सारांश/ Executive Summary

किसान मित्रा: बुंदेलखंड क्षेत्र में किसानों की आय दोगुनी करना

KISAN-MITrA: Knowledge-based Integrated Sustainable Agriculture Network- Mission India for Transforming Agriculture: Doubling Farmers' Income in Bundelkhand region

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Executive summary

Bundelkhand region of Uttar Pradesh is one of the water-scarce regions, a hot spot of poverty, malnutrition, land degradation, and out-migration. To address these issues, Government of Uttar Pradesh has assigned an ambitious initiative to be implemented by ICRISAT-led consortium across all seven districts of Bundelkhand region. In May 2017, with the help of district administration (DM, CDO, JDA, DDA), the pilot sites covering about 5000 ha area in about 2-3 villages (hydrological boundary) were identified for developing the sites of learning in each district. Between May 2017 and June 2018, ICRISAT worked towards rapport building with the community. ICRISAT initiated formation of the consortium of national institutes such as ICAR-Central Agroforestry Research Institute (CAFRI), Jhansi; ICAR-Indian Grassland and Fodder Research Institute (IGFRI), Jhansi; Banda University of Agriculture and Technology (BUAT), Banda; local NGOs based in Bundelkhand region.

Baseline survey covering 1403 households from 20 villages was carried out across seven districts in 2017 to capture demographic characteristics, land use, cropping system, water resources availability, livestock status, income sources and food consumption pattern along with soil and rainfall characterization. The average household size in the region is about 7 members with average landholding of 1.64 ha. About 50% and 30% of total agricultural area was kept fallow during monsoon and post-monsoon period, respectively largely due to poor water availability in wells, which is the major source of irrigation. Yield for most of the crops ranged from 0.5 to 1.5 t ha^{-1} whereas wheat and barley yield was 2.5 t ha^{-1} in the region. Livestock is the integral part of the farming system as 60% of the households own cattle, buffalo and goats. Total annual income of marginal, small, medium and large farmers was INR 0.93 lakh, INR 1.25 lakh, INR 1.75 lakh and INR 3.65 lakh per household per year, respectively. The share of agriculture and livestock income in total income was 50% (marginal), 60% (small), 70% (medium) and 78% (large farmers) and rest of the income was drawn from wage labour, remittances and other sources.

A large-scale rainwater harvesting plan was developed and implemented in a phased manner in pilot sites from May 2019 onwards. A total of 65 rainwater harvesting structures, including construction of haveli system, renovation of community pond, construction of check dams, deepening and widening of drainage networks, and construction of diversion drains, farm ponds, and other masonry structures. This effort created about 1.5 million cubic meter storage capacity. Besides, large-scale field bunding was developed in about 6000 acres to enhance soil moisture availability and control land degradation. These *in-situ* and *ex-situ* RWH interventions created about 6.0 MCM storage capacity and benefited more than 10,000 farming families across the project villages directly in terms of enhanced groundwater availability, moisture availability, crop intensification, and much more with indirect benefits such as reduction in migration, drudgery and cost of cultivation.

In addition to *in-situ* conservation practices, the project also focused on intensive agroforestry interventions in all the pilot sites. Nearly 2.5 lakh sapling of teak, Malabar Neem (*Melia dubia)*, lemon, guava, and other fruit saplings were planted during 2019 and 2020. Further 0.5 Lakhs high-quality tree saplings will be planted in July/Aug 2021. Good quality grafted saplings of different fruit trees were made available to farmers in all the pilot sites. Nearly 5000 local *ber* trees were also rejuvenated through budding.

From June 2018 onwards, a large-scale campaign on soil fertility management was undertaken through wall writings and distribution of soil health cards, and field demonstration of improved agricultural practices. Soil test-based results indicated that most of the pilot sites are deficient in organic carbon and available micro and secondary nutrients such as zinc, boron, and sulphur. About 10,000 balanced nutrient management demonstrations were undertaken since *rabi* 2017 to help demonstrate the effect of balanced nutrient application on crop productivity. Also, improved crop cultivars of sesame, green gram, black gram, groundnut, wheat, chickpea, field pea, mustard, barley were evaluated on over 10,000 farmers' fields. Landform management practices such as laser-guided land levelers were demonstrated in about 450 fields. This activity has benefited in reducing labor and energy cost for irrigation applications and enhancing water use efficiency. Use of zero-tillage multi-crop planter was demonstrated to reduce the seed quantity, cost of cultivation, encourage line sowing and, more importantly, better utilize residue soil moisture available in the surface soil layer.

For enhancing livestock productivity, sorted semen technology was promoted. Out of 226 cow/buffalos that were inseminated with sorted semen, 208 delivered female calves (92% success). A pregnancy test kit (total 536) was also used by farmers to detect their animal's pregnancy status. Balanced nutrition feed trials were also undertaken in different villages to reduce the mortality rate among small ruminants (goat) and enhance the growth of goat kids. Fodder interventions were initiated from June 2019 onwards. Improved quality of fodder seeds was made available in all pilot sites that benefited more than 3000 farming families.

The consortium has undertaken several capacity building programs for different stakeholders such as farmers, masons, NGO staff on soil fertility management, mechanization, productivity enhancement, construction of water harvesting structures, agroforestry, fodder development, balanced feeding, etc. Moreover, several stakeholder workshops, review meetings, exposure visits were also organized. More than 25,000 farming families have been directly benefited from the integrated approach of the DFI Bundelkhand initiative to date.

It was realized that traditional rainwater harvesting system (*haveli* cultivation) in central India has huge impact in ensuring water availability for both agriculture and domestic sectors. The community used to harvest surface runoff in their field by making earthen embankments at the catchment of 10-100 ha which were submerging land between 2-10 ha area. The harvested water remained there during rainy season and drained out during mid October. Farmers were cultivating this land during rabi with residual soil moisture. Of late, *Haveli* cultivation has served the communities in Malwa and Bundelkhand regions for centuries became defunct due to lack of collective action. Most of the *havelis* are suffering with high seepage from the embankment and insufficient surplusing arrangement. It is also observed that embankment of more than 90% *havelis* are dilapidated. Under this initiative, 23 such *havelis* have been constructed till date by introducing masonry core wall along with check dam with appropriate outlet for safe disposal of excess runoff after harvesting.

Landscape restoration interventions have helped to harvest surface runoff of about 6.0 (Million cubic meter, MCM)/year which has facilitated to enhance groundwater availability by 50-150%; enhanced base flow by 30-50% and reduced soil loss by 70-80% compared to baseline situation. As a result, water table in the dug wells increased by 2-5 meter on an

average facilitated for supplemental irrigation. About 2700 acres of fallow land has been brought back to productive cultivation which enhanced land and water use efficiency. Landform management such as field bunding and laser land leveling have contributed for enhancing residue soil moisture availability (additional by 50-80 mm/season) and reduced the irrigation requirement. Integration of Landscape and field scale interventions have facilitated to enhance crop productivity by 20-80% in different cropping system. The landscape restoration and field scale interventions together have contributed to enhanced income from agriculture by 100-140% compared to baseline situation. Of this, the contribution from productivity enhancement interventions was about 20-40%.

All the pilot sites have been developed as benchmark sites for long term monitoring of a range of impact parameters (biophysical, hydrological, socio-economic) for realizing the potential of combining landscape and field scale interventions in dryland ecosystem. For ensuring sustainability of impacts created under this initiative, local institutions were created, nurtured and empowered with the help of department of agriculture. To facilitate the process, revolving fund to the tune of INR. 20 lakhs has been established for the management of inputs particularly improved variety of seeds. In addition, convergence of departmental schemes such as khet-talab, solar pump, SCSP, mini kit of seeds of improved varieties has benefited more than 1000 farming families.

There is urgent need to replicate this model across the degraded landscapes of Bundelkhand region as these areas hold huge potential to harness the benefits of landscape restoration interventions.

Interventions undertaken

- Total 65 rainwater harvesting structures with storage capacity of 1.5 million cubic meter were constructed. Out of these, 25 were the haveli systems (Kindly refer ***Annexure -1***)
- Total 6000 acres of field bunding along with surplusing arrangement were undertaken (refer *excel sheet**, Annexure 2***)
- Total 1210 soil sampling were undertaken, analysed and soil health cards were provided to educate farming community about application of balanced fertilizer. More than 10,000 farmer participatory demonstrations on application of balanced fertilizer were undertaken in last 8 crop seasons (refer ***Annexure 2***);
- About 14000 farmer participatory demonstrations on improved crop cultivars including fodder were undertaken (refer ***Annexure 2***);
- About 450 demonstrations on laser land levelling, use of zero-tillage and farm mechanization were undertaken for enhancing water use efficiency;
- About 300,000 tree saplings of various timber and fruit species were planted benefited about 1500 farming families (refer ***Annexure 2***)
- About 300 trainings on crop production technology, agroforestry, rainwater harvesting, fodder development, livestock improvement and 200 awareness building programs (field days and exposure visits) were undertaken during the project period

Outputs and outcomes

- Exemplar sites in each of the districts were developed;
- About 1.5 MCM of storage capacity created to harvest minimum 6 MCM surface runoff which facilitated groundwater recharge;
- Enhanced groundwater availability (minimum by 3-5 meter additional head)
- Enhanced land and water use efficiency by converting about 2700 acres of fallow land into productive cultivation;
- Enhanced base flow availability for 2-4 months;
- A network of 20 km rural roads developed to improve access;
- Hydrological monitoring stations are established across all project sites for quality data collection for understanding water budgeting at field and village scale;
- Reduced land degradation more than 60% compared to baseline condition;
- Enhanced capacity and awareness of farming community on best management practices;

Impacts

- Reduced the risk of crop failure for about 10,000 farming families by enhancing groundwater and soil moisture availability;
- Improved crop cultivars along with best management practices enhanced crop productivity by 20-40% compared to control condition;
- Reduced the cost of cultivation by Rs 8000-10000/ha with increased groundwater availability and reduction of labor requirements;
- Enhanced well recovery period from 30-50 hours (before) to 10-15 hours (after) with enhanced groundwater availability;
- Improved groundwater availability for agriculture and domestic use reduced drudgery particularly of women and children
- Increased crop intensification from 120% (before) to 160% (after)
- Enhanced income of farmers by 40-140% compared to baseline status
- Reduced out-migration with increased groundwater availability and crop intensification
- Fodder availability has improved from deficit (50% deficit level) to surplus

Annexture-1

List of rainwater harvesting structures constructed between 2018 and 2021

SN	Location	Structure	Latitude	Longitude	Year of construction	Catchment area (ha)	Storage capacity created (m3)	Remarks
1	Chitrakoot	*Haveli* tank	25.2053	80.729	2019	220	50000	Ajay Gautam
2	Chitrakoot	*Haveli* tank	25.19581	80.7014	2021	23	30000	Avinesh Tripathi
3	Chitrakoot	*Haveli* tank	25.19787	80.70116	2021	30	25000	
4	Chitrakoot	*Haveli* tank	25.19874	80.69973	2021	17	22500	
5	Chitrakoot	*Haveli* tank	25.18374	80.69782	2021	112	45000	Prayag Yadav
6	Chitrakoot	*Field drainage str*			2021			
7	Chitrakoot	*Field drainage str*			2021			
8	Lalitpur	*Haveli* tank	25.1202	78.5396	2019	36	22500	Natho farmer
9	Lalitpur	Farm pond	25.119	78.5388	2019	17	2000	Yajudi farmer
10	Lalitpur	*Haveli* tank	25.1184	78.5402	2019	10	30000	Bahadur farmer
11	Lalitpur	*Channel-700m*	25.11824	78.540274	2019		3150	
12	Lalitpur	*Channel-1500m*	25.114178	78.534414	2020		6750	
13	Lalitpur	*Farm ponds (4 nos)*	25.119746	78.537816	2019		1350	
14	Lalitpur	*Haveli* tank	25.12028	78.53472	2021		9000	Nathu ram
15	Lalitpur	*Haveli* tank	25.11806	78.5325	2021		15000	Khilawan
16	Lalitpur	*Haveli* tank	25.11806	78.54056	2021		5000	Sriram
17	Lalitpur	*Pond in Haveli* tank	25.11806	78.54056	2021		4050	Sriram
18	Lalitpur	*Field drainage str*	25.11934	78.538283	2021			
19	Lalitpur	*Field drainage str*	25.118914	78.539885	2021			
20	Jalaun	*Haveli* tank	26.0765	79.5313	2019	256	80000	
21	Jalaun	*Haveli* tank	26.074	79.5357	2019	300	100000	
22	Jalaun	*Field drainage str*			2021			
23	Banda	Village tank	25.6776	80.5845	2019	15	25200	Baba talab
24	Banda	Haveli tank	25.6858	80.5906	2020	37	45000	
25	Banda	*Haveli* tank	25.68833	80.57626	2021	32	30000	
26	Banda	*Field drainage str*			2021			
27	Banda	*Field drainage str*			2021			
28	Banda	*Field drainage str*			2021			
29	Babina, Jhansi	Check dam	25.4194	78.3721	2019	44	4000	Culvert
30	Babina, Jhansi	Check dam	25.4216	78.3752	2019	78	7000	Bhaisasur Baba
31	Babina, Jhansi	Check dam	25.421833	78.38191	2019	141	10000	
32	Babina, Jhansi	Haveli tank	25.42796	78.400025	2020	37	15000	
33	Babina, Jhansi	*Field drainage str*	25.411401	78.382752	2021			
34	Babina, Jhansi	*Field drainage str*	25.411215	78.38335	2021			
35	Bamour, Jhansi	Haveli tank	25.69524	79.18186	2020	200	120000	Patel

36	Bamour, Jhansi	Haveli tank	25.69391	79.18862	2020	180	24000	Tiwari
37	Bamour, Jhansi	Haveli tank	25.69481	79.20589	2020	100	10000	Garwai
38	Bamour, Jhansi	Haveli tank	25.67103	79.19136	2020	220	30000	Rohit
39	Bamour, Jhansi	Haveli tank	25.69536	79.18078	2020	200	20000	Ayodhya
40	Bamour, Jhansi	Community pond	25.69386	79.17934	2020	200	14400	Nandai
41	Bamour, Jhansi	Community pond	25.6949	79.18324	2020	200	30,000	Bomari
42	Bamour, Jhansi	Farm ponds	25.69773	79.18829	2020		1200	Santosh Arwal
43	Bamour, Jhansi	Farm ponds	25.69391	79.18862	2020		3600	Inside of Tiwari hevali
44	Bamour, Jhansi	Farm ponds	25.67631	79.20279	2020		10000	Inside Patel Havei
45	Bamour, Jhansi	Farm ponds	25.67103	79.19136	2020		3600	Rohit Pond
46	Bamour, Jhansi	Farm ponds	25.67536	79.18078	2020		3600	Ayodhya pond
47	Bamour, Jhansi	Farm ponds	25.67189	79.19096	2020		9090	Akilesh tewari
48	Bamour, Jhansi	Deepening of drainage network-Sutta	25.67565	79.18456	2020		47250	Sutta village
49	Bamour, Jhansi	Deepening of drainage network-Sutta			2021		28000	
50	Bamour, Jhansi	Deepening of drainage network-Singar	25.68719	79.18682	2020		15000	Singar village
51	Bamour, Jhansi	Deeping of canal network	25.69374	79.17859	2020		4500	Sutta and Singar
52	Bamour, Jhansi	*Field drainage str*			2021			
53	Bamour, Jhansi	*Field drainage str*			2021			
54	Bamour, Jhansi	*RWH through sector road*			2020		357000	Sutta and Singar
55	Hamirpur	*Haveli* tank	25.87021111	80.16043611	2019	40	22500	
56	Hamirpur	*Haveli* tank	25.86997778	80.15956944	2019	150	10000	
57	Hamirpur	*Field drainage str*			2021			
58	Hamirpur	*Field drainage str*			2021			
59	Mahoba	*Haveli* tank	25.2807	79.81273	2020		24000	Jai Singh S/o Tej Singh
60	Mahoba	*Farm pond*	25.27507	79.80444	2021		3150	Raju Yadav
61	Mahoba	*Deepening of Channel*			2021		5625	
62	Mahoba	*V notch with Gauging Station Surplus structure*	25.28096	79.81238	2021			Ramashre Ahirwar S/o Kilkoti
63	Mahoba	Chute Type Surplus structure	25.27914	79.80955	2021			Dharamdas S/oRajwa
64	Mahoba	Tractor type surplus structure	25.28283	79.80962	2021			Hargovind Rajpoot S/o Swami prasad
65	Mahoba	Surplus structure	25.2759	79.80523	2021			Saroj Yadav D/o murlidhar
	Total	**Total Capacity (MCM)**					**1384015**	

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