Food and Agriculture Organization of the United Nations

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Promoting productive water use and efficient water management in paddy fields

Farming practices for enhanced water management in paddy fields in **Sri Lanka**

THE PROJECT

In view of the projected global water demand, improved water use efficiency in irrigation is crucial to sustainably increase agricultural productivity. Paddy field systems are particularly water demanding, though products such as rice are not only a staple food but also constitute a major social and economic activity that provides public goods, as well as employment and income, to the rural population.

Funded by the Government of Japan, the project "Promoting productive water use and efficient water management in paddy fields" is implemented by the Land and Water Division of the Food and Agriculture Organization of the United Nations (FAO) in collaboration with partners and national institutions in Sri Lanka and Zambia. The project primarily consists of establishing pilot sites to demonstrate enhanced water management and capacity building of stakeholders at different levels on the multifunctional and value-added paddy fields in the two countries.

The pilot sites are equipped with flow-measuring devices to monitor and collect data on paddy water management and compare the performance of conventional and improved water management measures in paddy fields.

Output (1) of the project – the technical assessment of water management and demonstration of enhanced water management in paddy fields at pilot sites – aims to find evidence-based results on the benefits of enhanced water management through selecting pilot demonstration sites for data collection and setting up water measuring equipment; monitoring and collecting data at the pilot site; and implementing full pilot demonstration sites.

COUNTRY PROFILE

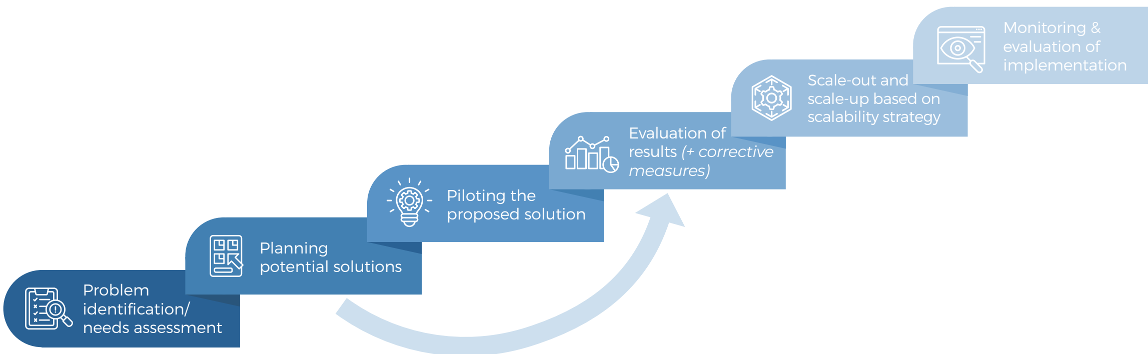
Rice is the staple food in Sri Lanka, with the average rice consumption at about 90 kg per capita per year. Some 8.1 million families or 72 percent of rural households – cultivate rice for their livelihoods, making rice production the largest contributor to food security and rural economy. Over 50 percent of the rice production comes from farms with less than 0.4 ha production area, providing jobs and food to the smallholders.

Rice is cultivated in two distinct cropping seasons throughout the country. The main cropping season is Maha, which lasts from late September to late March and is fed by the second intermonsoon and the northeast monsoon rains. A subsequent rice crop is grown in the second growing season called Yala. It lasts from early April to early September and is fed by the first intermonsoon rains and the southwest monsoon, which mainly brings rain to the southwest of the country.

THE APPROACH FOR DEVELOPING BEST PRACTICES FOR ENHANCED WATER MANAGEMENT

The project applies FAO's knowledge management cycle to ensure that the recommendations are robust, effective, sustainable and ready to use without entailing social or environmental risks.

FIGURE 1. **The project knowledge management cycle**



Source: Authors' own elaboration

Problem identification and needs assessment

The first phase of the project "Efficient agricultural water use and management enhancement in paddy fields" was implemented to increase the understanding of the status of water use efficiency and water productivity, identifying both limits and potential at the national level. The analysis formed a basis for assisting stakeholders in the target countries with technical and policy support to enhance water resources management in paddy fields. Strategies and investment portfolios were developed to ensure the scaling-up and replication of the results. Phase I collected and analyzed data and information on water resources and irrigation systems, and identified both technical and policy measures to sustainably improve water resources management and crop productivity with a focus on paddy fields. The analyses of phase I completed the problem identification and needs assessment step of the knowledge management cycle at the national level.

Another needs assessment was conducted at the community level to allow for a context-specific pilot design. Paddy rice-producing farmers in the project area are typical smallholders with a limited production area and no alternative income. The

average land size is around 0.4–0.6 ha, and farmers produce rice in double-cropping systems. Production in the third season is not universally practiced.

The needs assessment showed that there is a gap between the actual and potential yields. Nevertheless, the vastly varying practices make the characterization of the production practices difficult. The use of rice varieties suggests a moving baseline for the potential yield.

The yields per farm show a mixed picture of productivity, but the overall pattern indicates that farmers produce below the national average. Among others, water resource availability is a production-limiting factor, particularly during the Yala and third seasons. The root causes of the water shortage are the changing rainfall pattern and the insufficient capacity of the tanks. The mitigation measures introduced by farmers are manifold, *inter alia*, the use of short-duration varieties, early planting, the use of burnt rice husk, and composting. Although all measures are useful for adapting to water shortage, the individual and isolated natures of the measures indicate a lack of joint or central coordination, which is necessary to achieve water efficiency-related targets.

Planning potential solutions

Based on the situational analysis and needs assessment, phase II initiated expert consultations to find and tailor solutions for the identified problems and needs. The pilot aimed to support farm-level interventions that address both the national objective of water conservation and the farm-level goal of enhancing productivity. The pilot's design was established through a consultative process that utilized a multicriteria selection approach, addressing technical feasibility, social acceptance, economic viability and environmental impact. More precisely, the criteria for the measures involved in the pilot design focused on four aspects:

- measures that are centered around agricultural water management and multifunctional paddy production, in support of enhanced water use efficiency and water productivity;
- measures that increase yield productivity and farm profits;
- measures that qualify as innovation, thus bringing new transformative solutions; and
- measures that are scalable horizontally (valid in the wet, intermediate and dry zones) and vertically (valid for minor, medium and major irrigation schemes).

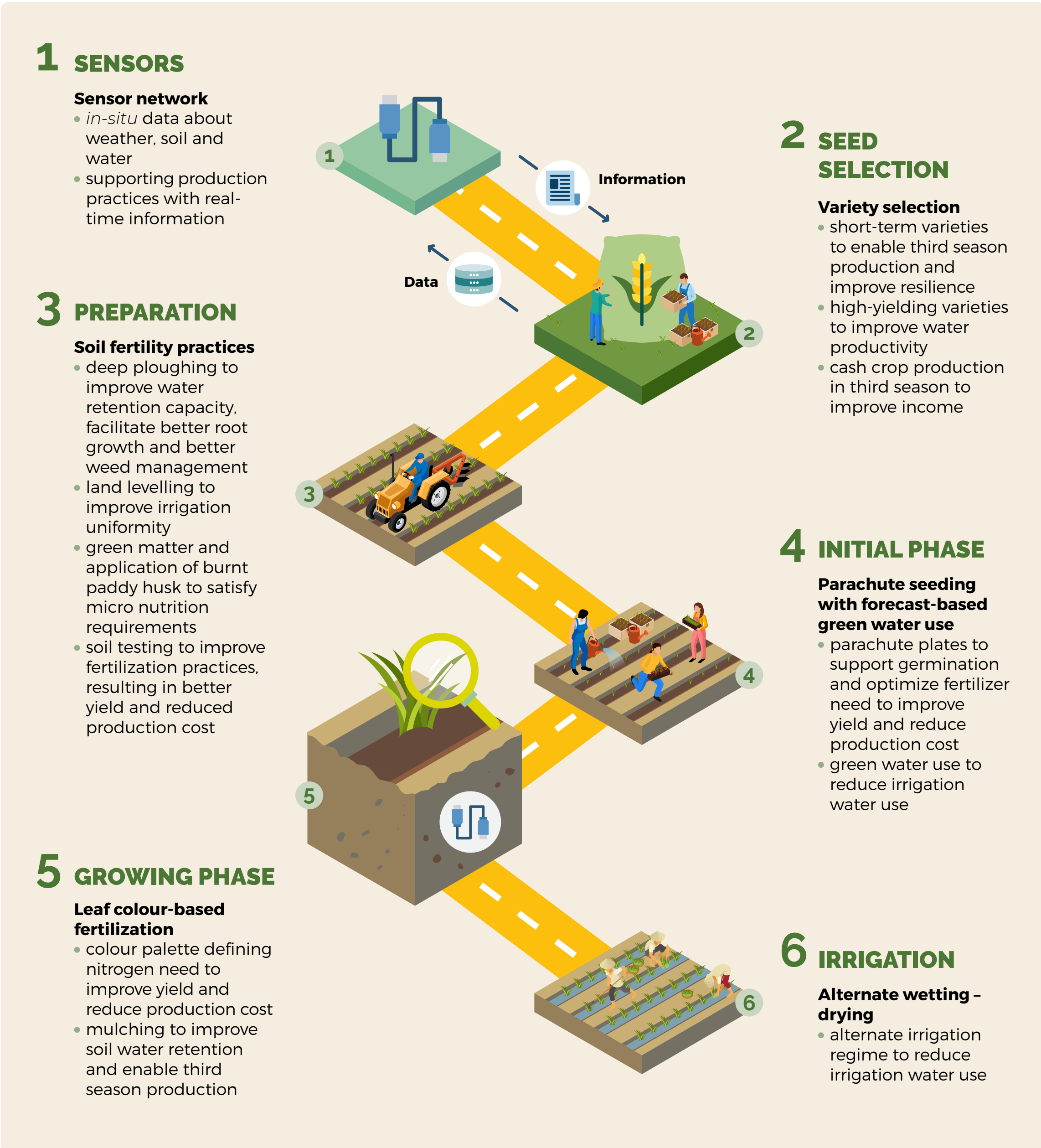
Piloting the proposed approach

To enable the performance evaluation through a comparative analysis in field conditions, the pilot included a treatment and a control field. The fields have similar production conditions to allow for comparison. They are supplied by the same water source, are adjacent, and have the same ownership. A monitoring protocol was introduced to document the implementation. The objective of the monitoring was to facilitate a process-oriented analysis instead of merely evaluating the outcomes. It aims to establish a causal relationship between the introduced measures and the farming outcomes through a set of performance indicators.

The pilot was implemented over two consecutive years, including six agricultural seasons (Maha, Yala and third season). The pilot applied an approach called suite of productivity and efficiency measures. The reason for adopting this approach is that often, a single and isolated measure may yield only partial results or be less effective than when implemented in combination with others. The suite of measures is crafted to respond to multiple objectives, including enhanced water use efficiency and water productivity, improved yield and farm profitability, and strengthened resilience to disasters.

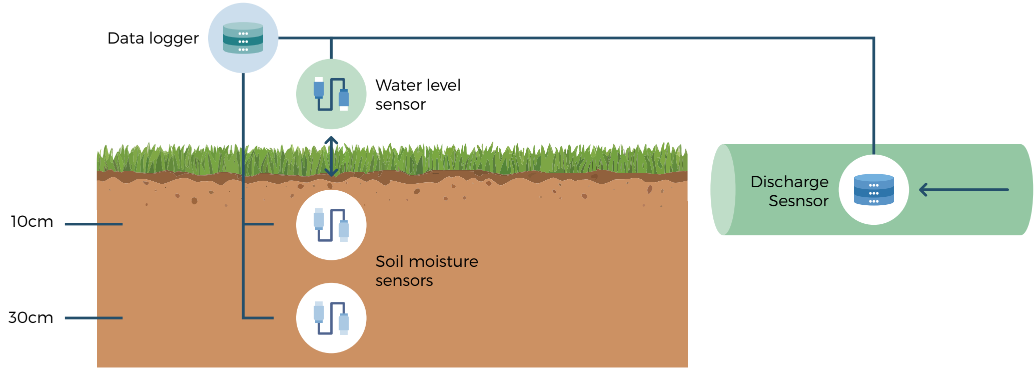
The suite of measures contributes to exploiting the multifunctional and value-added roles of paddies by reinforcing their diverse benefits. It offers economic, social and environmental benefits, thus encouraging and incentivizing all stakeholders to adopt them.

FIGURE 2. A suite of productivity and efficiency measures introduced in the pilot fields



Source: Authors' own elaboration

FIGURE 3. Stylized figure of the monitoring system components



Source: Authors' own elaboration

The project introduced a multidimensional monitoring system to support the evaluation of the results. The technology was a long-needed intervention as no automated system had ever been introduced to generate data and information within actual field conditions. The system consists of water level sensors for measuring the standing water depth in the paddy, soil sensors at multiple depths for recording the relative soil humidity, and a discharge sensor installed in a calibrated flume for estimating the applied irrigation water volume. The sensors are assembled in an automated system that takes measurements at a 30-minute frequency. The data are transferred, stored and managed on a cloud-based platform that provides readily available analysis of the water use trends. The collected data are complemented by a small-scale weather station for calculating the water demand and the rainfall.

Evaluation of results

The merit of the approach is the immediate and season-wise increase in key water, environmental and socioeconomic indicators. The suite of measures demonstrated remarkable results and an increase in all indicators during the pilot implementation. Beyond the efficiency and productivity-related objectives, the suite of measures proved to be effective in enhancing farm resilience. While 2023 was flood-prone, 2024 experienced severe drought periods, which was successfully mitigated through the measures, particularly water-saving practices such as alternate wetting–drying and the variety selection.

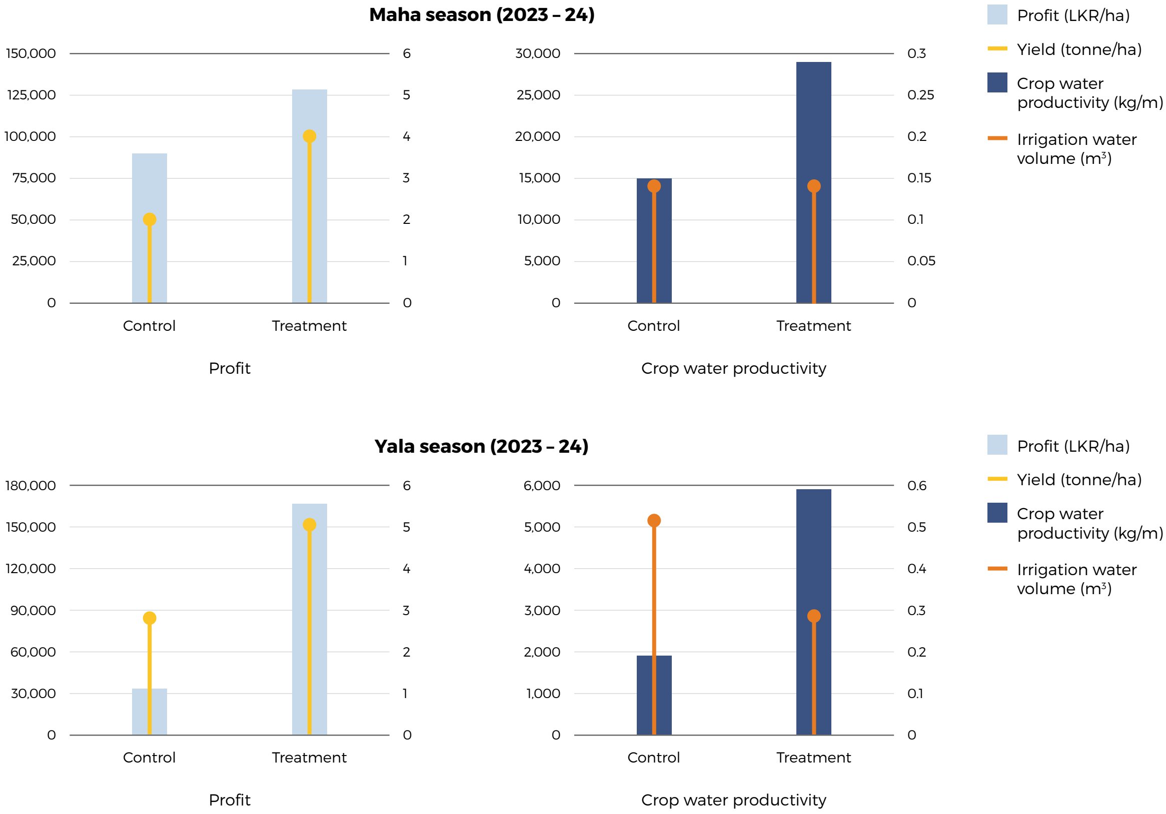
Key water and environmental indicators: The total irrigation water volume (m3 per ha) indicates the withdrawn water for irrigation without considering the rainfall. While the irrigation volume was reduced substantially through the implementation of the measures, the biomass increased from 6.6 tonnes/ha in the control field to 15.5 tonnes/ha in the treatment field. The reduced water amount and increased biomass, in turn, resulted in a triplefold crop water productivity in the treatment field. Better water management in the Maha season ensured sufficient reserve of stored water and soil moisture for unconstrained production in the Yala and third seasons.

As for key economic and social indicators – although the yield is not an accurate indicator for the comparison due to the different varieties used in the control and treatments field – the obtained profit proved that even if the measures require some investment, there is an immediate monetary return. The profit increased by five times in the dry season when water is usually a production-limiting input, and the measures enabled cultivation in the third season, thus improving land profitability. As a combined result of the water and economic indicators, the monetary crop water productivity increased by three times in the dry season.

Scalability strategy

The scalability strategy rests on three pillars: affordability, accessibility and sustainability:

FIGURE 4. **Results of the piloting phase**



Source: Authors' own elaboration

Affordability: The pilot design introduced an economic criterion within the multicriteria selection process. Its goal is to allow all farmers to adopt the measures without jeopardizing their economic stability. Affordability supports the scalability phase by allowing the implementation of measures at scale without requiring significant investment or being dependent on a central budget.

Accessibility: The pilot design involved only those resources that are locally available and do not require the development of the infrastructure ecosystem, e.g. deployment of new facilities for operation and maintenance or repair services as all inputs are locally available. Furthermore, they do not require mass production, and the scalability is not limited by resource-related conditions.

Sustainability: All measures support resource efficiency, including natural resources and other agricultural inputs. By implementing these measures on a large scale, the benefits, such as water and input savings, can be multiplied, making the scalability self-sustaining.

The main tool of the scalability strategy is the capacity-building component of the project. By fostering social learning and empowering the extension service, more communities can be reached as indirect beneficiaries of the project.

The key entry points for the scalability of the approach and measures are the following:

FIGURE 5. **Entry points for scalability**

Development of knowledge resources

1

- Stakeholder-differentiated knowledge products
- Guidelines for the distribution of the knowledge products

Advocacy

2

- Stakeholder consultation and validation of the knowledge products
- Identification of differentiated communication channels and publication outlets
- Launch of awareness-raising campaign

Monitoring mechanism

3

- Adoption of monitoring protocol to track the scale-out and its impact

Institutionalization

4

- Policy recommendations for mainstreaming the practices
- Update of the curriculum of the extension service
- Supervision of the within-community learning process

Source: Authors' own elaboration

LESSONS LEARNED

The pilot design was established to serve multiple purposes while keeping the objective of efficient and productive water management at the center of the intervention. The design was developed based on the situational analysis and needs assessment and involved a consultative process. Therefore, scalability and sustainability can be ensured. Based on the design and results, the following key messages can be concluded:

- Adopting the suite of productivity and efficiency measures is a more suitable and system-like approach if environmental and socioeconomic objectives are to be achieved simultaneously. Effective water management measures, combined with development objectives, are more likely to encourage communities to adopt this approach. This is because certain water management measures, such as alternate wetting–drying, require investment at the farm level, even though they do not lead to increased profits in all conditions. Therefore, such investments must be buffered to avoid negatively affecting farm profitability. Another benefit of this approach is that it counteracts the complexity of the diverse production environment where farmers have distinct measures and varying performance. As the suite of measures offers a range of measures, their farm-specific combinations can be inserted into different farm settings. The future scale-out should promote water efficiency measures together with yield and profit-increasing measures to secure the consent of farmers.

- The design of the recommended measures must consider the limited resources of farming communities. As farmers are smallholders with fragmented land plots and constrained mobility, the measures that require considerable investment from farmers or depend on inputs that are locally unavailable are less likely to be adopted. The pilot addressed the profitability-related concerns by producing considerably higher profits than the traditional farms. In the scale-out phase, it is essential to introduce the project approach in the context of an economic analysis. This is because if the advocacy focuses solely on the water-saving potential without demonstrating the economic benefits, farmers may be discouraged from investing in these measures.

- The water-saving potential of the suite of measures is substantial even if the measures are implemented only at the farm level. Reducing the applied water amount can create more equitable access among water users and improve resilience during water-scarce periods, among other benefits. On-farm modernization is often overlooked by large-scale infrastructure projects, so it is fundamental to complement infrastructure rehabilitation and modernization works with on-farm measures to fulfill their potential.

- Although the water-saving potential of the approach is high, the on-farm measures can achieve meaningful results only if practiced at scale. In particular, alternate wetting–drying is feasible and more effective only on a larger scale due to the movement of water on the surface and through the capillaries. Therefore, even on-farm practices require community-level coordination. Generating data and information is essential for this coordination, which requires a robust data management infrastructure. Future projects should consider the empowerment of the extension service and community-based organizations to create a permanent interaction for better coordination and accessible technical support for increasing the understanding of farmers.

- Automated sensors are inevitable to build data records in support of water management and production measures. Much of the production phase depends on natural processes such as rainfall at the crop establishment, adjusted water level at different growing stages, or sufficient soil moisture throughout the season. Sensors operated by relevant technical authorities can help establish evidence-based conditions for the measures. Therefore, automated technologies should be mainstreamed in the operation of research centers and extension services.

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With the financial support of the Ministry of Agriculture, Forestry and Fisheries, Japan

With the technical support of the Rice Research and Development Institute