and equitable development. The institutional arrangement involves details about program implementation committee for smooth operation and monitoring at different levels of project. The process involves three phase operation with pre-implementation, implementation and post implementation activities for successful operation and meaningful outcome.

3. BEED AT A GLANCE

3.1 DISTRICT PROFILE

Beed is one of the 36 districts of Maharashtra state located in the central region state (Figure 3). Geographical area of the district is 10,686 km^2 (~ 3.45% of total state area). Beed comprises of 11 tehsils[1]: Ambajogai, Ashti, Beed, Dharur, Georai, Kaij, Majalgaon, Parali, Patoda, Shirur-Kasar and Wadwani. The district is mainly divided into 5 subdivisions/blocks[2]: Ambajogai, Beed, Majalgaon, Parli and Patoda. The total population of the district is 25.85 lakhs and 82% of this is rural population (Census,

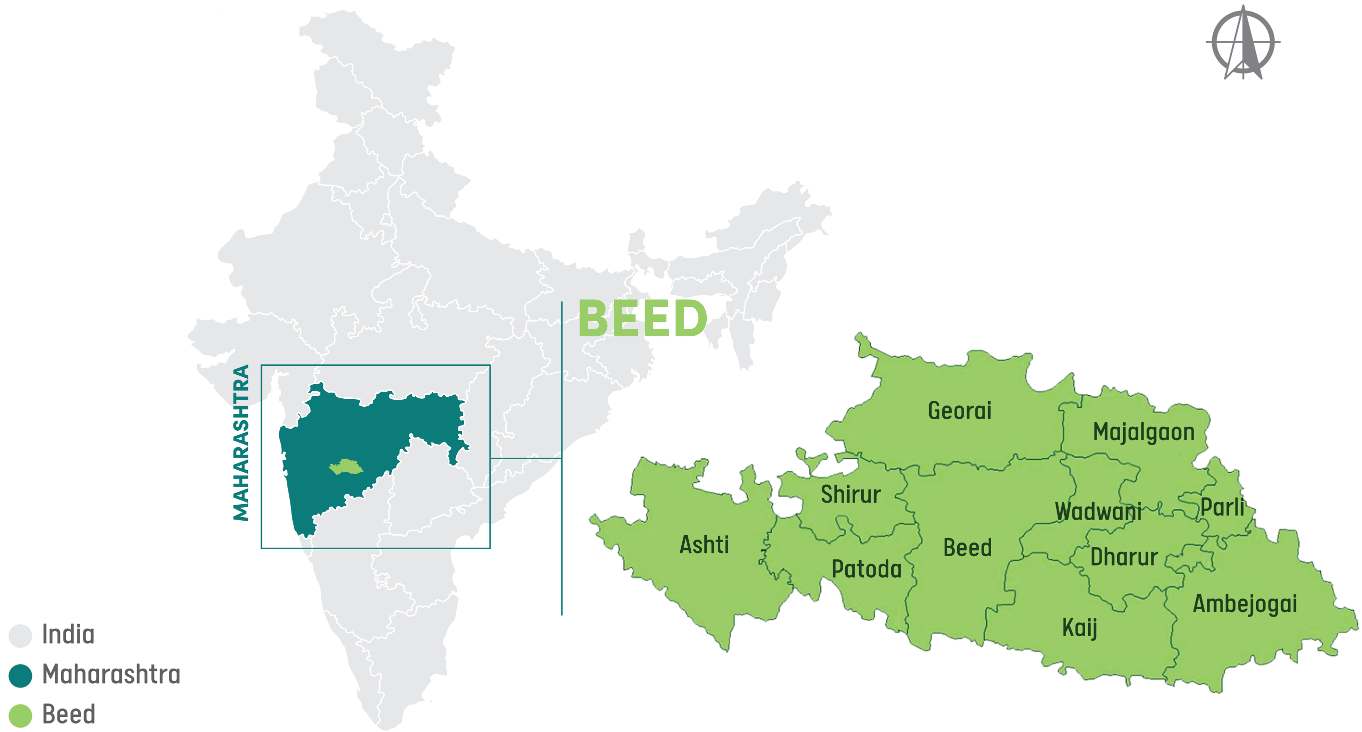


Figure 3. Geographical location map of Beed district and tehsils

2011).

1 Tehsils (also called Taluks/Taluka) are common across urban and rural areas for the administration of land and revenue department to keep tract of land ownership and levy the land tax.

2 Block is a district sub-division for the purpose of rural development department and Panchayati Raj institutes.
The primary difference between a block and tehsil is in their purpose: a tehsil is a geographical unit for revenue collection, whereas a block is a geographical unit for rural development.

3.2 CLIMATE

Climate of Beed district is semi-arid, hot and dry with three distinct seasons. Among the three seasons, summer lasts for five months during February to June. May is the hottest month with an average day temperature of 42°C and December is the coldest month with temperature ranging between 3 to 4 °C due to northern cold waves. Rains are infrequent and occur only during June to September. For the different blocks of Beed district, average annual rainfall varies from 679 mm to 826 mm and the number of rainy days varies between 42-56 days.

3.3 LAND USE

Beed district covering 1403 number of villages with total geographical area of 1068605 ha. The land use pattern of Beed district for the year 2015-16 is given at Table 1. Table 1 describes, 1026784 ha of total geographical area is under gross cropped area. In Beed district, agriculture is the primary land use category and about 81% (866225 ha) of total geographical area is under net sown area. The area under forest cover is only 2%, while the area under wasteland and other uses makes up 6% and 11% of the total district area, respectively.

Table 1. Land use pattern of Beed district (2015-16)

Sr. No.	Name of Tehsil	Number of the villages covered	Total geographical area (Ha)	Area under agriculture			Cropping intensity (%)	Area under forest (Ha)	Area under waste land (Ha)	Area under other uses (Ha)
				Gross cropped area(Ha) (1)	Net sown area(Ha) (2)	Area sown more than once (Ha) (1-2)				
1	Beed	239	155316	131849	124299	7550	106	6082	8936	15999
2	Patoda	107	77326	67353	63313	4040	106	1842	10722	1449
3	Ashti	177	124695	151285	124382	26903	122	3187	0	0
4	Shirur	95	63015	68026	53829	14197	126	982	2771	5433
5	Majalgaon	121	94459	88697	72654	16043	122	0	6457	15348
6	Gevrai	193	140676	137643	118274	19369	116	463	2628	19311
7	Dharur	74	58096	44140	42047	2093	105	4351	4848	6850
8	Wadvani	49	48635	38833	32453	6380	120	1436	6087	8659
9	Ambajogai	107	106722	116282	69834	46448	167	3213	7395	26280
10	Kaij	135	125931	109677	101260	8417	108	35	10017	14619
11	Parali	106	73734	72999	63880	9119	114	1382	3121	5351
	Total	1403	1068605	1026784	866225	160559	119	22973	60108	119299

(Source: Agriculture statistic of state agriculture, DSAO BEED)

3.4 CROPPING PATTERN

There are three cropping seasons: *Kharif*, *Rabi* and Summer. *Kharif* season starts in Second fortnight of June and lasts till first fortnight of October, *Rabi* season starts in second fortnight of October and ends in last week of February while summer season starts in March and ends by mid of June. The average cropping intensity of all tehsils in Beed district is 119%. Cotton, Soybean and Pigeon pea are the main crops taken during *Kharif* season while Sorghum, Wheat and Chickpea are the main crops of *Rabi* season. Fruits and Sugarcane are the perennial crops. In *Kharif* season, cotton is the major crop and occupies ~ 47% of crop sown area in the district. Soybean and pulses are the other major crops sharing 27% and 13% of all *kharif* season sown area, respectively. Cereal crops like wheat and sorghum are the principal crops in *Rabi* season, occupying ~ 63% of rabi sown area followed by pulses like chickpea, and grams with 32% of total rabi crop sown area. Vegetables are grown in only 1-3% of rabi area. The vegetable crops include coriander, onion, okra, brinjal, tomatoes, green chilies, turmeric etc. Sugarcane and different fruit crops (such as mango, pomegranate, sweet orange, lemon, sapota etc.) are the annual and perennial crops covering an average area of 29758 ha and 12320 ha, respectively (Appendix 1).

3.5 FARM HOLDINGS

The average size of holding in the district is 1.32 ha. Figure 4 presents the percentage of total number and area of farm holdings under different categories. There is pre-dominance of marginal and small farmers, constituting 52% and 22% of total farm holders with 22% and 36% of total farm area, respectively. Medium and large farm holders represent 17% and 1% of total farm holdings and 39% and 3% of total farm area, respectively. The marginal farms are more vulnerable to climatic and non-climatic stresses and risks.

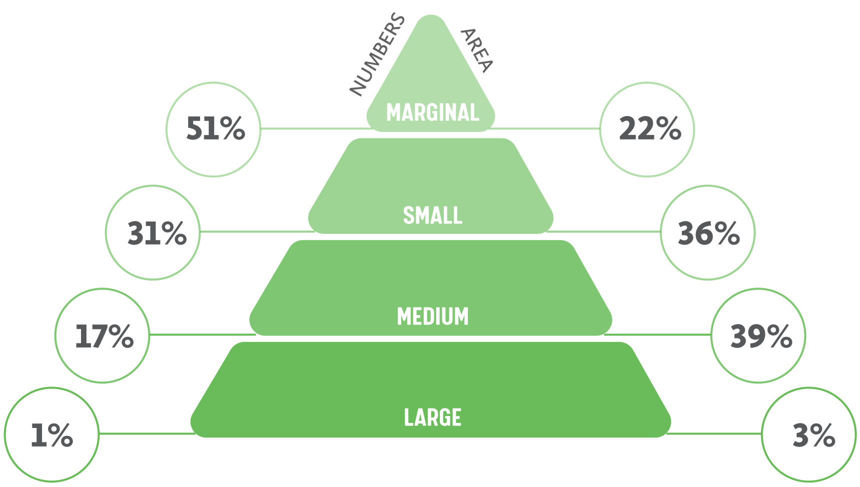


Figure 4. Farm holding numbers and area under different classes

3.6 IRRIGATION

In Beed district, gross cropped area is 1026784 ha, out of which 85% (871500 ha) area is rainfed and 15 % (155284 ha) area is irrigated, respectively. Of the classified irrigated area, 56% (87180 ha) area is partially irrigated, and 44% (68104 ha) area is gross irrigated. Ambajogai, Ashti, Beed, Gevrai and Kaij tehsils having maximum cultivable area are dependent on rainfall (Table 2).

Crop wise gross irrigated area is given in Table 3. Out of total irrigated area about 37% is under other crops consisting fruits, vegetables and sugarcane. However, cereal and fiber crops are having 22% and 19% irrigated area, respectively. Pulses and oil seeds have 10% and 12% irrigated area, respectively.

About 81% of area is irrigated by groundwater while only 19% of area is irrigated by surface water. The surface irrigation is provided through canals and reservoir lift from major irrigation projects like Jaikwadi, Terna, Dhanegaon and Sina-Kolegaon. The groundwater is mainly abstracted from dug wells. The total existing water availability of Beed district is 1443 MCM, out of which 1420 MCM is from groundwater and 23 MCM comes from surface water (DIP report, Beed, 2016).

Table 2. Classification of area based on irrigated and rainfed area under tehsils of Beed district

Sr. No.	Name of Block	Irrigated Area (Ha)		Rainfed Area (Ha)	
		Gross Irrigated	Net Irrigated	Partially Irrigated/Protective	Un Irrigated Or Totally Rainfed
1.	Ambajogai	5745	5240	10318	100215
2.	Ashti	5126	4790	13767	132392
3.	Beed	6396	5999	11498	113954
4.	Dharur	4560	3990	3769	35812
5.	Gevrai	11562	11093	9969	116113
6.	Kaij	7700	7189	9006	92972
7.	Majalgaon	10235	9788	7053	71409
8.	Parali	6950	6511	6564	59486
9.	Patoda	1964	1583	6295	59094
10.	Shirur	2265	1921	6053	59709
11.	Wadvani	5601	4730	2888	30344
Total area (Ha)		68104	62834	87180	871500

(source - Agriculture Statistic, DSAO Beed)

Table 3. Crop wise irrigated and rainfed area in Beed district

Crop types	Irrigated area (Ha)	Rainfed area (Ha)	Total area (Ha)
Cereal	34449	302728	337177
Pulses	15807	142270	158077
Oil seeds	18043	161560	179603
Fiber	29439	264942	294381
Other (fruit/vegetable/ sugarcane)	57546	0	57546
Total area (Ha)	155284	871500	1026784

3.7 SOIL

The area under major soil groups with predominant cropping system is given in Table 4. It also shows constraints under each category. The light soil with shallow depth is predominant in the district, occupying 44% of total cultivated area followed by heavy soils with deeper depth covering about 26% area. Most of the crops cultivated on light soils include sorghum, pigeon pea, bajra etc. Cotton, sugarcane and groundnut are cultivated on heavy soil. The alkalinity is a major problem due to low infiltration capacity and poor drainage. The rainwater stagnates on soil surface easily and leads to difficulty in cultivation. Low pH with a deficiency of micronutrients is one of the major problems in Beed district.

Table 4. Soil types and key cropping systems

Major soil groups	Soil depth (cm)	Area covered (%)	Season	Cropping system	Constraints
Heavy soils	50 to 100	26	*Kharif* *Rabi*	Cotton – Groundnut Sugarcane	Alkalinity problem, deficiency of micronutrient
Medium soils	25 to 50	19	*Kharif* *Rabi*	Cotton+ Greengram Soybean+ Pigeon Pea Soybean + Gram	Alkalinity problem, deficiency of micronutrient
Light soils	7.5 to 25	44	*Kharif* *Rabi*	Bajra + Pigeon Pea Sorghum+ Pigeon Pea Bajra-Safflower	Low pH with deficiency of micronutrients
Very light soils	0 to 7.5	11	*Kharif* *Rabi*	Bajra -Linseed	Salinity problem deficiency of micronutrient

3.8 LIVESTOCK AND POULTRY

Large share of crop production in Beed district comes from the rainfed system. Integrated farming activities like livestock and poultry production help to sustain the rainfed eco-system. Livestock and poultry are assured sources of income to the small farm holders. Cow, Buffalo, Sheep and Goat are the main livestock classes present in the Beed district. In large animals, 476507 indigenous cows, 105573 Hybrid Cows and 240284 undescriptive Buffaloes are present in Beed district. In small animals, 11368 Goats and 66211 Sheep are in district. Poultry is another secondary source of income from eggs and meat production. There are 977573 number of poultry birds in Beed district.

3.9 AGRICULTURE RESEARCH ISSUES, CHALLENGES AND KNOWLEDGE GAPS IN THE DISTRICT

Some issues related to agriculture and knowledge gaps as identified by researcher groups from Krishi Vigyan Kendra, Ambajogai, Beed are as below:

- Limited area under oilseed, pulses and cereals.
- Lack of awareness about nutrient deficiencies, their management though fertilizer application, soil health card and fertility status of soil with reclamation measures.
- Lack of knowledge in improvement of fruit quality, popularizing protective farming, use of soil test based Integrated Nutrient Management (INM) in fruits and vegetables, and hybrid seed production in vegetables.
- Lack of awareness about improved implements and machines to reduce the cost of cultivation.
- Lack of drudgery reducing technologies for farm women and less knowledge about improved tools/ implements to reduce drudgery.
- Non availability of demonstrations and extension for technology transfer.
- Awareness program for agricultural insurance scheme and subsidiary occupation.
- Lack of awareness about Information and Communication Technology (ICT.

4. CLIMATE RISK CHARACTERIZATION

Climate risk assessment is important in agricultural planning to mitigate the impacts of climate variability and extreme events. Different climate and weather systems affect farming decisions differently and hence, climate risk characterization is essential in planning and mitigating the risks. The climate risk characterization was done using climate data and in addition, stakeholders' consultation was also undertaken to identify the main climatic risks in major cropping systems (Appendix-2).

4.1 RAINFALL

Beed district receives rainfall from south-west and north-east monsoons. About 65% of the rainfall is contributed by southwest monsoon, 30% from north-east monsoon, and the rest as summer showers. Long term Indian Meteorological Department (IMD) rainfall data of grid- 0.25°x 0.25° for the duration of 1981 to 2015 was used to study block wise dry spells, excess and deficits rainfall events. The average annual rainfall of the district is 753 mm. During this period, the average annual rainfall and rainy days for each block are shown in Figure 5.

Across the blocks, average number of rainy days range between 42-56 days and rainfall vary from 680-826 mm (Figure 5). Relative to district average, above average rainfall takes place in Ambaojogai, Parli, Majalgaon and Dharur blocks and below average rainfall in Ashti, Georai, Shirur and Patoda blocks. June, July, August and September are the peak rainy months with average rainfall in the range of 130 to 170 mm per month

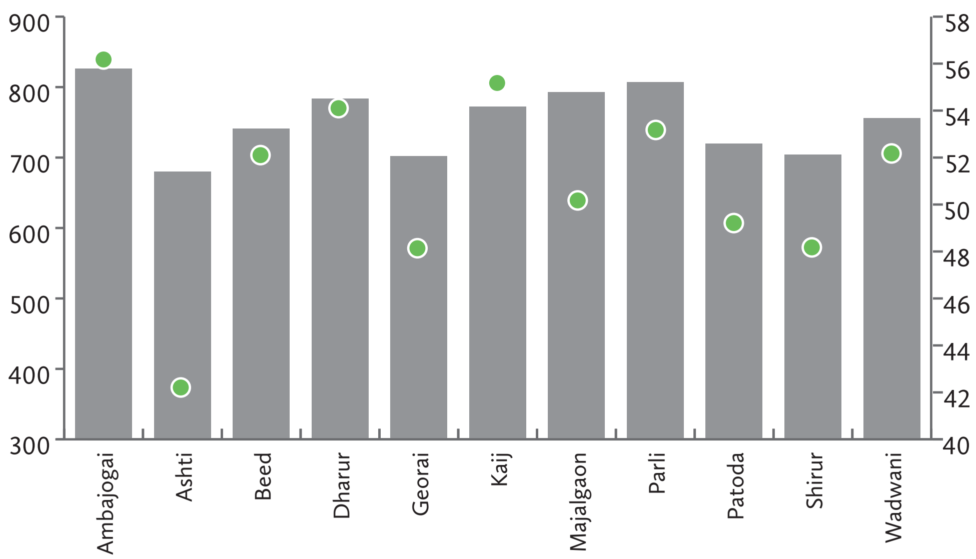


Figure 5. Block wise average annual rainfall and rainy days for the period 1981-2015

across all the blocks of Beed district. October receives around 80 mm of rainfall with average 5 number of rainy days.

The average annual rainfall for the district from year 1981 to 2015 is shown in Figure 6. The long-term trend line of average annual rainfall shows a decreasing trend in annual rainfall from 800m m to 700 mm. Long term (1981-2015) seasonal rainfall analysis is carried out and presented in Figure 7. The total average rainfall received during *Kharif* and *Rabi* season in Beed district is 609 mm and 106 mm, respectively. The trend of seasonal rainfall is seen decreasing from 1981 to 2015. The unseasonal rainfall damages the long duration *Kharif* crops during harvest time. The average annual number of rainy days for the district from year 1981 to 2015 are shown in Figure 8. The long-term trend line shows a decrease in average annual rainy days from 53 days to 49 days.

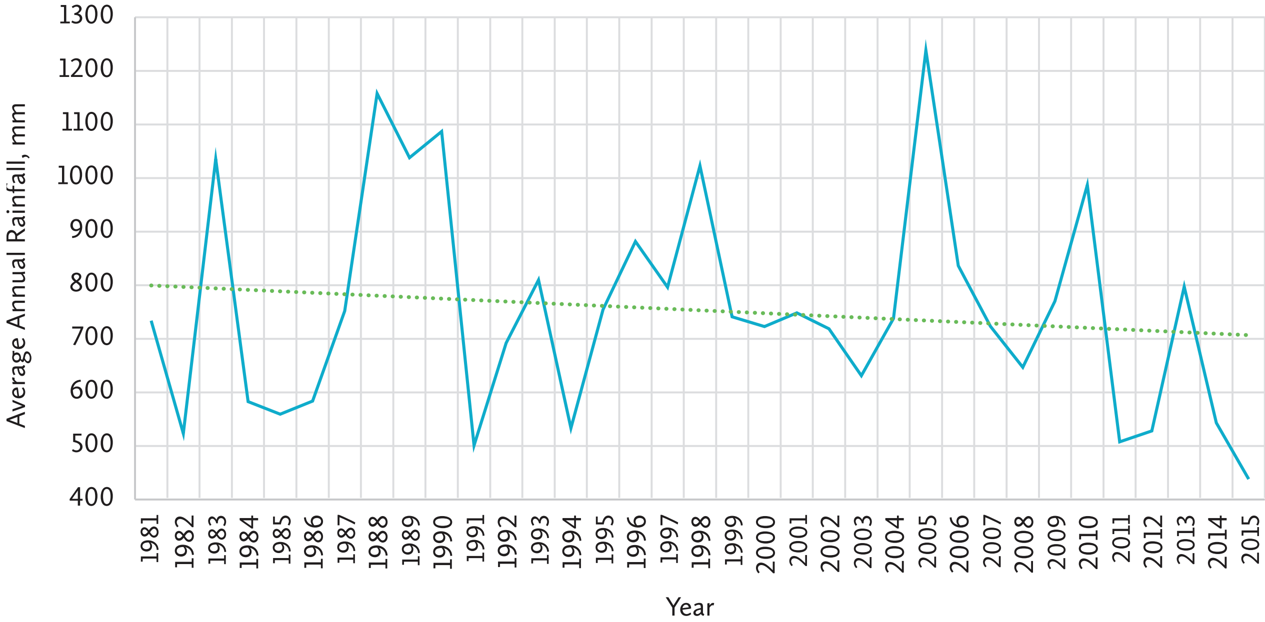


Figure 6. Trend of average annual rainfall in Beed

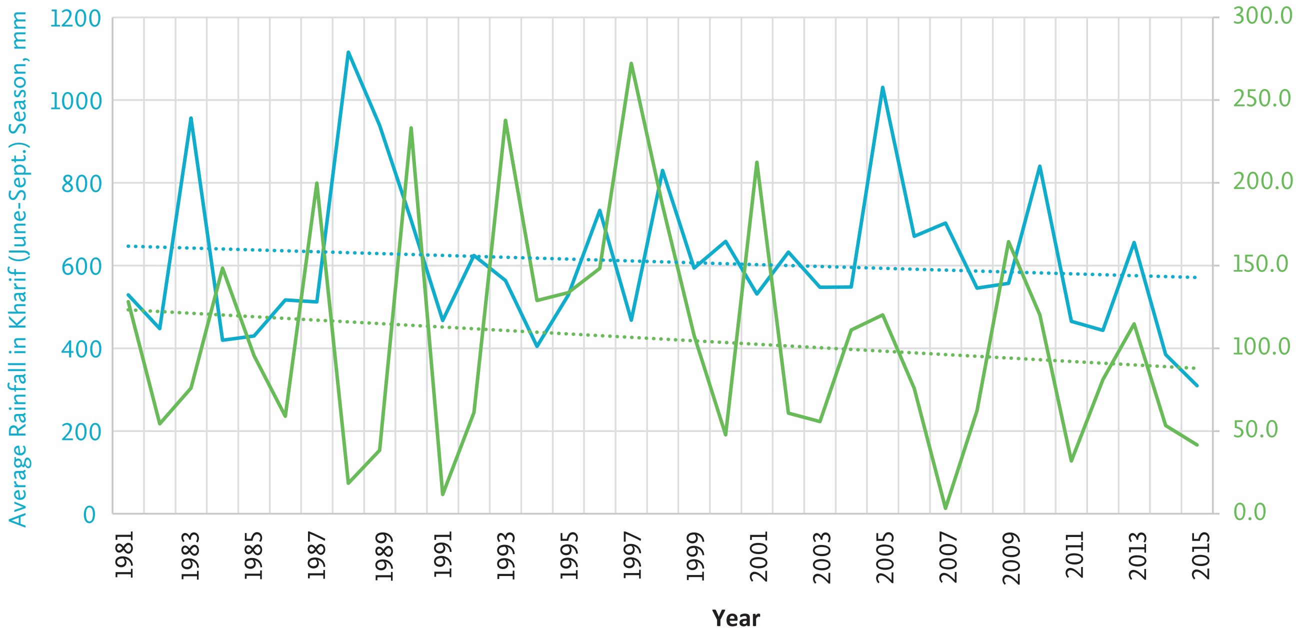


Figure 7. Trend of average rainfall during Kharif and Rabi season in Beed

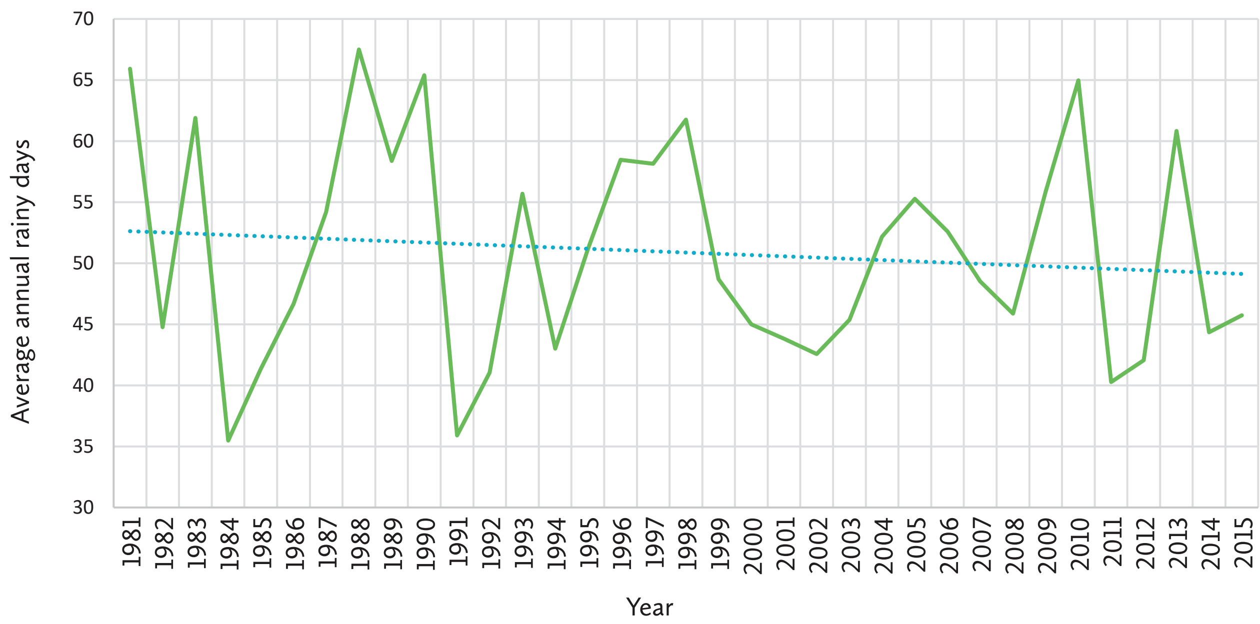


Figure 8. Trend of average annual rainy days in Beed

4.1.1 EXCESS AND DEFICIT RAINFALL

Excess rainfall leads to flooding, soil erosion, risk to human life, infrastructure, loss of crop and livestock production. Deficit rainfall raises drought concerns which may lead to water deficiency and failure of crops. The rainfall is classified as excess, normal, deficient or scanty as per the criteria proposed by IMD. Excess: +20% of normal or

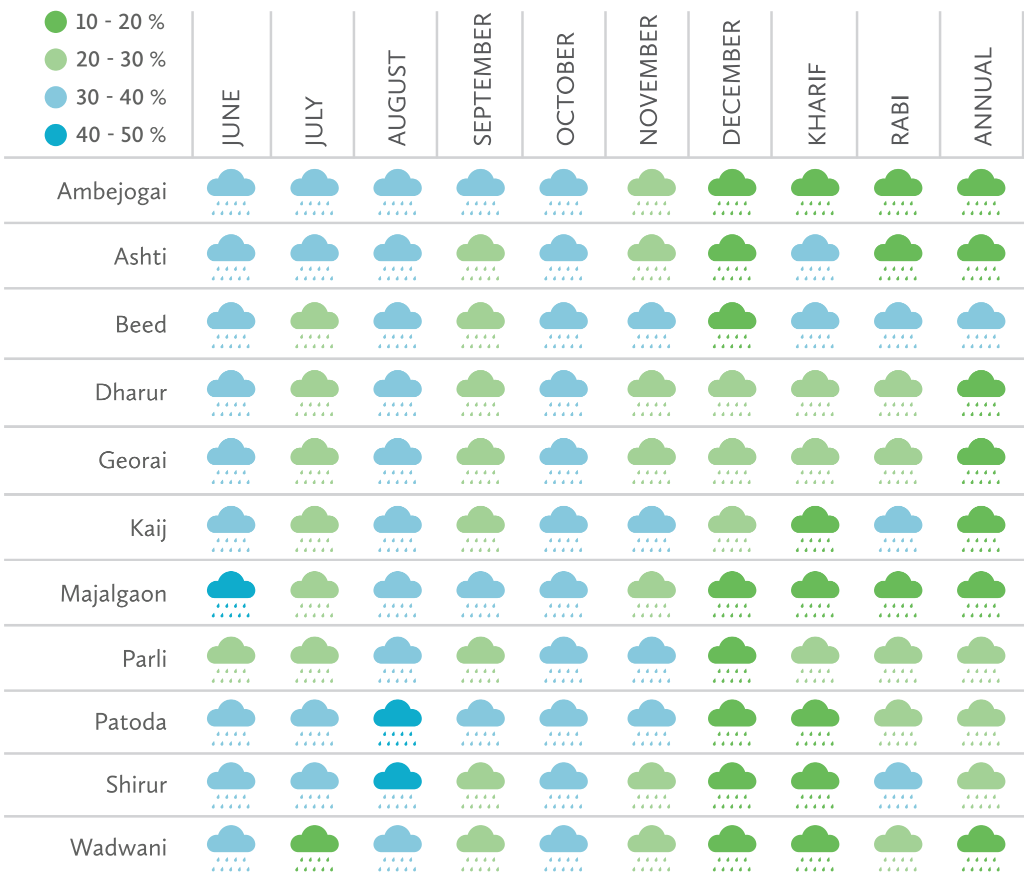


Figure 9. Excess rainfall years for every month from June to Dec, all seasons and annual during the period of 1981-2015 for all blocks of Beed district

more, Normal: + 19% to -19% of normal, Deficient -20% to -59% of normal, and Scanty: -60 % of normal or less. The analysis was carried out using long-term rainfall data (1981 to 2015) for different periods: monthly from June to December, *Kharif, Rabi* and annual season. Figure 9 shows the percent of years (35 years data from 1981-2015) which witnessed excess rainfall events.

The district receives very low annual rainfall i.e., in the range of 700 to 750 mm, and witnessed only 3 excess rainfall events during the period of 1981 to 2015 in the Majalgaon, Patoda and Shirur blocks. Only 2% of the total geographical area of district is flood prone (Amarnath et. al., 2017). However, the rainfall deficits during the period of 1981-2015 is higher (60-80%) in the month of November and December as shown in Figure 10. Ashti, Georai, Parli and Majalgaon blocks has shown a greater number of rainfall deficit years. *Rabi* season is most vulnerable to deficit condition with 40-60% rainfall deficit years.

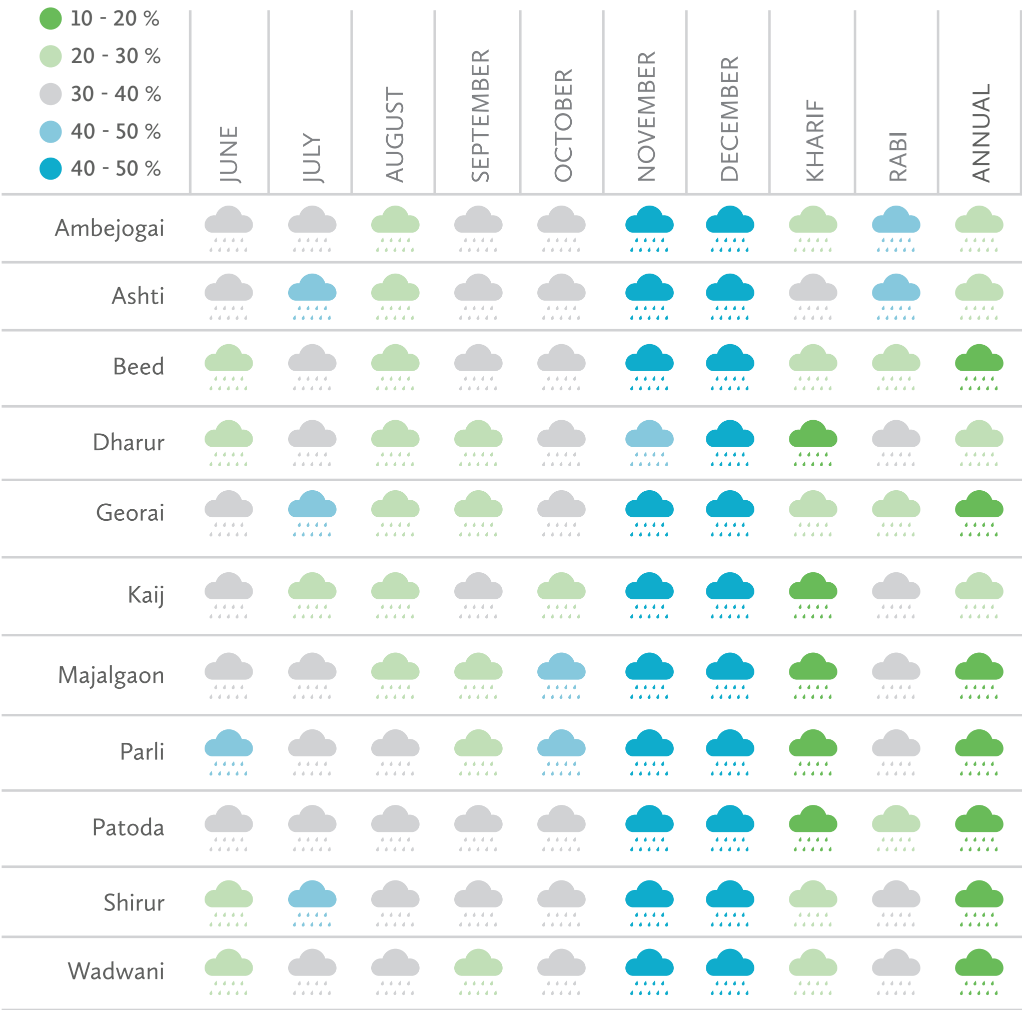


Figure 10. Deficit rainfall years for every month from June to Dec, all seasons and annual during the period of 1981-2015 for all blocks of Beed district

4.2 DRY SPELL

Agriculture in Beed district highly depends on monsoon rainfall and exposed to risks of dry spells and drought conditions. Prolonged period of dry spell has an adverse effect on *kharif* crops like cotton, soybean and pigeon pea which are largely rainfed. Dry spell is a sequence of dry days with less than a threshold value (2.5 mm) of rainfall. It leads to the moisture deficit and prolonged dry spell in the rainy season leads to drought. Dry spells analysis was carried out using IMD gridded rainfall data for the months of JAS: July to September, JJAS: June to September and JJASO: June to October for all tehsils of Beed district and is presented in Figure 11.

It is observed that, during the period 1981 to 2015, the average dry spell period for JAS, JJAS and JJASO were 16 days, 18 days and 22 days, respectively (Figure 11). Ashti, Georai, Shirur and Patoda talukas are relatively more vulnerable to the dry spells.

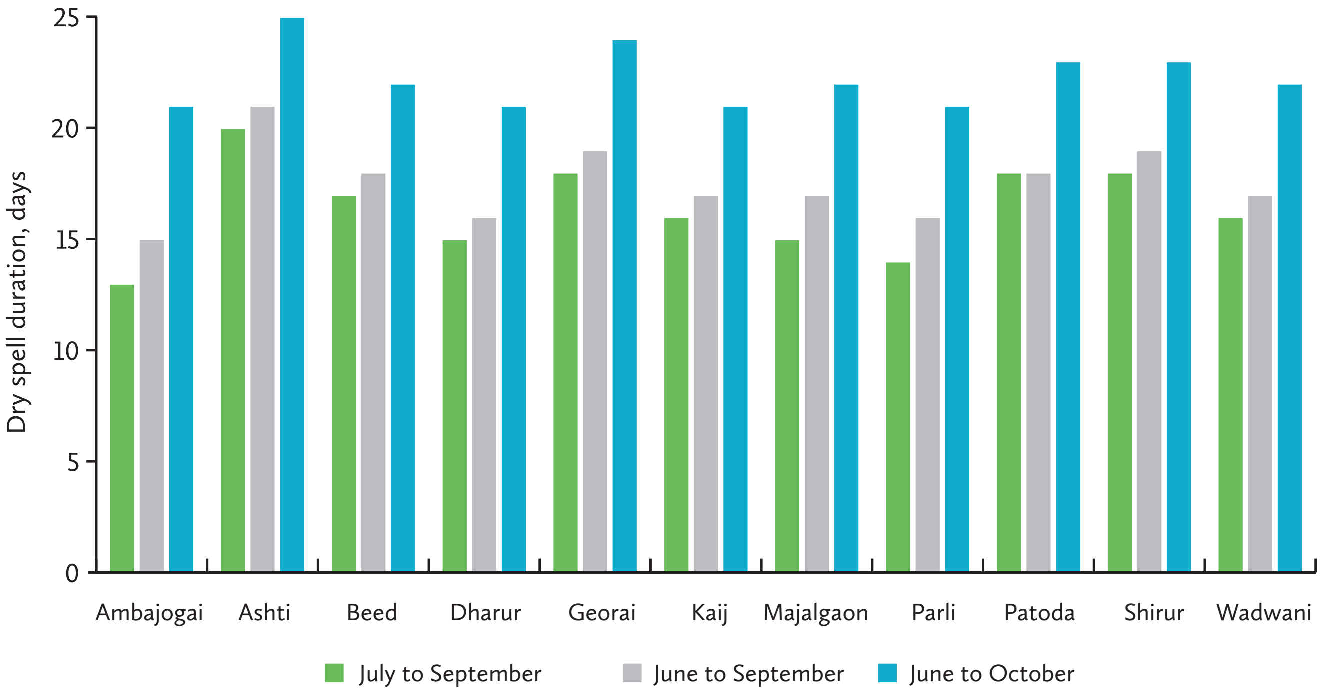


Figure 11. **Dry spell duration in different seasons in Beed district tehsils**

4.3 DROUGHT

Drought is a prolonged period with a shortage of moisture and water supply due to dry weather condition and low rainfall. Drought prone area under each block is calculated from Normalized Difference Drought Index by using NASA" MODIS surface reflectance data from 8-day composite images (500m resolution) for the period 2001 to 2013 (Amarnath et. al., 2017). According to this, around 87% of total geographical area of Beed district is drought prone/affected. In Beed district, out of 35 years period from 1981 to 2015, drought situation occurred in 10 years, which illustrates the frequency of drought is once in 3.5 years.

Heat wave is a prolonged period of high temperature, which is quite more than daily average temperature. Beed district faces the heat wave particularly during April to

May. May is the hottest month of the year with an average day temperature of 42 °C. About 85% of the total district area is vulnerable to heat wave condition (Amarnath et. al., 2017).

Relative humidity is lowest in winter season and December is the driest month in a year with the relative humidity as low as 30% (DIP, 2016).

4.4 STAKEHOLDERS' RISK PERCEPTION

During the stakeholders' workshop, ranking of climatic risks in the district on 0-5 scale was undertaken. On the scale of 0-5, 0 indicates no risk, 1- very low risk, 2- low risk, 3- medium risk, 4- high risk and 5- very high risk. Block wise ranking of climatic risks as perceived from stakeholders is presented in Figure 12.

Stakeholders identified the risk as per their experiences and evidence in the Beed district. Risk from drought is ranked the highest followed by heat wave which depicts *Rabi* and summer seasons are most vulnerable. Stakeholders also identified dry spell as a major risk whch mainly affects *Kharif* cropping system. Cold wave, hailstorm, excess rainfall, storms and flood are the least occurring risks in Beed district.

Stakeholders risk perception is in line with climate risk characterization, which showed deficit rainfall and drought as the major risks whereas excess rainfall and flood pose limited risk in the district. The summary of tehsil wise crops, climate risks, dry spell period, extreme rainfall, drought, heat wave and flood hazardous area is given in Table 5.

Climatic risk	Kaij	Ashti	Ambajogai	Parli	Georai	Majalgaon	Shirur	Beed	Wadwani	Dharur	Patoda	Average
Drought	3.6	4.0	3.0	3.0	3.5	2.5	4.2	2.8	2.8	3.4	4.0	3.3
Heat wave	1.9	2.1	1.8	2.7	2.3	1.9	2.4	2.3	1.9	2.0	2.0	2.1
Dry spell	1.6	2.0	2.1	3.0	2.2	1.8	2.5	1.7	1.9	1.9	1.8	2.0
Cold wave	1.0	1.2	1.2	1.3	0.8	0.7	0.8	0.8	1.0	1.0	1.0	1.0
Hailstorm	1.1	0.8	1.2	1.1	0.8	0.7	0.6	1.0	1.0	1.3	0.5	0.9
Excess rainfall	0.8	0.8	0.6	1.4	0.7	1.1	0.7	0.9	1.0	0.5	0.7	0.8
Storm/Cyclone	0.8	0.5	0.7	0.9	0.6	0.6	0.7	0.7	0.9	0.9	0.5	0.7
Flood	0.1	0.0	0.1	0.3	0.3	0.4	0.0	0.3	0.1	0.1	0.0	0.1

0 - No risk | 0.1 to 1-Very Low Risk | 1.1 to 2- Low Risk | 2.1 to 3- Medium Risk | 3.1 to 4- High Risk | 4.1 to 5- Very High

Figure 12. Climatic risks ranking frequency marked by stakeholders

Table 5. Tehsil wise crops and climate risks in Beed district

Sr. No.	Tehsils	Crop name	Dry spell duration (days)[3]			Extreme rainfall hazard area[4] (km^2)	Drought hazard area[5] (km^2)	Heat wave hazard area[6] (km^2)	Flood hazard area[7] (km^2)	Vulnerability to
			JAS	JJAS	JJASO					
1	**Ambajogai**	Soybean, Cotton, R. Jowar, gram	13	15	21	0	1240	571	9	Drought/ dry spell/ uncertain rains
2	**Ashti**	Cotton, Soybean, Gram	20	21	25	0	1194	1470	27	Drought/ dry spell/ uncertain rains
3	**Beed**	Cotton, Soybean, Gram	17	18	22	0	1306	1526	17	Drought/ dry spell/ uncertain rains
4	**Dharur**	Cotton, Bajra, Red gram/Gram, Saflower	15	16	21	0	530	502	6	Drought/ dry spell/ uncertain rains
5	**Gevrai**	Cotton, Soybean, Gram	18	19	24	0	1508	1532	55	Drought/ dry spell/ uncertain rains
6	**Kaij**	Cotton, Soybean, Maize, Redgram-Gram/R. jowar/ Wheat	16	17	21	0	1065	844	18	Drought/ dry spell/ uncertain rains
7	**Majalgaon**	Cotton, Sugarcane, Soybean/ Gram, Wheat/G. nut	15	17	22	0	808	805	78	Drought/ dry spell/ uncertain rains
8	**Parli**	Soybean, Cotton, Green gram/ Gram, R. Jowar	14	16	21	0	249	111	7	Drought/ dry spell/ uncertain rains
9	**Patoda**	Cotton, Soybean, Gram	18	18	23	0	606	754	1	Drought/ dry spell/ uncertain rains
10	**Shirur**	Cotton, Soybean, Gram	18	19	23	0	374	546	3	Drought/ dry spell/ uncertain rains
11	**Wadwani**	Soybean, Cotton/Gram	16	17	22	0	381	428	37	Drought/ dry spell/ uncertain rains

3 Average dry spell duration estimated using long term analysis for the period of 1981-2015, JAS-July to September, JJAS-June to September and JJASO- June to October.
4 Extreme rainfall hazard area identified using APHRODITE and TRMM data for 1951-2013, Amarnath et.al, 2017.
5 Drought hazard area identified from Normalized Difference Drought Index (NDDI) using MODIS surface reflectance 13 years (2001-2013) timeseries
6 Heat hazard area identified using MOD11C2 data from 13 years (2001-2013) timeseries
7 Flood hazard area identified using MODIS surface reflectance product (MOD09A1) for 13 years (2001-2013) timeseries

4.5 SUMMARY OF RISKS

Changes in rainfall and temperature pattern pose serious risks to farm production system. Climate risk analysis shows that rainfall deficit, dry spells, drought and heat wave events are common in Beed district. Stakeholders also prioritized drought, dry spell and uncertain rains as the potential climate risks in the district (Appendix 2). Based on the risks identified, summary of impact of climate risks on different cropping system is given in Table 6.

4.5.1 IMPACT OF CLIMATE RISK ON LIVESTOCK AND POULTRY

Changes in temperature due to climate variability is the most critical factor for livestock and poultry production system. Heat stress resulted from an increase in temperature, may increase daily water consumption, reduce feed intake which decreases milk production, reproduction and meat production in livestock system. In poultry, increased temperature reduces reproduction rate in hens and consequently lower the egg and chicken production. Long dry season and uneven rainfall reduces the forage quality and growth, and low forage availability affect the production, body weight and decreased resistance to disease. Hence, there is an urgent need to focus on livestock system along with cropping system.

Table 6. Summary of impact of different climate risks on cropping system

<table>
<tr><th>Rainfed/ Irrigated</th><th>Soil types</th><th>Cropping system</th><th>Climate risks</th><th>Impact of climate risk on cropping system</th></tr>
<tr><td rowspan="2">Rainfed</td><td>Black soil</td><td>Cotton – Fallow
Cotton + Redgram (6:1)
Soybean + Redgram (4:2)
Jowar – Gram</td><td rowspan="4">Dry spell,
Excess and uneven rainfall
Drought
Cold wave
Heat wave
Drought</td><td rowspan="2">• Crop damage due to rainfall at harvest time
• Low yields due to moisture stress at reproductive stage
• Vulnerability due to dry spells
• Vulnerability due to erratic rains
• Low yields due to rainfed cultivation
• Reduction in quality of produce</td></tr>
<tr><td>Light soil</td><td>Bajra+ Redgram
Cotton + Green gram
Soybean + Redgram (2:1)
Jowar-Fallow
Soybean-Safflower-linseed</td></tr>
<tr><td rowspan="2">Irrigated</td><td>Black soil</td><td>Sugarcane-gram
Cotton-Wheat-Groundnut
Cotton + Redgram
Soybean – Gram -Wheat/R. Sorghum
Soybean - Vegetables
Turmeric/ginger
Tomato-Vegetables
Vegetables - Vegetables</td><td rowspan="2">• Low support price in the market
• Crop loss due to water logging with excess rains at early stages
• Flowers drop due to stress, rains
• Water stress during growth stages of crop reduces yield
• Low returns
• Lack of water supply and moisture stress
• Heat wave damage to crops
• Crop failure
• Low production and returns</td></tr>
<tr><td>Light soil</td><td>Cotton - Fallow
Sugarcane
Soybean-Gram</td></tr>
</table>

5. CSA TECHNOLOGY IDENTIFICATION AND PRIORITIZATION

CSA technologies could enhance resilience and improve crop yields, water and nutrient use efficiency and have co-benefit of reducing Greenhouse Gas (GHG) emissions (Branca et al., 2011; Jat et al., 2014; Sapkota et al., 2015). As there are many suitable CSA technologies, it is necessary to identify and invest in those technologies that are location specific and cost effective. There is a need to select locally appropriate CSA technologies, products, and practices that help address the impacts of the changing environmental conditions, and will suit the developing economic trajectories. Basically, the identification and prioritization of CSA technologies and practices support climate change adaptation planning in agriculture by designing and implementing situation specific portfolio of smart practices across the given socio-economic and agro-environmental conditions.

For the identification of best technologies, it is required to evaluate them for different parameters, such as their impact on production and income, feasibility in implementation, adoption barriers, availability of finance, inputs, markets, government support, subsidies etc. Consultations with wide range of stakeholders including farmers, researchers, agricultural officers and field practitioners are required for prioritization and selection of area and crop specific best CSA technologies.

5.1 STAKEHOLDERS CONSULTATION FOR CSA TECHNOLOGY PRIORITIZATION

Stakeholder consultation is the process of engaging different local, regional partners and experts to discuss the main issues facing the district and to suggest appropriate solutions for the same. Stakeholders' consultation workshops were organized to identify and evaluate a range of CSA technologies, practices and services in Beed district. The list of participants included officers from the district agriculture departments, extension offices, agriculture research institutions, development organizations and private sector (NGO) along with farmers and local resource persons. Stakeholders from government, development and private sectors were selected based on their area of work, knowledge on climate change adaptation in agriculture, and working experience with farming communities in the district.

5.2 CSA TECHNOLOGY PRIORITIZATION

A list of CSA technologies under different categories of water-smart, energy-smart, carbon-smart, nutrient-smart, weather-smart and knowledge-smart interventions was shared with stakeholders as a suggestive list to select and prioritize technologies and they were asked to list any other appropriate technology that is not included but relevant to their area (Appendix-3). The steps used for CSA technology prioritization are shown in Figure 13.

Potential CSA technologies for 11 blocks of Beed district were identified by stakeholders. Identified list of technology was then evaluated by them for different parameters to assess the implementation feasibility, acceptability, adoption barriers, synergy with government plans/schemes, incentive mechanisms and key institutions required. The stakeholders' prioritization of CSA technologies provides valuable information for planning and designing CSA interventions and resultant investment planning in developing adaptation plan and mitigation options for resilient agriculture.

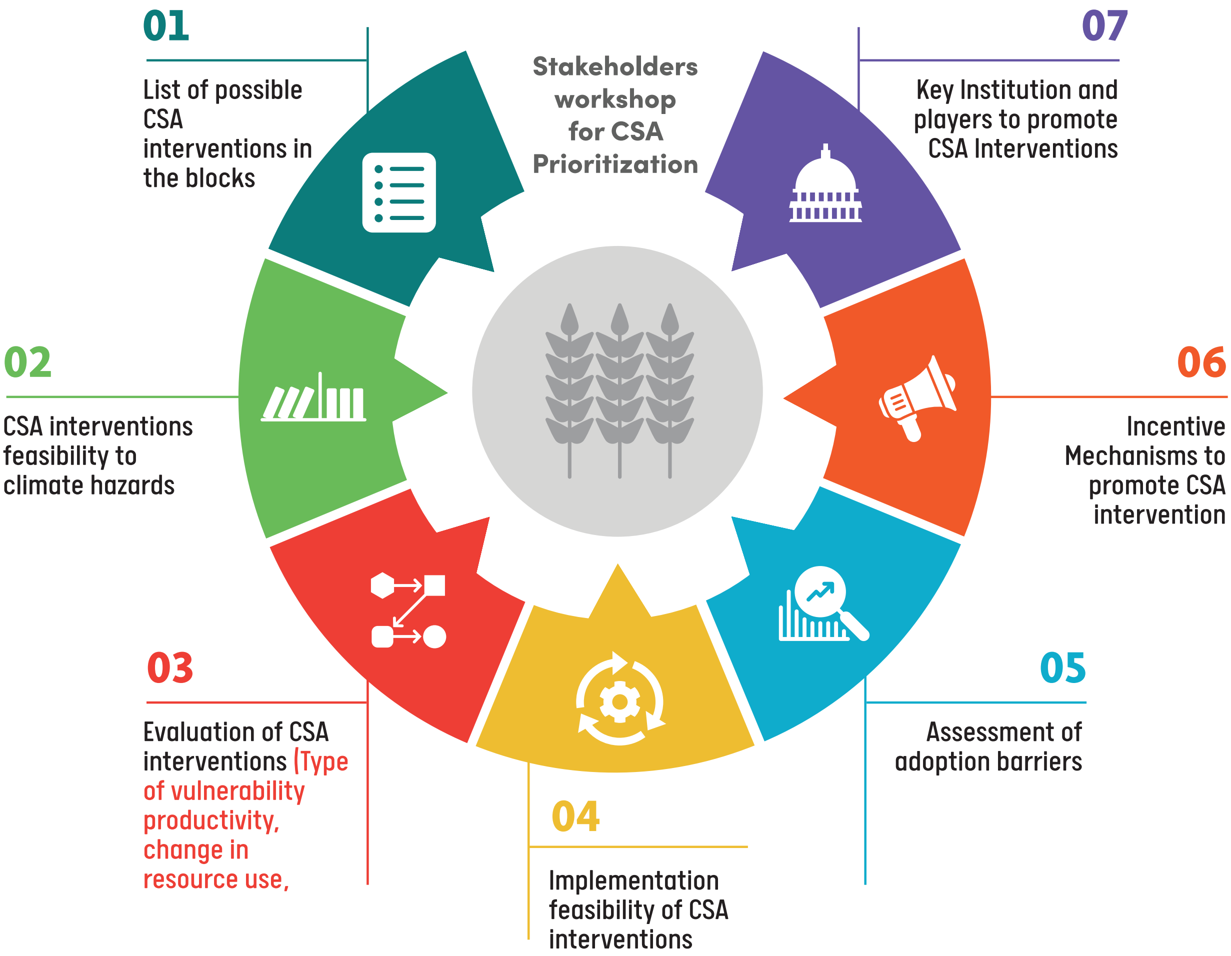


Figure 13. Step wise procedure used in stakeholders' workshop for CSA technology prioritization

In each step of CSA technology prioritization, stakeholders were asked for the area specific information on indicators relevant to CSA technologies. The details are given in Table 7.l

Table 7. Indicators used for the different stages of CSA technology prioritization

Stages	Indicators
List of possible interventions in block	Existing and possible major CSA intervention in districts under water, nutrient, energy, carbon, weather and knowledge smart categories
CSA Interventions feasibility to climate risk	List of major climatic risk in district and feasibility of CSA interventions to major climatic risk in district
Evaluation of CSA interventions	Prioritization of CSA interventions based on cropping system, type of crops, type of vulnerable risk, change in production and income, change in resource use i.e., mitigation and reduction in climate risk i.e., resilience.
Implementation feasibility of CSA	Implementation feasibility of CSA interventions in terms of cost of technology, gender inclusivity, technical feasibility, and synergy with government plans.
Assessment of adoption level and barriers	Availability of finance, inputs, awareness of technology, awareness and acceptability of technology, government support for adoption of technology, different extension services
Incentive mechanisms to promote CSA interventions	Available subsidy for CSA technology, access to affordable farm credit, capacity building and access to market
Key institutions to scale out CSA	Role/support of different institution for scaling out CSA intervention. Private sector retailers, Non-Government Organizations, Farmer Producer Organizations, Custom Hiring Centers, Women Self Help Groups, Youth Farmer Centers

Stakeholder's inputs in CSA prioritization were used for analyzing and selecting the best practices. For this, CSA smartness scores (CSA-SS) indices were used for the evaluation of CSA interventions. CSA-SS consists of CSA technology performance index and CSA- implementation feasibility index, which are summarized below.

5.2.1 CSA TECHNOLOGY PERFORMANCE INDEX (CSA-PI)

CSA intervention performance was evaluated based on CSA technology-performance index (Khatri-Chhetri et al., 2019). CSA-PI includes the scores given by stakeholders for productivity, income, resilience and emission related indicators against each technology.

CSA PI = $\alpha1$*Productivity (%) + $\alpha2$*Income (%) + $\alpha3$* Resilience (%) - $\alpha4$* Emission (%)

Where,

CSA-PI=CSA Performance Index,

$\alpha1=0.25$, $\alpha2=0.30$, $\alpha3=0.35$ and $\alpha4=0.10$ are the weights for each indicator of CSA technology suggested by the stakeholders.

Figure 14 presents stakeholders' evaluation of the selected CSA technologies based on their contribution to improve farm productivity, income, resilience and reduction of emissions. Majority of the water-smart technologies *viz.*; raised bed planting for vegetables, irrigation scheduling, broad bed furrow planting for crops, mulching, drip irrigation, farm/field bunding, farm ponds, sprinkler irrigation and aquifer recharge shaft and wells were ranked highest according CSA-PI score. These water-smart CSA technologies are important for building water resilience and reducing adverse impact of climate risks on crop production.

Similarly, knowledge-smart technologies also received high CSA-PI score, with particularly emphasizes on crop diversification by fruit and vegetables, short duration crop varieties, stress tolerant poultry breeds and fodder banks. After knowledge-smart technologies, nutrient-smart technologies specifically, use of Farmyard Manure (FYM) and vermi-compost, Integrated Plant Nutrient Management (IPNM) and inter-cropping with legumes acquired good CSA-PI score. Carbon-smart technologies such as crop residue incorporation, concentrate feeding for livestock and energy-smart technologies like solar pump, zero tillage were also ranked with good CSA-PI score. Information and Communication Technology (ICT) is the only one technology under weather-smart category found suitable as per the CSA-PI. In Beed district, as more agricultural area is under rainfed system, livestock and poultry production system is having importance as it provides sustainable income source to the farmers. Concentrate feeding and stress tolerant breeds of livestock and poultry were ranked as good practices as per the CSA-PI score related to livestock/poultry management.

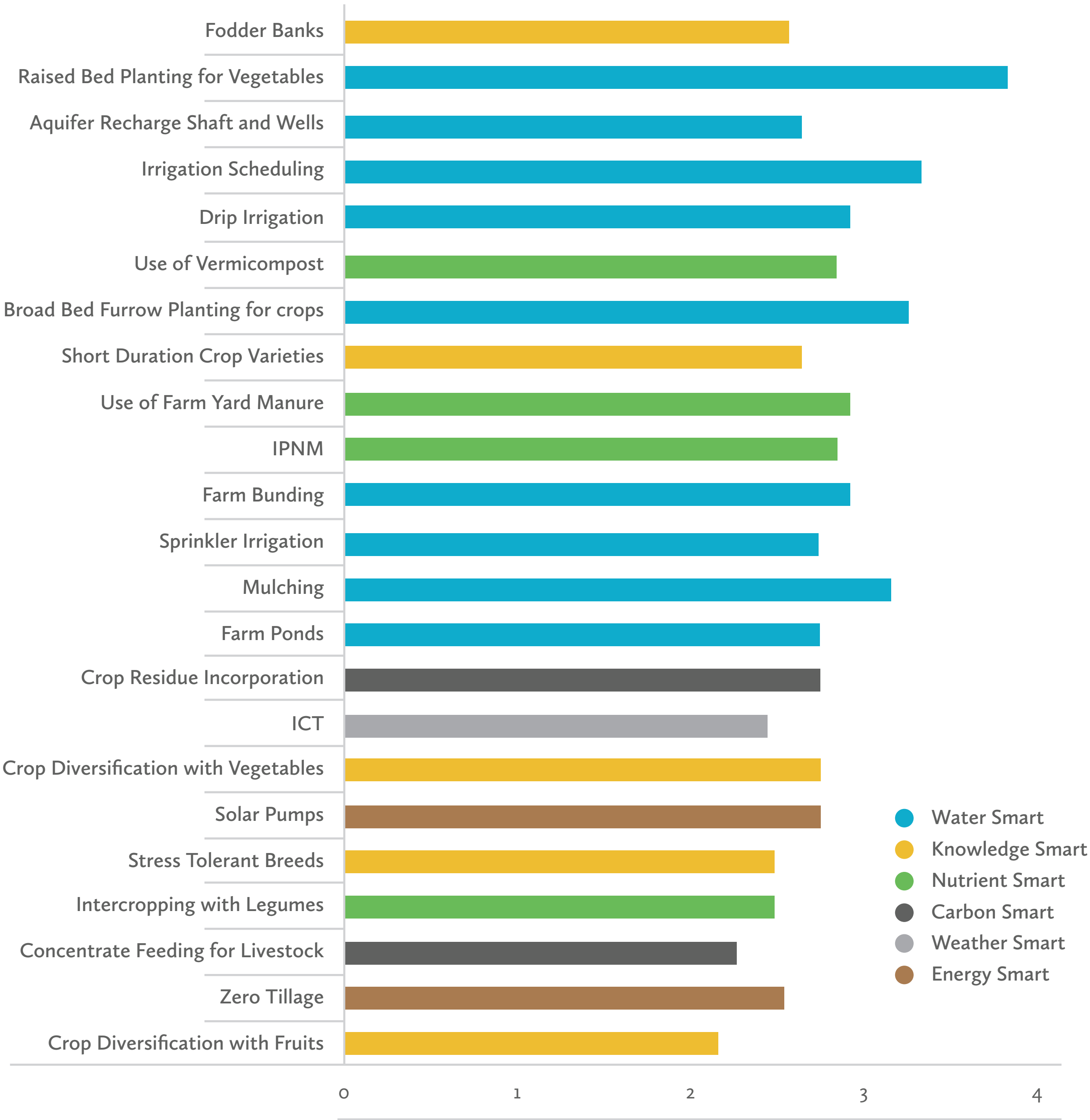


Figure 14. CSA technology performance index

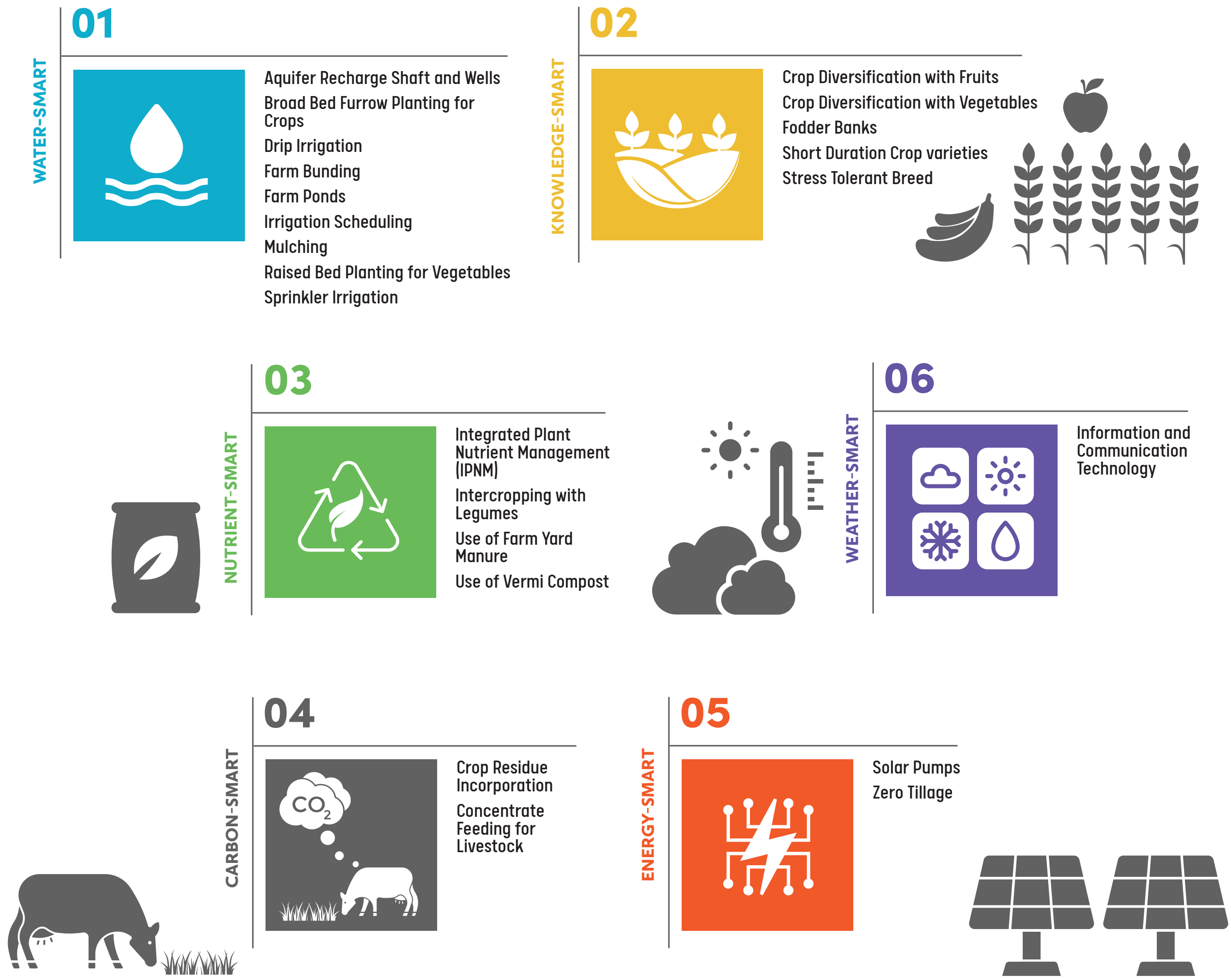


Figure 15. Category wise list of selected CSA technologies

The selected list of technologies based on high CSA technology- performance index under each category is shown in Figure 15.

5.2.2 CSA TECHNOLOGY IMPLEMENTATION FEASIBILITY

Overall implementation feasibility of CSA technologies is assessed based on their technical feasibility, cost of technology, gender inclusivity and synergy with government plans. Implementation feasibility was evaluated by using 0–5 Likert Scale, where 0=not relevant, 1=very low importance, 2=low importance, 3=medium importance, 4=high importance and 5=very high importance. Likert scale is a rating scale commonly used in social science research to evaluate human attitude, which can be considered an interplay of human cognition, feeling and action (Joshi et al., 2015;

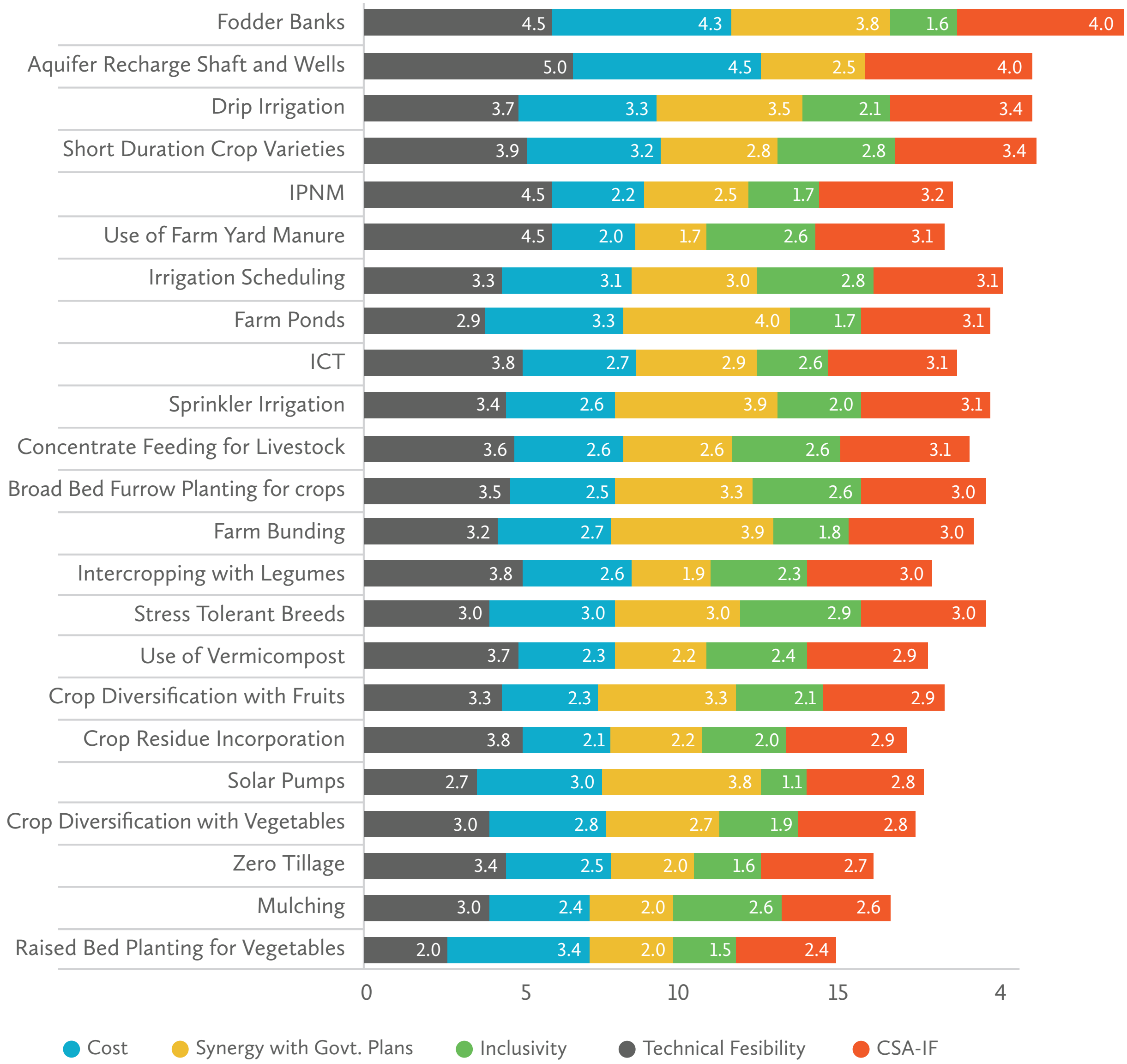


Figure 16. CSA technologies implementation feasibility

Udmale et al., 2014).

CSA-IF = *β1* Technical Feasibility Score* + *β2* Cost Score* + *β3* Inclusivity Score* + *β4* Synergy with Government Schemes*

Where,

CSA-IF=CSA technology- Implementation Feasibility index,

β1=0.45, β2=0.30, β3=0.10 and β4=0.15 are average weights suggested by the stakeholders.

Using these weights, implementation feasibility index was estimated based on the inputs provided by stakeholders against each indicator for each selected technology. The results indicated that the overall implementation feasibility was largely influenced by their technical feasibility, cost of implementation and intervention's synergy with government plans. Figure 16 presents the implementation feasibility of selected CSA interventions.

For all the selected technologies, implementation feasibility was found over 50%. The technologies, namely fodder bank, aquifer recharge shaft and wells, drip irrigation, use of vermi-compost, short duration crop varieties, raised bed planting for vegetables and IPNM scored high in overall implementation feasibility of technology. The technical feasibility represents level of farmer's knowledge or skill required to implement or use the technology. The technologies like aquifer shaft and wells, fodder bank, IPNM, drip irrigation, ICT, short duration crop varieties ranked high in technical implementation feasibility. Majority of small holder farmers often lack in investment capacity to implement the CSA technologies. Fodder bank, aquifer shaft and wells, drip irrigation, ICT, short duration crop varieties, solar pump, farm pond, raised bed planting, stress tolerant breeds of livestock/poultry etc. are the technologies which needs more attention for investment. Synergy with government plans for the financial support is required to promote wide scale adoption of CSA technologies. Farm pond, solar pump, fodder bank, farm bunding, sprinkler and drip irrigation, BBF planting etc. are the technologies where the synergy with government plans topped high score for implementation feasibility. Inclusivity score mainly focus on role of women farmers in terms of labor contribution to adopt particular CSA technology.

Best CSA technologies with high score (more than 6) for both CSA-PI and CSA-IF values include fodder banks, raised bed planting for vegetables, aquifer recharge shaft and wells, irrigation scheduling, drip irrigation, use of vermi-compost, broad bed furrow planting for crops, short duration crop varieties, use of FYM and IPNM.

5.2.3 ASSESSMENT OF ADOPTION LEVEL AND BARRIERS

Selected CSA technologies were evaluated for different adoption level and barriers, if any. Availability of finance, inputs, awareness of technology, awareness and acceptability of technology, government support for adoption of technology, different extension services etc. are key elements of barriers. Many studies indicate that despite technology requirement and farmers' interest to implement, their investment capacity limits adoption of many CSA technologies and practices in agriculture (Gebregziabher et al., 2013; Palanisami et al., 2015). Figure 17 presents the average of responses given by stakeholders for the selected technologies against different adoption barriers. Color scale of 0-5 is used to indicate the level of adoption barriers for different indicators.

Beed district has significant number of marginal farmers. Farmer's economic condition is one of the main constraints to adopt CSA technologies. Many technologies such as drip irrigation, sprinkler irrigation, mulching, solar pump, farm pond, ICT etc. require monetary input for implementation in the field. Hence, finance is found as one of the major barriers to adoption of such technologies.

Awareness of the technology and acceptability are other major barriers in the district. Some government schemes such as PMKSY, RKVY, MIDH support implementation of these technologies. But awareness about the technology and lack of acceptability due to awareness are again the constraints. Figure 17 shows that drip irrigation, use of vermi-compost, IPNM, farm bunding, sprinkler irrigation, mulching, farm pond, ICT, solar pump etc. are the technologies that commonly face lack of awareness and acceptability by farmers. Extension services are required to create awareness and provide a knowledge about the technology. Majority of the marginal and small farm holders lack access to required farm machinery and other inputs for timely operation. This becomes one of the key limitations for implementing smart interventions, Adoption Barrier Level: Very High, High, Medium, Low, Very Low

	FINANCE	INPUTS	AWARENESS	ACCEPTABILITY	LABOUR	RAINWATER	GOVERNMENT SUPPORT	EXTENSION SERVICE
Fodder Banks	Medium	Medium	Medium	Medium	Medium	Medium	Medium	High
Raised Bed Planting for Vegetables	Low	Low	Low	Medium	Low	Low	Low	Medium
Aquifer Recharge Shaft and Wells	Medium	Medium	Low	Very High	Medium	Very High	Low	Low
Irrigation Scheduling	Medium	Low	High	Medium	Low	Medium	Low	Medium
Drip Irrigation	High	Medium	High	High	Low	Medium	High	High
Use of Vermicompost	High	Medium	High	High	Medium	Medium	Medium	Medium
Broad Bed Furrow Planting for crops	High	Medium	Medium	Very High	Low	Low	Low	Low
Short Duration Crop Varieties	Medium	Medium	Medium	Medium	Low	Medium	Low	Medium
Use of Farm Yard Manure	Medium	Medium	Medium	Medium	Medium	Low	Medium	Medium
IPNM	High	Medium	High	Medium	Medium	Medium	Medium	Medium
Farm Bunding	Medium	Medium	High	High	Low	Low	Medium	Medium
Sprinkler Irrigation	High	Medium	Very High	High	Low	Medium	Medium	High
Mulching	High	Medium	High	High	Medium	Medium	Medium	Medium
Farm Ponds	Medium	Medium	High	High	Low	Low	Medium	Medium
Crop Residue Incorporation	Medium	Medium	High	Medium	Medium	Medium	Medium	Medium
ICT	High	Medium	High	High	Low	Low	Medium	High
Crop Diversification with Vegetables	High	Medium	High	High	Medium	Low	Low	Medium
Solar Pumps	High	Medium	High	High	Low	Low	Medium	High
Stress Tolerant Breeds	Medium	Low	Medium	Medium	Low	Medium	Medium	Medium
Intercropping with Legumes	Medium	Medium	High	High	Medium	Medium	Medium	Medium
Concentrate Feeding for Livestock	Medium	High	Medium	High	Low	Medium	Medium	Medium
Zero Tillage	Medium	Low	High	High	Medium	Medium	Medium	High
Crop Diversification with Fruits	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

Figure 17. Assessment of adoption level and barriers in implementation of CSA technology

especially when the window of carrying out agricultural operations is narrow as that usually is the case in such rainfed areas. Analysis also revealed that, availability of labor and rainwater is crucial for the adoption of CSA technologies, practices and services.

5.2.4 INCENTIVE MECHANISMS TO PROMOTE CSA TECHNOLOGIES

Incentives such as subsidy in technology, access to affordable farm credit, capacity building and access to market were assessed through CSA prioritization to scale out many CSA technologies at the local level. Table 8 presents stakeholders' ranking of incentive mechanisms for scaling out CSA technologies at the local level. The scale of 0–5 was used, where 0=not relevant, 1=very low importance, 2=low importance, 3=medium importance, 4=high importance and 5=very high importance.

Subsidy in technology was identified as major incentive mechanism to promote and support CSA technologies at wide scale such as raised bed planting for crops and vegetables, drip and sprinkler irrigation, farm pond, solar pump, IPNM etc. Affordable credit is also required for wide scale adoption of technologies. Capacity building in terms of agro-advisory support/demonstration plots for many CSA technology applications was also identified as another major incentive mechanism to increase farmers' awareness on technologies and building confidence to implement these technologies in their farms. Capacity building was found important for the technologies *viz*.; mulching, raised bed planting, solar pump, irrigation scheduling, crop residue incorporation, crop diversification with fruits etc. Linkage of market for easily available services and inputs to adopt the technologies was found was found important for short duration crop variety, drip irrigation, stress tolerant breeds, concentrate feeding for livestock etc.

Table 8. Assessment of different incentive mechanisms to promote CSA technologies

Selected CSA Technologies	Subsidy	Affordable Credit	Capacity Building	Linkage with market
Fodder Banks	2.9	1.8	2.0	1.3
Raised Bed Planting for Vegetables	4.0	3.0	4.0	1.0
Aquifer Recharge Shaft and Wells	3.5	2.0	1.5	1.5
Irrigation Scheduling	3.3	2.0	3.0	3.0
Drip Irrigation	4.5	2.8	2.8	1.7
Use of Vermi-compost	3.5	2.0	2.6	1.6
Broad Bed Furrow Planting for crops	4.0	2.0	2.3	1.7
Short Duration Crop Varieties	2.0	1.9	2.6	2.3
Use of Farm Yard Manure (FYM)	2.4	1.9	2.4	1.6
Integrated Plant Nutrient Management (IPNM)	3.9	2.0	2.7	1.8
Farm Bunding	3.5	2.0	2.6	1.1
Sprinkler Irrigation	4.4	2.6	2.8	1.7
Mulching	2.4	2.3	3.7	1.9
Farm Ponds	4.5	1.9	3.1	1.8
Crop Residue Incorporation	2.9	1.7	2.6	1.3
Information and Communication Technology (ICT)	3.2	3.0	3.0	2.5
Crop Diversification with Vegetables	2.1	1.7	2.2	2.0
Solar Pumps	4.0	3.4	3.3	1.6
Stress Tolerant Breeds	2.8	2.5	3.0	3.0
Intercropping with Legumes	2.5	1.3	2.7	1.7
Concentrate Feeding for Livestock	3.0	2.8	2.2	2.7
Zero Tillage	1.9	2.0	3.3	1.2
Crop Diversification with Fruits	3.1	2.4	3.0	2.6

5.2.5 KEY INSTITUTIONS TO SCALE OUT CSA TECHNOLOGIES

Multiple institutions play multiple roles at different level for farmers and farming communities with different responsibilities. The institutions such as private sector retailers, NGOs, FPOs help to scale out CSA technologies in rural sector. Role of such organizations in supporting adoption of CSA technologies, practices and services was also evaluated.

Table 9 presents the ranking of key institutions in scaling out CSA technologies. The scale of 0–5 was used, where 0=not relevant, 1=very low importance, 2=low importance, 3=medium importance, 4=high importance and 5=very high importance. Youth farmers group and farmer producer organizations turned out to be the key institutions to scale out information and communication, for the technologies such as fodder bank, raised bed planting, drip irrigation, mulching, IPNM, farm pond etc. The role of young farmers' group was identified to be instrumental in promoting CSA technologies at the local level. Non-government organizations also found prominent to form linkage between government and farmers for implementation of different government programs at farm level. Women self-help groups were also identified for empowering women about technologies and promoting CSA. Private sector retailers are necessary for marketing agriculture and horticulture produce and improving productivity. It is important to note that these local level institutions have a vital role in scaling out climate resilient interventions and help in complementing government support.

Table 9. Key institutions for scaling out CSA technologies

Selected CSA Technologies	CHC	YFG	WSHG	FPO	NGO	PSR
Fodder Banks	1.0	2.0	2.2	1.2	1.5	1.0
Raised Bed Planting for Vegetables	0.0	2.3	1.3	3.0	2.0	1.5
Aquifer Recharge Shaft and Wells	0.0	1.0	0.0	2.0	2.0	1.5
Irrigation Scheduling	0.5	3.0	1.8	2.0	1.5	2.3
Drip Irrigation	0.5	1.8	1.4	1.8	1.6	1.6
Use of Vermi-compost	0.1	1.8	1.7	1.8	1.2	0.9
Broad Bed Furrow Planting for crops	1.0	1.8	0.5	0.8	0.5	0.8
Short Duration Crop Varieties	0.0	1.0	0.0	2.0	2.0	1.5
Use of Farm Yard Manure (FYM)	0.1	1.8	1.7	1.8	1.2	0.9
Integrated Plant Nutrient Management (IPNM)	0.2	2.6	2.0	2.2	1.8	1.8
Farm Bunding	0.2	1.8	1.3	1.9	2.1	1.8
Sprinkler Irrigation	1.1	1.7	1.1	1.7	1.4	1.3
Mulching	0.3	1.4	1.0	1.7	1.1	1.3
Farm Ponds	0.4	2.1	1.5	2.1	1.9	1.6
Crop Residue Incorporation	0.0	2.2	1.8	2.3	1.7	1.3
Information and Communication Technology (ICT)	0.5	1.3	1.7	1.4	1.1	0.6
Crop Diversification with Vegetables	0.7	1.5	1.9	1.3	1.3	0.8
Solar Pumps	0.5	1.5	0.6	1.6	1.7	2.2
Stress Tolerant Breeds	1.5	1.7	2.0	1.5	2.0	1.0
Intercropping with Legumes	0.1	2.2	2.2	2.2	1.7	1.5
Concentrate Feeding for Livestock	0.8	0.9	1.4	1.2	1.7	1.3
Zero Tillage	0.7	1.5	0.9	1.5	1.8	1.7
Crop Diversification with Fruits	1.1	1.9	1.9	1.5	1.0	1.0

CHC: Custom Hiring Centers, **YFG:** Youth Farmers Groups, **WSHG:** Women Self Help Groups, FPO: Farmer Producer Organizations, **NGO:** Non-Government Organizations, **PSR:** Private Sector Retailers

5.3 CSA EVIDENCE FRAMEWORK

Many prioritized CSA technologies are already being adopted on farmers' field in Beed district. The evidence collected from field shows usefulness of CSA practices to maintain yield levels and increase farmers' income. Integrated nutrient management, inter-cropping, raised bed planting, crop diversification with fruit crops and vegetables, short duration varieties, stress tolerant breeds and concentrate feed for livestock are some crucial CSA technologies found functional with significant evidence of enhancing resilience in Beed district.

Evidence of climate smart agriculture technologies implemented in the district/ blocks by KVK/ research institutes/ station in agriculture and allied sectors in the areas of natural resource management, crop/ horticultural production systems, livestock and fisheries production systems are given in the Table 10.

5.3.1 EVIDENCE OF CLIMATE SMARTNESS OF TECHNOLOGIES FOR CROPPING SYSTEM

Cotton is the major crop grown in all the blocks of Beed district in rainfed system on black soils. Bt-Cotton is a commonly used variety. In view of presence of a greater number of cotton ginning and pressing industries available in the district, there is a good scope for production of export-oriented quality lint and also cotton seed oil through existing oil mills. Mono cropping, absence of using soil testing-based fertilizer applications, indiscriminate spacing, no seed treatments, weed infestation, non-adoption of integrated crop management practices, pink boll worm and sucking pest problem are some of the problems in raising cotton. Spacing trials of cotton with 3x3 against 5x1 and 3x2 feet spacing proved best for cotton. Integrated weed management trials with power weeder for weed infestation problems proved helpful in drudgery reduction of women. Integrated nutrient management using inter-cropping with green gram in rainfed cotton in medium soil type has proved advantageous to gain more yield and returns, with benefit cost ratio of 1.69.

Soybean is the second important crop cultivated on black soils during *Kharif* season. Imbalanced use of fertilizers, low yield due to non-adoption of seed treatment, water stress during growth stages of crop, low yield due to weeds and use of old varieties are the major problems identified in Beed district for soybean crop. Cultivation of improved soybean varieties with package of integrated nutrient management and crop practices proved better with BC ratio of 2.42. Pigeon pea is another important crop in *Kharif* season. Inter-cropping with sesame on micro irrigation, introduction of rainfed wilt and sterility mosaic resistant variety, management of pod borer and pod fly are the interventions being used in Beed which yielded BC ratio in the range of 2.77 to 2.94.

Table 10. Evidence of climate-smart agriculture practices implemented in Beed district

Sr. No.	Crop	Intervention implemented*	Farming situation (rainfed/ irrigated, soil type)	Year	Season	Cost of inter-vention (Rs/ha)	Yield (kg/ha)		Net Returns (Rs/ha)		BC ratio
							Demo	Check	Demo	Check	
1	Soybean	Cultivation of soybean varieties on INM and ICM packages.	Rainfed/ medium	2017	Kharif	6750	19.81	15	36614	22833	2.42
2	Pigeon Pea	Introduction of rainfed wilt and sterility mosaic resistant var. with whole package.	Rainfed/ medium	2017/ 2018	Kharif	6750	15.14	10.40	49533	28747	2.77
3	Pigeon Pea	Management of pod borer and pod fly	Rainfed/ medium	2017/ 2018	Kharif	5687	15	11.85	49050	37343	2.83
4	Pigeon pea+ Sesamum	Introduction of pigeon pea BDN-711 intercropping with Sesamum on micro irrigation	Rainfed/ medium	2018/ 2019	Kharif	6250	10.47 +0.41	10.67	52175	32100	2.94
5	Cotton + Green gram	Introduction of cotton based intercropping with Mod. P. M. resistant var.BM-2003-2	Rainfed/ medium	2017	Kharif	2500	9.10 +7.41	6.50 +4.82	36960	21670	1.69
6	Chick Pea	Introduction of wilt resistant var. Of chickpea with INM,IPM tech-nology	Rainfed/ medium	2017/ 2018	Rabi	6750	16.30	12.39	40106	29858	2.60
7	R. Sorghum	Introduction of rainfed sorghum var. PKV-Kranti/ Phule Vasudha	Rainfed/ medium	2017	Rabi	2500	20.33	14.90	32742	21220	2.45
8	R. sorghum	Introduction of R. sorghum PKV-1009 on drip irrigation method	Irrigated/ medium	2019	Rabi	2500	21.23	16.25	50250	32438	2.67
9	Wheat	Cultivation of Var. NIAW-1415 (Ne-travati) for less water available areas with INM	Irrigated/ medium	2017	Rabi	5000	29.46	20.60	35855	20350	2.56
10	Wheat	Zero till drill	Irrigated/ medium	2017/ 2019	Rabi	2000	29.46	20.60	35855	20350	2.56

In *Rabi* season, sorghum, gram and wheat are the major crops grown on medium soil. For *Rabi* sorghum introduction of rainfed sorghum variety *PKV-Kranti/ Phule Vasudha* proved good with BC ratio of 2.45 while introduction of PKV-1009 variety on drip irrigation method proved best with BC ratio of 2.67. Introduction of variety NIAW-1415 (*Netravati*) for water deficit areas with INM practice and zero till drill for wheat yielded BC ratio of 2.56.

Ginger, turmeric and vegetable crops need awareness of modern technologies. Raised bed with drip irrigation cultivation, use of high-tech horticultural practices like protected cultivation, crop cover, training and pruning technology, introduction of prominent cultivars, introduction of new fruit and vegetable crops for diversification are some key interventions being implemented in Beed district. Cultivating variety of vegetables under permanent pandal system and adopting modern technologies like poly houses can achieve higher yields. Hence, there is a scope for promoting vegetable cultivation as an alternative to commercial agricultural crops, especially under irrigated conditions.

5.3.2 CSA EVIDENCE FOR LIVESTOCK AND POULTRY

In livestock, use of *Sampurna* forage grass variety and *Gunwant*- new hybrid Napier variety for feed purpose leads to an increase in forage yield by over 40% and increased milk production by 18%. For poultry production, indigenous *Vanraja* poultry proved better with 67% increase in weight and 150% improvement in egg production. Introduction of *Kadaknath* breed increased weight by 37% in cock. To improve the socio-economic status of the traditional farmers, backyard poultry is a handy enterprise with low-cost initial investment, but high economic return along with guarantee for improving protein deficiency among the poor. Till now KVK Beed has distributed 55,000 poultry birds in the KVK jurisdiction area. *Giriraja* for back yard poultry farming showed 49% increase in weight.

In summary, inter-cropping, use of improved varieties, IPM, IPNM, drip irrigation, mulching, raised bed plantation techniques etc. are the CSA practices being mostly practiced in the Beed district have showed better results. Farm pond, broad bed furrow planting, use of vermi-compost and FYM, crop residue incorporation, zero tillage are other significant prioritized CSA technologies for resilient cropping system. As drought and heat wave are the major climatic risks in Beed district, stress tolerant breeds of livestock and poultry and short duration crop varieties are required for resilient and sustainable production in dry season.

6. SCALING UP AT DISTRICT LEVEL

To scale out the area specific CSA technologies for resilient farming and sustainable production under climate change, convergence with ongoing development schemes and programmes is critical. This section focuses on funds/investments required for scaling up implementation of these CSA technologies and convergence possibilities with existing functional government schemes for upscaling.

6.1 ESTIMATED FUNDS REQUIREMENT

Total cost of the proposed project in scaling out CSA technologies for resilient farming is estimated based on number/area of potential CSA practices and interventions required in the district. Number/area of prioritized CSA technologies are based on certain assumptions (in Table 11) reflecting the demonstration scale required for effective dissemination and upscaling. However, these numbers/area may vary when actual implementation plan is prepared with more micro level fine tuning at sub-district level. Table 11 gives an individual intervention's cost with proposed numbers/area under intervention.

Total cost of implementation of CSA project is estimated to be Rs. 387.0 Crore. A major part of the total cost is required for the implementation of CSA practices in water smart components at the cost of Rs. 220.8 Cr. As the district receives very low rainfall and much of the area is rainfed, the construction of recharge wells, farm ponds, farm bunding etc. and use of farm machineries assume importance. Other major components are knowledge and energy smart technologies involving Rs. 77.8 Cr and Rs. 56.0 Cr, respectively, largely involving demonstrations and capacity building. However, cost doesn't signify the importance of a smartness component or technology as integrated development is needed to maximize the benefits, as standalone implementation would not build required level of resilience to climate change.

Table 11. Cost and total number/area of individual CSA practices across different smartness component

Technologies	Total number	Unit	Total cost	Assumptions to estimate number/area of interventions
Water-Smart				
Raised Bed Planting for Vegetables	4000	ha	2.5	Vegetable area all season
Aquifer Recharge Shaft and Wells	2806	no.	8.4	2 per village
Irrigation Scheduling	1500	no.	0.2	Training to farmers
Drip Irrigation	20000	ha	100.0	In 25 % of non-paddy, non-cereal crops area (includes cotton, vegetable and orchard area)
Broad Bed Furrow Planting for crops	1403	no.	5.6	BBF planter 1 in each village
Farm Bunding	500	no.	0.1	Training to farmers
Sprinkler Irrigation	20000	ha	70.0	In 25 % of Pigeon pea, groundnut, vegetables etc. area
Mulching	2000	ha	6.0	50% of vegetable and fruit crops area
Farm Ponds	2806	no.	28.1	2 FP / village
Water-smart technologies total cost = Rs. 220.8 Cr.				
Energy-Smart				
Solar Pumps	1000	no.	50.0	replacing 1000 existing pumps
Zero Tillage	2000	ha	6.0	20% of Maize crop area
Energy-smart technologies total cost = Rs. 56.0 Cr.				
Nutrient-Smart				
Use of Vermi-compost	2806	no.	1.4	2 vermi-compost plants per village
Use of Farm Yard Manure	2806	ha	2.8	2ha/village
Integrated Plant Nutrient Management (IPNM)	1500	no.	0.2	Training to farmers
Intercropping with Legumes	1403	ha	1.4	1 ha/village
Nutrient -smart technologies total cost = Rs. 5.8 Cr.				
Carbon-Smart				
Crop Residue Incorporation	1500	no.	0.2	Training to farmers
Concentrate Feeding for Livestock	28060	no.	20.5	each village 20 animals
Carbon -smart technologies total cost = Rs. 20.6 Cr.				
Weather-Smart				
Information and Communication Technology	200	no.	6.0	1 unit on each 50 sq. km
Weather -smart technologies total cost = Rs. 6.0 Cr.				
Knowledge-Smart				
Fodder Banks	1403	no.	0.4	1 ha/village
Short Duration Crop Varieties	50000	ha	75.0	25 % Cotton crop area, ha
Crop Diversification with Fruit and Vegetable	1500	no.	0.2	Training to farmers
Stress Tolerant Breeds	140	no.	2.2	1 poultry unit per 10 villages
Knowledge -smart technologies total cost = Rs. 77.8 Cr.				

6.2 CONVERGENCE OF EXISTING GOVERNMENT SCHEMES AND PLANS

Planning and implementation of prioritized CSA interventions for resilient agriculture in a district requires enormous resources and this often becomes a constraint. While it is also apparent that different government departments at the district level are having several development schemes with significant resources for implementing a variety of activities and works those are relevant for climate smart agriculture. To optimize public investments made under existing schemes, convergence of resources by establishing synergy within these investments for building resilience is required. Government is also pushing the agenda of convergence as a policy instrument to make resources from various schemes complementary to one another rather than duplicity and thin distribution of resources. This will help in leveraging and integrating resources from relevant agriculture and rural development programs for providing critical mass for scaling out climate resilient agriculture at development scale.

Through convergence, available and existing resources under different schemes will be targeted in a more integrated manner to develop and implement district climate-smart agriculture plan for resilient agriculture. It is aimed at bringing convergence of both financial and human resources of different programmes/schemes and institutions implemented by different departments. It is proposed that during the project planning and pre-implementation phase, project partners/ district line departments come together to plan, discuss, and finalize the convergence matrix and process guidelines.

Several schemes of the state and central government under implementation have considerable scope for piloting their activities in convergence with CSA. In the proposed convergence plan, CSA practices are mapped to the existing government schemes and departments for implementation within the permissible activities/works and parameters of that particular scheme as per the respective guidelines.

Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) *Har khet ko pani and Per drop more crop*, Rashtriya Krishi Vikas Yojana (RKVY), National Food Security Mission (NFSM), Rainfed Area Development RADP- National Mission for Sustainable Agriculture (NMSA) etc. are some key schemes proposed by central government having potential for convergence in Beed district. Some of the Maharashtra state government proposed programs such as PoCRA – Nanaji Deshmukh Krishi Sanjeevani Prakalp, Bhausaheb Phundkar Phalbag Lagwad Yojana, Unnat Sheti, Samrudhh Shetkari – Farm Mechanization sub-scheme, Agricultural Technology Management (ATMA) are also useful for convergence. These central and state government schemes with the possibility of convergence for optimized use of resources for a common/shared cause of making agriculture resilient are listed in Table 12. There could be even few more that may provide an opportunity for convergence on case-by-case basis.

The CSA technologies such as vermi-compost, use of farmyard manure and solar pump currently don't have any linkage with existing government plan functioning in Beed district. Therefore, the need arises to find suitable schemes for providing required funding for implementing these technologies. Alternatively, additional resources will have to be mobilized for implementing these climate smart interventions. In this project plan, Paramparagat Krishi Vikas Yojana and MNRE-Solar off grid schemes/ KUSUM are proposed additionally, to link with CSA technologies like, use of vermi-compost/ use of farm yard manure and solar pump, respectively, as presently these schemes do not exist in the district. The current approach of providing funds through different schemes needs to be re-visited based on prioritized best applicable CSA technologies in Beed district.

Table 12. Convergence of existing govt. schemes and plans with selected CSA technologies

Intervention/Technology/Practice/Services	Govt. scheme name
Water-Smart	
Raised Bed Planting for Vegetables	Rashtriya Krishi Vikas Yojana (RKVY)
Aquifer Recharge Shaft and Wells	*Jal Yukt Shivar Abhiyan*
Irrigation Scheduling	PoCRA – Nanaji Deshmukh Krishi Sanjeevani Prakalp
Drip Irrigation	Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)-Per drop more crop
Broad Bed Furrow Planting for crops	PoCRA – Nanaji Deshmukh Krishi Sanjeevani Prakalp
Farm Bunding	National Food Security Mission (NFSM)
Sprinkler Irrigation	Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)-Per drop more crop
Mulching	Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)-Per drop more crop
Farm Ponds	*Magel Tyala Shet-tale* (Farm pond for every demand)
Energy-Smart	
Solar Pumps	Ministry of New and Renewable Energy (MNRE)-Solar off grid/ Pradhan Mantri Solar Pump Yojana- KUSUM
Zero Tillage	National Food Security Mission (NFSM)
Nutrient-Smart	
Use of Vermicompost	Paramparagat Krishi Vikas Yojana (PKVY)
Use of Farm Yard Manure	Paramparagat Krishi Vikas Yojana (PKVY)
Integrated Plant Nutrient Management (IPNM)	National Food Security Mission (NFSM),
Intercropping with Legumes	National Food Security Mission (NFSM)
Carbon-Smart	
Crop Residue Incorporation	National Food Security Mission (NFSM)
Concentrate Feeding for Livestock	Rainfed Area Development (RAD)- National Mission For Sustainable Agriculture (NMSA)
Weather-Smart	
Information and Communication Technology	CROPSAP/HORTSAP/National e-Governance Plan in Agriculture (NeGP-A)
Knowledge-Smart	
Fodder Banks	Rashtriya Krishi Vikas Yojana (RKVY)
Short Duration Crop Varieties	Rainfed Area Development (RAD)- National Mission For Sustainable Agriculture (NMSA)
Crop Diversification with Fruit and Vegetable	National Horticulture Mission(NHM), RKVY-NHM, *Bhausaheb Phundkar Phalbag Lagwad Yojana*, Government Fruit Nursery
Stress Tolerant Breeds	Rainfed Area Development (RAD)- National Mission For Sustainable Agriculture (NMSA)

Some funds are already available in the selected government schemes and details are given in Appendix- 5. The funds required from government to implement CSA is estimated based on the relevant guidelines of the schemes for respective CSA interventions.

The details used for estimating government contribution through each scheme are given in Appendix-6. This estimate is compared with the available funds in each of these schemes. Table 13 gives the details of funds available, required and the gap in funding requirement for implementation of climate adaptation plan.

Table 13. Funds required from the government schemes and top up for viable gap funding for implementation of CSA plan

Government Schemes	Funds Available (Rs. Cr.)	Matched technologies	Government support required as per CSA plan (Rs. Cr.)	Funding gap (Rs. Cr.)
Jal Yukt Shivar Abhiyan	17.16	Aquifer Recharge Shaft and Wells	8.42	--
MagelTyalaShet-tale (Farm pond for every demand)	16.94	Farm Ponds	21.05	4.10
PMKSY-Micro irrigation	6.25	Drip Irrigation, Sprinkler irrigation, Mulching	62.70	56.45
National Horticulture Mission, RKVY-NHM, Bhausaheb Phundkar Phalbag Lagwad Yojana, Government Fruit Nursery	6.07	Crop Diversification with Fruit and Vegetable	0.15	--
NFSM	1.43	Farm Bunding, Zero Tillage, IPNM, Intercropping with Legumes, Crop Residue Incorporation	7.75	6.32
RAD-NMSA	0.61	Concentrate Feeding for Livestock, Short Duration Crop Varieties, Stress Tolerant Breeds	48.86	48.25
RKVY	0.91	Raised Bed Planting for Vegetables, Fodder Banks	0.22	--
CROPSAP/HORTSAP/ National e-Governance Plan in Agriculture (NeGP-A)	0.36	Information and Communication Technology	6.00	5.64
PoCRA – Nanaji Deshmukh Krishi Sanjeevani Prakalp	0.26	Broad Bed Furrow Planting for crops, Irrigation Scheduling	2.96	2.70
PKVY	NA	Use of Vermi-compost, Use of Farm Yard Manure	0.70	0.70
MNRE-Solar off grid/KUSUM	NA	Solar Pump	10.00	10.00
Total Rs. Cr.	**50.00/-**		**168.8/-**	**134.3/-**

From the Table 13, it is understood that the available funds through different schemes are only Rs. 50.0/- Cr. while the government support needed for implementing district level CSA plan is estimated at Rs. 168.8/- Cr. Thus, the funding gap of Rs. 134.3/- Cr. needs to be arranged from other relevant schemes or through separate budget provision. PMKSY scheme is playing a major role in implementation of CSA with its sub component of *Per Crop More Drop or micro irrigation.*

7. INSTITUTIONAL ARRANGEMENT AND WAY FORWARD FOR IMPLEMENTATION

4. Institutional arrangement and way forward for implementation

The District Climate Adaptation Plan for Resilient Farming is to be implemented at the ground level by district authorities following an institutional arrangement with Krishi Vigyan Kendra of the district as a facilitator and nodal agency for capacity building activities. CCAFS and CGIAR Centres and ICAR/SAUs can help in mentoring from time to time in planning field implementation. While implementing the plan, climate risk prone and most vulnerable blocks will be given priority for implementation. ICAR institutes in the vicinity will have a key role in advising district authorities in translating this plan to implement on the ground and help in needs based fine tuning of the plan at the sub-district level. ICAR institutes and key SAUs experts would provide knowledge support, build capacity of field officials together with KVK and CGIAR Centres and required guidance during field implementation from time to time. It will be better to form a small Advisory Group at the district level.

Integrating the physical, institutional, social and economic capital is key for comprehensive development at the district and sub-district level. The process of convergence of institutions and resources should ideally start right from the pre-planning stage itself. Collective planning and implementation among different departments/sectoral institutions will enhance social capital, common and shared understanding for improved planning, implementation and management. The convergence matrix must clearly identify source(s) of funding for each type/nature of activity/work including the quantity. All the central and state government schemes have their respective guidelines with a multi-level institutional structure where responsibilities such as guiding principles, finance, planning, admissibility of works/activities, entitlements, identification of beneficiaries and implementation procedures are explained. For smooth implementation therefore, a suitable institutional arrangement/mechanism is crucial at the district, block and GP level.

District level Program Implementation and Coordination Committee (DPIC) is proposed to be formed, headed by the District Collector/District Magistrate or Chief Development Officer (CDO)/CEO (ZP) to coordinate, guide, approve, oversee and monitor the project at district level. The Committee will have district level officials representing line departments responsible for implementing schemes for agriculture, rural development, animal husbandry, irrigation/water resources, groundwater, and other key schemes likely to be converged, and representative from district KVK. Representatives responsible for implementing other need-based schemes as per local needs of CSA components may be co-opted. Similar institutional arrangements in the form of committees with all relevant departments and implementing organizations will need to be formed at the block and GP levels.

Such institutional arrangement ensures smooth and effective collaboration of government and non-government organizations. This would also ensure collective responsibility at all levels of project implementation and devolution of responsibilities to the most appropriate level.

Key players from relevant line departments should be involved in the joint field visits, planning and preparation of detailed local area action plans with a clear convergence matrix indicating source(s) for leveraging funds for given components from respective schemes. The convergence matrix must clearly identify source of funding for each type/nature of activity/work including the quantity.

The project is proposed to be rolled out in 11 Blocks of Beed district over a period of five years (an example scenario given in Appendix-7).

The activities can be divided into three phases for smooth and optimized implementation of the district level plan that ensures maximum benefits.

Pre-implementation/planning phase: (1 year)

- Final selection of villages where CSV approach would be implemented based on set of indicators discussed in the report. This would involve wider consultation with government and field level implementing organizations and local community and NGOs.
- Rapport building to optimize the benefits of CSVs- it is essential and necessary that village communities understand and accept the project. Thus, a critical step in pre-implementation would be wider consultations with village community and community level organizations to build awareness.
- Capacity building of officials and training of implementing organization(s)
- Beneficiary selection where the CSA plan would be implemented
- Baseline study for agro-ecological and socio-economic context

Implementation phase (3-5 year):

- Implementation of CSA plan on field level in a coordinated manner by line departments and village level organizations.
- Regular monitoring according to pre-planned approach and reporting

Post-implementation phase (1 year):

- Impact assessment and evaluation: through the implementation phase and post implementation, extensive data would be collected though household and farm level surveys and discussions to evaluate impacts.
- Dissemination of outcomes: comprehensive result dissemination plan be developed that would include but not limited to workshops with relevant stakeholders, use of social media, blogs and articles.

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APPENDIX 1

AREA WISE, CROP WISE IRRIGATION STATUS (2015-16)

Season	Crops	Irrigated, Ha	Un-irrigated, Ha	Total (Ha)
Kharif	Cereal	8652	77897	86549
	Pulses	6924	62320	69244
	Oilseeds	17679	159110	176789
	Cotton	29438	264943	294381
	Vegetables	4367	0	4367
	Total	67060	564270	631330
Rabi	Cereal	24981	224831	249812
	Pulses	8883	79950	88833
	Oilseeds	272	2450	2722
	Vegetables	2620	0	2620
	Total	36756	307231	343987
Summer	Cereal	816	0	816
	Oilseeds	92	0	92
	Vegetables	1742	0	1742
	Sugarcane	35188	0	35188
	Fruit	13629	0	13629
	Total	**51467**	**0**	**51467**

AVERAGE CROP AREA (HA) IN EACH SEASON DURING THE YEAR 2017 TO 2019

Kharif	
Crops	Area (Ha)
Rice	49
Jowar	9707
Bajara	63282
Maize	10483
Other cereals	249
Tur	47411
Mug	20901
Udid	29409
Other pulses	503
Groundnut	3783
Sunflower	55
Sesamum	2229
Soybean	203600
Niger	297
Other oilseed	248
Cotton	349985
Sugarcane	1152
Total (Ha)	**743342**

Rabi	
Crops	Area (Ha)
Jowar	106384
Wheat	19742
Maize	4648
Other cereals	386
Gram	65139
Other pulses	10
Safflower	403
Linseed	128
Sunflower	70
Other oilseeds	67
Sugarcane	12402
	209380

Summer	
Crops	Area (Ha)
Groundnut	21
Sugarcane	16204
Bajra	16
Maize	12
	16253

Annual/Horticultural	
Fruits	Area (Ha)
Mango	4286
Sweet orange	1909
Pomegranate	2630
Guava	260
Lemon	1701
Sapota	775
Banana	222
Grape	92
Orange	198
Fig	19
Watermelon	26
Anola	74
Custard apple	129
	12320

(Source: KVK, Beed)

AREA AND PRODUCTION OF MAJOR CROPS DURING *KHARIF* AND *RABI* SEASON - AVERAGE OF YEAR 2013 TO 2018

	Crops	Area (ha)	Production(t)
Kharif	Cotton	146780	156482
	Soybean	126931	95260
	Pigeonpea	20187	11212
Rabi	Sorghum	40093	28622
	Wheat	14316	20057
	Gram	46338	35733

APPENDIX 2

DETAILS OF BLOCK WISE CROPPING SYSTEM AND DIFFERENT RISK VULNERABILITIES

Sr. No.	Block/ tehsil/ mandal	Cropping system	Crop name	Season	Vulnerability	Period of occurrence
1	Ambajogai	Cotton – fallow Soybean – gram Soybean – R. Jowar	Soybean, Cotton/R. Jowar, gram	Kharif/ Rabi	Drought/Dry Spell/uncertain rains	June July August
2	Majalgaon	Cotton base Sugarcane +gram Sugarcane+groundnut Soyabean-wheat – Groundnut	Cotton, Sugarcane, Soybean/ Gram, Wheat/ G. nut	Kharif/Rabi/ Summer	Drought/Dry Spell/uncertain rains	July August September October
3	Wadwani	Soybean-gram Cotton based	Soybean, Cotton/ Gram	Kharif/Rabi	Drought/Dry Spell/uncertain rains	July August September October
4	Parli	Soyabean-gram Cotton +green gram Horticultural crops	Soybean, Cotton, Green gram/ Gram, R. Jowar	Kharif/Rabi	Drought/Dry Spell/uncertain rains	July August September October
5	Dharur	Cotton based Bajra-safflower	Cotton, Bajra, Red gram/ Gram, Saflower	Kharif/Rabi	Drought/Dry Spell/uncertain rains	July August September October
6	Kaij	Maize-gram Soybean-gram Cotton based	Cotton, soybean, Maize, Redgram-Gram/ R. jowar/ Wheat	Kharif/Rabi	Drought/Dry Spell/uncertain rains	July August September October

APPENDIX 3

LIST OF CSA TECHNOLOGIES SUITABLE FOR DIFFERENT CROPS AND CROPPING SYSTEMS

Technology/Practice/Services	How it help to adaptation/mitigation of climatic risks
Water-Smart	***Technologies that improve Water-Use Efficiency***
Dugout Ponds and Storage Tanks	Collection of rainwater not allowing to run-off and use for agriculture in rainfed/dry areas and other purposes on site.
Rooftop Rainwater Collection	Provides good opportunities for augmenting the common pool of groundwater resources.
Nala Bunding	Impounds surface runoff coming from the catchments and stabilize the *nala* grade to facilitate percolation of stored water into the soil sub-strata with a view to raise ground water level
Farm ponds	Small water storage structures constructed across small streams or *nallas* to collect and impound the surface runoff from catchments of the streams during monsoon season.
Diversion Channels	Diversion channel is a simple excavated long structure to convey water from a higher elevation to the point of storage or use near the habitation.
Drip Irrigation	Application of water directly to the root zone of crops and minimize water loss
Sprinkler	The system can supply small and uniform application on demand and meet the emergent situations of climatic aberrations. The water application is controlled and only the required amount of needed water is applied by the system.
Alternate Wetting and Drying (Rice)	Need based application of water in the rice filed, minimize overuse of water. Saves water and energy use
Broad bed Furrow Irrigated Planting for crops	This method offers more effective control over irrigation and drainage as well as rainwater management during the monsoon (also improves nutrient use efficiency)
Conservation Furrow	Conserve water and allows better drainage and run-off
Raised Bed Planting for vegetables	Conserve water and allows better drainage and run-off
Drainage Management	Removal of excess water (flood) through water control structure
Farm Bunding	Decrease the length of the slope and help in intercepting the runoff flowing down the slope thereby conserving moisture and reducing soil erosion
Vegetative Contour Barriers	Planted with perennial grasses and shrubs, the barriers reduce runoff velocity and increase infiltration opportunity time and also trap fine soil and nutrients.
Laser Land Levelling	Quick and more effective land levelling practice which modifies the land surface to a planned grade or zero grade to provide a suitable field surface for controlling flow of water, check soil erosion, provide improved surface drainage, conserve moisture and ensure uniform application and distribution of water and nutrients.
Mulching	Mulch is any type of material that is spread or laid over the surface of the soil as a covering. It is used to retain moisture in the soil, suppress weeds, keep the soil cool, and make the garden bed look more attractive. Organic mulches also help improve the soil's fertility, as they decompose. e.g. Bark, compost, composted manure, newspaper, straw etc.
Conservation Trenches (sallow and deep)	Artificially dug trenches along the contour line, water flowing down the hill is retained by the trench and infiltrating the soil below.

Technology/Practice/Services	How it help to adaptation/mitigation of climatic risks
Irrigation Scheduling	Planning when and how much water to apply in order to maintain healthy plant growth during the growing season.
Aquifer Recharge Shaft and wells	Used to recharge both the shallow aquifers located below clayey surface and deep aquifers by conveying water from surface (surplus runoff from runoff, reservoirs, storm water, tank, canal etc.) to aquifers.
Gully Control Structures like Gabion Structure	These are structures made to control soil erosion. They are simple in construction, flexible, self-draining and are made of construction materials locally available. These structures are cheaper than conventional structures and yet quite effective.
Dug well	Water extraction structure to provide water for irrigation
Tube wells	Device for obtaining water from beneath the ground. Most ideal for tapping high yielding confined granular aquifers occurring at considerable depths.
Wells in stream /river beds	These wells are typically of shallow depth of 10-15 feet in depth in the ground and about 3-4 feet above ground. During the rainy season, the structures remain submerged under the water and supply water during the winter and summer season
Cultivation of Millets in light soils	Cultivation of millets requires less water
Recycling of crop residues (Cotton stalks)	Recycling of crop residues enhances soil fertility intern increase the absorption of water
Increase of crop intensity through intercropping	Under *rain fed* situation water use efficiency is more when increased the crop intensity through intercropping

Energy-Smart	***Technologies that improve Energy-Use Efficiency***
Minimum Tillage/Zero Tillage	Reduces amount of energy use in land preparation. In long-run, it also improves water infiltration and organic matter retention into the soil
Solar Pumps	Increased access to power through renewable energy; adaptation and mitigation
Wind Turbines	Using wind power to lift water for irrigation
Wind Mills	Water lifting from wells by wind mills for irrigation
Ram Pump	Lifting of flowing water in river or canal by ram pump on no fuel cost
Direct Seeded Rice	Requires less water compared to traditional transplanting
Drudgery reduction technologies for Farm women	Ergonomic and drudgery reduction technologies for farm women to reduce individual energy loss and increasing of mechanization from seed to plate

Nutrient-Smart	***Technologies that improve Nutrient-Use Efficiency***
Green Manuring	Growing and incorporating legume biomass into soil. This practice improves nitrogen supply and soil quality.
Intercropping with Legumes	Cultivation of legumes with other main crops in alternate rows or different ratios. This practice improves nitrogen supply and soil quality
Use of Farmyard Manure	Type of organic manure which is a varying mixture of animal manure, urine, bedding material, fodder residues, and other components
Use of Vermi-compost	Organic manure (bio-fertilizer) produced as the vermicast by earth worm feeding on biological waste material; plant residues.
Integrated Plant Nutrient Management	Involves the application of organic, inorganic and bio-fertilizers in a balanced manner so as to fully meet the requirements of all the major, secondary and micro nutrients for the given crop/ cropping system.
Site Specific Nutrient Management using Leaf Colour Chart	Quantify the required amount of nitrogen use based on greenness of crops. Mostly used for split dose application in rice but also applicable for maize and wheat crops to detect nitrogen deficiency

Technology/Practice/Services	How it help to adaptation/mitigation of climatic risks
Site Specific Nutrient Management using Green seeker	Optimum supply of soil nutrients over time and space matching to the requirements of crops with right product, rate, time and place
Crop Residue Incorporation	Incorporating crop residues like leaves, stems and seed pods into the ground, instead of burning. It can be helpful to mitigate GHGs and also help in nutrient management.
Crop Rotation	Crop rotation is the systematic planting of different crops in a particular order over several years in the same growing space. This process helps maintain nutrients in the soil, reduce soil erosion, and prevents plant diseases and pests.
Fertigation	Applying of nutrients through drip system at different intervals. This Process helps the nutrient use efficiency.

Carbon-Smart	*Technologies that reduce GHG emissions*
Agro Forestry/Fodder Trees	Promote carbon sequestration including sustainable land use management
Concentrate Feeding for Livestock	Reduces nutrient losses and livestock requires low amount of feed
Integrated Pest Management/ Organic Pesticides	Reduces use of chemicals
Bio-gas	Reduced methane emissions and fossil fuel use
Prophylaxis & Area Specific Mineral Mixture for Livestock	Livestock better withstand abiotic stresses
Crop Residue Incorporation (Cotton)	Incorporating crop residues like cotton stubbles into the ground, instead of burning. It can be helpful to mitigate GHGs and also help in nutrient management.
Cultivation of Pulses	By producing a smaller carbon footprint pulses indirectly reduce greenhouse gas emissions
Bund planting with Horticulture and forest plants	Promote carbon sequestration and income generation to the farmers.

Weather-Smart	*Technologies that provide services related to income security and weather advisories to farmers*
Climate Smart Housing for Livestock	Protection of livestock from extreme climatic events (e.g. heat/cold stresses)
Information and Communication Technologies (ICT)	Advance climate information help reduce climate risk or take advantage of better seasons
Crop Insurance	Crop-specific insurance to compensate income loss due to vagaries of weather
Livestock Insurance	Livestock specific insurance provided as a compensation for loss of livestock due to natural calamities/disease/accident

Knowledge-Smart	*Use of combination of science and local knowledge*
Contingent Crop Planning	Climatic risk management plan to cope with major weather related contingencies like drought, flood, heat/cold stresses during the crop season
Improved/Short Duration Crop Varieties	Crop varieties that are tolerant to drought, flood and heat/cold stresses
System for Rice Intensification (SRI)	Reduce water requirement, increase productivity, and build resilience
Fodder Banks	Conservation of fodders to manage climatic risks
Seed Systems/Banks	Ensuring farmers access to climate ready cultivars
Stress Tolerant High-Yielding Breeds of Livestock	Livestock breed that perform better under climatic stress/drought

Technology/Practice/Services	How it help to adaptation/mitigation of climatic risks
Livestock & Fishery as Diversification Strategy	Reduce risk of income loss due to climate variability
Crop Diversification with Fruits	Growing fruits orchards along with other crops. Helps to augment income.
Crop Diversification with Vegetables	Growing vegetables along with other crops. Helps to augment income.
Pest disease and Nutrient deficiency identification	Reduce risk of crop damage
Compatibility of Pesticides during spraying	Reduce risk of crop damage and decreases the number of sprays.
Farm mechanization (seed to seed)	Reduce the input costs, labour wages and save the time
Maintenance of Drip system and developing of Fertigation schedules for major crops in the district.	Reduce water requirement, enhances the nutrient use efficiency, increase productivity.
On farm processing technologies for better remuneration	On farm processing or minimal processing fetches better price to farmers.
Grain Storage	Reduce the loss of grains due to various physical, Chemical, Biological or Physiological factors.
Backyard Kitchen Gardening and Backyard Poultry for balanced diet	Reduce the nutrient deficiencies in rural areas. Helps to augment income.
Safety Measures for use of Agro chemicals, Bio fertilizers	Reduce risk of health hazards
Modern Horticulture Practices (Staking, Mulching, Shade net, Poly-houses etc.	Growing Horticulture crops with modern technologies increases the productivity.
Knowledge on Bio fertilizers and Bio pesticides	Reduce the input costs and increases the productivity
Value addition to perishables	Reduces post-harvest losses and increases the income
Livestock Management	Increases the income and ensure the health of the animals

APPENDIX 4

EXISTING GOVERNMENT SCHEMES IN BEED DISTRICT

The National Food Security Mission (NFSM), during the 12th Five Year Plan, had five components (i) NFSM- Rice; (ii) NFSM-Wheat; (iii) NFSM-Pulses; (iv) FSM Coarse Cereals; and (v) NFSM-Commercial Crops. During 2017-18, the programme was implemented with components/interventions/cost norms/pattern of assistance of 12th plan. On the basis of EFC commendations which was held on 29.11.2017, from the years 2018-19 and 2019-20, NMOOP and Seed Village Programme are now a part of NFSM and thus NFSM will have eight components viz. (i) NFSM- Rice; (ii)NFSM-Wheat; (iii) NFSM-Pulses; (iv) FSM-Coarse Cereals (Maize, Barley), (v)NFSM-Sub Mission on Nutri Cereals; (vi) NFSM-Commercial Crops; (vii) NFSM Oilseeds and Oil palm; and (viii) FSM-Seed Village Programme. These Operational Guidelines are for NFSM-Food grains, Commercial Crops, Oilseeds and Oil palm, Seed Village Programme and Sub Mission on Nutri -cereals.

Rashtriya Krishi Vikas Yojana (RKVY) scheme was initiated in 2007 as an umbrella scheme for ensuring holistic development of agriculture and allied sectors. The scheme has come a long way since its inception and has been implemented across two plan periods (11th and 12th). The scheme incentivizes States to increase public investment in Agriculture & allied sectors. The Cabinet has approved (as on 1st November 2017) for continuation of the ongoing Centrally Sponsored Scheme (State Plans) - Rashtriya Krishi Vikas Yojana (RKVY) as Rashtriya Krishi Vikas Yojana- Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RKVY-RAFTAAR) for three years i.e. 2017-18 to 2019-20 with a financial allocation of Rs. 15,722 crores with broad objectives of making farming a remunerative economic activity through strengthening the farmer’s effort, risk mitigation and promoting agri-business entrepreneurship.

Agricultural Technology Management Agency (ATMA) Scheme was launched during 2005-06. It aims at making extension system farmer driven and farmer accountable by way of new institutional arrangements for technology dissemination in the form of an Agricultural Technology Management Agency (ATMA) at district level to operationalize the extension reforms. ATMA has active participation of farmers/farmer-groups, NGOs, Krishi Vigyan Kendras (KVKs), Panchayati Raj Institutions and other stakeholders operating at district level and below. Release of funds under ATMA scheme is based on State Extension Work Plans (SEWPs) prepared by the State Governments. Allocation of resources for activities related to extension is linked to number of farm households and Blocks. At present, the Scheme is under implementation in 614 districts in 28 States and 3 UTs in the country.

APPENDIX 5

EXISTING POLICIES IMPLEMENTED AND FUNDING ARRANGEMENTS (IN RS. LAKHS) AT DIFFERENT BLOCKS OF BEED DISTRICT:

	Funds allotted through schemes in Lakh							
Blocks	NFSM-Oilseed and Oil palm	NFSM-Nutri-Cereals	NFSM-Wheat	NFSM-Sugar-cane	Unnat Sheti, Samrudhh Shetkari – Farm Mechanization sub-scheme	Rashtriy Krishi Vikas Yojana (RKVY) – Farm Mechanization	CROPSAP	PoCRA – Nanaji Deshmukh Krishi Sanjeevani Prakalp
Ambajogai	19.86	2.71	2.57	0.11	0.11	11.04	6.32	4.57
Kaij	26.48	3.61	3.42	0.15	0.15	14.72	8.42	6.1
Parli	19.86	2.71	2.57	0.11	0.11	11.04	6.32	4.57
Dharur	13.24	1.81	1.71	0.08	0.08	7.36	4.21	3.05
Wadwani	13.24	1.81	1.71	0.08	0.08	7.36	4.21	3.05
Majalgaon	19.86	2.71	2.57	0.11	0.11	11.04	6.32	4.57
Total	**112.54**	**15.36**	**14.55**	**0.64**	**0.64**	**62.56**	**35.8**	**25.91**

Blocks	Promotion of Group Farming	NMSA – Forestry sub mission	RAD-NMSA	HORTSAP	Bhausaheb Phundkar Phalbag Lagwad Yojana	Magel Tyala Shet- tale (Farm pond for every demand)	Jal Yukt Shivar Abhiyan	PMKSY-Micro irrigation
Ambajogai	19.08	0.16	10.56	0.07	2	299.02	302.74	110.35
Kaij	25.45	0.22	14.09	0.09	2.67	398.69	403.66	147.13
Parli	19.08	0.16	10.56	0.07	2	299.02	302.74	110.35
Dharur	12.72	0.11	7.04	0.05	1.34	199.34	201.83	73.57
Wadwani	12.72	0.11	7.04	0.05	1.34	199.34	201.83	73.57
Majalgaon	19.08	0.16	10.56	0.07	2	299.02	302.74	110.35
Total	**108.13**	**0.92**	**59.85**	**0.4**	**11.35**	**1694.43**	**1715.54**	**625.32**

Blocks	Government Fruit Nursery	RKVY – Fodder production and Seed Quality Control Centre	RKVY – Soil Health Card Scheme	ATMA	National Horti-culture Mission	RKVY-NHM	IWMP
Ambajogai	3.64	0.31	4.64	18.21	54.57	46.92	21.29
Kaij	4.86	0.41	6.19	24.28	72.76	62.56	28.39
Parli	3.64	0.31	4.64	18.21	54.57	46.92	21.29
Dharur	2.43	0.21	3.1	12.14	36.38	31.28	14.2
Wadwani	2.43	0.21	3.1	12.14	36.38	31.28	14.2
Majalgaon	3.64	0.31	4.64	18.21	54.57	46.92	21.29
Total	**20.64**	**1.76**	**26.31**	**103.19**	**309.23**	**265.88**	**120.66**

Round Total: Rs. 53.31 Crore

APPENDIX 6

GOVERNMENT SUPPORT AND FARMER'S CONTRIBUTION IN TOTAL COST OF PROJECT PLAN

CSA intervention	Total amount Rs. Cr.	Support basis	Govt. subsidy Rs. Cr.	Viable gap funding/ Enhanced conversions/ Farmers contribution Rs. Cr.
Water-Smart				
Raised Bed Planting for Vegetables	2.5	-	0.0	2.5
Aquifer Recharge Shaft and Wells	8.4	100% Govt.	8.4	0.0
Irrigation Scheduling	0.2	100% Govt.	0.2	0.0
Drip Irrigation	100.0	35% Govt.	35.0	65.0
Broad Bed Furrow Planting for crops	5.6	50% Govt.	2.8	2.8
Farm Bunding	0.1	100% Govt.	0.1	0.0
Sprinkler Irrigation	70.0	35% Govt.	24.5	45.5
Mulching	6.0	50% Govt. up to 16000/-	3.2	2.8
Farm Ponds	28.1	Up to @ 75000/FP	21.0	7.0
Energy-Smart				
Solar Pumps	50.0	Govt. subsidy up to 1Lakh/ unit	10.0	40.0
Zero Tillage	6.0	100% Machinery and training provided by Govt. centers	6.0	0.0
Nutrient-Smart				
Use of Vermicompost	1.4	50% Govt.	0.7	0.7
Use of Farm Yard Manure	2.8	-	0.0	2.8
Integrated Plant Nutrient Management (IPNM)	0.2	100% Govt.	0.2	0.0
Intercropping with Legumes	1.4	100% Govt.	1.4	0.0
Carbon-Smart				
Crop Residue Incorporation	0.2	100% Govt.	0.2	0.0
Concentrate Feeding for Livestock	20.5	50% Govt.	10.2	10.2
Weather-Smart				
Information and Communication Technology	6.0	100% Govt.	6.0	0.0
Knowledge-Smart				
Fodder Banks	0.4	50% Govt.	0.2	0.2
Short Duration Crop Varieties	75.0	50% Govt.	37.5	37.5
Crop Diversification with Fruit and Vegetable	0.2	100% Govt.	0.2	0.0
Stress Tolerant Breeds	2.2	50% Govt.	1.1	1.1
Total Rs. Cr.	**387.00/-**		**168.80/-**	**218.20/-**

APPENDIX 7

YEAR WISE FINANCIAL OUTLAY PLANNED

CSA intervention	Year 1	Year 2	Year 3	Year 4	Year 5	Total (Rs. Cr.)
Water-Smart						
Raised Bed Planting for Vegetables						2.5
Aquifer Recharge Shaft and Wells						8.4
Irrigation Scheduling						0.2
Drip Irrigation						100.0
Broad Bed Furrow Planting for crops						5.6
Farm Bunding						0.1
Sprinkler Irrigation						70.0
Mulching						6.0
Farm Ponds						28.1
Energy-Smart						
Solar Pumps						50.0
Zero Tillage						6.0
Nutrient-Smart						
Use of Vermicompost						1.4
Use of Farm Yard Manure						2.8
Integrated Plant Nutrient Management (IPNM)						0.2
Intercropping with Legumes						1.4
Carbon-Smart						
Crop Residue Incorporation						0.2
Concentrate Feeding for Livestock						20.5
Weather-Smart						
Information and Communication Technology						6.0
Knowledge-Smart						
Fodder Banks						0.4
Short Duration Crop Varieties						75.0
Crop Diversification with Fruit and Vegetable						0.2
Stress Tolerant Breeds						2.2
Total (Rs. Cr.)	**38.5/-**	**37.0/-**	**34.0/-**	**32.3/-**	**27.0/-**	**168.8/-**