IIT Bombay - PoCRA
MoU III Closure Report
16th August 2021

The Government of Maharashtra (GoM) is implementing the World Bank aided project on climate resilient agriculture namely Nanaji Deshmukh Krushi Sanjeevani Prakalp (NDKSP). The project development objective is to enhance climate-resilience and profitability of smallholder farming systems in project districts of Maharashtra. The project aims to achieve the objective through promotion of climate resilient technologies and commodity value chain across approximately 4,000 drought-prone villages in 15 districts, namely, Jalgaon, Aurangabad, Jalna, Beed, Parbhani, Hingoli, Osmanabad, Latur, Nanded, Buldhana, Washim, Akola, Amravati, Yavatmal, and Wardha and approximately 1000 salinity affected villages in the basin of Purna river spread across Akola, Amravati, Buldhana and Jalgaon districts.

Since August 2018, IIT Bombay has been contributing as a technical partner to PoCRA through three MoUs. The fourth MoU between the Government of Maharashtra and IIT Bombay is on the anvil.

The collaborations have led to design and development of water balance models and tools and their incorporation into village plans. As more datasets were made available, these models and tools were further refined. An IT stack and database support was developed to enable advisories and to run a dashboard. Support was provided to PMU in various activities. In MoU-III, special attention was given to extension of water balance concepts and resilience at the village and institution level. Access to energy for irrigation was studied and its impact on water security was outlined and proposals were made to improve energy access and reliability.

Objectives and Broad Deliverables

The objectives of the PoCRA, that of bringing about climate resilience at the farm, community and extension agency, must be implemented as a series of interventions based on sound scientific principles. The evolution of these principles has been the core objectives of several MoUs between IIT Bombay and Govt. of Maharashtra. The broad objectives of the MoUs have been:

- Address key problems at farmer- and village- level
- Strengthen knowledge and extension frameworks for better quantification of stress and better community comprehension
- Strengthen local planning processes - better formats and processes for local planners and village committees

Over the years, concrete problem areas have been identified as areas which need interventions. These are:

- Kharif dry spells and wet spells resulting in low yields, low incomes

- Access to protective irrigation. identification of vulnerable farmers and appropriate solutions,
- Spatial imbalance within village, wide variation in yields, low median yield
- Rabi unsustainable cropping pattern, rationing, low yields, low incomes
- Rabi GW uncertainty, competition, risks and investments, debts, zero sum game

While the above have been studied during MoUs I, II and III, the following problem areas were added in MoU III.

- Difficulties in access to energy - in terms of quality and hours of service
- Analysis of public and private investments made by farmers for energy and water

The overall table of achievements in MoUs I,II and III are summarized as follows:

MoU-I	16th August 2017 Water	• Point Model, GIS Plug-in for village level water budget, MLP
MoU-II	2nd November 2018 Water	• Improvements - soil, weather mapping, cadastral, ET0. • Analysis of the model • Crop Hierarchy and Rabi • DPR and village level validations • Initial work on the Dashboard
MoU-III	1st January, 2020 Water	• Hourly model, hourly weather, integration with MLP • Dashboard, IT Stack, Advisory framework • Pilot Extension to Community
	Energy	• Key problem - constraint and quality, infrastructure • Energy Demand estimation - simple indices, overloading • Extension - pumps, capacitors, transformer burn-outs

The core deliverables for MoU-III were organized in 7 deliverables going on until December 31, 2021, with the last phase being a PMU support component. However, it was felt that new work including post-harvest processing needed to be done in the period from July to December 2021. *Therefore, with mutual agreement, MoU III was terminated after Phase VI to enable a fresh MoU IV to begin*.

The deliveries of MoU-III are in the areas of Water and Energy and are discussed below.

Water

A core achievement has been to develop a GIS-based scientific planning framework based on water-balance in order to:

- Increase aggregate water availability at village/cluster level
- Ensure access to water at farm-level

- Stabilize yields Improve incomes and profitability

The framework has been developed through the design of a point level soil-water balance model, its implementation as a GIS-plugin usable in a spatio-temporal manner and its conversion to village-level water budgets. The model provides estimates of runoff, changes to soil moisture, groundwater recharge and crop water uptake and deficits.

All these outputs are published for every PoCRA village as a chart which is displayed in the village. These model outputs are crucial as far as planning and expenditure are concerned. The water budget is expected to be used by the local planners such as cluster assistants, krushi sahayaks (KS) to plan the NRM activities so as to reduce the deficits. At the same time efforts are undertaken so that the community understands and makes use of the water budget results in making crucial cropping decisions and investments.

Thus, the effectiveness of the water budget model depends on two key principles -

Soundness of the model – This has been achieved, to a large extent, and over the last two years, through continuous engagements and interactions with PMU, experts, external agencies and through preliminary validation of the model through on-field measurements and farmer experiences. Further improvements in the computation of groundwater recharge (resulting from the interactions with GSDA and World Bank experts) and incorporation of regional flows to compute inter-zone and inter-village water movements and cluster-level water balance is slated for MoU IV. These will further enhance the results of the model.

Utility of the model – At the same time, it is now required that extension activities move beyond the computation of the village water budget. In order to attain resilience, village cropping patterns must change. For this, the demand-side and supply-side, along with key concepts such as the stocks and flows, basic biophysical parameters, the notion of an area budget, etc. must be better understood by the community. This should be done by linking these water balance concepts to concrete problems faced by them which will further help in suggesting possible remediation measures. The key issues are profitability, risk management and sustainability. An important mechanism for extension will be to strengthen the platform of the Village Climate Risk Management Committee and its periodic meetings.

Deliverables

Refined Water balance framework and support to PMU

1. Mainstreaming of inputs from external technical agencies for formalization of model and planning methodology
2. Design and support for the development of Contingency Planning Framework based on inputs from CRIDA and other agencies.
3. IT tools: Extending Dashboard for various applications ranging from monitoring of project activities, biophysical parameters, water-related status indicators, contingency planning across a variety of user themes. Development of farm-level applet usable for various purposes such as computing water productivity, marking interventions etc.
4. Extension activities and research for better community comprehension.
5. Delivery of models, tools, reports, applications along with source code, training material and manual for scaling up.

Energy

Investigations and solutions development

Access to a connection, and quality and schedule of power, for irrigation, is a major problem for farmers. Since access to reliable irrigation is an important aspect in strengthening farmers against unreliable rainfall, the energy component was included in MoU III. As crops and irrigation practices change, energy problems and issues in PoCRA villages have become prominent. These relate to increase in energy demand due to water-saving technologies and transfers, unreliable supply due to insufficiency in infrastructure, delay in new connections, and sub-optimal distribution system design practices which do not explicitly consider irrigation requirements. The correlations between water and energy usage were incorporated into a framework based on cropping, irrigation methods, and water source parameters. Feeder level and DT level energy consumption data was used to validate the framework. A first level model to base Distribution Transformer loading to cropping was presented. These problems were studied and quantified in MoU-III and solutions were proposed.

Main Objectives

- Calculations of water productivity and cost of water/energy in crop production based on protective irrigation measurements and water balance calculations.
- A framework to identify and evaluate risks in access and quality of power to farmers as a constraint to farming and its mitigation.
- Design of an extension program to improve pump selection and water infrastructure thus improving system performance and making energy use more efficient.
- Report on village level irrigation energy infrastructure and its determinants and impacts on access.
- Delivery of framework, tools, reports and dashboard facility.

Outcomes

- Demonstration of stress in the network and its contours.
- The proposal of optimization of infrastructure through restructuring of LT networks, loading of Distribution Transformers based on irrigation requirements
- Extension work, building farmers awareness of use of capacitors, pump selection and load management
- Water-energy correlations development through measurements of water and energy usage of about 40 farmers, and the implementation of a framework for crop-wise energy-water usage estimations at the feeder level
- Observation and measurement of irrigation practices including water transfers to understand water-energy correlations and water usage
- The status and reasons for the constraints in getting new agricultural connections
- IT Stack representation of Distribution Transformers and related connections and cropping areas.

Recommendations and Future scope

Many models were built and improved in MoU III, such as the hourly water balance, Energy-water correlations, and power demand prediction based on cropping pattern, and water and energy rabi requirements. These may be utilized for extension activities by implementation agencies. Through such extension, the models may be further validated , refined, and extended to wider areas and a broader range of situations.

Specific extension programmes were suggested and pilots were carried out. These may be incorporated into training activities for the department. Their reach may be expanded.

The Government of Maharashtra recently passed a GR on village level agricultural committee which is to hold seasonal meetings. This platform should be utilized to record kharif stress, undertake rabi planning, and to record the status of NRM assets and activities within the village. This will formalize the interaction between the village and departments such as Dept. of Agriculture, MSEDCL, Minor Irrigation and WRD.

Suggested pilot interventions LT network restructuring, and of protective irrigation system, may be carried out.

Some of the above items have been incorporated in MoU IV.