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Final report

Small research and development activity

project	**Water management in rainfed areas for improving livelihoods security of smallholder farmers: Outscaling Australian-supported R4D in Odisha, Karnataka and Andhra Pradesh**
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1 Acknowledgments

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2 Executive summary

The Learning Water Resource Management (LWRM) project introduced four previously tested research-based tools or approaches into five large-scale agricultural development programs operating in three Indian states - Andhra Pradesh, Karnataka and Odisha. These five programs collectively aim to empower 1.4 million Indian farmers in rainfed areas to optimise their water use.

The LWRM project aimed to build capacity of staff in these outreach programs as a mechanism to influence uptake by individuals, programs and farmers. The overarching capacity that was built was around effective water management in rainfed agriculture and the four components each delivered different aspects: strategic irrigation, groundwater management, analysing and acting on climate risk and optimising water use efficiency.

The project was funded by the Australian Water Partnership (AWP), the Australian Centre for International Agriculture Research (ACIAR) and CSIRO. It was formally launched in November 2020 and completed in March 2023. A series of learning workshops were initially planned to be delivered in-country, but COVID-19 travel restrictions necessitated adaptation for online delivery and collaboration.

Four learning events were delivered by Australian research teams and facilitated by WASSAN. Over 90% of participants rated the quality of the training and excellent or very good; all participants reported that aspects of all training events were relevant to their role and most had demonstrated this value by applying it outside their original role.

At the end of each training, between 75 and 90% of participants reported the intent to apply at least one aspect of course content in their home program. Although COVID-19 risks restricted movement in all study areas, at the end of the project, 75% of participants had applied or tested aspects from each of the four learning components in their home programs. Some changes were necessary to adapt training design and delivery to local production systems, the project context and COVID-restricted field work

Feedback at the end of the fourth training event suggested that collectively, participants had shared new knowledge or skills with around 6000 others, inside and outside their home programs. Conservatively, this equates to an average of around 350 people per participant. Participants also reported proactively changing design and delivery of relevant home program and other activities, based on enhanced understanding of different aspects of water management, such as climate risk, irrigation efficiency and soil and plant health

Significant outreach opportunities have emerged from external interest in the project and its approach. The national development bank NABARD and the project team are exploring options to apply project elements in their new nationwide initiative around agricultural soil; JIVA aims to improve 550,000ha in both watershed and tribal development projects in rainfed areas in the next four years. Similarly, the Sehgal Foundation are keen to apply methods and approaches from the project in ten pilot villages across five states as part of their ‘smart technology initiative’ in agriculture.

When asked about the value of the project, managers noted the usefulness of project training (of participants and subsequently farmers) and tools to existing home programs. They also noted the intent and/or examples of integrating the project approach and learnings into new locations, new programs and future designs.

For the project partners, a number of success factors were identified, including: contextualising tools and training; employing adaptive project management; using established and networked partners; and planning and resourcing expansion.

Considerations for similar future investments include: a more explicit and proactive participant selection process to address gender and social inclusion; implementing a hybrid model for training that could incorporate specifically developed online training for theory with in-person practical application and support; and building discussions around scale and beyond-project capability into original (precedent) research projects.

3 List of abbreviations and acronyms

APDMP	Andhra Pradesh Drought Mitigation Project
APZBNF	Andhra Pradesh Zero Budget Natural Farming
AWP	Australian Water Partnership
CRIDA	Central Research Institute for Dryland Agriculture
CSIRO	Commonwealth Scientific and Industrial Research Organisation
IFAD	International Fund for Agricultural Development
LWRM	Learning Water Resource Management; shorthand project title
MARVI	Managing Aquifer Recharge through Village-level Intervention
NABARD	National Bank for Agriculture and Rural Development
NRAA	National Rainfed Areas Authority
OMM	Odisha Millets Mission
RRAN	Revitalization of Rainfed Agriculture Network
SARDI	South Australian Research and Development Institute
SPPIF	Special Programme for Promotion of Integrated Farming
SRA	Small Research Activity
VIA	Virtual Irrigation Academy
WASSAN	Watershed Support Services and Activities Network
WS	Watershed
WSU	Western Sydney University
WUE	Water Use Efficiency

4 Introduction

Water management in rainfed areas for improving livelihood security of smallholder farmers: Out-scaling Australian- supported R4D in Odisha, Karnataka and Andhra Pradesh (or the Learning Water Resource Management project in shorthand) introduced four previously tested research-based tools or approaches into five large-scale agricultural development programs operating in three Indian states - Andhra Pradesh, Karnataka and Odisha. These five programs collectively aim to empower 1.4 million Indian farmers in rainfed areas to optimise their water use.

The LWRM project aimed to build capacity of staff in these outreach programs as a mechanism to influence uptake by individuals, programs and farmers. The overarching capacity that was being built was around effective water management in rainfed agriculture and the four components each deliver different aspects: strategic irrigation, groundwater management, analysing and acting on climate risk and optimising water use efficiency through soil microbiology.

Context

Andhra Pradesh is one of the most climate-vulnerable regions in India. Rainfall is low and unreliable, with frequent droughts. Irrigation is limited; there are scarce surface water resources to meet agricultural and other needs, while groundwater resources have been over-exploited, with borewell drilling frequently failing to strike water and/or running dry.

Rainfed crops are predominantly oilseeds followed by pulses and cotton - all grown as cash crops. Soils over most of the area are shallow, with low water holding capacity. Rainfall and crop yields vary considerably from year to year, making farming a risky business, with typical marginal or smallholder farmers (80% of farmers are in this category) generating one third of their income from farming and the balance from public safety net program and seasonal migration to low paid jobs in cities.

Limited areas of irrigation are used for commercial horticulture which is an important sub-sector. However, horticultural farmers are vulnerable to wells running dry. Lack of soil moisture is further aggravated by poor soil fertility, crop pests and diseases, poor quality seed, lack of access to improved and drought tolerant crop varieties, and delays in weather-critical crop operations caused by lack of labour and machinery. Farmers also lack access to information and advice on drought-adapted technologies (APDMP Project design document, 2017).

Background to the SRA

This SRA originated from an Australian Water Partnership (AWP) Activity, designed to provide technical support from Australian experts to an International Fund for Agricultural Development (IFAD) and Andhra Pradesh Government-funded project on drought mitigation, IFAD-APDMP (2017-2022). The focus for IFAD-APDMP program was to improve water use efficiency, leading to improve productivity and livelihoods in drought prone regions of Andhra Pradesh State.

The original intent for the technical collaboration was to provide training and guidance in three broad and interconnected areas of interest to the IFAD-APDMP project and AWP – efficient irrigation, groundwater monitoring and climate resilience – to influence efficient water use and livelihood outcomes.

Technical support was to be in the form of working on a few case study locations within the program area to refine, contextualise and scale participatory ground water management, strategic irrigation and climate risk management approaches that had been developed in previous Australian-funded projects.

The Australian research teams, their Indian partner, the Watershed Activities and Support Services Network (WASSAN) and the National Rainfed Area Authority (NRAA) explored the opportunity of including four additional outscaling programs. The expanded proposal, was discussed and supported by AWP and ACIAR, through this SRA.

Scope of the SRA

The LWRM project is a collaboration between the Commonwealth Scientific and Industrial Research Organization (CSIRO); Western Sydney University (WSU); South Australian Research and Development Institute (SARDI); WASSAN; NRAA; Government of India's Ministry of Agriculture; and Revitalization of Rainfed Agriculture Network (RRAN).

The project was formally launched in November 2020 and concluded in March 2023.

An additional technical component was added, and the four water management tools and approaches are summarised in Box 1.

Box 1. Four learning components of the LWRM project

Climate Risk Analysis (Section 6)

This component was built from Climate Information Centres (CLICs) work in Andhra Pradesh as part of the ACIAR-funded Adapting to Climate Change in Asia project (ACCA). It focused on measuring and understanding local conditions and acting according to the unfolding season. It was delivered by the South Australian Research and Development Institute (SARDI) and included:

- Tools to understand and analyse climate (historic, current and forecasted)
- Analysing risk eg around sowing decisions, irrigation decisions (cluster and village level)
- Crop pattern analysis.

Strategic Irrigation (Section 7)

This component was about optimising water use and nutrient uptake in irrigated environments. It was delivered by CSIRO, based on the ACIAR-funded Virtual Irrigation Academy technology and learning approach developed in southern Africa. It included:

- Assessment of root-zone soil moisture using Chameleon sensors and soil nutrients using Wetting Front Detectors, electrical conductivity and nitrate meters
- Optimal/ strategic irrigation decisions
- Decisions on extending cropping seasons based on soil water balances.

Soil microbiology, organic matter and water use efficiency (Section 8)

This component was about understanding the relationship between soil microbiology and water use efficiency, representing a critical addition to predominant research on physical and chemical properties of soil. The component was delivered by CSIRO and is based on management-induced responses in soil biological function in rainfed (grains) and irrigated (cotton) cropping systems. It included:

- Participatory analysis of various bio-inputs, their effectiveness and standardisation
- Participatory experimentation and learning on soil micro-biology and water use efficiency.

Groundwater / Aquifer Management (Section 9)

This component was about empowering village communities to monitor and manage groundwater resources more efficiently. It was delivered by Western Sydney University (WSU), building on their ACIAR-funded Managed Aquifer Recharge through Village-level Intervention (MARVI) activities in Rajasthan and Gujarat states in India. It included:

- Participatory mapping of aquifers and their characteristics
- Delineating aquifer recharge areas
- Participatory groundwater management

Partner programs and expected outreach

The LWRM project connected formally with five large-scale water-centric outreach programs operating in three Indian states – Andhra Pradesh, Karnataka and Odisha.

- *Andhra Pradesh Drought Mitigation Project* (APDMP) aims to mitigate the adverse impacts of drought in dryland districts. It is supported by the Government of Andhra Pradesh and the International Fund for Agricultural Development (IFAD).
- *Andhra Pradesh Zero Budget Natural Farming* (APZBNF) aims to enhance farmer welfare, consumer welfare and conservation of the environment through holistic alternatives to high-cost chemical inputs-based agriculture. It is supported by the Andhra Pradesh Department of Agriculture through the Rythu Sadhikara Samstha organisation.
- The *National Bank for Agriculture and Rural Development* (NABARD) supports a number of watershed projects. The collective mission is to promote sustainable and equitable agriculture and rural development through participative financial and non-financial interventions, innovations, technology and institutional development for securing prosperity. The NABARD scheme aims to provide funds for India's rural infrastructure to enable long term irrigation practices, generally offering financial services and aid for the development and improvement of rural India.
- The *Special Programme for Promotion of Integrated Farming* (SPPIF) in tribal areas of Odisha was launched in 2017 by the Government of Odisha's Department of Agriculture and Farmers Empowerment. It aims for comprehensive development of agriculture, horticulture, livestock and fisheries in rainfed areas. It was initiated in Malkangiri in 2017, targeting 20,000 households. It is now expanding to another four districts, targeting another 100,000 households.
- The *Special Programme for promotion of millets in tribal areas (Odisha Millets Mission* (OMM)) was launched by Department of Agriculture and Farmers Empowerment in 2017 to revive millets on farms and plates. It is currently being implemented in 81 blocks, covering 15 districts and targeting 500,000 households.

Anticipated farmer outreach for each partner program is summarised in the following table:

State	Program	Outreach target	LWRM learning sites
Andhra Pradesh	APDMP	~165k farmers	3
Andhra Pradesh	APZBNF	~500k farmers	4
Karnataka	NABARD-supported watershed projects	~250k farmers	2
Odisha	SPPIF	~120k farmers	1
Odisha	OMM	~500k farmers	3

Learning as a mechanism for scale

The LWRM project was formed around a series of four learning workshops, interspersed with practical application for government and non-government organisations involved in outreach programs where these tools, technologies and training opportunities may not have previously been available.

Underpinning aims of the learning workshops were:

- to facilitate transfer of relevant, applicable knowledge and tools in water management;
- to promote practical experimentation and adaptive management; and
- to support equitable access to knowledge and tools.

Staff from each of the five ‘home programs’ participated in the capacity building activities of the LWRM project. Forty-eight staff from across the five programs were nominated to participate in the learning components; WASSAN staff also joined training.

These staff play an active role in testing, mainstreaming and contextualising tools, approaches and practices into their respective home programs (through the use of program ‘learning sites’) and have been key to outscaling these tools and practices into larger water management programs and into respective farming communities.

A final synthesis workshop was held in Hyderabad in March 2023.

5 MEL framework

The LWRM project's MEL framework was co-developed by the WASSAN and CSIRO teams and approved in May 2021 by AWP and ACIAR.

The framework is broadly aligned to relevant AWP and ACIAR strategic objectives, particularly around supporting capacity development and knowledge generation, uptake of equitable, efficient and sustainable practices, and improving natural resource use for food security and resilience – noting that these are well beyond the scope of the project.

5.1 Program logic

The LWRM project theory of change is visually represented in Figure 1. The project has one key intervention – delivery of remote learning training modules – which was followed through knowledge transfer to application in home outreach programs, to the result of built capacity on-ground.

We undertook a second activity to interrogate the utility and value of the training to individuals (with an iterative loop to guide delivery and content of subsequent training) and then to their home programs and organisations (with an anticipated link to future program design and investment).

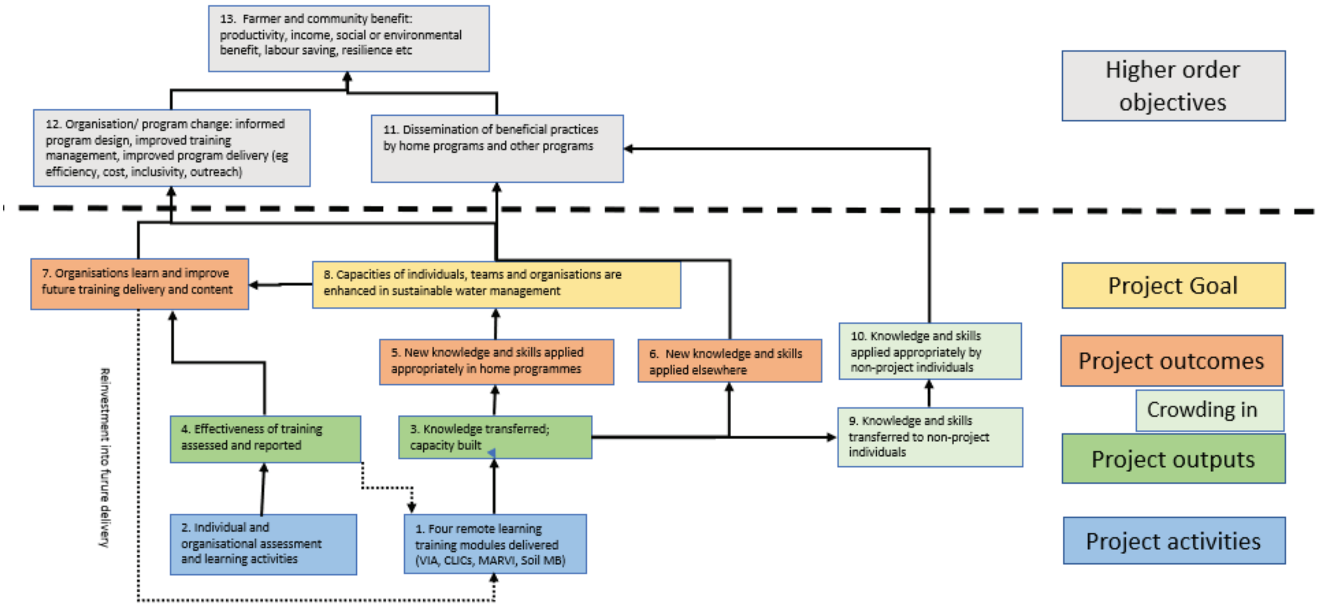

Figure 1. LWRM project Theory of Change

Our key project activity was delivery of four remote-learning training modules (on VIA, MARVI, soil microbiology and climate risk). While in-country delivery of training workshops was preferred, travel was not feasible during the life of the project due to COVID-19 risks.

From a learning perspective, we undertook ongoing assessment and evaluation of training content, delivery and accessibility, with particular emphasis around equitable access to training and content that recognises potential challenges for social inclusion in application.

Our key project outputs were that training modules were attended; relevant knowledge was transferred and capacity was built.

From a learning perspective, we collected data on the effectiveness of the training, as well as license to apply and transfer new skills and knowledge in home outreach programs.

Our key project outcomes were that knowledge and skills learned from project training were applied appropriately (or adapted to context) in home outreach programs. We looked for evidence of knowledge and skills transferred to non-project individuals and/or programs, although this was beyond the agreed scope of the project[1].

From a learning perspective, we interrogated the value of new knowledge and skills built during the training to the home programs and organisations, and how it would be used.

Our project goal was that capacities of individuals, teams and organisations were enhanced around sustainable water resource management.

5.2 Project progress against program logic

Our primary objective with the program logic and MEL indicators was to track transfer of knowledge to application and sharing of knowledge, arising from the project's key intervention – delivery of four remote learning training modules on water management.

An additional objective was to explore the value and relevance of the training for individuals and their home programs/organisations and to use this information to both improve content and delivery of project training and inform future program design and delivery.

Data collected throughout the project is provided in the detailed accompanying MEL report for the project. This section provides a summary of progress, with some illustrative examples.

Knowledge and skills transfer

Four learning events (multiple-day remote training) were delivered by Australian research teams and facilitated by the Indian partner team WASSAN. Fifty-two participants from five large-scale water-centric outreach programs in three states started the training; thirteen 'learning sites' were identified for participants to apply new knowledge and skills between learning events, supported remotely by Australian teams and WASSAN.

Fifty-one percent of the original cohort participated in the final learning event, with departures due to competing work commitments, the challenges of remote and self-learning or transfer out of the position or organisation. Ten participants were replaced.

At the end of each training, between 75 and 90% of participants reported the intent to apply at least one aspect of course content in their home program. Over 90% of participants rated the quality of the training and excellent or very good; all participants reported that aspects of all training events were relevant to their role and most had demonstrated this value by applying it outside their original role.

While equitable access to participation in the project was encouraged, the selection process and criteria varied between home programs. As a result, women were under-represented in the participant cohort; context and recommendations are provided in Box 2.

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[1] The 'crowding in' concept suggests that other individuals or programs see value in the new knowledge/skills generated by the project training or potential benefit in their application, resulting in copying or adopting behaviours, practices or tools.

Applying new knowledge and skills in home programs

Although COVID-19 risks restricted movement in all study areas, at least 75% of participants were able to apply or test aspects from each of the four learning components in their home programs, foremost: crop calendars, root nodule analysis, root health as correlated with crop yield, soil testing, critical irrigation and sowing dates and rainfall data.

Some changes were necessary to adapt training design and delivery to local production systems, the project context and COVID-restricted field work; examples arising from consultation between participants and component leads are provided in Box 3.

Throughout the project, participants noted that remote learning was not a preferred learning style. At the end of the project, there was general agreement that a combination of theory (online delivery was adequate given the circumstances and can now be used as a future resource, particularly for new starters) and practice is preferred for understanding and uptake. Many also felt that ongoing training or support will be needed to optimise Training-of-Trainer activities.

Sharing new knowledge and skills

Feedback at the end of the fourth training event suggested that collectively, participants had shared new knowledge or skills with around 6000 others, inside and outside their home programs. Conservatively, this equates to an average of around 350 people per participant.

This knowledge sharing was predominantly with colleagues, field coordinators and farmers (noting that these people will also likely share beneficial knowledge) in their home programs or organisations; common mechanisms for transfer of knowledge were village-level meetings, interactions with farmers, demonstrations (including testing on own farms where COVID restrictions prevent travel) and helping colleagues with project activities.

Participants also reported proactively changing design and delivery of relevant home program and other activities, based on enhanced understanding of different aspects of water management, such as climate risk, irrigation efficiency and soil and plant health. A novel example of using education curricula as a mechanism for knowledge sharing with university students is provided in Box 4.

Interest from others

Significant outreach opportunities have emerged from external interest in the project and its approach. The national development bank NABARD and the project team are exploring options to apply project elements in their new nationwide initiative around agricultural soil; JIVA aims to improve 550,000ha in both watershed and tribal development projects in rainfed areas in the next four years (see Box 6).

The Sehgal Foundation are keen to apply methods and approaches from the project in ten pilot villages across five states as part of their ‘smart technology initiative’ in agriculture (see Box 7).

There has also been interest in the project as a result of participation in national networks and workshops. Senior officers of the National Rainfed Area Authority shared the project’s approach and design at a national workshop on drought-proofing; international institutes including IWMI and ICRISAT showed strong interest in understanding more about relevant learning tools.

The WASSAN team shared experience and learnings with PRADAN (a large NGO operating in several states), the Development Support Center (Gujarat NGO) and other national NGOS, along with the federal agency, Central Research Institute for Dryland Agriculture (CRIDA).

There have been initial discussions with the REWARD (Rejuvenating Watersheds for Agricultural Resilience through Innovative Development) program, a new partnership between Government of India, the State Governments of Karnataka and Odisha and the World Bank to restore 26 million ha of degraded land by 2030 through improved watershed management practices to improve resilience, income and productivity. Potential intersections with the program are in relevant training and technology.

The value of WASSAN's networks, visibility and reputation in drawing interest from external initiatives should be noted here.

Influence on future activities

When asked about the value of the project, managers noted the usefulness of project training (of participants and subsequently farmers) and tools to existing home programs. They also noted the intent and/or examples of integrating the project approach and learnings into new locations, new programs and future designs (see Box 8).

For the project partners, a number of success factors were identified, including: contextualising tools and training; employing adaptive project management; using established and networked partners; and planning and resourcing expansion.

Considerations for similar future investments include: a more explicit and proactive participant selection process to address gender and social inclusion; implementing a hybrid model for training that could incorporate specifically developed online training for theory with in-person practical application and support; and building discussions around scale and beyond-project capability into original (precedent) research projects.

Box 2. Unpacking under-representation of women in the training cohort

Despite the project's intention for equal representation in the training cohort, only 10% of participants were women. Exploring this low participation rate uncovered that gender imbalance is very common for this type of agricultural extension role, mostly because the role is dominated by field work and requires travel.

Insights from participants and women outside the project suggested that women can find field work difficult because of family commitments, limited transport options and physical expectations of the work.

To counter the gender bias, the project made some adjustments to application (eg VIA sensors were placed near participant homes, rather than remotely; rainfall gauges were placed on rooves rather than in the field; local resource people for the groundwater component were always one woman and one man) and provided training in the importance of women's participation and gender equity in water management activities.

During the course of the project, state policies around recruitment of women into similar positions changed (eg in Andhra Pradesh, 30-50% women recruits are targeted); however, this is not reflected in the project cohort. The project also relied on the strong gender equity and empowerment approaches of the five home programs to deliver inclusive outcomes and benefits.

For future similar activities, the project team would be more explicit and proactive in the selection process of participants, seek to have more female resource people in the project and establish a resource panel that reflects diversity in gender, ability and age.

Box 3. Adaptation to optimise application

Iterative changes were made by component leads and participants in their application of new knowledge and skills introduced by the project. This was in recognition that previous applications needed to be modified to suite the home program context, the local productions systems and COVID-related restrictions to field work.

In response to participant feedback, the VIA component: reduced the number of loggers per field location and positioned them in more convenient locations for the participants; re-oriented from a data collection approach to a learning approach; and will use WASSAN as a Trainer-of-Trainers for future and extension activities. Damaged sensors were recalled for repair after the final workshop.

The MARVI component needed to adapt from a network of trained volunteers in Rajasthan to a learning approach using demonstrations in select villages; there were also adjustments from Rajasthan's shallow well system to deep tube wells in southern case study states. It was also realised that deep aquifer mapping/ management requires different tools for measuring and monitoring water tables.

The Soil Microbiology component made a number of practical adjustments to field-based activities to suit production and seasonal conditions (eg delayed onset of monsoon)

In the Climate Risk component, rainfall data from the nearest local government-managed rain gauge was used for generating trends and scenarios when on-site gauges were found to be inadequate.

Box 4 Training university students and farmers in Karnataka

Krishi Vigyan Kendras (KVK or 'farm science centres') are district-based agricultural knowledge centres managed by the Indian Council of Agricultural Research. They include extension and awareness activities such as laboratories and demonstration plots and they are part of the home programs.

Farmers visiting KVKs as part of the home programs in Karnataka were given demonstrations of VIA and climate risk aspects of the project by eight project participants working in the state (December 2021).

These participants also shared information and approach from all four components to 150 agricultural diploma students studying at Keladi Shivappanayaka University of Agricultural and Horticultural Sciences

As a result of these exchanges, the Foundation for Ecological Security (FES), who are part of the project, have used and modified techniques from the project to better understand crop health. This includes modifying FES their project design to incorporate more activities towards water conservation for potential dry spells predicted for project sites.

Box 5. Incorporating soil health knowledge and tools into new districts and design

Under the Cambridge University-supported Transforming India's Green Revolution by Research and Empowerment for Sustainable Food Supplies (TIGR2ESS) project, soil samples were collected by the WASSAN team using protocols learned in the soil microbiology component. Data from 18 plots in Anantapur District were analysed for physical, chemical and biological parameters in the context of developing appropriate crops and cropping practices for different climatic regions.

In addition, one of the trainees applied skills learned in soil health to four existing projects in Nuapada District; Special Program for Promotion of Millets in Tribal Areas of Odisha; Special Program for Promotion of Integrated Farming in Tribal Areas; Bharatiya Prakritik Krishi Padhhati; and Chuktia Bhunjia Development Agency. As part of this expansion, over 1500 farmers and 70 Community Resource Persons were trained in the knowledge and skills from the project.

Box 6. Connecting with the national development bank's JIVA initiative

National Bank for Agriculture and Rural Development (https://www.nabard.org/) is India's national development bank, with a vision for 'fostering rural prosperity'. It was established in 1982 and is already involved in the projects as one of the home programs of training participants.

Jiva (life) is large scale national project being rolled out by NABARD through its network of NGOs and other rural stakeholders. In essence, Jiva is about 'creating a system where no further harm can be done to agricultural soil' and has components of soil health and productivity, livelihood improvement, natural resource management, climate resilience, local wellbeing and healthy food. Jiva will be implemented at watershed scale across 11 Indian states.

WASSAN is one of the NGOs involved in Jiva. They noted that there are tangible connections between Jiva and three of the four themes in the AWP-ACIAR project. The LWRM project leader was subsequently invited to present to the NABARD leadership, which is a rare and valuable request. They expressed an interest in collaborating through capacity building and scaling of project approaches and technologies during the project's timeframe of 2023-2028.

It is anticipated that training will be offered to NABARD/Jiva staff and that WASSAN will lead the training. Project materials and tools will be used, once they are customised for the Jiva initiative.

This collaboration offers an opportunity to expand into new watersheds, with a potential reach of hundreds of thousands of farmers in several hundreds of watersheds, through WASSAN's participation in the program (other partners would be minor contributors). It is also an opportunity to work directly with NABARD who are investing several million dollars in the program and are already in place in key rural areas.

Box 7. Joining the Sehgal Foundation's Smart Technology Initiative

SM Sehgal Foundation is a large Indian rural development NGO that was established in 1999 (https://www.smsfoundation.org/). The Foundation has reached over three million people in over 1300 villages across 46 districts and 11 states and adopts a community-led development approach.

The Foundation has recently established a smart technology initiative for agriculture and is looking for appropriate innovations to pilot with farmers in five states. Two villages (around 5000 people per village) in each state will be involved in the pilots and if farmers see value, the Foundation will explore scaling options. Pilot activities are aimed at village scale, rather than individual or household scale.

The pilot initiative lead found articles about the project on AWP and ACIAR websites and newsletters; WASSAN is also aware of the Foundation and its activities. He subsequently contacted the project leader to explore opportunities for collaboration and followed with a formal letter requesting technical support.

WASSAN coordinated a successful visit by the initiative lead to one of the project field sites, to look at the VIA *in situ*. The Foundation are keen to use VIA equipment in their pilots and see value in the project approach. For the pilots, AWP and ACIAR support provision of VIA equipment (eg 100 Chameleon cards; ten in each village); the Foundation will cover all on-ground expenses for the pilots and will approach other donors to support scaling activities.

The Foundation will also build capacity in the VIA and its application in a small group from Foundation, who will then train others in the villages. WASSAN will lead this training, using VIA's Water School learning modules and the VIA component lead will provide support and trouble-shooting.

Box 8. The value of the project to outreach programs

Managers of home programs and other outreach programs were asked what they valued about the project and what they might take forward from the project.

Home program managers valued the training received by their colleagues, and that was subsequently transferred to farmers. They mentioned both direct application of the tools and contextualised application to other programs and areas.

Beyond tools and training, home program managers also talked about their intention to integrate the approach and learnings from the project into new locations and programs; some had already both modified existing programs based on new knowledge (eg understanding climate risk) and taken aspects of the project approach into the design of new programs.

At the final workshop, the TIGR2ESS representative suggested 'Scientists need to engage more with development agencies, otherwise the value of the science isn't realised. The outcomes of 80% of current research is limited to research papers, when the impact needs to be seen on the ground'.

The NABARD representative noted that 'The uniqueness of this program was its collaboration between NGOs, research institutes, government institutes, non-government institutes and Australian organisations'.

6 Climate risk analysis component

This learning component was built through the CLimate Information Centres (CLICs) work in Andhra Pradesh as part of the Adapting to Climate Change in Asia project (ACCA). It focused on measuring and understanding local conditions and acting according to the unfolding season and was delivered by the South Australian Research and Development Institute (SARDI).

The original CLICs concept was designed to develop farmers' capacity to respond to various climate risks by providing timely information on their local weather, by creating an environment that allowed them to more readily interpret this information and by developing management strategies for coping with climate variability. A participatory action research approach (combining field based on-farm research, climate modelling and participatory engagement) was key to building capacity in the farming community to observe and act on climate and weather information.

This LWRM component aims to improve the links between weather and climate information and decision making, and to build capacity in development practitioners for the collection and application of climate information for agricultural decision making. Smallholder farmers are exposed and vulnerable to climate extremes such as drought or a delayed start to the monsoon. Extreme risk aversion due to uncertainty about the climate can also contribute to poverty or disadvantage.

While vulnerability to climate has increased, there has also been a vast increase in information from weather and climate science, such as more accurate warnings of extreme events, advances in numerical weather models, emerging skill in seasonal climate forecasts and projections of future climates under enhanced greenhouse gasses. This component is driven by the challenge of how to better use this information and is part of a general shift from climate products to climate services (Nidumolu et al 2021)

The original learning plan for the LWRM project is summarised in the following table.

Learning event[2]	Topics and activities
1: Nov-Dec 2020	Introductory workshop on identifying weather and climate sensitive decisions Scoping local material on climate smart farming including crop calendars Scoping access to sources of information of local climate data Introduce framework to identify and analyse weather and climate sensitive decisions Work with participants to set up an activity plan to identify 1) climate data, 2) local material relevant to climate smart farming and 3) identify weather and climate sensitive decisions Introduction/revision on ranking of historical rainfall in deciles
2: Jul-Aug 2021	Organise and collate available climate information into World Meteorological and India Met Office frameworks based on lead time (long term past records, immediate records, warning, short term weather, long term weather, seasonal climate and climate change) Collate and compare material on climate smart farming with particular attention to the potential role of information in weather and climate sensitive decisions

[2] Details of each learning event have been provided in Progress Report 1 (March 2021), Progress Report 2 (September 2021), Progress Report 3 (May 2022) and Progress Report 4 (October 2022).

	Participants present and compare the weather and climate sensitive decisions that they have identified. Participants use MS Excel templates to sort historical climate data
3: Oct 2021-Mar 2022	Review and update the collation of sources of weather and climate information and climate smart farming material with special emphasis on forecast information (to date the primary emphasis is on historical data) Work with participants to use decision analysis tools on weather and climate sensitive decisions Develop framework to consider the broader social and psychological context of weather and climate decisions
4: Jun-Oct 2022	Update the collation of sources of weather and climate information and climate smart farming material Compare results of decision analysis on weather and climate sensitive decisions Compare insights from decision analysis and broader consideration of social and psychological aspects of making climate risky decisions

Changes to the learning plan include:

- Rainfall data from the nearest local government-managed rain gauge was used for generating trends and scenarios when on-site gauges were found to be inadequate
- Rain gauges supplied and installed at each learning site so that participants had responsibility for collecting and analysing their own data.
- Long term climate data was sourced from Indian Meteorological Department because historical local data was not available at learning sites.

Highlights from participants and component leads include:

- Farmers visiting Krishi Vigyan Kendras (KVK; ‘farm science centres’ managed by the Indian Council of Agricultural Research) in Karnataka were given demonstrations of VIA and climate risk aspects of the project by eight project participants working in the state (December 2021).
- Participants shared information and project approach from all four components to 150 agricultural diploma students studying at Keladi Shivappanayaka University of Agricultural and Horticultural Sciences.
- The Foundation for Ecological Security (FES) has used and modified techniques from the project to better understand crop health. This includes modifying their project design to incorporate more activities towards water conservation for potential dry spells predicted for project sites.
- Localising the crop climate calendar and preparing crop pest climate calendars in Mayurbhanj District in Orissa
- Using crop calendars to support agro-climatic advisories in Panchali with KVK; using the calendars to communicate with farmers about potential risks associated with weather and pests through a cropping season.

7 Strategic irrigation component

This learning component is about optimising water use and nutrient uptake in irrigated environments. It was delivered by CSIRO and VIA Ltd, based on the Virtual Irrigation Academy (VIA) technology and learning approach developed in southern Africa.

The Virtual Irrigation Academy (VIA) began in 2016 as an ACIAR-funded CSIRO research project. The work started in southern and eastern Africa and has spread to more than 15 countries through a range of development and research partners.

The mission of the VIA is: 'Through our unique monitoring tools that give output as colours, the Virtual Irrigation Academy enables farmers to merge the science of irrigation with their own practical experience. Together with partners, we seek to reduce water use while increasing food production. We provide data that underpins the governance of irrigation to ensure that water is shared fairly and used efficiently.' (Stirzaker, Mbakwe and Mziray, 2017).

In October 2020, the VIA sent sufficient equipment to India to monitor 100 sites in the project area. The shipment included: 100 Chameleon sensor arrays (comprising three soil water sensors plus one temp/ID sensor); 40 WiFi enabled Chameleon Readers; 100 pairs of Wetting Front Detectors (WFD); 40 VIA Electrical Conductivity meters and 40 vials for nitrate test strips.

The aim of this project for the VIA component was to train participants to understand, deploy and interpret soil water and nutrient monitoring tools. Each participant will install one Chameleon sensor array and one pair of WFDs at their home location to familiarise themselves with the system. Then they will install the same equipment on nine farms, each participant working in a separate village, and engage in co- learning with the farmers. Finally, they will translate these experiences into the needs of the home programs.

The original learning plan for the LWRM project is summarised in the following table.

Learning event	Topics and activities
1: Nov-Dec 2020	Introduce the VIA tools (the Chameleon and FullStop) to participants: how they work, installation, and troubleshooting Introduce the VIA data platform participants: how to set up farms and visualise data Provide practical demonstrations on VIA tools: 1) Assembly of FullStop, Placement and installation of FullStop, taking soil water sample and measuring nutrients 2) Installation of the Chameleon and Pairing Field Reader to Wi-Fi Provide practical demonstration on VIA data platform: how setup crop on via.farm and visualize the Chameleon and FullStop data Work on activity plan with participants on installation, data collection and communication
2: Jul-Aug 2021	Review activities post-first workshop Troubleshoot issues Provide theory and practice of experiential based learning on water, nitrate and salt colour patterns Provide training on data collection, quality control and visualisation Training on interpretation of water, nitrate and salt colour patterns and how these relate to crop yields
3: Oct 2021-Mar 2022	Review learnings from workshop1 and 2

	Work with participant to move from data to information to knowledge Explain how analytics work for large amounts of Chameleon, WFD solute and crop monitoring data
4: Jun-Oct 2022	Procedures for deploying the VIA in large development projects Training in how to tailor information to the needs of different clients in the water sector Training in using the VIA for water governance

In response to participant feedback, the VIA component made significant changes to the learning plan, including:

- Reducing the number of loggers per field location and positioning them in more convenient locations for the participants
- Re-orienting from a data collection approach to a learning approach and using WASSAN as a Trainer-of-Trainers for future and extension activities
- Used VIA's Chameleon card system instead of wifi-enabled sensor so enable easier access to data by participants.

Highlights from participants and component leads include:

- The Sehgal Foundation are keen to apply methods and approach of this project in ten pilot villages across five states, as part of their 'smart technology' initiative for agriculture. They are particularly interested in the VIA approach and equipment; discussions are underway on options for collaboration.
- The District Magistrate of Malkangiri District received an award from 'The Indian Express' on his strategic irrigation project implementation across six villages.
- Widening the use of VIA equipment to a 200ha community surface water project in Malkangiri; extending understanding of soil moisture and reducing water extraction from the common water resource
- Using VIA tools to support decision-making for irrigation schedules for new vegetable crops (eg tomato) in Anantapur District.

8 Soil biology component

This learning component is about understanding the relationship between soil biology and water use efficiency, representing a critical addition to predominant research on physical and chemical properties of soil. The component was delivered by CSIRO and is based on management induced responses in soil biological function in rainfed (GRDC) and irrigated (Cotton RDC) cropping systems.

Despite recognition of the importance of soil biological health for sustainable agricultural production and overall ecosystem health, its inclusion as part of soil health or its use to improve water use efficiency of crops has been limited. This is because many soil biological measurements are considered too descriptive and difficult to interpret.

In this component, soil biological assessments are used that reflect the soil's ability to supply plant essential nutrients, support overall biological activity along with plant-based measurements that help quantify the impact of plant-microbe interactions.

Soil microbial activity plays a central role in soil's ability to supply nutrients, reduce the impact of plant diseases and in turn help improve water and nutrient use efficiency in particular in rainfed / dry land crops. The amount of soil microbial activity is one of the indicators of the levels of active organic matter and microbial populations. A low-cost tool has been standardized that can be used in local laboratories and with field soil samples to measure soil microbial activity levels as part of assessment of soil health (Gupta et al 2019; Gupta et al 2011; Gupta et al 2008; Ferris 2015).

The original learning plan for the LWRM project is summarised in the following table.

Learning event	Topics and activities
1: Nov-Dec 2020	Capacity building workshop in soil biological fertility monitoring to improve water use efficiency Scoping local resources in terms of analytical laboratories and tools for field monitoring Design protocols for field sampling and in-situ monitoring Primary training in field sampling and in-situ monitoring Identify suitable crops and crop performance parameters required to link with soil biological fertility Planning activities for the first 6 months
2: Jul-Aug 2021	Review activities in soil biological health monitoring Framework development to monitor soil biological fertility as part of integrated soil management approach implemented by projects Training in root health monitoring in selected crops Design activities for field monitoring for soil and plant health
3: Oct 2021-Mar 2022	Review year 1 data and revise protocols where necessary Identify new soil health measurements as required Initiate integration of biological health results with system performance
4: Jun-Oct 2022	Review the potential for integrating soil biodiversity assessments with improvements in water use efficiency Identify cross regional similarities in soil biology response to management and performance in selected crops

The Soil Microbiology component made a number of practical adjustments to field-based activities to suit production and seasonal conditions (eg delayed onset of monsoon) and COVID restrictions on in-person training. These include:

- Low-cost lab kits and providers were used for soil sample analysis, so analysis could be done locally.
- Create simple metrics for soil and plant health and nutrition from root and nodule analysis in the field

Highlights from participants and component leads include:

- The Cambridge University-supported Transforming India's Green Revolution by Research and Empowerment for Sustainable Food Supplies (TIGR2ESS) project have employed the project's soil microbiology protocols to develop appropriate crops and cropping practices for climatic regions, and have trained around 1500 farmers and community resource officers in soil health.
- Testing of soil samples led to the realisation that there is a significant deficit in soil organic carbon in many of the locations. This triggered the participants to identify methods and interventions that could improve soil organic carbon. For example, participants of the Krishni Vigyan Kendras farm science centres reviewed and analysed 3500 soil health cards and assessed the status of soil organic carbon across relevant locations.
- Participants under the natural farming stream conducted interesting tests/ application of root test in their home programs. The nodule test was used to understand and demonstrate the impact of deep ploughing and shallow ploughing under natural farming and chemical farming. The root test results could establish the relevance of natural farming protocols/ practices
- Understanding soil microbiology through use of semi qualitative parameters (roots and nodules) alongside chemical parameters developed a new outlook on soil health and potential.
- NABARD and the project team are exploring options to apply some project elements in their new nationwide initiative around agricultural soil. JIVA aims to improve 550,000 ha in both watershed and tribal development projects in rainfed areas over four years. JIVA incorporates all four project components - climate risk analysis, soil moisture measurement and management, soil biology in relation to water use efficiency and participatory management of groundwater.

9 Groundwater management component

This learning component is about empowering village communities to monitor and manage groundwater resources more efficiently. It was delivered by the Western Sydney University (WSU), building on their Managed Aquifer Recharge through Village-level Intervention (MARVI) activities in Rajasthan and Gujarat states in India.

Although about 60% of irrigation water for crop production and 80% drinking water in India is sourced from groundwater supplies, it is not well understood in terms of the available volume and movement in the area. Being difficult to control, groundwater use has been largely unregulated in India. This, along with easy availability of pumps, has led to groundwater use far more than the annual recharge that happens during the monsoon season.

The MARVI project developed methods to: a) establish a comprehensive database about groundwater depth fluctuations and availability; b) engage local villagers to monitor groundwater and empower them to develop their own solutions for sustaining groundwater use and improve livelihood; c) advance groundwater knowledge and understanding of farmers, local community (including schools) and decision makers; and d) provide tools for estimating annual groundwater recharge, water availability and crop demand and thus improve decision making for sustainable groundwater use (Jadeja et al, 2018).

The original learning plan for the LWRM project is summarised in the following table.

Learning event	Topics and activities
1: Nov-Dec 2020	Share and contextualise MARVI experiences from Gujarat and Rajasthan with theparticipants at the workshop.’ Engage with relevant state agencies, farmers, women group and local stakeholders (including disadvantaged groups) to scope out participatory groundwater monitoring in the study villages. Design pilot participatory groundwater monitoring based on MARVI approach in selected villages while making sure that women and other disadvantaged groups are benefitted. Develop action plan for implementing groundwater monitoring for the coming monsoon season.
2: Jul-Aug 2021	Review the participatory groundwater monitoring program and document lesson learnt. Analyse data collected during the last six months Identify capacity building needs and resources for study villages and develop plan for development of resource materials in local language.
3: Oct 2021-Mar 2022	Facilitate project partners and farmers to carry out groundwater balance analysis based on data collected so far. Develop guide for participatory approach for water data collection at the village level. The topics include criteria for selection of village volunteers, training modules for volunteers, the importance of GESI in groundwater management and tools for the analysis of volunteer collected data on groundwater levels, rainfall, water quality and check dam water depths.
4: Jun-Oct 2022	Develop framework for sustainable groundwater use at the village level Identify ways to embed gender and equity aspects in groundwater management programs and policies, tools for estimating groundwater recharge, designing and evaluating groundwater recharge structures to

	suit local situations, and using MyWell for crowd sourcing water data at village level. Develop action plan for the next six months to document (print, audio and video) experiences and lessons from the MARVI project and facilitate the design of a participatory groundwater monitoring program for outscaling beyond the project areas.

Changes to the learning plan include:

- The MARVI component needed to adapt from a network of trained volunteers in Rajasthan to a learning approach using demonstrations in select villages.
- There were also adjustments from Rajasthan's shallow well system to deep tube wells in southern case study states.
- It was also realised that deep aquifer mapping/ management requires different tools for measuring and monitoring water tables.

Highlights from participants and component leads include:

- Testing of soil samples led to the realisation that there is a significant deficit in soil organic carbon in many of the locations. This triggered the participants to identify methods and interventions that could improve soil organic carbon. For example, participants of the KVK centres reviewed and analysed 3500 soil health cards and assessed the status of soil organic carbon across relevant locations.
- Participants in APZBNF program applied the root test across activities in their home programs as a way to establish the relevance of natural farming protocols and practices. The nodule test was used to understand and demonstrate the impact of deep ploughing and shallow ploughing under natural farming and chemical farming.
- Application of soil testing protocols to multiple existing projects managed by the participants
- Understanding soil microbiology through use of semi qualitative parameters (roots and nodules) alongside chemical parameters developed a new outlook on soil health and farming impact.

10 Conclusions and recommendations

10.1 Conclusions

With catalytic investment, the project goal of enhancing the capacity of individuals, teams and organisations was met, despite the significant challenges of COVID-19 risks and restrictions.

In this project, there were a set of factors that contributed to its success in transferring knowledge to enhance capacity and create scaling opportunities. They include:

- **Contextualising tools and training:** While the four project components were chosen for their alignment with the aims of original five outreach programs, iterative improvements made to training content and delivery and modifications to application based on context enhanced the relevance to participants.

- **Adaptive project management**: Without adaptive management and problem solving, the onset of COVID restrictions at the start of the project could have resulted in fewer and less significant outcomes.

- **Established and networked partners:** A combination of WASSAN's networks and reputation in water management, CSIRO's past experience with water and climate research in India and a longstanding and trusted relationship between the two organisations enabled both project delivery and additional opportunities.

- **Planning and resourcing expansion**: Having a clear vision and strategy about what and how to scale and how to track knowledge transfer has been important in this project. When unexpected opportunities to scale emerged, they were also recognised and explored.

10.2 Recommendations

Considerations for similar future investments include:

- A more **explicit and proactive participant selection process** to address gender and social inclusion; seek to have more female resource people in the project; and establish a resource panel that reflects diversity in gender, ability and age. Beyond participation targets, a gender analysis and strategy that includes activities and beneficiaries would also be beneficial.

- Implementing a **hybrid model for training** that could incorporate specifically developed online training for theory (that would also be a resource) with in-person practical application and support.

- **Planning for participant turnover** or relocation, in terms of bringing new participants into learning modules and application.

- Developing a similar MEL framework to **explicitly track knowledge sharing to capacity building**, and application to sharing and scaling, rather than assuming technical training modules are a sufficient indicator on their own.

- Intentional searching for **evidence of adaptation to local context** (and the drivers behind it); incorporating changes to training content and delivery in response to iterative review; and noting unanticipated results (and relevant drivers).

- **Building discussions around scale and beyond-project capability** into original (precedent) research projects.

11 References

11.1 References cited in report

Andhra Pradesh Drought Mitigation Project (2017). Project design documents; Online at https://www.ifad.org/en/web/operations/-/project/2000001420

Gupta VVSR, Roper M and Thompson J (2019). Harnessing the benefits of soil biology in conservation agriculture. In: Australian Agriculture in 2020: From Conservation to Automation (Eds J Pratley and J Kirkegaard); pp 237-253. Agronomy Australia and Charles Sturt University: Wagga Wagga.

Gupta VVSR, Rovira AD and Roget DK (2011). Principles and management of soil biological factors for sustainable rainfed farming systems. In: Rainfed farming systems (Eds P Tow, I Cooper, I Partridge and C Birch); pp 149-184. Springer Science and Business Media.

Gupta VVSR, Dick RP and Coleman DC (2008). Functional microbial ecology: molecular approaches to microbial ecology and microbial habitats. Soil Biology and Biochemistry; 40, pp 1269-1271.

Ferris H and Tuomisto H (2015). Unearthing the role of biodiversity in soil health. Soil Biology and Biochemistry; 85, pp 101-109.

Jadeja Y, Maheshwari B, Packham R, Bohra, H, Purohit R, Thaker B, Dillon P, Oza S, Dave S, Soni P and Dashora Y (2018). Managing aquifer recharge and sustaining groundwater use: developing a capacity building program for creating local groundwater champions. Sustainable Water Resources Management; pp 1-13.

Nidumolu U, Adusumilli R, Tallapragada C, Roth C, Hochman Z, Sreenivas G, Reddy DR and Reddy VR (2021). Enhancing adaptive capacity to manage climate risk in agriculture through community-led climate information centres, Climate and Development; 13:3, pp 189-200.

Stirzaker RJ, Mbakwe I and Mziray NR (2017). A soil water and solute learning system for small-scale irrigators in Africa. International Journal of Water Resources Development; 33 (5), pp 788-803.

11.2 List of publications produced by project

Science publications

Padbhusan R, Kumar U, Sharma S, Rana DS, Kumar R, Kohli A, Kumari P, Parmar B, Kaviraj M, Sinha AK, Annapurna K and **Gupta VVSR** (2022). Impact of land-use changes on soil properties and carbon pools. A meta-analysis. Frontiers in Environmental Sciences; 9:794866 https://doi.org/10.3389/fenvs.2021.794866

Padbhushan R, Sharma S, Kumar U, Rana DS, Kohli A, Kaviraj M, Parmar B, Kumar R, Annapurna K, Sinha AK and **Gupta VVSR** (2021). Meta-Analysis Approach to Measure the Effect of Integrated Nutrient Management on Crop Performance, Microbial Activity, and Carbon Stocks in Indian Soils. Frontiers in Environmental Sciences; 9:724702. https://doi: 10.3389/fenvs.2021.724702.

Guidance publications

Kookana R, **Maheshwari B**, Dhillon P, Purohit R and Ojha S (2023). Understanding our Groundwater. Telugu Translation of MARVI Groundwater guide; 90pp.

Vadakattu G and Annapurna K (2023). Legume - Rhizobia Symbiosis for Nitrogen Fixation: Chickpea. Information leaflet prepared for wider circulation; 4pp.

Vadakattu G and Annapurna K (2023). Legume - Rhizobia Symbiosis for Nitrogen Fixation: Groundnut. Information leaflet prepared for wider circulation; 4pp.

Communication publications

Water management tools, methods scaled out in India; ACIAR article released on 15 December 2020. Online at https://aciar.gov.au/media-search/news/water-management-tools-methods-scaled-out-india

Increasing water availability and security for Indian smallholder farmers; AWP article released on 30 July 2021. Online at https://waterpartnership.org.au/increasing-water-availability-and-security-for-indian-smallholder-farmers/

12 Accompanying reports

12.1 Report 1: Final MEL Report

Water management in rainfed areas for improving livelihood security of smallholder farmers: Outscaling Australian-supported R4D in Odisha, Karnataka and Andhra Pradesh

Final MEL Report

M van Wensveen, U Nidumolu, PD Patil and M Ramachandrudu; April 2023

12.2 Report 2: AWP Activity Completion Report

Water management in rainfed areas for improving livelihood security of smallholder farmers: Outscaling Australian-supported R4D in Odisha, Karnataka and Andhra Pradesh

Australian Water Partnership Activity Completion Report

M van Wensveen, U Nidumolu, PD Patil and M Ramachandrudu; April 2023