Baseline Survey Report

Monitoring and Evaluation for PoCRA in Marathwada Region, Maharashtra

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Project on Climate Resilient Agriculture (PoCRA)

Submitted By

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Abbreviations

AA	Agriculture Assistant
APMC	Agricultural Produce Market Committee
ATMA	Agriculture Technology Management Agency
BBF	Broad Bed Furrow
CA	Cluster Assistant
CDC	Capacity Development & Coaching
CV	Coefficient of Variation
DBT	Direct Beneficiary Transfer
DPA	Drought Prone Area
DPR	Detailed Project Report
FGD	Focus Group Discussion
FIG	Farmer Interest Group
FFS	Farmer Field School
FPO/ FPC	Farmer Producer Organization/ Farmer Producer Company
GHG	Green House Gas
GSD	Geological Survey Department
IDI	In-Depth Interview
IPM	Integrated Pest Management
MIS	Management Information System
NBFC	Non-Banking Financial Company
PAD	Project Appraisal Document
PDO	Project Development Objective
PMU	Project Management Unit
PoCRA	Project on Climate Resilient Agriculture
PS	Project Specialist
SDAO	Sub-divisional Agriculture Officer
SHG	Self Help Group
VCRMC	Village Climate Resilient Management Committee
WB	World Bank

1. Executive Summary

Project on Climate Resilient Agriculture (PoCRA) is being implemented by Maharashtra government, in collaboration with the World Bank to enhance climate-resilience and profitability of smallholder farming systems in selected districts of Maharashtra. The project is built around a comprehensive, multi sector approach that focuses specifically on building climate resilience in agriculture through scaling up tested technologies and practices. Sambodhi in partnership with TERI is conducting M&E of PoCRA in all eight districts of Marathwada region.

As part of the impact evaluation, a baseline, midline and endline survey will be conducted. Baseline survey is the first step and a key component of the impact evaluation of PoCRA project in Marathwada region. The objective of the baseline study is to understand the current situation or the situation in the project area at the time of start of the project. Information collected on key indicators as part of the baseline survey will help to access the magnitude of change and attribute it to PoCRA by comparing the baseline survey data (across project and comparison) with midline and end line survey data. The baseline study would also assess the current situation on relevant variables mentioned in the results framework and on key ESMF related indicators.

In line with the methodology mentioned in the inception report, a quasi-experimental design with double difference method is being adopted for impact evaluation. The estimated sample size (number of household or respondents) that were targeted to be covered in project and comparison area was 2410 each i.e. a total sample of 4820. This proposed sample size is powered to have an MDI (minimal detectable impact) of 5 %. A multi-stage sampling distribution is adopted for this evaluation. For the baseline survey, representative sample is taken across all eight districts in Marathwada, from which 482 clusters (equally distributed in project and comparison) have been selected. Further two villages were randomly taken from each cluster and five households were selected from each village using systematic interval sampling. Along with the quantitative survey , qualitative interviews which include FGDs with different categories of potential beneficiaries (landless, farmers with landholding less than 5 acres and farmers with landholding more than 5 cares), SHG members, FIG representatives and IDIs with Gram Panchayat representatives and FPC/FPO representatives along with field observation visits by experts and research team members were conducted to the understand the challenges faced by the potential beneficiaries and the bottlenecks in the execution of the project. Complete sample coverage has been achieved as a sample of 4820 has been covered.

Key Findings

Socio-economic indicators were used to check for balance between the project and comparison arm of the study. Both project and comparison area comprised of approximately 90% males and 10% female respondents. The gender of the household head was primarily male with 97.4% in project and 98% in comparison area reporting so. The respondents were mainly Hindus (Project: 88.8%; Comparison: 88.8%) and Buddhists (Project: 6.9%; Comparison: 5.5%) followed by Muslims (Project: 4.3%; Comparison: 5.4%) and Sikhs and Jains comprised the rest. In the project area, 51.2% and 43.4% of the respondents reported that they belonged to APL and BPL category respectively. The numbers were similar in comparison area with 52.2% and 43.3% reporting to be in APL and BPL category respectively. Majority of the respondents reported to be from general category (Project: 56% ; Comparison: 51.8%) followed by Other Backward Classes (Project: 15.3%; Comparison: 13.6%), Nomadic Tribes (Project: 10.5% ; Comparison: 14.9%), Scheduled Castes (Project: 12.1% ; Comparison: 12.7%) and Scheduled Tribes (Project: 5.5% ; Comparison: 6.3%). Only 4.5% from project area and 3.6% from comparison

area reported that no member of their family had received any schooling. Highest education qualification of most of the HHs was in categories: education till class 12th (Project: 29.2%; Comparison: 29.3%) followed by 10th (Project: 19.5%; Comparison: 21.4%) and graduation (Project: 19.8%; Comparison: 20.1%). Calculating the SLI measure, we found that in project area 57.1% are in low category and 30.3% are in medium category. Likewise, in comparison area we see that 56.2% are in low and 30.0% are in medium category.

Baseline values have been calculated for the key results framework indicators mentioned in the PAD document. Water productivity has been calculated for the five main crops of Kharif season (as specified in the PAD document), namely Cotton, Soybean, Pigeon pea, Black gram and Green gram using the methodology developed by IIT-B team. Water productivity was seen to be slightly higher in comparison areas. The baseline values for water productivity for these crops are found to be viz. Cotton (Project: 0.83 kg/m^3; Comparison: 0.89 kg/m^3), Soybean (Project: 1.57 kg/m^3; Comparison: 1.73 kg/m^3), Pigeon pea (Project: 0.45 kg/m^3; Comparison: 0.48 kg/m^3), Black gram (Project: 0.43 kg/m^3; Comparison: 0.55 kg/m^3) and Green gram (Project: 0.79 kg/m^3; Comparison: 0.60 kg/m^3). The overall water productivity values for these five main crops of Kharif season is found to be 1.07 kg/m^3 in project area and 1.17 kg/m^3 in comparison area. The confidence intervals are overlapping for the CI values for all the five crops suggesting that difference in the water productivity values across project and comparison is not statistically significant. The spatial yield variability (CV) of soybean across the eight study districts ranges between 0.33 and 0.43 in project area (least is found in Nanded and highest in Jalna). In the comparison arm, CV of soybean is in the range of 0.32 (Hingoli) and 0.44 (Aurangabad). For pigeon pea, the range of spatial yield variability was larger, with the lowest value being 0.46 (Nanded) and the highest being 0.98 (Hingoli) in project area. The range was lesser in comparison arm, lying between 0.48 (Osmanabad) and 0.87 (Beed). Temporal CV has also been calculated using the secondary data available at Department of Agriculture website. Based on the agriculture productivity data from 2009 to 2019, the temporal CV for soyabean and pigeon pea for eight districts in Marthwada region is found to be 50% and 55% . With regard to estimating the GHG balance accounting, the ex-ante estimation of the GHG balance using Tier 1 for the PoCRA is shown to be negative, which means the project implementation will lead to a net carbon sequestration benefit. The main sources of GHG emissions are the inputs such as electricity, diesel and livestock rearing. All other interventions are projected to contribute to increasing carbon stocks in soil and tree biomass. Achieving an increase in carbon sequestration is an important benefit of PoCRA. The net GHG benefit on a per hectare basis for the project area is estimated to be 0.4672 tCO2/ha/year.

Further, the average farm income in project area is found to be INR 21,146 while it observed to be higher at INR 26,901 in comparison area. The comparator for this indicator is calculated as ratio of farm income of project farmers to farm income of non-project farmers and was calculated to be 0.79. Furthermore, the indicator on use of certified seeds was calculated as a ratio of land under certified seed variety to the total cropped land for the three main crops- soybean, pigeon pea and chickpea. The most percent of land under certified seeds is for chickpea (Project: 45%, Comparison: 43%), followed by soybean (Project: 26%, Comparison: 24%) and pigeon pea (Project: 24%; Comparison: 22%). The overlapping CIs for all the three respective crops present that there is no significant difference in percentage of land under certified seeds across project and comparison arms. The overall land under certified seeds for these three crops is 29% in project and 27 % in comparison. The proportions across project and comparison remain similar with 25% and 21% reporting to receiving training on any climate-resilience technology while 43% and 41% reported adopting any climate resilient technology, respectively. The summary of baseline values of the key Results Framework indicators calculated through baseline survey have been presented below

Table 1:Summary of RF indicators calculated in baseline survey

Indicator Name	Baseline(Done in October 2019)/ YR1
Project Development Objective Indicators	
Water productivity*(kg/m^3)* at farm level	Project- 1.07, Comparison- 1.17
Spatial yield variability for oilseeds (soybean) - *(coefficient of variation CV crop yield)*	Project -37%, Comparison-38%
Spatial yield variability for pulses (pigeon pea) - *(coefficient of variation CV crop yield)*	Project -72%, Comparison-60%
Temporal yield variability for oilseeds (soybean) - *(coefficient of variation CV crop yield)*	50% in Marathwada region
Temporal yield variability for pulses (pigeon pea) - *(coefficient of variation CV crop yield)*	55% in Marathwada region
Net greenhouse gas emissions (in '000 tCO2eq/year)	0.4672 tCO2/ha/year
Annual farm income *(as ratio with/without project)*	.79
Annual farm income of female headed HHs *(as ratio with/without project)*	.54
Intermediate Results Indicators	
Percentage of farmers adopting any improved agriculture technology adopted by the project	Project-43%, Comparison-41%
Percentage land under certified seeds (for soyabean, pigeon pea and chick pea)	Project- 29% Comparison- 27%

Apart from the key results framework indicators, the baseline survey also captured information on key indicators related to the agriculture situation of the target beneficiaries of PoCRA. It was found that 18.2% of the respondents in project area and 17.1% respondents in comparison area did not own any land nor practice agriculture. In project area, 62.7% own up to 5 acres of land and 18.7% own more than 5 acres. Similarly, in comparison area, 61.3% own less than 5 acres of land and 21.0% own more than 5 acres. Median of land owned is 4 acres in both project and comparison areas. Of the farmers who practiced farming, 0.51% (n=10) from project area and 0.70% (n=14) of farmers from comparison areas are landless. It was found that only 3.8% of HHs in project and 3.1 % HHs in comparison had the land owned only by female members (as per the land records) of their household. Majority of households had their agriculture land under the name of only male members of their household (project 81.6% and comparison 81.1%).

On an average, 97% of the land owned was reported as cultivable by the farmers. The number of farmers leasing-in land in project area is 131 and their median leased-in landholding is approximately 3 acres. In the comparison arm, 155 farmers reported to leasing in land and their median landholding is 4 acres. For land area cultivated in different seasons, Kharif season seeing the highest percent of cultivated land (P: 91%; C:95%), in rabi only a fourth of the land is cultivated (project 27% and comparison 24%) and in summer only a mere 1% of the total cultivable lend is under cultivation.

48.6% farmers in project and 47.4% farmers in comparison areas said that they have access to irrigation source for their land. In kharif, 25% and 22% of cultivated area was reported to be irrigated. In rabi, 46% of cultivated land in project area and 43% cultivated land in comparison area was reported to be irrigated. 75% of the total cultivated land in project arm and 100 % of the total cultivated land under comparison arm was under irrigation in the summer season. Though a decent proportion of farmers reported to have access to irrigation sources (as it is a requirement due to rainfall deficit), but only about 9% of the respondents from project area acknowledged that water was always available from the source when they required it. Perception of reliability of water from the source for irrigation is mostly between sometimes (Project: 38.4%; Comparison:35%), rarely (Project: 28.5%; Comparison:29.3%), and very rarely (Project: 24.4%; Comparison:25.7%). The main sources of irrigation for the farmers is dug well (Project: 70.8%; Comparison: 70.5%) followed by tube-wells (Project: 27.8%; Comparison: 27.6%) in both project and comparison study areas. Monoblock electric pump is the most widely used pump for

drawing water from the sources for irrigation, with 69% respondents from both project and comparison areas reporting so. It is followed by electric submersible pump for wells (Project: 16.6%; Comparison: 19%) and electric submersible pumps for borewell (Project: 10.7%; Comparison: 8.9%). 36.4% and 38% of the respondents in project and comparison areas reported of using a star-rated pump, respectively. The most popular type of pipe used in irrigation is the PVC pipe with 87.9% in project area and 90.5% in comparison area reporting the use of these pipes.

15% of the respondents in project and 14% in comparison had access to a water harvesting structure like farm pond and earthen nala bunds. Flood irrigation was the most common method used with 58.3% from project area and 58.7% from comparison area reporting its use. It was followed by drip irrigation (Project: 21.0%; Comparison: 24.2%), micro-sprinkler irrigation (Project: 16%; Comparison: 17%) and manual irrigation (Project: 13.6%; Comparison: 10.2%). Only 5% from project area and 4% from comparison area reported of having land under orchard or plantations. A high percent of farmers (Project: 67%; Comparison: 69%) reported of growing trees on the periphery of their agricultural lands, mainly neem, mango, babul, bor and tamarind.

Only eight farmers reported using shade-net while only one reported of using poly house for cultivation. No one reported using a polytunnel. The practice of fencing around the farmland is also negligent with only 1.8% and 2.2% of the respondents reporting of fencing their land in project and comparison area respectively.

Soybean (project: 59.8%, comparison: 63.7%) and cotton (project: 49.2%, comparison:48.0%) are the most widely grown crops in the kharif season, followed by pigeon-pea (Project: 25.8%, Comparison: 28.2%), green gram and black gram. In the rabi season, the most widely grown crops were found to be sorghum (Project: 59.8%, Comparison:57.3%) followed by chickpea (Project: 43.8%, Comparison:50.8%) and wheat (Project: 19.8%, Comparison:19.6%). The highest percent of irrigated land for kharif crops is of cotton (25%) and green gram (23%) in project area. Soybean and pigeon pea have the same percent of land under irrigation (14%) whereas black gram sees the least percent of irrigated land with only 6% under irrigation. For kharif crops in comparison area, cotton again sees the highest area under irrigation (23%) followed by pigeon pea (14%), soybean (12%) and black gram (7%) and green gram (7%). Productivity (calculated in quintal per acre) of the main crops is as follows: Soybean (Project: 5.2; Comparison: 5.4), Cotton (Project: 4.2; Comparison: 4.5), Pigeon pea (Project: 4.1; Comparison: 4.4), Black gram (Project: 2.2; Comparison: 4.6), green gram (Project: 4.1; Comparison: 6.8), chickpea (Project: 4.7; Comparison: 3.6), sorghum (Project: 3.1; Comparison: 3.6).

Only about 0.76% of farmers from project area and 1.1% farmers from comparison area reported engaging in seed production. A fairly high percentage of farmers reported that they are able to use/rent farm machinery when they required it (Project: 77.6% and Comparison:74.8%). When asked about availability of agriculture related skilled labour in their area, 70% from project area and 66% from comparison area said that skilled labour was available for work when they needed them.

Only 5% of the farmers in both project and comparison villages have reported that they prepare Jeevamrut/Beejamrut/Neem extract solution. 69 % of respondents in project arm and 65.6% of respondents in comparison arm were not aware of any natural enemies to the pests. 91% farmers from both project and comparison area agreed to using pesticides in their fields. 84% farmers in project area and 88.9% farmers in comparison area reported of their crop being affected by pests or diseases in the last 12 months. Only 21.5% in project and 27% in comparison said that measures for managing pests were employed at the godown or the place where they stored there produce.

Awareness of soil-testing was found to be very low with only 28% from project and 25% from comparison saying they knew about it. Of the respondents who were aware of soil-testing, 55% (in both project and comparison arm) had never gotten soil testing of their fields. Only 0.7% respondents in project and 1.8% respondents in comparison arm acknowledged getting soil testing done and having their soil heath card available with them. 13% in project area and 16% in comparison area reported that they have ever practiced intercropping. The most popular combination of crops for intercropping is soybean and pigeon pea (Project: 51%; Comparison: 50%) followed by cotton and pigeon pea (Project: 40%; Comparison: 39%). The most common method of farm residue management is burning of the residue in the field (Project: 61%; Comparison: 64%) and using it as animal feed (Project: 49%; Comparison: 46%). Only 2% farmers in both project and comparison areas use the remaining stubble as mulching in their fields.

55% of the farmers in project area and 51 % farmers in the comparison area reported of selling their produce directly through haat or via retail mode. Only 10 % of the farmers in project arm and 12 % in the comparison arm reported of selling their produce in the nearest APMC market. Farmers mostly use commercial vehicles such as pick-up trucks for transporting their produce to the market (Project:48 %, Comparison: 44%). This was followed by use of cars (Project:21%, Comparison: 22%) and tractors (Project:15 %, Comparison: 16%). The average distance travelled to sell produce is 20 kilometres in both project and comparison areas. 8% of the farmers interviewed knew about pledge loan. Out of the farmers aware about pledge loan, 13.2% from project and 9.8% from comparison areas had availed this loan. The biggest reason for not availing pledge loan despite being aware of it was that the farmers felt they did not require it. 2 % of the farmers across both project and comparison area acknowledged of having access to cold storage facility and 2.4% farmers in project and 2% farmers in comparison area reported of having access to grading and sorting facility.

13.4 % across project and 15% across comparison are engaged in dairy activity. 5.9 % respondents in project arm and 7.2 % respondents in comparison arm have reported of being engaged in rearing livestock. The uptake of other agri-allied activities is almost negligible in the project area. The technologies related to preparation and cultivation such as using improved seed varieties, land preparation, use of machinery and intercropping showed better adoption than others.

76% respondents from project area and 80% respondents from comparison area said they had been affected by climatic vulnerability or shocks in the past one year. The technology reported to be used to most to tackle climatic vulnerability is use of improved seed varieties (Project: 13%; Comparison: 17%). Approximately only 11% of the sample from both project and comparison study areas had used mobile applications or websites to access agriculture related information before start of PoCRA project. mKisan is used the most with 52% in project areas and 41% in comparison areas saying they use this application (Out of the respondents reporting of using mobile applications or websites to access agriculture related information. Only 4% of the respondents had received advisory on climate vulnerability.

On enquiring about the credit access, it was found that 58% from project and 60% from comparison area said they had availed credit before June 2018. Majorly, commercial banks are the source of credit for farmers with 79% from both project area and comparison area reported of taking loan from them. The major reason for availing credit by the respondents was agriculture, with the proportion being same across the two study areas (Project: 90%; Comparison: 90%). The average loan amount taken for agriculture is INR 1,21,233 for project area and INR 1,13,697 for comparison area. Debt waiver scheme was barely availed by the respondents as only 12% from project area and 14% from comparison area reported of availing this benefit. 24% in project and 25% in comparison reported of facing issues in availing farm loan. These problems were mainly due to the amount of

paperwork and the repeated number of visits required for loan sanctions. 51% from project area and 51.6% from comparison area had reported getting insurances for their crops. The main crop for which crop insurance was taken is soybean (Project: 61.1%; Comparison: 68.1%) followed by cotton (Project: 31.2%; Comparison: 27.3%).

Apart from the quantitative survey, qualitative component of the baseline survey presents the findings on the agriculture situation and the key challenges currently faced by the target beneficiaries of the project. During the qualitative survey too, water availability for agriculture was reported to be low and was reported to be the key concern by most of the farmers. Dug wells and bore wells were reported to be the most commonly available sources of irrigation available. On observing a few watershed structures during the expert visits, it is suggested that an assessment of the condition of existing water harvesting structures should be done in all project villages and their proper repair or maintenance should be done as required. When asked which cultivation season is perceived to be risky, majority of the farmers perceive cultivation to be risky throughout the year due to uncertainty in rainfall and water availability. The most frequently used tillage practices for land preparation were reported to be clod crushing, levelling, harrowing and use of plough. During the enquiry, it was found that most of the farmers purchase pesticides based on the suggestions of the input deals and also based on suggestions of agriculture officers and Krishi Mitras in a few cases. Indiscriminate use of agro-chemical without protective clothing and equipment was observed to be done during the field visits. Lack of storage facilities like warehouse or godowns in their village or nearby area was reported by most of the farmers and only the farmers who have storage facility or space at home are able to store the produce. While asked about the marketing/selling of produce, most of the farmers reported that they do not get appropriate price for their produce. It was reported that when the farmers sell their produce to the Grain Market/APMC, they are not able to get their payment immediately (they receive a partial amount initially and it could even take three to four months to get the full payment) due to which many are forced to sell their produce to middle-men who usually offer them less rate than MSP but would provide them cash up front. In most of the cases farmers reported that no value addition is done by them before selling their produce, though some farmers reported of cleaning and grading their produce before selling it. Though a high number of farmers reported of taking crop insurance, many farmers said that they have faced difficulty in getting benefit of crop insurance in case of crop damage. Farmers reported of facing problems in online application as the customer service centres are in block level and they need to travel these. Also lack of guidance, knowledge of application process and difficulty in filling forms are other key challenges in getting insurance claims. Lack of water availability was reported to be the biggest challenge in agriculture in Marathwada region. Controlling pest was reported as another key challenge as farmers are spending significant amount of money on pesticides application due to which the cost of production has been increasing every year. For this, farmers need to be encouraged to conduct soil testing on their land and use fertilizers as per the recommended dose.

Based on the FGDs with landless residents, farm labour, labour in nearby towns along with small retail shops were reported to be the key livelihood activities. Respondents engaged in farm labour reported that livelihood opportunities in their villages have reduced due to less /erratic rain and lower farm production in their village due to which they have to migrate for work in nearby towns and cities. It was also reported that reduction in profits in agriculture has adversely affected the landless too as the spending capacity of the majority of farmers have been reduced leading to lack of employment or business opportunities for them. This has led to increase in migration which usually starts in October and ends around Holi season. Respondents reported that they are interested in goat rearing, poultry and dairy activities if they are provided an opportunity.

On assessment of activities of the SHGs, it was found that only three of the 16 surveyed SHG's are currently engaged in income generating activities. These activities too are done individually by the members of the group and not collectively. It was observed that the SHG members mostly utilize the loan for consumptive purpose like paying fee of their children, marriage, heath expenditure and other domestic expenditure. Though in a few cases the loan was reported to be used for income generating activities. On being asked about the current challenges faced by their SHG, complying to the bank documentation process, improper accounting, irregular meetings, lack of market for their enterprises were the other challenges reported. We think, capacity building of the SHG members to understand the loan application process would be helpful for them in further loan applications. On enquiring about the support they would like from the government, SHG members requested for support including training on account management and on livelihood activities that can be taken up by their group. SHG members also wanted government to provide them financial support to set up enterprises like papad making and flour mill.

Interviews were also conducted with Farmer interest groups (FIGs) members to understand about their activities and the challenges faced by them. It was found that most groups were formed with the help of ATMA and agricultural department staff. For majority of FIGs, the only criteria was that the members should be farmers having agriculture land. On enquiring about the activities done by members of these FIGs, only in four out of 16 interviewed FIGs, collective activities were reported to be conducted by the group members. These activities were seed production by two groups, sericulture and goat rearing by one group and vegetable cultivation by one group. On enquiring about the current challenges faced by the FIGs, it was found that getting access to loans, lack of capacity to apply for loans (lack of knowledge of documentation process) and lack of capacity of running their group were the major reported challenges. On being asked about the future activities they would like to engage in, FIG members showed interest in seed processing plant, hydroponics for fodder cultivation, mushroom production plant, aloe vera and shatavari cultivation, nursery and floriculture in shade net. Some farmers also showed interest in collective goat rearing, poultry as well as vegetable cultivation through protective irrigation from farm pond. Capacity building support required by the farmers includes training on marketing, account management, general management, technical training on these livelihood activities which their groups want to engage in and on value addition and processing activities which could help them to improve their capability to run their FIGs more effectively.

FPO/FPC representatives were also interviewed to know about their current activities, challenges faced by them, activities they would like to engage in future and the support they require from the government to efficiently run their FPC/ FPO. Seed processing (cleaning, grading and packaging of seeds) was found to be the activity in which most of the surveyed FPCs were engaged in. Two FPO' had reported to be engaged in the turmeric powder making after boiling and polishing it. Some FPO's were engaged in contract farming and export of vegetables. One group had also reported to be engaged in equipment rental activity. Except turmeric, most of the other produce was sold at the local markets in the block level or in nearby district. On enquiring about the sources from where the FPC get information on current marker rates, it was interesting to note that majority of groups received information through WhatsApp groups and mobile applications. Other popular sources of information were TV, newspaper and markets themselves. On enquiring about the current challenges faced in operating their FPC/FPO, lack of availability of raw material (as climate change has led to a serious negative impact on their agriculture productivity), issue in getting bank loans, lack of guidance in accessing bank loans , lack of funds to run their business activities, lack of cold storage facility in their vicinity for storing their produce, high rates of electricity and poor and expensive transportation facilities were reported as the key challenges. On enquiring about the value addition activities their FPC/ FPO would like to engage in future, majority of them were

interested to open oil and dall mills and in expanding their existing seed production business. Some FPO/FPC also showed interest in expanding their existing turmeric powder business, opening jaggery unit, processing and exporting of vegetables, poultry farming and opening cold storage. It can be said that essentially most of the FPC/FPOs were interested to produce value added products from the agri commodities that are grown in their vicinity and by their member farmers.

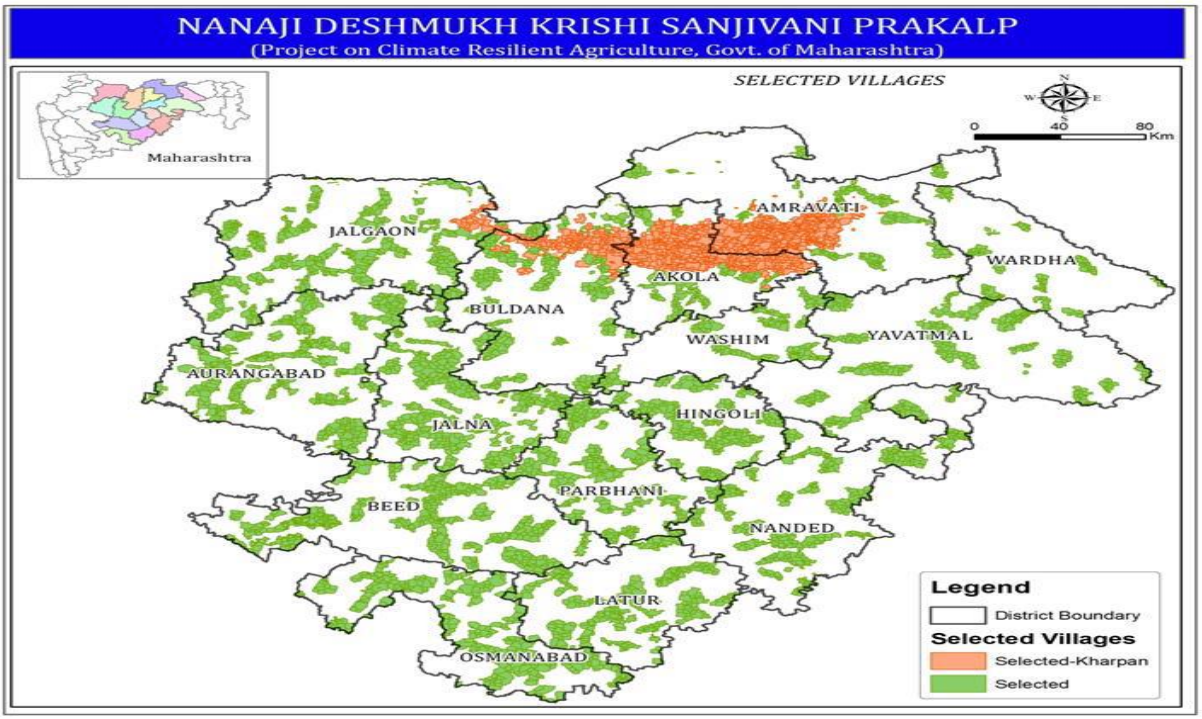
2. Introduction to PoCRA

Having agriculture as the primary source of livelihood in the state, Maharashtra has 22.6 million hectares of land under cultivation (gross cropped area) and 5.21 million hectares under forest. About 84% of the total area under agriculture in the state is rainfed and is dependent only on monsoon[1]. 49% of the landholdings in the state falls in marginal category, with less than one ha land. Most of these poor farmers with small and unirrigated land holdings are vulnerable to climate shocks. Moving these farmers out of the current crisis of high production cost, low profitability due to low productivity, lack of market access is one of the biggest challenges for the state. Also, the critical issues related to water scarcity, degraded land resources, increased cost of cultivation and the impacts of climate change need to be addressed to reduce the vulnerability and improve profitability of the smallholder farmers.

To respond to the above-mentioned challenges, the Government of Maharashtra, in partnership with the World Bank, conceptualized the Project on Climate Resilient Agriculture (PoCRA) for 5142 villages in 15 districts of Maharashtra. This project attempts to bring transformational changes in the agriculture sector by scaling-up climate-smart technologies and practices at farm and (micro) watershed level, that would contribute to drought-proofing and management of lands in states' most drought and salinity/sodicity-affected villages. The project focuses on smallholders (farmers up to 2.0 ha of farmland) with particular focus on vulnerable population whose livelihood is impacted by changing climate conditions and climatic uncertainties. The project has been implemented in 15 districts in Maharashtra which include 8 districts of Marathwada (Aurangabad, Nanded, Latur, Parbhani, Jalna, Beed, Hingoli, Osmanabad), 6 districts of Vidarbha (Akola, Amravati, Buldana, Yavatmal, Washim, Wardha) , Jalgaon district of Nashik Division and approximately 932 salinity affected villages in the basin of Purna river spread across Akola, Amaravati, Buldana and Jalgaon districts[2]. The below figure highlights the villages where the project is implemented. This project will be implemented over a period of 6 years from 2018-2024.

[1] Source: PoCRA Project Implementation Plan (PIP) document
[2] Source: Terms of Reference

Figure1: PoCRA project area and villages



The Project Development Objective (PDO) of PoCRA is to enhance climate-resilience and profitability of smallholder farming systems in selected districts of Maharashtra. The project is built around a comprehensive, multi sector approach that focuses specifically on building climate resilience in agriculture through scaling up tested technologies and practices. The strategic overview, thematic linkages and expected achievements of the project are highlighted in the below schematic.

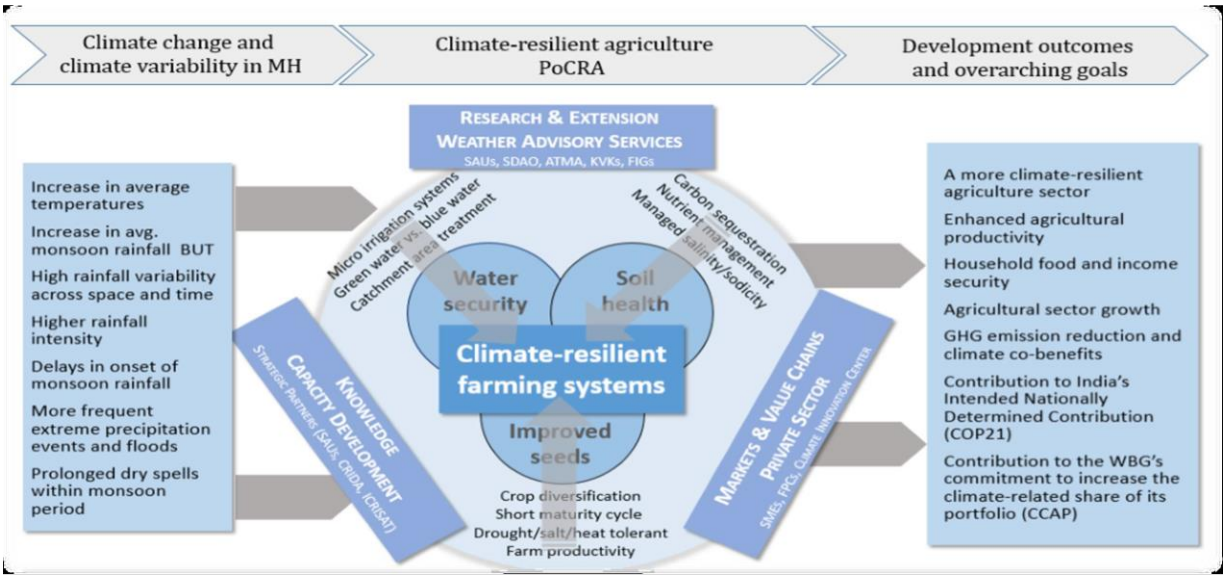


Figure 2: PoCRA strategic overview, thematic linkages and expected achievements

The overall project vision is to contribute towards three critical impact areas: a) Water Security b) Soil Health c) Farm Productivity and Crop Diversification. The need for intervention across these three areas in the region is evident given the type of agro-climatic attributes of the area.

Out of the 15 districts where PoCRA will be implemented, the current assignment is to be conducted in 8 districts of Marathwada region, covering 347 mini watershed clusters. The project will be implemented in a phased manner reaching out to 70 clusters in year I, 175 clusters in year II and 102 clusters in year III. The subsequent sections provide an overview of the demographic and agro-ecological attributes of this region while contextualizing the broader discourse of resilience.

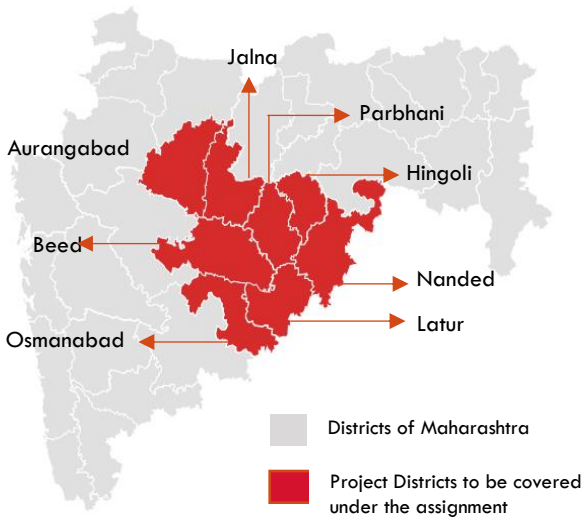


Figure 3:Project districts

2.1 Overview of the Study Area

About one-sixth of the total topographical region in India falls under the Drought Prone Area (DPA) and about 40% of the Maharashtra State falls under DPA, with less than 750mm of annual average rainfall[3]. In Maharashtra, Marathwada region specifically has been floundering under drought condition since 2012 with the highest rainfall deficit in the country at 48% in 2014. Marathwada region coincides with Aurangabad Division and consists of 8 districts namely, Aurangabad, Beed, Latur, Osmanabad, Parbhani, Jalna, Nanded and Hingoli.

The region has a population of about 1.87 Crores and a geographical area of 64.5 Thousand sq. kms[4]. Agriculture is the major source of income generation for over 64% of the state's population. However, given harsh weather conditions, the region's agricultural system has been depleting significantly. Jowar and Bajra, along with other kharif crops, were completely wiped out in 2012 when monsoon failed (Kumar, 2013). Jalna district, famous for being the biggest producer of sweet lime, had been the worst hit in the drought. Two important cash crops in Marathwada namely cotton and sugarcane were also severely affected. The anticipated impact of climatic change as well as climate variability presumably lead to an increased pressure on already scarce water resources.

Starting 2014, the Jalyukt Shivar Abhiyaan, one of the state government schemes started its intervention to make the state drought-proof by 2019. It aimed to make 5,000 villages free of water scarcity every year through deepening and widening of streams, construction of cement and earthen stop dams, work on nullahs and digging of farm ponds. A total of 158,089 water management works were to be carried out under this project, of which 51,660 have been completed till April 2018. This demonstrates that there is a need of more

[3] Hydrology and Water Resources Information System for India, National Institute of Hydrology, Roorkee http://nihroorkee.gov.in/rbis/India_Information/draught.htm

[4] Census 2011, http://shodhganga.inflibnet.ac.in/bitstream/10603/152935/11/11_chapter%204.pdf

concentrated efforts for mitigation and adaptation with an aim to reduce vulnerability of agriculture and making it more resilient.

Within this context, there is an urgent need for the farmers to enhance their resilience to the threats of climate variability. The fact that most of famers in the project region are small and marginal, their adaptive capacity is very limited hence economically viable and culturally acceptable adaptation techniques need to be developed and implemented. The Government of Maharashtra has realized the implications of building climate resilience in the agricultural sector and has developed a drought proofing and climate resilient strategy as a long-term and sustainable measure to address the likely impacts of climate change. With this backdrop, the Project on Climate Resilient Agriculture (PoCRA) has been formulated by the Government of Maharashtra with support from World Bank. This is the first large scale climate resilient agriculture project in India which aims to enhance climate-resilience in agricultural production systems through a series of activities at the farm level.

3. Objectives of Baseline Survey of PoCRA

A baseline survey along with a midline and endline survey will be conducted as part of the evaluation of PoCRA project. Baseline survey is the first step and a key component of the impact evaluation of PoCRA project in Marathwada region.

The objective of the baseline study is to understand the current situation or the situation in the project area at the time of start of the project. Information collected on key indicators as part of the baseline survey will help to find the magnitude of change and attribute it to the project by comparing the baseline survey data with midline and end line survey data. The baseline study would also assess the current situation on relevant variables mentioned in the results framework and on key ESMF related indicators.

4. Evaluation Design and Sampling Methodology

In line with the methodology mentioned in the inception report, a quasi-experimental design with Double difference method would be adopted for impact evaluation. A robust *a priori* matching has been used to match project and comparison clusters to ensure strong attribution of project results. Quasi-experimental designs will assist in identifying a comparison group that is as similar as possible to the project group in terms of baseline (pre-intervention) characteristics. The comparison group will in turn capture what would have been the outcomes if the programme had not been implemented (i.e., the counterfactual). The difference between ΔE and ΔB will give the net impact due to the project. This double difference can be calculated between baseline and midline at the midline survey stage and baseline and endline or midline and endline at the endline stage. The below figure diagrammatically illustrates the difference-in-difference design.

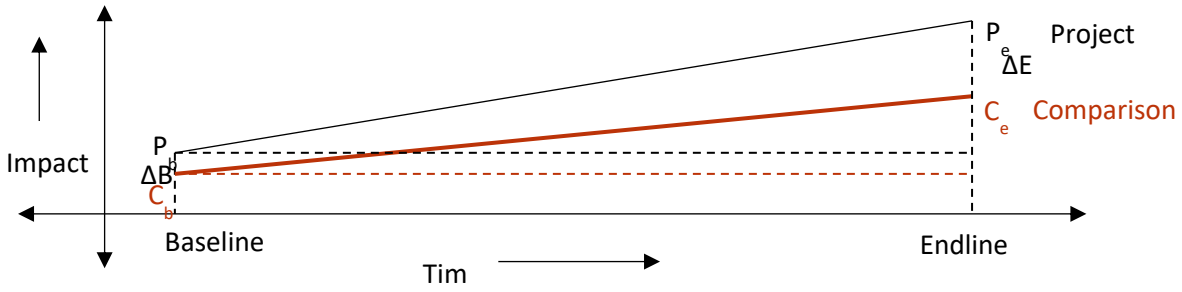


Figure 4: Difference-in-Difference evaluation method

4.1 Constructing a Comparison Group

For stronger attribution of the impact of the project, counterfactual has been taken for each sampled project cluster and village. Therefore, the ratio of project to comparison is 1:1. The first step of matching exercise was to match the project clusters of a particular district with the non-project clusters of that district. Comparison cluster has been identified for each project cluster. Comparison clusters were matched with project clusters based on their respective climate vulnerability index score. As the PoCRA project is focused on climate resilience, climate change vulnerability index (as defined by IPCC-2011) was deemed suitable for matching and selection of comparison clusters. Villages were further selected from the matched clusters. One to one matching technique was used to find the closest match to every project cluster in the same district. Finally, the comparison cluster corresponding to the sampled project cluster was selected for the survey.

4.2 Sampling Methodology

4.2.1 Sample Size

We have adhered to the sample distribution provided in the ToR by PoCRA PMU[5]. We understand that the distribution of sample across clusters, villages and households' level have been done to account for a minimum detectable impact (MDI) at the project level.

To conform to the sample proposed and ascertain MDI, we accounted for intra-class correlation and estimated the design effect equalling ρ (m – 1) + 1, where ρ is the intra-class correlation coefficient (ICC) and m is the average number of observations per cluster. The sample thus, provides 80% power to detect the minimum change at a 0.05 level of statistical significance6. The sample size estimation has been done using the below mentioned formula:

$$\boldsymbol{MDI = 2.8 * \sqrt{(b(1-b)} * \sqrt{\frac{1}{P(1-P)}\left(\frac{\rho_C(1-R_C^2)}{N} + \frac{(1-\rho_C)(1-R_I^2)}{rN}\right)}}$$

1. b is the baseline prevalence rate of a binary outcome (0.5[7])
2. P is the fraction of the sample in the treatment group (0.5)
3. ρc is the intra class correlation (ICC) i.e. the proportion of variance among catchment areas (0.02)
4. RC^2 and RI^2 are the regression R-squared values at the cluster and individual level respectively (0.3)

[5] 241 clusters, 2 villages in each cluster and 5 households in each village (ToR)
[6] The sample size reflects 95% Confidence and 10% margin of error (ToR, page 84)
[7] Maximum rate of prevalence

5. N is the total number of catchment areas selected
6. r is the total number of respondents in each catchment area

The estimated sample size (number of household or respondents) that were targeted to be covered in project and comparison area was 2410 each. This proposed sample size is powered to have an MDI (minimal detectable impact) of 5 %. Table below provides the overall sample for impact evaluation.

Table 2: Proposed Sample Size for impact evaluation

Phase	**Cluster**		**Villages**		**Households**	
	Project	*Comparison*	*Project*	*Comparison*	*Project*	*Comparison*
Baseline	241	241	482	482	2410	2410
Mid Term						
End Term						
Total (each phase)	**482**		**964**		**4820**	

4.2.2 Sampling Distribution

The sampling distribution approach adopted for this study has been detailed below. A multi-stage sampling method has been adopted for this study. The below table details the rolling sampling approach that will be used for the impact evaluation.

Table 3: Sampling distribution of cluster for evaluation

Total Project Cluster	**Baseline**	**Midterm**	**Endline**
347	241 out of 347 Random Selection	- 121 fixed out of 241 baseline clusters - 120 out of remaining 226 project clusters - Total 241 out of 347 clusters	- 121 fixed out of 247 midline clusters - 120 out of remaining project clusters - Total 241 out of 347 clusters
**During midterm and end term 120 clusters would be dropped. Those dropped clusters would also form a part of the remaining 226 project cluster from which a new set of 120 clusters would be sampled.* ***Comparison cluster corresponding to each sampled project cluster will be sampled.*			

The steps that have bene adopted as part of the multistage sampling for the baseline have been detailed below

A. Selection of District
All the 8 project districts were covered, namely Aurangabad, Bid, Jalna, Latur, Osmanabad, Nanded, Parbhani and Hingoli.

B. Selection of Clusters
As the next step, the project clusters were selected proportionately, (in line with the ToR) from each district, which has been presented in the table below. Non-PoCRA clusters were matched with the PoCRA clusters based on the climate vulnerability index in each district. Subsequently the clusters to be sampled were chosen from the total number of clusters in each district using simple random sampling. E.g. 37 PoCRA clusters were chosen from 58 PoCRA clusters in Aurangabad using simple random sampling. Subsequently, the corresponding matched comparison clusters for sampled project clusters were also chosen for the baseline survey. This procedure was followed for all eight districts in Marathwada region to select a total of 241 project and 241 corresponding comparison clusters.

Table 4: Distribution of sample in proportion to district cluster size

District	No. of talukas	Total number of mini watershed clusters under PoCRA	Total no. of clusters chosen for the sampling	Total no. of treatment villages chosen for the sampling	Total no of control villages	Total villages to be surveyed	Total households to be surveyed: 5 per village
Aurangabad	9	58	37	74	74	148	740
Beed	11	37	27	54	54	108	540
Jalna	8	54	35	70	70	140	700
Latur	10	42	30	60	60	120	600
Osmanabad	8	58	37	74	74	148	740
Nanded	16	34	26	52	52	104	520
Parbhani	9	39	28	56	56	112	560
Hingoli	5	25	21	42	42	84	420
Marathwada	**76**	**347**	**241**	**482**	**482**	**964**	**4820**

D. Selection of Villages

Subsequently in each cluster, two villages were selected on a random basis. Therefore, a total of 482 villages in each project and comparison clusters were selected for the evaluation. In cases where a sampled cluster had only village, a sample of ten instead of five was taken from that village as per the methodology agreed in discussion with PMU team.

E. Selection of Households

On assessing the various components of PoCRA project it can be rightly said the project components like FFS, community interventions and FPO/FPCs are targeted towards all type of farmers in the village and landless people are also eligible for benefits under PoCRA. Therefore, all residents of the village were identified to be potential beneficiaries of PoCRA and were included to be a part of the sample frame.

In line with the ToR, five households were selected from each village while ensuring geographical representation. For this, a village habitation map of each sampled village was prepared during which the approximate number of HHs in the village were initially identified. Further, systematic interval sampling was followed to sample the HHs for the survey. E.g., in case there were 100 HHs in a particular village and as we had to sample 5 HHs per village, the sampling interval was 20. Therefore, starting from a random number, every 20th farming HH was surveyed.

The primary respondent of the survey was the land based on land records or any adult member of the HH involved in agriculture activities. HH head or any adult family member was selected in case of landless households.

The below schematic summarizes the sampling distribution methodology that was adopted for the baseline.

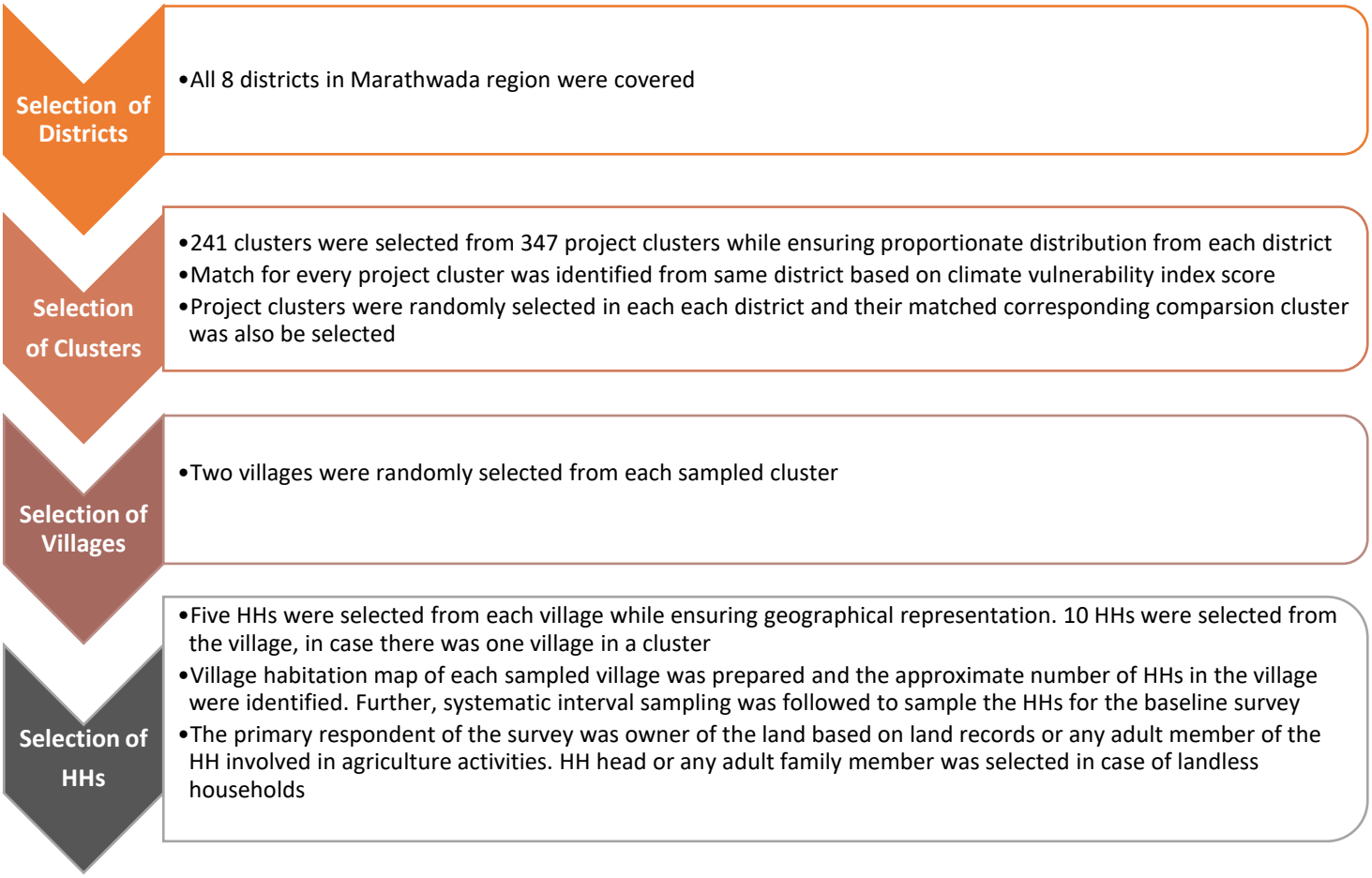


Figure 5: Sampling Methodology for Evaluation

4.2.3 Qualitative interviews

Along with the quantitative enquiry, qualitative enquiry was also conducted as part of the baseline study. It aimed at understanding the challenges faced by the potential beneficiaries and the bottlenecks in the execution of the project. Also, field observations were done by experts and research team members to understand the situation in project areas.

The qualitative interviews that were targeted to be conducted along with the sample size have been presented in the below matrix

Table 5: List of qualitative research tools to be administered

Target Respondent	Sample	Enquiry Technique	Remarks
FGDs with potential beneficiaries i.e. farmers with more than 5 acres, farmers with less than 5 acres, landless farmers	24 (16 in project area and 8 in comparison area. Distributed equally amongst the three	– FGD with community members	-Feedback on challenges faced in agriculture and the key challenges faced related to climate

	categories of target respondents)			change and the coping mechanisms adopted
Gram Panchayat Representatives	24 (16 in project area and 8 in comparison area. Distributed equally in 8 districts of Marathwada region)	–	IDI with Gram Panchayat representatives	Feedback on challenges faced by target project beneficiaries i.e. farmers and landless people
FPC/FPO Representatives	24 (16 in project area and 8 in comparison area. Distributed equally in 8 districts of Marathwada region)	–	IDI with FPC/FPO Representatives	Feedback on challenges faced by their FPC/FPO and support that can help them in increasing the income of its member farmers
FGDs with FIGs members	16 (two from each district in project area)	–	FGDs with members of Farmer Interest Groups	Feedback on the current activities and challenges faced by FIGs and what can be done to strengthen them
FGD with SHG members	16 (two from each district in project area)	–	FGDs with members from Self Help Groups	Feedback on the current activities and challenges faced by SHGs and what can be done to strengthen them

5. Sample Coverage

An overall sample coverage of 100% has been achieved in the quantitative interviews with 4820 interviews completed successfully out of the target of 4820. The district wise sample coverage and the sample achieved is presented in the table below

Table 6: Coverage of Quantitative Sample

DISTRICT	AURANGABAD	BEED	HINGOLI	JALNA	LATUR	NANDED	OSMANABAD	PARBHANI	TOTAL
COMPLETED	740	540	420	700	600	520	740	560	4820
TARGET	740	540	420	700	600	520	740	560	4820
COVERAGE	100%	100%	100%	100%	100%	100%	100%	100%	100%

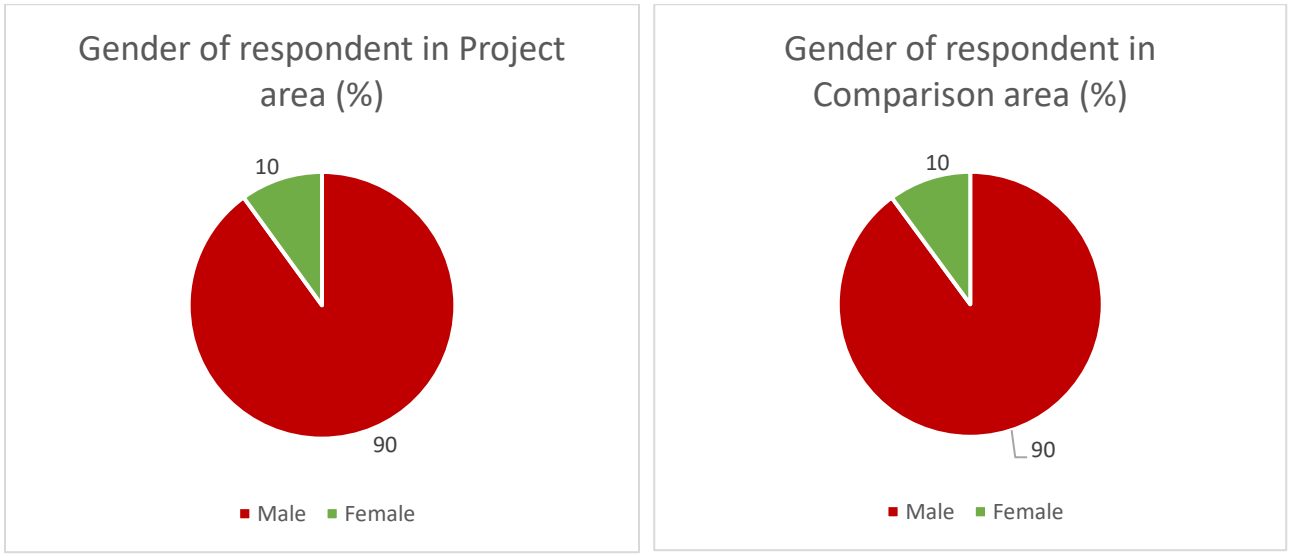
The qualitative sample covered as part of the baseline survey is 24 FGDs with potential beneficiaries(eight each with farmers less than 5 acres of land, farmers with more than 5 acres of land and landless residents), 16 FGDs with SHG members, 16 discussions with FIG members, 22 IDIs with FPO/FPC representatives and 23 IDIs with gram panchayat representatives.

6. Quantitative Findings from Baseline Study

6.1 Respondent Profile

Under PoCRA, the bouquet of project components would benefit not only their primary target population of smallholder farmers (having land holding less than 5 acres) but would also benefit other category of residents in the project village. This is because besides providing matching grants to small holder farmers, grants are also provided to landless farmers for ruminant rearing and the project also aims to increase the ground water level and water availability through community watershed interventions like catchment treatment, drainage line treatment, repair of old water harvesting structures would benefit all farmers within the watershed area. We have analysed the distribution of various socio-economic and demographic factors across project and comparison study area to check if the respondents across the project and comparison arm are balanced.

Of the respondents interviewed for the baseline survey, the project and comparison area both had approximately 90% males and 10% female respondents. The gender of the household head was primarily male with 97.4% in project and 98% in comparison area reporting so. As the confidence intervals in the proportions are found to be overlapping, it can be rightfully said that there is no significant difference across project and comparison in the distribution of gender of respondents and that of HH head.



P:2410; C: 2410 ; Total: 4820

Figure 6: Distribution of gender of respondent in project and comparison area

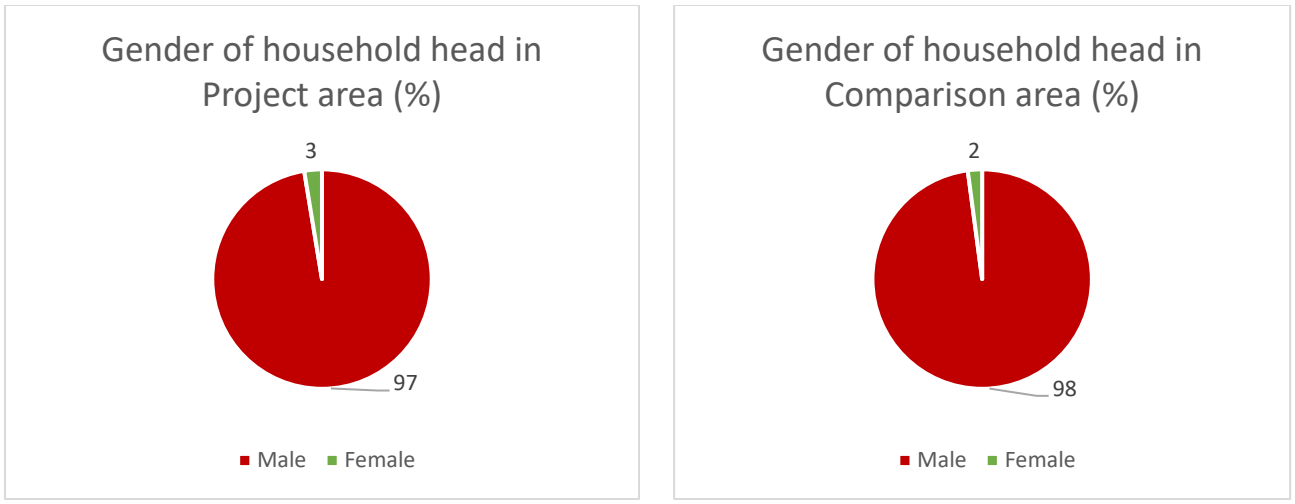


Figure 7: Proportion of gender of household head in project and comparison area

P:2410; C: 2410 ; Total: 4820

On enquiring about the religion of the respondents, it was found that they were mainly Hindus (Project: 88.8%; Comparison: 88.8%) with Buddhists (Project: 6.9%; Comparison: 5.5%), Muslims (Project: 4.3%; Comparison: 5.4%), Sikhs and Jains comprising the rest. In the project area, 51.2% and 43.4% of the respondents reported to belong to APL and BPL category respectively. The numbers were similar in comparison area with 52.2% and 43.3% reporting to be in APL and BPL category respectively. The remaining said they were unaware or did not have an APL/BPL card. Again, as the confidence intervals in case of the religion and ABL/BPL distribution is overlapping, no significant difference is observed across project and comparison.

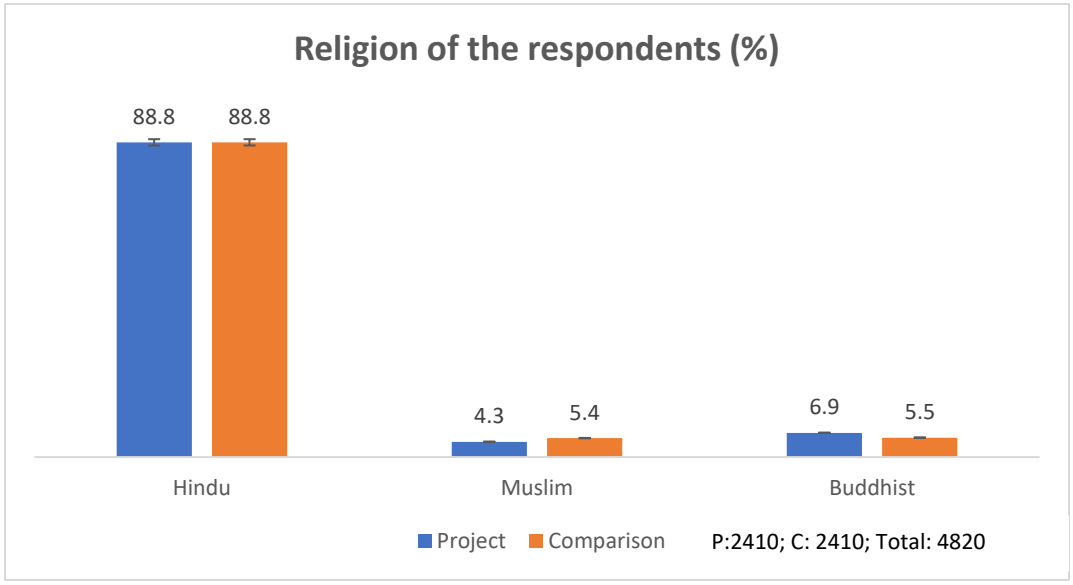


Figure 8: Distribution of religion in sample across project and comparison area

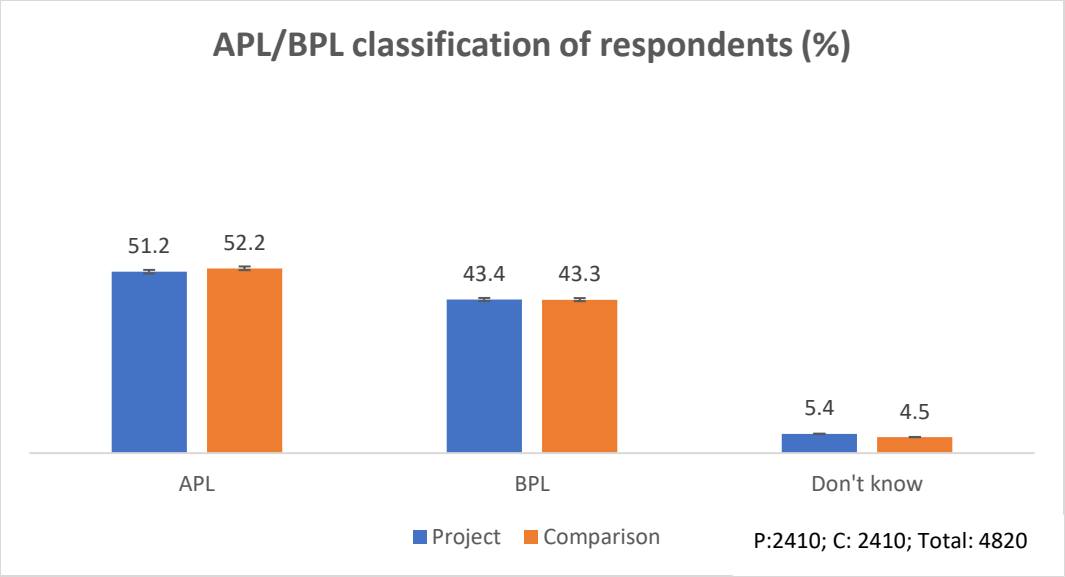


Figure 9: Distribution of APL/BPL in sample across project and comparison study area

When enquired about their social category, the majority of the respondents reported to be belonging to general category (Project: 56% ; Comparison: 51.8%) followed by Other Backward Classes (Project: 15.3%; Comparison: 13.6%), Nomadic Tribes (Project: 10.5% ; Comparison: 14.9%), Scheduled Castes (Project: 12.2% ; Comparison: 12.7%) and Scheduled Tribes (Project: 5.5% ; Comparison: 6.2%). Here too, no significant difference has been observed across project and comparison.

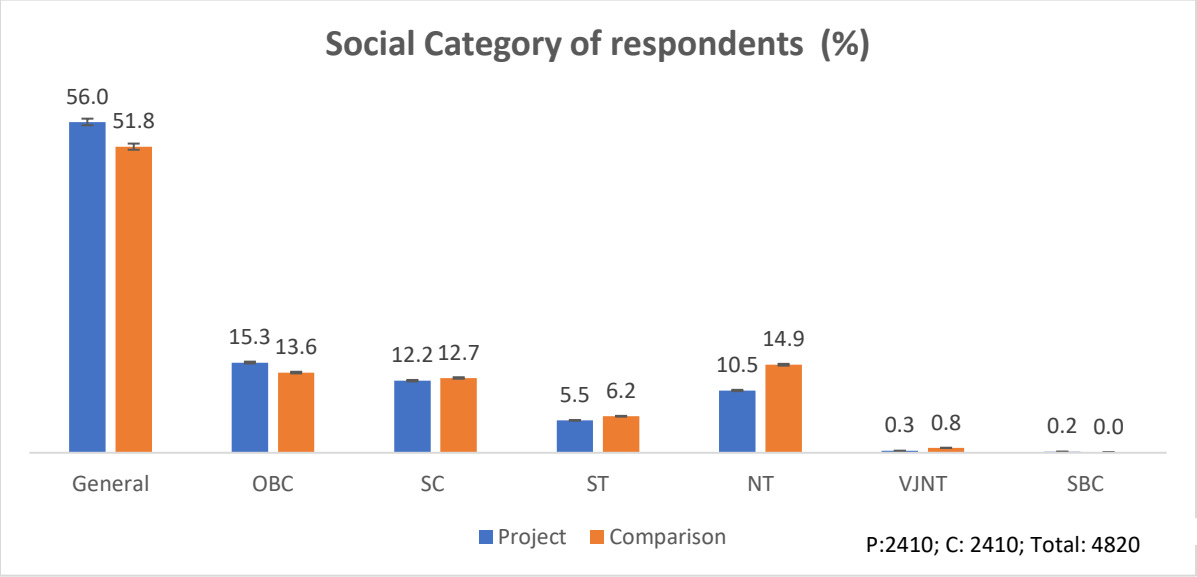


Figure 10: Distribution of social category in sample across project and comparison area

The respondents were enquired about the highest education qualification of any member of their household. It was encouraging to find that only 4.5% from project area and 3.6% from comparison area reported that no member of their HH had received any schooling. The responses were highest for education till class 12th (Project:

29.2%; Comparison: 29.3%) followed by 10th (Project: 19.5%; Comparison: 21.4%) and graduation (Project: 19.8%; Comparison: 20.1%).

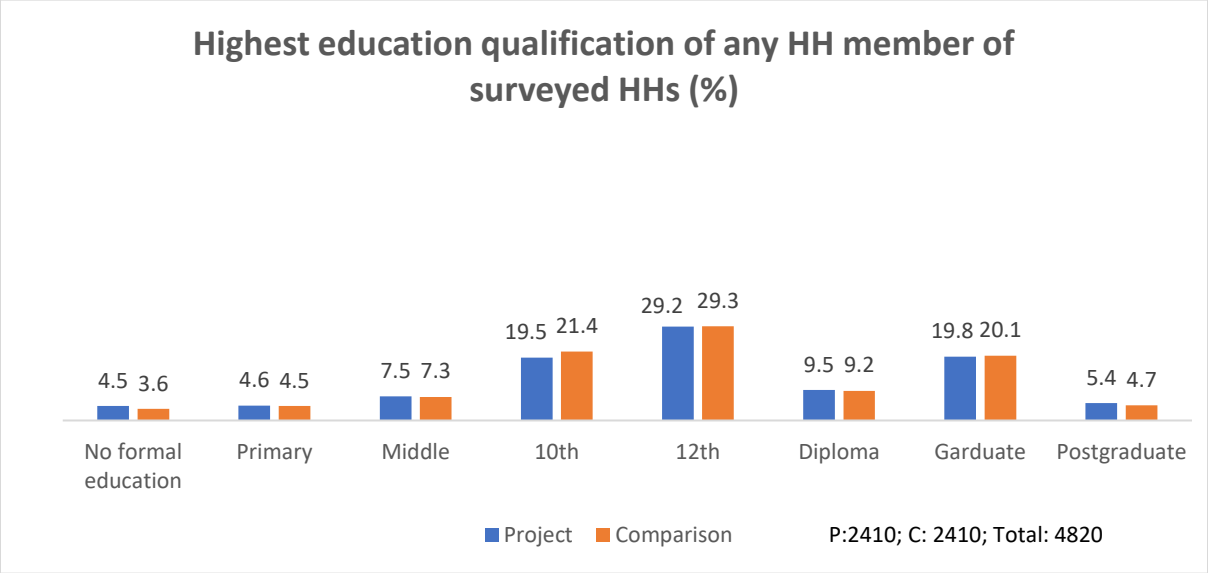


Figure 11: Distribution of highest education qualification of any household member in sample across project and comparison area

An assessment of the material ownership of the rural households which participated in the study was carried out. The physical assets of the study participants were recorded either through observation and query. Standard of Living Index (SLI) was measured by calculating the average of these indicators, with equal weightage given to each question (based on standard NSSO methodology). As evident from the below figure, the distribution of SLI is similar across both project and comparison area. In project area, 57.05% are in low category and 30.3% are in medium category. Likewise, in comparison area we see that 56.18% are in low and 30.04% are in medium category. In the standard of living too, no significant difference has been observed across project and comparison arms.

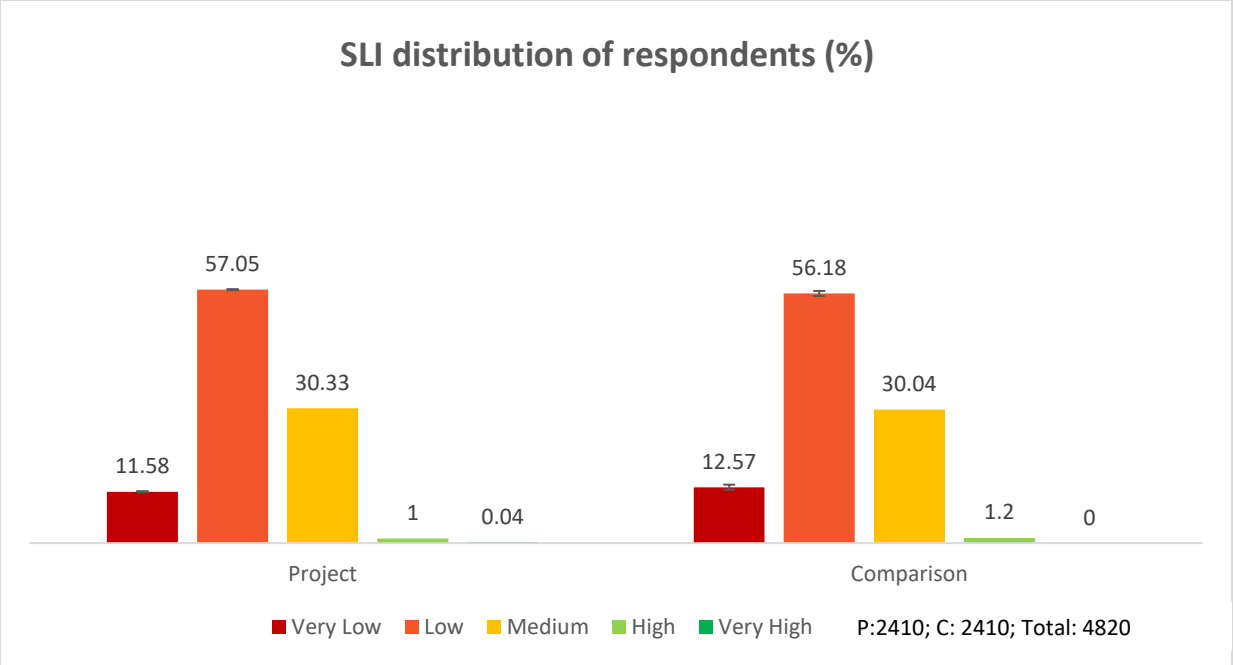


Figure 12: SLI distribution in sample across project and comparison arms

6.2 Land Ownership Profile

As part of the baseline evaluation survey, the current status of the land ownership across project and comparison was accessed. The respondents were asked if they own or had leased leased-in land for cultivation. Based on land ownership, the survey respondents were classified into three categories i.e. landless (those who did not own land or practice agriculture), farmers having land less than 5 acres and farmers having land more than 5 acres.

It was found that 18.2% of the respondents in project area and 17.1% respondents in comparison area did not own any land nor practice agriculture. Also, by splitting the respondents based on size of land owned by them, we find that proportion of land owning population is balanced across project and comparison. In project area, 62.7% own up to 5 acres of land and 18.7% own more than 5 acres. Similarly, in comparison area 61.3% own less than 5 acres of land and 21.0% own more than 5 acres. Average land owned is 4.75 acres in project areas while it is reported a little higher at 5.19 acres in comparison areas.

Of the farmers who practiced farming, 0.51% (n=10) from project area and 0.70% (n=14) of farmers from comparison areas are landless. The numbers are too low to slice further analysis based on landless farmers.

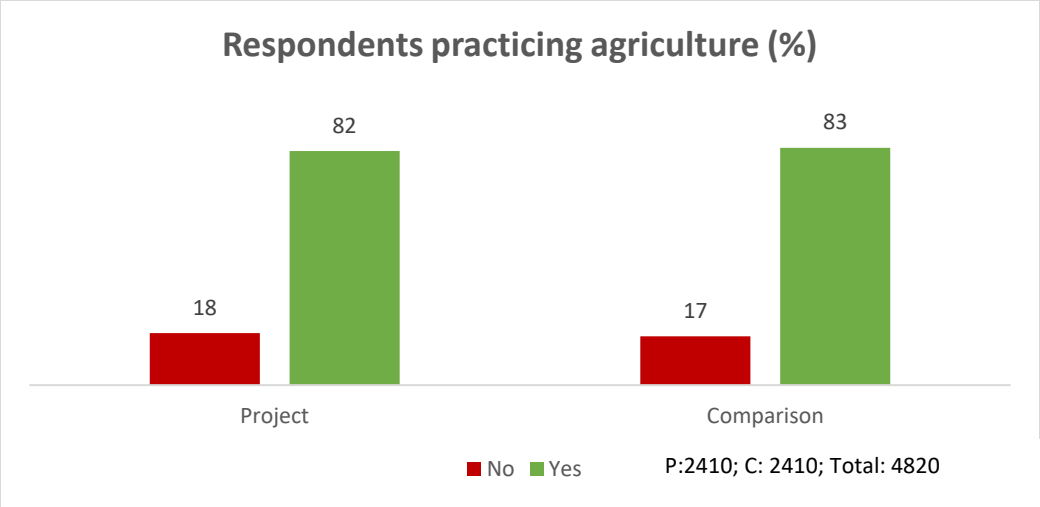


Figure 13: Percent of respondents in agriculture across project and comparison study area

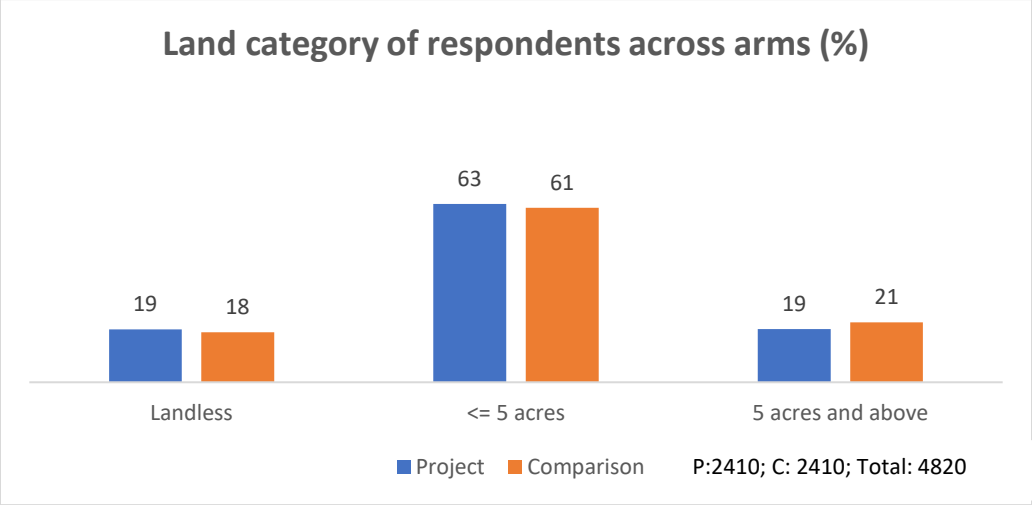


Figure 14: Distribution of respondents based on their land category across project and comparison area

To understand the land ownership status, the respondents were enquired about the owner of the land as per the land records. It was found that only 3.8% of HHs in project and 3.1 % HHs in comparison had the land owned only by female members of their household. In 14.6% HHs in project area and 15.8 % HHs in comparison area, their HH land was in name of both male and female members of their household. Majority of households had their agriculture land in name of only male members of their household (project 81.6% and comparison 81.1%).

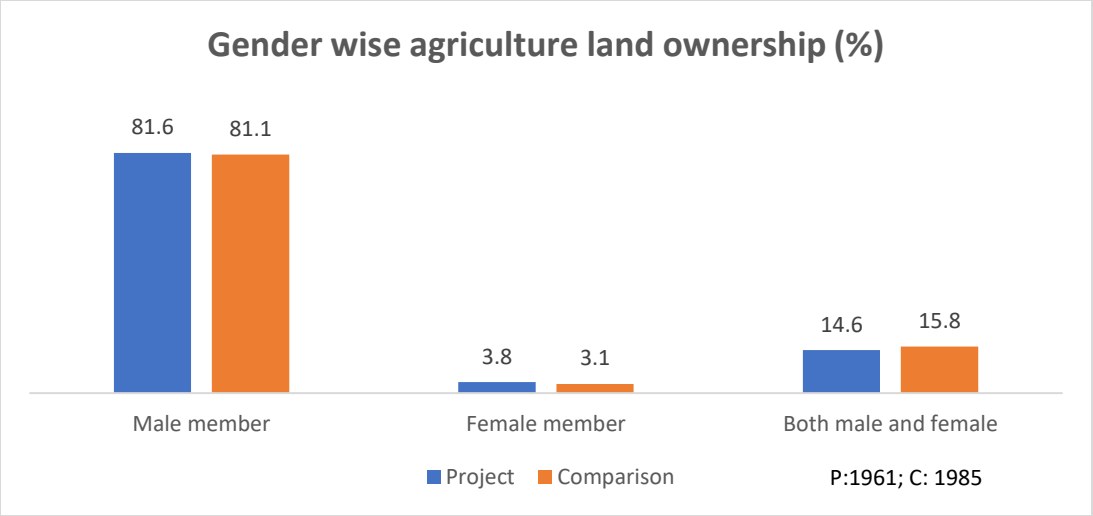


Figure 15: Distribution of gender wise landownership in sample across project and comparison study area

Cultivable land is defined as arable land that has been used for sowing of crops. We have calculated percent of cultivable land as cultivable land from total land owned by the farmers. It was found that on an average, 97% of the agriculture land owned was reported to be cultivable by the farmers.

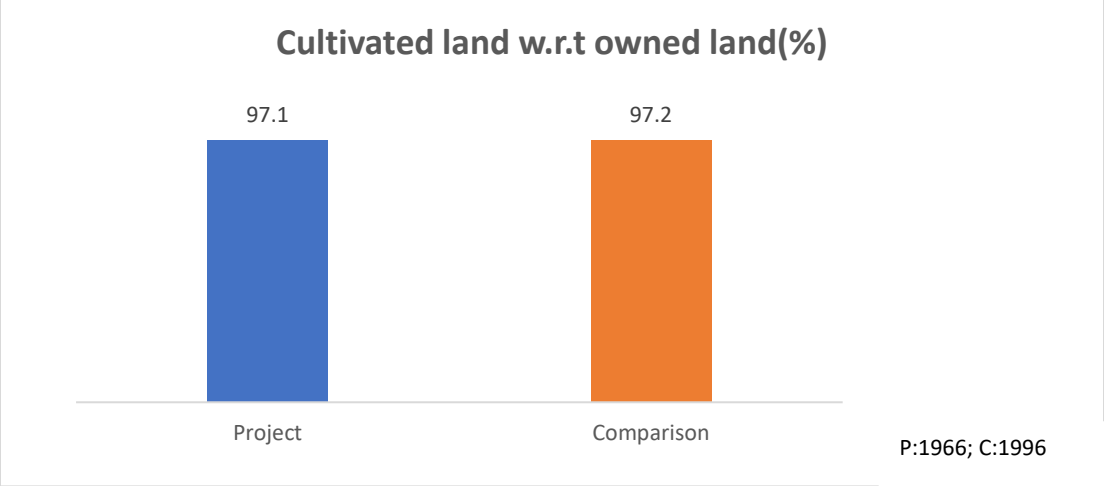


Figure 16: Percent of land cultivated from land owned by respondents

For the respondent HHs owning agriculture land, their average agriculture land owned by the households was also analysed. For the respondent HHs owning agriculture land, their average agriculture land owned by the households was also analysed. The median of the land-holding of farmers is around 4 acres for both project and comparison areas.

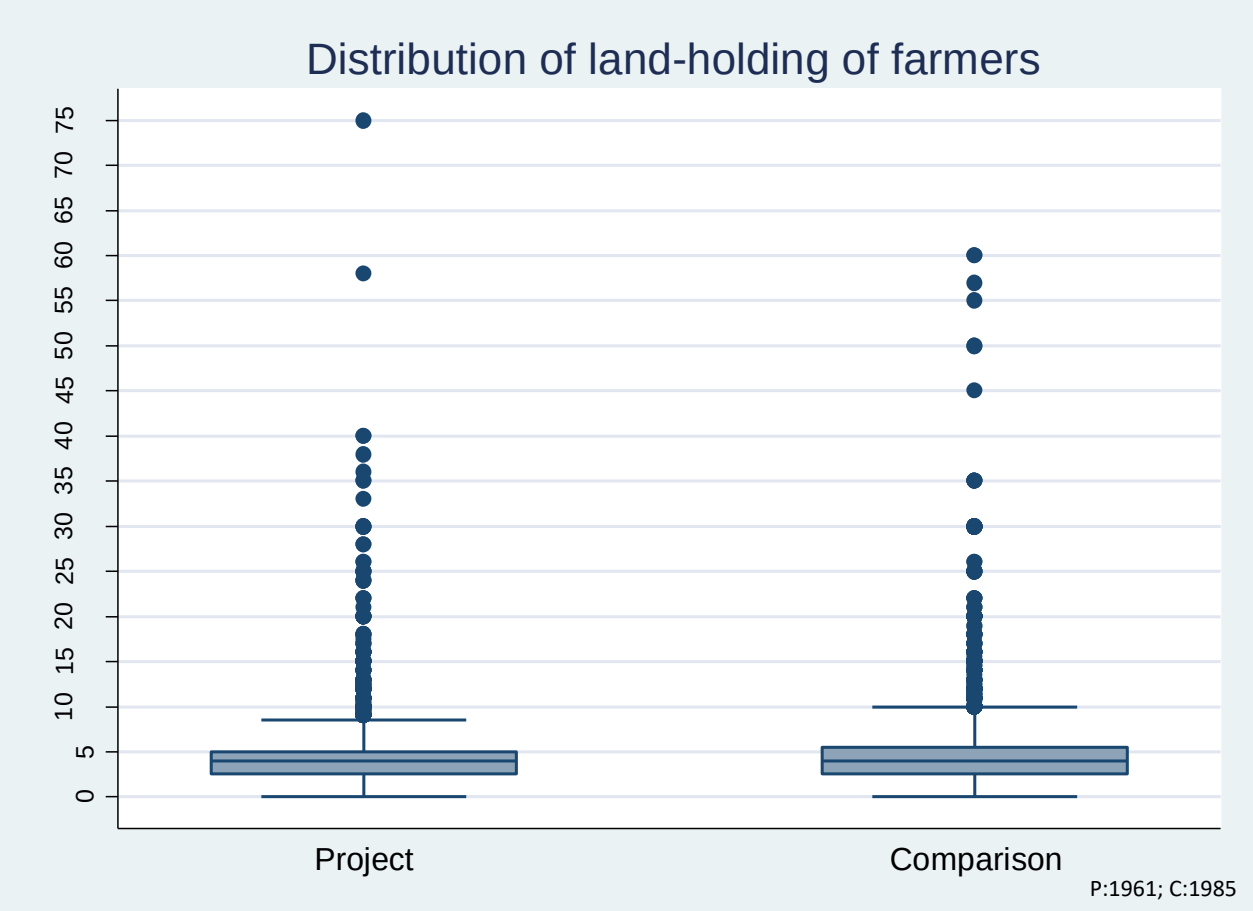


Figure 17: Distribution of land - holding of farmers

The number of farmers leasing-in land in project area is 131 and their median leased-in landholding is approximately 3.25 acres. In the comparison arm, 155 farmers reported to leasing in land and their median landholding is 4 acres.

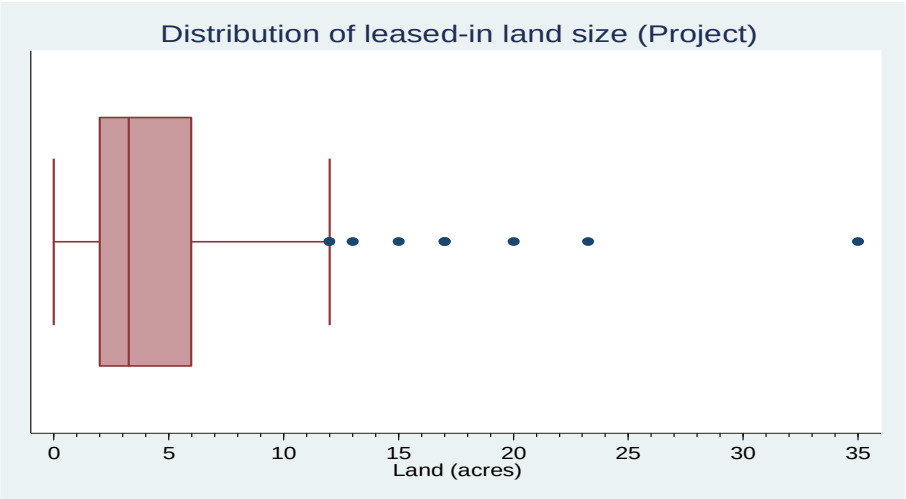


Figure 18: Distribution of land leased-in by project farmers (acres)

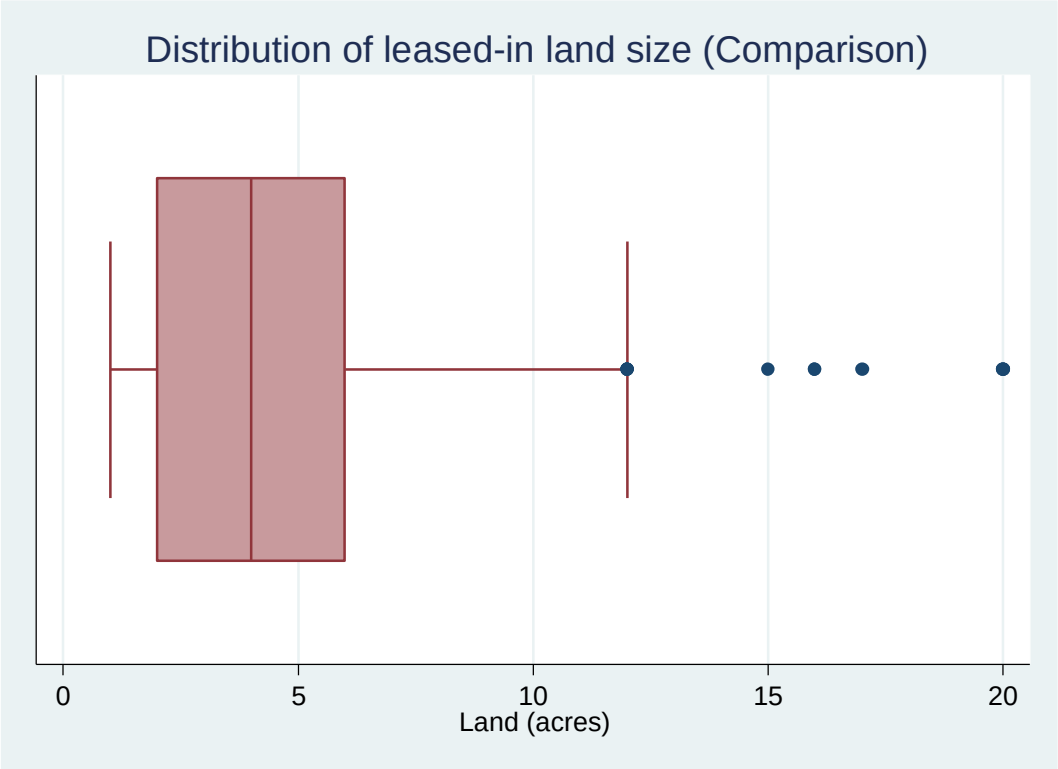


Figure 19: Distribution of leased-in land in comparison arm by farmers

The farmers were also enquired about the land area they had cultivated in different seasons in the last one year. Here, a drastic difference was observed in land cultivated across cropping seasons with Kharif season seeing the highest cultivation (P: 91%; C:95%). During rabi, only about a quarter of the land is cultivated which further drops to a mere 1% in summer.

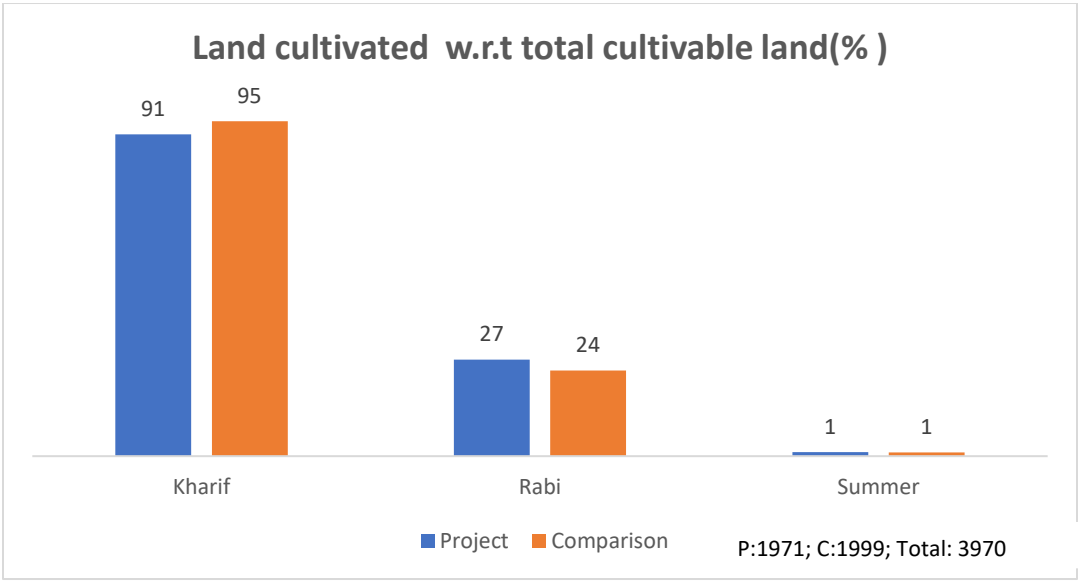


Figure 20: Percent of cultivable land cultivated across kharif, rabi and summer seasons

6.3 Irrigation Practices

As the area targeted by PoCRA is rainfall dependent and drought-prone area, irrigation plays a crucial role in agricultural production. This section presents the situational analysis of access to irrigation, irrigation practices of the farmers of the Marathwada region. This would assist in understanding the ground situation in the project areas and improve project implementation.

To know the access to irrigation, the farmers were enquired if they have any source of irrigation for the land they cultivate. Approximately 49% farmers in project and 47% farmers in comparison areas said that they have access to irrigation source for their land.

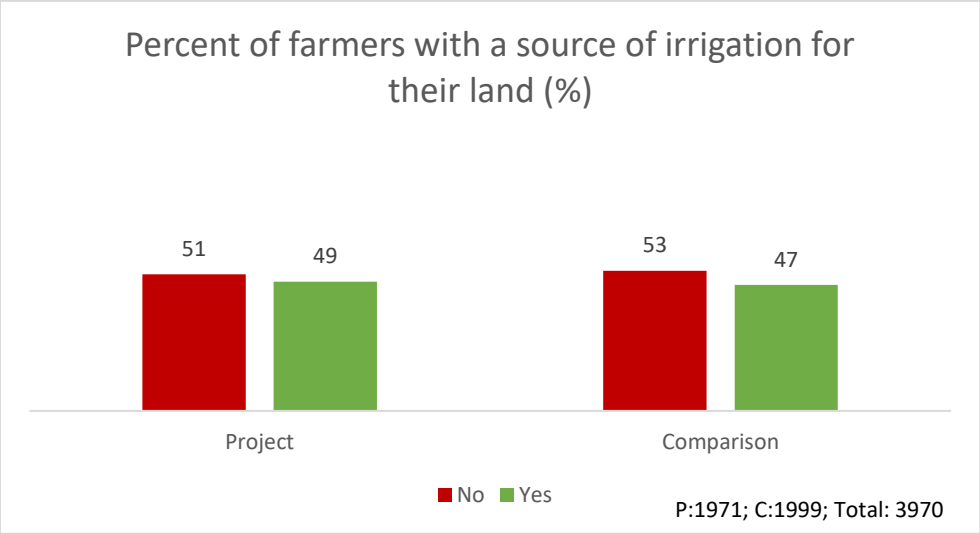


Figure 21: Farmers with a source of irrigation for their land

Further, it was analysed (season wise) what percentage of land was under irrigation when compared to the total cultivable land for farmers across both project and comparison areas. As evident in the below figure, the percent of cultivated land under irrigation was observed to be similar across project and comparison across different seasons. In kharif, 25% and 22.2% of total cultivated area was reported to be under irrigation. In rabi, 46% of land in project area and 43% land in comparison area was reported to be irrigated. It can be observed that 75% of the total cultivated land in project arm and 100 % of the total cultivated land under comparison arm was under irrigation in the summer season. This was mainly due to the fact that total area under cultivation in summer season is very low as compared to the total cultivable area (evident from figure 20).

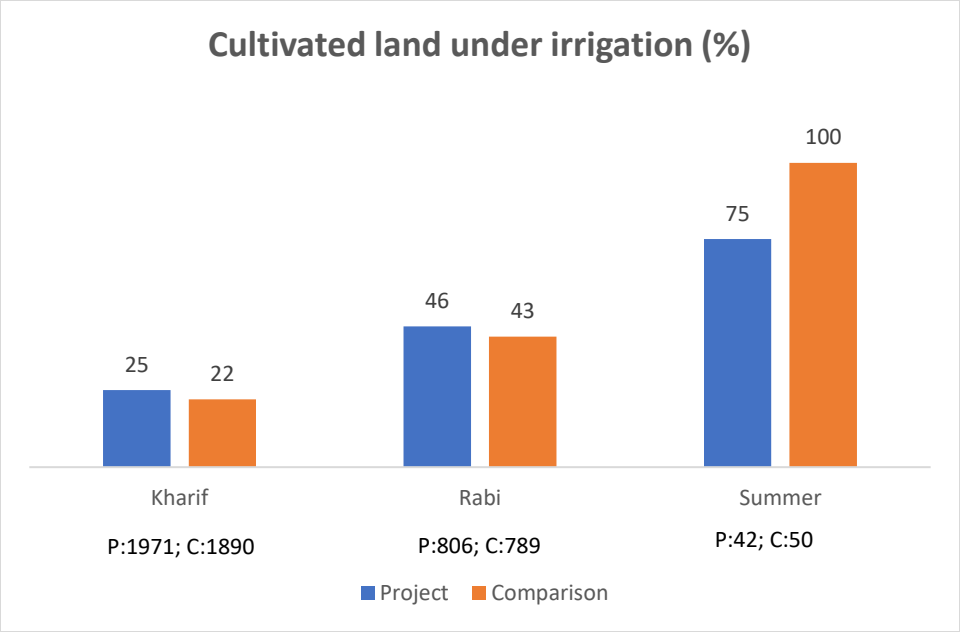


Figure 22: Percent of cultivated land under irrigation for each season

Though a decent percentage of farmers reported having a source of irrigation, it was further enquired if they are able to get water from their source when they require it for irrigation. Only about 9% from project and 10% from comparison acknowledged that water was always available from the source when they required it. Perception of reliability of water from the source for irrigation is mostly between sometimes (Project: 38.4%; Comparison:35%), rarely (Project: 28%; Comparison:29%), and very rarely (Project: 24%; Comparison:25.7%).

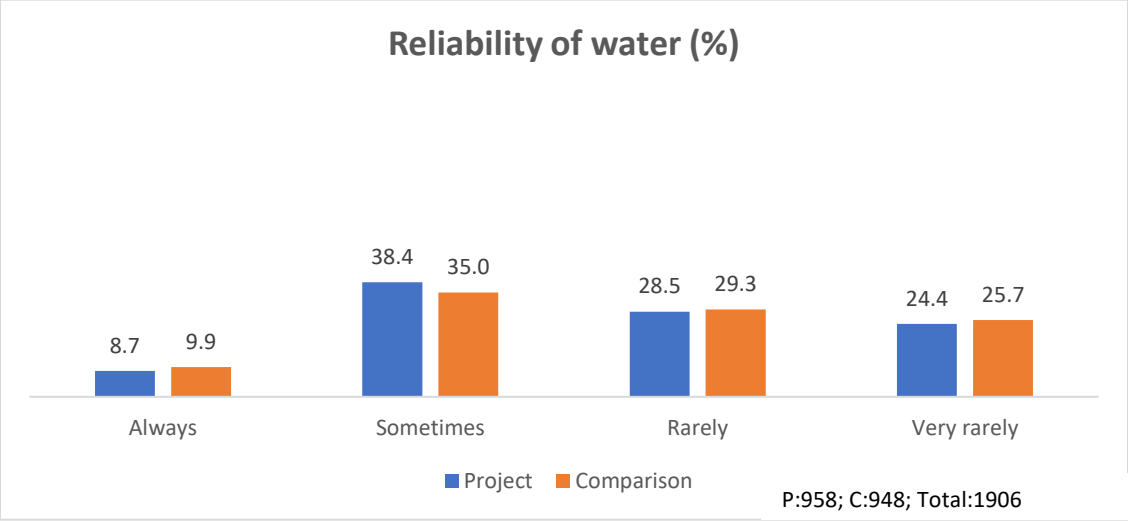


Figure 23: Perception of farmers over the reliability of water from its source for irrigation

As evident from the below figure, the main sources of irrigation for the farmers is dug well in both project and comparison study areas. Borewell/dug well are also used by approximately a quarter of the sample population. Surface water sources like ponds, check dams and rivers or canals were the irrigation sources of a very few farmers.

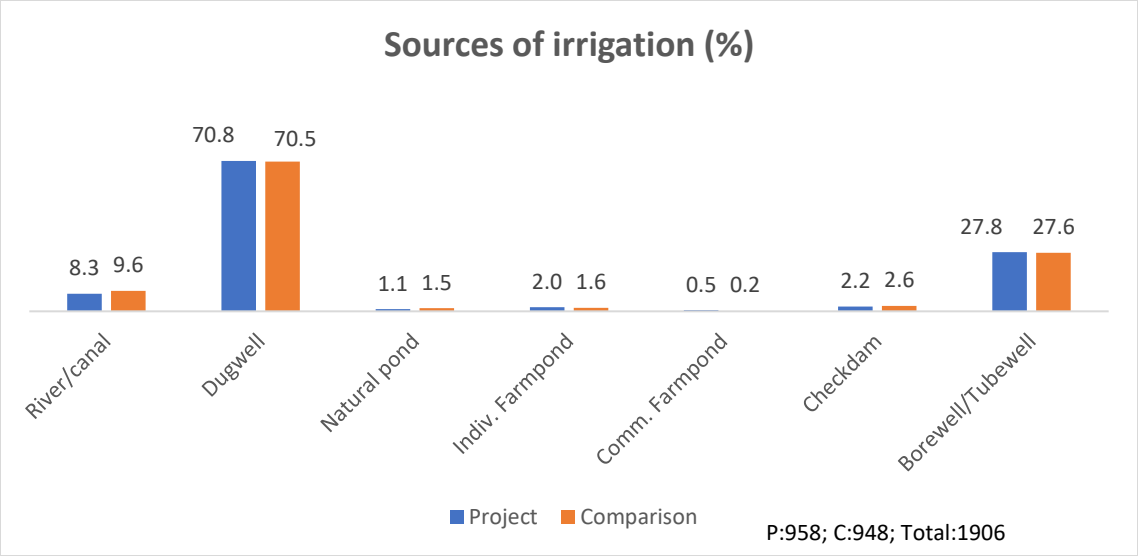


Figure 24: Sources of water for irrigation

The farmers were further enquired how water is drawn from these sources in their field. As evident from the below figure, monoblock electric pump is the most widely used pump for drawing water from the sources for irrigation. Electric submersible pump for wells and electric submersible pumps for borewell are the next most widely used by the farmers in the study area. Solar submersible pumps are used by a very tiny fraction of our sample with only 2.4% from project and 2% from comparison area saying they used these pumps.

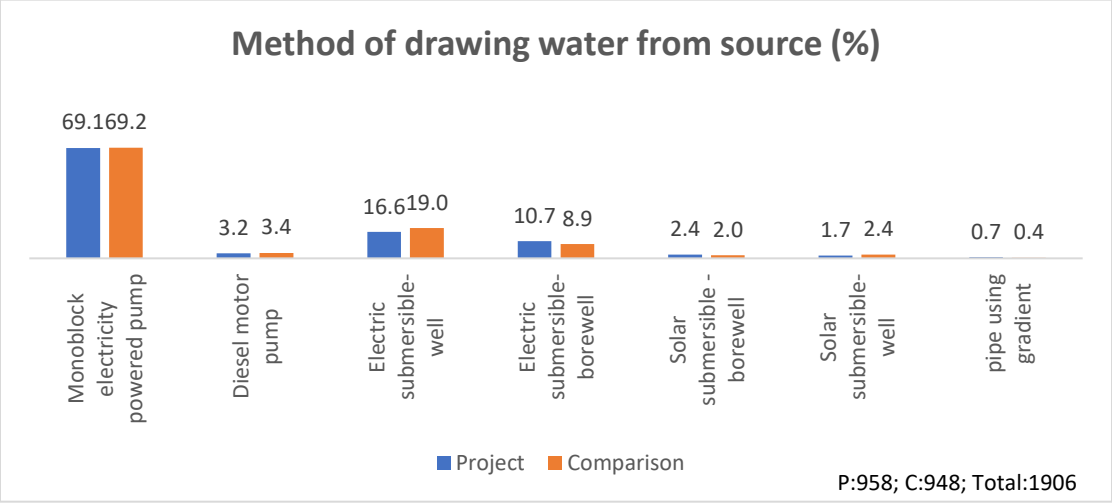


Figure 25: Type of pump used by farmers to draw water from source for irrigation

The farmers having access to pumps were further enquired if their pumps are star rated. 36.4% and 38% of the respondents in project and comparison areas reported of using a star-rated pump, respectively. The remaining either did not know the rating of their pump or did not use a star-rated pump. Farmers using pipes for irrigation were further enquired about the type of pipes used by them for irrigation. The most popular type of pipe used in irrigation is the PVC pipe with 87.9% in project area and 90.5% in comparison area reporting the use of these pipes.

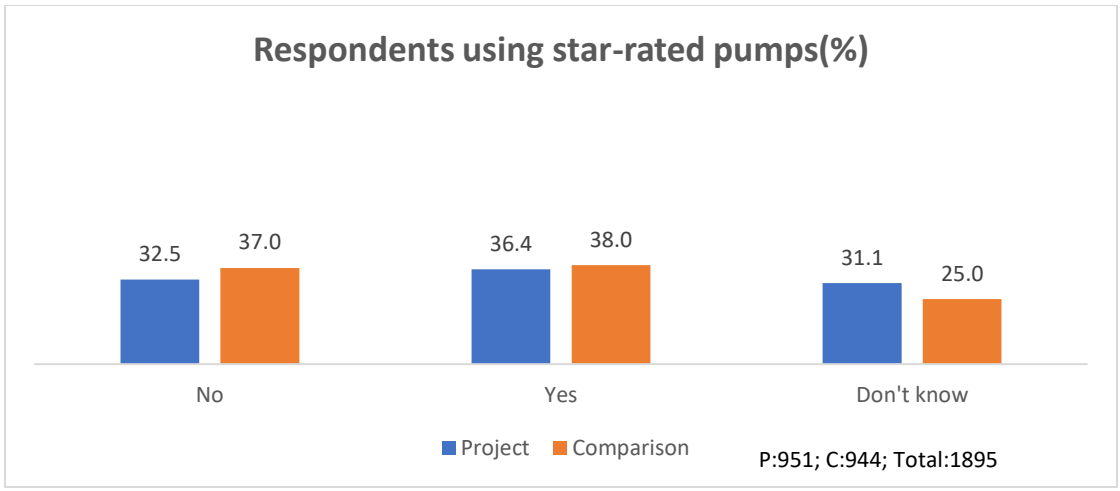


Figure 26 Percent of farmers using star-rated pumps

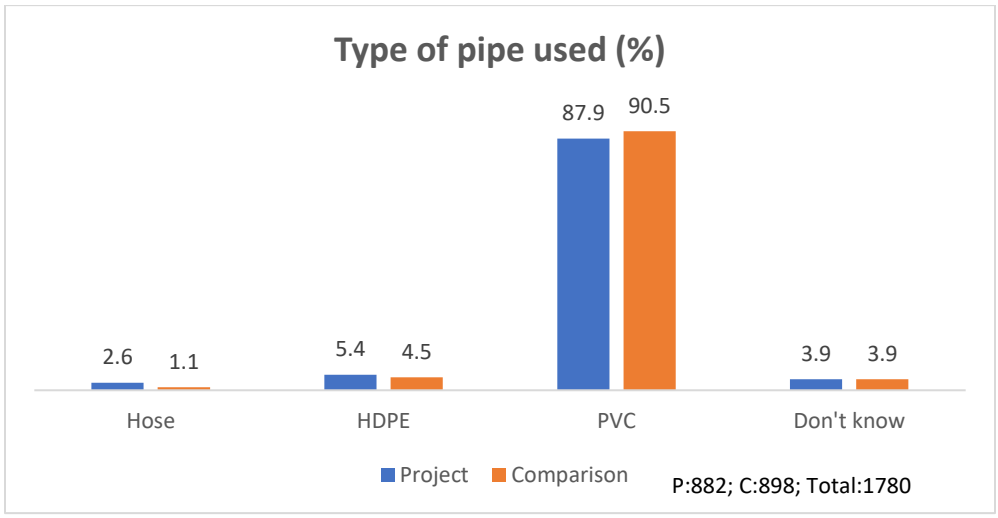


Figure 27: Type of pipe used by farmers for irrigation

As presented in the below figure, approximately 15% of the respondents from project and 14% from comparison had access to a water harvesting structure like farm pond and earthen nala bunds.

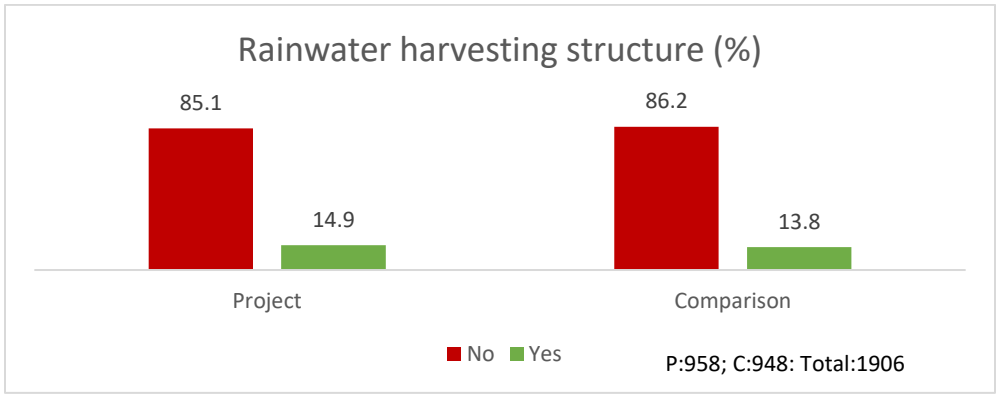


Figure 28: Farmers with rainwater harvesting structure

In cases where farmers reported of having a farm pond they were further enquired about the source of water for the same. The source of water for the farm pond is more towards ground water in project areas and surface or run-off water in comparison areas, as shown in the figure below.

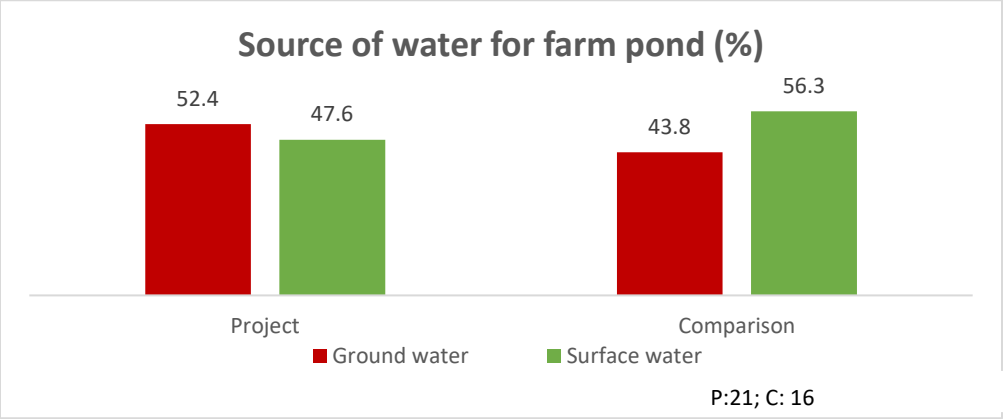


Figure 29: Source of water for individual or community farm pond

Further, when asked if their farm pond had plastic lining, 52% of respondents with farm ponds in project and 50% in comparison areas said that they did.

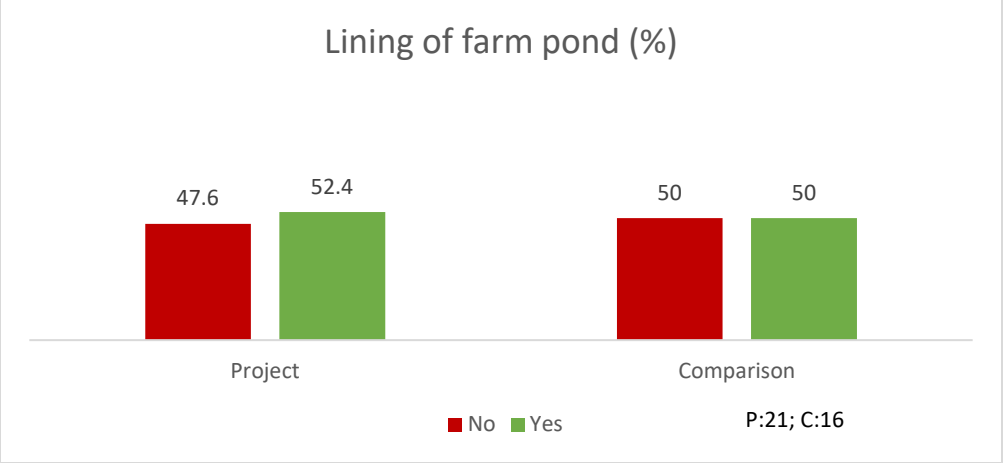


Figure 30: Percent of farm ponds with lining

Farmers having dug wells as source of their irrigation were further enquired if their dug wells are surrounded by walls. As presented in the below figure, 49.3% of respondents in the project area and 42.6% respondents in comparison area had their dug wells surrounded by a wall or fence.

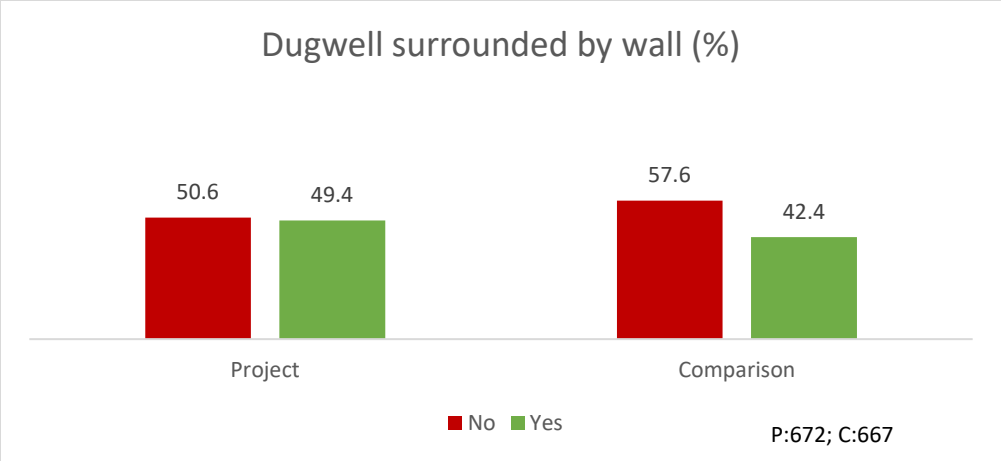


Figure 31: Percent of dug wells surrounded by wall or fence

Farmers having a source of irrigation were further asked about the methods (multiple response question) of irrigation they use. Flood irrigation was the most common method used with 58.3% from project area and 58.7% from comparison area reporting its use. It was followed by drip irrigation (Project: 21.0%; Comparison: 24.2%), micro-sprinkler irrigation (Project: 16%; Comparison: 17%) and manual irrigation (Project: 13.6%; Comparison: 10.2%). Hardly any responses were noted for rain-gun sprinkler.

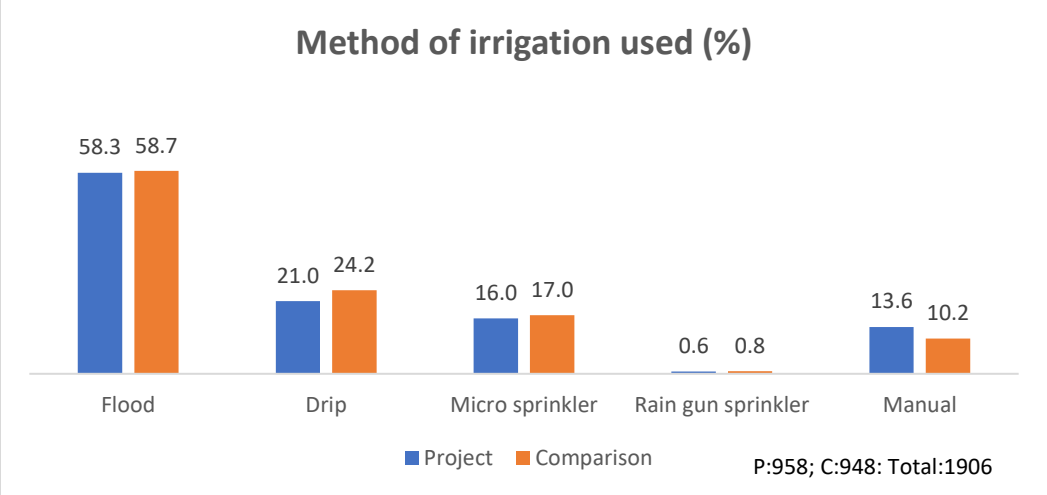


Figure 32: Method of irrigation used by farmers (in percentage)

The below figure presents the district wise use of different irrigation methods. Flood irrigation was used least in Aurangabad and most in Jalna. The use of drip irrigation was reported highest in Aurangabad, which could explain its low numbers in flood and manual irrigation. The use of micro sprinkler was highest in Hingoli, Latur and Nanded. Rain gun sprinkler is barely reported to be used by the respondents.

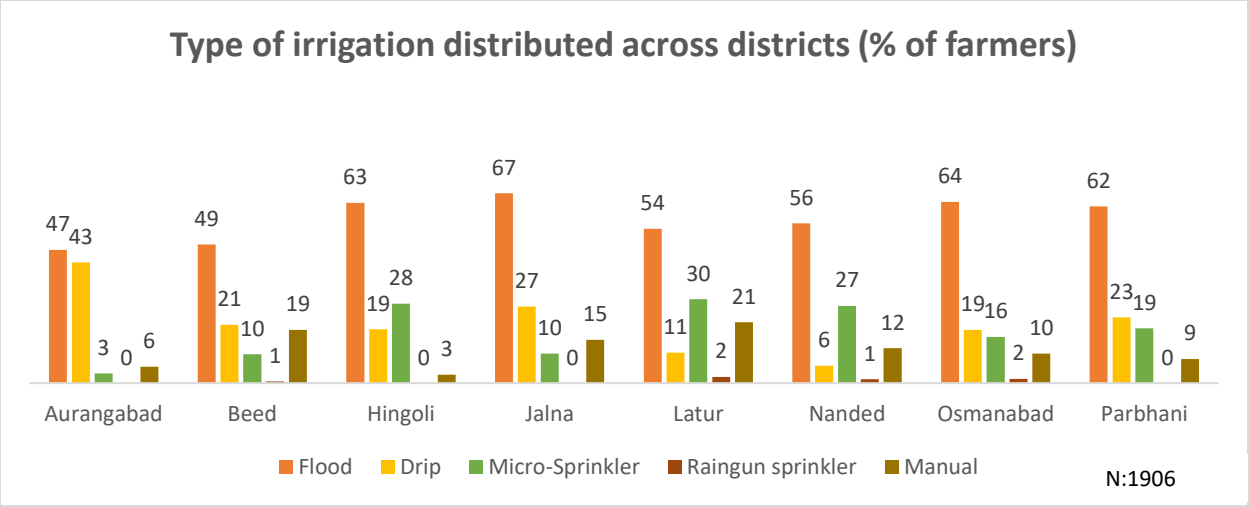


Figure 33: Percentage of farmers across districts practicing different type of irrigation

We further wished to understand the irrigation practices across districts. For this, we mapped the method of irrigation practiced using GIS. We used blue dots for respondents from project area and orange for respondents from comparison area.

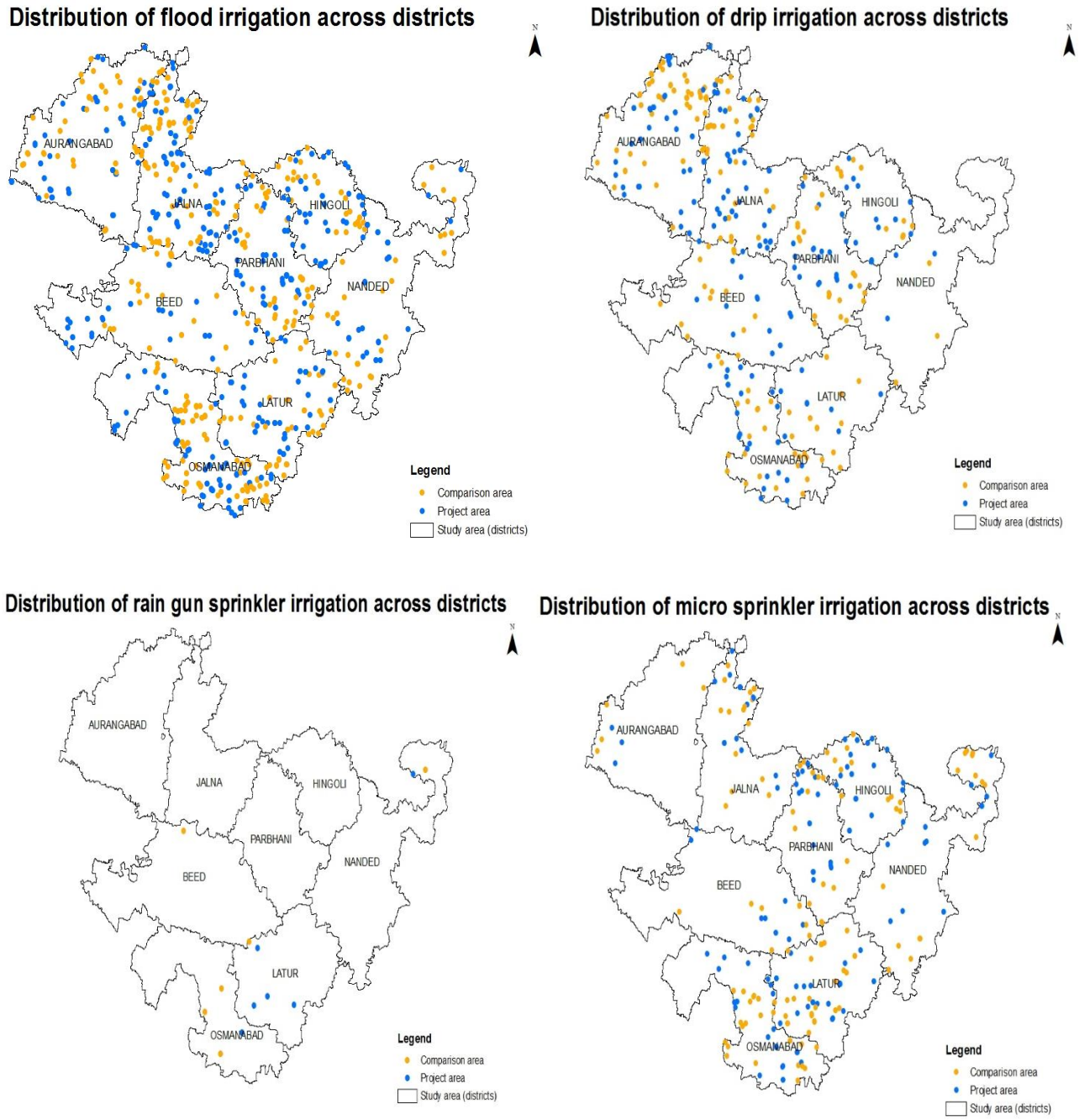


Figure 34: GIS maps of distribution of method of irrigation across districts

Respondents using drip or sprinkler irrigation were enquired about the season wise land area they have irrigated using drip or sprinkler irrigation in the last 12 months. Out of the total land, the percentage of land that was cultivated using drip and sprinkler in each season was calculated. It was found that use of drip and sprinkler irrigation in kharif and rabi seasons was low though a significant percentage of cultivated land was irrigated using drip irrigation in the summer season (project: 42.5% and comparison: 38.1%).

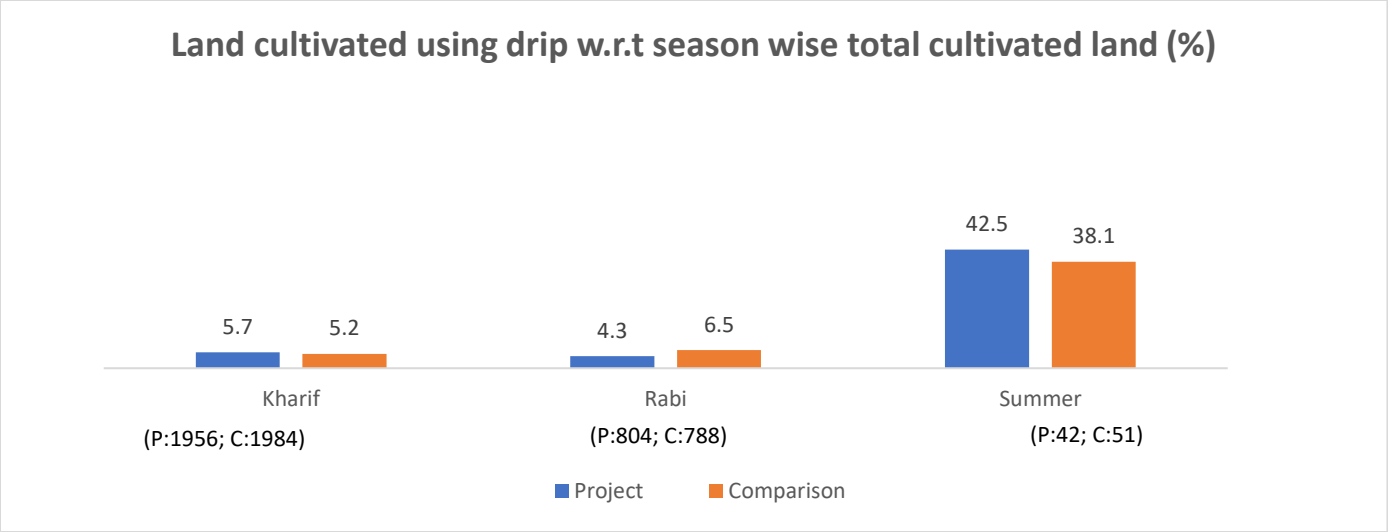


Figure 35: Percentage of land cultivated that is irrigated by drip irrigation

Similarly, low percentage of land was cultivated using sprinkler irrigation in kharif (Project:5.4%, Comparison:4.3%) but relatively higher in rabi (Project:13.8%, Comparison:12.9%) and summer (Project:7.1%, Comparison:26.5%). Though it is to be noted that the number of farmers cultivating in summer season and using sprinkler is because of which the difference across in percentage across project and comparison would not be conclusive.

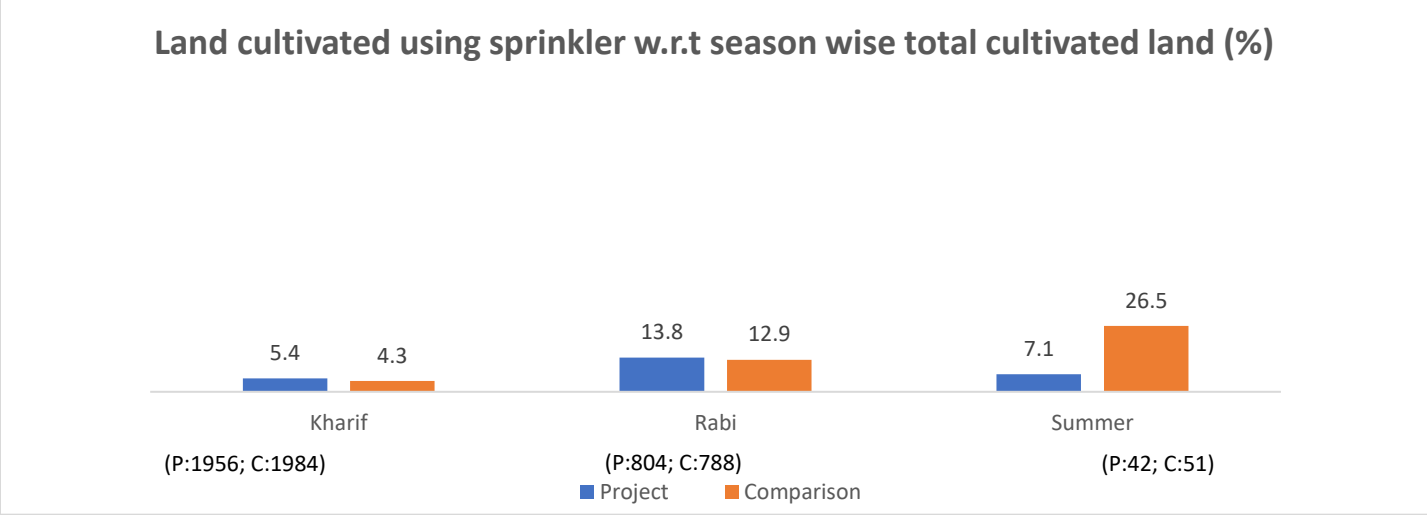


Figure 36: Percent of land under sprinkler irrigation

6.4 Orchards and Periphery management

When asked if they had any land under orchards or plantations, only 5% from project area and 4% from comparison area reported of having so. But a high percent of farmers (Project: 67%; Comparison: 69%) reported of growing trees on the periphery of their agricultural lands. As evident from figure 36, the most widely grown tree is neem, followed by mango and babul, bor and tamarind.

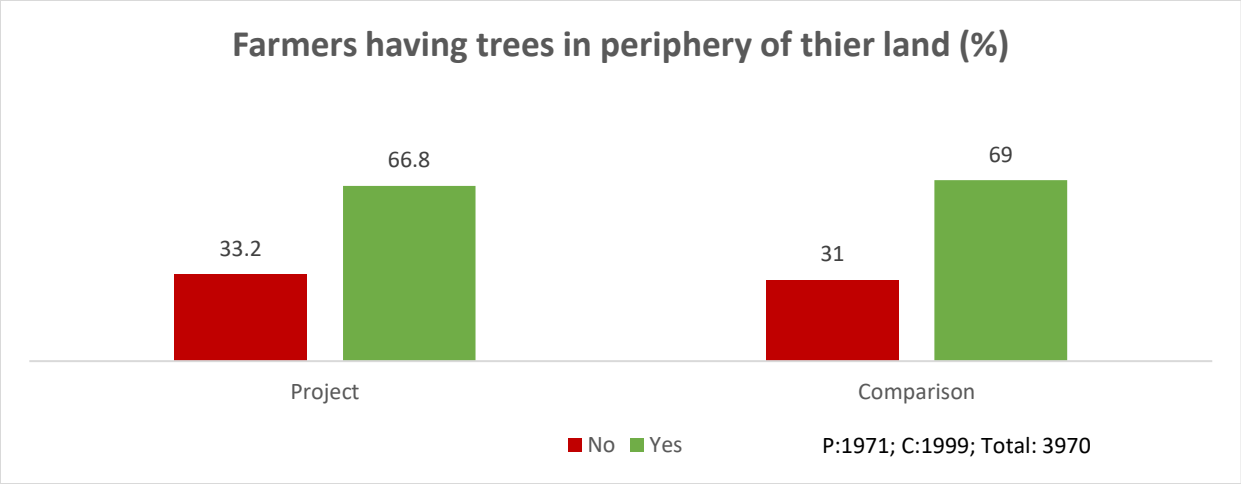


Figure 37: Percent of farmers with trees in the periphery of their agricultural lands

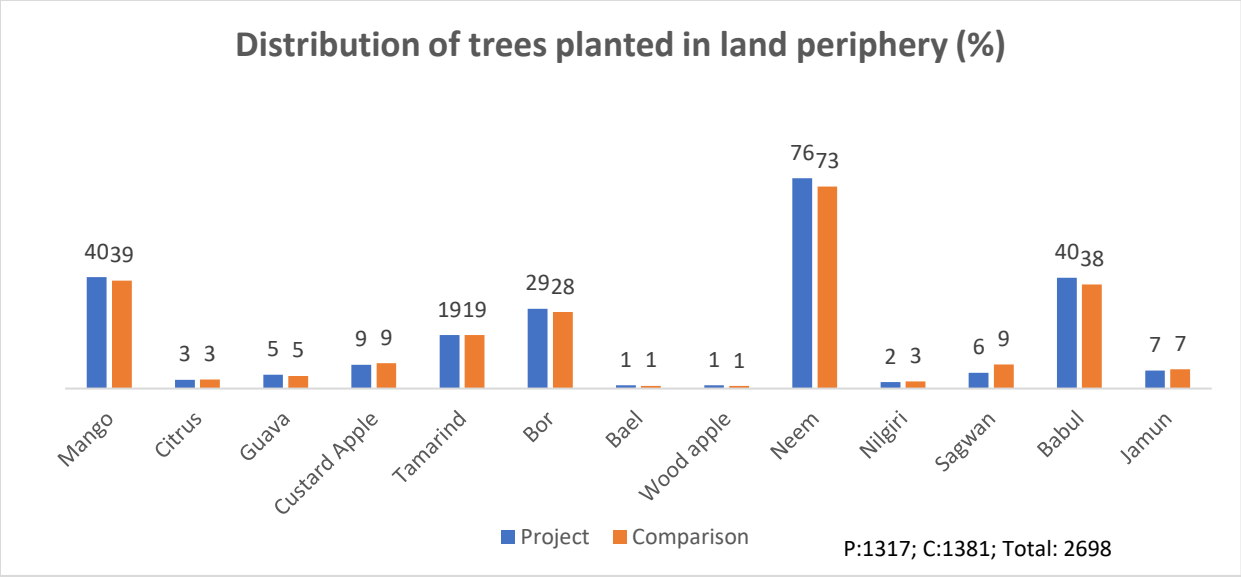


Figure 38: Tree species planted in the periphery of the farms

6.5 Protected farming

The baseline survey also aimed to enquire about the extent to which the protected farming practices like shade-net, poly house or polytunnel are currently adopted. From the sample of surveyed farmers, only eight reported used a using shade-net while only one reported of using poly house for cultivation. No one reported using a polytunnel. This shows that the penetration of protected farming practices is currently very low in the Marathwada region in both project and comparison areas. The practice of fencing around the farmland is also negligible with only 1.8% and 2.2% of the respondents reporting of fencing their land in project and comparison area respectively.

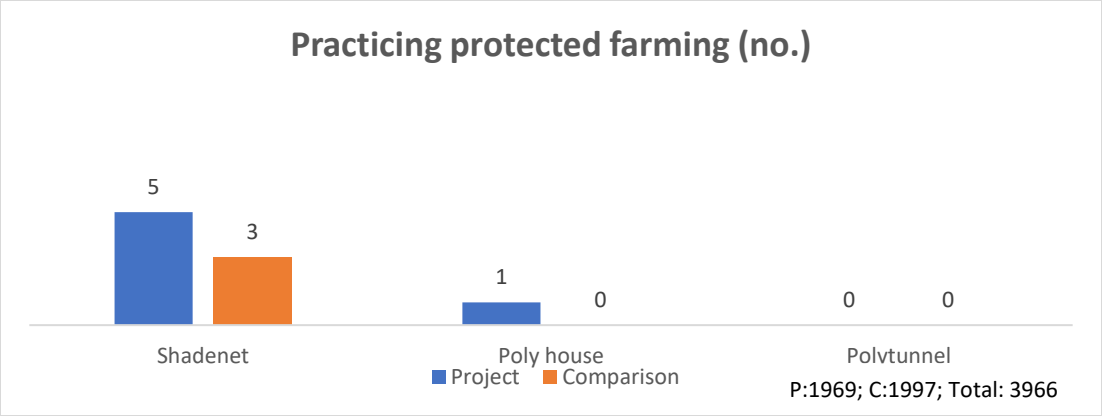


Figure 39: Number of farmers practicing protected farming using shade nets, poly houses and polytunnels

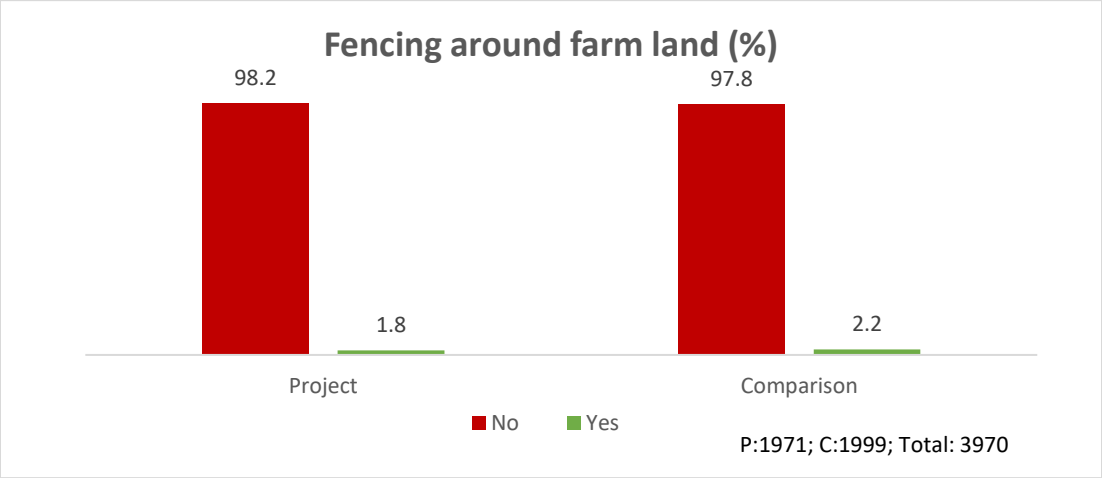


Figure 40: Percent of farmers who have fencing around their agricultural lands

6.6 Cropping Pattern

The net cropped area is the total cultivated area of the farmers, irrespective of the number of times the land was used to cultivate crops. It is the cultivable land of the farmers. Gross cropped area is the total area sown, even if it is sown more than once. The cropped areas are measured in acres.

The total net cropped area is higher in comparison villages than project villages. PoCRA, through its intervention, also aims to improve the cropping intensity in the project area. Cropping intensity is defined as gross cropped area divided by net sown area into hundred. The cropping intensity in the project area is 112 percent and that in the comparison area is 114 percent.

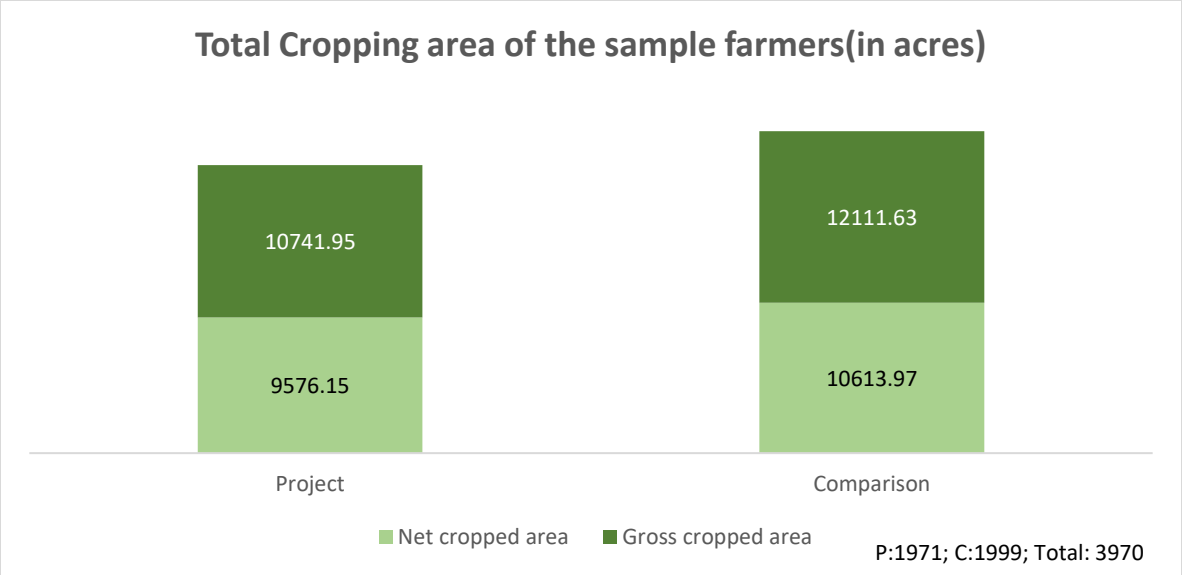


Figure 41: Net cropped area vs. Gross cropped area in project and comparison area

As part of the baseline survey, the farmers were asked in detail about the crops they had grown on their land in different agriculture seasons in the last one year. As evident from below figure, soybean (project: 59.8%, comparison:63.7%) and cotton (project: 49.2%, comparison: 48%) are the most widely grown crops in the kharif season. These are followed by pigeon-pea, green gram and black gram.

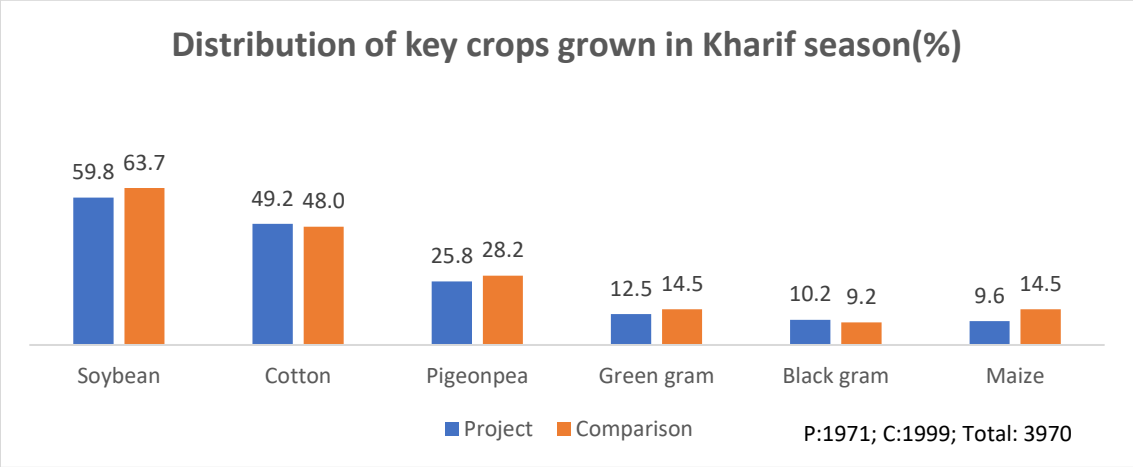


Figure 42: Main crops grown in Kharif

In the rabi season, the most widely grown crops among those who had sown crops in rabi season were found to be sorghum (Project: 59.8%, Comparison: 57.3%) followed by chickpea (Project: 43.8%, Comparison: 50.8%) and wheat (Project: 19.8%, Comparison: 19.6%).

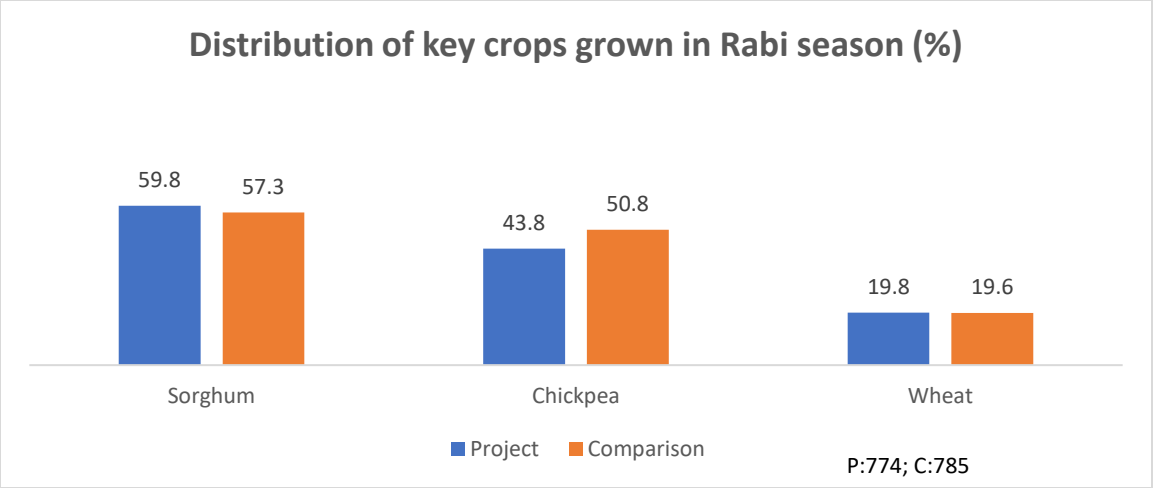


Figure 43: Main crops grown in Rabi

Crop wise percentage of land cultivated using irrigation was also analysed. Out of the kharif crops, it was found that the highest percent of irrigated land for kharif crops is of cotton (25%) and green gram (23%) in project area. Soybean and pigeon pea have the same percent of land under irrigation (14%) whereas blackgram sees the least percent of irrigated land with only 6% under irrigation. For kharif crops in comparison area, cotton again sees the highest area under irrigation (23%) followed by pigeon pea, soybean and black gram and green gram as evident in the below figure.

During cultivation of rabi crops, percentage of land under irrigated land is higher as expected. Percent of cultivated land under chickpea being irrigated is higher (Project:47%, Comparison:33%) than that of percentage of irrigated land under sorghum (Project:24%, Comparison:29%).

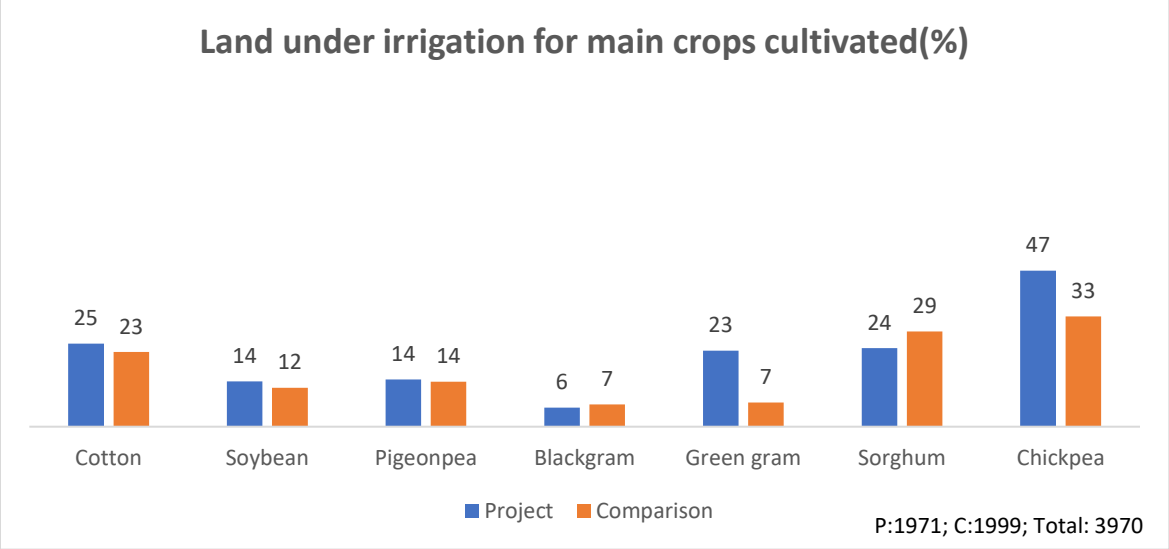


Figure 44: Percent of land under irrigation for main crops

Productivity for the main crops has been calculated as the ratio of gross production (in quintal) to cultivated land under that specific crop (in acres) and has been presented in the below table. The productivity of green

gram and black gram is higher in comparison than project area, though it is to be noted that the sample of farmers cultivating these crops in smaller.

Table 7: Productivity (quintal per acre) of main crops

Crop	Mean Productivity (quintal/acre)	Std.Dev	95%CI	
Soybean				
Project(n=1179)	5.2	1.9	5.1	5.3
Comparison (n=1274)	5.4	2	5.3	5.5
Cotton				
Project(n=969)	4.2	2.9	4.0	4.4
Comparison (n=960)	4.6	2.9	4.4	4.7
Pigeon Pea				
Project(n=509)	4.1	2.9	2.9	4.4
Comparison (n=563)	4.3	2.6	4.1	4.6
Black gram				
Project(n=199)	1.5	2.2	1.2	1.8
Comparison (n=181)	2	1.9	1.7	2.3
Green gram				
Project(n=243)	1.6	1.5	1.5	1.8
Comparison (n=283)	1.7	1.7	1.5	1.9
Chickpea				
Project(n=337)	3.7	2.8	3.4	4
Comparison (n=399)	3.6	2.6	3.4	3.9
Sorghum				
Project(n=460)	2.3	2.8	2.1	2.6
Comparison (n=447)	2.7	2.9	2.4	2.9

The below tables present the district wise average productivity for the above key crops. Average productivity has been presented separately for both project and comparison areas. Though it is to be noted that the district wise productivity values are indicative as the sample is not powered to give district wise statistical estimates.

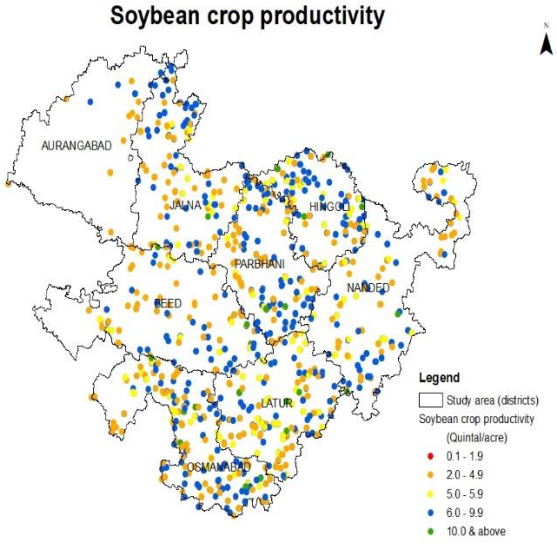
Table 8: Productivity of crops (quintal/acre) in project area across districts

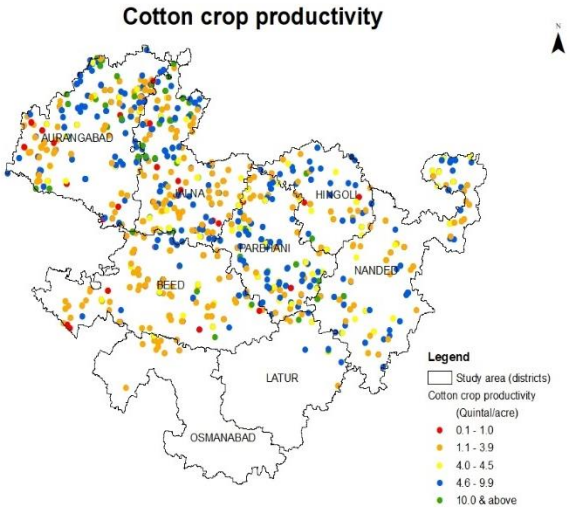
	Soybean	Cotton	Pigeonpea	Blackgram	Green gram	Sorghum	Chickpea
Aurangabad	5.1 (n=6)	4.2 (n=238)	3.56 (n=39)	4 (n=1)	2 (n=19)	1.2 (n=24)	1.8 (n=20)
Beed	4.9 (n=113)	3.1 (n=158)	2.84 (n=50)	1 (n=38)	1 (n=24)	1.7 (n=66)	2.5 (n=37)
Hingoli	5.6 (n=159)	5.7 (n=53)	4.8 (n=29)	1.6 (n=4)	1.8 (n=9)	4.5 (n=14)	5.4 (n=39)
Jalna	5.4 (n=99)	4.1 (n=222)	4.3 (n=56)	1.1 (n=19)	1.5 (n=45)	1.6 (n=56)	3.7 (n=15)
Latur	5.2 (n=224)	5 (n=21)	4.1 (n=104)	1.3 (n=27)	2.1 (n=41)	3.2 (n=60)	3.1 (n=79)
Nanded	5.3 (n=152)	4.1 (n=113)	4.6 (n=48)	2.3 (n=18)	2.2 (n=13)	4.5 (n=15)	5.5 (n=53)
Osmanabad	4.9 (n=260)	2.5 (n=11)	3.4 (n=114)	1.8 (n=82)	1.1 (n=47)	2.2 (n=147)	3.2 (n=70)
Parbhani	5.2 (n=166)	5.3 (n=153)	5.6 (n=69)	1.6 (n=10)	2 (n=45)	2.4 (n=78)	4.2 (n=24)

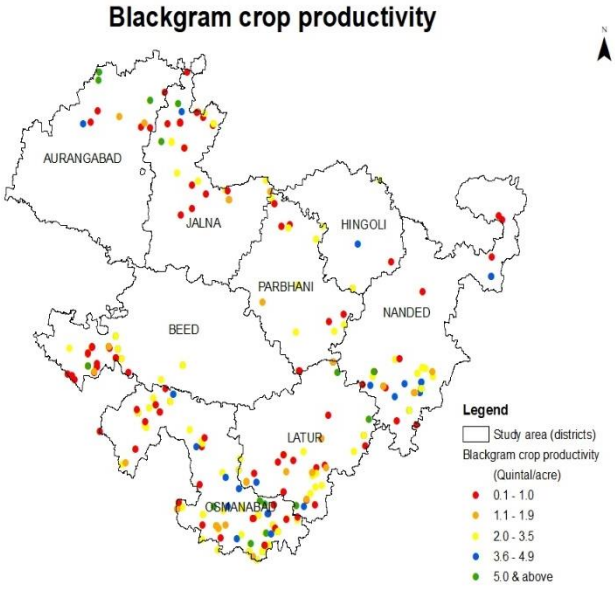
Table 9: Productivity of crops (quintal/acre) in comparison area across districts

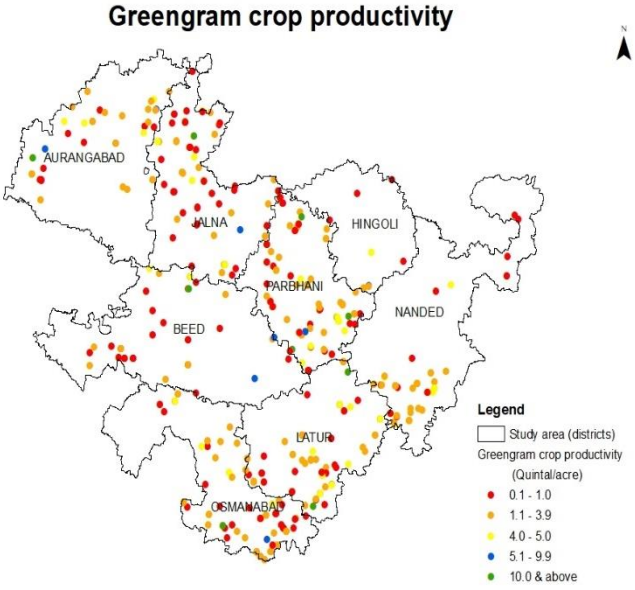
	Soybean	Cotton	Pigeonpea	Blackgram	Green gram	Sorghum	Chickpea
Aurangabad	5.4 (n=13)	4.7 (n=238)	4.8 (n=22)	2.5 (n=10)	1.8 (n=22)	3.2 (n=19)	1.7 (n=9)
Beed	4.9 (n=138)	3.6 (n=153)	3.1 (n=56)	0.6 (n=11)	0.9 (n=29)	1.1 (n=58)	2.2 (n=52)
Hingoli	5.7 (n=157)	4 (n=36)	4.8 (n=53)	1.6 (n=3)	0.8 (n=5)	2.3 (n=3)	4.9 (n=46)
Jalna	5.1 (n=109)	4.7 (n=229)	3.5 (n=53)	1 (n=19)	1.4 (n=43)	1.7 (n=54)	2.6 (n=26)
Latur	5.4 (n=243)	4.3 (n=7)	4.4 (n=124)	2.1 (n=29)	2.1 (n=40)	3.1 (n=62)	3.4 (n=96)
Nanded	5.3 (n=151)	5.2 (n=117)	4.7 (n=93)	2.3 (n=31)	1.8 (n=43)	4.7 (n=18)	4.7 (n=45)
Osmanabad	5.2 (n=282)	3.3 (n=19)	4.4 (n=85)	2.4 (n=68)	1.9 (n=50)	2.7 (n=150)	3.9 (n=86)
Parbhani	5.7 (n=181)	4.9 (n=161)	4.6 (n=77)	1.1 (n=10)	1.9 (n=51)	3.5 (n=83)	3.8 (n=39)

On mapping the productivity of these main crops, we tried to gauge the spatial variability in their yield. Soybean farmers were very few in Aurangabad district. For cotton, more farmers and higher yields were observed in Aurangabad, with very few farmers in the lower belt of Marathwada. Blackgram was sown mostly in the lower belt of Marathwada, with Osmanabad, Latur and Nanded accounting for most farmers. Greengram saw a spattering of farmers in all the districts, and Beed and Jalna showed low productivity. For the rabi crops of Chickpea and Sorghum, we again see higher concentration of farmers in Osmanabad and Latur. This region also accounts for high productivity numbers.


Soybean crop productivity
AURANGABAD
JALNA
HINGOLI
PARBHANI
NANDED
BEED
LATUR
OSMANABAD
Legend
Study area (districts)
Soybean crop productivity
(Quintal/acre)
0.1 - 1.9
2.0 - 4.9
5.0 - 5.9
6.0 - 9.9
10.0 & above


Cotton crop productivity
AURANGABAD
JALNA
HINGOLI
PARBHANI
NANDED
BEED
LATUR
OSMANABAD
Legend
Study area (districts)
Cotton crop productivity
(Quintal/acre)
0.1 - 1.0
1.1 - 3.9
4.0 - 4.5
4.6 - 9.9
10.0 & above


Blackgram crop productivity
AURANGABAD
JALNA
HINGOLI
PARBHANI
NANDED
BEED
LATUR
OSMANABAD
Legend
Study area (districts)
Blackgram crop productivity
(Quintal/acre)
0.1 - 1.0
1.1 - 1.9
2.0 - 3.5
3.6 - 4.9
5.0 & above


Greengram crop productivity
AURANGABAD
JALNA
HINGOLI
PARBHANI
NANDED
BEED
LATUR
OSMANABAD
Legend
Study area (districts)
Greengram crop productivity
(Quintal/acre)
0.1 - 1.0
1.1 - 3.9
4.0 - 5.0
5.1 - 9.9
10.0 & above

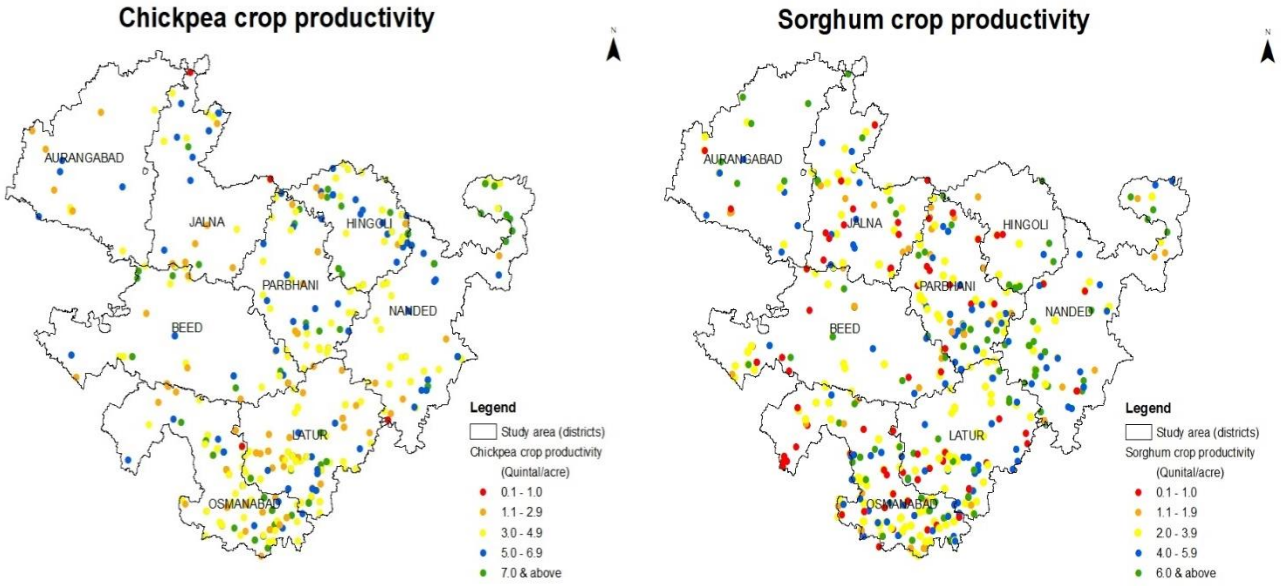


Figure 45: GIS map of productivity distribution of main crops

Additionally, as part of the baseline survey, the average per acre cost of cultivation under the key cost heads viz. cost of inputs, cost of labour and cost of marketing (which was further broken down) was enquired from the respondents. These costs have been presented in the below table. The cost of cultivation per acre has been calculated for the key crops namely cotton, pigeon pea, soybean, black gram, green gram, chickpea and rabi sorghum. Fertilizers, followed by pesticides, seeds and labour are the cost heads with maximum expenditure. Further, it is found that cost of irrigation is negligible for kharif crops, except for cotton which is water intensive. The cost of storage is also negligible, which can be related to our finding that storage facilities are not available in the study area.

Table 10: Average cost of cultivation under main cost heads for key crops

	Cotton		Pigeon pea		Soybean		Blackgram		Greengram		Chickpea		Sorghum	
	Project (n:969)	Comparison (n:960)	Project (n:509)	Comparison (n:563)	Project (n:1179)	Comparison (n:1274)	Project (n:201)	Comparison (n:184)	Project (n:246)	Comparison (n:288)	Project (n:339)	Comparison (n:399)	Project (n:462)	Comparison (n:449)
Key heads - Cost of cultivation														
Seeds (INR/acre)	1479	1562	480	472	1721	1936	665	724	429	559	1234	1222	426	189
Fertilizers (INR/acre)	3482	3556	1557	1489	1528	1559	1353	1540	1152	1509	2841	1141	1376	817
Pesticides (INR/acre)	2718	3000	1468	1788	1361	1446	810	1334	1043	1177	1856	911	189	333
Transportation (INR/acre)	355	357	212	243	353	351	128	161	117	110	282	224	64	42
Rent of machinery (INR/acre)	1243	1495	995	1199	1382	1797	896	1121	987	1093	2787	975	784	711
Labour (INR/acre)	2312	2883	1193	1743	2016	2001	1374	1123	997	1124	1326	1275	977	1073
Irrigation (INR/acre)	44	50	9	8	6	6	0	13	0.33	4.3	72	91	35	54
Draught animal (INR/acre)	666	765	386	416	402	416	344	315	413	345	222	228	268	305
Crop insurance (INR/acre)	401	401	245	214	351	391	286	263	196	261	310	190	170	170
Transaction cost (INR/acre)	50	51	39	42	65	61	41	18	15	17	44	34	7	7
Storage (INR/acre)	9	4	4	17	6	4	0	11	0	2	11	3	2	12

Furthermore, we looked at the water productivity of the five crops of kharif- soybean, cotton, pigeon pea, green gram and black gram. The baseline water productivity values have been presented in section 7.4 . This below table presents the water productivity of each of these crops disaggregated for irrigated and un-irrigated lands. In the figure below, we find that the water productivity of irrigated crops is higher than un-irrigated crops, except in the case of green gram.

Table 11: Crop wise WP for Irrigated and Non-Irrigated

	Mean WP (kg/m3)	Std. Dev.	Confidence Interval (95%)	
Cotton				
Non-irrigated	0.811	0.0232262	0.766167	0.857276
Irrigated	1.041	0.0548254	0.933756	1.148817
Soybean				
Non- irrigated	1.588	0.0421262	1.505924	1.671141
Irrigated	2.148	0.1450957	1.864354	2.433414
Pigeon pea				
Non- irrigated	0.461	0.0176531	0.426946	0.49624
Irrigated	0.506	0.0377151	0.432169	0.580213
Black gram				
Non- irrigated	0.485	0.0889384	0.31081	0.660826
Irrigated	0.571	0.1172456	0.340513	0.801933
Green gram				
Non- irrigated	0.701	0.1929695	0.322095	1.080692
Irrigated	0.512	0.1379858	0.241058	0.783505
Overall				
Non- irrigated	1.086	0.0266667	1.034054	1.138608
Irrigated	1.371	0.0649895	1.244106	1.498915

In addition to growing crops for consumption and selling, a few farmers are also engaged in seed production, though on a very small scale (presented in below figure). Only about 0.76% of farmers from project area and 1.1% farmers from comparison area reported being engaged in seed production. In project area farmers reported of being engaged in seed production for pigeon pea, soybean and chickpea. Though in comparison area, there is relatively more land under seed production for cotton and soybean and chickpea (Figure 44).

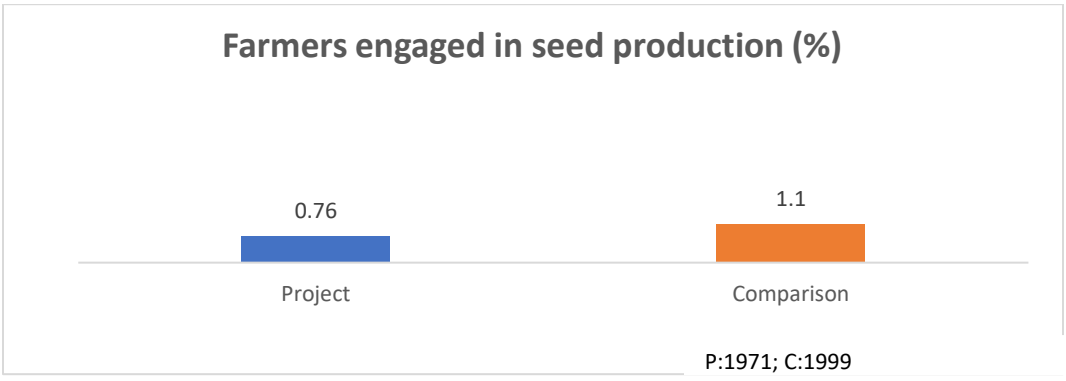


Figure 46: Percent of farmers involved in seed production activity

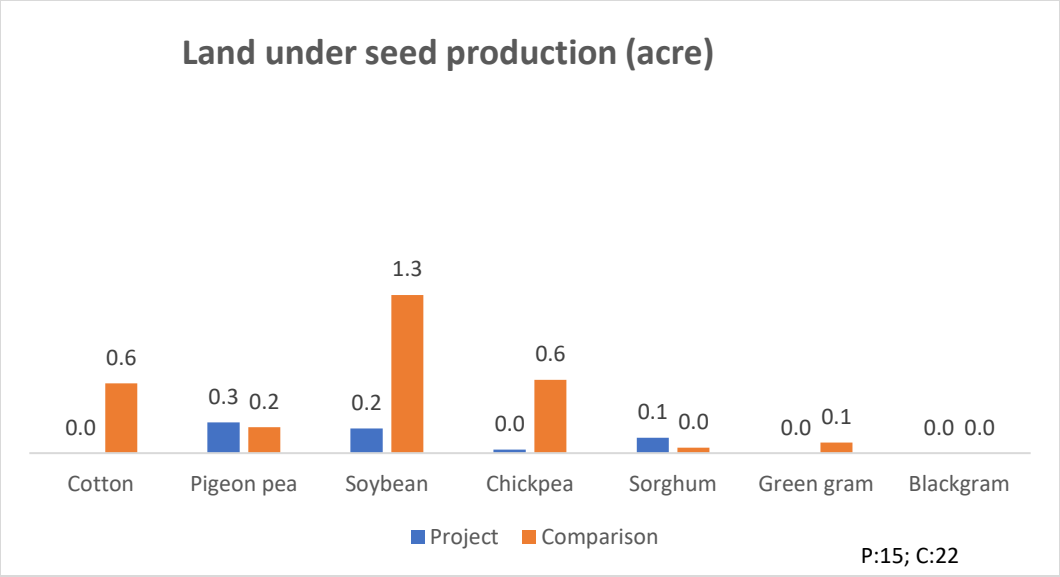


Figure 47: Land under seed production for main crops

As part of the baseline survey, response of farmers on availability of machine/tools on rent was enquired. As evident from the below graph a fairly high (Project: 77.6% and Comparison:74.8%) percentage of farmers were able to use/rent farm machinery when they required it. When asked about availability of agriculture related skilled labour in their area, 70% from project area and 66% from comparison area said that skilled labour was available for work when they needed them.

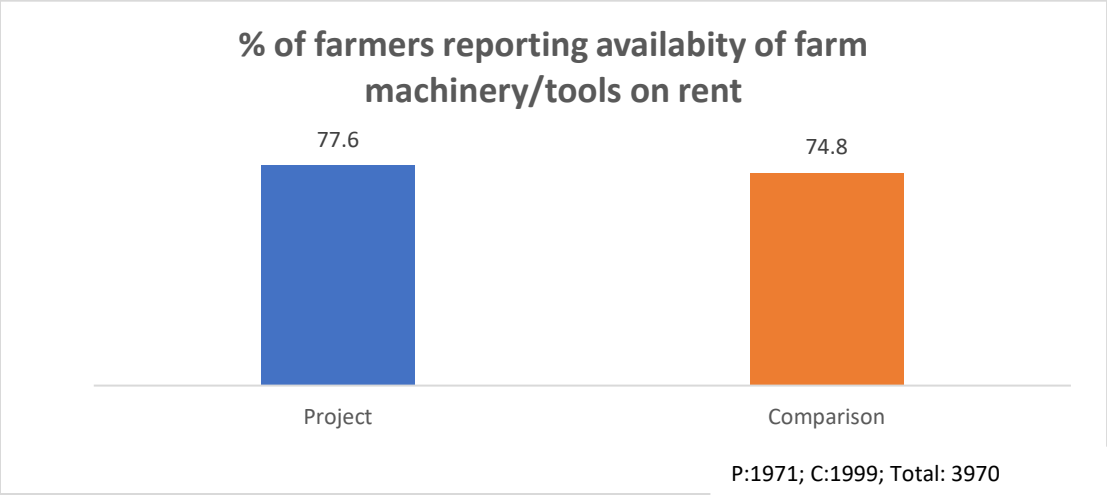


Figure 48: Percent of farmers who said that machinery is available

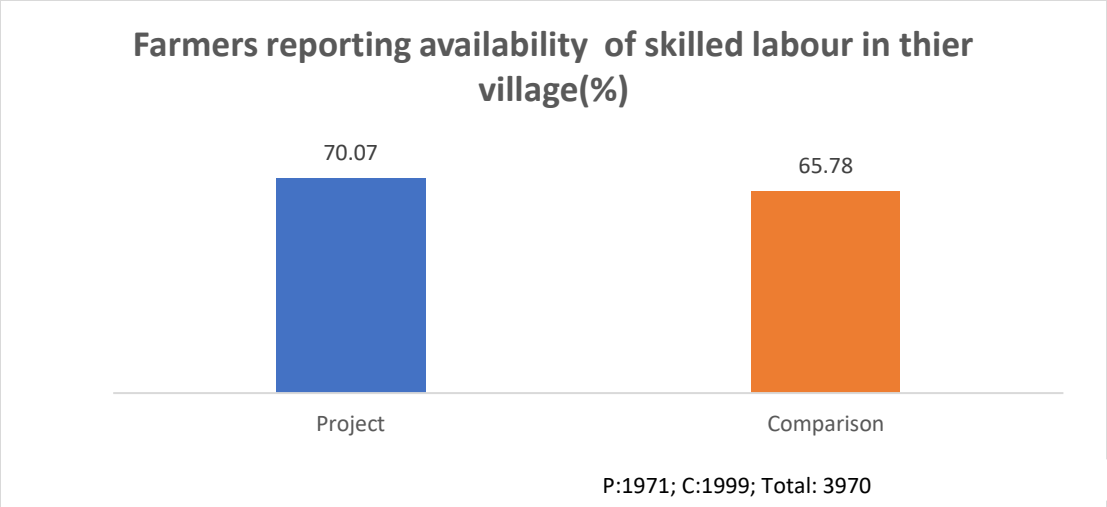


Figure 49: Percent of farmers who said skilled labour is available

6.7 Integrated Pest Management Practices

Pests attacks are a major bane to agriculture in Marathwada region, with most pests attacking cotton and soybean. We asked the farmers questions on how they managed the pests on their fields and their practices and awareness related to pest management.

Jeevamrut, Beejamrut and neem extract are made from natural ingredients by farmers. We asked the farmers if they prepared these solutions on their farm. As evident from the below graph, only 5% of the farmers in both project and comparison villages have reported that they prepare Jeevamrut/ Beejamrut/ Neem extract solution for application on their land.

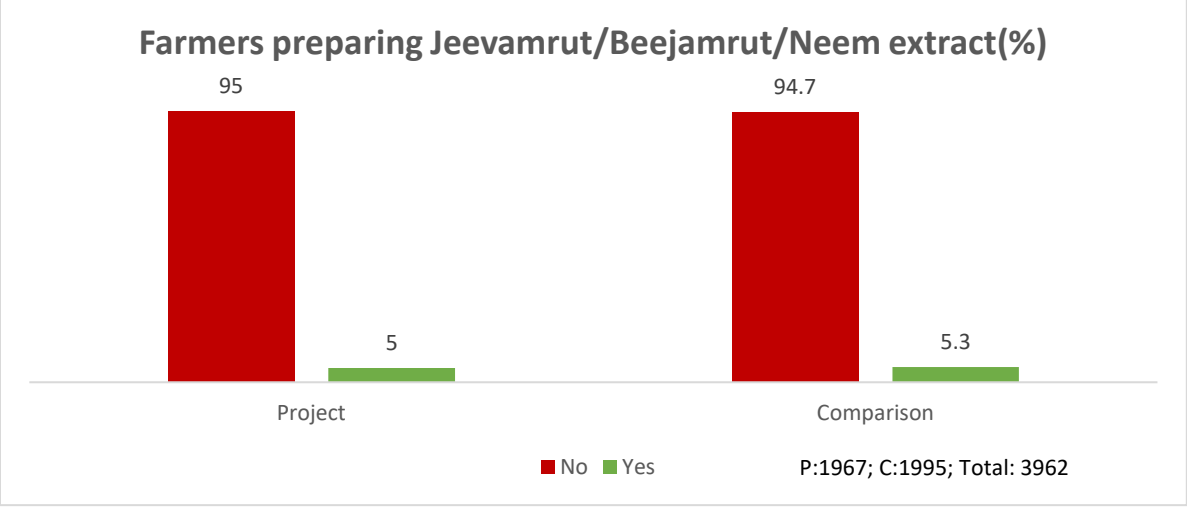


Figure 50: Percent of farmers who prepare Jeevamrut on their field

Another method of mitigating pest attack is introduction of natural enemies of pests like spider, ladybird and other insects in the crop. We enquired the farmers about the awareness of the different natural enemies to pests. As evident in the below graph, this awareness was observed to be low with most responses for spider,

parasitic wasp and dragonfly. 69 % of respondents in project arm and 65.6% of respondents in comparison arm were not aware of any natural enemies to the pests.

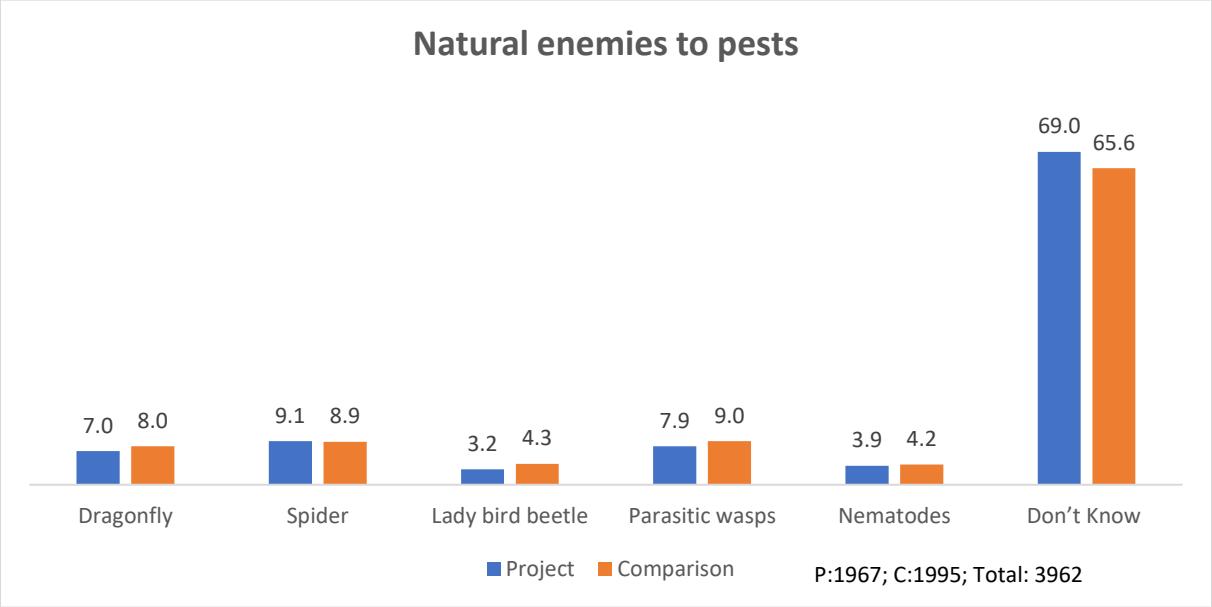


Figure 51: Percent of farmers aware of natural enemies to pests

Besides natural remedies, the farmers were asked about their use of pesticides. 91% farmers from both project and comparison area acknowledged of using pesticides in their fields. Chemical pesticides are highly toxic and safety measures have to be taken before, during and after their use. Farmers who acknowledged using pesticides were further enquired about the safety measures they adopt while spraying pesticides on the field. The most common safety measures adopted by the farmers who use pesticides are to cover eyes and nose while spraying, to wear gloves while spraying and take a bath after spraying pesticides in the field. Very low percentage of farmers reported of disposing the pesticide bottle safely after use. However, this reported finding differs greatly from field observations by experts. From the field visits, it was found that practice of safety precautions during and after use of pesticides is negligible. The high reported figures could mean that though the awareness amongst farmers of such safety precautions is high but the actual practice is low and needs to be improved.

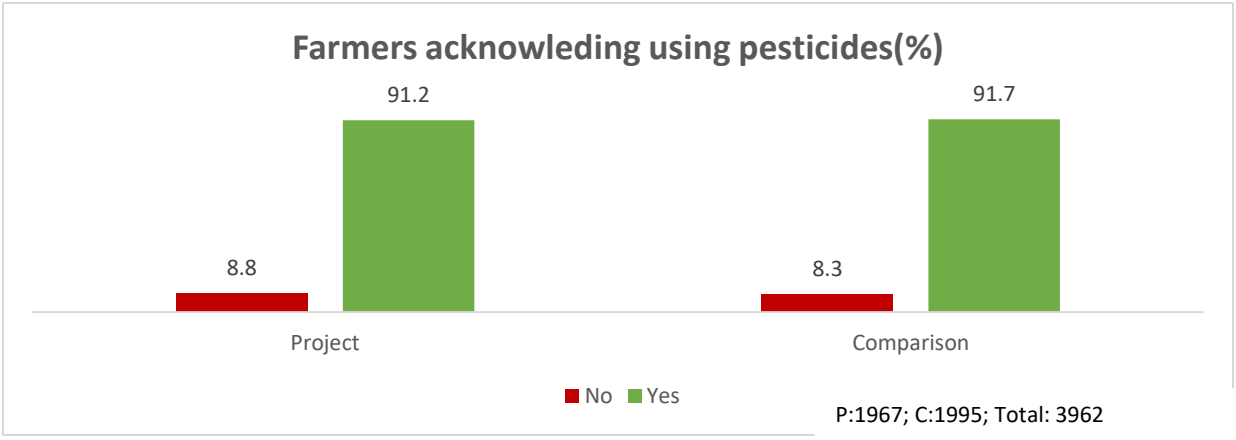


Figure 52: Percent of farmers who use pesticides

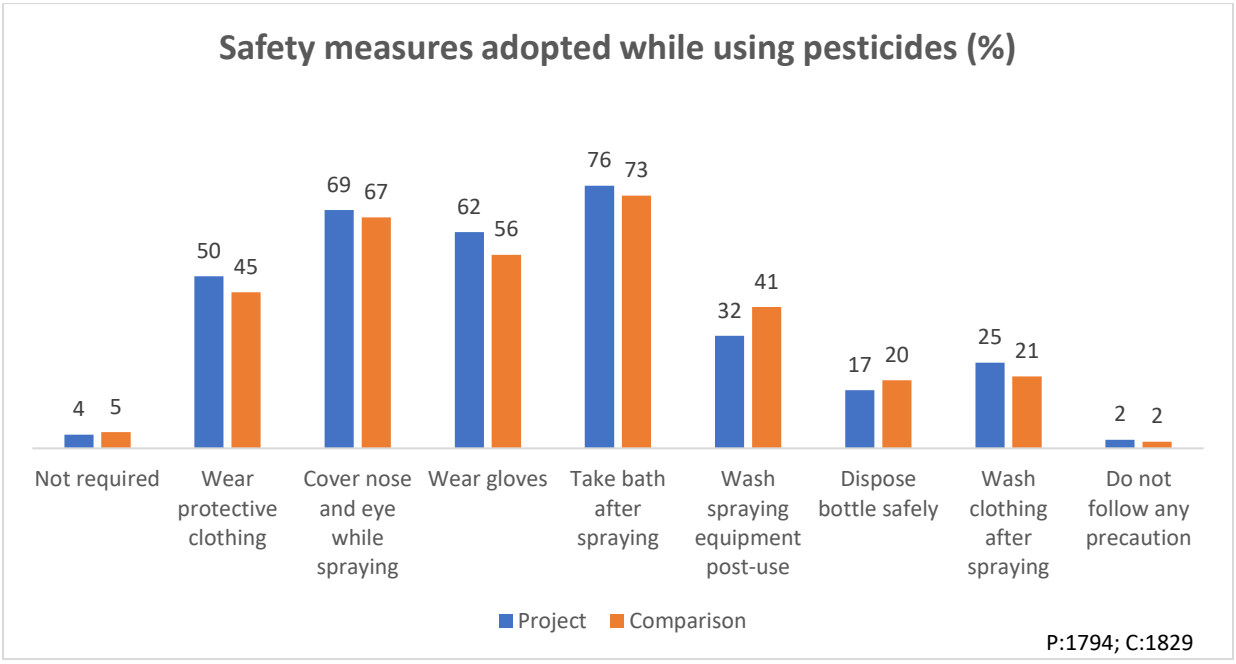


Figure 53: Safety precautions followed by farmers while spraying pesticides

To understand the extent to which the crops of the farmers were affected by pests, farmers were asked if their crop was affected by any pest or disease in the last 12 months. As reported in the below figure, 84% farmers in project area and 88.9% farmers in comparison area reported of their crop being affected by pests or diseases in the last 12 months.

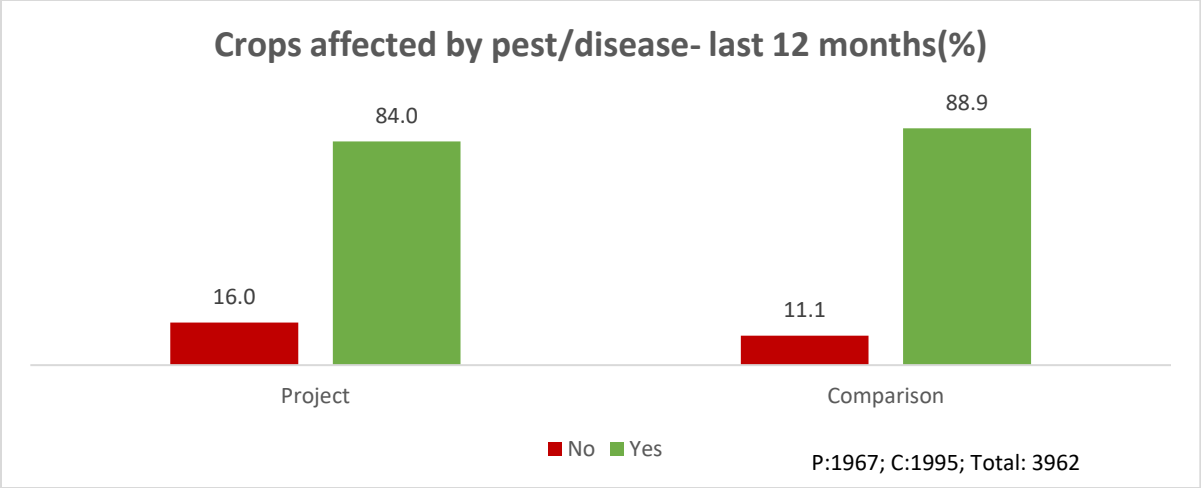


Figure 54: Percent of farmers acknowledging their produce was affected by pest or disease attacks in the last 12 months

Farmers who said that they had been affected by pests and diseases were asked to specify the main pests and diseases which affected these crops. The crops most affected by pests and diseases are soybean (Project: 63%; Comparison:65.6%) and cotton (Project: 50%; Comparison: 48.5%). Pigeon pea, sorghum, and chickpea were reported to be affected by pest by less than 30% of farmers, as seen in the figure below.

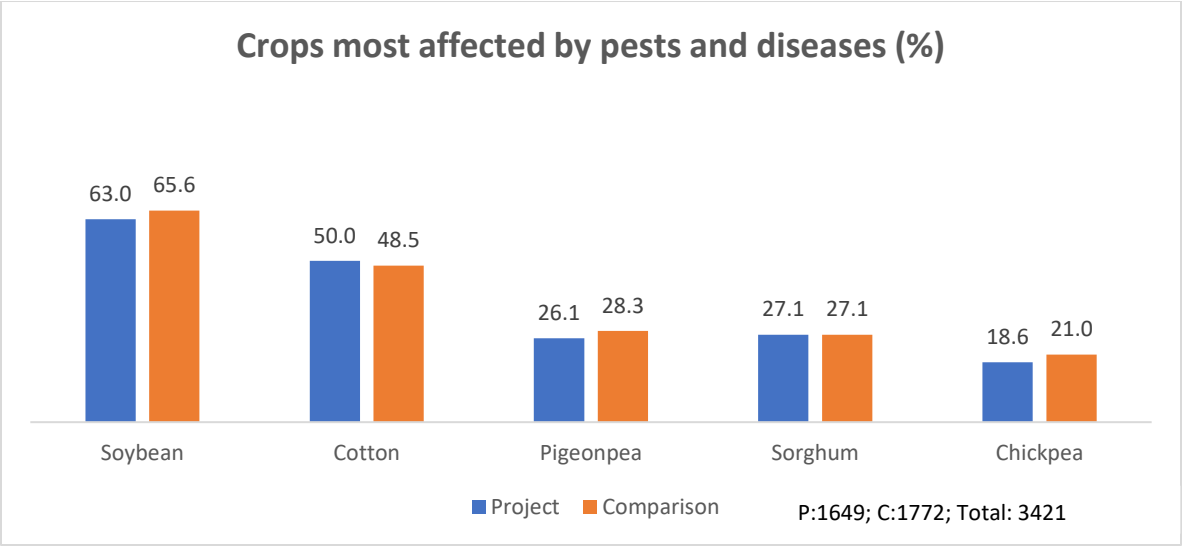


Figure 55: Percent of crops most affected by pests and diseases

We enquired further into the specific pests and diseases which affect these crops. Bollworm is reported to be the main pest which destroys cotton (Project: 93%; Comparison:94.6%). Caterpillar and podborer are two pests which are common for most of the crops. The list of crops and their corresponding pests is listed in the table below.

Table 12: Crops and the corresponding percentage of pests/diseases that affect them

CROP	DISEASE/ PEST	PROJECT	COMPARISON
COTTON	Bollworm	93%	94.6%
	Aphids	39.9%	44%

	Jassids	31.9%	34.9%
SOYBEAN	Caterpillar	60%	55.2%
	Podborer	54.4%	56.4%
	Aphids	33.4%	33.6%
PIGEON PEA	Caterpillar	60.6%	56.3%
	Podborer	61.2%	61.7%
	Leaf webber	41.1%	42.9%
SORGHUM	Caterpillar	60.7%	54.2%
	Aphids	39%	44.3%
CHICKPEA	Caterpillar	65.7%	61.1%
	Podborer	60.7%	56.5%
	Leaf webber	41.4%	41.7%

Apart from the field, another important site where pests destroy the harvest is at godowns/storage. We asked the farmers if pest management was followed in the godowns or storage facility they use. As presented in the below graph, most of the farmers did not know or said that no pest control measures were taken. Only 21.5% in project and 27% in comparison said that measures for managing pests were employed at the godown.

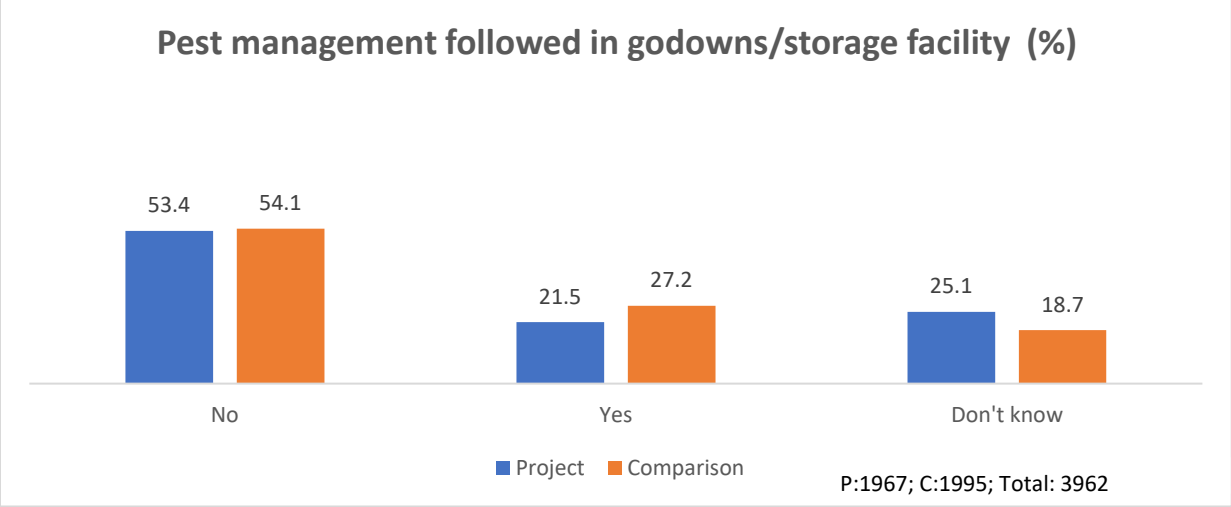


Figure 56: Percent of farmers reporting that pest management is followed in their godowns or storage facility

6.8 Integrated Nutrient Management

In addition to pest management, nutrient management is essential for improved crop productivity and reducing diseases in the crop. Soil testing is very important for understanding the nutrient composition and for nutrient management of the soil. As presented in the below graph, awareness of soil-testing was found to be very low with only 28% from project and 25% from comparison saying they knew about it. Of the respondents who were

aware of soil-testing, 55% (in both project and comparison arm) had never gotten soil testing of their fields. Out of the respondents aware about soil testing, 44% in project arm and 43 % in comparison arm reported of getting soil testing done but did not have their cards available with them. Only 0.7% respondents in project and 1.8% respondents in comparison arm acknowledged getting soil testing done and having their soil heath card available with them.

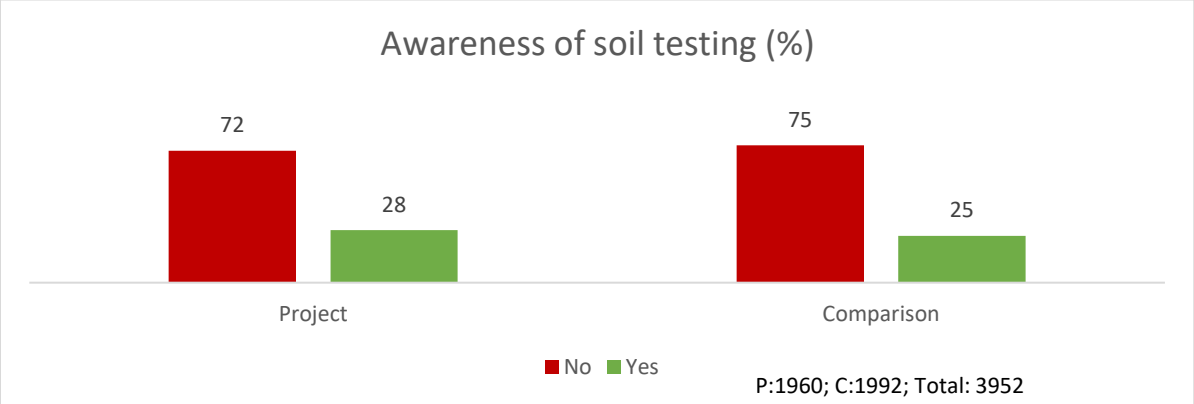


Figure 57: Farmers aware of soil-testing

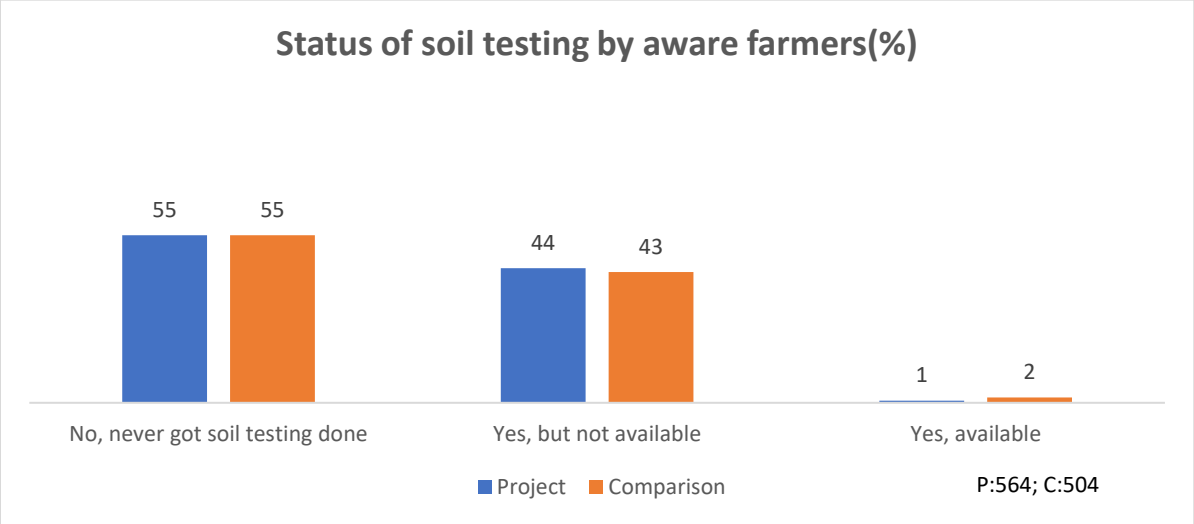


Figure 58: Percent of farmers who got soil-testing done

Another way of ensuring quality of soil is through intercropping where complementary crops are sown alongside. Practice of intercropping is not that widespread with 13% in project area and 16% in comparison area reporting that they have ever practiced it. The most popular combination of crops for intercropping is soybean and pigeon pea (Project: 51%; Comparison: 50%) followed by cotton and pigeon pea (Project: 40%; Comparison: 39%).

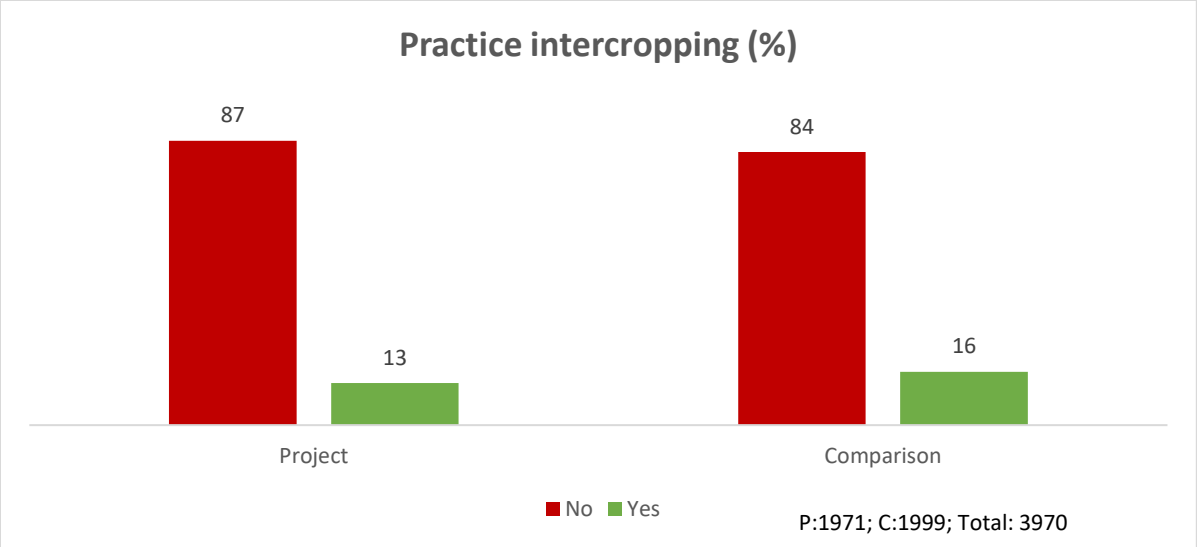


Figure 59: Percent of farmers who practice intercropping

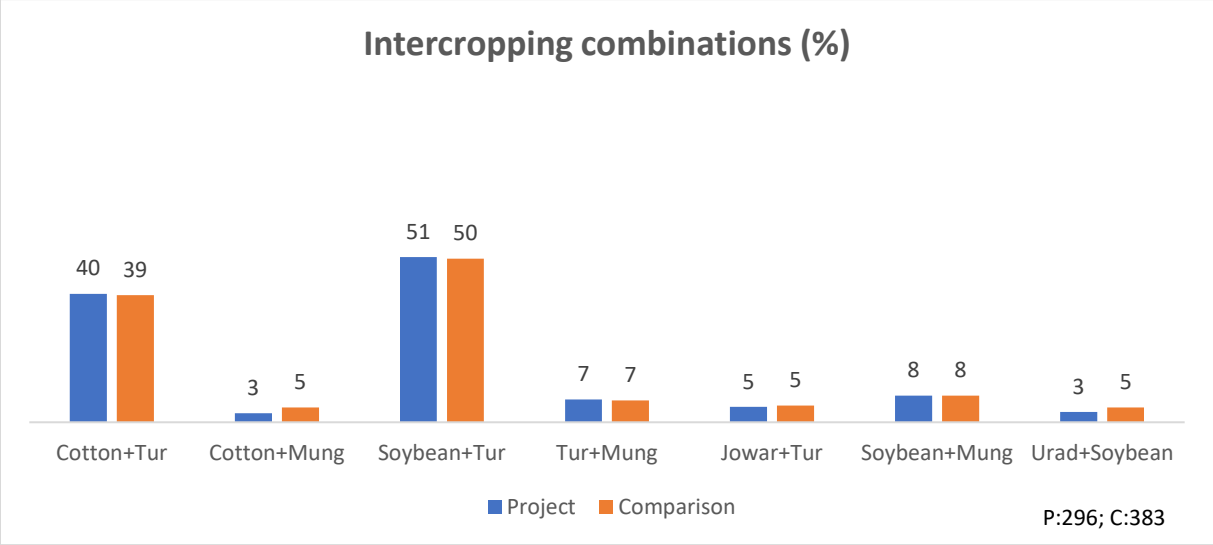


Figure 60: Combinations of crops used during intercropping

We also asked the farmers how they deal with crop residue after harvesting the crops. The most common method followed is burning of the residue in the field (Project: 61%; Comparison: 64%) and using it as animal feed (Project: 49%; Comparison: 46%). Only 2% farmers in both project and comparison areas use the remaining stubble as mulching for their fields (figure 58).

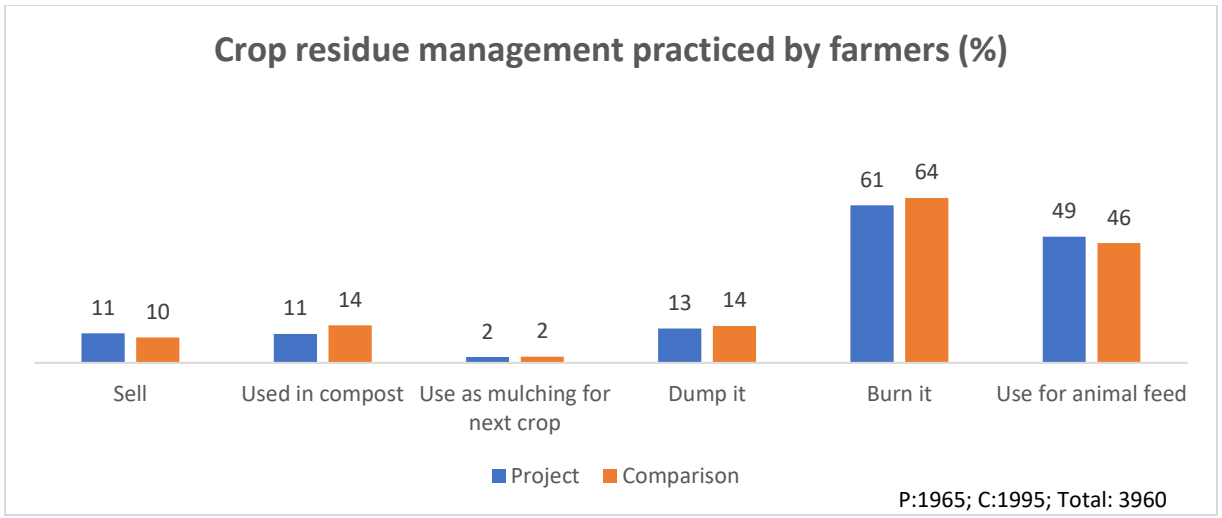


Figure 61: Methods of crop residue management adopted by farmers

6.9 Marketing of Produce

During the baseline survey, we asked the farmers how they sell their harvest (all sources where they sell their produce). As evident from the below graph, 55% of the farmers in project area and 51 % farmers in the comparison area reported of selling their produce directly through haat or via retail mode. It is to be noted that only 10 % of the farmers in project arm and 12 % in the comparison arm reported of selling their produce in the nearest APMC market. During the expert filed visits too it was found that crops such as cotton are mainly sold to dealers collecting produce from home or in haat or to dealers in their village.

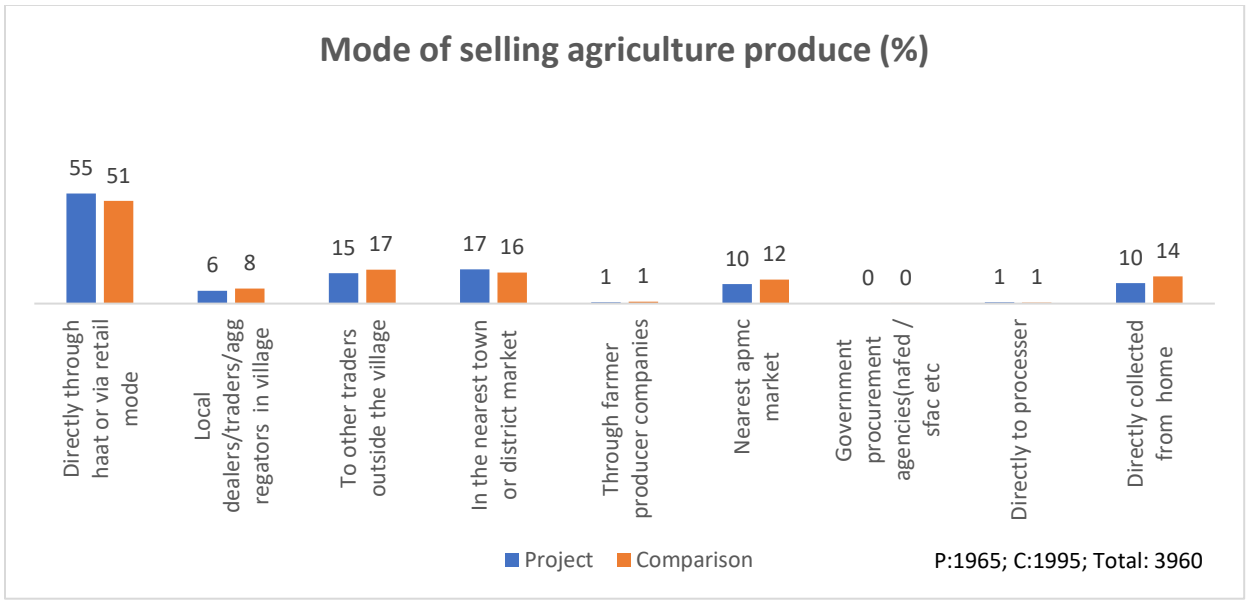


Figure 62: Mode of selling agriculture produce

We also asked the farmers how they transport the produce to the market in case they did not have it picked up from home. As evident in the below graph, farmers mostly use commercial vehicles such as pick-up trucks for transporting their produce to the market (Project:48 %, Comparison: 44%). This was followed by use of light vehicle (Project:21 %, Comparison: 22%) and tractors (Project:15 %, Comparison: 16%). The average distance travelled to sell produce is 20 kilometres in both project and comparison areas.

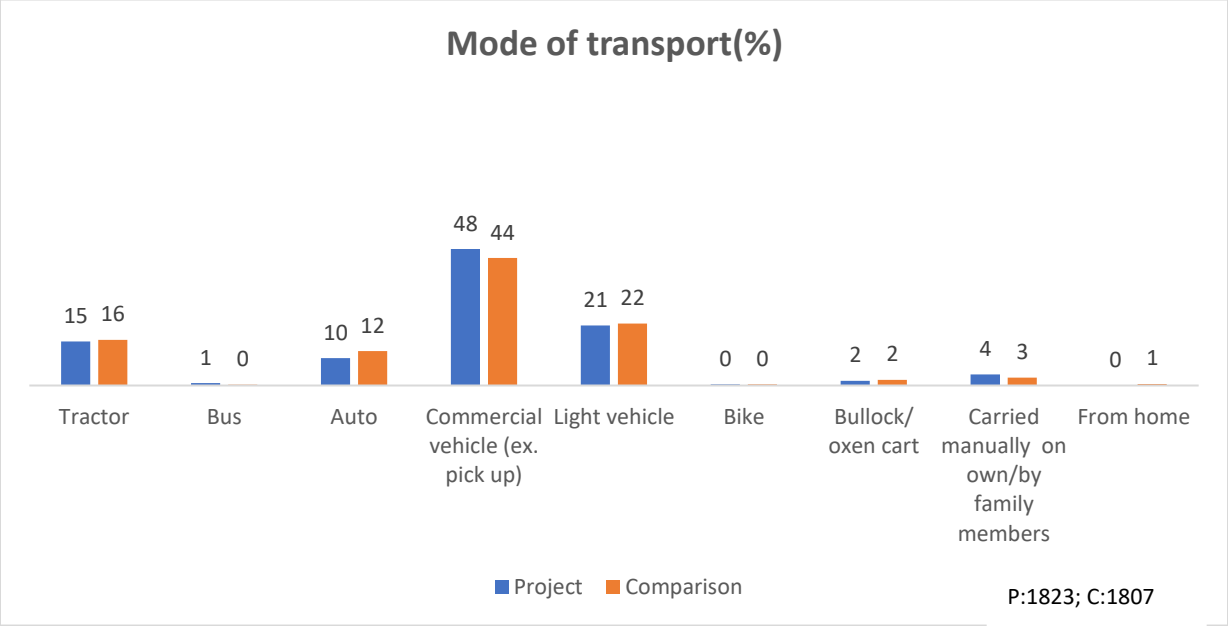


Figure 63: Mode of transporting produce for selling

Pledge loan scheme is provided by the Maharashtra State Agriculture Marketing Board (MSAMB) for the benefit of farmers of the State. The scheme of pledge loan is available for Moong, Tur, Udid, Soyabean, Paddy, Sunflower, Safflower (Kardai), Gram (Chana), Jawar, Bajra, Maize, Wheat, Ghewda (Rajma), Turmeric, Regime (Bedana), Cashew nuts and Betel nuts (Supari) in this scheme.

Under this scheme, a farmer can store his produce in Godowns of APMC and can immediately get 75% cost of his produce at an interest rate of 6%. Farmer can avail the pledge loan facility by storing the produce in the godowns of state Warehousing Corporation or Center Corporation. The APMCs maintain this pledged stock free of cost. The farmers can sell their produce when the prices are higher.

Under the scheme, the farmer gets agricultural pledge loan up to 75 % of the value of the produce prevailing in the market, an interest rate of 6%. The farmer is allowed to avail this facility up to a period of 180 days. Rebate of 3% on interest is given as promotional incentive to those APMCs who repay within 180 days. If APM fails to repay within 180 days, then APMC cannot avail the incentive rebate of 3%. After 180 days interest rate will be 8% for next 6 months, after that interest rate will be 12% next 6 months (source: MSAMB website).

Through our survey, we asked the farmers if they were aware of the scheme. As presented in figure 61, only 8% of the farmers interviewed knew about pledge loan. Of the farmers who were aware of pledge loan, we asked if they had availed of this scheme. It was observed that only 13.2% from project and 9.8% from comparison areas had done so. The biggest reason for not availing pledge loan despite being aware of it was that the farmers felt they did not require it (Figure 63).

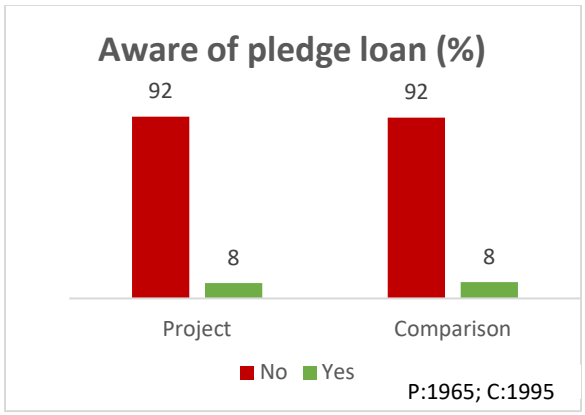


Figure 64: Percent of farmers who took pledge loan

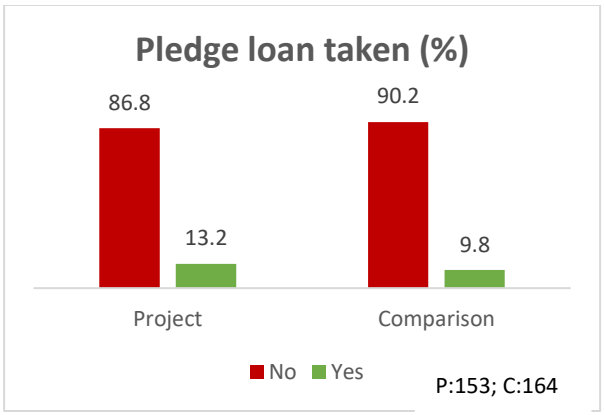


Figure 65: Percent of farmers aware of pledge loan

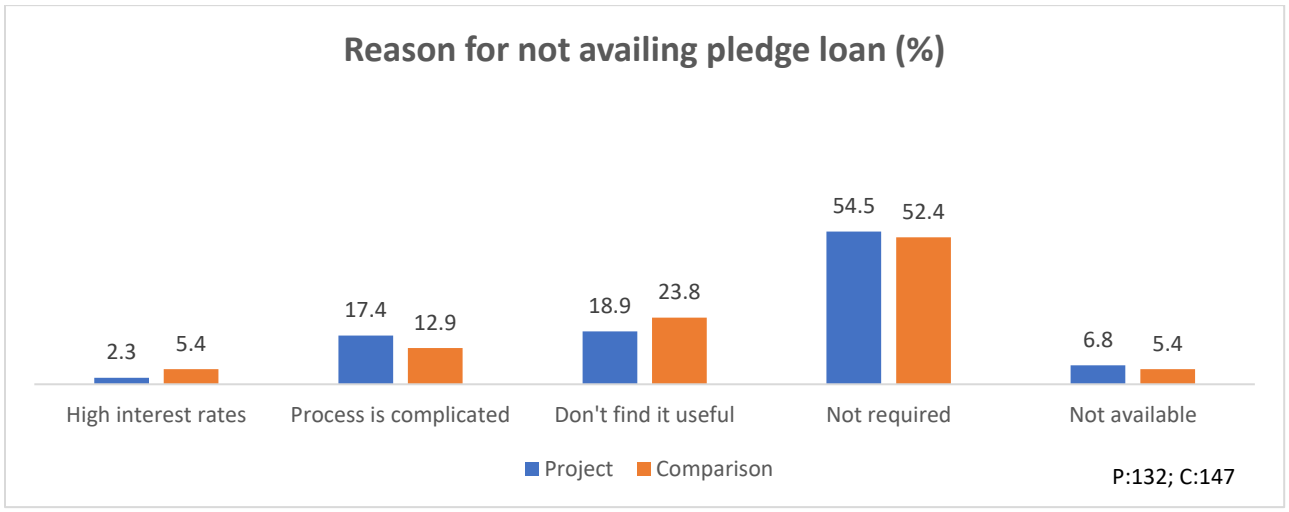


Figure 66: Farmers' reasons for not availing pledge loan

Another important aspect which adds to the resilience of farmers is access to cold storage so that they can safely store their produce and sell it at the right prices in the market. However, as evident from the below figure less than 2 % of the farmers across both project and comparison area acknowledged of having access to cold storage facility.

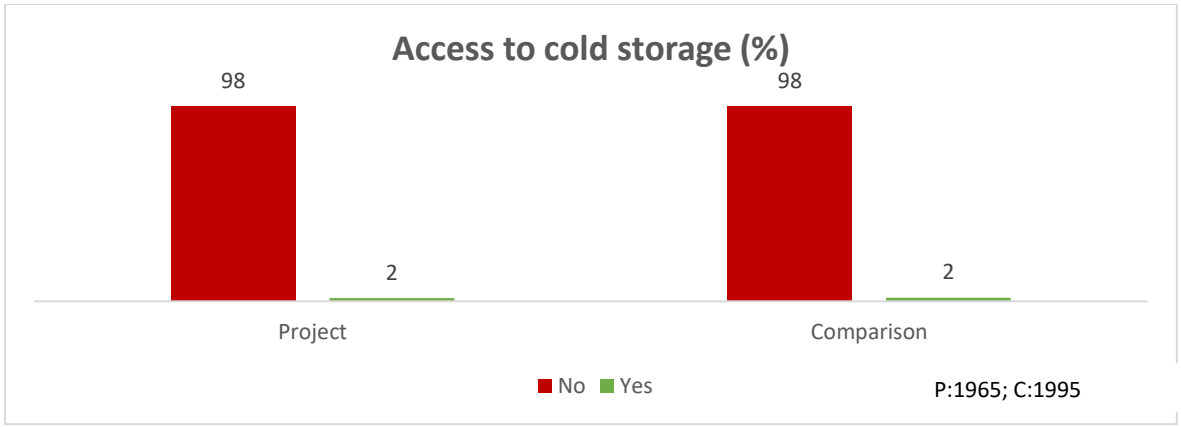


Figure 67: Percent of farmers with access to cold storage

Grading and sorting are basic value addition processes that enable farmers to sell their produce at better prices and with access to better markets. Lack of access to grading and sorting facilities in Marathwada region was observed as only 2.4% farmers in project and 2% farmers in comparison area reported of having access to grading and sorting facility.

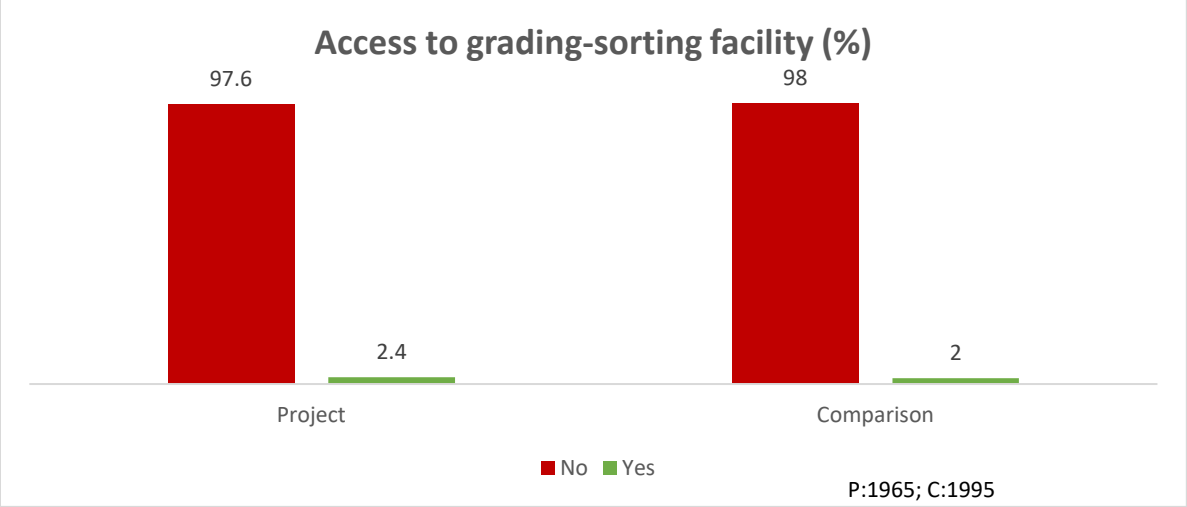


Figure 68: Access to grading sorting facilities by farmers

6.10 Sources of income

Apart from income from crop production, the respondents were also enquired about their agri-allied and non-agriculture income. The current farm income (including agriculture and agri-allied) is presented in the key indicators from results framework section.

All the study respondents across project and comparison were asked if they are involved in agriculture allied activities like dairy, honey, wool etc. Overall, it has been found that 13.4 % across project and 15% across comparison are engaged in dairy activity. 5.9 % respondents in project arm and 7.2 % respondents in comparison arm have reported of being engaged in rearing livestock. The uptake of other agri-allied activities is almost negligible in the project area.

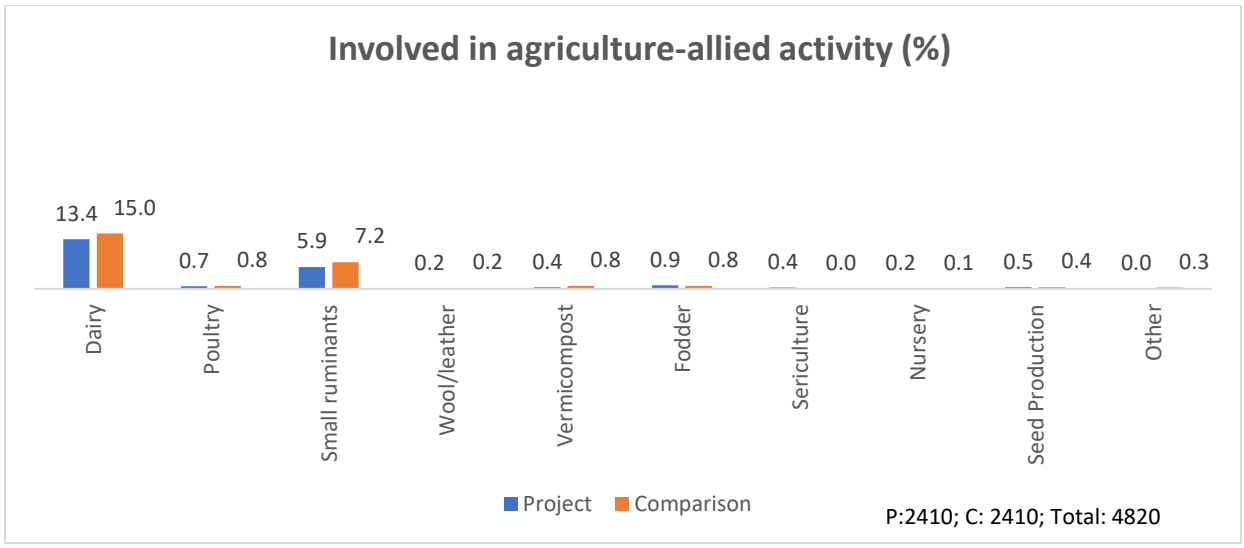


Figure 69:Distribution of involvement of respondents in different agri-allied activities

The respondents were also enquired about their non agriculture income from different sources. Agriculture labour, business and remittance are the three prominent non-agri sources of income for the respondents apart from their income from agriculture. The contribution of different non-agri source in the mean non-agri income in project areas have been in presented the below figure

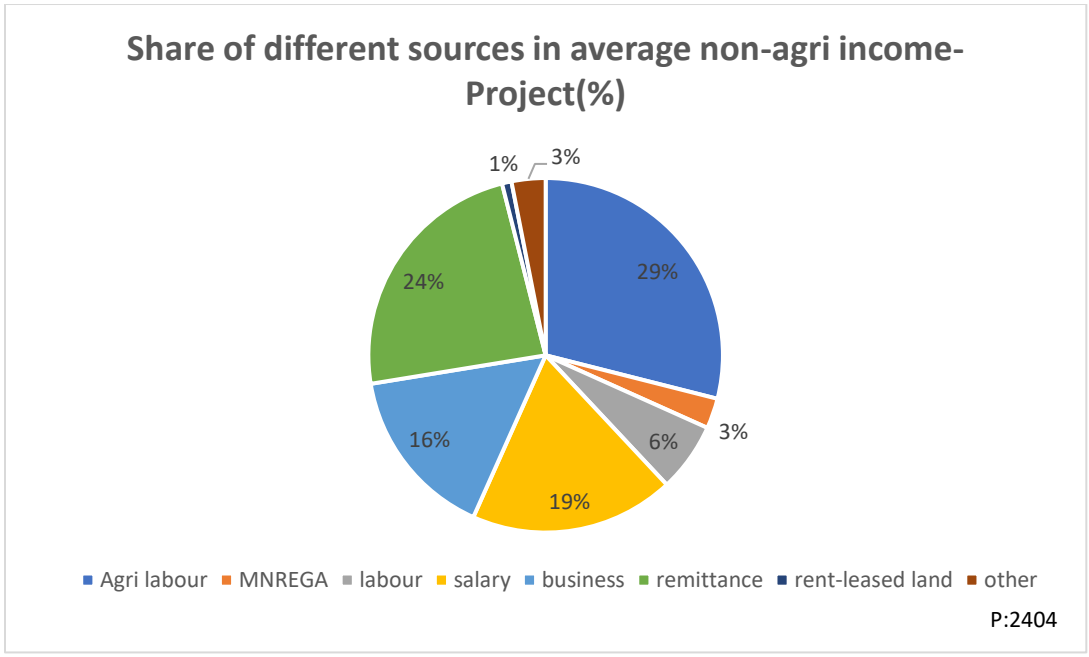


Figure 70: Sources of non-agri income- Project area

As evident from the below figure, the contribution of different sources in the mean income of the comparison area is also similar to that of project area.

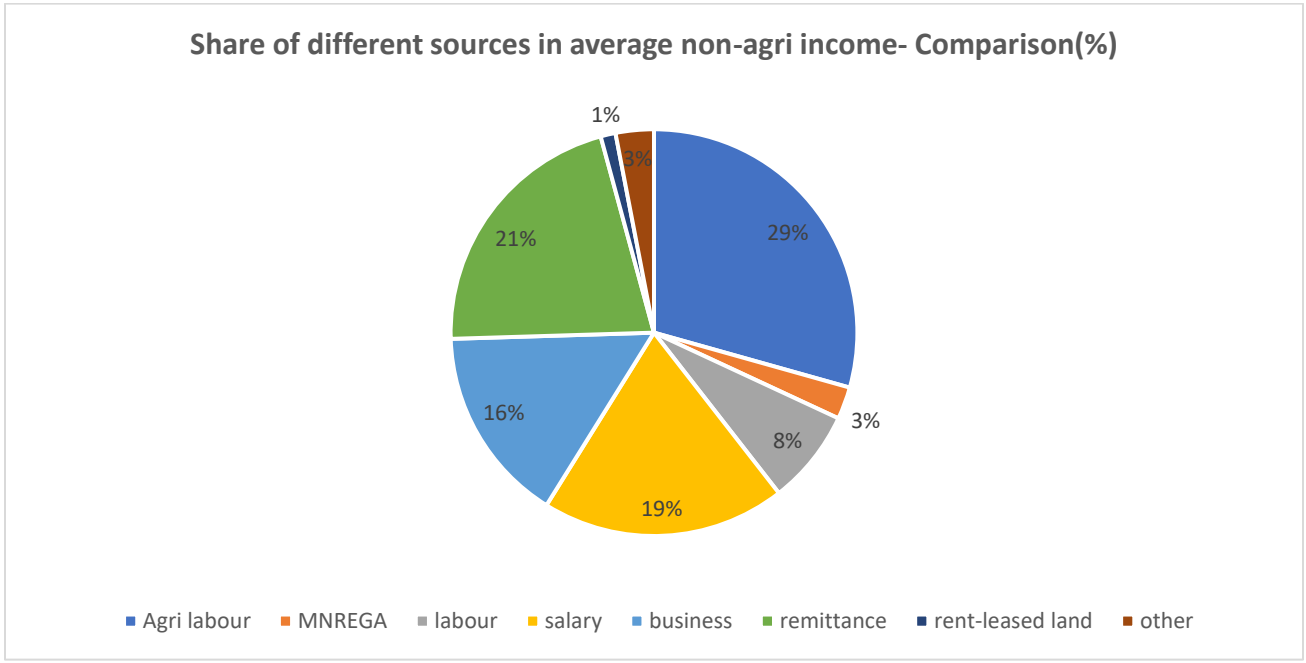


Figure 71: Sources of non-agri income- Comparison area

The below charts present the distribution of household sources of income across project and comparison. Separate charts are provided to present distribution of sources of income for landless and for framers (other sources of income excluding farming). For landless households it can be seen that agriculture labour is the main source of income, which is followed by other labour and small enterprises (e.g. petty kirana shops, tailoring etc.). Only approximately 5 percent of HHs have salaried income.

Similarly, the distribution of other sources of income have been presented for farming households. For these households too, agriculture labour is the other key source of income. Also, 33 percent in project and 26%framing HHs do not have any other source of income other than agriculture. This shows the high dependence are the other sources of income farmers, which are similar across both project and comparison.

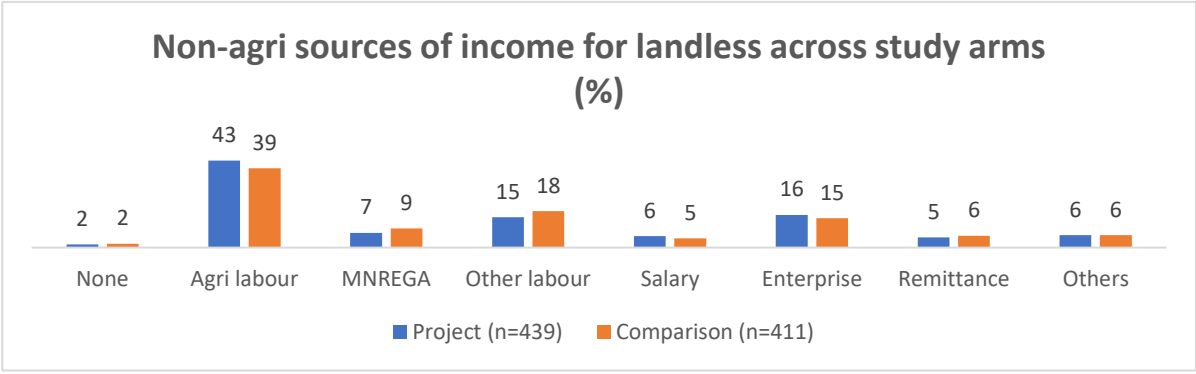


Figure 72: Distribution of non-agri sources of income for landless across study arms

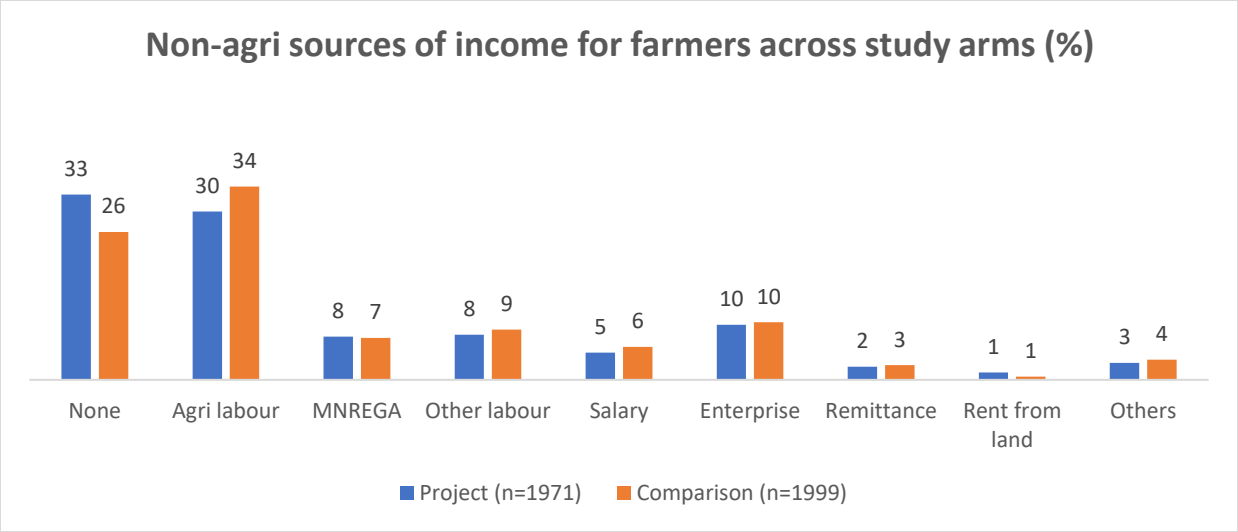


Figure 73: Distribution of non-agri sources of income for farmers across study arms

6.11 Agricultural Technology Adoption

As part of the baseline study, the current adoption rates of different climate resilient agriculture technologies were assessed. As evident from the below graph, the technologies related to preparation and cultivation such as using improved seed varieties, land preparation, use of machinery and intercropping showed better adoption than others. The adoption trends were observed to be similar across both project and comparison area.

Table 13: Adoption of technology across project and compariosn study arm

Agricultural technology	Project		Comparison	
	n	%	n	%
Contour cultivation	215	11.1	228	11.8
BBF	68	3.5	61	3.2
Intercropping	412	21.3	444	22.9
Improved seed	600	31.2	593	30.2
Seed treatment	165	8.5	194	9.9
INM	231	11.9	234	12.1
IPM	316	16.4	356	18.3
Furrow opening	64	3.4	64	3.3
Foliar spray	366	18.9	307	15.4
Farm pond	43	2.2	44	2.3
Conservation tillage	138	7.2	165	8.4
Biomass	57	2.9	81	4.2
Mulching	63	3.2	52	2.6
Citrus on broad ridges	33	1.7	39	2
Canopy management	28	1.5	23	1.2
Shadenet	16	0.9	4	0.2
Polyhouse	7	0.4	6	0.3
Polytunnel	6	0.4	1	0.1

Rainwater harvesting	131	5.5	104	4.2
Rearing animals	79	3.3	79	3.3
Poultry	47	2	43	1.8
Sericulture	14	0.6	8	0.3
Apiculture	6	0.2	3	0.1
Inland fisheries	12	0.7	8	0.5
Land preparation	538	28	554	28.3
Machinery	571	29.6	514	26
Drip	204	10.35	234	11.7
Sprinkler	167	8.47	169	8.45

6.12 Exposure to Climate vulnerability and management

As the objective of the PoCRA project is to reduce the climate vulnerability of its target beneficiaries, the respondents were asked about their perception if they have faced any climate vulnerability like (less rainfall, high temperature, dry spell, unseasonal rainfall) in the last one year. Climatic shocks affect not just the farmers, but every person's livelihood. As evident from the below figure, more than 75% of the respondents across the study arms reported that they have been affected by climate vulnerability in the past one year.

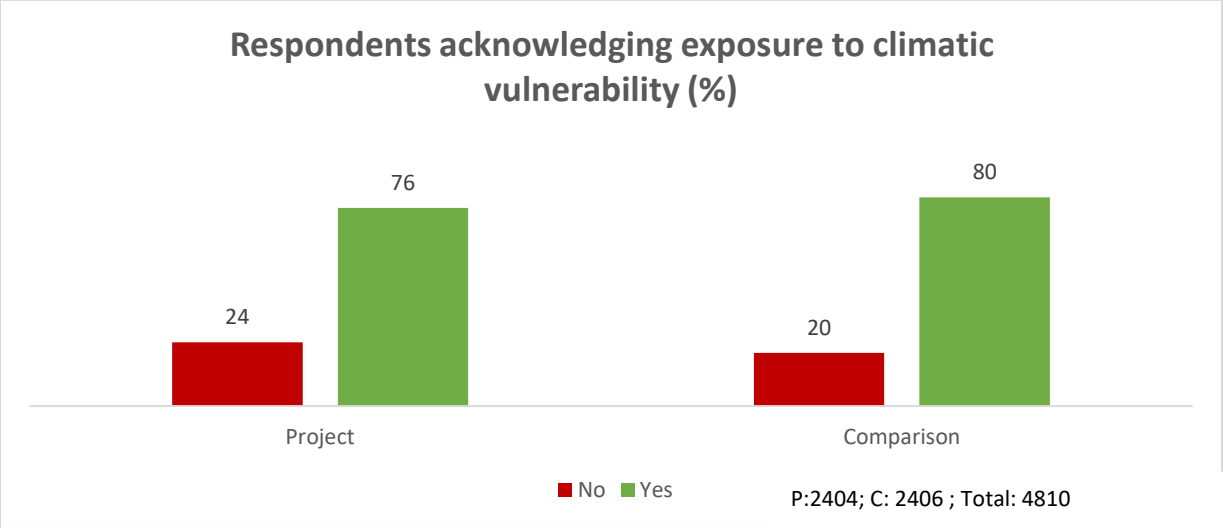


Figure 74: Exposure to climatic vulnerability

As presented in the below figure, drought and untimely rains followed by extreme temperature are climatic vulnerabilities experienced most by the farmers in our study area. Other common climate vulnerabilities reported were extreme temperature, pest attacks and crop diseases.

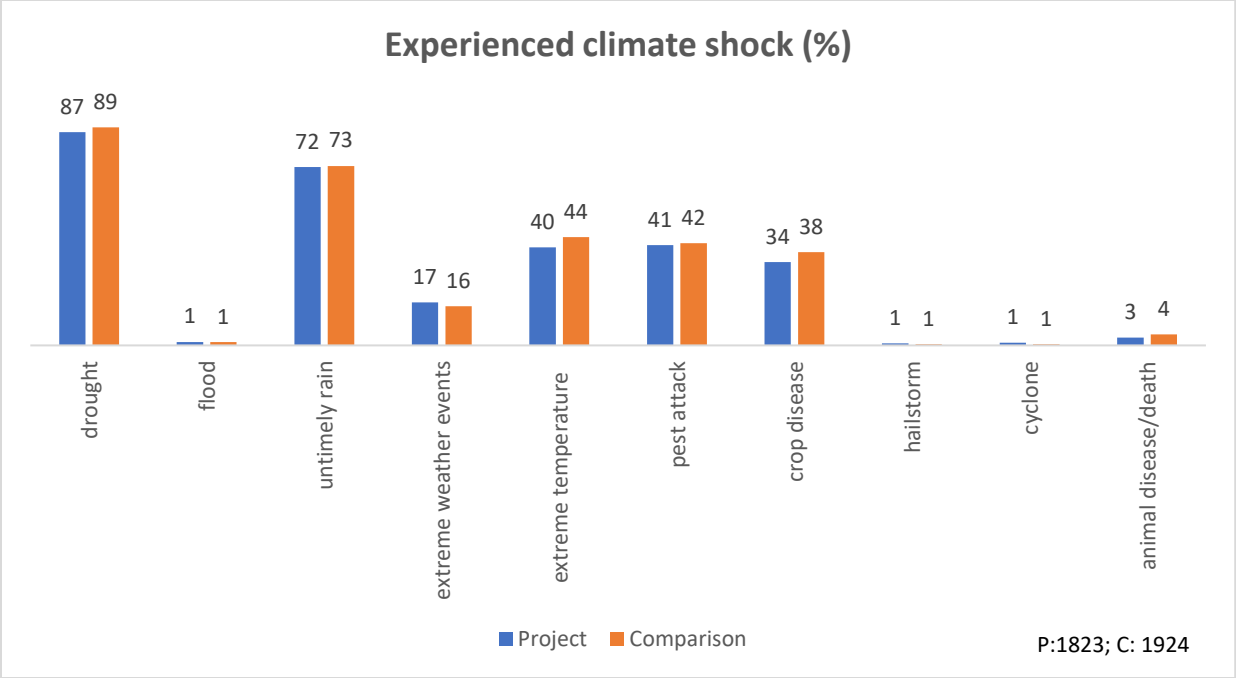


Figure 75: Type of climatic shock experienced by respondents

The respondents who were practicing farming and who claimed to have experienced any climatic shock were then asked about the technology adopted by them to deal with the situation. The perceived technology reported the most helpful to tackle climatic vulnerability is use of improved seed varieties (Project: 13%; Comparison: 17%). Practice of other technologies as a mitigation strategy against climatic vulnerability shows very low rates, less than 6% in most cases (as seen in the figure below).

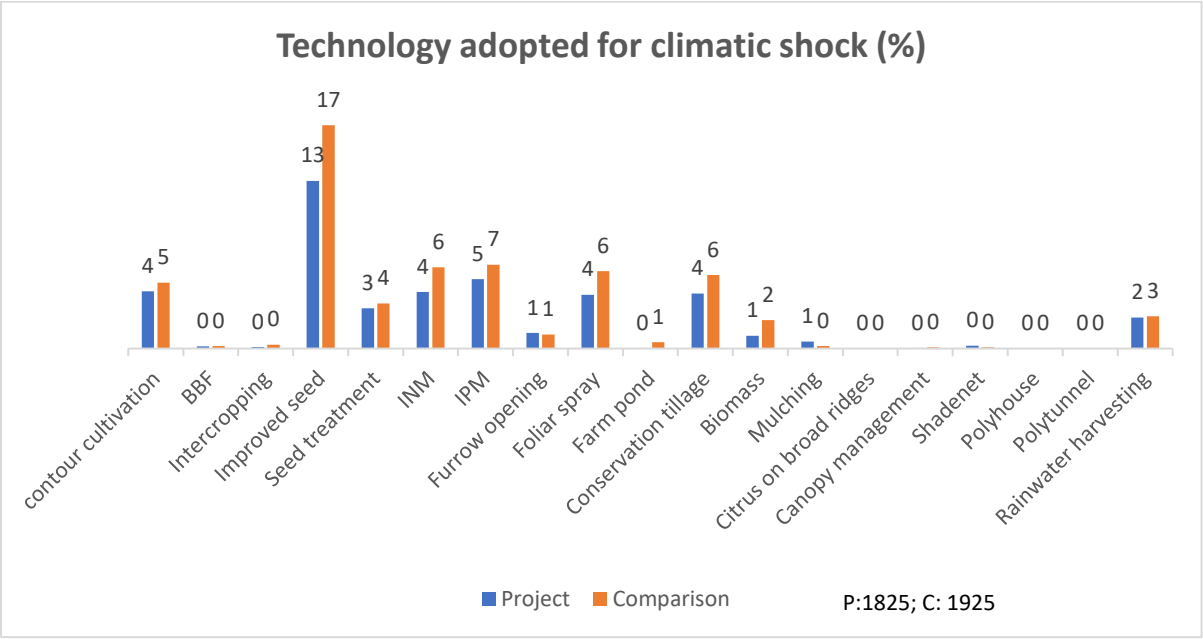


Figure 76: Technology adopted by respondents to deal with climatic vulnerability

To understand the penetration of digital platforms (mobile and web use) related to agriculture, the respondents were asked if they had used mobile applications and online websites related to agriculture before June 2018. As presented in the below graph, it can be seen that approximately only 11% of the sample from both project and comparison study areas had used mobile applications or websites to access agriculture related information.

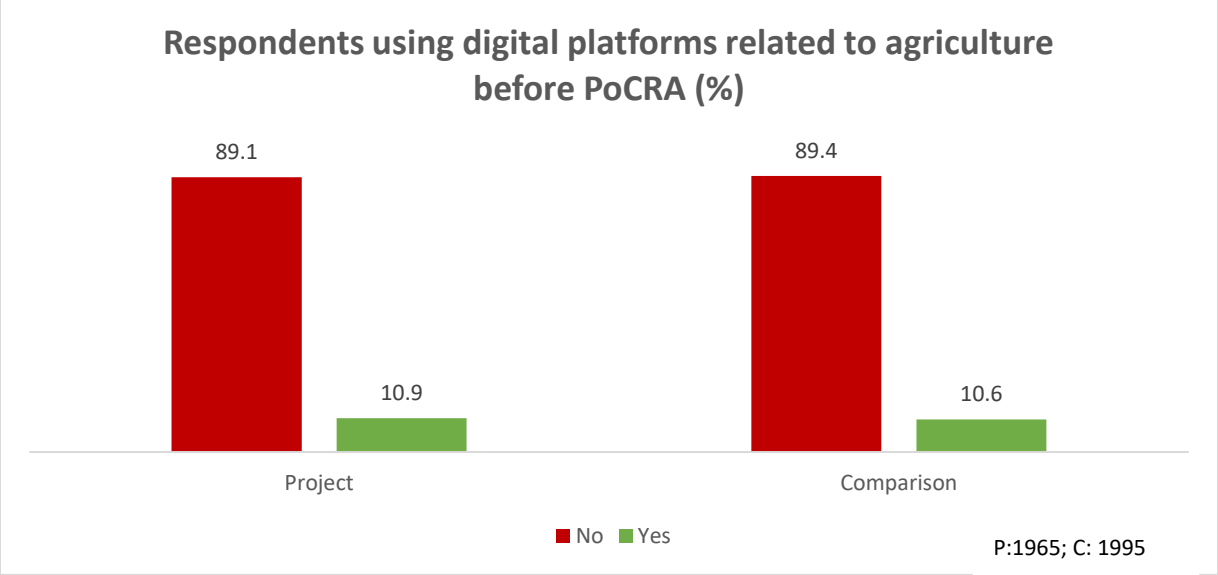


Figure 77: Percent of respondents using mobile applications for information

When further enquired about the type of digital solution used, it was found that the applications and websites mainly used are mKisan, MSAMB app and Krushi King. mKisan is used the most with 52% in project areas and 41% in comparison areas saying they use this application.

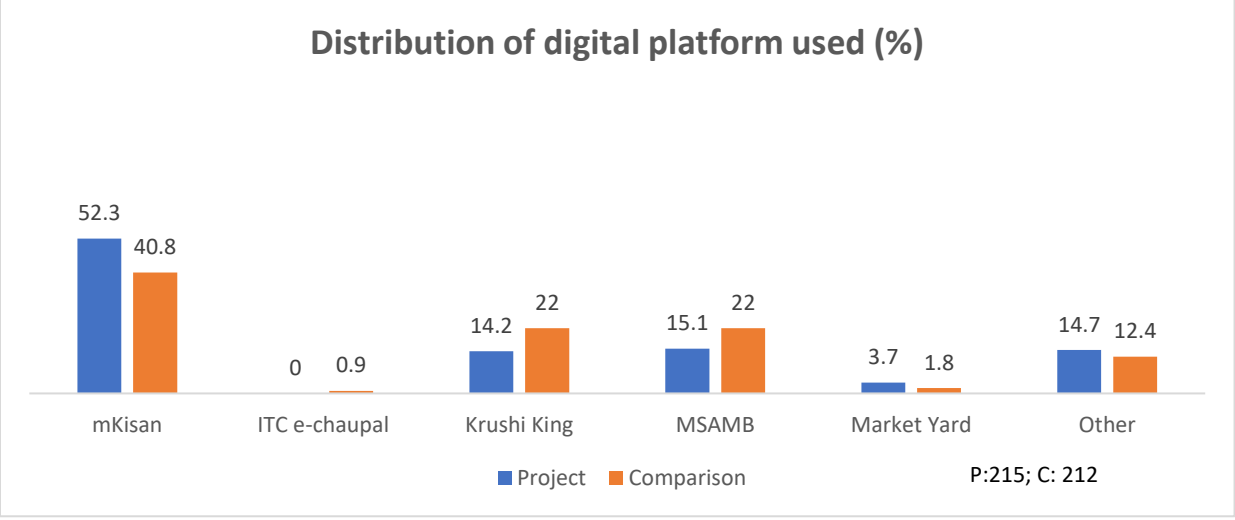


Figure 78: Different digital platforms used by respondents

We also enquired about other technological sources of information used by the respondents for information on agriculture before June 2018. Majority of the respondents replied that they did not use any such source. As evident from the below figure, television and SMS on phones seemed to be the two frequently used sources of information. Magazines, e-Seva and radio saw very few respondents.

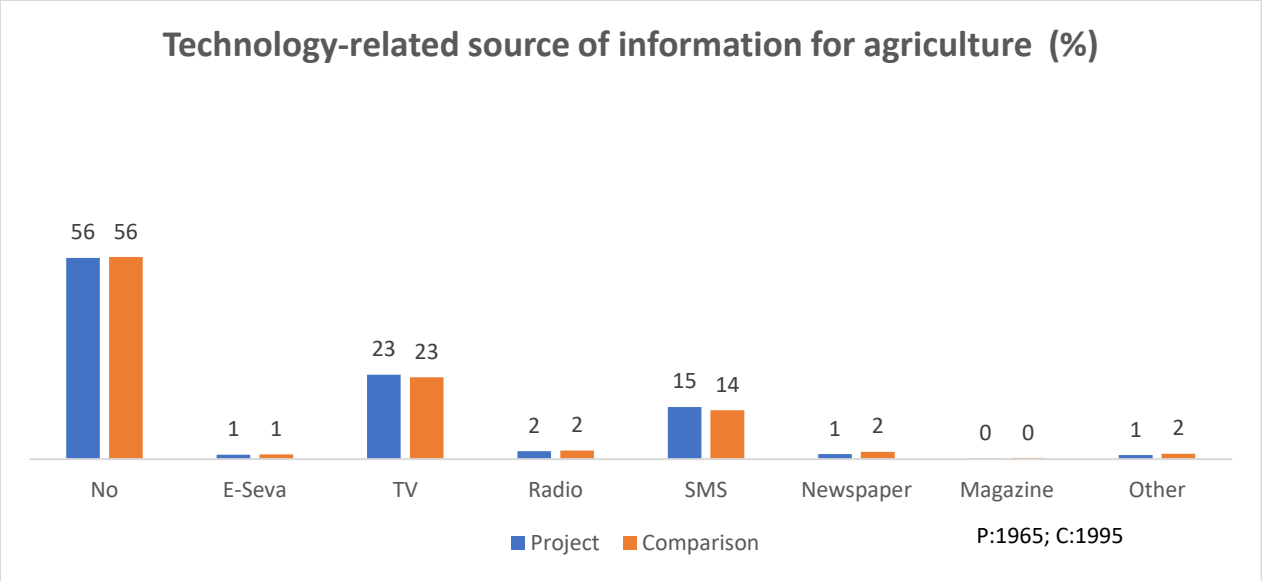


Figure 79: Other technology used for information

Apart from their own use of sources of information on agriculture, the respondents were also asked if they received advisories on climate or agriculture before June 2018. As evident from the below figure, an equal proportion of respondents had received such advisories compared to those who did not receive, and this was the same for both project and comparison areas.

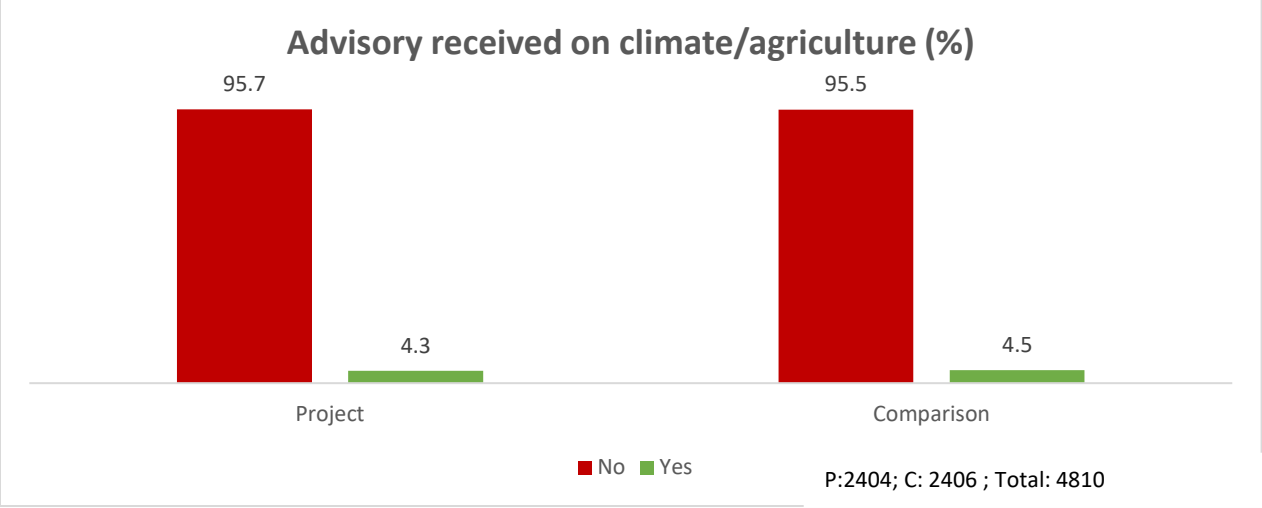


Figure 80: Percent of respondents who received advisory on climate and agriculture

For those who said they had received advisory on climate and agriculture, we further asked about the type of advisory they have received. As evident from the below figure, majority of respondents had taken advisory on crop pricing followed by pest and diseases, weather forecast and crop planning.

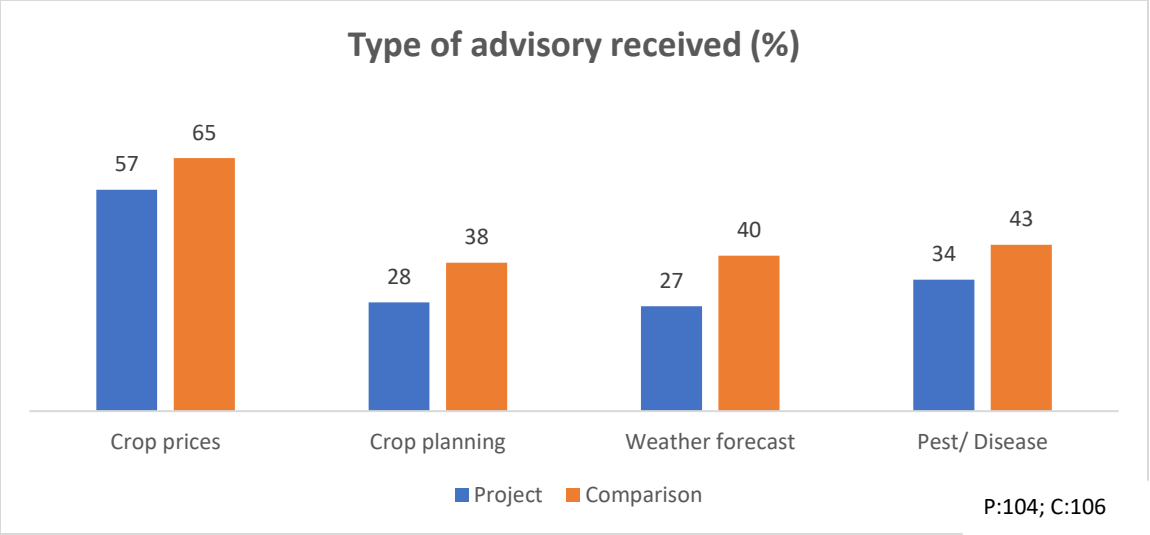


Figure 81: Type of advisory received

6.13 Access to credit

As part of the baseline survey the access to credit of the respondents was accessed. Access to credit is important for farmers so that they are able to sustain their livelihoods. This is because agriculture is input intensive and returns from selling harvest takes time.

We asked the respondents if they had availed any loans or credit before June 2018. As presented in the below figure, 58% from project and 60% from comparison area said they had done so.

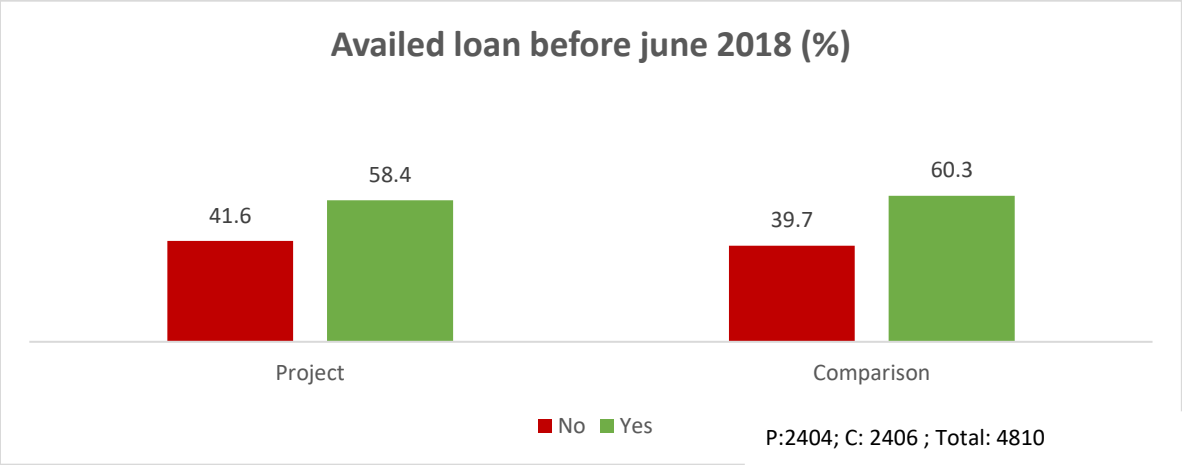


Figure 82: Availed loan before June 2018

The sources of loan were then asked of the respondents. Majorly, commercial banks are the source of credit for farmers with 79% from both project area and comparison area choosing this option. Informal sources, micro-finance institutions and self-help groups saw very low proportions.

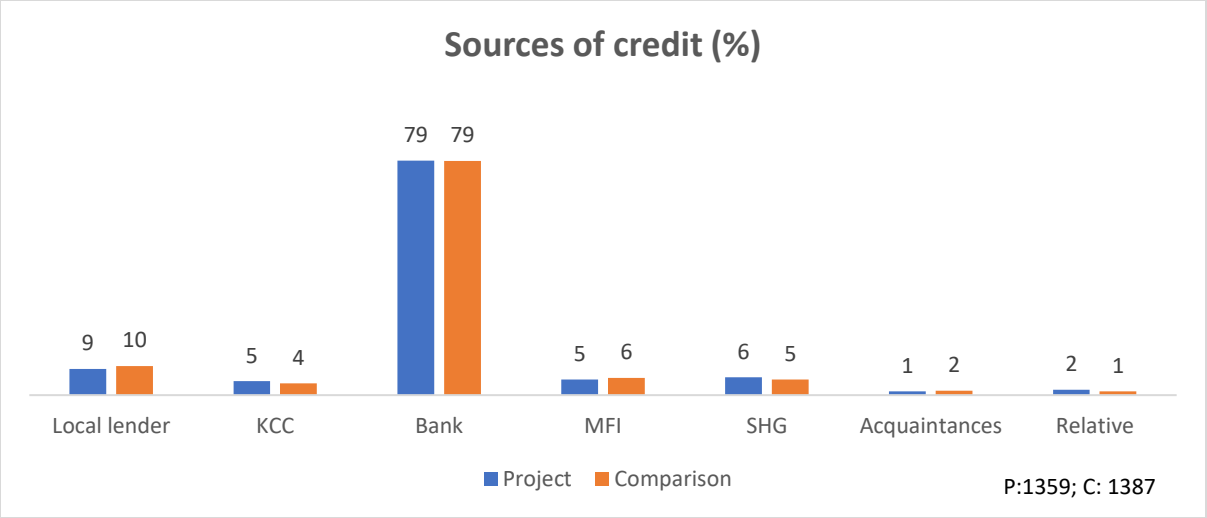


Figure 83: Sources of credit for respondents

The major reason for availing credit by the respondents was agriculture, with the proportion being same across the two study areas (Project: 89%; Comparison: 89%). The average loan amount taken for agriculture is INR 1,21,233 for project area and INR 113697 for comparison area (Figure 82).

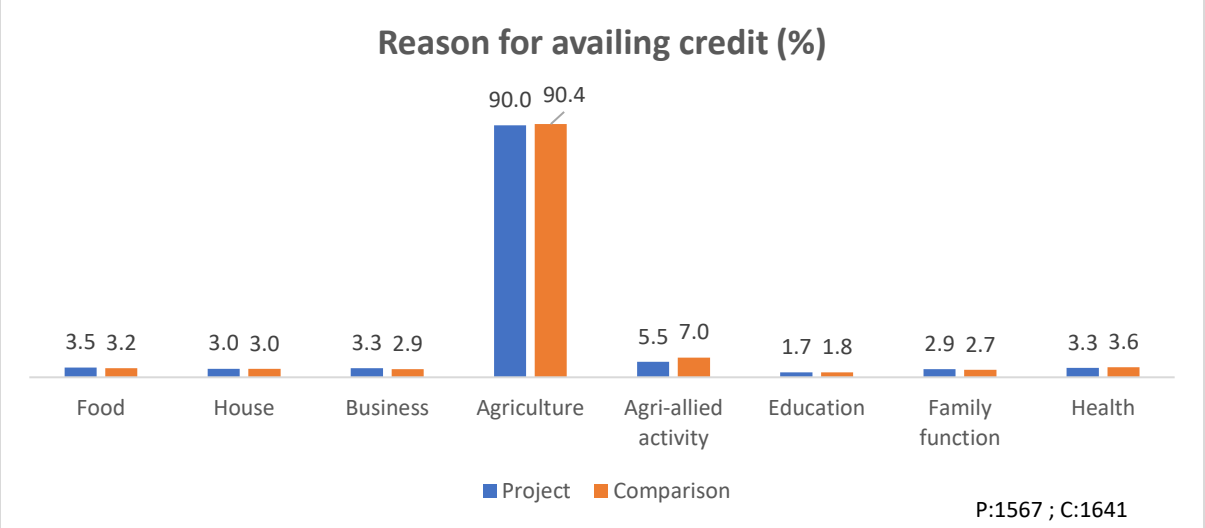


Figure 84: Reason for availing credit

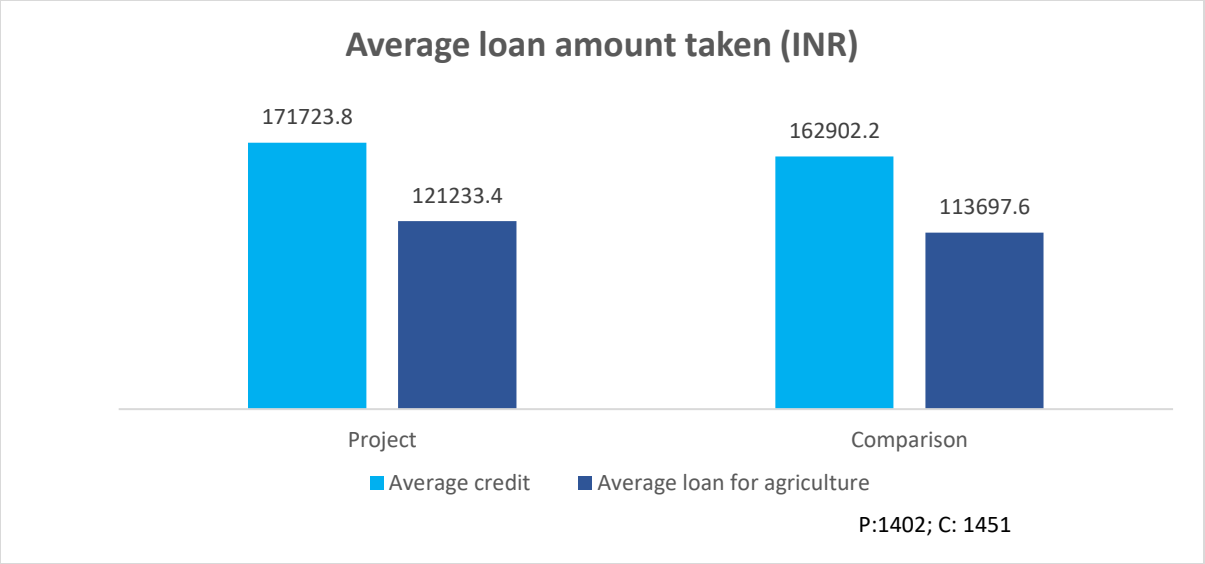


Figure 85: Average loan taken in total versus average loan taken for agriculture

As presented in the below figure, debt waiver scheme was barely available to any of the respondents and only 12% from project area and 14% from comparison area availed this benefit.

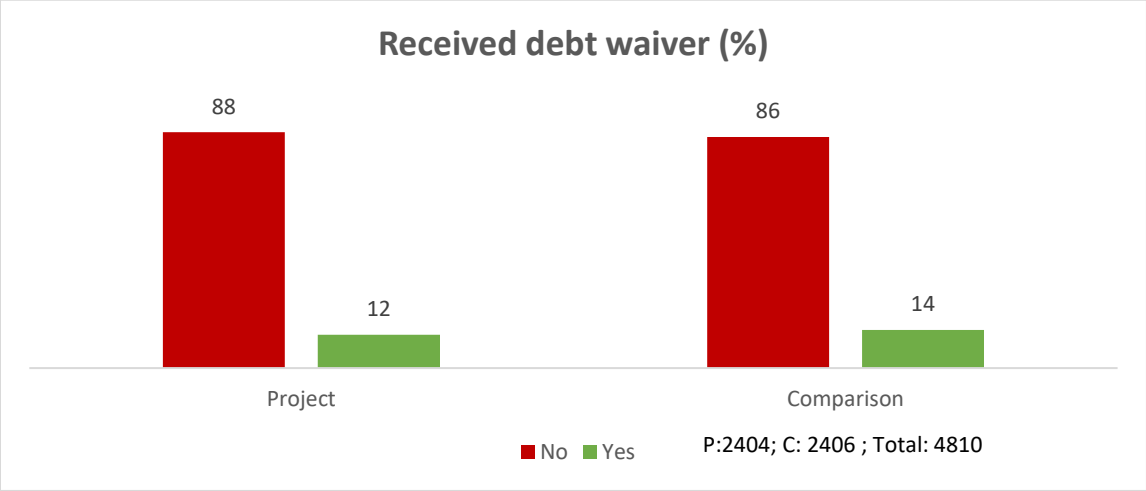


Figure 86: Availed debt-waiver scheme

As presented in below figure, across project and comparison areas, 24% in project and 25% in comparison reported of facing issues in availing farm loan. These problems were mainly due to the amount of paperwork and the repeated number of visits required for loan sanctions (Figure 85).

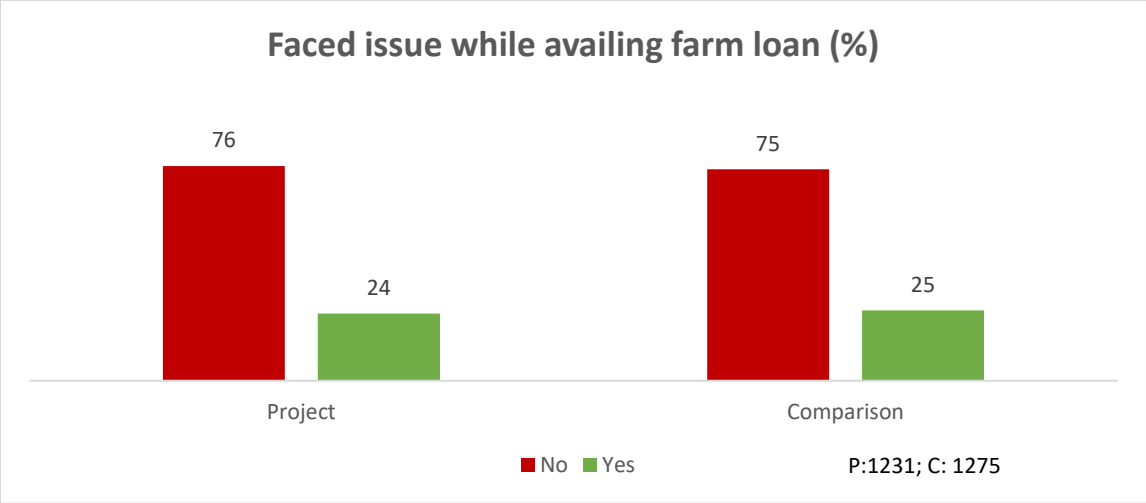


Figure 87: Percent of farmers facing issue in availing farm loan

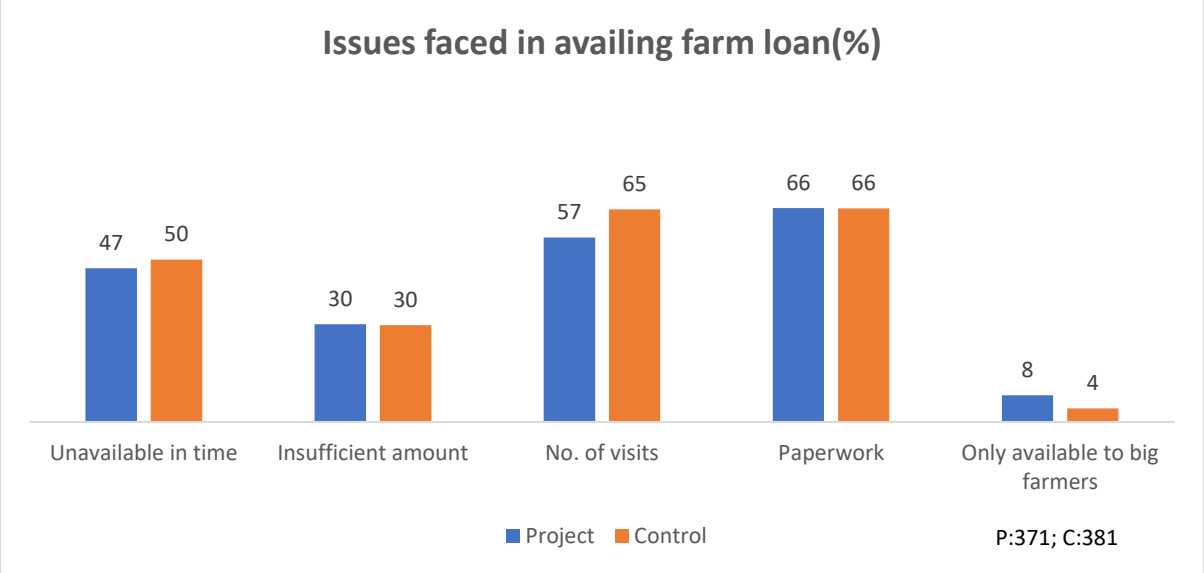


Figure 88: Issues faced while applying for farm loans

Crop insurance is essential for reducing the vulnerability of farmers, mitigating their losses from pest or disease attacks on their crops, weather-related damage. 51% from project area and 52% from comparison area had reported getting insurances for their crops. The main crop for which crop insurance was taken is soybean (Project: 61%; Comparison: 68%) followed by cotton (Project: 31%; Comparison: 27%).

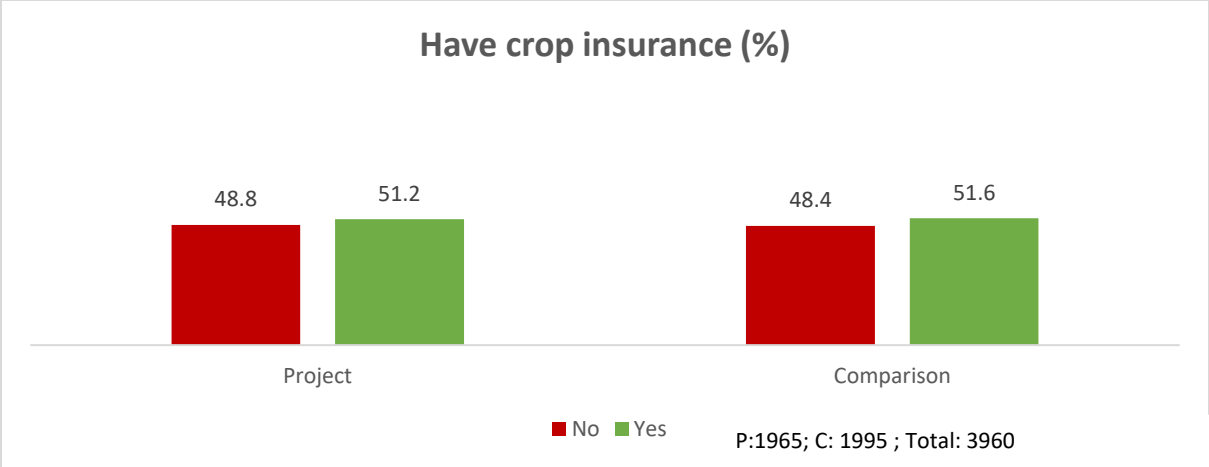


Figure 89: Percent of farmers who availed crop insurance

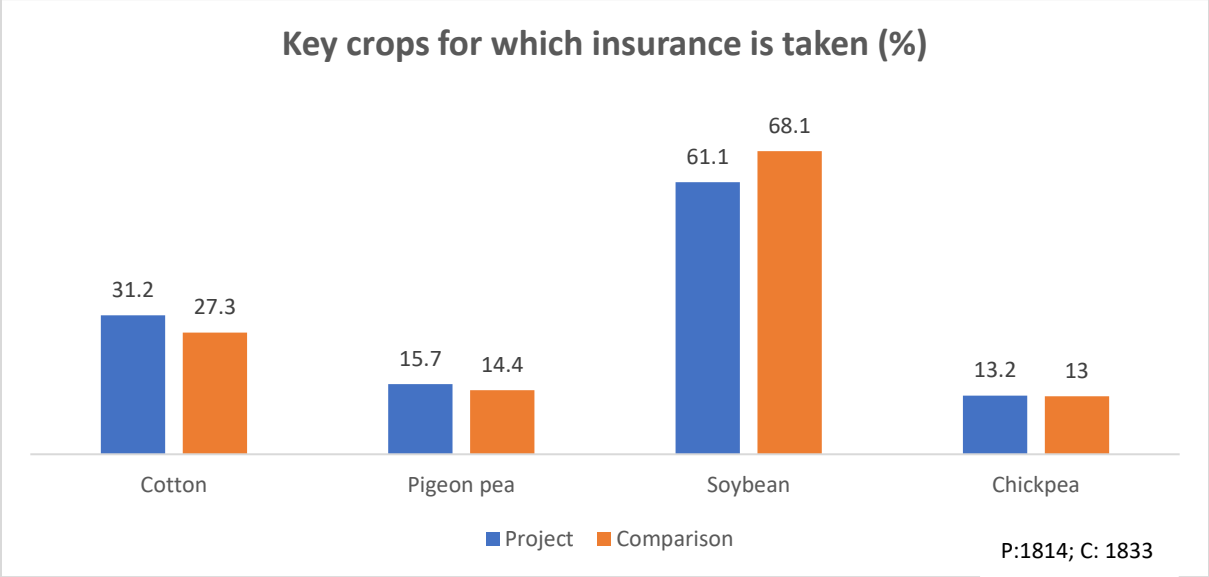


Figure 90: Main crops insured by farmers

7. Key Indicators from Results Framework

This section presents the baseline values for all the key results framework indicators. The values of these key indicators are presented by project and comparison arms.

7.1 Water Productivity

The concept of water productivity is mentioned by Kijne et al. (2003) as a robust measure of the ability of agricultural systems to convert water into produce. It is primarily used to evaluate the function of irrigation systems- as 'crop per drop'. It provides a diagnostic tool to identify low or high-water use efficiency in farming systems or sub-systems. Water productivity is computed at a range of scales and for different agriculture systems.

Water productivity is a key project development objective indicator as part of the results framework of PoCRA . As decided by the key project stakeholders , farm level water productivity calculation methodology, which has been developed by IIT B, has been used to calculate the water productivity for evaluating the impact of PoCRA project. The methodology note developed by IIT- B based on which water productivity values is calculated in baseline (and will also be calculated in midline and end line surveys as part of the evaluation of PoCRA) has been presented in Annexure section of this report.

Water productivity has been measured as yield in kg per cubic meter of water(kg/m^3) provided to particular crop. Water productivity for different crops varies on different parameters such as per soil type, soil depth, number and time of watering etc. These have been taken into account while measuring the AET for the crops.

$$water\ productivity = \frac{yield\ (kg)}{Total\ water\ taken\ up\ by\ crop\ (Rainfall\ AET + watering\ AET)(m3)}$$

Where,
Yield in kg = weight of harvested grain in kilograms in 1 acre of land.
Water taken up by crop = water available to the plant as Actual Evapotranspiration due to rainfall + Extra watering provided to the plant as per irrigation type in m^3.
Actual Evapotranspiration due to rainfall is computed by our plugin which is based on SWAT model based on daily rainfall data, soil type, slope and crop.

As required per the PAD document, water productivity has been calculated for the five main crops of Kharif season, namely Cotton, Soybean, Pigeon pea, Black gram and Green gram. In the table below, the water productivity for each of these crops has been given for the two study areas. Outlier values have been excluded from the analysis by omitting the values which were outside two standard deviation. Furthermore, cases where farmers had reported no yield or crop loss have been excluded from the analysis (for both project and comparison arm). There were 364 cases in which farmers had reported crop loss. Water productivity was observed to be highest for soybean (Project: 1.57 kg/m^3; Comparison: 1.73 kg/m^3). It can also be observed that the water productivity values are slightly higher in comparison arm as compared to project arm for most of the crops. Though the confidence intervals are overlapping for project and comparison arm mean values for all these five crops, suggesting that there is no statistically significant difference across the study arms.

Table 14: Water Productivity of main crops in Kharif season for project area

Crop	Project				
	n	Mean(kg/m^3)	Std. Dev.	Confidence interval (95%)	
Cotton	890	0.83	0.03	0.77	0.89
Soybean	1115	1.57	0.06	1.45	1.69
Pigeon pea	411	0.45	0.02	0.41	0.49
Black gram	148	0.43	0.11	0.21	0.64
Green gram	192	0.79	0.32	0.16	1.4
Overall WP	2719	1.07	0.037	0.99	1.14

Table 15: Water Productivity of main crops in Kharif season for comparison area

Crop	Comparison				
	n	Mean(kg/m^3)	Std. Dev.	Confidence interval (95%)	
Cotton	853	0.89	0.03	0.84	0.96
Soybean	1222	1.73	0.05	1.62	1.84
Pigeon pea	470	0.48	0.02	0.43	0.53
Black gram	159	0.55	0.13	0.29	0.79
Green gram	232	0.60	0.19	0.21	0.99
Overall WP	2930	1.17	0.03	1.11	1.24

7.2 Yield Variability- Soybean

One of the key results framework project development objective indicator is coefficient of variability (CV) which is in important indicator of climate variability. The lower the CV, the lower is the yield and climate variability. PoCRA during the six years of its implementation aims to bring down the yield variability, this giving stability to crop production and hence reducing climate vulnerability. As per the PAD document, at the base line spatial variability will be calculated. The total area under production for each crop grown by farmers and the total production from that crop has been recorded based on farmer response. To calculate the spatial variability of crop yield of soybean, we calculated its productivity which is the ratio of total production (in quintal) to the total area under production (in acres). The coefficient of variation was calculated by dividing the standard deviation of productivity by the mean of productivity (i.e. CV= standard deviation S/mean $\bar{X}$) for the specific crops across the eight districts under Marathwada. The overall CV for soybean productivity in project area is 37% and 38% in comparison area.

The below table presents the district wise spatial variability for soybean crop.

Table 16: Spatial variability of productivity of Soybean across Project study area in eight districts

DISTRICT	OBS	MEAN (QUINTAL/ACRE)	STD. DEV.	COEF. OF VARIATION
Aurangabad	6	5.1	2.0	39%
Beed	113	5.1	2.0	39%
Hingoli	159	5.6	2.3	41%
Jalna	99	5.4	2.3	43%
Latur	224	5.2	1.8	34%
Nanded	154	5.4	1.8	33%
Osmanabad	260	5.0	1.7	34%
Parbhani	166	5.2	1.8	35%
Marathwada Overall	1179	5.2	1.9	37%

Table 17: Spatial variability of productivity of Soybean across comparison study area in eight districts

DISTRICT	OBS	MEAN (QUINTAL/ACRE)	STD. DEV.	COEF. OF VARIATION
AURANGABAD	13	5.4	2.4	44%
BEED	138	4.9	1.9	39%

HINGOLI	157	5.7	1.8	32%
JALNA	109	5.1	1.9	37%
LATUR	243	5.4	2.0	37%
NANDED	151	5.3	2.0	38%
OSMANABAD	282	5.2	1.9	37%
PARBHANI	181	5.7	2.4	42%
MARATHWADA OVERALL	1274	5.4	2.0	38%

The Coefficient of Variation has also been calculated using the secondary data available at the Maharashtra Department of Agriculture website (http://krishi.maharashtra.gov.in/1238/District-Level). CV has been calculated using the department of agriculture productivity data available at the website. The overall spatial CV for productivity of soyabean eight districts in Marathwada region for FY 16-17 is 47.7 %, for FY 17-18 is 31.1 % and in FY 18-19 is 48.2 %.

Temporal CV has also been calculated using the secondary data available at Department of Agriculture website. Based in the agriculture productivity data from year 2009 to 2019 (ten year period), the temporal CV for soyabean for eight districts in Marthwada region is found to be 49.6%.

Additionally, yield of soybean in quintal/acre was also mapped using GIS to observe its spatial yield variability across districts. It is observed that soybean farmers are fewer in Aurangabad, Beed and Nanded as compared to other districts.

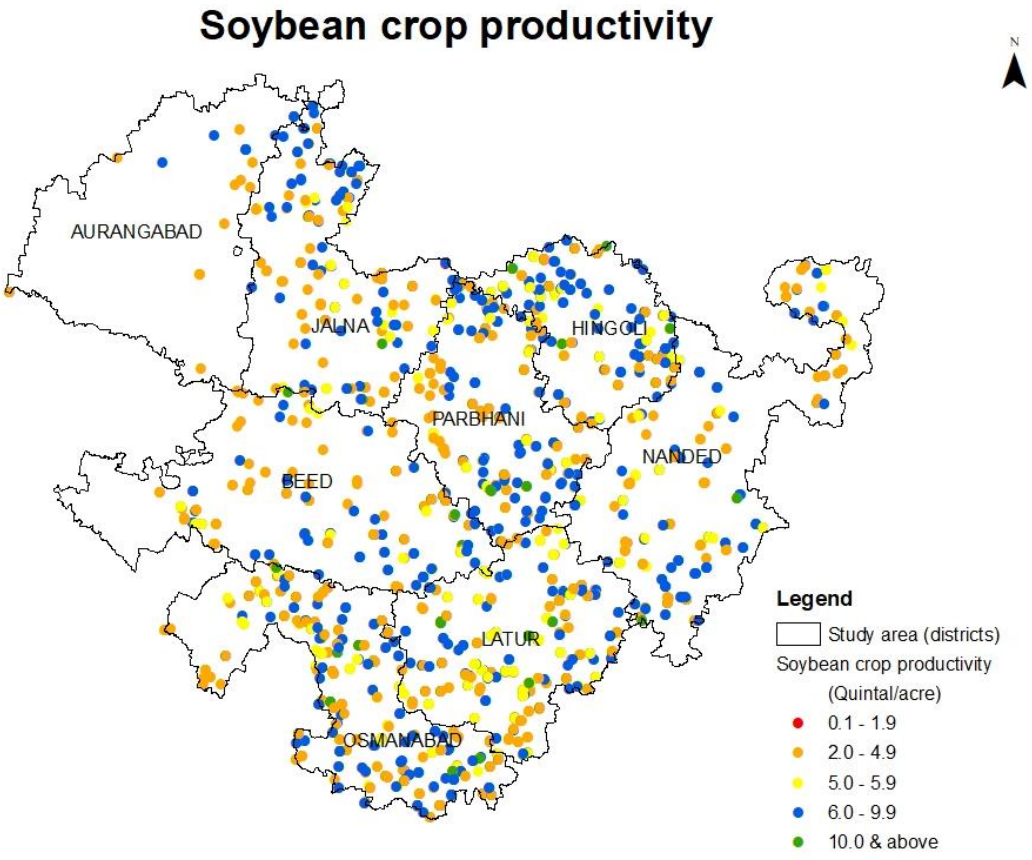


Figure 91: Variability of soybean yield across districts

7.3 Yield Variability- Pigeon pea

To calculate the spatial variability of crop yield of pigeon pea, we calculated its coefficient of variation across the eight districts under Marathwada applying the same method as we had used for Soybean. For overall CV of pigeon pea productivity, it is 71.8% in project area and 60.2% in comparison area.

Table 18: Productivity of pigeon pea in project area across eight districts

DISTRICT	OBS	MEAN	STD. DEV.	COEF. OF VARIATION
AURANGABAD	39	3.6	2.5	69%
BEED	50	2.8	2.5	89%
HINGOLI	29	4.8	3.0	62%
JALNA	56	4.4	4.3	98%
LATUR	104	4.1	2.4	58%
NANDED	48	4.6	2.1	46%
OSMANABAD	114	3.5	2.8	80%
PARBHANI	69	5.6	2.9	52%
MARATHWADA OVERALL	509	4.1	2.9	72%

Table 19: Productivity of pigeon pea in comparison area across eight districts

DISTRICT	OBS	MEAN	STD. DEV.	COEF. OF VARIATION
AURANGABAD	22	4.8	3.2	67%
BEED	56	3.1	2.7	87%
HINGOLI	53	4.8	2.4	50%
JALNA	50	3.7	2.4	65%
LATUR	124	4.4	2.4	55%
NANDED	93	4.7	3.0	64%
OSMANABAD	85	4.4	2.1	48%
PARBHANI	77	4.7	2.8	60%
MARATHWADA	563	4.3	2.6	60%
OVERALL				

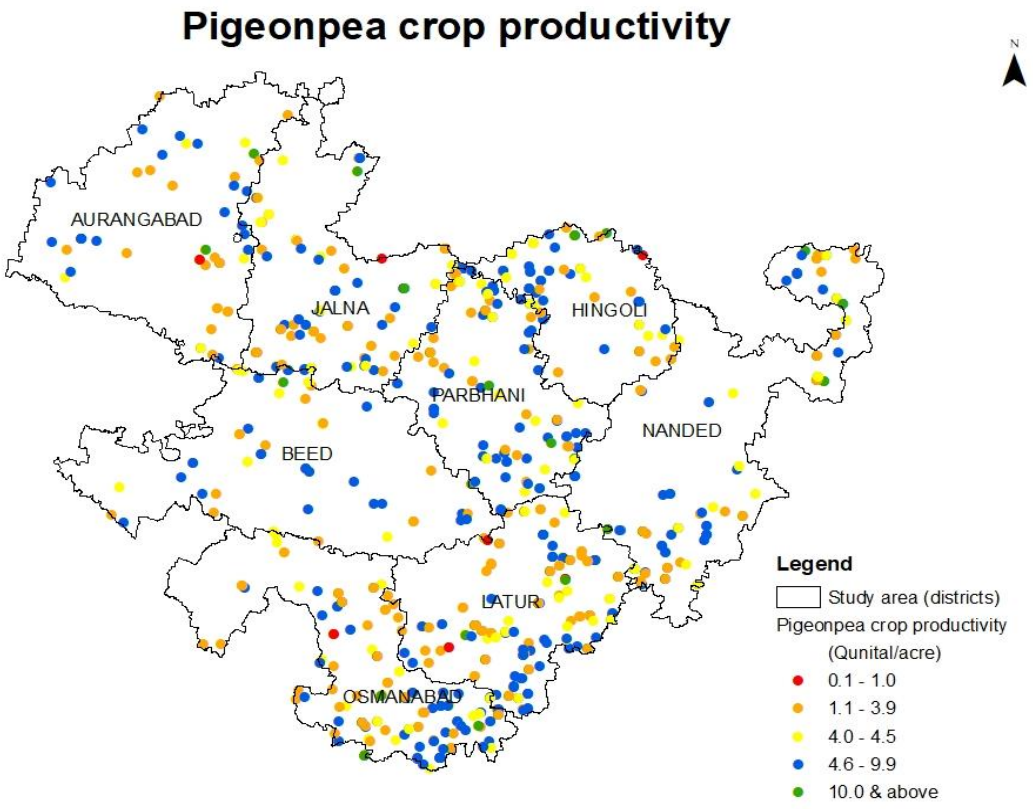


Figure 92: Yield variability of pigeon pea across districts

For pigeon pea too, the Coefficient of Variation has also been calculated using the secondary data available at the Maharashtra Department of Agriculture website (*http://krishi.maharashtra.gov.in/1238/District-Level*) . CV has been calculated using the department of agriculture productivity data available at the website. The overall CV for productivity of pigeon pea in eight districts in Marathwada region for FY 16-17 is 58.9 %, for FY 17-18 is 31.5 % and in FY 18-19 is 43.6 %. We also mapped productivity of crops across districts to observe their spatial

yield variability. The lower belt of Osmanabad and Latur see higher yield and more pigeon pea farmers than other districts. Simlarly temporal CV has also been calculated using the secondary data available at Department of Agriculture website. Based on the agriculture productivity data from year 2009 to 2019 (ten year period), the temporal CV for pi for eight districts in Marthwada region is found to be 54.6%.

7.4 Greenhouse Gas Balance Accounting

Mandate

The World Bank Environment Strategy (2012), has adopted a corporate mandate to account for the greenhouse gas (GHG) emissions for its investment lending. The quantification of GHG emissions is an important step in managing and ultimately reducing emissions, as it provides an understanding of the project's GHG mitigation potential. Further, Paris Agreement also mandates reporting of assumptions and methodological approaches including those for estimating and accounting for anthropogenic greenhouse gas emissions to achieve the goals of Article 2.

Agriculture sector is one of the dominant sectors contributing to GHG emissions in India (accounting for 18% of India's GHG emissions) and globally. According to IPCC and the World Bank Report on "Enhancing Carbon Stocks and Reducing CO2 Emissions in Agriculture and Natural Resource Management Projects" (http://documents.worldbank.org/curated/en/830421468331786085/pdf/704030WP00PUBL00Stocks00Toolkit0web.pdf), agriculture sector provides opportunity for reducing GHG emissions and in particular enhancing carbon stocks. Enhancing carbon stocks in semi-arid soils will have a positive co-benefit on crop yields and also in building resilience to moisture stress. Thus, synergy between enhancing carbon stocks and climate resilient agriculture development is likely.

As part of PoCRA project, the focus is largely on building resilience in agriculture and allied sectors to tackle climate variability, droughts and long-term climate change. PoCRA aims to enhance climate resilience and profitability of small holder farming systems in the drought prone semi-arid regions of Maharashtra. The project proposes to incorporate improved agronomic, water and nutrient management, agroforestry, etc., practices to build resilience in semi-arid agriculture, while reducing the GHG emissions and enhancing carbon stocks.

Accounting methodology

The World Bank had adopted the Ex-Ante Carbon-balance Tool (EX-ACT), developed by FAO in 2010, to estimate the impact of agricultural investment lending on GHG emissions and carbon sequestration in the project area. EX-ACT is a land-based appraisal system that allows the assessment of a project's net carbon-balance, defined as the net balance of CO2 equivalent GHG that are emitted or sequestered because of project implementation compared to a no project or without project scenario. EX-ACT captures project activities in the following five modules: land use change, crop production, livestock and grassland, land degradation, inputs and investment. The GHG values have been recalculated as part of the baseline evaluation survey.

Project Activities Relevant for the Analysis

Project area

As mentioned in the project background section, PoCRA is being implemented in the 15 district across Marathwada and Vidarbha region, covering an area of 64,500 square km. Cropping pattern in the selected districts of the project area is dominated by cereals (mostly sorghum and millet), cotton, pulses and oilseeds (soybean). As mentioned in the previous sections, the objective of this assignment is to conduct baseline survey in 8 districts of Marathwada. Project area (Pa) in these 8 districts covers 1808002 ha.

Project activities

Under PoCRA, several interventions are being adopted to promote climate resilience. Most of the practices or interventions are likely to have implications for carbon stocks. Annexure provides an overview of project activities and related assumptions for the 'With' and 'Without' project scenarios. All 'with project' area in these districts during the baseline survey was considered as 'without project' areas. Project activities were not considered under the "without project" scenario. It is assumed that the without-project situation is the same as the 'Start' project, unless otherwise indicated in the Annex.

As mentioned in the PoCRA PAD document, improved and climate resilient practices proposed under the project and considered for GHG accounting, considering the EX-ACT modules, include:

- No till and residue retention
- Nutrient management
- Improved agronomic practices
- Water management
- Manure application
- Crop residue management

Based on the baseline survey data, the cropland area (CA) of a particular crop under the 'with project' and 'without project' situations were estimated with the following equation:

$$[CA]_i = (S[CA]_i / S[CA]) \times Pa$$

Where, $[CA]_i$ is the area of a particular crop (i) in the project area; S[CA] is the total area of cropland in the baseline survey.

Similarly, the area under a particular crop in the without project area was also calculated based on the baseline survey data. The baseline survey data was also used to calculate the total amount of fertilizer application, electricity consumption, crop production etc. in both 'with project' and 'without project' areas.

The forest and degraded land area in the selected districts are given in the below table. The district wise livestock data is provided in the subsequent table.

Table 20: District-wise forest and degraded land

District	Forest Area (ha)[1]	Degraded land (ha)[2]	Project Village-level degraded land (ha)
Aurangabad	89840	173,000	1084
Beed	20560	332,000	9033

Hingoli	16450	3000	2788
Jalna	9090	3000	6176
Latur	2320	75,000	4506
Nanded	102900	3000	7052
Osmanabad	6670	234,000	5206
Prabhani	6400	10,000	4104
Total	254230	833000	44014

Source: Department of Agriculture, Government of Maharashtra; NAAS, 2010

Table 21: District-wise livestock dataset

Districts	Buffalo	Cattle	Other cattle	Poultry	Sheep	Goat	Exotic Pig	Ind_Pig
Aurangabad	93523	276601	306056	194672	88219	303013	4010	5008
Jalna	79144	159995	254267	181420	25669	183603	1246	17497
Beed	240284	263963	318117	443439	66211	336223	1038	10330
Latur	232584	173536	187789	175317	35901	122615	1633	6953
Osmanabad	172564	190252	164676	253150	31524	178660	2052	2898
Nanded	211721	328441	321862	362343	41173	253302	1490	11514
Parbani	96763	151735	205605	152080	25902	133667	1895	5493
Hingoli	66323	118256	157735	138961	6607	111210	849	2222
Total	1192906	1662779	1916107	1901382	321206	1622293	14213	61915

Source: 19th Livestock Census, Department of Animal Husbandry, Government of Maharashtra, 2012.

Results of the GHG Balance Analysis

Agriculture development and natural resource management projects are normally expected to contribute to net GHG (in particular Carbon) benefit, as a co-benefit to the resilience building objectives. The below table presents the estimated impact of the project activities on GHG balance including emissions from inputs in the

form of fertilizers, pesticides and energy use (electricity and diesel consumption). The ex-ante estimation of the GHG balance using Tier 1 for the PoCRA is shown to be negative, which means the project implementation will lead to a net carbon sequestration benefit. The main sources of GHG emissions are the inputs such as electricity, and diesel and livestock rearing. All other interventions are projected to contribute to increasing carbon stocks in soil and tree biomass. Achieving an increase in carbon sequestration is an important benefit of the CRA project. The net GHG benefit on a per hectare basis for the project area is estimated to be 0.5 tCO2/ha/year. The negative GHG balance estimated using EX-ACT shows that the CRA project interventions will lead to net GHG emission reductions or net CO2 sequestration, over the baseline or 'Without' project scenario. The CRA project will lead to mitigation of climate change.

Table 22: Greenhouse Gas balance of project activities under the CRA project in Maharashtra (Negative (-) values indicate Net GHG benefits or CO2 sequestration; Positive values indicate net GHG or CO2 emissions)

Components of the project	Gross fluxes (tCO2eq)		
	Without project	With project	Balance
Land use changes			
Deforestation	0	0	0
Afforestation	0	0	0
Other LUC	0	-50,710	-50,710
Agriculture			
Annual	-19,122,520	-27,249,592	-8,127,071
Perennial	0	-232,693	-232,693
Rice	0	0	0
Grassland & Livestock			
Grassland	0	0	0
Livestock	20,826,739	20,832,416	5,677
Degradation & Management			
Forest degradation	0	0	0
Peat extraction	0	0	0
Drainage organic soil	0	0	0
Rewetting organic soil	0	0	0
Fire organic soil	0	0	0
Coastal wetlands	0	0	0
Inputs & Investments	438,494	664,539	226,045
Fishery & Aquaculture	0	0	0
Total	2,142,713	-6,036,041	-8,178,753
Per hectare per year	0.1	-0.3	-0.5

The details of the assumptions are presented in the Annex.

i. *Estimates include proposed interventions for both Kharif (monsoon) and Rabi seasons*
ii. *Total project period is considered to be 20 years – which includes 6 years of implementation phase and 14 years of capitalization phase of the project.*
iii. *The area under 'Start' scenario and 'Without' project scenario is assumed to be the same, since the area under different crops especially under rainfed agriculture varies from year to year, depending on the*

monsoon rainfall, which is highly variable. There is therefore no clear year to year trend that can be observed in the area under different crops.

7.5 Net Farm Income

Farm income is another key results framework project development objective indicator to evaluate the impact of PoCRA. Farm income is defined as the net farm income calculated as the sum of net income from crops (gross income from all selling crops i.e. total quantity of each crop sold multiplied by the average price received minus the total cost incurred through the agriculture life cycle in production and selling of crops) and net income from agriculture-allied activities (gross income from sale of produce minus costs of production). We calculated the farm income for values lying within 3SD (99%) of the sample, thereby excluding outliers from our analysis.

The comparator of net farm income was calculated as ratio of net farm income of project area to the net farm income of comparison area. The comparator was calculated as 0.79. As presented in the below graph the mean annual farm income in project arm is INR 21,146 as compared to INR 26901 in comparison arm. As the confidence intervals are overlapping, the difference in the annual farm income in project and comparison is not significant.

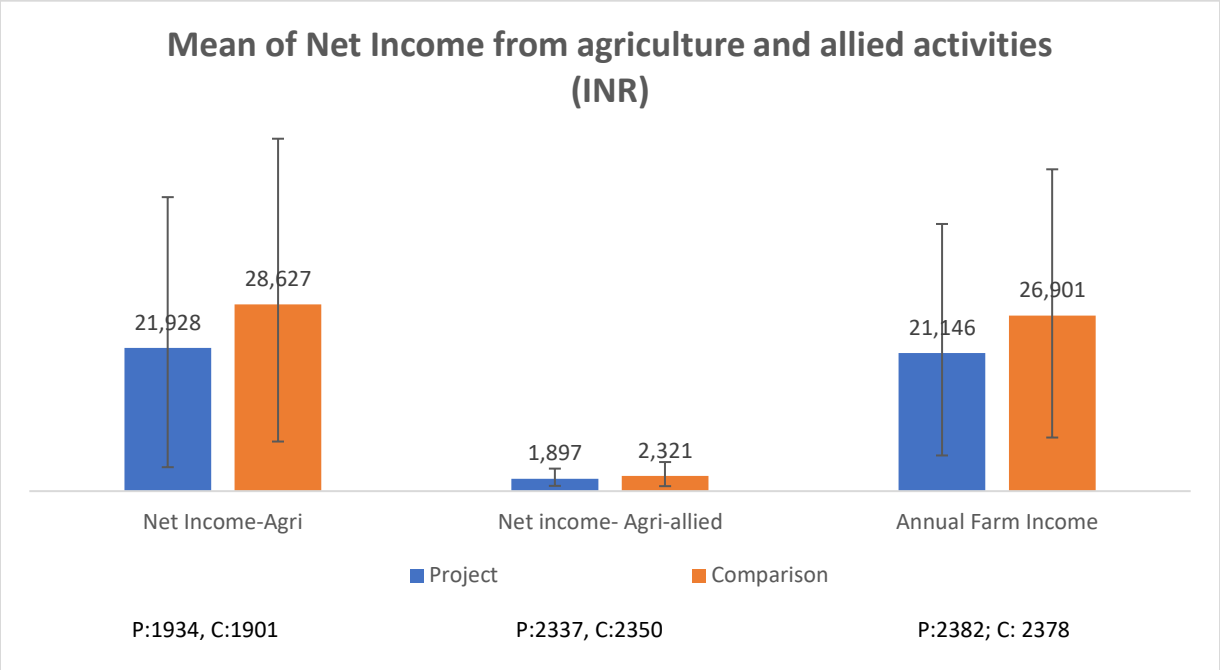


Figure 93: Net farm income of respondents

Further, as required in the PAD document, farm income is also calculated separately for male and female headed households at baseline and will be further tracked in mid-line and end line to see the impact of PoCRA on these different types of households. When we look at the mean farm income of farmers based on land ownership, we find that the mean net farm income of women-headed households is almost half at INR 6630/- in project area when compared to INR 12333/- in comparison area. In contrast, the average net farm income of male-headed households was found to be INR 21534/- in project area and INR 27207 in comparison area.

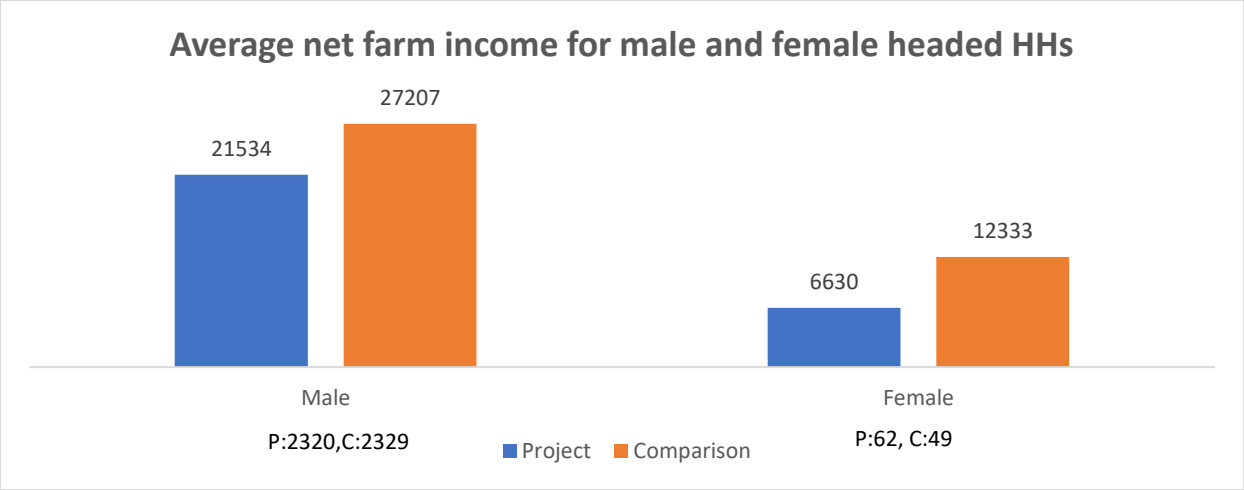


Figure 94: Average net farm income for male and female headed households across study arms

7.6 Adoption of Technology for Agriculture

For a set of 26 climate resilient agriculture technologies which will be promoted through PoCRA project, the respondents were asked if they have received any training or have adopted any of these technologies in the last one year. In the baseline, 25% farmers from project and 21% from comparison areas reporting that they received training on any one of the 26 technologies. On enquiring about the adoption status, 43% from project arm and 41% from comparison have arm reported of adopting at least one of these climate resilient agriculture technologies.

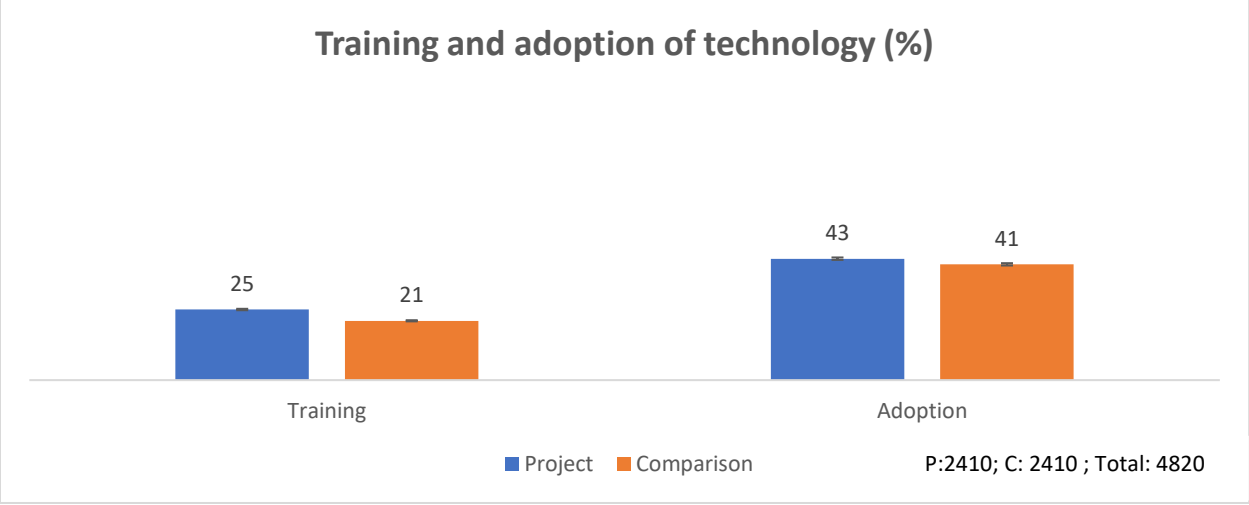


Figure 95: Training received versus adoption of any technology

7.7 Land under Certified Seeds

Certified seeds are an essential tool in the farmer's basket for climate resilient agriculture. These certified seeds can have various improved characteristics like pest resilience, drought-resilience or higher yield variety. The farmers were asked about the type of seeds they use for cultivating each crop. Farmers reporting using certified seeds were further asked about the area cultivated using certified seeds. This was used to calculate the percent of land under certified seed for the three crops mentioned in the PAD i.e.- soybean, pigeon pea and chickpea presented in Table below. The most percent of land under certified seeds is for chickpea (Project: 45% , Comparison: 43%) and the least is seen for pigeon pea (Project: 24%%; Comparison: 22%).

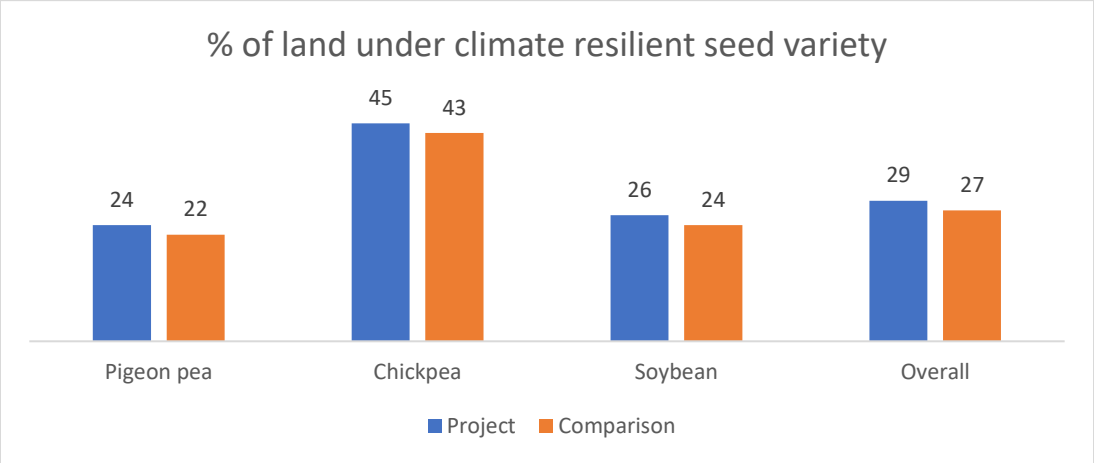


Figure 96: Percentage of land under cliamte resilient seeds for pigeonpea, chickpea and soybean

Further, we delved deeper to understand which were the common varieties used for these specific crops. For pigeon pea, maximum farmers had reported using climate resilient varieties including BDN-716, BDN-711 and ICPH 8863 (Maroti). JS-335 was the most used climate resilient variety for soybean. Other varieties used were Maus-162 and Maus-158. For chickpea, Rajvijay, Vijay and Jaki-9218 were found to be the most commonly used varieties.

7.8 Summary of Result Framework Indicators assessed in Baseline

The summary of resultsframework indicators calculated as part of the baseline survey has been presented below

Table 23:Summary of RF indicators assessed in baseline

Indicator Name	Measurement Method	Baseline(Done in October 2019)/ YR1	YR2	YR3	YR4	YR5	YR6
Project Development Objective Indicators							
Water productivity(kg/m^3) at farm level	Farm level water productivity has been calculated using the methodology developed by IIT B $water\ productivity = \frac{yield\ (kg)}{Total\ water\ taken\ up\ by\ crop\ (Rainfall\ AET + watering\ AET)(m3)}$	Project- 1.07, Comparison-1.17					
Spatial yield variability for oilseeds (soybean) - coefficient of variability	Spatial variability is determined by calculating the spatial coefficient of variance for the said crops using the production data. Production statistics of the crops of interests were collected during the household survey. Key variables included area sown and production which is used to compute yield. Using the yield data from the survey across different geographical area coefficient of variation (CV= standard deviation S/mean $\bar{X}$) has been calculated.	Project -37%, Comparison-38% region					
Spatial yield variability for pulses (pigeon pea) - coefficient of variability		Project -72%, Comparison-60%					
Temporal yield variability for oilseeds (soybean) - coefficient of variability	Temporal variability is determined by calculating the temporal coefficient of variance for the said crops using the production data. During the baseline, temporal variability has been calculated using the secondary productivity data of last 10 years(2009 to 2019) available at Maharashtra Department of Agriculture website . Coefficient of variation is calculated as CV= standard deviation S/mean $\bar{X}$. During the midline and end line, temporan variability too will be calculated using the primary data from baseline, midline and endline survey.	50% in Marathwada region					
Temporal yield variability for pulses (pigeon pea) - coefficient of variability		55% in Marathwada region					
Net greenhouse gas emissions	As suggested in the PAD document, the Ex-Ante Carbon-balance Tool (EX-ACT), developed by FAO in 2010, is used to estimate the impact of agricultural investment lending on GHG emissions and carbon	0.4672 tCO2/ha/year					

	sequestration in the project area. EX-ACT is a land-based appraisal system that allows the assessment of a project's net carbon-balance, defined as the net balance of CO2 equivalent GHG that are emitted or sequestered because of project implementation compared to a no project or without project scenario. EX-ACT captures project activities in the following five modules: land use change, crop production, livestock and grassland, land degradation, inputs and investment.						
Annual farm income	For calculating the annual farm income, agricultural production and sale statistics have been collected from the household survey. The gross production value and the farm revenue have also been calculated. Annual farm income has been calculated using the below mentioned steps 1. Gross production as well as the net revenue from sale of all crops grown by a farming HH is calculated. 2. The income from all agriculture allied activities is calculated 3. Total expenditure on cultivation of each crop and also total expenditure for every agriculture allied activity is calculated. 4. Finally, the total farm income is calculated by subtracting the total farm expenditure from total farm revenue This indicator value is reported as a comparator which is the mean net farm income in project area devided by mean net farm income in compasrion area **It is to be noted that the base for calculating the Annual farm income for female headed HHs is very small i.e. 62 and 49 for project and comparison respectively. Annual Farm income has been calculated for August 2018 to July 2019*	.79					
Annual farm income of female headed HHs		.54					
Intermediate Results Indicators FY							
Percentage of farmers adopting any improved agriculture technology adopted by the project	This indicator is calculated as the percentage of surveyed beneficiaries who acknowldeged adopting any of the improved agriculture technology practice.	Project-43%, Comparison-41%					
Percentage land under certified seeds (for soyabean, pigeon pea and chick pea)	As part of the baseline survey the respondents were enquired about both 1) their total area under cultivation for oilseeds (soybean) and pulses (pigeon, chickpea) and 2) the area under cultivation using climate resilient certified seed varieties for oilseeds (soybean) and pulses (pigeon, chickpea) . Using this data, the proportion of area under cultivation using certified seeds has been calculated .	Project- 29% Comparison-27%					

8. Findings- Qualitative

Feedback on Agriculture practices adopted currently

As mentioned above in the methodology section, feedback of the key project stakeholders including farmers (separate for farmers having landholding less than 2 Ha and for farmers having landholding more than 2 Ha) as well as Gram Panchayat representatives was taken to assess the agricultural situation in the Marathwada region. Along with these qualitative interviews, field observation visits were also done by experts and research team members to assess the ground level situation related to agriculture.

The key crops that were reported to be cultivated in the kharif season were soybean, cotton, pigeon pea, black gram, green gram and maize. The crops most commonly reported to be cultivated in rabi were wheat, jowar and chickpea. The key crops reported to be grown in summer are groundnut and onion. The annual crops mostly cultivated were reported to be sugarcane and turmeric.

Irrigation availability was reported to be low by all stakeholders, therefore most of the farmers are dependent on rainfall. Dug wells and bore wells were reported to be the most commonly available sources of irrigation. The farmers reported that they aim to use the irrigation water, if available, for cultivation of rabi and summer crops and for watering in kharif in case of absence of or delayed rainfall. During the experts' visits, it was observed that the wells which are available in the village are limited and do not provide sufficient water to raise rabi crops effectively.

During an expert field observation visit in Rahuli Khurd village, Hingoli it was observed that one earthen check dam had been built long back by the Agriculture department, but siltation has created problems and the storage capacity has reduced considerably. Desiltation of the check dam was required immediately to increase water storage capacity. In this village, about 6 cement check dam were available but their closing gates were totally damaged and needed replacement to increase the capacity of the storage reservoir. Hence, it is suggested that an assessment of the situation of existing water harvesting structures should be done in project villages and their proper repair or maintenance should be done accordingly.

When asked about which cultivation season is perceived to be risky, majority of the farmers perceive cultivation to be risky throughout the year due to uncertainty in rainfall and water availability. Kharif is perceived to be risky due to uncertain rainfall and risk of pest attack. Rabi and summer season are perceived to be risky due to unavailability of water and lack of irrigation sources.

The most frequently used tillage practices for land preparation were reported to be clod crushing, levelling, harrowing and use of plough. Use of oxen and tractor with rotavator was also reported for land preparation. Some of the farmers also reported using compost and animal dung manure in the field during land preparation. Majority of small farmers reported that they do not do any seed treatment. One of the reasons is that the farmers believe that the certified seeds they use are already treated with chemicals. In cases where seed treatment is done, the commonly used chemicals are Gaucho, Thiram and Bavistin. These chemicals are used for crops such as turmeric, soybean, chickpea and pigeon pea. Seed treatment was reported to be generally done at home with separate containers being used for the same.

Farmers were also asked about the major pests and diseases which affect their crops. The crop-wise major diseases which were reported of affecting their crops are a) Soybean- Pod borer, Stem Borer, Green worm, Semi looper and army worm b) Cotton- pink boll worm, leaf reddening, fruit borer, sucking pest, Pod borer, lalya disease, white fly, army worm c) Pigeon pea, Green Gram and black grams- Aphids and Pod borer d)Sweet Lime- Black spots. Aphids and Jassids were the commonly reported pests for all crops. The general practice adopted to avoid pests is spraying of pesticides. Farmers mostly purchase pesticides based on the suggestions of agri-input dealers and, in a few cases, also based on suggestions of agriculture officers and Krishi Mitras. It was understood during the expert visits that indiscriminate use of agro-chemical without protective clothing and equipment is being practiced.

When enquired about soil testing, very few respondents reported to getting soil testing done. Lack of awareness and information on how to get it done were reported to be the key reasons for these very low rates of soil testing. Also, pessimism in the farmers because of low rainfall in the past years was also a reason because of which farmers were demotivated and believed that there is no benefit in getting soil testing done. Though most of the farmers reported using traditional methods of farming, raising beds for soybean and turmeric crop using Broad Bed Furrow maker was adopted by a few farmers as it was helpful in increasing crop production. Though their adoptions is low, yet many farmers believe that shade net and polyhouse technology are effective in increasing production as they help to do cultivation in a controlled environment.

When enquired about the fertilizers which are most commonly used, DAP and urea were reported to be most commonly used by farmers. Superphosphate was also reported to be used commonly and potash was reported to be used for turmeric crop. The application of fertiliser was reported to be more during the sowing phase. It was noted that very few cases reported the use of organic fertilizers.

When enquired about the use of machinery in agriculture, most of the farmers reported that they rent it. Most commonly used machineries are tractor with mounted plough, harrower and rotavator. The farmers also reported that during the harvest season, the cost of renting becomes high. It was reported that it is difficult to get threshers and tractors during the peak season of sowing and harvesting. It was also reported that small farmers face more difficulty in hiring machinery due to lack of money.

"*Only rich people can afford to use the machinery and skilled labour. They do not share the skills of using machinery*"- FGD Farmers less than 5 acres, Nanded District

Lack of storage facilities like warehouse or godowns in their village or nearby area was reported by most of the farmers. Only farmers who have storage facility or space at home are able to store the produce, though it is not possible for most of the farmers due to lack of storage space in their homes. As a solution it was suggested to create common storage facility in the form of warehouse with minimum rent to the farmers.

On being asked about the challenges faced in selling their produce, most of the farmers reported that they do not get appropriate price for their produce. Roads were reported to be in poor condition by a few farmers and high transportation cost to reach the markets is also a challenge. During the expert field visits , it was observed that in cases where the farmers sell their produce to the Grain Market/APMC, they are not able to get their payment immediately (they received a partial amount initially and it could even take three to four months to get the full payment) due to which many are forced to sell their produce to middle-men who usually offer them less rate than MSP but would provide them cash up front. It was observed that major portion of the cotton produce is sold to private traders in their villages on cash and carry basis. In case of perishable produce,

particularly vegetable crops, farmers are forced to dispose their produce at price lower than market rate as the storage facilities at the village level is almost negligible. Support to farmers for aggregating their produce while selling and warehouse facility support can help them to get better prices for their produce.

Most of the farmers reported that no value addition is done by them before selling their produce, though some farmers reported of cleaning and grading their produce before selling it. Though in Somthan Patti village in Nanded district, it was reported that 50% of the turmeric farmers process turmeric into powder and sell it as a value-added product.

Many farmers reported that they face difficulty in getting access to credit. They reported the process for getting loan to be complicated and that it takes a lot of time to get it processed. In Kundi village in Parbhani district the farmers reported that they need to engage an agent as they find it difficult to get their loan processed directly. Due to these challenges and to get immediate access to credit, some farmers have to take loan from private money lenders at higher interest rates.

"*Talathi in the village does not submit the documents in the bank on time as he is supposed to, therefore the credit claim is delayed or rejected, and we do not get benefits*"- FGD Farmers less than 5 acres, Hingoli district

"*We do not get loan on time and the crop sowing time gets surpassed till we get the loan*"- FGD with farmers above 5 acres, Nanded district.

High number of farmers were found to have taken crop insurance though many farmers reported that they have faced difficulty in getting benefit of crop insurance in case of crop damage. Farmers reported of facing problems in online application as the customer service centres are in block level and they need to travel these. Also, lack of guidance, lack of knowledge of application process and difficulty in filling forms are other key challenges in getting insurance claims. In Bharadi village, Hingoli district, farmers informed that they received crop insurance benefit 2-3 years after the season of damage. Some farmers stated that they don't have enough money to pay as insurance premium. During the expert field visit too it was observed that farmers could not get benefit of crop insurance schemes because of lack of transparency in the system of claim. (In one instance in Butegaon village in Jalana district, it was reported that in the event of crop failure last year, farmers could not establish the reason for crop failure and did not get any claim from insurance service provider).

Almost all farmers expressed their concern about climate related challenges they have been facing in the last few years due to uncertain rainfall. Low and untimely rainfall in the last few years and heat waves were informed to be responsible for poor crop produce. Most of the farmers mentioned they do not adopt any particular strategy to cope with climate vulnerability and mentioned that they are helpless against nature. Though in the expert visits it was analysed that in some cases farmers adjust by adopting shot duration varieties and by adopting intercropping (most commonly Cotton + Black gram and Soybean+ Pigeon pea) to improve water use efficiency.

On asked about their training requirement, majority of farmers reported that the they want training on water management practices. Overall, lack of water availability was reported to be the major challenge faced by the farmers.

The major agriculture-related challenges that were identified from the expert visits are summarized below:

a) Poor water availability for irrigation. To address this major challenge, it is important to create infrastructures like rainwater harvesting structures, ground water recharge structures, promote use of

pressurized irrigation system for high water consuming crops, development of net-shed/poly-house for growing high value vegetables and flower plants (olericulture), medicinal plants during non-seasonal period. It is encouraging that all these activities have been included under PoCRA project.

b) Another challenge is to control pests specially in cotton crop as the pest infestation is very severe. The farmers are spending significant amount of money on pesticides application due to which the cost of production has been increasing every year. Farmers need to be encouraged to adopt soil testing practices and use fertilizers as per the recommended dose. Farm laborers are not enough to finish the assigned field job in stipulated time and thus, farm mechanization is essential to complete the farm activities like sowing, inter-culture operation, pesticide application, fertilizer injection at root zone, harvesting the crop within time frame.
c) Marketing network at village level is poor and the perishable farm produce are damaged within a short period, therefore the farmers are not able to generate decent income from the available land holdings. Access to storage support to farmers can help to get them avail better prices for their produce.
d) During field visit it was observed that farmers are using lot of chemical and without protective clothing. The FFS sessions can incorporate training on safe and judicious use of chemicals.
e) It is important to assess the condition of the existing watershed structures in the project areas and repair them wherever required.

Feedback of Landless residents on their current livelihood opportunities and related challenges

FGDs were also conducted with landless residents as part of the baseline survey to understand their key challenges. Farm labour and labour in nearby towns or cities are the major livelihood activities in which the landless residents are engaged in. Some of them also reported to be engaged in masonry, carpentry, tailoring and running small retails shops. During the expert visits, it was observed that though some of the landless families have taken up rearing of small ruminants as their livelihood activity, they require training on best practices of livestock management. Respondents engaged in farm labour reported that livelihood opportunities in their villages have reduced drastically due to less /erratic rain and lower farm production in their village due to which they have to migrate for work in nearby towns and cities. Landless farmers reported that droughts or less water availability for agriculture has made farming unprofitable and higher unemployment has led to more competition for farm labour. Landless residents were asked which livelihood activities they would like to engage in if provided an opportunity. Majority of respondents reported that they are interested in goat rearing, poultry and dairy. While enquiring about the migration pattern, it was reported to be between 5% to 25% across villages. Migration from villages was reported to usually start in October and November (after the kharif harvesting) and people return around Holi season. On enquiring what kind of support from government can help them in increasing their income, people reported requiring loan at low interest rates to start their own business. Few respondents also expressed their interest in starting dairy, goat rearing and poultry activities. Support in increasing the water access was also reported to be beneficial for increasing the farm labour opportunities in their village. On asking about their perception of climate vulnerability and its impact on their employment, most of the respondents acknowledged that rainfall has decreased in the last five years. Due to impact of climate change on agriculture, the crop production of farmers has decreased which has led to lack in consumption, and also reduced other livelihood opportunities in the village.

"*Not much masonry work has been done in our village since last year as farmers do not have money*" -FGD Landless, Osmanabad district

As reported above, climate vulnerability has led to loss of employment in farm labour and other farm allied activities. Also, the education of children was affected due to migration. They do not have any coping mechanism

to adapt to climate change. Respondents reported finding migration as the safer way to cope with climate change. In a one village, respondents reported planting trees to cope against climate vulnerability.

"*We planted 2500 trees in the village but only 50 survived due to adverse climate*" -FGD Landless, Osmanabad district

There was mixed response about awareness and participation in Gram Sabha. Though even in cases where landless residents attend Gram Sabha, they were not satisfied with the support provided to resolve their concerns.

"*We are unable to present our concerns and problems to the government through gram sewak as the gram sewak does not come to the gram panchayat often. Also, most of the times we do not know the timing of the gram sabha meeting*"-FGD landless, Aurangabad district

Assessment of current activities and challenges of SHGs

As part of the baseline evaluation, FDGs were conducted with SHG members to understand their current activities, challenges and the activities they would like to engage in in the future.

It was found that out of 16 SHGs interviewed, members of only three SHGs reported to be engaged in income generating activities currently. The members were engaged in income generating activities like beauty parlor, dairy and tailoring. In an instance of an SHG in Somthana village in Nanded, its members had established a fertilizer shop, but it was shut down due to conflicts among group members. The current activities are done mainly by members individually but not in group. On average, INR 100 was found to be the average saving per member in a SHG. Generally, about 4 meetings were reported to be conducted each month.

It was observed that most of the SHGs provided loan to their members at 2% interest rate per month. On being asked about how the SHG loan is utilized, most of the members reported using it for their household consumption purpose like paying fee of their children, marriage, health expenditure and other domestic expenditures. A few members had also reported utilizing the loan amount for income generating activities like agriculture inputs, fodder, vegetable cultivation and for starting enterprises like parlor and flour mill.

On being asked if they were interested in engaging in income generating activities and about these activities, in all group discussions SHG members showed interest to start income generating activities. They showed interest in activities like dairy, goatery, poultry and setting up enterprises to make papad, sevaiya and flour/dal mill. Some groups even showed interest in agri activities such as horticulture and vermicompost unit.

On being asked about the challenges faced by their SHG, complying to the bank documentation process was reported to be a major challenge. It was reported that some members are unable to save every month due to poor economic conditions. Improper accounting, irregular meetings, lack of market for their enterprises were the other challenges reported.

We think capacity building of the SHG members to understand the loan application process would be helpful for them in further loan applications. On enquiring about the kind of support they would like from the government, SHG members requested for support including training on account management and on livelihood activities that can be taken up by their group. SHG members also wanted government to provide them financial support to set-up enterprises like papad-making and flour mill.

Assessment of current activities and challenges of FIGs

As part of the baseline study, interviews were conducted with Farmer interest groups (FIGs) members to understand about their activities and challenges faced by them.

It was found that most groups were formed with the help of ATMA and agricultural department staff. For majority of FIGs, the only criterion was that the members should be farmers having agriculture land. In some FIGs, farmers were required to have one-acre land, though in some FIGs even landless people were allowed to be their member.

On enquiring about the activities done by members of these FIGs, most of the FIGs were currently not engaged in any group activity. In only four out of 16 interviewed FIGs, collective activities were reported to be conducted by the group members. These activities were seed production by two groups, sericulture and goat rearing by one group and vegetable cultivation by one group.

On enquiring about the current challenges faced by the FIGs, it was found that getting access to loans, lack of capacity to apply for loans (lack of knowledge of documentation process) and lack of capacity of running their group were the major reported challenges.

On enquiring if the FIGs had applied for any grant under any government scheme, seven out of the 16 FIGs reported that they have applied for grant under different government schemes. The FIGs had applied for benefits including seed processing, setting up warehouse under PoCRA, application for tractor and machinery under ATMA, shed for sericulture, cattle shed and matching benefits under PoCRA. The key challenges faced by farmers in these applications were: difficulty in online application and lack of complete knowledge about the application process.

"*The process for applying for godown is very hard. Bank officials told us to deposit the grant amount first, only after which they would be able to pass the loan*" FIG member, Aurangabad district.

Some farmers complained about the server problem in online application. Some groups have tried to get the matching grant for starting the activities under PoCRA, but the banks are not providing them loans as they are asking the grant amount to be deposited first before release of the loan.

On being asked about the future activities they would like to engage in, FIG members showed interest in seed processing plant, hydroponics for fodder cultivation, mushroom production plant, aloe vera and Shatavari cultivation, nursery and floriculture in shade net. Some farmers also showed interest in collective goat rearing, poultry as well as vegetable cultivation through protective irrigation from farm pond. The challenges foreseen in implementing these activities were uncertain climate, market access and credit availability for starting a new activity.

Farmers asked for training on marketing, account management, general management, technical training on these livelihood activities which their groups want to engage in and on value addition and processing activities which could help them to improve their capability to run their FIGs more effectively.

Assessment of current activities and challenges of FPO/FPCs

Qualitative interviews were also done with the FPO/FPC representatives in order to know about their current activities, challenges faced by them, activities they would like to engage in future and the support they require from the government to efficiently run their FPC/ FPO.

The member strength of FPO/FPCs ranged from a minimum of 10 to maximum of 1300. The average number of female members was around 25% while ranging from zero percent to 60%. The percentage of SC members was an average 20 %. On average, the surveyed FPO/FPCs had 69 % of the farmers as small farmers.

Seed processing was found to be the activity in which most of the FPCs were engaged in. It included cleaning, grading and packaging of seeds. Two FPOs reported that they were engaged in the turmeric powder making after boiling and polishing it. Some FPO's were engaged in contract farming and export of vegetables. One group had also reported to be engaged in equipment rental activity. Except turmeric, most of the other produce was sold at the local markets in the block level and in nearby district. The seeds are mainly sold in the villages to the farmers at the price lower than the market price. Representative of 'Rangsharda Agro Farmer producer Company', an FPO in Jafrabad takula, Jalna had reported of starting trading business and exporting their produce to Dubai too. The local market distance was reported to vary between 15 to 50 kms. The marketplace for turmeric was farther and was between 100 to 500 Kms from the farmer producer organisation.

On enquiring about the sources from where the FPC got information on current marker rates, it was interesting to note that majority of groups received information through WhatsApp groups and mobile applications. Other popular sources of information were TV, newspaper and markets themselves.

On enquiring about the current challenges faced in operating their FPC/FPO, many representatives who were engaged in the seed production activity expressed concern over the availability of raw material as they felt that climate change has led to a serious negative impact on their agriculture productivity. Issue in getting bank loans, lack of guidance in accessing bank loans and lack of funds to run their business activities were the other major reported challenges. High rates of electricity and poor and expensive transportation facilities were also reported to be other key challenges. Lack of cold storage facility in their vicinity for storing their produce was also reported as a challenge by one FPC.

On enquiring about the value addition activities their FPC/ FPO would like to engage in future, majority of them were interested to open oil and dal mills and in expanding their existing seed production business. Some FPO/FPC also showed interest in expanding their existing turmeric powder business, opening jaggery unit, processing and exporting of vegetables, poultry farming and opening cold storage. Essentially, most of the FPC/FPOs were interested to produce value added products from the agri commodities that are grown in their vicinity and by their member farmers. On asked about the challenges they foresee in implementing these activities, lack of capital and issues in getting bank loan was reported as a major challenge. Along with this, marketing of their products, lack of assured raw material due to uncertain rains, lack of capacity to run their organization cohesively, lack of storage facility to store their produce were the major reported challenges. Also, bad roads and high transportation cost are other hurdles for starting a new activity.

"*Electricity rates are very high, and it is not available when required. We do not get transportation vehicle on time for carrying agricultural produce when needed*"- FPO Representative, Aurangabad district

The FPO/FPCs were also asked about the previous activities in which they were unsuccessful. In a few cases, the organizations had procured commodities like cereals and pulses such as chickpea and red gram in bulk quantity, but the market rate had collapsed due to which they had to suffer huge loss. The FPO/FPC had reported being unsuccessful in activities like procurement of bio fertilizers, seed processing and apiculture. The key reasons analysed to be responsible for these failures were inability to forecast the market rates of the commodities, lack of capacity in operating their FPO/FPC, lack of coherence amongst the group members and risks in agriculture due to uncertainty in rainfall.

The FPO/FPC representatives were asked about the trainings or capacity building support that can help them to run their organizations effectively. They reported that training on general management, marketing, accounts management, preparation of business plan and technical trainings related to value addition would be helpful for them in running their organization successfully.

Support in getting bank loan, access to cheaper and reliable electricity, access to storage infrastructure in their vicinity and technical support or training to run their enterprises effectively were the key type of support that that the FPCs required from the government to address their challenges. Some representatives felt that the current loan process is complicated and needs to be simplified. Other expectations were to improve their irrigation facility so that there is more certainty in availability for the produce which would be raw material for their FPC/FPO business.

When asked if their FPC/FPO had followed environmental safeguards during construction of their building or infrastructure, it was found that almost all the FPOs do not have their own buildings and rented them. Some FPOs said that they have followed the environmental safeguards but when probed further, they were not aware about the environmental safeguards that are to be followed during construction of physical infrastructure.

Annexure

Methodology note on Water Productivity by IIT-B

Modelling Irrigation Scenarios for Sprinkler, Drip and Flood Irrigation

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Reviewed By - Prof. Milind Sohoni

Reference Documents: M&E Framework Document link, Water productivity Note

Following document illustrates the methodology used for modelling drip and sprinkler irrigation scenarios based on collected survey data. This document must be used for computing irrigated AET for varying irrigation methods. It explains the computation process for denominator (AET) in water productivity formula for irrigation methods –

1. Sprinkler
2. Drip
3. Flood

$$water\ productivity = \frac{yield\ (kg)}{Total\ water\ taken\ up\ by\ crop\ (Rainfed\ AET + watering\ AET)\ (m3)}$$

Where *Irrigated AET = Rainfed AET + watering AET*

Modelling any type of irrigation requires following information on crop, which should be collected irrespective of irrigation method –

1. Crop Name-C01
2. Crop sowing date-C02
3. Crop harvesting date-C03
4. Crop Area in acre-C11
5. Crop damage (to account for / find the cause for less yield – it may be pest attack/animal attack/unable to give water during dry spells/untimely rains)
6. Crop Yield-C15

In addition to this, irrigation information required for different irrigation types, the parameters used while modelling irrigation behaviour and assumptions are explained here

1. Sprinkler Irrigation:

A typical scenario for sprinkler irrigation on field is shown in figure 1.

1. Standard pipes of 20 foot size are connected to form a sprinkler pipeline.
2. The sprinkler nozzles are mounted after each pipe at a spacing of 20 foot on pipeline or at 40 foot spacing after 2 pipes on the pipeline as per the choice of farmer.
3. Normally 10 – 20 sprinkler nozzles are connected on a pipeline based on pump HP (3 HP or 5 HP), nozzle spacing etc.
4. Typically, a sprinkler nozzle has a radius of 20 foot, so that it irrigates in the diameter of 40 foot.
5. The sprinkler pipeline would approximately irrigate a rectangular plot of 40x'y' foot on the field on given day.
6. This sprinkler pipeline with nozzles is moved horizontally across the field to irrigate the entire field.

7. In this way, according to typical farmer practices it takes a few days to irrigate complete field by sprinkler irrigation.

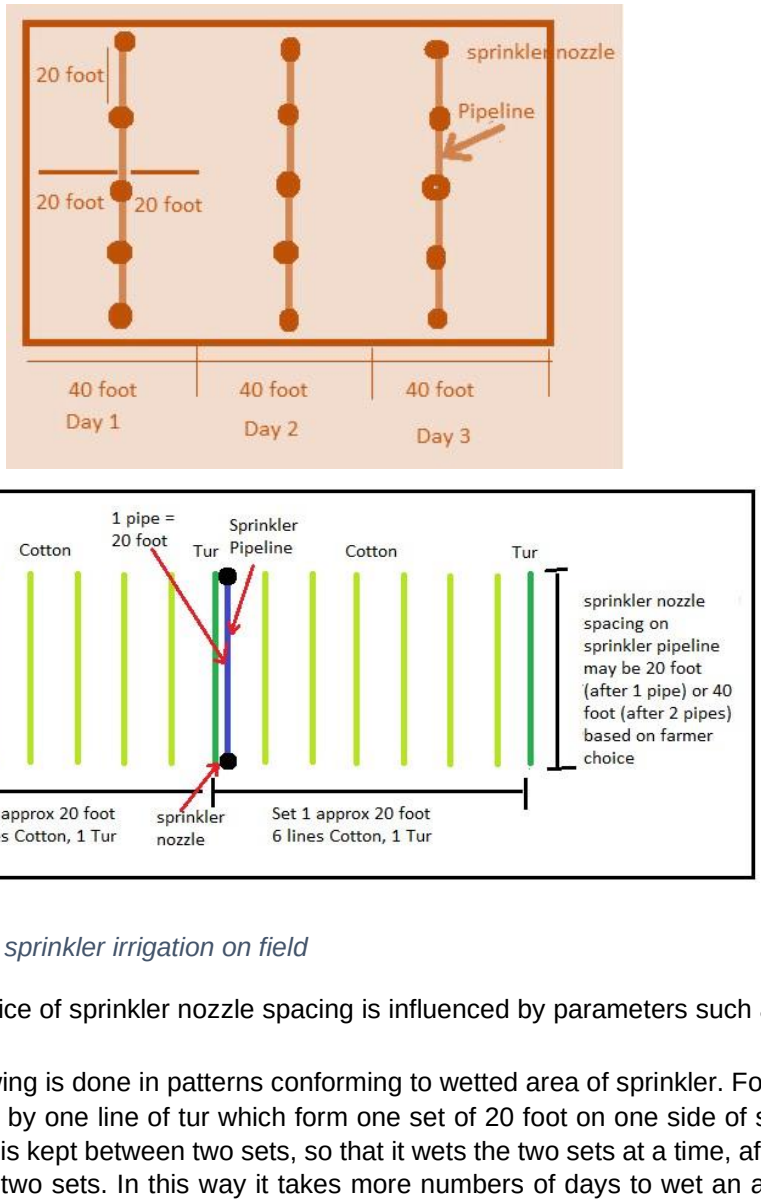

Figure 1 Typical sprinkler irrigation on field

8. The choice of sprinkler nozzle spacing is influenced by parameters such as pump HP, water available in well etc.
9. The sowing is done in patterns conforming to wetted area of sprinkler. For example, 6 lines of cotton are followed by one line of tur which form one set of 20 foot on one side of sprinkler pipeline. The sprinkler pipeline is kept between two sets, so that it wets the two sets at a time, after this it is moved by 40 foot to another two sets. In this way it takes more numbers of days to wet an area as it cannot be done all at once like drip.

Assumptions: The norms followed to model sprinkler irrigation are -

1. The sprinkler irrigation water is added to rainfall
2. The crop water requirement has been adjusted for sprinkler irrigation by reducing its crop factor Kc from October onwards to 0.9Kc.
3. If the crop duration is longer than that available in our plugin, then Kc of last crop stage is padded for extra days of crop till its harvest date.
4. The farmer may not know the sprinkler nozzle flow rate, in such case it can be selected from Table 1 below provided by sprinkler manufacturers. This Table 1 contains sprinkler spacing in meter and precipitation rates in mm/hr for each spacing along with its uniformity.

Selection of sprinkler flow rate:

i. Sprinkler spacing (in foot) to be converted to meter later – C05 (survey data): Suppose the sprinkler nozzle spacing is (40x40 foot) around 12x12 meter look for this spacing in top row of Table 1. All values

under this spacing denote the flow rate in mm/hr. we have selected average or middle value under this spacing 10.2 mm/hr (marked by red circle) here for computation. This method may be used for selection of sprinkler flow rate.

ii. Since the actual flow rate is influenced by number of factors on field such as pump HP, number of sprinkler nozzles running on the pump which are difficult to account for together, so we select average flow rate based on *sprinkler nozzle spacing*. The choice of spacing 20x20 foot or 20x40 foot depends on factors such as water available in well, how early the farmer wants to irrigate the field and his pump HP. *Table 1 Selection table for sprinkler flow rate in mm/hr*

Technical Specifications

Single Nozzle **(Trajectory 25°)**

Precipitation rates (mm/hr) & uniformity (CU) at various spacing

Nozzle	P	Q	D	Spacing (m)							
(mm)	(Kg/cm²)	(lpm)	(m)	12x8	12x9	12x10	12x11	12x12	13x12	18x9	14x12
4.3	2.0	17.23	28	10.8	9.6	8.6	7.8	7.2	6.6	6.4	6.2
	2.5	19.40	28	12.1	10.8	9.7	8.8	8.1	7.5	7.2	6.9
	3.0	21.55	28	13.5	12.0	10.8	9.8	9.0	8.3	8.0	7.7
	3.5	23.31	28	14.6	13.0	11.7	10.6	9.7	9.0	8.6	8.3
	4.0	24.60	28	15.4	13.7	12.3	11.2	10.3	9.5	9.1	8.8
4.7	2.0	20.05	26	12.5	11.1	10.0	9.1	8.4	7.7	7.4	7.2
	2.5	22.21	28	13.9	12.3	11.1	10.1	9.3	8.5	8.2	7.9
	3.0	24.40	28	15.3	13.6	12.2	11.1	10.2	9.4	9.0	8.7
	3.5	26.32	28	16.5	14.6	13.2	12.0	11.0	10.1	9.7	9.4
	4.0	27.12	26	17.0	15.1	13.6	12.3	11.3	10.4	10.0	9.7
5.1	2.0	22.92	28	14.3	12.7	11.5	10.4	9.6	8.8	8.5	8.2
	2.5	24.96	28	15.6	13.9	12.5	11.3	10.4	9.6	9.2	8.9
	3.0	27.71	28	17.3	15.4	13.9	12.6	11.5	10.7	10.3	9.9
	3.5	29.63	28	18.5	16.5	14.8	13.5	12.3	11.4	11.0	10.6
	4.0	31.89	30	19.9	17.7	15.9	14.5	13.3	12.3	11.8	11.4

Note:
- Sprinklers are tested under standard test conditions.
- P= Pressure; Q= Discharge; D = Diameter
- Colour code - Distribution uniformity

CU < 85%	CU = 85-88%	CU = 88-92%	CU > 92%

Source:
https://www.jains.com/PDF/Catalogue_2015/sprinkler/overhead_sprinkler/metal_impact_sprinkler/JI_2_sprinkler.pdf

Such tables will be available for various sprinkler manufacturing companies.

5. The irrigation given is then computed as –

$$Water\ per\ irrigation\ (mm) = Flow\ rate\ in\ \frac{mm}{hr} * pump\ operation\ time\ per\ day\ in\ hrs\ hr$$

Assuming that the entire field was irrigated on single day, this water is added to the rainfall on the date of irrigation as per survey.

Following are 3 examples on computation of irrigated AET from survey. We have selected the red circled flow rates based on our farmer survey. The graphs for each case better explain the modelling methodology.

Relevant questions:

iii. Sprinkler flow rate in LPH – C05 iv. Sprinkler spacing (in foot) to be converted to meter later – C05

v. Number of irrigations given-C06
vi. Watering days per irrigation-C09
vii. Sprinkler operation time on a single area (per day pumping hrs) -C10
viii. Irrigation dates (month-week)– C08

this information is used to run the daily level farm level model.

Table 2 Survey Examples:

Sr. no.	Farmer name	Baban Dane	Gajanan Gaikwad	Gajanan Raut
1	Village	Chapadgaon	Bhidi	Bhidi
2	Taluka	Ghansavangi	Deoli	Deoli
3	District	Jalna	Wardha	Wardha
4	Year	2018	2018	2018
5	Crop Area (Acre)	6	4	6
6	Soil type	clay loam	loamy sand	clay loam
7	Soil depth (m)	1	1	1
8	Sowing date	6th june	10th june	10th june
9	Harvest Date	15th feb	30th November	31st march
10	**Sprinkler spacing (foot)**	**20x40**	**40x40**	**20x40**
11	Sprinkler flow rate (mm/hr)	15	10	15
12	Number of waterings	6	2	5(1st sprinkler,2,3,4 flood)
13	Irrigation time in hrs to irrigate 1 acre* (pumping time per day for given land)	2	6	2.5
14	watering days per irrigation	10 days	4 days	10-12 days
15	irrigation dates (month-week)	31 july, 12th august, 28th august, 9th sept, 18th sept, 28th sept	29th july, 19th september	21st june, 23rd nov, 23rd dec, 23rd jan, 23rd feb
16	**Water per irrigation (mm) = (11*13)** (This should be added to rainfall at every irrigation date (15))	**30 mm**	**60 mm**	**37.5 mm**
17	**Total Irrigation given (mm) = (16*12)**	**180 mm**	**120 mm**	**237.5 (50 mm per flood irrigation)**
18	**Yield (quintal/acre)**	**4.5**	**5.75**	**8.3**

*Irrigation time in hrs to irrigate 1 acre is actually the time required to irrigate each rectangular patch around the sprinkler pipe-line, which is moved throughout the field to irrigate the rectangular patches one after the other.

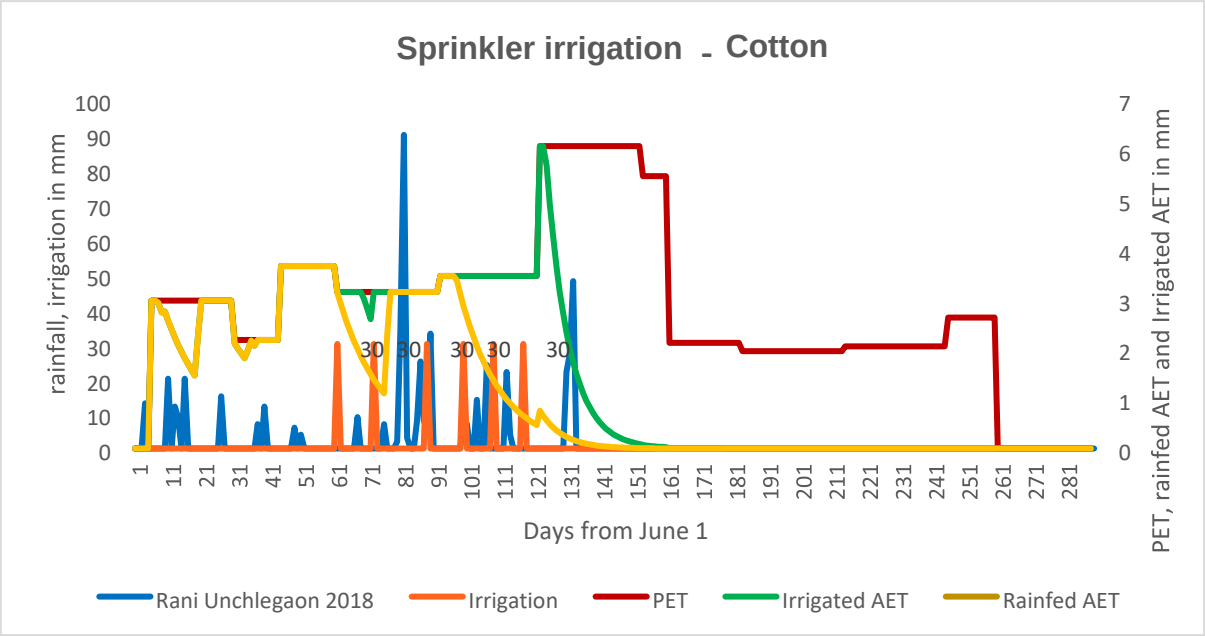

Figure 2 Baban Dane- Chapadgaon, Jalna

Observation: In case of Figure 2, The farmer has given water to crop during dry spell in July and before its flowering stage in august – September. 6 waterings of 30 mm each were given in gap of 10 days, where he took 10 days to water his 6 acre field once by moving the sprinkler pipeline across his field.

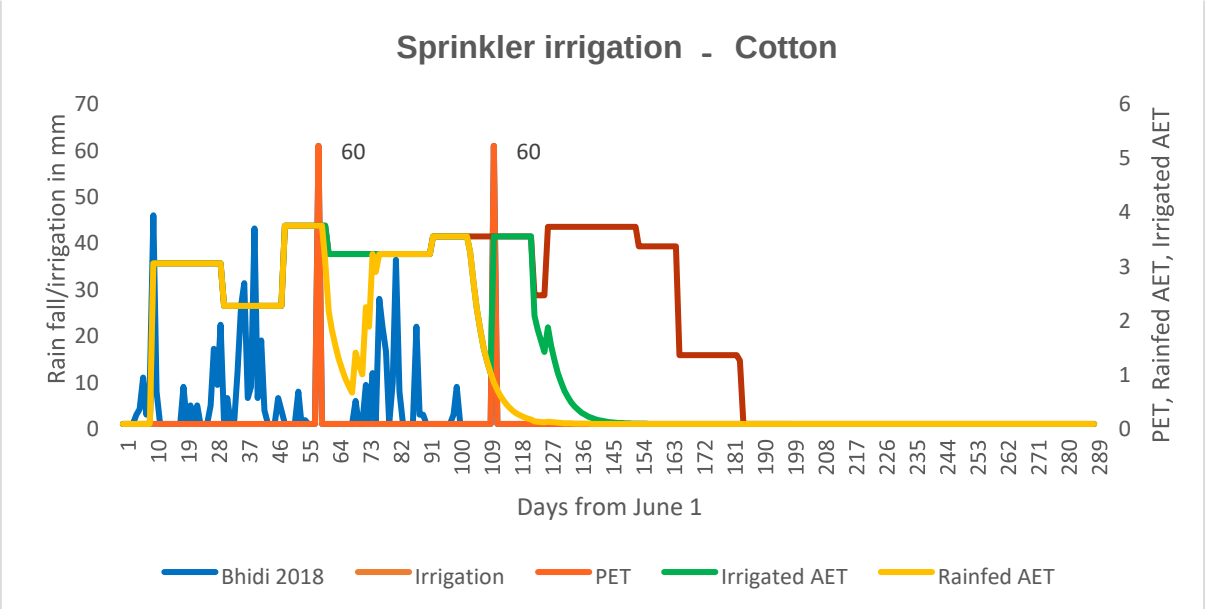

Figure 3 Gajanan Gaikwad Bhidi, Wardha

Observation: Farmer Gajanan Gaikwad in Bhidi village had light deep soil, which he said did not hold much moisture and water penetrated downwards instead of horizontal movement, due to which according to him any amount of irrigation did not suffice his requirement. He operated pump for longer time compared to the other sprinkler farmers as evident through Table 2, and 2 60 mm watering. He kept cotton crop till December (one

flowering of the crop – 2 pickings – around 75% flowering in picking 1 and 25% flowering in picking 2) as his well did not have water after December.

He watered the crop once in July to provide protective irrigation and then in September before flowering, which gave him average yield.

As per his narrative he kept a greater sprinkler spacing of 40x40 foot and was able to water 1 acre in 1 day whereas typically those farmers with sprinkler spacing 20x40 foot took 2 days to water 1 acre.

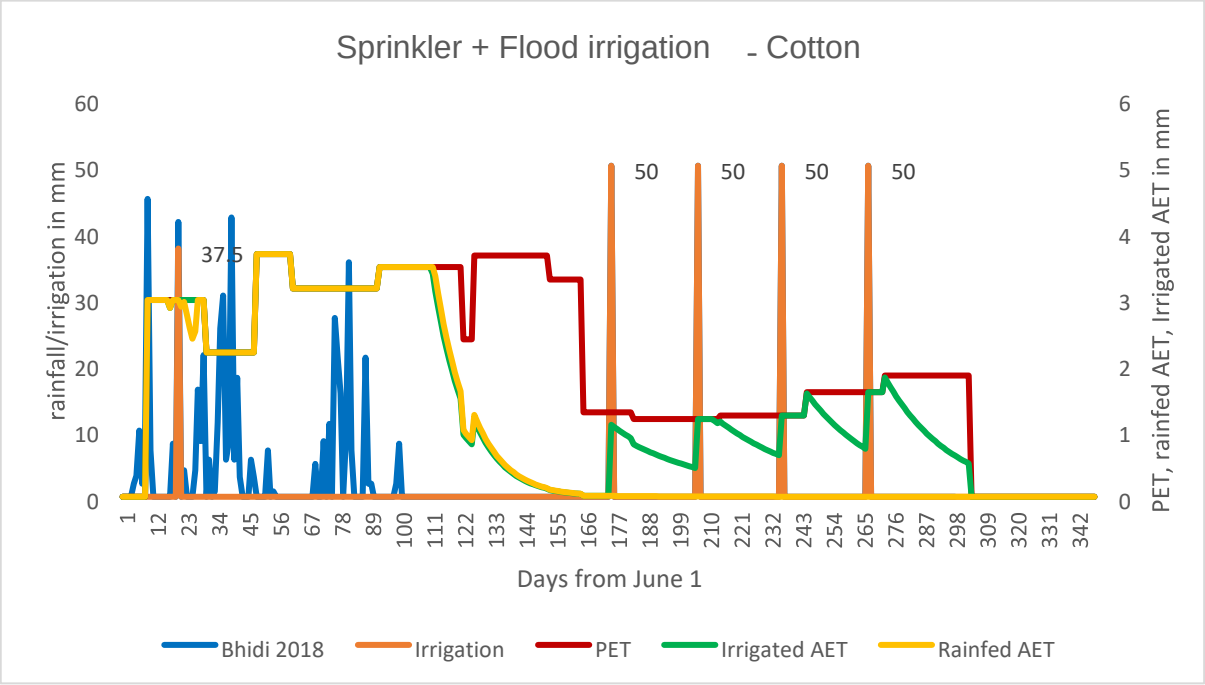

Figure 4 Gajanan Raut Bhidi, Wardha

Observation: Farmer Gajanan Raut applied water to his cotton crop by sprinkler for protective irrigation in early monsoon (37.5 mm), when the crop height was small. He provided flood irrigation (50 mm each) after crop's first flowering, in order to take second flowering, sprinkler irrigation after the crop flowered would have led to crop damage. With two flowerings his crop was harvested by March end.

This case shows typical farming practice followed based on different stages of crop.

Table 3 Sprinkler Irrigation Water Balance summary

Farmer name	Baban Dane		Gajanan Gaikwad		Gajanan Raut	
Village	Chapadgaon		Bhidi		Bhidi	
Taluka	Ghansawangi		Deoli		Deoli	
District	Jalna		Wardha		Wardha	
Soil Type	clay loam		loamy sand		clay loam	
	Irrigated	rainfed	Irrigated	rainfed	Irrigated	rainfed
Rainfall (input)	577.0	397.0	610.8	490.8	728.3	490.8
Runoff	167.4	102.2	57.9	40.8	217.6	125.9
Infiltration	409.6	294.8	552.9	450.0	510.7	364.9
SM	0.0	0.0	6.0	6.0	25.6	8.3

GW recharge	0.0	0.0	191.4	166.8	4.0	0.0
AET	409.6	294.8	355.5	277.2	481.0	356.6
PET (input)	811.0	811.0	522.2	522.2	696.6	696.6
Deficit	401.4	516.3	166.7	245.0	215.6	340.0
Irrigation	180		120		237.5	

* All values are in mm **Inference:**

1. From Rainfed and Irrigated water balance in Table 3 for sprinkler irrigation, it becomes clear that the water amount given through irrigation does not become entirely available to the crop as AET, but gets divided among other water balance components such as ground water soil moisture based on soil properties.
2. Also, the choice of irrigation method is influenced by multiple factors like water availability, finance availability for purchase of micro irrigation equipment, crop and *growth stage of crop* to name a few.
3. These minute details such as number of flowerings, pickings, other external factors affecting yield and watering should get properly captured in survey, so that water productivity may be measure accurately.
4. The effect of providing protective irrigation and irrigation before flowering in can be seen to translate into yield increase.
5. This irrigated AET in mm can be converted to meter-cube by multiplying with crop area to get the denominator in water productivity formula 'Total water taken up by the crop'.

$$water\ productivity = \frac{yield\ (kg)}{Total\ water\ taken\ up\ by\ crop\ (Rainfall\ AET + watering\ AET)(m3)}$$

$$\boldsymbol{Total\ water\ taken\ up\ by\ the\ crop\ (m3)} = \boldsymbol{Total\ crop\ area\ in\ acre} * \boldsymbol{Irrigated\ AET\ (mm)} * \mathbf{4}$$

2. Drip Irrigation

Assumptions:

1. The drip irrigation water is added to soil moisture with 90% efficiency
2. Similar to sprinkler, The crop water requirement has been adjusted for drip irrigation by reducing its crop factor Kc from October onwards to 0.6Kc.
3. The farmer usually knows the dripper/emitter flow rate and *can tell how much water is thrown out by emitter in an hour (LPH).* This is used to compute the water per irrigation to be used in model.
4. The irrigation per day is computed as –
    a. Number of drippers in crop area = crop area in acre*4046 (sq-m)/ dripper spacing (sq-m)
    b. $$Irrigation\ water\ in\ ^{mm} = \frac{day\ [number\ of\ drippers\ in\ crop\ area * dripper\ flow\ rate\ in\ LPH * pumping\ hrs\ per\ irrigation]}{crop\ area\ in\ acre * 4046}$$
    c. This irrigation water is added to the model on the irrigation dates (for number of days in each irrigation) obtained from farmer survey
5. If the crop duration is longer than that available in our plugin, then Kc of last crop stage is padded for extra days of crop till its harvest date.

Relevant questions:

1. Dripper flow rate in LPH – C05
2. Dripper spacing (in foot) to be converted to meter later – B13
3. Number of irrigations given-C06
4. Watering days per irrigation-C09
5. Dripper operation time (per day pumping hrs) -C10 6. Irrigation dates (month-week)– C08 this information is used to run the daily level farm level model.

Table 4 Drip Irrigation Farmer Samples

Sr. no.	Farmer name	Yashodabai	Kasubai Jadhav	Vitthal Munchal
1	Village	Chapadgaon	Tongaon	Tongaon
2	Taluka	Ghansawangi	Aurangabad	Aurangabad
3	District	Jalna	Aurangabad	Aurangabad
4	Year	2017	2018	2018
5	Crop Area (Acre)	10	2	1.5
6	Soil type	clayey	gravelly clay sandy loam	gravelly sandy clay loam
7	Soil depth (m)	1	1.2	1
8	Sowing date	6th june	6th June	8th june
9	Harvest Date	15th feb	15th dec	20nd December
10	Dripper spacing (sqm)	0.45x1.2	0.5x1.6	0.3x1.3
11	Number of drippers = (5) * 4046/ (10)	74925	10115	15561
12	Dripper flow rate (LPH)	8	6	6
13	Number of waterings	6	5	10
14	Irrigation time (hrs/day)	1.5	3	2.5
15	watering gap between irrigations (days)	10 days	10 days	7 days
16	irrigation dates (month-week)	starting from 13th Nov to 22nd Dec	starting from 1st august to 16th september	starting from 1st august to 13th october

17	Irrigation water (mm/day) = [(11) * (12)*(14)] / [(5) *4046]	22.22	22.50	15.38
18	Total irrigation (mm) = (17)*(13)	133	112.5	153.8
19	Total Effective Irrigation (90% efficiency)	120	101	138
20	Yield (quintal/acre)	3.5	4	10

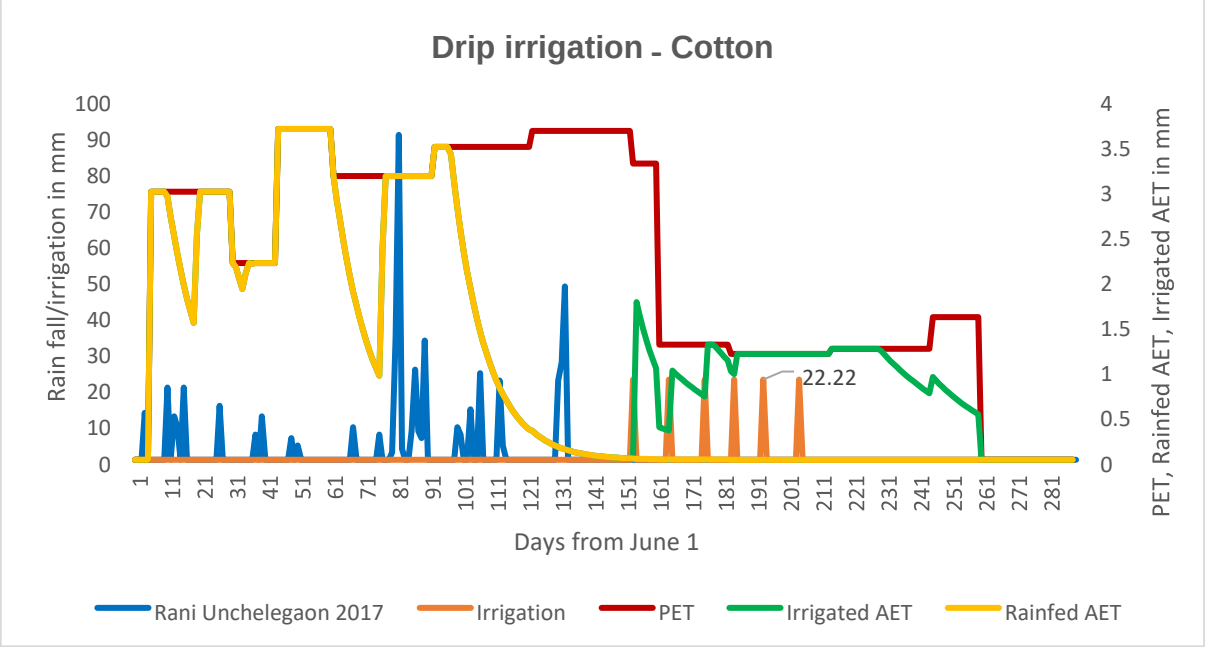

Figure 5 Yashodabai Chapadgaon

Observations: In case of Figure 5, Farmer Yashodabai has irrigated her crop starting from November onwards. This is because her well did not have water earlier. She was not able to provide for protective irrigation during dry spells which affected her yield (3.5 quintal/acre). She took second flowering by providing water in November and December, when she had water in well due to nearby canal rotation.

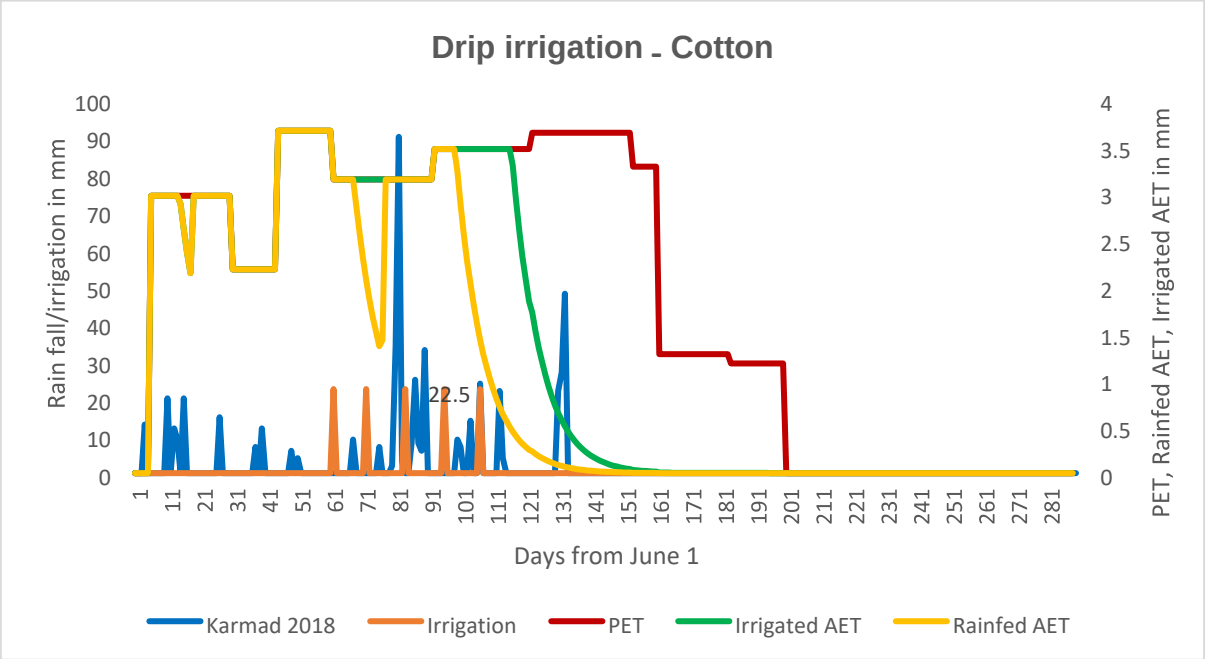

Figure 6 Kasubai Jadhav Tongaon

Observations: In case of Farmer Kasubai, 5 waterings were given to cotton before the flowering stage in gap of 10 days. Crop was harvested in December after one flowering with a yield of 4 quintal per acre.

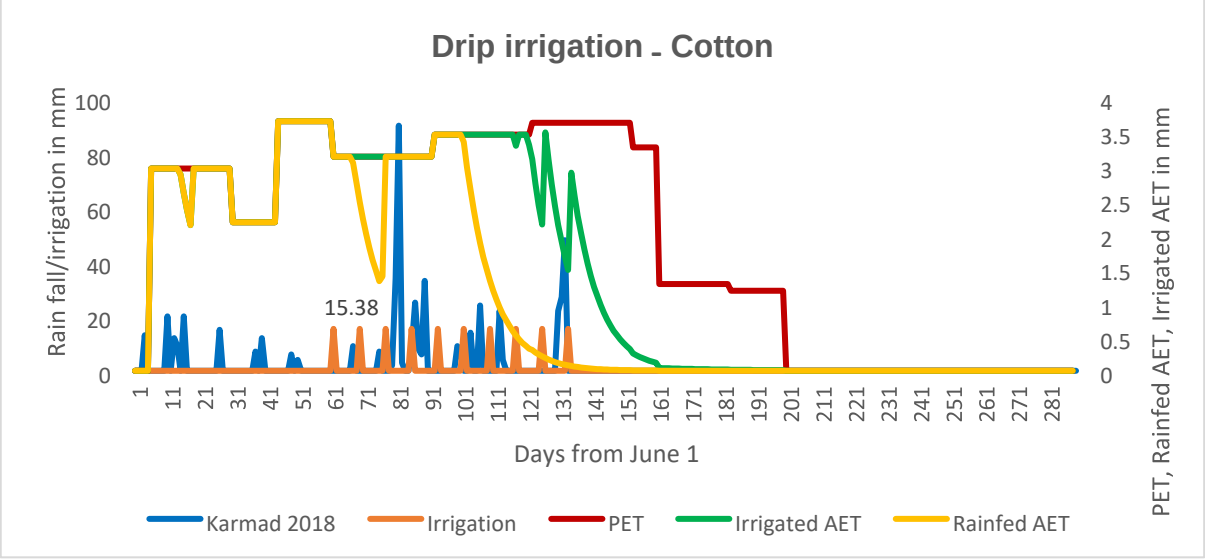

Figure 7 Vitthal Munchal-Tongaon

Observations: Farmer Vitthal Munchal gave 10 waterings to cotton before and during its flowering stage from August to October and obtained a good yield of 10 quintal per acre through one flowering. He harvested the crop by mid December.

Table 5 Drip Irrigation Water Balance Summary

Farmer name	Yashodabai Sarpanch		Kasubai Jadhav		Vitthal Munchal	
Village	Chapadgaon		Tongaon		Tongaon	
Taluka	Ghansawangi		Aurangabad		Aurangabad	
District	Jalna		Aurangabad		Aurangabad	
	Irrigated	rainfed	Irrigated	rainfed	Irrigated	rainfed
Rainfall (input)	397.0	397.0	475.0	475.0	475.0	475.0
Runoff	107.2	107.2	152.2	132.6	145.0	130.4
Infiltration	289.8	289.8	322.8	342.4	330.0	344.6
SM	11.6	0.0	30.1	30.0	10.2	10.0
GW recharge	0.0	0.0	18.2	6.8	37.5	21.5
AET	398.3	289.8	375.8	305.6	420.7	313.1
PET (input)	634.1	634.1	555.8	555.8	555.8	555.8
Deficit	235.8	344.2	180.0	250.2	135.1	242.8
Total Irrigation	133.3		112.5		153.8	
Total Effective Irrigation (90% efficiency)	120		101.0		138.0	

Inference:

1. In case of drip irrigation it can be noted that watering can be done during any growth stage of the crop, unlike sprinkler. Also drip has less maintenance compared to sprinkler as it has to be installed once in the field during sowing, whereas sprinkler pipeline needs to be moved to cover entire field.
2. Around 100 – 200 mm of watering is given to crops through drip/ sprinkler irrigation
3. This irrigated AET in mm can be converted to meter-cube by multiplying with crop area to get the denominator in water productivity formula 'Total water taken up by the crop'.

$$water\ productivity = \frac{yield\ (kg)}{Total\ water\ taken\ up\ by\ crop\ (Rainfall\ AET + watering\ AET)(m3)}$$

$$\boldsymbol{Total\ water\ taken\ up\ by\ the\ crop\ (m3)} = \boldsymbol{Total\ crop\ area\ in\ acre * Irrigated\ AET\ (mm) * 4}$$

3. Flood Irrigation:

In case of flood Irrigation, we have assumed 50 mm watering per irrigation and added it to rainfall in the model as per irrigation dates obtained in survey. Figure 3 can be referred for this where last 4 irrigations have been added as 50 mm flood type.

It must be noted here that AET will usually be less than the water applied in all irrigation cases and will depend on soil parameters.

Assumptions and Details for GHG Balance Estimation

1. Accounting Period

The accounting period for GHG balance is 6-years of project implementation period and 14-years of capitalisation period, where project benefits continue to accrue, totalling 20 years period.

2. Land Use Change

10% of degraded land will be converted through afforestation (agroforestry). No change in the degraded land area under the 'without project' system.

3. Crop Production

The analysis for crop production was based on selecting the most sown crops (Soybean, Cotton, Pigeon pea, Green gram, Maize, Black gram, Millet, Sorghum, Groundnut, Turmeric, Onion, Chickpea and Wheat) by farmers in Kharif and Rabi season.

The production of a crop in the project area was calculated using the following equation;

$PC_i = (S[P]_i/S[CA]_i) \times [CA]_i$

Where, $S[PA]_i$ is the production of a particular crop (i) in the project area; and PC_i is the production of a crop (i) in the project area. In similar way production of particular crop in the 'without project' area also calculated. It is assumed that there will be an increase of cropping area under individual crops by 1.5 times over the baseline "without project" system.

It is expected that management interventions such as improved agronomic practices, water management (through drip and sprinkler irrigation), improved nutrient management, and improved manure application will be adopted under the project scenario.

4. Livestock and Grassland

Poultry and Goats are the major livestock found in the project area. The population is expected to increase in the project area by about 10,000 goats and 500 poultry annually during the implementation period. Results show that the number of poultry in the project area has been around 0.8 million and for goats is around 0.4 million. Similarly, in comparison to the non-project area, the number of poultry is 1.3 million and goat is 1.1 million. No other interventions under management of livestock and management of grassland or grazing land have been proposed.

5. Inputs Investments

Fertilizer: It is assumed that the current rate of consumption of chemical fertilizers would continue under the project, despite increase in the area to be brought under irrigated crops, due to adoption of IPN management practices. Based on the average consumption rate as per the baseline survey data, it is estimated that there will be a utilization of around 200 tonnes per year of urea, 90 tonnes per year of phosphorus and 150 tonnes per year of potassium during the implementation of project activities.

Electricity: The electricity consumption is estimated to be 2,600 MWh/year without the implementation of the project and 5,760 MWh/year under the "with project" scenario.

Diesel: The total diesel consumption in the with project is projected to be 7283 m3/ year and similarly in the with-out project it is around 5,579 m3/ year.

It was assumed that irrigation systems development activities under the project will be in the 310,432 ha (which the increase in the crop land area under the project). This account for a total of 14,554 tonne of CO2eq emission

Schedule of Field Visit by Experts

Name of the key Expert	Designation	Districts visited	Blocks and villages		Date Visited
Dharmendra Chandurkar	Team Leader	Latur	Ausa	Nagarsoga	30th September 2019
				Tungi Bk.	
			Renapur	Itti	1st October 2019
				Morwad	
Arindam Datta	Environment Expert	Osmanabad	Kalamb	Bodgaon	20th September 2019
			Osmanabad	Ambehol	
				Junoni	
			Tuljapur	Khandala	21st September 2019
				Apsinga	
Dr. R.B Singandhupe	Agronomist Expert	Hingoli	Aundha	Yehalgaon Solanke	13th September 2019
				Turk Pimpri	
		Nanded	Ardhpur	Kamtha	14th September 2019
				Ganpur	
Deodutt Singh	Agribusiness Expert	Jalna	Badnapur	Butegaon	8th September 2019
				Ranjangaon	
			Jalna	Wadiwadi	9th September 2019
				Sarwadi	
Preeti Jain Das	Sociologist	Nanded	Ardhapur	Kamtha	22nd September 2019
		Hingoli	Aundha	Aunda	23rd September 2019
				Turk Pimpri	
Vivek Warade and Shefali Roy	Research Manager	Aurangabad	Paithan	Inyatpur	4th August 2019
				Kadethan	1st August 2019
				Tekadi Tanda	1st August 2019
Vivek Warade			Kannad	Wasadi	6th August 2019
			Khultabad	Verul	7th August 2019
Varun Dutt	Project Coordinator	Aurangabad	Paithan	Anjandoh	1st August 2019
				Mandki	2nd August 2019