Monitoring and Evaluation Framework

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1. Introduction

This document details out the monitoring and evaluation (M&E) framework for PoCRA. The M&E framework has been carefully designed to cater to critical requirements such as longitudinal tracking of project outcomes, fair representation of ground conditions and, even and equitable coverage at taluka and revenue circle level. The Sampling and survey strategy has been designed to ensure satisfaction of these parameters. This framework has been described in chapters consisting of M&E framework Overview, Village Sampling Mechanism, Farmer Sampling Mechanism, Key Performance Indices and Case Studies in this document.

Chapter one introduces the topic. Chapter two provides an overview on overall Monitoring and Evaluation framework by delineating the village and farmer sampling strategy along with possible sample frames available for analysis. Chapter three details out the sampling criteria and selection procedure for sample villages based on monitoring and evaluation schedule and other statistical requirements. Chapter four illustrates the mechanism for selection of sample farmers in the village based on various bio-physical and socio-economic parameters. Chapter five provides the analysis framework for Crop, Farm and Village level. It details out the key performance indices, measurement methodology, input dataset, questionnaires and timeline for various village and farmer sample frames available through designed sample strategy. It also provides example village case studies showing analysis of key performance indicators.

2. Overview of Monitoring and Evaluation Framework

This framework is in alignment with the existing microplanning framework consisting of three phases spread across geography and years. Each M&E phase is linked to Microplanning phase such that it draws the village samples for Monitoring and Evaluation from that microplanning phase. 10% sampling has been decided for the project, so that 10% samples will be selected in phase wise and taluka wise manner. From amongst total of 5129 PoCRA villages spread across 15 districts in Marathwada and Vidarbha region, 10% sample set of 528 villages will be selected for M&E as given in Table 2-1.

Table 2-1 M&E samples across three M&E phases

Number of Villages	Phase I	Phase II	Phase III	Total
Microplanning	1216	2862	1051	5129
Monitoring and Evaluation (10%)	124	296	108	528

Each M&E phase will span across 3 years called base-line, mid-line and end-line which depict the start of project year 1, mid term of project year 2 and end term of project year 3 in that village. Such monitoring and evaluation timeline will help estimate the impact of project outcomes based on fluctuation of indicator values from baseline to endline over the period of 3 consecutive project years. However, once the sample villages are selected during the baseline year for each M&E phase, this may

also result in biased program implementation in villages selected as samples for M&E and those not selected as samples. To rule out this possibility and ensure unbiased and fair representation of project outcomes the sampling strategy has been devised such that out of total 10% phase wise samples, 5% of village samples in each phase will remain constant for the span of 3 M&E years (baseline, midline and endline), and remaining 5% samples will vary randomly in taluka proportional manner for each of the 3 M&E years. This means that the village sample list will get updated for every year of each phase, which will ensure random sample selection and unbiased estimation of project indicators. There will be a total of 264 constant village samples monitored longitudinally from baseline to endline. Whereas a total of 792 village samples with one temporal data point. Around 20% (1056) of villages will be covered spatially through sampling in this manner and 5% (264) of villages will be covered longitudinally.

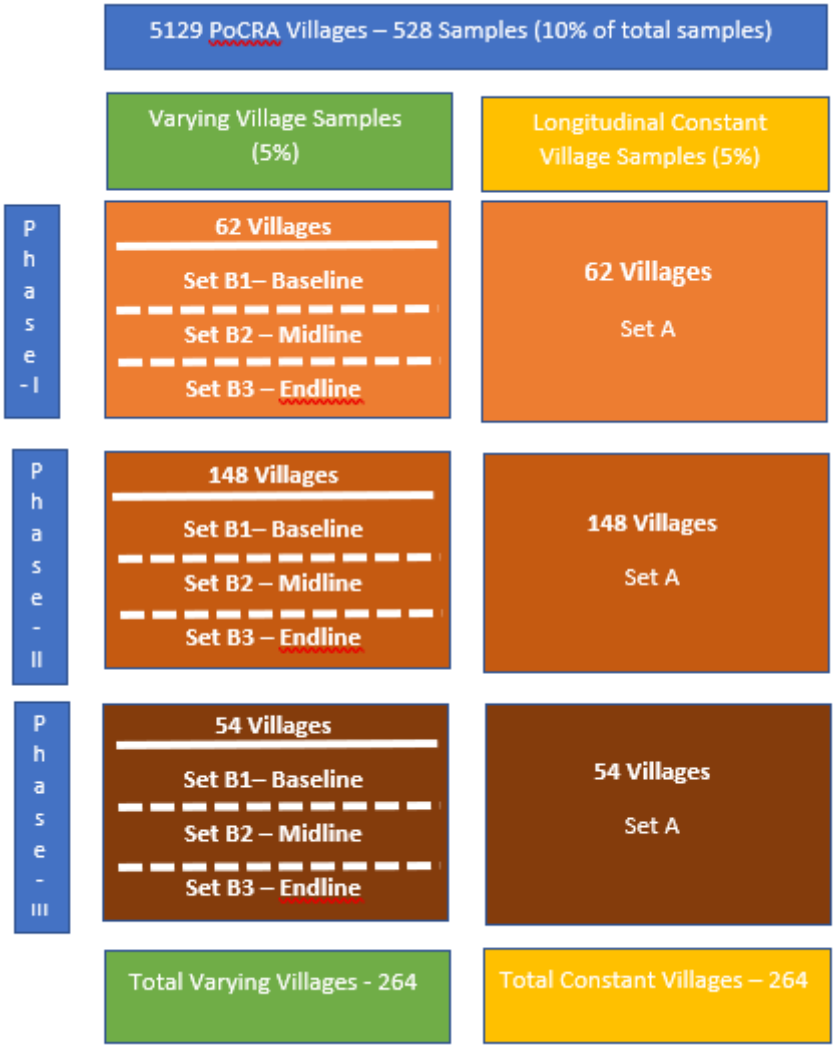

Figure 2-1 Village Sampling strategy

Schedule

The project implementation duration being 3 years in each village, consisting of microplanning in first year, partial implementation of approved village plan in second year and implementation of complete plan in third year. The Baseline, Midline and Endline survey will occur in following manner depending on MLP phase of the village.

1. Base-line - Year 1- Before project implementation in village (after microplanning – 2nd year)

2. Mid-line – Year 2 – After partial project implementation in village (3rd year)
3. End-line – Year 3 – After complete project implementation in village (4th year)

Following this rule the M&E will be conducted in three phases, with M&E Phase I beginning in first year of project, M&E Phase II beginning in second year of project and M&E phase III beginning in third year of project. This follows the microplanning schedule for project villages, ensuring that M&E is conducted in village to capture baseline situation before project implementation, midline situation during project implementation and endline situation in third year after project implementation. All M&E phases will run in parallel and the table below illustrates the number of sample villages to be surveyed by monitoring and evaluation agency every year for a M&E duration of 5 years.

Table 2-2 M&E schedule for project

M&E Phases-> Microplanning Phases	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Phase I Constant	Set A – 62 Circle A	Set A – 62 Circle A	Set A – 62 Circle A	0	0
Phase I Varying	Set B1 – 62 Circle B	Set B2 – 62 Circle C	Set B3 – 62 Circle F	0	0
Phase II Constant	0	Set A – 148 Circle D	Set A – 148 Circle D	Set A – 148 Circle D	0
Phase II Varying	0	Set B1 – 148 Circle E	Set B2 – 148 Circle G	Set B3 – 148 Circle J	0
Phase III Constant	0	0	Set A – 54 Circle H	Set A – 54 Circle H	Set A – 54 Circle H
Phase III Varying	0	0	Set B1 – 54 Circle I	Set B2 – 54 Circle K	Set B3 – 54 Circle L
Total Yearly Samples	**124 villages**	**420 villages**	**528 villages**	**420 villages**	**108 villages**

*Red, Green colour – Baseline, Yellow, Orange – Midline, Blue, Purple - Endline

Village Data frames

The sampling strategy diagram in Figure 2-1 depicts the overall village sampling mechanism in phase-wise manner, where Set A in each phase represents the constant village samples monitored longitudinally for 3 consecutive M&E years and Sets B1, B2 and B3 represent the varying village samples for each of the 3 M&E years – Baseline, Midline and Endline respectively. This kind of sampling gives rise to 2 different village data frames -

1. Longitudinal data frame – consisting of the constant village samples (5% villages) to be monitored for 3 consecutive M&E years
2. Varying data frame - The varying samples (5% villages) to be monitored once during the 3 year M&E duration

These data frames will have different analytical framework and will be utilized in varying capacities for analysis of project outcomes. These analytical frameworks will also shape the farmer level data frames within the village and will be detailed out in Chapter four on Key performance indicators.

Farmer Data Frames

Farmer surveys will be conducted in sample villages to gather information required to estimate key indicators, and the farmer survey data frames will be based on village data frames. To elaborate, the farmer samples selected in constant sample villages can be surveyed longitudinally (constant farmer samples) for consecutive 3 years, or new farmers (varying farmer samples) can be surveyed every year from these constant sample villages for each of the 3 M&E years, the data for varying samples will not be available for 3 consecutive project years, but for only one of the M&E year. Similarly, the varying villages will always have varying farmer samples with single temporal data point. So, this will create three possible farmer data frames as represented in Table 2-3 based on village and farmer sampling method.

The bifurcation of samples among these data frames is done such that it replicates the features of village sampling method, which include randomness in temporal selection leading to unbiased representation of ground reality. In case of longitudinal villages 50% of farmers sampled in baseline year are kept constant and surveyed longitudinally till endline. Whereas, remaining 50% farmer samples are selected newly in random manner for each year of the M&E span. In case of varying village samples, there will always be varying farmer samples. These three data frames will be used in varying capacities for estimation of selected indicators.

Table 2-3 Proposed Data Frames for Village and Farmer Survey

Combinations / Data Frames	Longitudinal village samples	Varying Village samples
Longitudinal Farmer samples	50%	0%
Varying Farmer samples	50%	100%

Project outcomes and Key performance Indicators

The main purpose of M&E framework is to measure the impact of project activities through various crop, farmer and village level indices. PoCRA has defined a Result Management Framework for same which provides a list of indicators at various levels. 5 of these have been identified as Key performance indicators for the project. Table 2-4 provides a mapping of these KPI's with Result Framework indicators (RFI) along with measurement level and tools used for measurement in our M&E framework. This framework caters to the limited water budget related Result Framework indicators which are illustrated in Table 2-4.

Table 2-4 Mapping of M&E indicators, KPI's and Result management framework with tools used

Sr. number	Selected Result Framework indicator (RFI)	Key Performance Indicators	M&E indicator level	Tools used
1	RFI1: Climate Resilient Agriculture: Farmers adopting improved Agricultural technology	KPI5: Farmers reached with agricultural assets or services by gender	Village Level	DBT database
2	RFI2: improved water use efficiency at Farm level	KPI1: increased water productivity at Farm level	Crop level for 3 main kharif crops	Farmer survey

3	RFI4: Profitability – Annual Farm Income	KPI4: Farm income by Gender	Farm level	Farmer survey
4	RFI5: Direct Project Beneficiaries	KPI5: Farmers reached with agricultural assets or services by gender	Village Level	DBT database
5	RFI6: Climate Resilient Agriculture – improved yield uniformity and stability	KPI2: Improved yield stability across space and time	Crop Level and Village Level	Farmer Survey
6	RFI7: Climate resilient Agriculture – Improved Availability of water for Agriculture	Storage capacity at Village level Water Access at farm Level	Village Level and Farm Level	MLP water Budget dataset DPR dataset

Source: PoCRA PIP Manual, PoCRA PAD Manual

An integration of all M&E IT tools would be essential for the implementation of overall framework. The RFI specifies some limited number of indicators and this document will delineate more indicators linked with RFI's based on existing water balance tools and water allocation methods. This will help provide better analysis on impact measurement.

Each of these sections summarized in this chapter – Village sampling methodology, Farmer sampling Methodology, Conceptual design of Indicators and measurement methods will be detailed out in coming chapters.

3. Village Sampling Methodology

The selection of villages will be done using a multi-frame random sampling method where multiple parameters will be considered for sampling at each stage. This would ensure that varying samples are selected over parameters such as districts, talukas, circles, agroclimatic zones, microplanning agencies, cluster assistants to name a few.

The overall village selection frames will consist of –

1. District frame – This will ensure the selection across different microplanning agencies and agro-climatic zones.
2. Taluka frame – 10% villages in each taluka will be covered in phase wise manner during the project duration. (eg – if there are 4 PoCRA villages in phase I in a taluka then 10% sample would mean 0.4 which will get rounded off to 0. However, it will be ensured that atleast 1 village from each taluka is selected as sample. Taluka for which the number of samples is '0' will be examined and 1 sample village will be added to the phase will has highest number of villages.)
3. Revenue Circle frame – A District wise, Taluka wise and Circle wise list of villages for each phase of microplanning will be used for village selection, and selection over M&E phases will be made on random basis at taluka level to ensure even coverage across revenue circles in the Taluka. The randomized selection process will be automated through script.

Table 3-1 Sampling Levels and criteria for Village Selection

Sampling Frame	Variations	Selection
District	Agro-climatic zones, Microplanning agencies	From phase wise list of villages for microplanning at Taluka level within district
Taluka	10% samples in each taluka	
Circle	Rainfall zones, 10% samples in taluka spread across rainfall or revenue circles	From Phase wise list of villages at circle level within Taluka for microplanning – selection process will be automated

A M&E Taluka-wise table with number of villages to be sampled in each phase (using 10% rule) will be used for automation. This table is provided in Annexure I. Table 3-2 provides a phase wise compiled summary at district level with of number of PoCRA villages and number of samples. Based on the taluka wise summary table in Annexure I, the given number of villages will randomly be selected from taluka-wise, phase-wise and circle-wise PoCRA village list, while ensuring even coverage of all samples in taluka across revenue circles.

This means that each sample village from taluka will belong to different revenue circle in that taluka, unless all circles in taluka get exhausted. A randomized multi-frame selection script will provide second- and third-year's randomized sample of 50% varying village sets (set B2, B3) based on previous year's sample and all village list to ensure the taluka proportional and even coverage across circles criteria.

Table 3-2 District wise and Phase wise summary of PoCRA villages and M&E samples

District name	Revenue Circles	Clusters	Phase I villages	Phase II villages	Phase III villages	Total villages	sample villages Phase I	sample villages Phase II	sample villages phase III	Total sample villages
Akola	45	81	112	322	58	492	11	34	6	51
Aurangabad	61	71	77	194	135	406	7	19	13	39
Bid	55	50	58	218	115	391	6	22	13	41
Buldana	69	90	105	272	61	438	12	27	6	45
Hingoli	25	33	39	129	72	240	4	14	7	25
Jalgaon	71	74	124	229	107	460	13	23	12	48
Jalna	42	74	67	188	108	363	7	20	11	38
Latur	45	52	84	144	54	282	8	15	6	29
Nanded	51	45	70	215	99	384	7	25	9	41
Parbhani	37	52	84	145	46	275	9	14	5	28
Wardha	21	15	39	71	15	125	4	8	2	14
Washim	27	27	29	81	39	149	3	8	5	16
Yevatmal	63	32	75	195	39	309	8	19	4	31
Osmanabad	42	73	48	137	102	287	5	14	9	28
Amravati	72	85	205	322	1	528	20	34	0	54
Total	**726**	**854**	**1216**	**2862**	**1051**	**5129**	**124**	**296**	**108**	**528**

Selection procedure for constant and varying sample set

The selection of constant and varying villages will be done at district level using the phase wise taluka level sample number table in Annexure I. 50% of sample villages in each district will come in varying set (B) and remaining in constant set (A). If total number of sample villages in a district is odd, then (n-1)/2 or (n+1)/2 number of samples may be selected in either of the sets. The procedure for set selection is illustrated here with an example.

Example

District: Buldana Taluka: Malkapur

Total number of PoCRA villages: 438 Total number of sample villages: 45

Table 3-3 provides taluka wise and phase wise number of samples for Buldana district. Suppose we start selecting constant samples for phase I and phase II from top of taluka list and that for phase III from

bottom of taluka list in Table 3-3. We keep selecting the talukas until 50% of village sample number ((n+1)/2 or (n-1)/2) in case of total odd samples in district) is reached. These get finalized as constant talukas and corresponding villages samples selected in baseline year of that phase get selected as constant villages.

Table 3-3 Phase wise Taluka level summary of number of villages and samples

Sr. number	District name	Taluka name	Number of circles	Number of clusters	Number of villages phase I	Number of villages phase II	Number of villages phase III	Total villages	10% villages Phase I	10% villages Phase II	10% villages phase III	Total sample villages
1	Buldana	Motala	4	3	7	15	0	22	1	2	0	3
2	Buldana	Lonar	2	2	0	15	0	15	0	2	0	2
3	Buldana	Nandura	7	15	19	50	0	69	2	5	0	7
4	Buldana	Buldana	3	1	0	14	0	14	0	1	0	1
5	Buldana	Sangrampur	6	15	5	48	7	60	1	5	1	7
6	Buldana	Jalgaon Jamod	6	14	5	52	2	59	1	5	0	6
7	Buldana	Deolgaon Raja	3	2	4	2	0	6	0	0	0	0
8	**Buldana**	**Malkapur**	**5**	**10**	**10**	**14**	**23**	**47**	**1**	**1**	**2**	**4**
9	Buldana	Shegaon	5	12	28	28	2	58	3	3	0	6
10	Buldana	Mehkar	4	5	0	10	7	17	0	1	1	2
11	Buldana	Sindkhed Raja	6	3	9	3	8	20	1	0	1	2
12	Buldana	Khamgaon	11	3	18	12	0	30	2	1	0	3
13	Buldana	Chikhli	7	5	0	9	12	21	0	1	1	2
Total			69	90	105	272	61	438	12	27	6	45

The coloured samples in Table 3-3 indicate the taluka level constant sample set that got selected for three phases using this method. Now remaining talukas in each phase get selected as varying talukas and the number of village samples in varying talukas get selected newly for mid-line and end-line years of that phase. Table 3-4 represents the phasewise constant and varying sample numbers

Table 3-4 Phase wise Constant and Varying village sample numbers for Buldana district

Phase	Constant Set – sample numbers	Varying Set – sample numbers
Phase I	6	6

Phase II	13	14
Phase III	3	3

To simplify, the random sampling method will randomly select constant samples from top or bottom of randomly shuffled phase-wise taluka level sample number list until 50% samples are selected as constant. In cases where the total number of samples (n) in district is odd, the random selection for constant villages will stop if (n-1)/2 or (n+1)/2 samples get selected, whichever is first.

The steps to be followed for varying sample selection are -

1. Selection of constant talukas from Taluka level phase wise table for 50% sample number, remaining talukas will get selected as varying.
2. Finalization of constant villages, those selected in baseline for selected constant talukas in each phase.
3. Selection of varying village samples from varying talukas in random manner while ensuring coverage across revenue circles. This step is illustrated in following section.

Selection procedure for Varying villages

Once the phase wise varying talukas are fixed new villages will be selected for set B2 and B3 of midline and endline respectively from these talukas. even coverage across circles criteria will be ensured while doing this. The process for selecting varying villages in given taluka is explained using example of Malkapur taluka in Buldana district. The steps followed for this are as follows –

1. The selection will happen as per schedule in Table 3-5 in phase wise and year wise manner

Table 3-5 Phasewise Schedule for selection of varying villages

Varying sets	Year 2	Year 3	Year 4	Year 5	Year 6
Phase I	Set B1	Set B2	Set B3		
Phase II		Set B1	Set B2	Set B3	
Phase III			Set B1	Set B2	Set B3

2. For Malkapur taluka, first we check if it has got selected as constant or varying taluka in phase I from Table 3-6. Malkapur has got selected as constant taluka in phase I. So, we move ahead to check phase II.

Table 3-6 Malkapur taluka phase wise constant and varying samples

Sr. number	District name	Taluka name	Number of circles	Number of clusters	Number of villages phase I	Number of villages phase II	Number of villages phase III	Total villages	10% villages Phase I	10% villages Phase II	10% villages phase III	Total sample villages
8	Buldana	Malkapur	5	10	10	14	23	47	1	1	2	4

3. Malkapur taluka has got selected as varying sample (set B1) in phase II, so a new village sample will have to be selected for set B2 of this phase for Midline in year 4. Refer Table 3-5 and Table 3-6 for this.

Table 3-7 Selection of village samples in year 1 and 2

Sr. number	VIL_NAME	UNICODE	Mini_Water	District	Taluka	Circle	PoCRA Phase	Set
1	Narwel	528588	500_pt-14a_02	Buldana	Malkapur	Narvel	Phase I	Set A
2	Kund Bk.	528611	500_ptn-2_04	Buldana	Malkapur	Dharangaon	Phase II	Set B1

4. To select this sample, the revenue circle samples of all villages selected in this taluka till year 4 will be eliminated. Refer Table 3-7 for this. As seen Narvel and Dharangaon circles have got selected earlier in phase I set A and phase II set B1 respectively. The villages in these circles will be eliminated (shown in blue) from taluka level selection table for phase II (Table 3-8) and then random samples will be picked.
5. As per Table 3-8 only 3 samples from Datal and Malkapur circles are remaining for selection in phase II list. Of these suppose Wakodi village from Malkapur circle gets selected for set B2 in year 4.
6. Now two more village samples are to be selected for year 4 from same taluka for phase III set B1. This will be selected from village samples for Jambuldaba and Datal circle remaining after eliminating previously selected circles. Suppose Kamrdipur and Shiradhon villages get selected in set B1 of phase III.

Table 3-8 All village phase wise selection list Malkapur Taluka

Sr. number	VIL_NAME	UNICODE	Mini_Water	District	Taluka	Circle	PoCRA Phase	
1	Narwel	528588	500_pt-14a_02	Buldana	Malkapur	Narvel	Phase I (A)	Constant Set I – Baseline – Midline - Endline
2	Gahukhed	528642	500_pt-14a_01	Buldana	Malkapur	Malkapur	Phase I	
3	Warkhed	528653	500_ptv-1_04	Buldana	Malkapur	Datal	Phase I	
4	Bhadgani	528649	500_pt-14a_01	Buldana	Malkapur	Datal	Phase I	
5	Ghirni	528641	500_pt-14a_01	Buldana	Malkapur	Malkapur	Phase I	
6	Khaparkhed	528620	500_pt-14a_01	Buldana	Malkapur	Malkapur	Phase I	
7	Balad Pr. Malkapur	528639	500_pt-14a_01	Buldana	Malkapur	Malkapur	Phase I	
8	Gadegaon	528619	500_pt-14a_01	Buldana	Malkapur	Malkapur	Phase I	
9	Umali	528648	500_pt-14a_01	Buldana	Malkapur	Datal	Phase I	

Sr. number	VIL_NAME	UNICODE	Mini_Water	District	Taluka	Circle	PoCRA Phase	
10	Makner	528643	500_pt-14a_01	Buldana	Malkapur	Malkapur	Phase I	
11	Chinchol	528585	500_pt-13_04	Buldana	Malkapur	Narvel	Phase II	Varying Set (circles marked in red are eliminated)
12	Kalegaon Pr.Malkapur	528582	500_ptv-2_02	Buldana	Malkapur	Narvel	Phase II	
13	Hingana Nagapur	528587	500_ptv-1_05	Buldana	Malkapur	Narvel	Phase II	
14	Kund Bk.	528611	500_ptn-2_04	Buldana	Malkapur	Dharangaon	Phase II (B1)	
15	Datala	528644	500_ptn-2_04	Buldana	Malkapur	Datal	Phase II	
16	Waghola	528584	500_pt-13_04	Buldana	Malkapur	Narvel	Phase II	
17	Lahe Kh.	528606	500_ptn-2_04	Buldana	Malkapur	Dharangaon	Phase II	
18	Wakodi	528618	500_ptn-2_04	Buldana	Malkapur	Malkapur	Phase II (B2)	
19	Korwad	528586	500_pt-13_04	Buldana	Malkapur	Narvel	Phase II	
20	Telkhed	528599	500_ptn-2_04	Buldana	Malkapur	Dharangaon	Phase II	
21	Harsoda	528601	500_ptv-1_05	Buldana	Malkapur	Narvel	Phase II	
22	Tandulwadi Pr.Malkapur	528598	500_ptn-2_04	Buldana	Malkapur	Dharangaon	Phase II (B3)	
23	Malkapur (Rural)	528613	500_ptn-1_04	Buldana	Malkapur	Malkapur	Phase II	
24	Dudhalgaon Kh.	528583	500_pt-13_04	Buldana	Malkapur	Narvel	Phase II	
25	Tighra Pr.Malkapur	528593	500_pt-13_03	Buldana	Malkapur	Narvel	Phase III	Varying set
26	Kamrdipur	528624	500_ptw-1_02	Buldana	Malkapur	Jambuldaba	Phase III (B1)	
27	Siradhon	528645	500_ptn-1_04	Buldana	Malkapur	Datal	Phase III (B1)	
28	Shivni	528602	500_ptw-1_02	Buldana	Malkapur	Dharangaon	Phase III	
29	Lonwadi Pr.Malkapur	528638	500_ptn-1_04	Buldana	Malkapur	Jambuldaba	Phase III	
30	Khokodi	528615	500_ptn-1_04	Buldana	Malkapur	Malkapur	Phase III (B2)	
31	Deodhaba	528623	500_ptw-1_02	Buldana	Malkapur	Jambuldaba	Phase III	
32	Wiwara	528595	500_pt-13_03	Buldana	Malkapur	Narvel	Phase III (B3)	
33	Dasarkhed	528596	500_pt-13_03	Buldana	Malkapur	Narvel	Phase III (B3)	
34	Khamkhed Pr.Malkapur	528629	500_ptw-1_02	Buldana	Malkapur	Jambuldaba	Phase III	

Sr. number	VIL_NAME	UNICODE	Mini_Water	District	Taluka	Circle	PoCRA Phase	
35	Dudhalgaon BK.	528637	500_ptn-1_04	Buldana	Malkapur	Jambuldaba	Phase III (B2)	
36	Rastapur	528616	500_ptn-1_04	Buldana	Malkapur	Malkapur	Phase III	
37	Hingana Kazi	528626	500_ptw-1_02	Buldana	Malkapur	Dharangaon	Phase III	
38	Rantham	528591	500_pt-13_03	Buldana	Malkapur	Narvel	Phase III	
39	Bhangura	528592	500_pt-13_03	Buldana	Malkapur	Narvel	Phase III	
40	Ghodi	528603	500_ptw-1_02	Buldana	Malkapur	Dharangaon	Phase III	
41	Nimbari	528617	500_ptn-1_04	Buldana	Malkapur	Malkapur	Phase III	
42	Gorad	528622	500_ptw-1_02	Buldana	Malkapur	Jambuldaba	Phase III	
43	Khadki	528627	500_ptw-1_02	Buldana	Malkapur	Jambuldaba	Phase III	
44	Pimpalkhunta (Mahadeo)	528628	500_ptw-1_02	Buldana	Malkapur	Jambuldaba	Phase III	
45	Rangaon	528594	500_ptw-1_02	Buldana	Malkapur	Narvel	Phase III	
46	Bhalegaon	528625	500_ptw-1_02	Buldana	Malkapur	Dharangaon	Phase III	
47	Jambhuldhaba	528631	500_ptw-1_02	Buldana	Malkapur	Jambuldaba	Phase III	

7. All circles in taluka get covered by year 4, after which further selections will now take place randomly from entire village list for that phase and taluka. The selection of villages for set B3 of phase II followed by set B2 of phase III in year 5 will be done by considering all villages and similar process will be followed for selection of set B3 of phase III for year 6. All villages selected as sample are highlighted in yellow color in Table 3-8.

Table 3-9 M&E Sample villages from Malkapur Taluka

Sr. number	VIL_NAME	UNICODE	Mini_Water	District	Taluka	Circle	PoCRA Phase	Set
1	Narwel	528588	500_pt-14a_02	Buldana	Malkapur	Narvel	Phase I	Set A
2	Kund Bk.	528611	500_ptn-2_04	Buldana	Malkapur	Dharangaon	Phase II	Set B1
3	Wakodi	528618	500_ptn-2_04	Buldana	Malkapur	Malkapur	Phase II	Set B2
4	Tandulwadi Pr.Malkapur	528598	500_ptn-2_04	Buldana	Malkapur	Dharangaon	Phase II	Set B3
5	Kamrdipur	528624	500_ptw-1_02	Buldana	Malkapur	Jambuldaba	Phase III	Set B1
6	Siradhon	528645	500_ptn-1_04	Buldana	Malkapur	Datal	Phase III	Set B1
7	Khokodi	528615	500_ptn-1_04	Buldana	Malkapur	Malkapur	Phase III	Set B2

Sr. number	VIL_NAME	UNICODE	Mini_Water	District	Taluka	Circle	PoCRA Phase	Set
8	Dudhalgaon BK.	528637	500_ptn-1_04	Buldana	Malkapur	Jambuldaba	Phase III	Set B2
9	Wiwara	528595	500_pt-13_03	Buldana	Malkapur	Narvel	Phase III	Set B3
10	Dasarkhed	528596	500_pt-13_03	Buldana	Malkapur	Narvel	Phase III	Set B3

In this way the villages will be sampled for M&E process. The main features of this framework include–

1. Taluka proportional phasewise coverage of 10% samples
2. Temporally and spatially randomized village selection mechanism to ensure fair representation (5% varying samples across M&E phases)
3. Mechanism ensuring longitudinal tracking of indicators (5% constant samples)

A total of 1056 villages will be covered spatially through this method.

4. Farmer Sampling Mechanism at Village level

This chapter details out the farmer sampling methodology within a village, that is used to select sample farmers for survey to measure the crop, farm and village level indicators. This sampling methodology ensures that minimum number of samples for all possibilities of critical socio-economic and bio-physical attributes are covered through the survey, so that a statistically sufficient dataset is available for analysis.

Generation of Random Survey number list

The geographical sampling method at stage I and list sampling method at stage II is used here for this. Based on randomly selected coordinates from MRSAC Cadastral Layer random gat/survey number are fetched. List of such randomly selected survey numbers is then used for selecting sample farmers for interview.

Stage I: Geographical Sampling at PMU

1. A list of random survey numbers within village is generated using a random sampling function in QGIS. 1/3rd of total survey numbers in village are selected randomly by setting the parameters for this function.

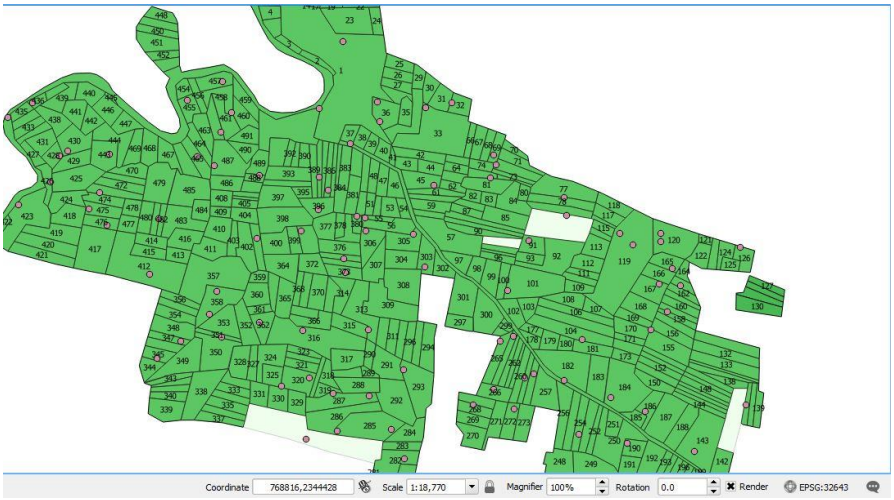

Figure 4-1 Geographical sampling using QGIS function

2. The Landuse type of each survey number in this list is checked to ensure all selected survey numbers lie in agricultural area. If the Landuse type is not agriculture then the survey number is discarded (i.e remove survey numbers like forest, fallow land, habitation mask, water body etc).
3. Finally, a result of randomly generated survey numbers list along with their longitude and latitude is prepared. step 2 and step 3 are performed using automated scripts.

This step is performed at PMU and the generated random survey number list is provided for field level processes.

Stage II: List Sampling on Field

The farmer sample selection from random survey number list is done based on following critical farmer attributes. The sampling is based on these attributes because the project outcomes are functions of these attributes.

Below mentioned are sampling attributes with their significance.

1. PoCRA Beneficiary: project beneficiary and non-beneficiary both type of farmers will be considered in sampling.
2. Stream Proximity: stream proximity of survey number must be checked and farmers from both categories-stream proximity and non-proximity are considered for sampling. This attribute directly affects the availability of water on farm and thus crop yield and economic indicators.
3. Water Source Availability: Water source availability is one of the important physical attributes contributing to socio-economic vulnerability. It will be checked whether selected survey number farmer has any water source available. Farmers with water source and without water source both will be selected to capture variations.
4. Primary Crops: World Bank has identified 5 main crops for measuring water related project indicators. These crops consist of cotton, soybean, tur, green gram, black gram. Since each village may not have required number of samples for all these crops. It has been proposed that area wise 3 main crops would be covered in each sampled village through farmer survey. These 3 main crops become part of sampling attributes.
5. Land Holdings: Land holding is a biophysical attribute which contributes to socio-economic vulnerability. Farmers with landholding above and below the criteria are selected for survey.

   This criteria for land holding is decided as below:
   Land holding reference value is based on the landholding size corresponding to the survey number obtained at 50% of total agricultural area after computing cumulative landholding from the ascending order survey number list of village.
   a. Arrange All survey numbers in village (only Agricultural landuse) based on their area in ascending order.
   b. Assign serial number to the list.
   c. Add area of all survey numbers to find total agricultural area of village.
   d. Find the value of 50% area of total area calculated at step c.
   e. Find cumulative sum based on area in ascending ordered list.
   f. Stop at the serial number where cumulative sum reaches 50% of the total agricultural area in village. The landholding area of this serial number is now the reference landholding criteria value for this village.

Example: Dahigaon Village, Amravati District

Analysis of Dahigaon for finding land holding criteria is shown below. (For analysis Cadastral layer data is used) Table 4-1 describes computation of land holding criteria for Dahigaon Village.

a. There are 481 Survey numbers in Village Dahigaon.
b. All survey numbers arranged in ascending order based on their area and are assign serial numbers.

c. By summing area of all survey number Total Agricultural area is found to be 836.3 hectare.
d. 50% area of total agricultural area is 418.2 hectare.
e. Now cumulative sum is computed
f. At serial number 360 it is found that cumulative area exceeds 50% of total agricultural land. So, we have land holding criteria as 19986.73m^2.i.e 1.99 hectare.

Table 4-1 Dahigaon village landholding list

Serial Number	Gat No.	AREA	Cummulative Area	Satisfying Land Holding Condition
356	270	19659.89	4110620.336	YES
357	468	19661.84	4130282.172	YES
358	230	19686.68	4149968.852	YES
359	273	19764.8	4169733.648	YES
360	376	19986.73	4189720.383	NO
361	360	20312.76	4210033.141	NO
362	20	20624.6	4230657.742	NO
363	461	20647.06	4251304.805	NO
364	424	20783.3	4272088.109	NO

From this land holding criteria, it is clear that out of 481 survey numbers 360 survey numbers covers 50%(half) of total agricultural land and are small farmers in that village. The graph in Fig 4-2 shows that land distribution till serial number 360 is equal to land distribution above serial number 360. Based on this both type of farmers can be selected if land holding criteria is known.

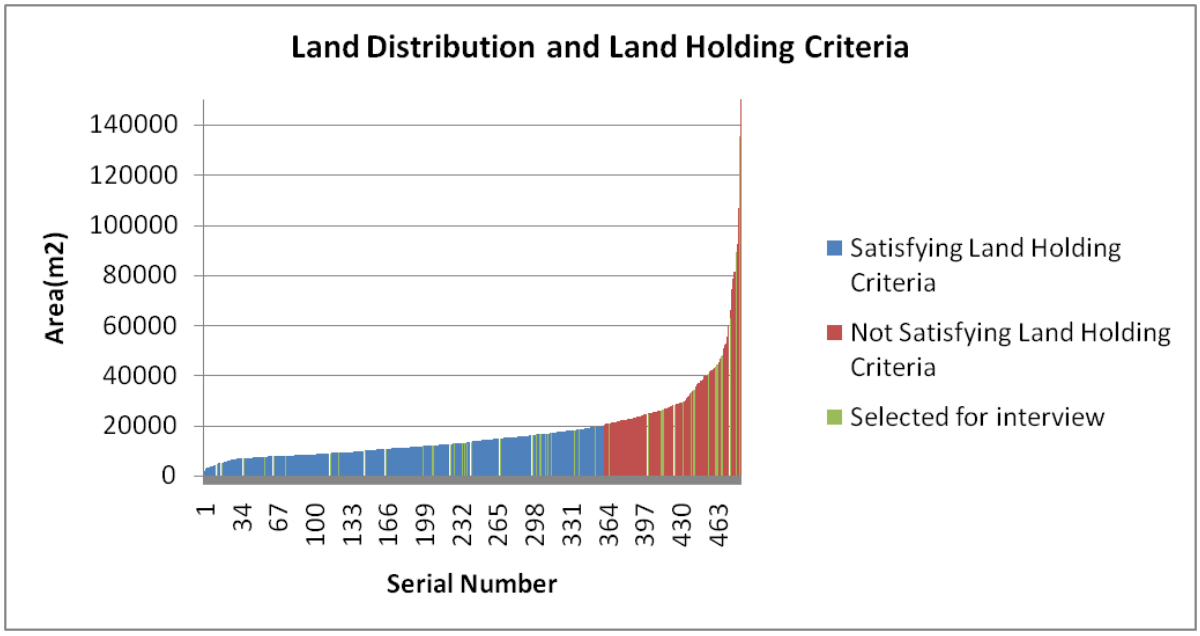

Figure 4-2 Dahigaon village landholding graph

Table 4-2 Data sources for sample selection attributes and other required fields

Sr. No	Data Required	Data Source	Availability
1.	PoCRA Beneficiary's List	DBT / Field officer	On field
2.	Stream Proximity	QGIS generated	Before field processes
3.	Water Source Availability	Field officer	On field
4.	Gat Wise Land Holdings	Field officer/KrusiMitr	On field
5.	Primary crops	Field officer	On field
6.	Farmers Name	Field officer/KrusiMitr	On field

Table 4-2 outlines the data sources for each of these attributes and their availability. Only stream proximity attribute in above table can be generated from QGIS and provided in advance as a part of Table 4-3.

List Sampling and Sample Frames

A typical sample selection table from random survey number list can be seen in Table 4-3. The 5 main attributes used for sampling give rise to 11 pre-survey parameters for each sample, which capture all variations for given attributes in the sample. Here, each parameter of farmer must be marked before starting the survey on field to create a pre survey table. Marking of these parameters would create a sample frame as seen in Table 4-3. Further sample selection will be done in serial manner such that at least one parameter will get added newly to create a new frame for a new survey. This is called list sampling based on sample frames.

Table 4-3 Random survey number sample selection table

Serial Number	Survey Number	Farmers name	Crop 1 e.g Cotton	Crop 2 e.g Soya	Crop 3 e.g Tur	PoCRA Beneficiary		Stream Proximity		Water Source Availability		Land Holding Criteria		Remark
						Yes	No	Yes	No	Yes	No	Yes	No	
			C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	
1.	362		✓	✓		✓			✓		✓	✓		
2.	14		✓	✓	✓	✓		✓			✓		✓	
3.	163			✓	✓		✓		✓	✓		✓		
4.	184		✓	✓	✓		✓	✓		✓		✓		
5.	165		✓			✓			✓		✓		✓	
6.	287		✓		✓		✓		✓		✓	✓		
7.	476			✓	✓		✓	✓				✓		
8.	373			✓	✓		✓	✓			✓	✓		
	Frame count		5	6	6	3	5	4	4	2	6	6	2	

Number of Samples

To ensure satisfaction of data points in statistical terms it has been decided that there should be at least 6 samples points for each of the 11 parameters. Which means the survey process will stop once frame count (as given in Table 4-3) reaches 6 for each of the 11 parameters.

This also means that number of farmers to be interviewed in village is not constant and is dependent on how many survey numbers fulfils the attributes criteria with required sample numbers. So, we provide a list of 1/3rd random survey numbers in village.

Pre-processing of sample list

Pre-processing is required on provided random survey number sample list before undertaking actual survey on field. This is to partially finalize the samples. Table 4-3 with blanks for all parameters except stream proximity would be provided on field. The field officer would be required to fill in two parameters before survey –

1. Farmer Name
2. PoCRA beneficiary (As per DBT)
3. Landholding criteria (as per 8A)

These parameters will ensure that ample number of beneficiaries are present in the list and landholding criteria is also available. In case ample beneficiaries are not present in the list, then beneficiary survey numbers may be appended to the list later. An example table is given in Annexure II.

Sample Selection during survey Process

1. The sample selection will take place sequentially from partially finalized random survey number sample list.
2. The sample frame for first survey number will be filled in by questioning farmer before beginning actual survey.
3. Next survey will be conducted for next survey number in list (serial number 2) only if it gives rise to a new frame.

Table 4-4 duplicate sample frames

Serial Number	Survey Number	Farmers name	Crop 1 e.g Cotton	Crop 2 e.g Soya	Crop 3 e.g Tur	PoCRA Beneficiary		Stream Proximity		Water Source Availability		Land Holding Criteria		Remark
						Yes	No	Yes	No	Yes	No	Yes	No	
			C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	
1	123			✓	✓	✓		✓			✓		✓	
2	12			✓	✓	✓		✓			✓		✓	

4. In this manner final samples will be selected while surveying. Few samples from list may get dropped due to unforeseen reasons such as –
    a. Repeated in same family

b. Not cultivating any primary crop
c. Survey number is not actually agricultural.
d. Farmer has stopped farming in that survey number.

These reasons must be illustrated in remarks column and next sequential sample must be selected for survey.

5. The frame count must be cumulatively updated after every 8 surveys to see the progress.
6. If Frame count column becomes equal to or greater than 6 for few parameters/ columns then farmers satisfying remaining column criteria must be prioritized from sampling table.
7. In case all parameters expect beneficiary get satisfied for 6 sample points, then selected beneficiary not surveyed till now must be appended to the survey list to complete the count.
8. The survey should stop once count for all parameters becomes equal to or more than 6.

An example table for this is given in Annexure III.

Farmer Sampling for Longitudinal Villages

As 50% of villages will be selected as random and 50% will be selected as longitudinal. The farmer sampling will also be done in following manner for longitudinal villages. 50% of first half surveyed farmers from final survey list will be kept constant for the 3 years of surveying during baseline, midline and endline and remaining 50% will be selected from a newly provided random survey number table after removing selected ones. Same procedure will be used for selection of farmer samples everytime. An example table for this is given in Annexure IV.

Combinations / Data Frames	**Longitudinal village samples**	**Varying Village samples**
Longitudinal Farmer samples	50%	0%
Varying Farmer samples	50%	100%

Outputs

The outputs provided at field level will be as follows –

1. Village wise list of land holding criteria for sampled villages
2. Random survey number list with stream proximity criteria (based on MRSAC Cadastral Map)

The outputs required in database from field after completion of process for the purpose of analysis are –

1. Final farmer survey list like Table 4-4 after completion of survey process
2. Farmer survey data

Process Bottlenecks

1. Cadastral gat number mismatch: The MRSAC cadastral later gat numbers usually do not match with the 7/12 gat numbers for farmers on field – this may lead to incorrect landholding criteria, issue in farmer identification on field.
   An updated cadastral shapefile with correct survey numbers will solve this issue and village wise 8A list may be useful for determining landholding criteria.
2. DBT beneficiary list: The survey numbers and farmer names in this list do not match with the cadastral numbers provided in random survey number list for village. Which would again result in difficulty in beneficiary identification in provided list.
   DBT portal linked to farmer selection may be useful to fetch survey numbers and beneficiaries from sampling list if updated cadastral shapefile is available.

Future Scope

Online system to generate random sample list, received surveyed list and maintain farmer database for further analysis

5. Key performance Indicators

Project on Climate Resilient Agriculture was envisaged with an objective to enhance climate resilience and profitability of smallholder farming systems in project area. With this in view, a concrete village level micro planning process was designed and implemented to address on farm water security and reduce risks associated with inter and intra seasonal climate variability. Water balance played a critical role in this process by allowing estimation of farm level vulnerability and climate stress based on geo-physical and agricultural characteristics of village.
The project strategized increasing the surface water storage capacity, ground water recharge and in situ water conservation to increase farm productivity and income. Based on these objectives and strategies it became imperative to measure the benefits of project that it targeted to achieve. These project outcomes are to be estimated at –

1. Crop Level
2. Farm Level and
3. Village Level

Key performance indicators (KPI) to be monitored for outcome assessment have been identified for this purpose which include –

1. Increased water productivity at farm level
2. Improved yield stability across space and time
3. Net greenhouse gas emissions
4. Farm income by Gender
5. Farmers reached with agricultural assets or services by gender

This chapter defines various indices to measure KPI and delineates the methodology for estimation at crop, farm and village level. It elaborates the tools to be used for same.

Review of Existing Indicators

There are existing indicators for the different Project Development Objectives that are augmented with few other indicators to capture the ground reality. The different indicators which can be used are mentioned in the table below. These indicators will require data from different key instruments used for measurements such as:
Data tools for survey:

1. Farmer survey: for fixed and variable farmer frame
2. DBT information collected
3. DPR: village level indicators

PDO, proposed indicators and data source

This table maps the project development objectives, key performance indicators and proposed indicators at crop, farm and village level. It also mentions the tools to be used to gather data for arriving at the indicator value. The indicators suggested in this document cater to the water related project development objectives and key performance indicators as illustrated in Table 5-1.

Table 5-1 PDO, proposed indicators and data source

PDO Level Indicator	Proposed indicators	Data source
PDO 2) Climate resilient agriculture: Improved water use efficiency at farm level (Area provided with new/improved irrigation or drainage services (in ha)) **KPI 1**	Water productivity (crop level)	Farmer survey
	Economic productivity (crop and farm level)	Farmer survey
	Budyko point	Farmer survey
PDO 4) Profitability: Annual farm income (Farm income comparator (as ratio with/ without farm income) between beneficiaries and non-beneficiaries) **KPI 4**	Annual farm income for P1 category farmers (beneficiary and non-beneficiary)	Farmer survey
	Annual farm income for P2 category farmers (beneficiary and non-beneficiary)	Farmer survey
	Annual farm income for P3 category farmers (beneficiary and non-beneficiary)	Farmer survey
PDO 5) Direct project beneficiaries (Number of farmers reached with agricultural assets or services (% of female)) **KPI 5**	Number of farmers using drip/ sprinkler for the first time.	Farmer survey
	Number of farmers provided horticulture benefit upto year 1, year 2 and year 3.	DBT (Village level)
	Number of farmers provided with polyhouse/ polytunnel	DBT (Village level)
	Number of farmers provided with farm pond- GW based/ run-off based	DBT (Village level)
	Number of farmers provided with plastic sheet for farm pond	DBT (Village level)
	Number of farmers going for sericulture	DBT (Village level)
	Number of villages covered amongst number of villages where provision of wells is possible.	

PDO 6) Climate resilient agriculture: improved yield uniformity and stability (Spatial and temporal yield variability for crop A (std. deviation of avg. yield in kg/ha)) **KPI 2**	CV for yields of different crops for rainfed and irrigated	Farmer survey, Plugin output
PDO 7) Climate resilient agriculture: Improved availability of water for agriculture (Surface water storage capacity from new farm ponds (in 1,000 m3)) **(KPI 1 and 2)**	Ratio of water access on farm in mm to total deficit in mm Ratio for water access on farm in mm to total deficit for P1, P2 and P3 category crops Area under P1/ P2/ P3 crops	Farmer survey Village level (DPR)
	W1/ W2/ W3 water access in mm	Farmer survey (farm level), DPR (village level)
	Last watering month	Farmer survey

The bio-physical productivity indices are mapped to PDO 2 or KPI 1 concerning water use efficiency. Economic indicators are mapped to PDO 4 and KPI 4 consisting of profitability. PDO 5 and KPI 5 are linked to project benefits. Climate resilience indicators on yield variability become a part of PDO6 or KPI 2 whereas water access indicators become part of PDO 7 and, KPI 1 and KPI 2.

Each of these indicators has a different measurement mechanism depending on level of indicator – Village, Farm or Crop. Sample farmer survey in selected villages will be conducted to estimate crop and farm level indicators whereas the village level indicators may be computed based on the DBT, water budget and DPR datasets. The classification of these indicators into Village, Farm and Crop level is as given in Table 5-2 along with unique indicator code.

Table 5-2 Indicators – Village, Farm and Crop level

Indicator Code	Indicator	PDO	KPI	Data Source	Frequency
Village Level Indicators					

Indicator Code	Indicator	PDO	KPI	Data Source	Frequency
V1.	Number of farmers using drip/ sprinkler for the first time.	5	5	MIS/DBT	Annual
V2.	Number of farmers provided horticulture benefit upto year 1, year 2 and year 3.	5	5	MIS/DBT	Annual
V3.	Number of farmers provided with polyhouse / polytunnel.	5	5	MIS/DBT	Annual
V4.	Number of farmers provided with farm pond- GW based/ run-off based	5	5	MIS/DBT	Annual
V5.	Number of farmers provided with plastic sheet for farm pond	5	5	MIS/DBT	Annual
V6.	Number of farmers going for sericulture	5	5	MIS/DBT	Annual
V7.	Budyko point*	2	1	DPR	Annual
V8	W1/ W2/ W3 water access in mm*	7	1&2	DPR	Annual
V9	Area under P1/ P2/ P3 crops*	7	1&2	DPR	Annual
Farm Level indicators					
F1	Economic productivity*	2	1	Fixed frame and variable frame farmer survey for beneficiary and non-beneficiary	Annual
F2.	Budyko point*	2	1	Fixed frame and variable frame farmer survey for beneficiary and non-beneficiary	Annual
F3	Ratio of water access on farm in mm to total deficit in mm*	7	1&2	Fixed frame survey for beneficiary	Annual

Indicator Code	Indicator	PDO	KPI	Data Source	Frequency
F4	Annual farm income for P1 category*	4	4	Fixed frame survey for beneficiary and non-beneficiary	Annual
F5	Annual farm income for P2 category farmers*	4	4	Fixed frame survey for beneficiary and non-beneficiary	Annual
F6	Annual farm income for P3 category farmers*	4	4	Fixed frame survey for beneficiary and non-beneficiary	Annual
F7	Ratio for water access on farm in mm to total deficit for P1, P2 and P3 category crops*	7	1&2	Fixed frame survey for beneficiary	Annual
F8	Last watering month*	7	1&2	Fixed frame and variable frame farmer survey for beneficiary and non-beneficiary	Annual
F9.	W1/ W2/ W3 water access in mm*	7	1&2	Fixed frame and variable frame farmer survey for beneficiary and non-beneficiary	Annual
F10.	Area under P1/ P2/ P3 crops*	7	1&2	Fixed frame farmer survey for beneficiary and non-beneficiary	Annual
Crop Level Indicators					
C1	Water productivity	2	1	Fixed frame and variable frame farmer survey for beneficiary and non-beneficiary	Annual
C2	Economic productivity	2	1	Fixed frame and variable frame farmer survey for beneficiary and non-beneficiary	Annual
C3	CV for yields for rainfed soybean, tur	6	2	Fixed frame and variable frame farmer survey for beneficiary and non-beneficiary	Annual

Indicator Code	Indicator	PDO	KPI	Data Source	Frequency
C4	CV for yields of irrigated soybean, tur	6	2	Fixed frame and variable frame farmer survey for beneficiary and non-beneficiary	Annual

Measurement Methodology

These indicators are detailed out further in this section to illustrate their relevance, unit of measure, frequency of measurement and key measurement framework. This measurement framework is illustrated PDO wise for selected indicators.

Table 5-3 Farmers reached with Agricultural Assets or Services – KPI 5

PDO Level Indicator 5) Direct project beneficiaries						
Number of farmers reached with agricultural assets or services (% of female)						
Frequency: Annual		Unit of measure: Number		End Target: 12,72,800		
The number of farmers adopting improved agricultural technologies need to be looked at separately for different technologies and benefits provided under PoCRA. Farmers in many villages are already using drip and sprinklers for irrigation and are provided a new set through PoCRA. The number of farmers adopting improved agriculture technologies for the first time need to be considered.						
Sr.	Indicator	unit	Level	Frequency	Data source	Remarks
V1.	Number of farmers using drip/ sprinkler for the first time.	Number	Village, district, project area	Annual	Primary survey (Variable frame farmer survey) and PoCRA MIS	The percentage of farmers using drip or sprinkler irrigation for the first time needs to be considered.
V2.	Number of farmers provided horticulture benefit upto year 1, year 2 and year 3.	Number	Village, district, project area	Annual	Primary survey and PoCRA MIS	The benefit for horticulture is provided over a period of 3 years. The farmers receiving the benefit in year 2 and 3 are the

						farmers who could maintain the trees for the 3 years. It is important to look at all 3 Numbers to understand whether or not the Number is reducing and the kind of economic implications is has on the farmers.
V3.	Number of farmers provided with polyhouse/ polytunnel	Number	Village, district, project area	Annual	PoCRA MIS	
V4.	Number of farmers provided with farm pond- GW based/ run-off based	Number	Village, district, project area	Annual	PoCRA MIS	
V5.	Number of farmers provided with plastic sheet for farm pond	Number	Village, district, project area	Annual	PoCRA MIS	This will provide an idea of the Number of farmers with a farm pond before the project in the project area.
V6.	Number of farmers going for sericulture	Number	Village, district, project area	Annual	PoCRA MIS	

Water use efficiency is a bio-physical quantity which is a function of various parameters such as soil type, soil depth, land topography, nearby interventions, irrigation method, water application time to name a few. It can be measured through certain indicators such as water productivity, economic productivity and budyko point. The measurement framework for these is illustrated in Table 5-4

Table 5-4 Improved water use efficiency at Farm Level – KPI 1

PDO Level Indicator 2) Climate resilient agriculture: Improved water-use efficiency at farm level						
Area provided with new/improved irrigation or drainage services (in ha)						
Frequency: Annual		Unit of measure: Number		End Target: 6,24,000		
The area provided with new irrigation or drainage services (ha); and the area provided with improved irrigation or drainage services (ha). Irrigation or drainage services refers to the better delivery of water to, and drainage of water from, arable land, including better timing, quantity, quality, and cost-effectiveness for the water users. New irrigation or drainage services refers to the provision of irrigation and drainage services in an area that has not had these services before. The area is not necessarily newly cropped or newly productive land, but is newly provided with irrigation and drainage services, and may have been rain-fed land before. Improved irrigation or drainage services refers to the upgrading, rehabilitation, and/or modernization of irrigation or drainage services in an area with existing irrigation and drainage services. This indicator looks at the area to which irrigation and drainage services are provided but does not look at the number of farmers reached with the service. Watershed works are conducted in most of the works and the area provided with new irrigation does not capture the concept of water use efficiency. Water use efficiency should be looked at as the output obtained from water.						
Sr. Number	Indicator	unit	Level	Frequency	Data source	Remarks
C1.	Water productivity	Number	Crop	Annual	Farmer survey (Fixed frame-beneficiary, non-beneficiary and variable frame-beneficiary non-beneficiary.	Crop water productivity differs from region to region and the reasons for variation in crop water productivity are various and numerous such as insufficient irrigation, animal and pest attacks etc. Thus it is important to study crop water productivity through actual primary data and not through yield

						estimation techniques.
C2, F1.	Economic productivity	Number	Crop, farm	Annual	Farmer survey (Fixed frame and variable frame beneficiary, non-beneficiary)	Economic productivity looks at the kind of monetary value farmers are able to convert their water into. Economic productivity will be able to aggregate the different crops a farmer has and help provide an overall understanding of water productivity for the farmer.
F2.	Budyko point	Number	Farm, Village	Annual	Fixed frame farmer survey and DPR	Budyko point will be able to map a farmer and his trajectory over the different years over which data will be collected through fixed frame farmer survey. It will show that with changing rainfalls how has the farmer/ villages cropping pattern managed to adjust to the changing rainfall patterns.

Table 5-5 caters to profitability indices. Profitability is measured at farm level taking into account the cropping pattern of farmer. As different crops have different propensity to profit and investment risk. For example, there is higher fluctuation in prices of annual crops as compared to kharif and long kharif crops like Soybean, Tur, Cotton which also have comparatively lower investment risks. But the annual crops with higher investment risks have more market value compared to the kharif or long kharif crops and so lie in a different profit margin. Considering this and based on the cropping pattern, farmers are classified as rainfed (P3), irrigated (P2) and those having annual crops (P1) and their profit indices are measured

accordingly in these three categories. These indices are determined only for fixed frame farmers so that the increase in profit can be gauged over time.

Table 5-5 Improved Farm Income – KPI 4

PDO Level Indicator 4: Profitability: Annual farm income						
(Farm income comparator (as ratio with/ without farm income) between beneficiaries and non-beneficiaries)						
Frequency: Annual Unit of measure: Number End target : 1.5 times existing						
This indicator tracks the annual farm income of project beneficiaries. It measures how the income of landholders evolves with project activities, compared to the income of landholders that do not benefit from project interventions. It is necessary to track the annual farm income for the different types of cropping patterns being adopted based on the type of benefit provided by PoCRA. The changing annual farm income of a farmer with horticulture and a farmer moving from rainfed cropping pattern to irrigated cropping needs to be tracked separately.						
Sr.	Indicator	unit	Level	Frequency	Data source	Remarks
F4.	Annual farm income for P1 category	Number	Farmer survey	Annual	Farmer survey-fixed frame-beneficiary and non-beneficiary.	The annual income from farm activities needs to be assessed every year for the same farmers to understand clearly the impact of the project.
F5	Annual farm income for P2 category farmers	Number	Farmer	Annual	Farmer survey-fixed frame-beneficiary and non-beneficiary.	The annual income from farm activities needs to be assessed every year for the same farmers to understand clearly the impact of the project.
F6	Annual farm income for P3 category farmers	Number	Farmer	Annual	Farmer survey-fixed frame-beneficiary and non-beneficiary.	The annual income from farm activities needs to be assessed every year for the same farmers to understand clearly the impact of the project.

Table 5-6 caters to yield stability which is a sign of climate resilience. Yield uniformity is a function of water access at farm level along with various other parameters. So, this is proposed to be measured spatially and temporally through coefficient of variability of yield for major crops in village for consecutive years. Table 5-6 has given sample spatial and temporal CV values for primary data collected across five villages in Bid, Latur, Wardha districts.

Table 5-6 Improved yield uniformity and stability

PDO Level Indicator 6: Climate resilient agriculture: improved yield uniformity and stability						
(Spatial and temporal yield variability for crops (std. deviation of avg. yield in kg/ha))						
Frequency: Mid Term, End Term Unit of measure: Percentage Soyabean spatial yield variability: Baseline =30 End target = 23 Soyabean temporal yield variability: Baseline 52 End target= 38 Pigeon pea spatial yield variability: Baseline =39 End target = 30 Pigeon pea temporal yield variability: Baseline 44 End target= 36						
The yield for crops needs to be studied separately for rainfed and irrigated crops as the yield variability defers greatly with changing number of irrigations provided and soil type in rainfed crops.						
Sr.	Indicator	unit	Level	Frequency	Data source	Remarks
C3.	CV for yields of soybean, tur for rainfed	Number	Crop	Annual	Farmer survey- fixed frame and variable frame- beneficiary and non-beneficiary.	
C4.	CV for yields of soybean, tur for irrigated	Number	Crop	Annual	Farmer survey- fixed frame and variable frame- beneficiary and non-beneficiary.	

The objective of the project being water access at farm level to improve climate resilience and profitability of small holders. Table 5-7 provides a framework for farm level indices measuring access to water in supply and demand terms.

Table 5-7 improved availability of water for agriculture – KPI 1 and KPI 5

PDO Level Indicator 7) Climate resilient agriculture: Improved availability of water for agriculture
Surface water storage capacity from new farm ponds (in 1,000 m3)
Frequency: Semi-annually Unit of measure: Number End target : 8,39,00,000

Looking at improved water availability only through surface water is not sufficient. Water availability will increase through PoCRA interventions as surface water availability, ground water availability and improved soil moisture as well. It will primarily reflect through shifting farmers from rainfed to irrigated and also shifting farmers from seasonal crops to annual horticulture crops. While the proposed frequency is semi annual, for the proposed indicators the frequency chosen is annual since water available to crops based on number of irrigations can be taken for a farmer in the entire year.						
Sr.	Indicator	unit	Level	Frequency	Data source	Remarks
F3, F7.	Ratio of water access on farm in mm to total deficit in mm Ratio for water access on farm in mm to total deficit for P1, P2 and P3 category crops	Number	Farm	Annual	Fixed frame and variable frame farmer survey for beneficiary and non-beneficiary	Non beneficiary fixed farmer survey will help evaluate the watershed development works undertaken in the village. Beneficiary will help evaluate the individual benefits provided by the scheme.
F9.	W1/ W2/ W3 water access in mm	Number	Village Farm	Annual	DPR Fixed frame and variable frame farmer survey for beneficiary and non-beneficiary	Non beneficiary fixed farmer survey will help evaluate the watershed development works undertaken in the village. Beneficiary will help evaluate the individual benefits provided by the scheme.
F8.	Last watering month	Number	Farm	Annual	Fixed frame and variable frame farmer survey for beneficiary and non-beneficiary	Non beneficiary fixed farmer survey will help evaluate the watershed development works undertaken in the village. Beneficiary will help evaluate the individual benefits provided by the scheme.

F10.	Area under P1/ P2/ P3 crops	Number	Village Farm	Annual	DPR Fixed frame farmer survey for beneficiary and non-beneficiary	Non beneficiary fixed farmer survey will help evaluate the watershed development works undertaken in the village. Beneficiary will help evaluate the individual benefits provided by the scheme.

An app may be built for farmer survey purpose to collect required data for estimation of indicators. A farmer report card may be generated from the app which will provide a summary of all the indicators used for monitoring and evaluation at the farm level. A sample report is as shown in Fig 5-1.

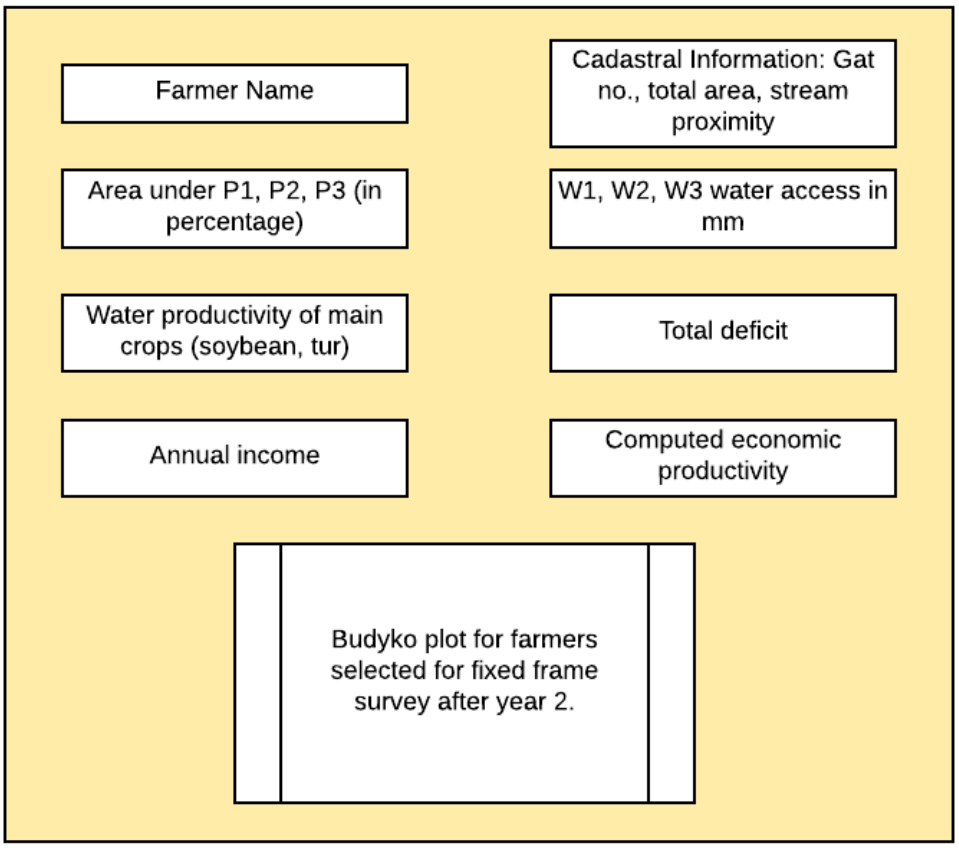

Figure 5-1 Farmer Report

Input data and Measurement mechanism

This section details out the measurement mechanism for proposed indices along with required input datasets.

C1. Water productivity

Water productivity is measured as yield per cubic meter of water provided to particular crop. Water productivity for different crops is seen to be varying as per soil type, soil depth, number and time of waterings etc.

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

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 computed through the plugin + Extra watering provided to the plant as per irrigation type in m3.

Computation method:

Following are the inputs required for computation of water productivity through farmer survey:

1. Crop Name
2. Area under crop
3. Irrigation Type: rainfed/flood/drip/sprinkler
    a. For flood irrigation:
        i. Number of waterings provided
        ii. Date/ Month of watering
        iii. Approximate mm watering provided to farm
        iv. Number of days required to provide 1 watering
        v. Pumping time required in a day in hours

    Drip irrigation
        vi. Frequency of watering (number of times/days in a week)
        vii. Number of months irrigation is provided
        viii. Dripper flow rate
        ix. Number of drippers installed or spacing between drippers used to determine number of drippers in the area
        x. Number of hours of drip irrigation provided during one irrigation
    b. Sprinkler irrigation
        . Frequency of watering (number of times/days in a month)
        i. Number of months irrigation is provided
        ii. Number of sprinkler nozzles
        iii. Sprinkler flow rate
        iv. Number of sprinklers installed or spacing between drippers used to determine number of sprinklers in the area
        v. Number of hours per irrigation

Yield

Crop yield and watering information are the details required to compute water productivity. While some methodologies for yield computation look at biomass generated, and some others estimate yield based on harvest index of different crops, our proposed methodology looks at primary yield information. As yield is also affected by other factors like pest attack, animal attack which come into play on field and shift the measure. These factors need to be considered

and adjusted for, while computation of water productivity index. This survey incorporates the inputs for external factors.

While the survey is conducted in sample villages for sample fixed and variable farmers, it is designed so as to cover 3 main kharif crops in the village and gathers complete farmer data on all crops cultivated by farmer.

Calculation of extra watering provided

The amount of extra water given is computed in following manner for different irrigation types

1. Flood

Watering given in mm:
Number of times soil was saturated with moisture through irrigation will be asked through questionnaire. This will then be used to estimate the total amount of watering given.
To elaborate further, number of times soil was saturated for that crop along with dates of irrigation will be fed into the farm level app to get the irrigation water consumed by plant that is its AET with watering.

2) Drip irrigation
The quantity of water provided to the crop is estimated by multiplying the number of drippers with the hours of use and the frequency of irrigation and number of months irrigation is provided. The water application efficiency for drip irrigation as recommended by FAO is 90% and is considered for calculations

$$\text{Watering (mm)} = \frac{(\text{Number of drippers} * \text{flow rate of dripper (LPH)} * \text{irrigation frequency (total no. of days)} * \text{irrigation hrs per day} * 90\%)}{\text{Total area(ha)} * 10\text{^}4}$$

Where -
Number of drippers = Total area (m^2) / Spacing between drippers (m^2)

If the farmer cannot provide details regarding the flow rate of the dripper, a flow rate of 8 lph is assumed.

3) Sprinkler irrigation
The quantity of water taken up by the crop is estimated through the number of sprinklers, sprinkler flow rate, hours of use, frequency of irrigation and number of months irrigation is provided. The water application efficiency for sprinkler irrigation as recommended by FAO is 75% which is considered for calculations

$$\text{Watering (mm)} = \frac{(\text{Number of sprinkler nozzels} * \text{flow rate of sprinkler (LPH)} * \text{irrigation frequency (total no. of days)} * \text{irrigation hrs per day} * 75\%)}{\text{Total area(ha)} * 10\text{^}4}$$

Where
Number of sprinklers = Total area(m^2) / Spacing between drippers (m^2)

If the farmer cannot provide details regarding the flow rate of the sprinkler, a flow rate of 715 LPH is assumed.

Example

The water productivity for different crops based on data collected from 5 different villages in Maharashtra Yelda, Mamdapur in Beed, Tadmugli, Latur, Yewati, Jalgaon and Wabgaon, Wardha is shown here. The total number of farmer samples collected were 192 and vilalges were visited during year 2018-19.

The results from the data are summarized in the table below

Table 5-8 Water productivity from primary survey of 5 villages

Crop Name	WP Range (kg/m^3)	WP Mean	WP std dev	Number of samples
Cotton	0.00-0.98	0.35	0.13	142
Tur	0.00-0.91	0.36	0.20	101
Sorghum	0.03-0.53	0.21	0.13	56
Soybean	0.00-0.80	0.36	0.17	85

The WP range is affected by the following parameters:

1. Soil type (primarily for rainfed agriculture)
2. Number of waterings
3. Pest/ Animal Attack (Based on the characteristics of the crop, ability to spray pesticide)
4. Last harvest (in case of crops like cotton)

The box plot below compares the water productivity for different crops and also shows the outliers. The red dotted line indicates the water productivity of 0.3 which was taken as a base value for comparison.

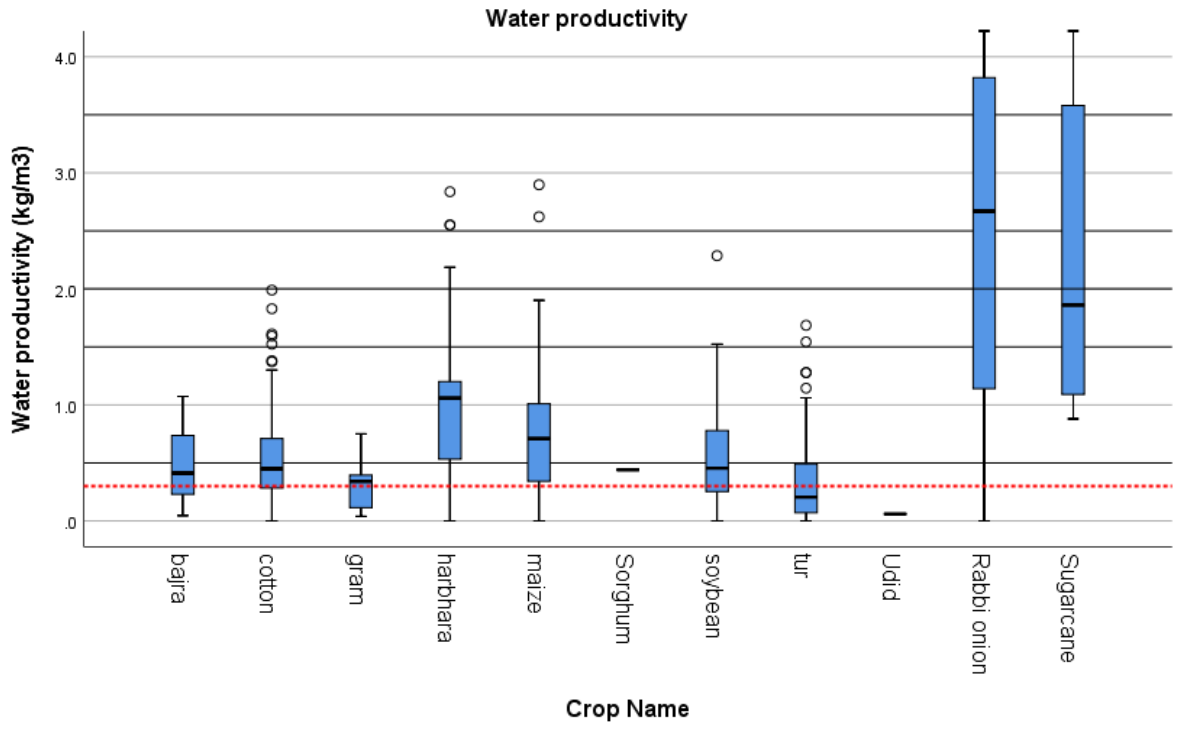

Figure 5-2 Water productivity for Main crops – study for 6 villages in PoCRA region

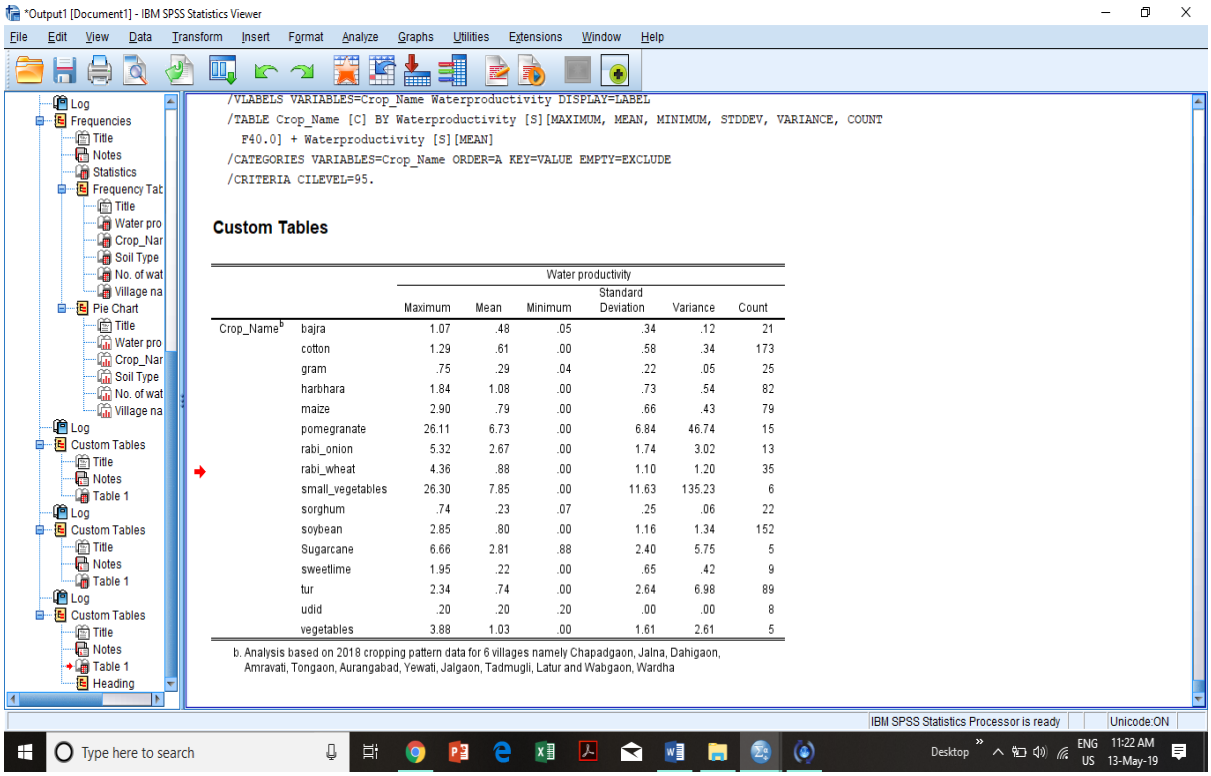

Figure 5-3 Water productivity and statistical details for main crops in 6 villages

The water productivity of the crops is seen to be varying with changing soil types and number of irrigations provided to the crop. A slight increase in water productivity in most cases is observed. The graph below shows how the water productivity varies with varying number of irrigations.

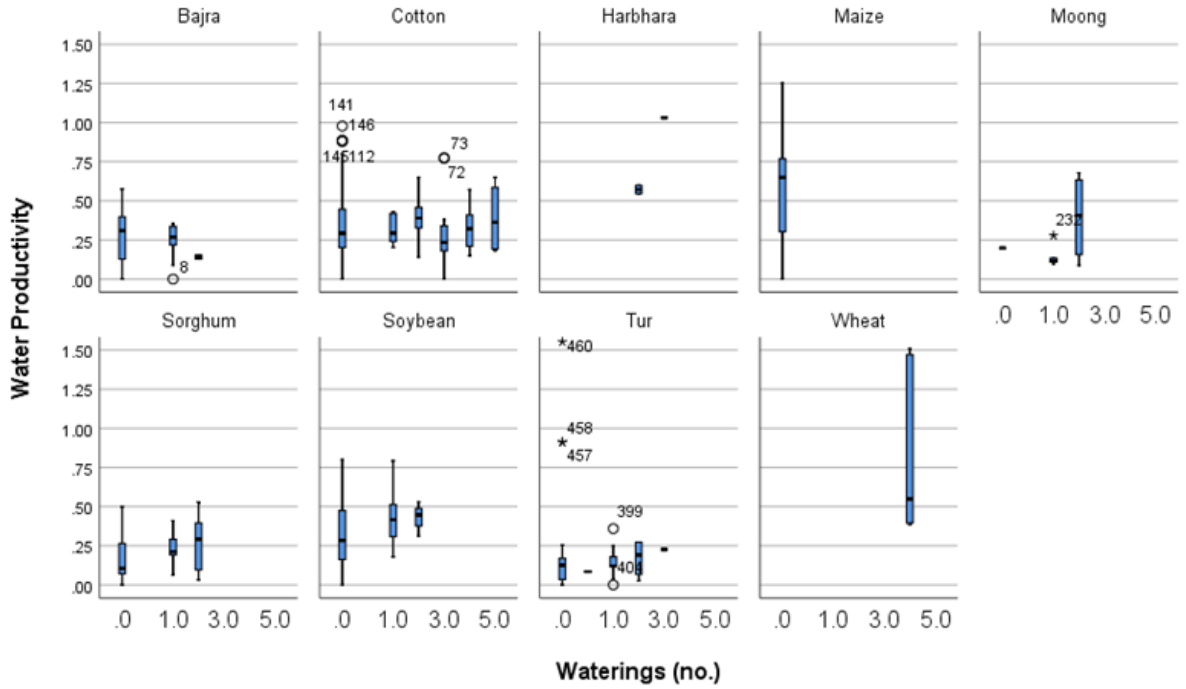

Figure 5-4 Water productivity variation with number of waterings

It is observed that the average water productivity is increasing with every irrigation and the range of water productivity reduces. Thus, the instances of crop loss etc. reduce drastically. Water productivity is also highly dependent on changing soil types. It is observed that increasing number of irrigations provided reduces the impact of the soil type on water productivity.

Current studies use Aquacrop to estimate water productivity. Aquacrop estimates the yield of the crop considering the harvest index and the irrigations provided. The range estimated by the model is much smaller than the range estimated through primary survey. Following table provides a comparison of water productivity from our study and that from Aquacrop model

Table 5-9 Comparative study with existing models in use (Aquacrop)

Crop	**WP range (Aquacrop) (kg/m3)**	**WP range computed from primary survey (kg/m3)**
Wheat	1.0-1.2 kg/m3	0.2-1.5 kg/m3
Rice	0.2-1.2 kg/m3	-
Cotton	0.49 to 0.54 kg/m3	0-1.2 kg/m3
Soyabean	1.2-1.6 kg/m3	0-0.8 kg/m3

C2 Economic productivity

While the water productivity can tell us about the yield and how it changes with extra water provided to crops and soil texture, it does not cover the price fluctuations in local markets and input cost behind the different crops. Economic productivity thus looks at the profit per amount of water utilised. This makes it possible to compare productivity of different crops effectively.

Economic productivity is defined as profit per m3 of water utilised.

Economic productivity (EP) = Profit per acre in Rs. / Water taken up by the plant in m3

Where,
Profit per acre is estimated through primary data regarding input cost and market price received and Water taken up by an acre of the crop in m3 (Total AET with watering is used)

This is estimated with the same methodology in which water productivity is estimated.

The definition for input cost varies from author to author depending on the kind of use being made of the indicator. For the calculation of MSP in India, the following format is used for computing input cost. The input cost data collected through primary surveys is the actual cost incurred by the farmers and not computed cost.

Table 5-10 MSP input cost computation format

Sr.	Cost items	Considered during computation
1	Operational Cost	
1.1	Human Labour	
1.1.1	Casual	Yes
1.1.2	Attached	Yes
1.1.3	Family	
1.2	Bullock Labour	
1.2.1	Hired	Yes
1.2.2	Owned	
1.3	Machine Labour	
1.3.1	Hired	Yes
1.3.2	Owned	
2	Seed	Yes
3	Fertilisers	Yes
4	Manure	Yes
5	Pesticides/ Insecticides	Yes
6	Irrigation charges	
7	Interest on working capital	
8	Miscellanous	
9	Rental value of owned land	
10	Rent paid for leased-in land	
11	Land revenue, cesses and taxes	
12	Depreciation on implements and farm buildings	
13	Interest on fixed capital	

The economic productivity varies based on the following factors:

1. Fluctuating market prices
2. Water productivity
3. Varying input costs

The indicator is thus indicative of varying and rising input costs in different areas for different crops and fluctuating market prices for different crops.

The graph in Figure 5-5 shows the varying economic productivity of different crops.

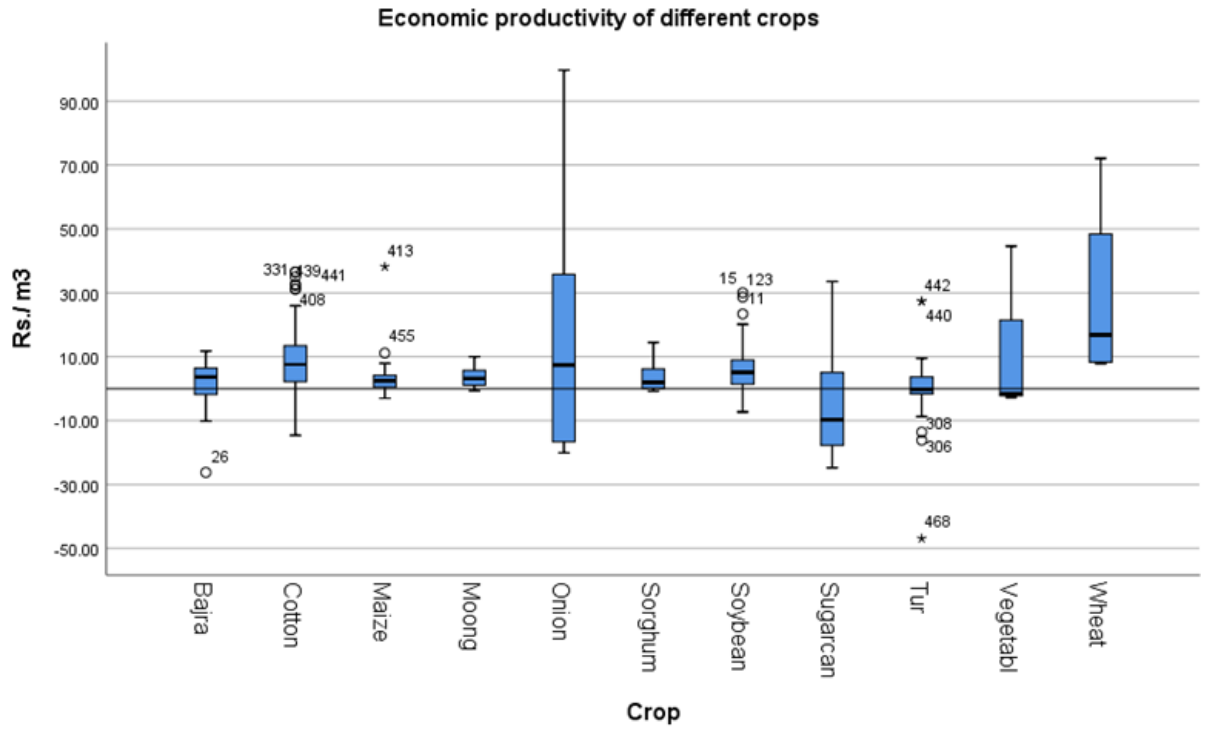

Figure 5-5 Economic productivity for crops – study in 5 villages

The economic productivity of different crops shows that for crops such as onion and sugarcane the market prices are such that the crop is many times unviable. Whereas crops such as tur, soyabean, bajra, sorghum, maize etc. have stable yields and market rates with a smaller variation in the prices observed.

C3/C4 Co-efficient of Variability for yields for rainfed/ irrigated soybean, tur

Spatial and temporal variability of yield can be understood through the CV for yields of different crops. Co-efficient of variability depicts the proportion of variability for different crops spatially and temporally. Co-efficient of variability can be calculated as standard deviation divided by mean and it is an indicator of climate resilience. Improvement in water access achieved through project is linked to reduction in yield variability. i.e. improvement in adaptive capacity to face climate vagaries.

Table 5-11 Coefficient of spatial variability for study conducted in 6 PoCRA villages

Crop Name	Village name																	
	Chapadgaon, Jalna			Dahigaon, Amravati			Kubhephal, Aurangabad			Tadmugli, Latur			Wabgaon, Wardha			Yewati, Jalgaon		
	Yield (kg/acre)			Yield (kg/acre)			Yield (kg/acre)			Yield (kg/acre)			Yield (kg/acre)			Yield (kg/acre)		
	Std Dev	Mean	CV	Std Dev	Mean	CV	Std. Dev	Mean	CV	Std Dev	Mean	CV	Std Dev	Mean	CV	Std. Dev	Mean	CV
bajra		0.50	0.00			-	4.90	7.00	0.70									
cotton	7.73	10.27	0.75	10.10	16.18	0.62	5.58	9.08	0.61				2.88	5.97	0.48	1.23	7.69	0.16
harbhara	4.73	4.67	1.01	18.72	20.95	0.89			-									
maize			-			-	7.93	12.15	0.65							4.54	7.94	0.57
moong			-	0.15	4.00	0.04			-									
onion		1.00	0.00	2.35	40.00	0.06	4.2	20.00	0.21									
orange			-	1.2	6.00	0.20			-									

pomegranate			-		30.00	0.00	34.25	61.40	0.56								
rabi_wheat	4.52	6.00	0.75	3.06	9.33	-	2.3	11.00	0.21				4.27	8.60	0.50	5.61	8.06	0.70
small_vegetables		10.00	0.00		10.00	0.00			-									
sorghum	4.19	3.75	1.12			-	0.52	1.50	0.35				0.35	2.00	0.18			
soybean	7.15	7.95	0.90	27.22	25.75	1.06			-	2.73	4.47	0.61	2.01	4.38	0.46			
sugarcane			-			-			-				89.57	230.00	0.39			
tur	1.96	2.08	0.94	12.27	16.03	0.77	4.82	4.42	1.09	0.72	1.08	0.67	1.10	2.62	0.42	79.99	37.00	2.16
vegetables			-			-			-				33.94	26.00	1.31	0.00	8.00	0

This table shows the spatial variability for different crops

F3 Ratio of water access on farm in mm to total deficit in mm

The ratio of water access on farm in mm to total deficit in mm gives an idea about the amount of deficit the farmer could cover through irrigation. It is dependent on both cropping pattern, rainfall pattern and capacity of well.

The total deficit is computed using the plugin deficit values for the particular gat number collected through the farmer survey for different crops multiplied with respective crop areas.

Total deficit (in mm) = (Crop 1 Area * Deficit for crop 1 + Crop 2 Area * Deficit for crop 2...+Crop n Area * Deficit for crop n) /Crop 1 Area

The water access on farm is computed through irrigation information collected through the farmer survey and AET as per the plugin as explained in indicator 5.1

The graph below shows the comparison between farmers of Wabgaon, Wardha on ratio of water access to total deficit. The farmers with low ratio have a high water consuming cropping pattern

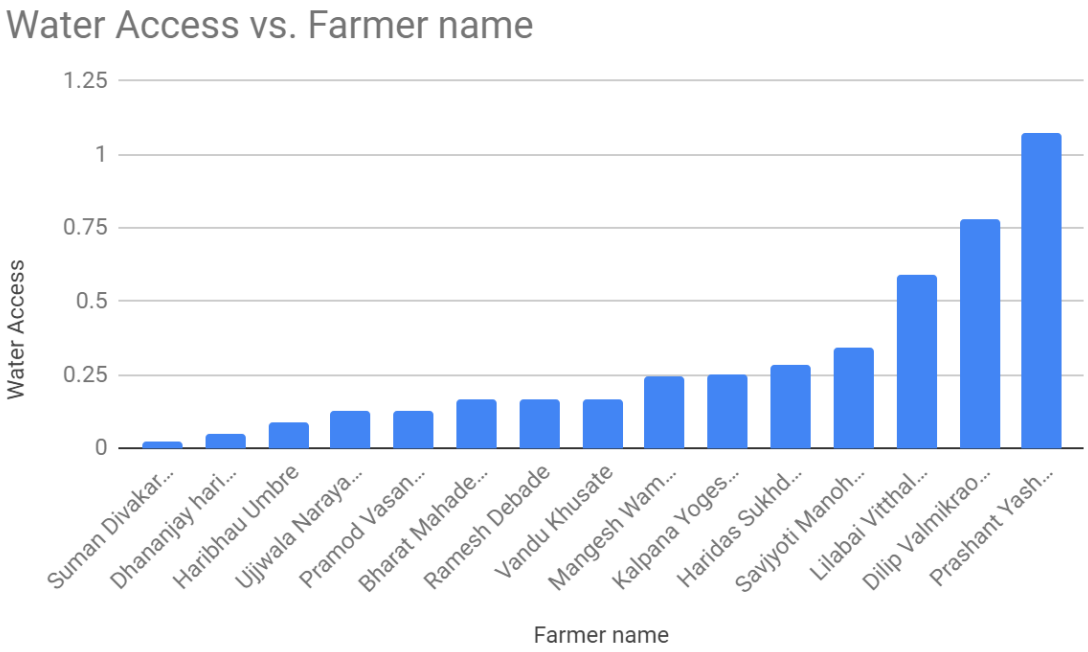

Figure 5-6 Water access ratio - farmerwise

F4/F5/F6 Annual farm income for P1/P2/P3 category farmers

Annual farm income is computed for the farmers based on input cost and market price for different crops as reported by the farmers. The detailed definition of input cost is provided in indicator C2 economic productivity.

Table 5-12 Range of farm income in surveyed villages

Range	Yewati	Tadmugli	Wabgaon	Dahigaon	Tongaon	Chapadgaon
<-10000	3	0	6	0	2	4
-10000-(-5000)	4	0	7	1	1	3
-5000-0	2	2	4	5	2	3
0-5000	8	3	8	5	2	5
5000-10000	2	3	4	4	5	5
10000-20000	1	3	2	6	4	2
>20000	1	2	1	6	2	4

The Table 5-11 shows the range of annual farm income for different farmers in 6 villages. It can be seen that the range is highly varying. The loss-making farmers are due to crop loss and also due to annual horticulture crops. It is necessary to distinguish between the two and thus farmer category needs to be looked at.

Based on cropping pattern the farmers can be looked at as 3 types of farmers.
P1: Farmers with annual crops on some or entire land available.
P2: Farmers with the capacity to provide irrigation to the crops they sow.
P3: Farmers dependent on rain entirely and do not provide extra water to the crops they sow.

P1 farmers generally have access to a water source all year round or most of the year and make water available for the remaining months by relying on tanker service or purchasing water etc. P2 farmers have access to water but is generally lesser than P1 farmers and thus have the capacity to provide protective irrigation or irrigation in rabbi but do not take any annual crop. P3 farmers do not have any access to water and are dependent on rainfall entirely.

The reason to study the 3 types of farmers separately is because the reasons for vulnerability and losses are different for each category. P1 farmers need to provide irrigation all year long, require heavy investments and do not earn profits till the fruit bearing period begins which induces a huge amount of risk. P2 farmers are able to provide irrigation but may not be able to meet the deficit faced by the crops. They face risks due to pests and animal attacks and fluctuation of market prices. P1 farmers are not able to provide protective irrigation and are entirely dependent on the rainfall patterns in the area.

Table 5-13 Average profit across categories for study in 6 villages

Farmer category	Tadmugli	Wabgaon	Yewati	Dahigaon	Tongaon	Chapadgaon
P1		-6179	-8666	-2425		-3524
P2	3834	2132	8236	6123	7542	8348
P3	1277	2283	7222	3425	1253	3521

F10. Area under P1/ P2/ P3 crop percentage

Area under P1/ P2/ P3 crop percentage = (Area under P1/P2/P3 crops/ Total area)*100

Where, area under P1, P2, P3 will be available from farmer survey for farm level indicator.

Farmer survey will include fixed frame beneficiary and non-beneficiary farmers. Fixed frame beneficiary and non-beneficiary farmers will help understand the change in P1, P2, P3 area due to different individual and community benefits of water access and horticulture in the village. The fixed frame non-beneficiary farmers analysis will help understand the impact of the watershed works in the village on effectively converting various drain line treatments in the area to irrigations by the farmers.

Table 5-14 shows the study villages visit schedule; whose primary survey data was used to conduct the sample analysis provided in this report.

Table 5-14 Study Villages visit schedule

Date	Villages visited	Team
2nd – 3rd Feb'19	Wabgaon, Deoli Taluka, Wardha	Swapnil Patil, Adarsh Jaju, Shubhada Sali
2nd – 3rd Feb'19	Yevati, Bodwad Taluka, Jalgaon	Manasi Bhopale, Amit Patil, Rohit Shende
15th -16th March	Kubephal and Tongaon, Aurangabad Taluka, Aurangabad	Rohit Shende, Sagar Tikore, Gopal Chavan
4th – 5th Feb'19	Tadmugli, Nilanga Taluka, Latur	Sagar Tikore, Ekant Amin, Parth Gupta
14th -15th March'19	Chapadgaon, Ghanswangi Takula, Jalna	Swapnil Patil, Adarsh Jaju, Shubhada Sali
1st – 2nd April'19	Dahigaon, Chandur Bazaar, Amravati	Ekant Amin, Amit Patil, Manasi Bhopale

Conclusion

An integrated system of digital tools consisting of DBT platform, DPR, Water Budget apps and M&E tools will be needed for overall implementation of M&E framework and analysis based on same.

Annexure I Taluka wise Phase wise list of Number of Village Samples

Sr. number	District name	Taluka name	Number of circles	Number of clusters	Number of villages phase I	Number of villages phase II	Number of villages phase III	Total villages	10% villages Phase I	10% villages Phase II	10% villages phase III	Total sample villages
1	Akola	Patur	2	3	4	10	5	19	0	1	1	2
2	Aurangabad	Sillod	6	8	15	11	19	45	2	1	2	5
3	Aurangabad	Gangapur	9	6	14	16	19	49	1	2	2	5
4	Aurangabad	Paithan	8	7	4	24	29	57	0	2	3	5
5	Aurangabad	Vaijapur	11	16	11	24	30	65	1	2	3	6
6	Bid	Georai	10	6	0	52	10	62	0	5	1	6
7	Bid	Wadwani	2	3	5	1	9	15	1	0	1	2
8	Bid	Dharur	2	2	13	8	0	21	1	1	0	2
9	Bid	Parli	4	4	14	4	7	25	1	0	1	2
10	Bid	Patoda	3	4	0	25	5	30	0	3	1	4
11	Bid	Kaij	7	4	2	19	22	43	0	2	2	4
12	Bid	Ashti	6	11	5	31	19	55	1	3	2	6
13	Bid	Ambejogai	5	5	4	9	22	35	0	1	2	3
14	Bid	Majalgaon	4	2	0	10	15	25	0	1	2	3
15	Bid	Beed	9	5	15	39	0	54	2	4	0	6
16	Bid	Shirur (kasar)	3	4	0	20	6	26	0	2	1	3
17	Buldana	Motala	4	3	7	15	0	22	1	2	0	3
18	Buldana	Lonar	2	2	0	15	0	15	0	2	0	2
19	Buldana	Nandura	7	15	19	50	0	69	2	5	0	7
20	Buldana	Buldana	3	1	0	14	0	14	0	1	0	1
21	Buldana	Malkapur	5	10	10	14	23	47	1	1	2	4
22	Buldana	Jalgaon Jamod	6	14	5	52	2	59	1	5	0	6

Sr. number	District name	Taluka name	Number of circles	Number of clusters	Number of villages phase I	Number of villages phase II	Number of villages phase III	Total villages	10% villages Phase I	10% villages Phase II	10% villages phase III	Total sample villages
23	Buldana	Deolgaon Raja	3	2	4	2	0	6	0	0	0	0
24	Buldana	Sangrampur	6	15	5	48	7	60	1	5	1	7
25	Buldana	Shegaon	5	12	28	28	2	58	3	3	0	6
26	Buldana	Mehkar	4	5	0	10	7	17	0	1	1	2
27	Buldana	Sindkhed Raja	6	3	9	3	8	20	1	0	1	2
28	Buldana	Khamgaon	11	3	18	12	0	30	2	1	0	3
29	Hingoli	Aundha Nagnath	3	7	6	26	15	47	1	3	2	6
30	Hingoli	Sengoan	6	7	11	18	21	50	1	2	2	5
31	Hingoli	Hingoli	5	6	21	26	4	51	2	3	0	5
32	Hingoli	Basmath	6	6	0	36	10	46	0	4	1	5
33	Hingoli	Kalamnuri	5	7	1	23	22	46	0	2	2	4
34	Jalgaon	Raver	4	6	9	12	1	22	1	1	0	2
35	Jalgaon	Erandol	3	5	0	20	0	20	0	2	0	2
36	Jalgaon	Jamner	8	9	6	24	23	53	1	2	2	5
37	Jalgaon	Bhusawal	3	2	4	10	0	14	0	1	0	1
38	Jalgaon	Jalgaon	5	4	3	8	15	26	0	1	2	3
39	Jalgaon	Chopda	6	5	18	5	8	31	2	1	1	4
40	Jalgaon	Amalner	5	3	10	3	21	34	1	0	2	3
41	Jalgaon	Yawal	5	4	5	22	0	27	1	2	0	3
42	Jalgaon	Muktainagar	5	11	9	47	6	62	1	5	1	7
43	Jalgaon	Bodvad	2	3	8	6	0	14	1	1	0	2
44	Jalgaon	Bhadgaon	3	5	0	8	9	17	0	1	1	2
45	Jalgaon	Parola	5	4	25	12	0	37	3	1	0	4

Sr. number	District name	Taluka name	Number of circles	Number of clusters	Number of villages phase I	Number of villages phase II	Number of villages phase III	Total villages	10% villages Phase I	10% villages Phase II	10% villages phase III	Total sample villages
46	Jalgaon	Dharangaon	4	2	0	22	0	22	0	2	0	2
47	Jalgaon	Chalisgaon	7	7	14	21	15	50	1	2	2	5
48	Jalgaon	Pachora	6	4	13	9	9	31	1	1	1	3
49	Jalna	Bhokardan	8	10	0	25	25	50	0	3	3	6
50	Jalna	Mantha	4	8	27	17	2	46	3	2	0	5
51	Jalna	Jafrabad	5	7	0	11	22	33	0	1	2	3
52	Jalna	Jalna	7	12	11	33	15	59	1	3	2	6
53	Jalna	Ghansavangi	5	10	12	16	22	50	1	2	2	5
54	Jalna	Badnapur	4	7	2	25	2	29	0	3	0	3
55	Jalna	Partur	5	12	8	20	14	42	1	2	1	4
56	Jalna	Ambad	4	8	7	41	6	54	1	4	1	6
57	Latur	Ausa	6	7	18	16	11	45	2	2	1	5
58	Latur	Latur	7	6	0	21	15	36	0	2	2	4
59	Latur	Chakur	4	4	0	19	6	25	0	2	1	3
60	Latur	Jalkot	2	2	14	1	0	15	1	0	0	1
61	Latur	Renapur	2	2	18	1	0	19	2	0	0	2
62	Latur	Shirur	3	6	1	17	2	20	0	2	0	2
63	Latur	Deoni	3	4	8	6	1	15	1	1	0	2
64	Latur	Udgir	6	5	0	24	8	32	0	2	1	3
65	Latur	Ahmadpur	4	6	12	17	4	33	1	2	0	3
66	Latur	Nilanga	8	10	13	22	7	42	1	2	1	4
67	Nanded	Mahoor	1	2	0	3	11	14	0	0	1	1
68	Nanded	Mudkhed	2	2	5	6	0	11	1	1	0	2
69	Nanded	Dharmabad	3	2	0	12	0	12	0	1	0	1
70	Nanded	Nanded	3	2	0	21	1	22	0	2	0	2

Sr. number	District name	Taluka name	Number of circles	Number of clusters	Number of villages phase I	Number of villages phase II	Number of villages phase III	Total villages	10% villages Phase I	10% villages Phase II	10% villages phase III	Total sample villages
71	Nanded	Mukhed	5	4	0	27	9	36	0	3	1	4
72	Nanded	Hadgaon	6	5	0	16	24	40	0	2	2	4
73	Nanded	Kandhar	3	4	14	16	0	30	1	2	0	3
74	Nanded	Deglur	3	4	14	7	7	28	1	1	1	3
75	Nanded	Kinwat	7	7	9	37	19	65	1	4	2	7
76	Nanded	Biloli	3	2	0	5	12	17	0	1	1	2
77	Nanded	Himayatnagar	2	1	0	15	0	15	0	2	0	2
78	Nanded	Bhokar	3	2	11	6	0	17	1	1	0	2
79	Nanded	Ardhapur	2	1	8	0	0	8	1	0	0	1
80	Nanded	Loha	4	2	0	14	14	28	0	1	1	2
81	Nanded	Umri	1	2	1	15	0	16	0	2	0	2
82	Parbhani	Sonpeth	2	2	9	5	0	14	1	1	0	2
83	Parbhani	Purna	5	5	11	13	0	24	1	1	0	2
84	Parbhani	Jintur	5	10	13	33	8	54	1	3	1	5
85	Parbhani	Palam	3	2	11	13	0	24	1	1	0	2
86	Parbhani	Gangakhed	4	5	12	22	0	34	1	2	0	3
87	Parbhani	Selu	5	6	7	23	0	30	1	2	0	3
88	Parbhani	Parbhani	7	11	5	18	25	48	1	2	3	6
89	Parbhani	Pathri	3	5	10	11	4	25	1	1	0	2
90	Wardha	Seloo	3	2	0	16	0	16	0	2	0	2
91	Wardha	Wardha	4	2	0	12	5	17	0	1	1	2
92	Wardha	Samudrapur	2	3	4	7	0	11	0	1	0	1
93	Wardha	Deoli	4	2	19	6	0	25	2	1	0	3
94	Wardha	Ashti	1	1	0	14	0	14	0	1	0	1
95	Wardha	Hinganghat	3	2	0	9	6	15	0	1	1	2

Sr. number	District name	Taluka name	Number of circles	Number of clusters	Number of villages phase I	Number of villages phase II	Number of villages phase III	Total villages	10% villages Phase I	10% villages Phase II	10% villages phase III	Total sample villages
96	Wardha	Karanja	3	2	0	7	4	11	0	1	0	1
97	Wardha	Arvi	1	1	16	0	0	16	2	0	0	2
98	Washim	Risod	2	6	4	7	7	18	0	1	1	2
99	Washim	Karanja	7	6	12	15	6	33	1	2	1	4
100	Washim	Washim	4	2	6	14	0	20	1	1	0	2
101	Washim	Manora	6	6	0	14	25	39	0	1	3	4
102	Washim	Mangrulpir	4	3	2	20	0	22	0	2	0	2
103	Washim	Malegaon	4	4	5	11	1	17	1	1	0	2
104	Yevatmal	Wani	4	2	0	9	10	19	0	1	1	2
105	Yevatmal	Kelapur	2	2	2	8	0	10	0	1	0	1
106	Yevatmal	Arni	5	2	0	14	1	15	0	1	0	1
107	Yevatmal	Mahagaon	5	2	12	1	0	13	1	0	0	1
108	Yevatmal	Ner	3	1	0	24	0	24	0	2	0	2
109	Yevatmal	Babulgaon	4	4	0	10	4	14	0	1	0	1
110	Yevatmal	Maregaon	2	1	0	13	0	13	0	1	0	1
111	Yevatmal	Ralegaon	4	2	0	30	0	30	0	3	0	3
112	Yevatmal	Pusad	2	1	0	16	0	16	0	2	0	2
113	Yevatmal	Kalamb	7	2	28	4	0	32	3	0	0	3
114	Yevatmal	Zari Jamni	4	1	0	18	0	18	0	2	0	2
115	Yevatmal	Ghatanji	4	2	0	9	7	16	0	1	1	2
116	Yevatmal	Yavtmal	7	5	16	16	6	38	2	2	1	5
117	Nanded	Naigaon	3	3	8	15	2	25	1	2	0	3
118	Osmanabad	Kalamb	5	8	1	8	24	33	0	1	2	3
119	Osmanabad	Bhum	4	8	6	22	3	31	1	2	0	3
120	Osmanabad	Lohara	4	7	2	20	1	23	0	2	0	2

Sr. number	District name	Taluka name	Number of circles	Number of clusters	Number of villages phase I	Number of villages phase II	Number of villages phase III	Total villages	10% villages Phase I	10% villages Phase II	10% villages phase III	Total sample villages
121	Osmanabad	Paranda	5	7	2	18	11	31	0	2	1	3
122	Osmanabad	Osmanabad	9	14	12	23	13	48	1	2	1	4
123	Osmanabad	Washi	3	8	5	11	9	25	1	1	1	3
124	Buldana	Chikhli	7	5	0	9	12	21	0	1	1	2
125	Osmanabad	Tuljapur	7	12	9	29	18	56	1	3	2	6
126	Osmanabad	Umarga	5	9	11	6	23	40	1	1	2	4
127	Parbhani	Manwat	3	6	6	7	9	22	1	1	1	3
128	Akola	Akola	9	21	58	59	10	127	6	6	1	13
129	Akola	Balapur	7	13	3	46	8	57	0	5	1	6
130	Akola	Barshitakli	5	3	20	5	0	25	2	1	0	3
131	Akola	Akot	7	10	13	67	12	92	1	7	1	9
132	Akola	Murtizapur	9	20	5	98	9	112	1	10	1	12
133	Akola	Telhara	6	11	9	37	14	60	1	4	1	6
134	Amravati	Chandur Bazar	7	10	36	17	0	53	4	2	0	6
135	Amravati	Daryapur	9	19	8	139	0	147	1	14	0	15
136	Amravati	Chikhaldara	3	4	8	4	0	12	1	0	0	1
137	Amravati	Morshi	4	1	24	0	0	24	2	0	0	2
138	Amravati	Dharni	5	4	13	5	0	18	1	1	0	2
139	Amravati	Bhatkuli	7	11	31	85	0	116	3	9	0	12
140	Amravati	Achalapur	1	1	0	1	0	1	0	0	0	0
141	Amravati	Anjangaon Surji	7	10	16	39	1	56	2	4	0	6
142	Amravati	Achalpur	5	6	1	10	0	11	0	1	0	1
143	Amravati	Chandur Railway	2	1	11	0	0	11	1	0	0	1

Sr. number	District name	Taluka name	Number of circles	Number of clusters	Number of villages phase I	Number of villages phase II	Number of villages phase III	Total villages	10% villages Phase I	10% villages Phase II	10% villages phase III	Total sample villages
144	Amravati	Warud	4	1	12	0	0	12	1	0	0	1
145	Amravati	Dhamangaon Railway	3	1	13	0	0	13	1	0	0	1
146	Amravati	Teosa	3	1	8	0	0	8	1	0	0	1
147	Amravati	Amravati	9	13	21	16	0	37	2	2	0	4
148	Amravati	Nandgaon Khandeshwar	3	2	3	6	0	9	0	1	0	1
149	Aurangabad	Khuldabad	3	5	10	10	1	21	1	1	0	2
150	Yevatmal	Darwha	3	1	16	0	0	16	2	0	0	2
151	Yevatmal	Umarkhed	3	2	1	21	0	22	0	2	0	2
152	Yevatmal	Digras	4	2	0	2	11	13	0	0	1	1
153	Aurangabad	Aurangabad	7	7	9	11	34	54	1	1	3	5
154	Aurangabad	Kannad	8	10	8	51	2	61	1	5	0	6
155	Aurangabad	Soegoan	4	6	3	22	0	25	0	2	0	2
156	Aurangabad	Phulambri	5	6	3	25	1	29	0	3	0	3
	Total		726	854	1216	2862	1051	5129	124	296	108	528

Annexure II: Pre-survey Random Survey Number Table with partially filled attributes

Serial Number	Survey Number	Farmers name	Crop 1 e.g Cotton	Crop 2 e.g Soya	Crop 3 e.g Tur	PoCRA Beneficiary		Stream Proximity		Water Source Availability		Land Holding Criteria	
						Yes	No	Yes	No	Yes	No	Yes	No
			C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
1.	362					✓			✓			✓	
2.	14					✓		✓					✓
3.	163						✓		✓			✓	
4.	184							✓				✓	
5.	165					✓			✓				✓
6.	287						✓		✓			✓	
7.	476					✓		✓				✓	
8.	373					✓		✓				✓	
9.	358						✓	✓					✓
10.	91					✓			✓			✓	
11.	375						✓	✓					✓
12.	475					✓			✓			✓	
13.	197					✓		✓				✓	
14.	155						✓		✓				✓
15.	119						✓		✓				✓
16.	401						✓	✓					✓
17.	266					✓		✓				✓	
18.	254						✓		✓			✓	
19.	158					✓		✓					✓
20.	482					✓			✓			✓	
21.	455					✓		✓					✓
22.	78						✓	✓				✓	

Serial Number	Survey Number	Farmers name	Crop 1 e.g Cotton	Crop 2 e.g Soya	Crop 3 e.g Tur	PoCRA Beneficiary		Stream Proximity		Water Source Availability		Land Holding Criteria	
						Yes	No	Yes	No	Yes	No	Yes	No
			C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
23.	388					✓			✓			✓	
24.	396						✓	✓					✓
25.	268						✓	✓				✓	
26.	264					✓			✓				✓
27.	443					✓		✓					✓
28.	120					✓			✓			✓	
29.	11						✓		✓				✓
30.	265					✓			✓			✓	
31.	457					✓		✓					✓
32.	119					✓		✓					✓
33.	126					✓			✓			✓	
34.	32					✓		✓				✓	
35.	120					✓		✓				✓	
36.	345					✓		✓					✓
37.	386					✓		✓				✓	
38.	293					✓			✓				✓
39.	282					✓			✓			✓	
40.	192					✓		✓					✓

Annexure III: Random Survey Number Table during Survey

Serial Number	Survey Number	Farmers name	Crop 1 e.g Cotton	Crop 2 e.g Soya	Crop 3 e.g Tur	PoCRA Beneficiary		Stream Proximity		Water Source Availability		Land Holding Criteria		Remark
						Yes	No	Yes	No	Yes	No	Yes	No	
			C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	
9.	362		✓	✓		✓			✓		✓	✓		
10.	14		✓	✓	✓	✓		✓			✓		✓	
11.	163			✓	✓		✓		✓	✓		✓		
12.	184		✓	✓	✓		✓	✓		✓		✓		
13.	165		✓			✓			✓		✓		✓	
14.	287		✓		✓		✓		✓		✓	✓		
15.	476			✓	✓		✓	✓				✓		
16.	373			✓	✓		✓	✓			✓	✓		
	Frame count		**5**	**6**	**6**	**3**	**5**	**4**	**4**	**2**	**6**	**6**	**2**	
17.	358		✓		✓		✓	✓			✓		✓	
	91	**Farmer not available**				✓			✓			✓		
18.	375			✓	✓		✓	✓			✓		✓	
	~~475~~	~~**Repeated in same family**~~		~~✓~~		~~✓~~			~~✓~~		~~✓~~	~~✓~~		
19.	197		✓				✓	✓		✓		✓		
20.	155		✓		✓		✓		✓		✓		✓	
21.	119			✓	✓		✓		✓		✓		✓	
	Frame count		**8**	**8**	**10**	**3**	**10**	**6**	**6**	**3**	**10**	**8**	**6**	
22.	401				✓		✓	✓		✓			✓	
	~~266~~	~~**No primary crop**~~					~~✓~~	~~✓~~		~~✓~~		~~✓~~		
23.	254			✓			✓		✓		✓	✓		

Annexure IV: Random Survey Number list for Longitudinal Villages (XXX indicated already surveyed and selected farmers with given frame count)

Serial Number	Survey Number	Farmers name	Crop 1 e.g Cotton	Crop 2 e.g Soya	Crop 3 e.g Tur	PoCRA Beneficiary		Stream Proximity		Water Source Availability		Land Holding Criteria		Remark
						Yes	No	Yes	No	Yes	No	Yes	No	
			C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	
24.	362	**XXX**	✓	✓		✓			✓		✓	✓		
25.	14	**XXX**	✓	✓	✓	✓		✓			✓		✓	
26.	163	**XXX**		✓	✓		✓		✓	✓		✓		
27.	184	**XXX**	✓	✓	✓		✓	✓		✓		✓		
28.	165	**XXX**	✓			✓			✓		✓		✓	
29.	287	**XXX**	✓		✓		✓		✓		✓	✓		
30.	476	**XXX**		✓	✓		✓	✓				✓		
31.	373	**XXX**		✓	✓		✓	✓			✓	✓		
	Frame count		**5**	**6**	**6**	**3**	**5**	**4**	**4**	**2**	**6**	**6**	**2**	
32.	**285**						✓		✓					✓
33.	**190**						✓			✓			✓	
34.	**282**						✓		✓				✓	
35.	**192**						✓		✓				✓	
36.	**140**						✓		✓					✓
37.	**22**						✓		✓				✓	
38.	**72**						✓			✓				✓
39.	**278**						✓			✓			✓	
40.	**340**						✓		✓					✓

Appendix V: Farmer survey questionnaire

Farmer Survey questionnaire Date of survey_____ Interview#_____ lat/long_____/_____

Name of interviewer_____ Village Census code: _____ Village name: _____ District _____ Taluka _____

1. **General information**

1	Name of person			
2	Contact number			
3	Number of family members	Age 0-15_____ Age15-60_____ Age >60_____		
4	Number of earning members	Farm	Other	
6	Main occupation	☐ Agriculture & Allied ☐ Artisans ☐ Business	☐ Service (Salaried) ☐ Ag. Labor	☐ Non-ag. Labor ☐ Any Others (Specify)
7	Secondary occupation	☐ Agriculture & Allied ☐ Artisans ☐ Business	☐ Service (Salaried) ☐ Ag. Labor	☐ Non-ag. Labor ☐ Any Others (Specify)
9	Gat No.s and their Area in acre			
10	Total Area in acre			

2. **Livestock: Bulls/ cattle/ goats**

No. of bulls
No. of cows
No. of goats
Approximate annual income from livestock:
Annual Cost from livestock:

Migration information:

Do you migrate?		Do you migrate along with your family?	
How many months?		Daily wages recieved	
Where do you migrate?			

3. **Resources: water**

Source of Fodder _____ Availability in months

Source of Drinking Water: _____ availability in months_____

4. **<u>Soil properties</u>**

Soil type_____ Soil colour _____ **Soil layer thickness (m)_____;** murum layer starts (m) _____

Hard rock layer starts (m)_____ Does the soil hold on to moisture or lets go _____

Can you take an unirrigated Rabi crop just on soil moisture : Never/ in good rainfall year / every year.

5. **Watering Assets and gat no. : Well /borewell/ Farm pond (inlet-outlet/lined/unlined)- (GW filled/runoff filled) – Tick**

No.	Source type: well/bore	Gat no.	Depth	Max level	Max level month	Dried in month	Pump capacity (HP)	Pumping Distance (ft/m)

6. Cropping Pattern

Crop year	name and variety	Type (k/l k/r /a)	Area under crop in acre (**ratio-crop mix)**	Sowing month – harvesting month	Total yield in quintal/ acre (no. of pickings if applicable)	Watering type? (rainfed/Drip /flood/sprinkler**) (lph for drip/sprinkler and dripper or sprinkler spacing in m x m)**	Watering source (well/bore/fp /stream/tanker) and gat and pump HP	Number of watering days per month and number of months watered	**Watering time in hrs/day**	Avg input cost (including labour, seeds, chemicals, transportation etc)	Selling price (Rs./quintal)	APMC market sold	Remarks on pest attack or loss

7. Crop Loan

Area for which crop loan was taken?		Unpaid loan amount (thakbaaki)	
Bank Name		Why could you not repay the loan? Why?	
Crop for which it was taken		Did you ever receive loan waiver? Year?	
Amount of the crop loan taken this year			

PoCRA Individual assets demanded and status (approved/not approved/in process/ implemented

Form	Gat No.	Form	Gat No.	Form	Gat No.	Form	Gat No.
Falbaug		Well		Pipes		Poultry	
Sericulture		Well Rehabilitation		Compartment Bunding		Apiary	
Tree plantation		Farm Pond		Pumpset		Fishery	
Shed-net		Lining of farm pond		Drip /Sprinkler		Vermicompost	
Polyhouse							

Changes after receiving interventions

Falbaug/ Sericulture/ Polyhouse

Area under Falbaug/ Tutti		Additional water (source)		Source of finance	
Sufficient Water		Cost of additional water			

Well/ Well rehabilitation

New cropping pattern		How do you expect yields to increase?	