

FINAL REPORT

Smart Sprayer: Efficient Terrace Irrigation in Nepal



REPORT

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CLIENT **Netherlands Enterprise Agency (RVO)**

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Climate Resilience Research Centre**

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Summary

The challenge

Smallholder farmers in the mid-hills of Syangja District, Gandaki Province, depend on springs and small streams to irrigate their terraces. From November to March many springs lose flow or dry up, and the remaining water has little pressure and a limited flow. Farmers therefore irrigate by hand with hoses and watering cans, or with small sprinklers that perform poorly at low pressure and must be moved often. This work is labour-intensive and loses water through evaporation and uneven wetting. Only 37% of the farmland in Putalibazar and 43% in Bheerkot is irrigated, and many terraces lie fallow in the dry season, even though off-season vegetables fetch high prices.

The Smart Sprayer

The Smart Sprayer combines a simple irrigation device with digital advice. The Sprayer, designed by Practica Foundation, is a low-pressure mechanical mini-pivot whose two rotating arms irrigate a circle of 10.9 m diameter (about 93 m²) from one position. It runs on gravity at about 0.2 bar, needs no electricity, and weighs 3.5 kg. Cromptal, the advisory service of FutureWater, calculates the daily water need of each crop from satellite-based evapotranspiration data (FAO WaPOR), crop type, and growth stage. Farmers receive the advice by SMS or WhatsApp as an irrigation time in minutes, which is easy to follow on a basic mobile phone. A rain gauge and a conversion table allow farmers to deduct rainfall from the advice.

Field testing

The consortium of FutureWater, Practica Foundation, and the Climate Resilience Research Center (CRRRC) tested the Smart Sprayer with 10 farmers in Putalibazar and Bheerkot municipalities. The farmers grew cabbage and cauliflower through the 2025/26 dry season and received daily advice from October 2025 until the harvest in March–April 2026. CRRRC registered the farmers in Cromptal, checked weekly that messages arrived, and collected field data, with three sprinkler- or hose-irrigated control plots for comparison. The two municipalities helped select farmers and monitor the trials.

Results

Farmers and local governments experienced clear benefits. The study reported water savings of 40–60%, achieved through even application and irrigation matched to daily crop demand. The same scarce dry-season water can therefore irrigate a larger area. Irrigation time per cycle fell by about 80%, as the Sprayer runs unattended once positioned and needs moving far less often than a sprinkler. Farmers, most of whom are women, valued this time saving most, together with the light weight of the device. Gentle, uniform application also reduced splash erosion and nutrient leaching.

Farmers reported 30–60% higher yields. On Smart Sprayer plots, measured head weights of cabbage and cauliflower were 60–135% higher than on control plots. Differences in transplanting and harvest dates, plant spacing, and crop management mean that this gain cannot be attributed to irrigation alone. Farmers followed the Cromptal advice closely: they applied exactly the advised amount in 77% of irrigation events, less in 21%, and more in only 2%. Many farmers use basic phones without WhatsApp, which made SMS delivery essential.

Lessons learned and product development

Field testing also revealed practical constraints. The 10.9 m circle does not always fit small, irregular terraces, the aluminium arms were considered somewhat fragile, and farmers stressed the need for local spare parts and repair. Price is the main barrier to adoption. An imported aluminium Sprayer would retail at about €142 (NPR 24,974), whereas farmers indicated a willingness to pay NPR 5,000–7,000 (€28–40).

In response, the consortium developed a low-cost prototype with arms of locally available bamboo carrying a polyethylene spray pipe and demonstrated it to farmers and municipalities in June 2026. Users can cut the arms to 3–6 m to suit their terraces, and the estimated retail price falls to about €60. Combined with the 50% subsidy offered by the participating municipalities, this brings the cost within the range farmers consider affordable. Cromptal was fully redesigned, with a new dashboard, a more reliable backend, advice by SMS as well as WhatsApp, and support for the Sprayer.

Market potential and upscaling

A market and supply-chain study by 500B Solution Pvt. Ltd. identifies semi-commercial and commercial vegetable farmers in water-scarce hill areas as the most promising initial target group. The report estimates their number at 8,547 in Syangja, 85,537 in Gandaki Province, and 593,271 nationally. The study recommends demonstrations and subsidised distribution through municipalities, NGOs, and agricultural programmes first, followed by commercial sales through agrovets, regional suppliers, and cooperatives. Farmers preferred Cromptal bundled with the Sprayer as a one-time purchase. Upscaling has already started. Putalibazar and Bheerkot intend to include the technology in their budgets and subsidy programmes, and the consortium is in discussions with DanChurchAid (DCA) and the Nepali organisation LI-BIRD on a joint pilot. Collaboration with GIZ and FinnChurchAid, and market access through SNV, are being explored.

The way forward: funding needed

The Smart Sprayer works under real farming conditions, meets a clear need, and has attracted interest from municipalities and development partners, but it is not yet ready for commercial roll-out. The bamboo Sprayer must prove its durability over an entire season, the design must suit smaller terraces, and local production, spare parts, and distribution must be put in place. Cromptal must be prepared to serve 1,000 or more farmers, with a lower-cost Nepali SMS provider, finer-scale evapotranspiration estimates, and automated rainfall correction. The consortium has therefore proposed a pilot with 30–100 farmers to validate the complete package at scale and strengthen the supply chain, with potential co-financing by local governments.

The results achieved with 10 farmers in Syangja could benefit tens of thousands of vegetable farmers working under similar conditions across Nepal's mid-hills. Funding is now needed to ensure the continuation and upscaling of the Smart Sprayer technology.

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1 Introduction

1.1 Background and objective

Syangja District, Gandaki Province, faces growing water scarcity and unpredictable rainfall, especially on hillside farms reliant on spring-fed irrigation and rain-fed agriculture. These conditions make traditional irrigation unworkable and create a need for low-pressure, affordable, and locally adaptable solutions. The Smart Sprayer combines practical hardware with a digital advisory tool to optimise limited water use, an innovation tailored for smallholder needs.

The project entails the feasibility of an integrated, low-cost “Smart Sprayer” irrigation system tailored for hillside farming and pairs it with a digital smart irrigation tool that delivers practical WhatsApp/SMS irrigation advice. The main innovation is the Smart Sprayer, a gravity-fed, low-pressure micro-pivot irrigation device, the sprayer, paired with a tailored smart irrigation tool, called Cromptal. The sprayer is designed to operate under low-pressure conditions without requiring external energy. It is simple, portable, and easy to maintain. Cromptal, on the other hand, is a mobile application that uses remote sensing data on evapotranspiration to provide location-specific irrigation advice. Together, the Sprayer and Cromptal aim to improve water-use efficiency, support off-season production, and strengthen the livelihood resilience of smallholders.

1.2 Problem statement

Water scarcity in Syangja, a mid-hill district in Nepal's Gandaki Province, poses a critical challenge to smallholder farmers who depend on rain-fed and spring-fed agriculture. These farms, especially on hillside terraces, suffer from low water availability during the dry season, limiting crop cultivation outside the monsoon period. Without appropriate, low-pressure irrigation solutions, farmers cannot irrigate efficiently or reliably, resulting in reduced agricultural productivity and heightened food insecurity.

The lack of water access during the dry season prevents the production of off-season crops—typically higher-value or staple vegetables—which are essential for household income and year-round food supply. Addressing this constraint is key to increasing farmer resilience and improving rural livelihoods.

Additionally, water scarcity in agriculture places pressure on shared natural water sources, including springs and streams, that are also relied on for domestic use. While not all water used in irrigation is lost—much is returned through recharge or downstream use—improving water productivity remains essential. Most farmers currently rely on low-efficiency surface irrigation systems that require large volumes of water and cannot operate at low pressure. These systems often result in unnecessary evaporation from soil surfaces and non-targeted wetting, particularly on sloped terrain.

1.3 Objective

The main objective is to improve water security and agricultural productivity for mid-hill smallholders during the dry season in Nepal. The specific aim is to demonstrate the technical, economic and social feasibility of a low-pressure irrigation solution and build capacity for wider adoption. This includes market research and development of business cases for both farmers and local suppliers. In particular, the following topics are addressed:

1. Water availability and scarcity – how sufficient and reliable existing spring sources are throughout the dry season, and how current irrigation practices distribute water.
2. Technical performance – how effectively the Smart Sprayer functions under low-pressure conditions, and how accurately the satellite-based advice from Cromptal aligns with actual crop water needs.

3. User experience and adoption potential – how farmers perceive, operate, and value both technologies in relation to their current practices, and whether the package presents a viable local market opportunity.

1.4 Stakeholders

The feasibility study involved Putalibazar and Bheerkot Municipalities, Agriculture Development Office (Syangja), ward offices of respective municipalities, farmers as direct stakeholders. Putalibazar and Bheerkot Municipalities supported site and farmer selection, and were involved in ongoing monitoring and testing of the Smart Sprayer system throughout the study. The Agriculture Development Office (ADO), Syangja coordinated closely with CRRC over the course of the study, contributing valuable technical suggestions, and supported the project commercially by purchasing several Smart Sprayer units for testing in farmers' fields.

Among the implementing partners, CRRC was responsible for field implementation and data collection across the selected plots; Practica Foundation was responsible for the technical design of the Smart Sprayer; and FutureWater was responsible for the digital advisory system i.e. Cromptal. Bhagyodaya Secondary School also served as one of the study's testing sites, hosting a demonstration plot that made the technology visible to the students studying there.

2 Smart Sprayer technology

Sprayer refers to the physical irrigation device whereas Smart refers to the Cromptal digital irrigation advisory. Combining the two technologies results in the Smart Sprayer. Each of the two technologies is described below.

2.1 Sprayer: low-pressure irrigation solution

The Sprayer is an irrigation technology developed by Practica to enable efficient irrigation under low-pressure conditions. The system has been designed to remain as simple and affordable as possible, ensuring that the cost of production stays low and that individual parts can easily be repaired or replaced when necessary. The lightweight (3.5 kg) aluminium construction ensures that the Sprayer is easily portable, allowing farmers to move it around their fields with minimal effort. With this technology, Practica aims to introduce an innovative and cost-effective product that helps farmers save water while maintaining accessibility and ease of maintenance.

The sprayer consists of a vertical pipe through which filtered water flows before entering the system. Attached to this vertical pipe are two horizontal arms, each 5.40 m long, see Figure 1. The vertical pipe is 10 centimetres in diameter, making the total diameter of the system 10.90 m. Each arm is divided into three two-metre sections. The first section contains holes that spray upwards, while the following two sections contain horizontally oriented holes. The horizontal outflow of water causes the arms to rotate, evenly distributing water across the field without the need for any external energy input. Each arm contains 28 holes, 56 in total, through which the water is released. The outer sections contain more holes over the same length, so the spacing between the holes is smaller. This design compensates for the larger surface area covered by the outer ring of the circle compared to the inner ring. The holes are positioned alternately rather than aligned, ensuring that, as the arms rotate, the sprayer irrigates the field in a series of evenly distributed circular patterns, resulting in the irrigation pattern shown in Figure 2. The sprayer irrigates an area of approximately 93 m². With this optimised spraying pattern, the Sprayer has an application efficiency of 90%.

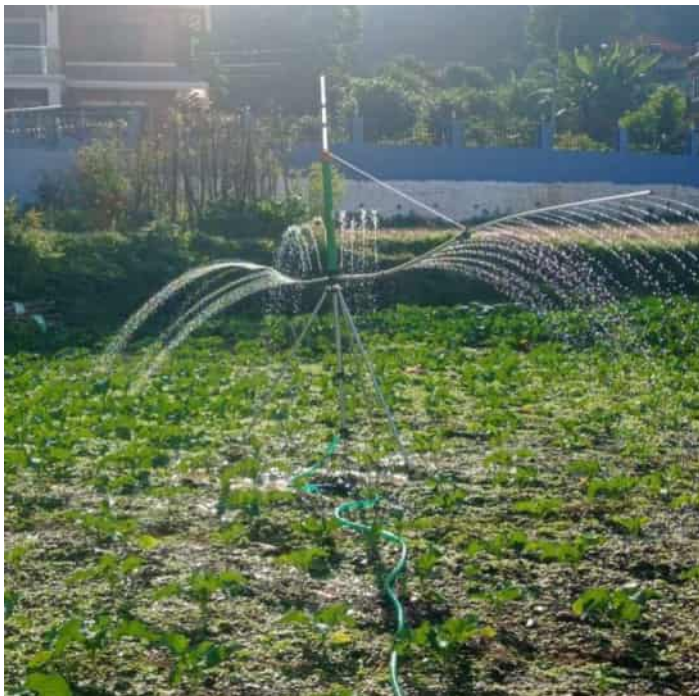


Figure 1 Smart Sprayer set-up in Nepal (photo by Maaïke de Wit)

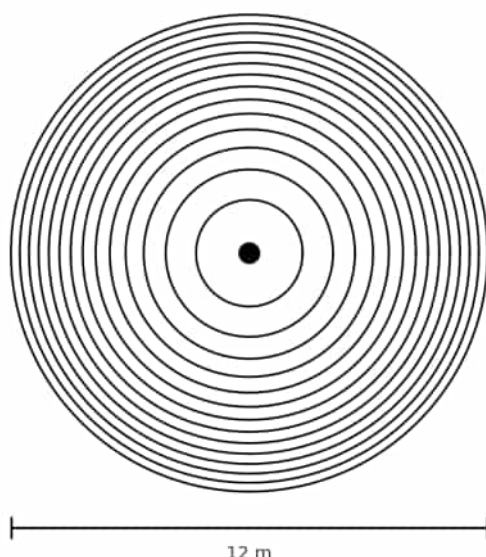


Figure 2 Schematic overview of the irrigation pattern of the Smart Sprayer showing decreasing spacing between rings towards the outer edge of the irrigated area.

To measure the pressure within the sprayer, a transparent plexiglass tube is mounted on top, containing a small float that indicates the pressure level. To maintain a consistent flow during irrigation, it is important that this float remains within the range marked by the red lines. The sprayer is designed to operate at low pressure. When all holes are open, the typical water flow of the Sprayer is 960 L/h at 0.2 bar pressure. If this flow cannot be achieved by the water source, half of the holes will be sealed, reducing the flow of the Sprayer to approximately 550 L/h at 0.2 bar pressure. At the given conditions, the Sprayer has an application rate of 10.3 mm/h with all holes open and 5.9 mm/h with half of the holes sealed.

2.2 Cromptal: satellite-based irrigation advisory

Cromptal is a daily irrigation advisory service using WhatsApp and SMS, developed by FutureWater. The system is based on crop water theory from FAO to calculate daily crop water requirements. In its calculations it considers:

- **Current weather:** temperature, sunshine, wind
- **Crop type:** different crops need different amounts of water
- **Growth stage:** young plants need less water than mature ones
- **Irrigation system:** drip or sprayer specifications, flow rate of the system

The advice is provided in **minutes of irrigation time** instead of mm irrigation, using the calibrated application rate of the Sprayer. Field experience has shown that irrigation advice in minutes allows for easier implementation by small and medium scale farmers, especially in settings where literacy is low. The different components and workflow of Cromptal are presented in Figure 3.

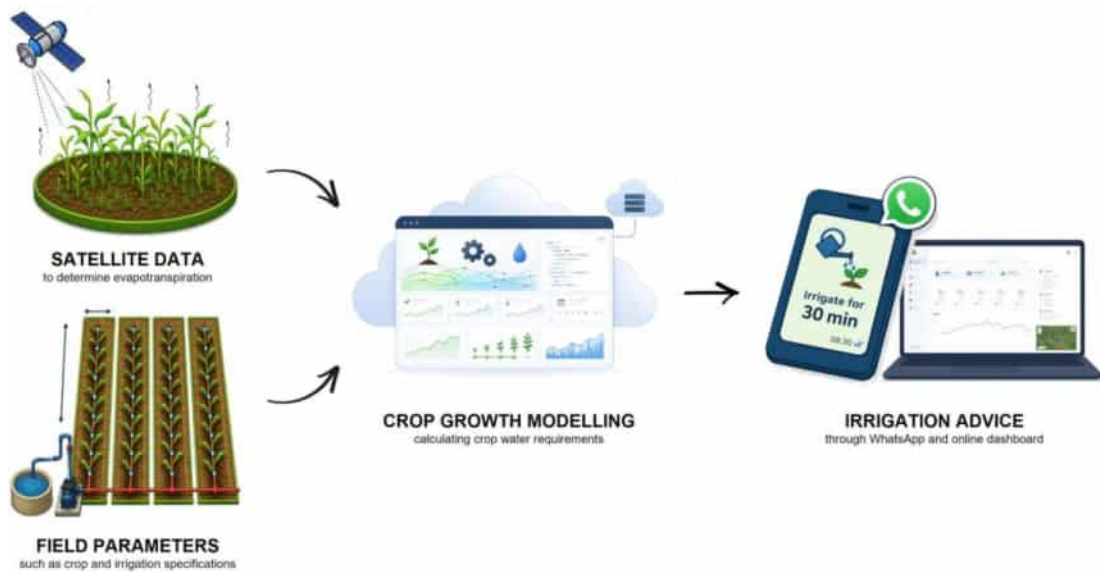


Figure 3 Schematic overview of how Cromptal works.

The Cromptal system follows several steps to supply daily irrigation advice (Figure 4).

1. Reference evapotranspiration (ET_0 , from WaPOR) for the farmer's location for the past 3 days is downloaded and averaged.
2. The sowing date in Cromptal is used to calculate the plant's current growth day and corresponding K_c value.
3. ET_0 is multiplied with K_c (based on FAO data) to calculate the crop evapotranspiration (ET_c) for today, in millimetres.
4. The farmer's field area is multiplied with the ET_c , to get the required water volume.
5. The flow rate of the irrigation system is combined with the required water volume, to calculate the irrigation advice in minutes.
6. The advice is sent at the preferred time to the farmer over SMS or WhatsApp.
7. Farmers measure precipitation in the field and use a precipitation conversion table to subtract minutes from the advice, based on their specific irrigation system. Rain gauges were provided to enable farmers to record rainfall and subtract it from the advice. For this, a farmer-specific rainfall conversion table was developed, helping to convert rainfall in millimetres to irrigation in minutes.

An extensive guide was also developed to explain to extension workers and advisory companies how to set up new farmers, fields and crops within Cromptal (Annex A).

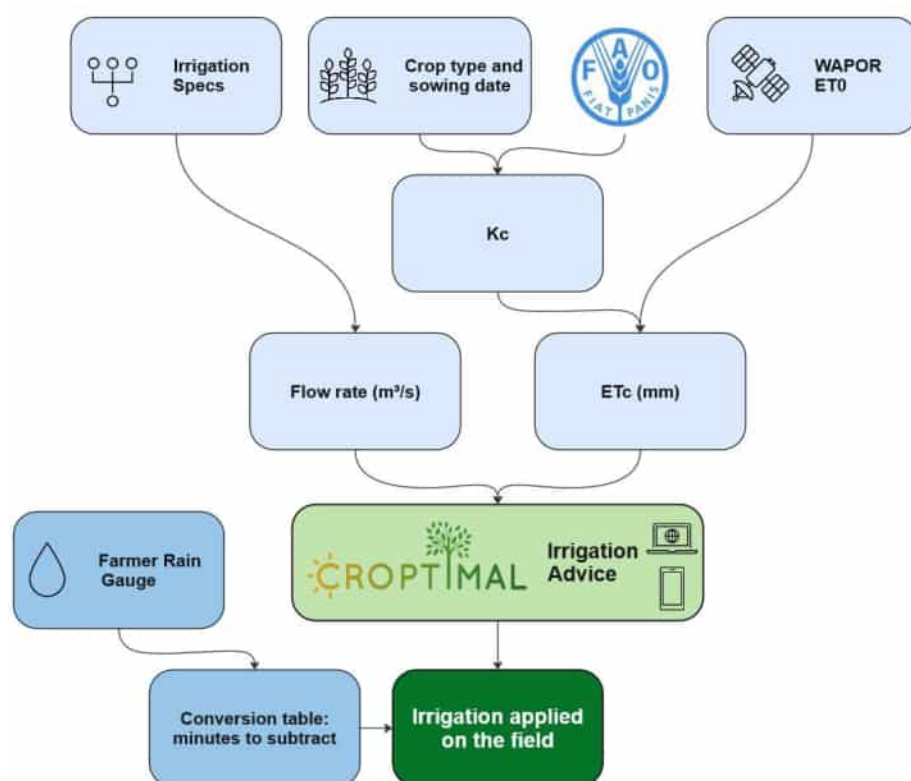


Figure 4 Schematic workflow of Cromptal to generate irrigation advice.

The updates to Cromptal were tested in the field in Nepal. Close coordination with the team from CRRC and training of the CRRC staff during the project visit allowed for quick and smooth onboarding of farmers in Cromptal. CRRC's on-the-ground presence also made it possible to quickly find and resolve any bugs in the system and improve overall user experience. Their local presence has proven vital for Cromptal's success in the project.

From the start of the dry season in October 2025, when sowing commenced, until the harvest in April 2026, Cromptal provided daily crop-specific irrigation advice to farmers in the project. Staff from CRRC served as extension workers and added all farmers, their fields and their crops to Cromptal, making sure that the farmers' details – such as location, phone number and planting date – were correct. The farmers could also choose a daily preferred advice time, giving them more control on the use of the Smart Sprayer. CRRC verified weekly that messages were being received correctly.

During the project Cromptal was improved significantly and was turned from a first prototype to a fully developed dashboard. The development can be seen in Figure 5.

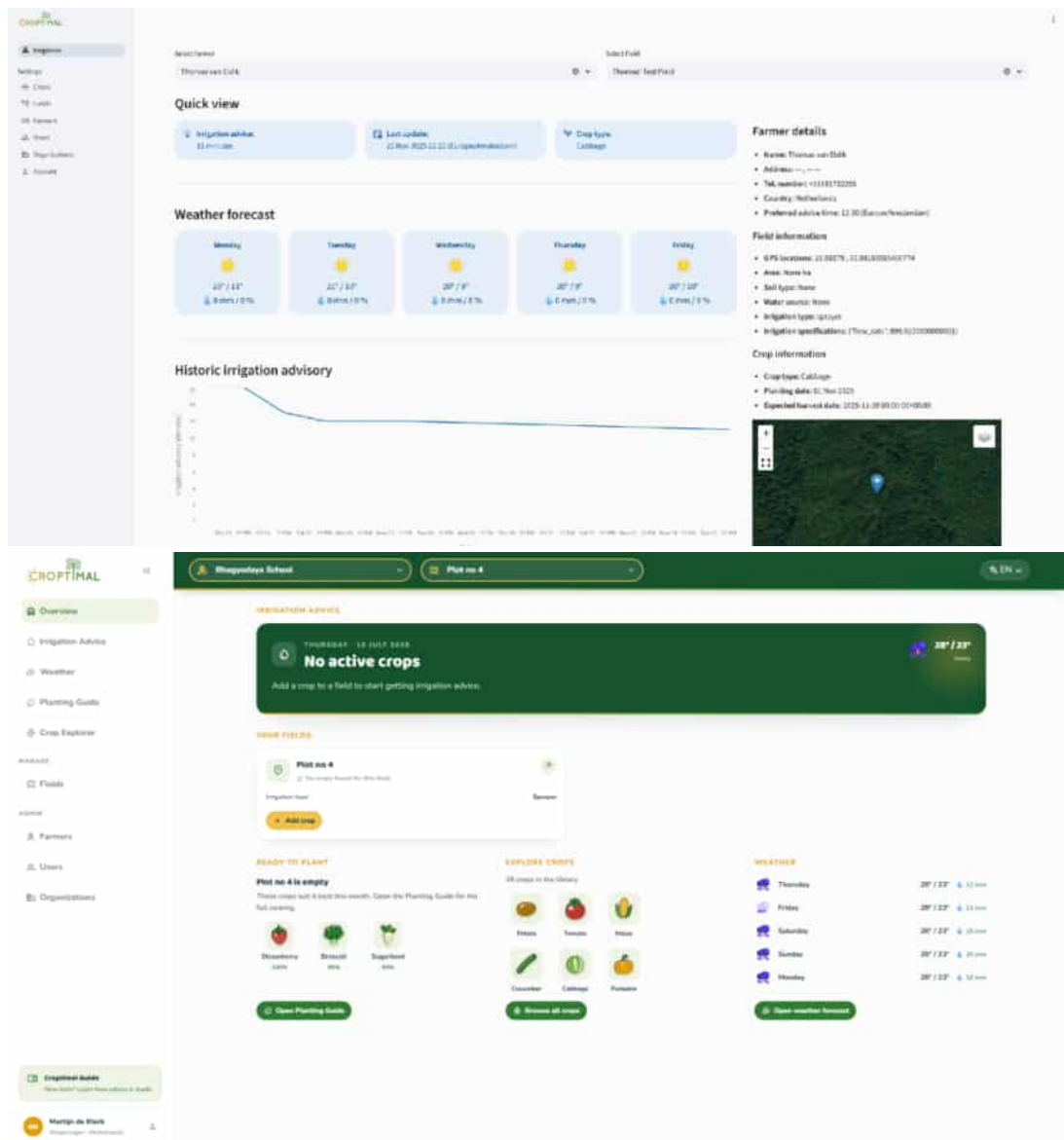
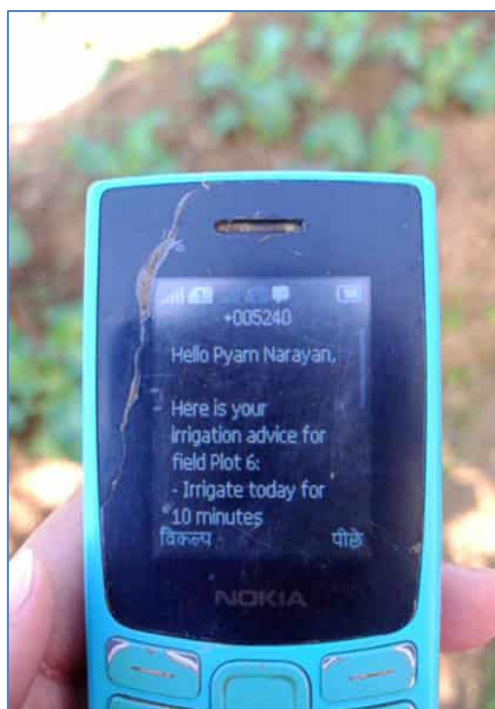


Figure 5 During the project CROPTIMAL developed from a prototype (top) to a fully developed dashboard (bottom).

Figure 6 shows the irrigation advice arriving on a farmer's phone. The advice indicates how long a farmer must irrigate a single Sprayer circle (~93 m²), assuming no precipitation. Farmers measured precipitation with a rain gauge, subtracting precipitation from the advice using a farmer-specific conversion table; an example can be seen in Figure 6.



CROPTIMAL वर्षा रूपान्तरण तालिका (Croptimal Precipitation Conversion Table)	
स्प्रेयर प्रवाह दर (एल/घ) (Sprayer flow rate (L/h))	700
वर्षा (मिलिमिटरमा) (Precipitation (mm))	सल्लाहबाट घटाउनुपर्ने मिनेटहरू (Minutes to subtract from advice)
1	10
2	15
3	25
4	35
5	45
6	50
7	60
8	70
9	80
10	85
तपाईंको वर्षा मापन उपकरण खाली गर्न नबिर्सनुहोस्! (Don't forget to empty your rain gauge!)	

Figure 6 SMS-based irrigation advice arriving on a farmer's phone, and the tailor-made precipitation conversion table.

3 Project study sites

3.1 Putalibazar and Bheerkot municipality

In the Syangja District, two municipalities were selected as the focus areas of this study: Putalibazar and Bheerkot (Figure 7). The population of Putalibazar municipality was 44,876 with 7,582 farmers' families as recorded in agriculture census 2021 AD (2078 BS). Cultivable land is 5,025 hectares.

Despite the productive land, the total irrigated field is 1,873 hectares i.e., only about 37% of cultivable land is irrigated. Similarly, the total population of Bheerkot municipality is 18,134 with 4,722 farming families. Bheerkot municipality consists of a total of 2,245 ha cultivated land, and the total irrigated land is 956 ha (i.e. 43% of cultivated land). So, most of the land in the region is rain-fed, especially the fruit orchards. However, during the dry season the cultivation of most vegetables needs irrigation. To understand these irrigation practices, it is important to first understand the current hydrological systems.

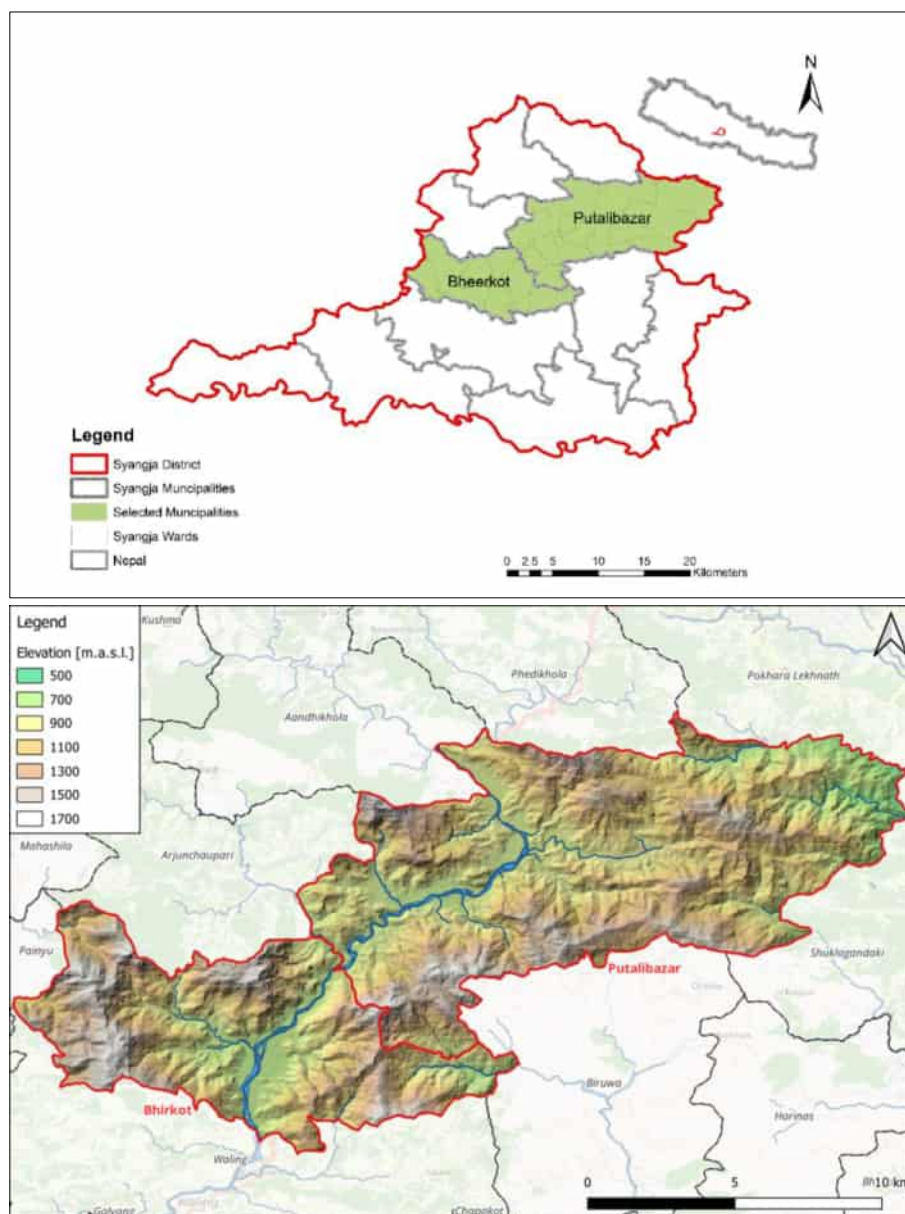


Figure 7 Syangja district and the municipalities Bheerkot and Putalibazar.

3.2 Water resources and availability

Both Putalibazar and Bheerkot Municipalities are supplied by a network of rivers, springs, and streams originating in the mid-hills of Syangja. Andhikhola River is the major perennial river (Figure 8), providing irrigation and fulfilling domestic water requirements in both municipalities. The smaller tributaries and seasonal streams are used for the terraces. Traditional canals (*kulo*) in irrigated *khet* terraces channel water from rivers such as the Andhikhola to support paddy cultivation during the monsoon season. These farmer-managed irrigation systems are maintained collaboratively, with households contributing labour to clean and repair channels prior to planting season but also facing the challenges of labour availability and climate-induced variability in water flow.

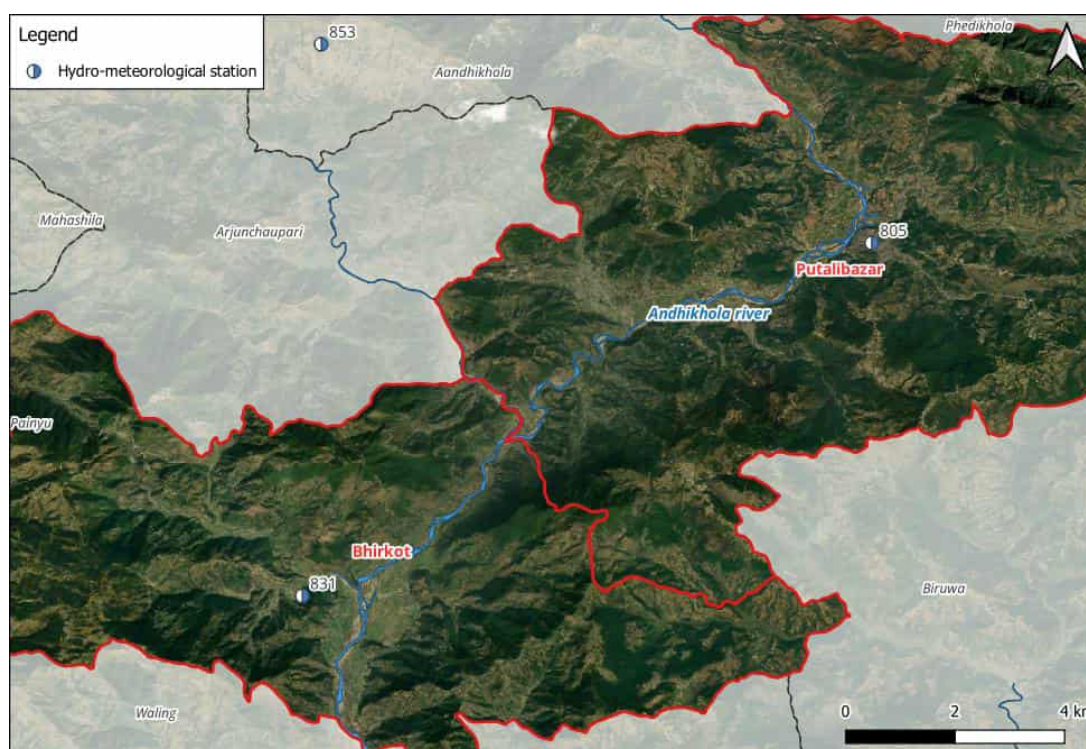


Figure 8 Map of the municipalities of Bheerkot and Putalibazar and the river Andhikhola.

Insufficient supply of water has become an ongoing concern in Putalibazar and Bheerkot municipalities, particularly during the dry months from Mangsir to Chaitra (November to March), when numerous springs reduce their flow or completely dry up. Residents and farmers must rely mostly on river water, which is channelled via small dams and kept in water tanks—which is currently accessible in a few wards, including Wards 05 and 12 of Putalibazar municipality. Many farms are located well above the elevation of water sources. Solar pumps are effective near rivers or in flatter terrain but are not viable at these elevations, where pumping vertical distances of over 100 metres is technically and financially challenging. Available spring water is typically low pressure and flow-limited, making it incompatible with conventional irrigation methods like flood irrigation or sprinklers. This situation contributes to reduced crop yields, abandonment of terraces during the dry season, and a missed opportunity to intensify agriculture sustainably. Furthermore, without improved irrigation control, water use in agriculture remains disconnected from crop demand, leading to poor returns on limited water inputs.

Recognising these constraints, the municipality has taken some irrigation management steps, such as building canals, distributing drip irrigation sets, promoting HDPE pipes (20–50 mm) for carrying water across steep terraces, and constructing small water ponds to store rainwater or diverted river flow in Putalibazar municipality. These techniques contributed to vegetable cultivation and reduced some of the

seasonal stress, yet they are insufficient to fully meet demand. A further problem is the lack of a wastewater treatment system, which raises concerns about water quality, especially since untreated home and farm effluents frequently enter nearby streams. As a result, municipalities face a dual challenge: maintaining adequate water supply during the dry months while preserving the quality of its limited water supplies for both household as well as agricultural purposes (Source: discussions with Putalibazar Municipality and Bheerkot Municipality).

3.3 Current irrigation practices and water systems

Most farmers convey water to their fields using pipes with a diameter of 20 mm. Water is supplied either directly from a spring, tapped from a communal distribution line, or drawn from a private storage tank. All systems operate at low flow. In many cases, water is transported over relatively long distances (up to 900 m was observed) using 20 mm pipes, which leads to considerable pressure losses within the system.

Traditional irrigation practices include manual irrigation, the use of watering cans, and sprinkler irrigation. Traditionally, irrigation is carried out manually by farmers using hoses or watering cans (Figure 9). This approach is highly labour-intensive and time-consuming, as water must be applied and distributed by hand across the field. A more advanced method is sprinkler irrigation, which operates under low pressure and distributes water in a circular pattern while rotating (Figure 10). It irrigates an area with an approximate diameter of three metres. However, in many fields the available water pressure is insufficient, resulting in suboptimal sprinkler performance. This is reflected in reduced distribution uniformity and a smaller effective irrigation radius. Although sprinkler irrigation reduces labour requirements compared to manual irrigation, it still demands considerable labour time because the sprinkler needs to be moved frequently due to its limited coverage radius.



Figure 9 Woman irrigating manually with the hose (Maaïke de Wit, October 2025)



Figure 10 Sprinkler irrigation (Maaik de Wit, October 2025)

3.4 Socio-economic context

The major occupation of people in Syangja district is agriculture, followed by animal husbandry, tourism-related work and foreign employment (remittances). Agriculture is the primary livelihood of people of Syangja district. Paddy, maize, millet, wheat, vegetables and fruits are the major crops growing here. Similarly, oranges, coffee, ginger, cardamom and potatoes are the major horticultural crops and are the major source of income. Mostly Syangja is famous for oranges which contribute a significant area of cultivation and yield. Besides this, cottage industries, handicrafts and small-scale business also contribute to the local economy. Tourism-related industries are also gaining high attraction because of its natural beauty, cultural and historical sites and the recreational possibilities inside the district (*Syangja District - Wikipedia*, n.d.).

Besides the natural gift and the potential, Syangja district faces several challenges including the lack of infrastructures, poor road connectivity leading to poor access to essential services and markets, outmigration by mostly men causing labour shortage, vulnerability to natural disasters like floods and landslides, limited access to quality education and healthcare facilities, and water resources challenges.

An estimated 10,000 people in the Syangja district are directly affected by seasonal water shortages and inefficient irrigation practices. Inability to produce off-season crops forces many households to rely on less nutritious staples, purchase food at higher prices, or seek alternative income sources.

Off-season crops, such as leafy vegetables, onions, or tomatoes typically fetch higher market prices due to scarcity, meaning that even modest increases in production during dry months can significantly boost household income. This untapped market opportunity makes dry-season irrigation a key lever not just for food security, but also for economic resilience.

4 Smart Sprayer testing and product development

It was decided to test the Smart Sprayer by focusing on two crops: cauliflower and cabbage. These vegetables are in high demand during the dry season, remain close to the ground (and therefore do not interfere with the sprayer), and are well suited as winter crops. Each farmer participating in the feasibility study received one sprayer.

Of the seed costs, 80% was paid from the project budget and 20% by the participating farmers. The seeds were sown in the nursery between 7–10 October 2025. Timing of seedling transplantation to the plots was dependent on environmental factors and growth of the seedlings. The transplantation took place between 2–7 November 2025.

The product was well received by smallholder farmers. The novelty lies in combining highly uniform, low-pressure mechanical irrigation – working on gravity or a small pump, with no electricity – with a digital advisory that reaches farmers on a basic mobile phone. From October 2025 to April 2026, Croptimal sent daily, crop-specific advice indicating exactly how long to irrigate a single Sprayer circle (~93 m²), with a tailor-made conversion table to subtract measured rainfall.

The effect on water availability matches the foreseen effect: by applying water uniformly and only when needed, the same scarce dry-season water irrigates a larger area – directly addressing the springs' declining flows in the mid-hills.

The testing and product development for each of the two components are described in the next paragraphs.

4.1 Sprayer testing

Overall findings

Overall, farmers were eager to test the Smart Sprayer and responded positively to its performance during the field trials. The main advantages identified were the uniform and gentle application of water, the relatively large area irrigated from a single position, and the reduction in labour required for irrigation. Its lightweight construction also made the Sprayer relatively easy to carry and reposition between different parts of a field.

At the same time, testing under actual farming conditions revealed several practical constraints. The circular irrigation pattern does not always correspond well with the small and irregularly shaped terraces found in the study area. The aluminium arms were also considered somewhat fragile, and farmers stressed the importance of locally available spare parts and easy repair. These findings point to a trade-off in further product development: the Sprayer should be adaptable and affordable enough for smallholder plots while retaining the large coverage area and low labour requirement that distinguish it from conventional sprinklers.

The main findings from field testing are discussed in more detail below.

Irrigation performance and uniformity

Farmers were generally positive about the irrigation performance of the Sprayer. They reported that water was distributed evenly over the irrigated area, without noticeable wet spots or areas receiving excessive amounts of water. Farmers also appreciated the relatively soft application of water. Because the droplets are applied close to the crop rather than sprayed from greater height, they cause limited disturbance to the plants and soil. Farmers perceived this as reducing splash erosion and the risk of nutrient leaching associated with localised over-irrigation.

There are, however, small gaps in the irrigation pattern. The Sprayer arms consist of three segments that slide into one another. At the connection points between these segments, no irrigation holes are installed. This creates two narrow circular bands that receive little or no direct irrigation, as illustrated in Figure 11.



Figure 11 Drone image showing the irrigation pattern of the Smart Sprayer, with two dry circles corresponding to gaps in irrigation at the arm connections.

Farmers expressed little concern about these dry bands because of their limited width and the expected lateral redistribution of water through the soil. Given that soils in the study area are predominantly clay and loam, some redistribution within the soil profile can reasonably be expected.

Nevertheless, the dry bands could pose a potential risk for recently transplanted crops that have not yet developed sufficiently large root systems to access moisture from the surrounding soil. This could not be assessed conclusively during the study because farmers generally started using the Smart Sprayer approximately two weeks after transplanting, when the crops were already established. The performance of the Sprayer immediately after transplanting should therefore be examined in further testing and, if necessary, addressed in future design iterations.

Ease of use and labour requirements

One of the main practical advantages identified by farmers was the reduction in labour required for irrigation. The Smart Sprayer covers a diameter of approximately 10.9 m, corresponding to an irrigated area of approximately 93 m² from a single position. This is considerably larger than the area covered by the conventional sprinklers commonly used in the study area. As a result, the Sprayer needs to be relocated less frequently during irrigation.

Once positioned and operating at the correct pressure, the Sprayer can also be left to operate without continuous supervision. Farmers can therefore carry out other farm or household activities while irrigation is taking place, rather than continuously applying water manually or frequently moving a conventional sprinkler. This is an important practical benefit in a context where agricultural labour availability is limited.

Despite its relatively large dimensions, the Sprayer itself is lightweight. At approximately 3.5 kg, farmers found it easy to carry and move between irrigation positions. This combination of a large coverage area and low weight was generally considered an important advantage of the design.

Plot size, shape and adaptability

The large irrigation diameter also creates a trade-off. Agricultural terraces in the study area are often small and irregularly shaped. Some are rectangular, while others are tapered or follow the contours of the hillside. The circular irrigation pattern of the Smart Sprayer therefore does not always correspond with existing field boundaries and cultivation patterns.

Farmers can respond to this in different ways. Where possible, cultivation can be organised around the circular irrigation pattern, as illustrated in Figure 12. Alternatively, farmers can maintain their existing field layout and irrigate areas outside the Sprayer's reach using another method, such as a hose. Farmers will require experience with the technology to determine which field layouts and planting arrangements work best under their particular conditions.



Figure 12 Drone image of a farmer's field showing how the field layout was adapted to the circular irrigation pattern of the Smart Sprayer.

For some of the smallest plots, accommodating the Sprayer's 10.9 m diameter proved difficult. Where the irrigation circle extends beyond the cultivated area, part of the applied water does not contribute directly to crop production, reducing the potential water-saving benefit. Irregular field shapes can also limit the number of locations in which the Sprayer can be positioned. At some sites, the Sprayer fitted in only one part of the field, meaning that the remaining area still had to be irrigated using another method (Figure 13).



Figure 13 Drone image showing a field where the Smart Sprayer can only be accommodated in one part of the plot; the remaining cultivated area requires another irrigation method.

Several farmers therefore indicated that they would prefer a Sprayer with a smaller or adjustable diameter. Adjustable arm lengths could potentially make the technology suitable for a wider range of terrace sizes and shapes. However, reducing the diameter also reduces the area irrigated from a single position and consequently increases the number of times the Sprayer needs to be relocated.

Other farmers, particularly those engaged in more commercial vegetable production and operating relatively larger plots, preferred the existing large diameter because it enables them to irrigate a larger area with fewer relocations. This highlights an important consideration for further product development: a single Sprayer configuration may not be optimal for all farmers. Further testing could therefore explore whether adjustable arm lengths or different Sprayer sizes can provide greater flexibility without compromising irrigation performance or substantially increasing cost and complexity.

Robustness, maintenance and spare parts

Farmers stressed that the Sprayer needs to be robust and easy to repair under local conditions. Although the aluminium construction contributes to the low weight of the product, the arms were considered somewhat fragile for prolonged use under farm conditions. Greater robustness would therefore be desirable, provided this can be achieved without substantially increasing the weight or cost of the Sprayer.

The availability of replaceable components and locally obtainable spare parts was considered equally important. Farmers indicated that previous experiences with introduced agricultural technologies have sometimes been negative because damaged components could not be repaired or replaced locally. Once a relatively minor component failed, the entire product could become unusable.

For wider adoption, the Sprayer should therefore be designed so that commonly damaged or worn components can be replaced individually, preferably using basic tools and parts that can be produced or stocked locally. This consideration contributed to subsequent product development, including the exploration of locally sourced materials described in Section 4.2.

Comparison with conventional sprinklers

Conventional sprinklers are the most relevant direct competitor to the Smart Sprayer in the study area. Their principal advantage is price: a conventional sprinkler costs approximately NPR 250 (€1.50), whereas the estimated cost of the Smart Sprayer tested during the project was approximately €142 (NPR 24,974). The Smart Sprayer therefore needs to provide substantial additional benefits to justify the higher investment.

The main advantage observed during testing is coverage (Figure 14). A conventional sprinkler used by farmers in the study area typically irrigates a much smaller diameter and consequently needs to be repositioned frequently. The Smart Sprayer covers approximately 93 m² from a single position and can operate without continuous supervision. This reduces both the number of relocations and the amount of farmer attention required during irrigation, freeing time for other farm and household activities.

Farmers also perceived differences in the way water is applied. Conventional sprinklers spray water higher into the air, whereas the Smart Sprayer applies water relatively close to the crop. Farmers reported that the resulting softer droplets caused less disturbance to crops and soil. Together with the more uniform distribution observed during the trials, this was perceived to reduce wet spots, splash erosion and the risk of localised over-irrigation.

The comparison with conventional sprinklers illustrates an important design trade-off. Reducing the length of the Sprayer arms could make the system better suited to small and irregular plots, but would also reduce one of its main competitive advantages: the large area irrigated from a single position. Further product development should therefore seek to improve adaptability without losing the labour-saving benefits associated with the current coverage area.

Ultimately, the significantly higher purchase price remains an important barrier to adoption. The extent to which farmers are willing and able to pay for the additional benefits of the Smart Sprayer, and the opportunities to reduce its production cost, are addressed further in Sections 4.2 and 5.4.

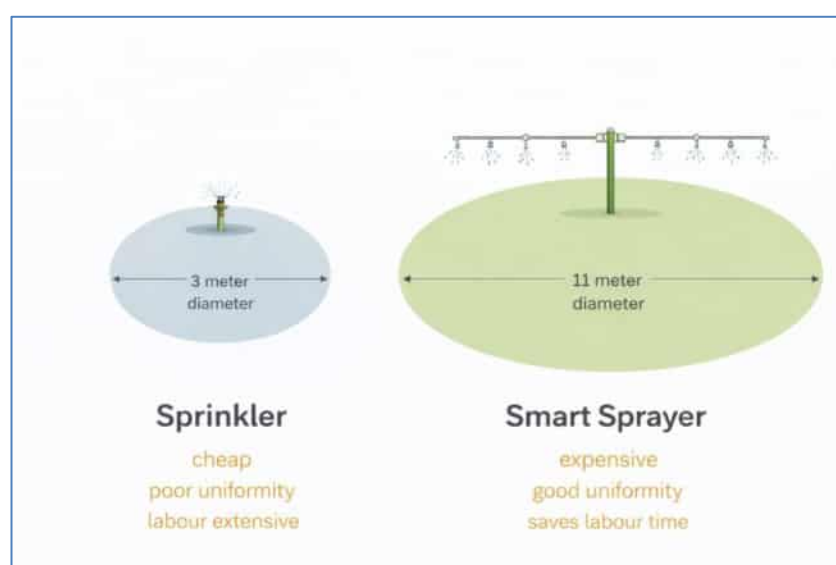


Figure 14 Illustration of specifications of the traditional sprinkler irrigation and the Smart Sprayer.

4.2 Sprayer product development

Field testing identified affordability, robustness and local repairability as important factors determining the potential for wider adoption of the Smart Sprayer. In particular, the anticipated retail price of the

aluminium version was considered too high for many smallholder farmers. This led the project team to explore design modifications that could reduce production costs while maintaining the main advantages of the Sprayer: low-pressure operation, a large irrigation area, uniform water application and easy handling.

Development of a low-cost bamboo Sprayer

The most significant product development during the project was the introduction of a low-cost version in which the imported aluminium arms were replaced with locally available bamboo. Bamboo was selected because it is widely available in Nepal, inexpensive, lightweight and can potentially be processed and replaced locally.

A prototype bamboo Sprayer (Figure 15) was developed during the study and demonstrated to farmers and representatives of the participating municipalities in June 2026. Initial testing showed that the basic operating principle of the Sprayer could be maintained using bamboo arms. The development therefore offers a promising pathway to substantially reduce both material and production costs while increasing the potential for local manufacturing and repair. While bamboo provides the structural support, a polyethylene (PE) pipe is used for the water spray. The PE pipe and bamboo can be cut to length (3–6 m per arm, 6–12 m diameter) by the user to accommodate different field sizes and farmer preferences.



Figure 15 Low-cost bamboo version of the Smart Sprayer developed and demonstrated during the study.

The estimated retail price of the bamboo version is approximately €60, compared with approximately €142 for the aluminium version tested during the project. Further cost reductions may be possible through local sourcing, standardisation of components and production at larger scale. This is important because farmer feedback indicated that the purchase price is one of the main barriers to adoption.

Local production could provide additional benefits beyond cost reduction. Individual bamboo arms could potentially be manufactured and replaced locally, reducing dependence on imported components and addressing farmers' concerns about access to spare parts. The use of bamboo could therefore contribute both to affordability and to the long-term repairability of the product.

At the same time, the bamboo version remains a prototype and requires further field testing before commercial introduction. In particular, its durability over multiple irrigation seasons, resistance to repeated wetting and drying, dimensional stability and connection strength need to be assessed. Future testing should therefore compare the technical performance and lifetime costs of the bamboo and aluminium versions under normal farmer use.

Applied irrigation volume monitoring

A second product development focused on giving farmers better information on the amount of water actually applied. A simple monitoring feature was developed that indicates the applied irrigation depth in millimetres. This allows farmers to verify how much water has been applied during an irrigation event rather than relying only on irrigation duration.

This feature is particularly relevant when combining the Sprayer with Cromptal. Cromptal calculates crop water requirements and translates these into an advised irrigation duration based on the expected application rate of the Sprayer. Providing farmers with information on the actual irrigation depth creates an additional means of checking whether the recommended amount of water has been applied. In this way, the monitoring feature can help connect the physical Sprayer more directly with the digital irrigation advice.

Further testing is required to determine the accuracy, robustness and ease of use of this feature under field conditions and whether farmers find the additional information useful in their day-to-day irrigation decisions.

Priorities for further product development

The field testing and prototype development demonstrate that there is scope to further adapt the Smart Sprayer to the conditions of Nepal's mid-hill farming systems. The next development phase should focus on achieving an appropriate balance between affordability, durability, coverage and adaptability. In particular, further testing should assess the long-term performance of the bamboo version, opportunities for local production and repair.

A larger field pilot involving a wider range of farmers and plot conditions is therefore recommended before finalising the design for commercial production. Such a pilot would allow the consortium to validate technical performance over a longer period, refine the product based on farmer experience, establish realistic production and retail costs, and determine which Sprayer configuration is most suitable for wider market introduction.

4.3 Cromptal testing

Throughout the fieldwork, it became clear that this type of technology is very new for most farmers. Traditionally, irrigation decisions are based on tactile assessment of the soil or visual observations of crop conditions. With Cromptal, farmers are instead asked to rely on an SMS-based recommendation generated by an external system. Farmers indicated that they were curious and interested in this new technology, as they are motivated to improve their practices and develop further as farmers. At the same time, they also expressed that such digital advisory tools are unfamiliar, and they are still exploring whether and how this technology can reliably support their irrigation decisions.

Comparing irrigation advice with actual application

Most farmers applied irrigation volumes that matched the Cromptal irrigation advice. The study results show that in 77% of the irrigation events, the amount of irrigation applied matches exactly the Cromptal advice. In total, during 21% of all irrigation events, less irrigation was applied than advised. In contrast, applied irrigation volumes exceeding the advice occurred only rarely (2% of irrigation events). This

pattern suggests that the Cromptal irrigation advice is often perceived as being slightly too high under field conditions.

It is also possible that some farmers did not fully understand how to calculate the irrigation advice. The advice is obtained by using a conversion table to account for local rainfall recordings, as described in Chapter 2. Misinterpretation of how the advised irrigation should be translated into the actual amount of irrigation applied by farmers occurred in 6% of the irrigation events. This reflects some difficulty in correctly converting the SMS advice into the total irrigation time. For this reason, irrigation amounts are compared against the interpreted Cromptal advice rather than the original advisory values.

Practical use

It became clear during the field visits that farmers, in a broader sense, were not yet familiar with modern technologies. The initial assumption was that farmers would receive irrigation advice via WhatsApp messages. However, during field visits it became apparent that many farmers do not have access to WhatsApp. Instead, they rely on basic mobile phones, such as older Nokia models, which only support SMS. This finding highlights the importance of assessing whether farmers in a given area actually have access to smartphone-based communication platforms before implementing digital advisory tools.

4.4 Cromptal development

At the start of the project Cromptal was a product in an early stage of development and required further refinement before it could be fully integrated into farmers' daily irrigation practices. The purpose of this study was therefore to identify where practical challenges arise in the field and where improvements can be made to enhance usability, reliability, and adoption. We are grateful to the farmers who participated in this research and generously shared their time, experiences, and feedback, as their input has been essential in understanding how the system performs under real-world conditions.

Cromptal was an existing digital service at the start of this project, developed by FutureWater in previous projects in Rwanda and Ghana. The core of Cromptal has remained the same since its inception: practical irrigation advice in minutes based on field characteristics, crop data and satellite data. However, over the years Cromptal has become outdated and faced frequent downtime and bugs. Therefore, this Partners for Water (PvW) project was used for a complete redesign of Cromptal, both for the frontend and the backend.

A new dashboard was developed, improving the user experience and making the Cromptal data more easily accessible to farmers and extension workers. Figure 16 shows an example page of the new Cromptal dashboard. The backend was also redesigned according to the latest Python standards, leveraging an object-oriented approach to make the system faster, more reliable and resilient for future developments. Cromptal was also moved to a new cloud server and was integrated with state-of-the-art web technologies to ensure a high uptime and speed.

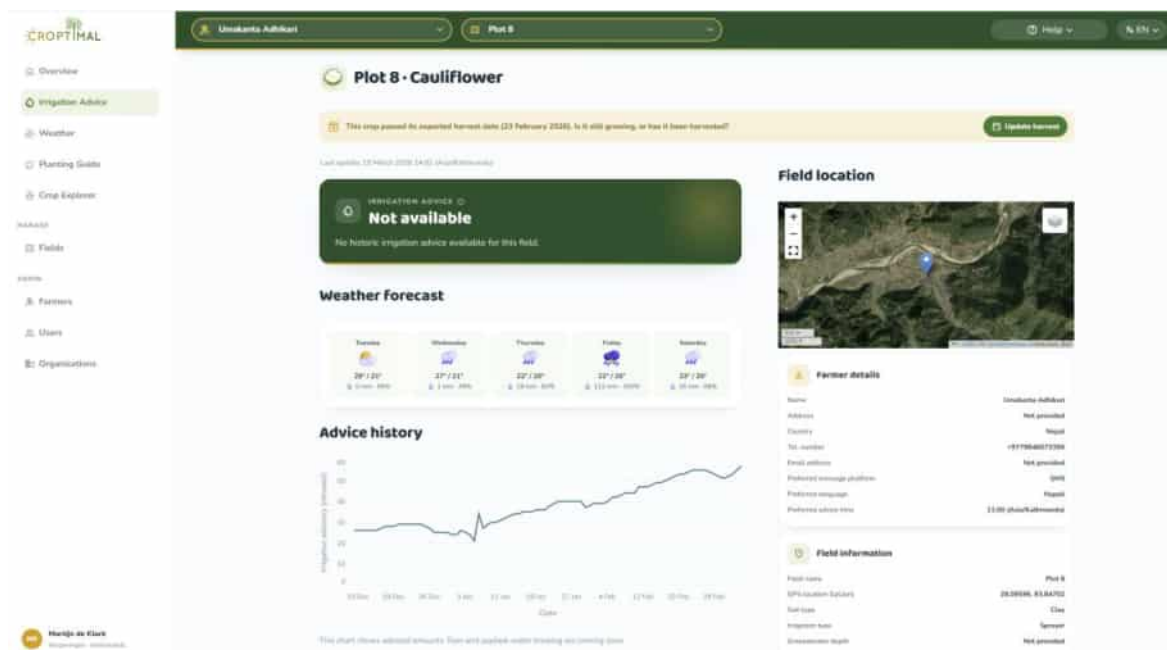


Figure 16 Screenshot of the Cromptal app for one of the farmers.

Besides the technical updates, the system also received several new features. The most important one was the compatibility with the Sprayer. Before, Cromptal only worked for drip irrigation systems. In this project Cromptal was updated to also work accurately with the Sprayer irrigation system. Another important feature is that Cromptal can now send advice through both SMS and WhatsApp. Lastly, Cromptal also started using the newest WaPOR v3 data to retrieve local reference evapotranspiration rates. WaPOR v3 is updated every day and available at 30 km resolution, making it significantly more reliable than previous WaPOR versions in determining crop evapotranspiration.

Even though Cromptal proved to be a great success with the project farmers, decreasing time spent irrigating, saving water and increasing yields, several improvements are desired in a follow-up project.

- Improve reliability, ease of use and customer service handling to support a pool of 1,000+ farmers.
- Switch to a Nepali-based SMS provider to bring down SMS costs, as the current system is too expensive for long-term operations and WhatsApp – which is nearly free of charge – is not accessible for many smallholder farmers in Nepal.
- Improve evapotranspiration estimations by downscaling WaPOR data using high-resolution elevation data
- Automate the precipitation-conversion table and make it available in the Cromptal dashboard.
- Research the effect of soil types on application efficiencies in irrigation advice calculations

5 Results

5.1 Key outcomes

Farmers and local governments experienced clear benefits of the Smart Sprayer. Key outcomes reported during the study:

- 40–60% water savings through highly uniform application and daily, plot-specific advice.
- ~80% time savings per irrigation cycle – the benefit most valued by farmers, most of whom are women.
- 30–60% higher crop yields, with farmers reporting healthy crops and good harvests.
- Women appreciate the ease of handling the equipment thanks to the lightweight product.
- Reduced splash erosion and nutrient leaching, protecting soil structure.

Mid-project questionnaire feedback from all participating farmers is summarised in Figure 17, showing the positive experiences with the Smart Sprayer.

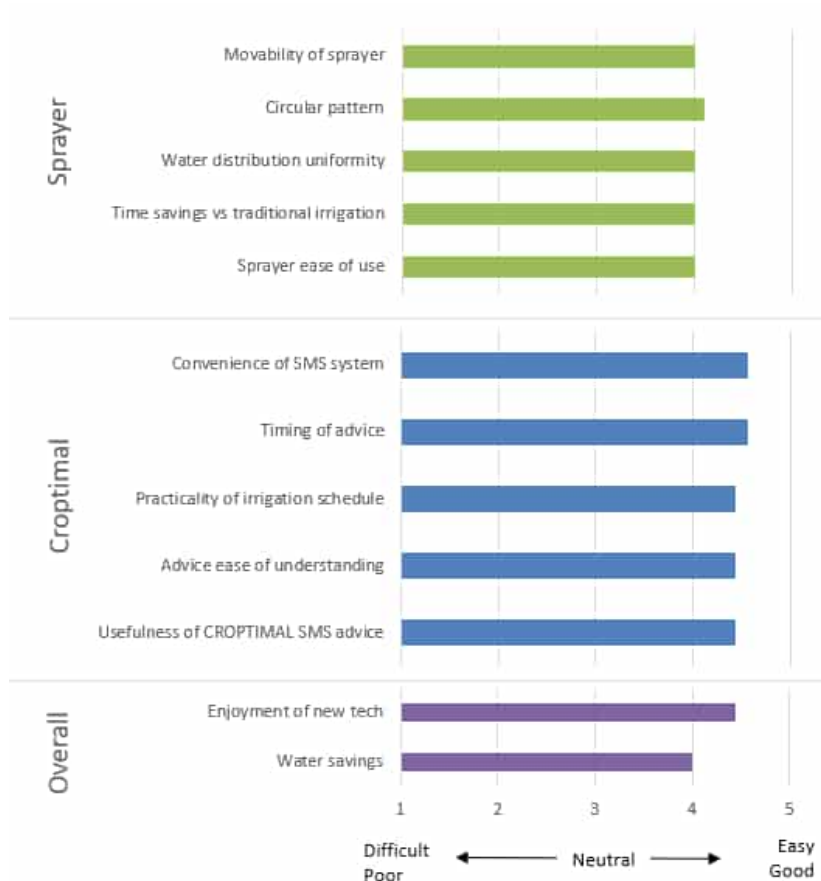


Figure 17 Questionnaire feedback from all 10 participating farmers



Figure 18 The Smart Sprayer in a farmer's field in Syangja, Nepal.

5.2 Yield and harvest parameters

The study was conducted in Syangja district as a pragmatic feasibility assessment. The primary objective was to assess the qualitative and practical feasibility of the Smart Sprayer under real farming conditions, not to isolate irrigation as the sole variable affecting yield.

Alongside the 10 test plots equipped with the Smart Sprayer, three control plots with sprinkler and/or hose irrigation were incorporated in the study to allow for comparison. There was one control plot in Putalibazar (cauliflower only) and two in Bheerkot (one with cabbage and one with cauliflower). Quantitative parameters included growth (plant height, leaf number) and yield parameters (head weight, head diameter). Site-level averages were calculated in Excel and yield (t/ha) was derived.

Smart Sprayer plots outperformed control plots across all measured parameters i.e. head weight, head diameter, plant height, and leaf number at every site, for both cabbage and cauliflower, in both municipalities. Averaged by crop and location, head weight (the primary yield indicator) was higher in Smart Sprayer plots by 60–135%, with the largest gains in Bheerkot, where pre-existing irrigation infrastructure was weakest.

Different factors play a critical role in agriculture research when it comes to measuring growth and yield. Some of the factors include:

- Transplanting and harvesting date: Transplanting and harvest dates differed between control and treatment plots at several sites, meaning plants were not compared at truly equivalent growth stages. The control plots were harvested earlier than the treatment plots, meaning the crop's potential yield was not fully understood before harvest.
- Plant spacing: The recommended spacing for cabbage and cauliflower (60 cm × 45 cm) was not consistently followed. Farmers frequently planted more densely than recommended

according to their convenience in order to maximise output from their limited plot size, which affects both the growth and yield parameters.

- Climate and soil heterogeneity: Weather conditions were favourable this season, without the droughts and floods of previous years.
- Soil conditions varied across the 10 sites and were not standardised or tested prior to the study.
- Farm management practices: Control and treatment plots were managed differently. The amount and type of manure applied varied in the areas. The treatment plots received more intensive care than the control plots. The Putalibazar cabbage control plot, which was under sprinkler irrigation, received visibly less consistent management, and was harvested earlier than the treatment plots, so its full yield potential was never reached. This site in particular inflates the apparent Smart Sprayer advantage.

5.3 Market research

A market and supply-chain study was conducted by an external consultant (500B Solution Pvt. Ltd.) to assess how the Sprayer and Cromptal could be sustainably introduced and scaled in Nepal (included in Annex F). The study focused particularly on farmer affordability, potential distribution and supply chains, private-sector engagement, and opportunities for government support. It combined desk research with farmer surveys, key-informant interviews and field observations, including consultations with farmers, agrovets, wholesalers/importers, financial institutions, cooperatives and local governments. Given the small sample (N=10), the findings are primarily qualitative and should be interpreted as an initial market assessment rather than a definitive market forecast.

The market study identifies semi-commercial and commercial vegetable farmers in water-scarce hill areas as the most promising initial target group. Farmers showed clear interest in the technology, but affordability emerged as the main barrier to commercial adoption. The calculated retail price of an imported Sprayer in Syangja is approximately NPR 24,974 (€142), whereas farmers indicated willingness to pay around NPR 5,000–7,000 (€28–40). The study therefore recommends an initial farmer-level price below NPR 5,000 (approximately €28), potentially supported by subsidies. Agrovets indicated that a price of up to approximately NPR 10,000 (€57) could be acceptable if farmers are convinced of the added value and return on investment.

If a farmer pays about €40 for the Smart Sprayer (NPR 7,000), it pays for itself once it has produced 230–350 kg of extra vegetables, assuming farmers sell their vegetables for NPR 20–30 per kg. On a 250 m² plot with the average control-plot yield of about 35 t/ha, the lowest yield gain reported by farmers (30%) adds about 260 kg of cabbage or cauliflower per season. The investment is therefore recovered within one to two dry seasons, and within one season on plots of 500 m² or more. This still holds after allowing NPR 500–1,000 per season for minor repairs.

The estimate is conservative. It leaves out the value of the irrigation time saved and the option to irrigate a larger area with the same water. The actual payback depends on plot size, market access and demand for the extra produce, the prices farmers get at harvest time, and the durability of the Sprayer.

The existing irrigation supply chain provides a possible route to market, but local availability, repair services and spare parts need to be established. Local production or assembly should therefore be investigated as an alternative to importing complete units from India, both to reduce costs and to strengthen after-sales support. The study recommends a mixed market approach: initially working through municipalities, NGOs and agricultural programmes for demonstrations and subsidised distribution, followed by commercial distribution through regional suppliers, agrovets and agricultural cooperatives once sufficient awareness and demand have been created.

Municipalities appear particularly important for early market development, as they already support irrigation technologies through subsidy programmes and expressed interest in supporting the Sprayer

following further validation. Farmers preferred Cromptal to be bundled with the Sprayer rather than offered through a separate subscription, suggesting that a simple, one-time purchasing proposition is currently more suitable for the Nepalese market.

The potential market is substantial but remains indicative. Cost reduction and detailed financial modelling are required before commercial scale-up.

5.4 Market uptake

Commercial sales were not an objective or activity of the current project. The project focused on feasibility testing, technical validation, farmer feedback and assessing the potential for future market introduction.

Commercialisation would form part of a next phase, following further product development and testing. This next phase should focus on validating the final product configuration, establishing production and supply arrangements, determining an appropriate retail price and testing different routes to market. A larger number of Sprayers should also be operated under farmer conditions over a full irrigation season before moving towards wider commercial sales.

Nevertheless, the demonstrations and field testing have generated initial interest among several organisations and partners in Nepal. Some have indicated that they may be interested in purchasing small numbers of Sprayers, typically between 1 and 10 units, for their own testing, demonstration, or farmer programmes during the 2026–2027 irrigation season. These discussions provide an opportunity to expand field experience beyond the current project sites and to generate additional evidence on performance under different conditions.

At the time of reporting, however, these potential purchases had not been confirmed and should not be considered committed sales. They are better regarded as an initial pipeline of interested organisations. Follow-up with these partners, and conversion of this interest into small-scale demonstration purchases, would be an appropriate first step in the next phase towards commercialisation.

6 Upscaling strategy

The ambition for upscaling is not only still realistic but has strengthened over the past months. The market is substantial: an estimated 8,547 semi-/commercial vegetable farmers in Syangja, 85,537 in Gandaki Province and 593,271 nationally, with comparable conditions across Nepal's mid-hill terraces.

Upscaling has already begun during the project, and new opportunities are emerging:

- Putalibazar and Bheerkot intend to include the Smart Sprayer in municipal budget and subsidy programmes.
- Joint pilot in design: the consortium is in advanced discussions with DanChurchAid (DCA) and implementing partner LI-BIRD to jointly design a pilot project.
- Further collaborations being explored with GIZ and FinnChurchAid to widen the pilot.
- Market penetration: close contact with SNV, who can support market access through their network. This is work in progress.
- Revenue model and follow-up financing: municipal subsidy schemes combined with cost reduction (bamboo, local sourcing and bulk supply) target a farmer-level price well below the current imported unit cost. A larger pilot (>30 farmers) is the key next step to establish the return of investment and make the technology ready for uptake by the Nepalese agricultural sector.
- The participating farmers clearly recognised the benefits of the Smart Sprayer, reporting 30–60% higher crop yields and approximately 80% savings in irrigation time. However, the perceived return on investment strongly depends on the purchase price of both the Smart Sprayer hardware and the irrigation advisory service. At the initially envisaged retail price of €142, farmers showed limited willingness to invest, even with the 50% subsidy offered by the participating municipalities. Farmers indicated that a retail price of around €50 would make the technology affordable. In response, the consortium developed the bamboo Sprayer, reducing the estimated retail price to approximately €60. Combined with the existing 50% municipal subsidy, the investment falls within an acceptable range for the target group, significantly improving the commercial prospects for wider adoption.
- Explore funding opportunities for a pilot study through Partners for Water Programme amongst others.

The 40–60% reduction in water use generates substantial benefits beyond the individual farm. By increasing water-use efficiency, the Smart Sprayer enables limited dry-season water resources to be shared more effectively across the catchment. In addition, the technology is lightweight and therefore easily handled by women. These wider societal benefits provide a strong rationale for public investment and municipal subsidy schemes to accelerate adoption of the technology. The strengths and applicability of the Smart Sprayer are summarised in the Pilot Project Proposal document, included in Annex G.

Annex A – Cromptal Guide

Technical Guide

Croptimal: Smart Irrigation Advisory



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DATE

September 2026

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1 Introduction to Cromptal

This quick guide is for extension workers who use Cromptal with their client farmers. It explains the theory behind the irrigation advice and how to use the dashboard, and it answers frequently asked questions from farmers.



1.1 Cromptal principles

Cromptal is a daily irrigation advisory service developed by FutureWater. Every day it calculates how much water each field needs, following the FAO crop water requirement method, and sends the advice to the farmer on WhatsApp. It considers:

- **Today's weather:** the forecast water demand of the air, based on temperature, sunshine, humidity and wind.
- **Crop type:** different crops need different amounts of water.
- **Growth stage:** young plants need less water than mature ones.
- **Soil and groundwater (optional):** if you enter the groundwater depth, Cromptal subtracts the water that rises from the groundwater into the root zone (capillary rise) before it gives the advice. The amount depends on the soil type.
- **Irrigation system (advice in minutes only):** drip or sprayer specifications and the flow rate.

For each field, the 'Advisory Type' setting decides how the advice is given:

- **'Irrigation (in min)':** an irrigation time in minutes, plus the matching volume in liters. Field experience showed that small- and medium-scale farmers find minutes easier to apply than volumes.
- **'Evapotranspiration (in mm)':** a depth of water in millimeters, with no irrigation specifications needed.

New fields start on this option.

Messages go out on WhatsApp in English, Arabic, French, Nepali or Dutch. Farmers who were set up on SMS before can stay on SMS. SMS messages are in English or Nepali and give the advice in minutes, so set the 'Advisory Type' of their fields to 'Irrigation (in min)'. The advice is also shown in the dashboard.

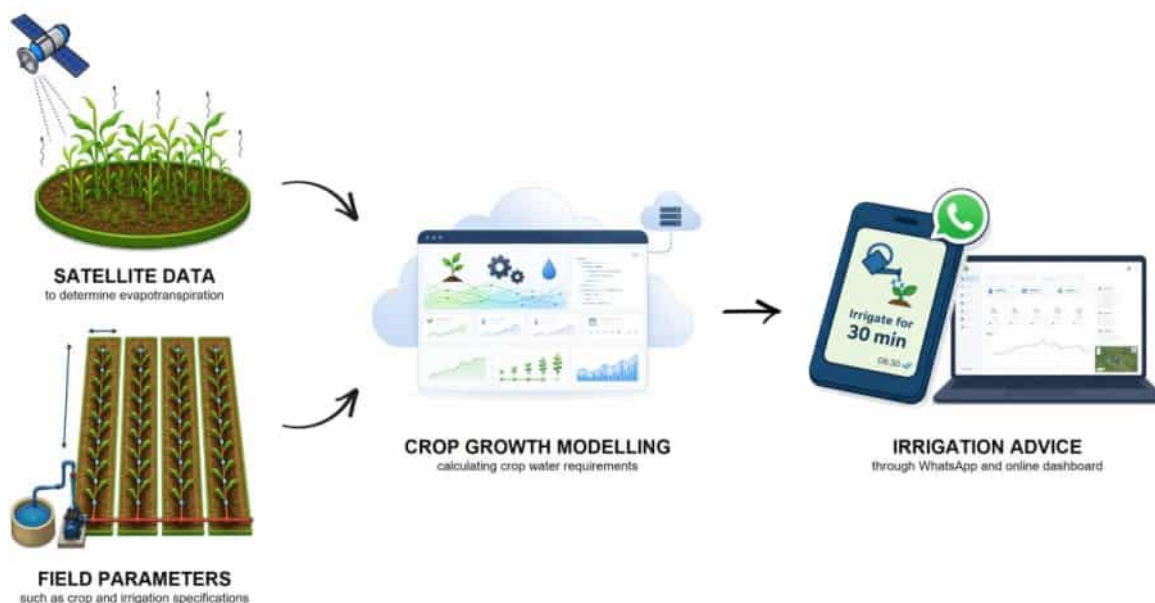


Figure 1. Schematic overview of how Cromptal works: evapotranspiration data and field parameters go into the calculation of the crop water requirement, and the advice reaches the farmer on WhatsApp and in the dashboard. Cromptal takes the reference evapotranspiration (ET₀) from the Open-Meteo weather forecast, with WaPOR satellite data as a backup.

1.2 Crop water requirement theory

Croptimal is based on the FAO formula for irrigation water demand, extended with capillary rise:

$$\text{Irrigation} = (ET_0 \times K_c) - P - CR$$

ET₀ is the reference evapotranspiration: how much water a standard reference crop (well-watered grass) would lose in today's weather. Croptimal uses today's ET₀ forecast for the field from the weather service Open-Meteo (FAO Penman-Monteith method), with FAO WaPOR satellite data as a backup. Figure 2 shows how water moves in and out of a field.

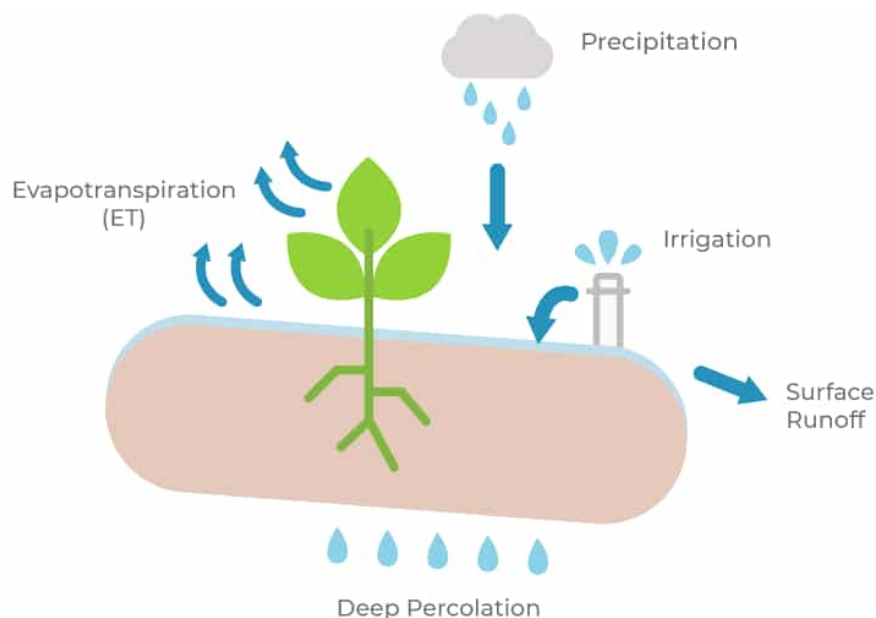


Figure 2. Concept of crop water requirements (source: UNESCAP): evapotranspiration, precipitation, irrigation, surface runoff and deep percolation.

K_c is the crop coefficient: how much water the crop uses compared to the reference crop, depending on the crop and its growth stage (Figure 3). A small crop transpires little, so K_c is low. K_c rises as the crop grows and declines again at the end of the cycle, as the crop matures and its leaves age. When K_c is below 1, the crop water requirement is below ET₀; above 1, it is above ET₀. Croptimal uses published K_c values, mainly from FAO, which you can look up in the 'Crop Explorer' (see Crop Explorer and crops). In the dashboard, ET₀ × K_c is called the 'Crop water requirement'.

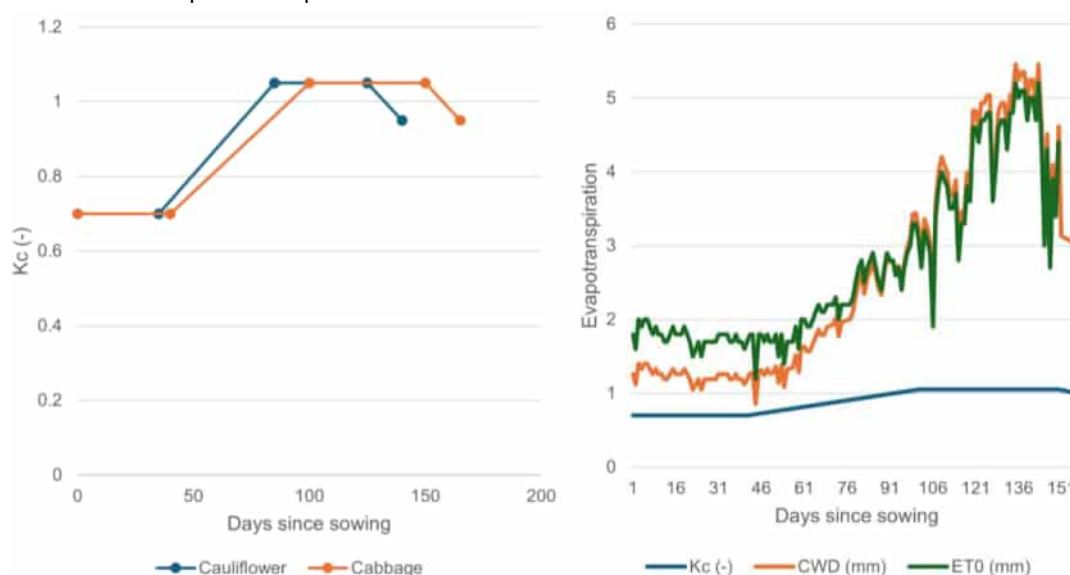


Figure 3. Kc values for cauliflower and cabbage across growth stages (left, source: FAO) and Kc, ET0 and the crop water requirement (CWD in the chart) over time (right).

CR is capillary rise: water drawn up from the groundwater into the root zone. Shallow groundwater supplies part of the crop's water, so less irrigation is needed. Cromptal looks up the capillary rise in Table 1 by 'Soil Type' and 'Groundwater depth (cm)', for a root depth of 30 cm. When the 'Groundwater depth (cm)' is empty, or 'Groundwater depth unknown' is ticked, the capillary rise is zero. For example, 'Sandy loam' with groundwater at 100 cm gives 4 mm per day, so a crop water requirement of 5 mm leaves 1 mm to irrigate.

Table 1. Capillary rise (mm per day) by 'Soil Type' and groundwater depth, for a root depth of 30 cm. Cromptal interpolates between depths. A depth shallower than 50 cm uses the 50 cm value, and a depth deeper than 200 cm uses the 200 cm value. The values are indicative and come from a Dutch reference table.

Soil type	50 cm	75 cm	100 cm	125 cm	150 cm	175 cm	200 cm
Sand	4	3	0.5	0	0	0	0
Sandy loam	4.5	4.5	4	3.5	3	2	1
Loam, Silt loam, Silt, Clay loam	4.5	4	3	2	1	1	0.5
Sandy clay / Silty clay	3.5	3	2	1	0.5	0	0
Clay	2	0.5	0.5	0	0	0	0
Peat	4	3	2	1	0.5	0	0

P is precipitation. Rain can meet part or all of the crop water requirement. The farmer measures the rain with a rain gauge and subtracts it from the advice (see Applying the advice in the field).

1.3 How is the advice created?

Each field with an active crop gets its advice once a day, at the farmer's 'Preferred Advice Time' in the farmer's 'Timezone'. For each field Cromptal:

1. Gets today's ET0 for the field from the Open-Meteo forecast. If that is not available, it uses the average WaPOR satellite ET0 over the six days from seven to two days ago (satellite data arrives with a delay of about two days), or else the WaPOR average for the same calendar day over 2018 to 2024.
2. Counts the days since the 'Sowing Date' to find the crop's growth stage and today's Kc.
3. Multiplies ET0 by Kc to get the crop water requirement (ETc) in millimeters, shown rounded to the nearest 0.5 mm.
4. Looks up the capillary rise in Table 1 (zero when the groundwater depth is unknown).
5. Subtracts the capillary rise, never going below zero, and turns this net water need into advice for the field's 'Advisory Type':
 - a. 'Evapotranspiration (in mm)': the advice is the net water need in millimeters, to one decimal place. For this option, Cromptal first rounds the crop water requirement to the nearest 0.5 mm and then subtracts the capillary rise.
 - b. 'Irrigation (in min)': the net water need times the irrigated area, plus a margin for water losses (about 22% for drip, 20% for sprayers), gives a volume in liters. Cromptal divides this volume by the flow rate, adds the 'Initialization time (minutes)' for drip, and rounds the result up to whole minutes. Cromptal calculates the irrigated area from the irrigation specifications (see Frequently asked questions).
6. Saves the advice for the dashboard and sends it on the farmer's 'Preferred Message Platform' in their 'Preferred Language', one message per field.

The farmer then reads the rain gauge and subtracts the measured rain from the advice (see Applying the advice in the field).

Advice runs from the 'Sowing Date' until the day before the 'Expected Harvest Date'. It stops earlier once the days since sowing exceed the total length of the crop's growth stages by more than 25%, and it stops when the crop, the field or the farmer is deleted. Cromptal sends the message when the farmer has a 'Phone Number' and a 'Preferred Message Platform' other than 'None'. Without these, it calculates the advice and shows it in the dashboard.

Croptimal checks every five minutes which fields are due. A field is due from five minutes before the 'Preferred Advice Time', so the advice arrives at about that time. A failed calculation is retried every five minutes. If there is still no advice three hours after the 'Preferred Advice Time', the farmer gets a message that no advice could be calculated today, and the dashboard shows 'Not available'.

The farmer's message gives the same advice as the dashboard. When the capillary rise covers the whole crop water requirement of a field advised in mm, the message gives 0.0 mm and the dashboard says 'No irrigation needed today. The crop water requirement is fully met.'

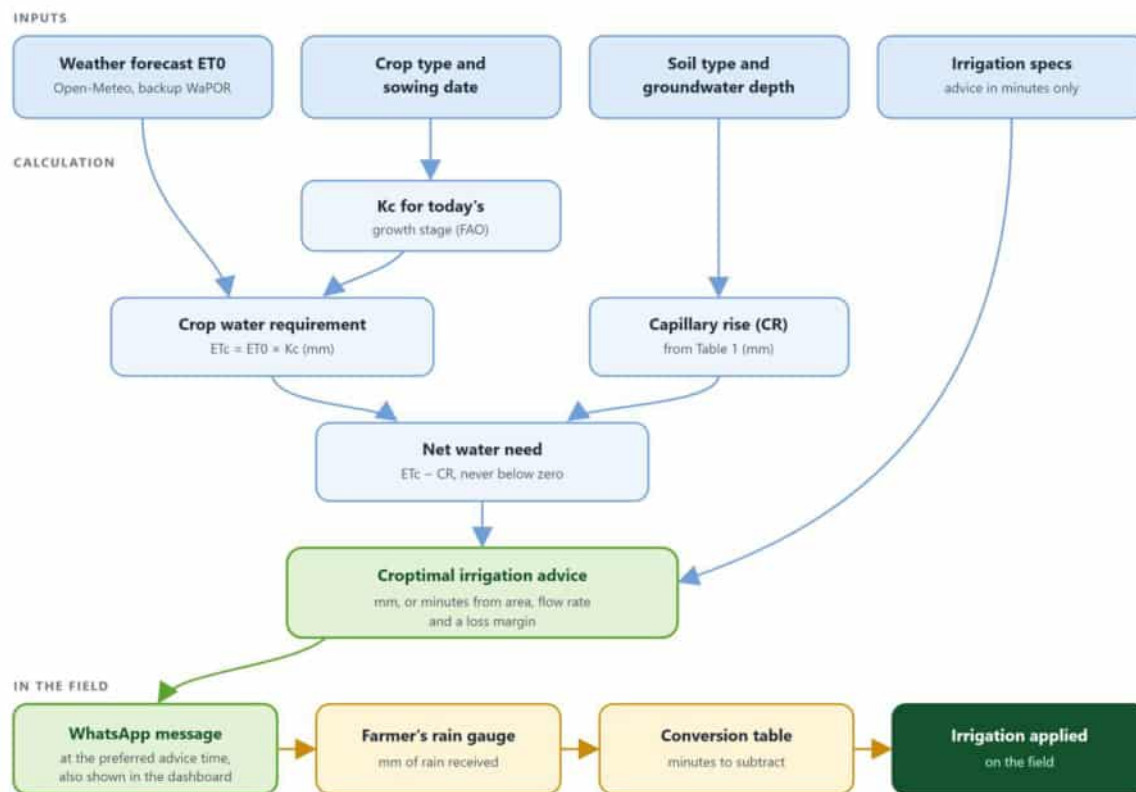


Figure 4. Schematic workflow of Croptimal to generate irrigation advice.

2 Using Croptimal

Use the Croptimal dashboard to manage farmers, their fields and crops, and to follow the irrigation advice each farmer receives. It runs in a web browser at <https://croptimal.app/>. The menu has the following pages:

- **'Overview'**: today's irrigation advice for all fields of one farmer. You land here after logging in.
- **'Irrigation Advice'**: the daily advice for one field, its history, and the farmer, field and crop details.
- **'Weather'**: the weather at the field right now, over the next 24 hours and over the next five days.
- **'Planting Guide'**: which crops suit a field's climate and soil for a chosen sowing month, and why.
- **'Crop Explorer'**: the library of every crop Croptimal can advise on.
- **'Fields'**: each field's location, soil, irrigation setup and crop.
- **'Farmers'**: add and manage farmers and how they receive their advice.
- **'Users'**: give colleagues access to the dashboard.

To open your own 'Account' page, click your name at the bottom of the menu (see Account).

2.1 Steps to onboard a farmer

To onboard a new farmer you need the farmer's name and phone number, the location and soil type of the field, the crop and its sowing date and, for advice in minutes, the irrigation specifications. Follow the steps below, and the farmer can receive irrigation advice the same day.

1. Log in at <https://croptimal.app/> (see Logging in).
2. In the menu, under 'Admin', click 'Farmers', then click 'Add new farmer'. Enter the 'First Name' and 'Last Name', select the 'Country' and enter the 'Phone Number'. Set 'Preferred Message Platform' to 'WhatsApp' (it starts at 'None'), then select the 'Timezone', set the 'Preferred Advice Time', select the 'Preferred Language' and click 'Create Farmer' (see Adding a farmer).
3. Select the new farmer in the top bar: it still shows the farmer you were viewing before, and the 'Add new field' dialog starts on the farmer selected there. Then, in the menu under 'Manage', click 'Fields' and click 'Add new field'. Enter the 'Field Name', the 'Latitude (decimal degrees)' and 'Longitude (decimal degrees)', the 'Groundwater depth (cm)' if you know it, the 'Soil Type' and the 'Advisory Type', plus the irrigation specifications for advice in minutes, and click 'Create Field' (see Adding a field).
4. The 'Fields' page opens on the new field. Click 'Add a crop on this field', select the 'Crop Type' and the 'Sowing Date', check the 'Expected Harvest Date' and click 'Create Crop' (see Adding a crop to a field).
5. Give the farmer a rain gauge and show them how to reduce the advice for the rain that fell: by subtracting the measured rain in millimeters for advice in mm, or with the precipitation conversion table for advice in minutes (see Applying the advice in the field).
6. Croptimal calculates the advice once a day at the farmer's 'Preferred Advice Time' and sends it on WhatsApp (see How is the advice created?). Advice starts on the 'Sowing Date'. If the 'Sowing Date' is today or earlier and today's 'Preferred Advice Time' has already passed when you add the crop, today's advice follows within about five minutes.
7. Help the farmer read and understand the advice the first time they receive it. You can follow the advice on the 'Overview' and 'Irrigation Advice' pages.

2.2 Logging in

To log in to the dashboard:

1. Go to <https://croptimal.app/>. Croptimal takes you straight to its login screen.
2. Enter the email address you are registered with in Croptimal. No access yet? Ask your organization's manager to invite you. If you are the manager, contact c.hurink@futurewater.nl.
3. Check your inbox for the login email and enter the one-time code it contains. Every login uses a new code, sent to your email address.
4. You now land on the 'Overview' page.

If Cromptal shows 'Something went wrong with the authentication, please contact support.', your email address does not belong to an active Cromptal user. Ask your manager to check the 'Users' page. If your user is missing, for example because it was deleted, the manager invites you again with 'Invite user' and the same email address.

2.3 Finding your way around

Every page has the same layout: the menu on the left, the green top bar across the top, and the page content below it.

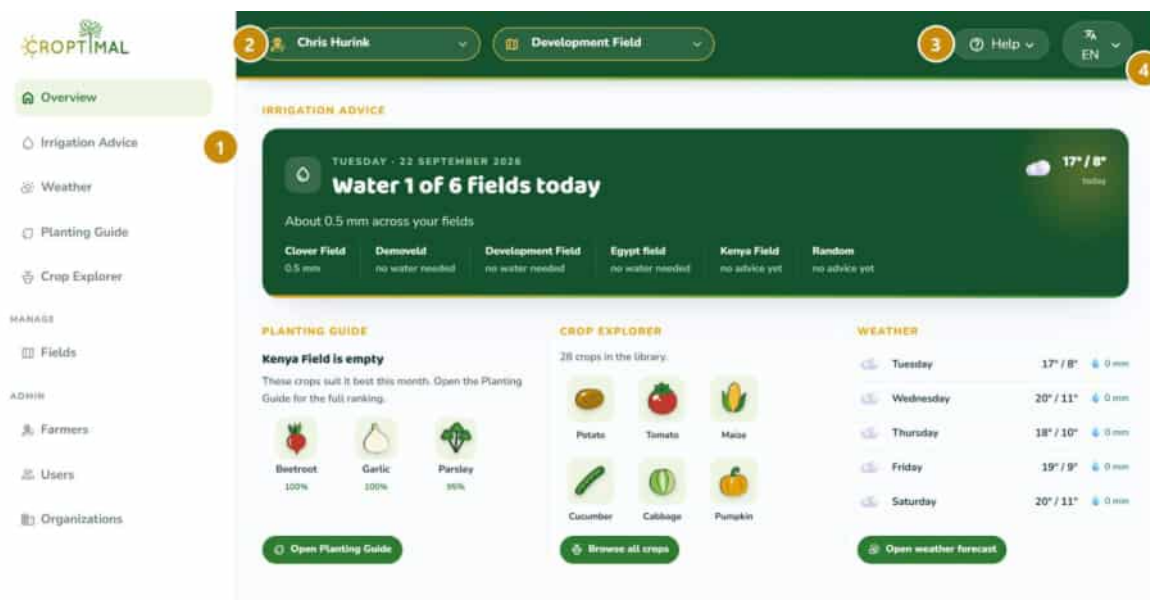


Figure 5. The dashboard layout: the menu (1), the farmer and field selectors (2), the 'Help' button (3) and the language button (4). This menu belongs to a FutureWater account; an extension worker sees only 'Farmers' under 'Admin'.

2.3.1 The menu

The menu lists the pages. The first five and 'Fields', under 'Manage', are the same for everyone. Under 'Admin', managers and extension workers see 'Farmers', managers also see 'Users', and FutureWater accounts also see 'Organizations' (see User roles). If the menu is hidden, for example on a phone, open it with the button in the top-left corner.

2.3.2 The top bar

The top bar sets which farmer and field you are looking at. It stays in view as you scroll.

- **Farmer selector:** pick the farmer from the farmers you have access to. Type part of a name to search. A farmer who logs in sees their own name here instead of a list.
- **Field selector:** pick one of that farmer's fields. When you change farmer, it jumps to that farmer's first field in alphabetical order.

Your choice carries over to every page and stays after a page refresh, so you pick a farmer and field once and then move between pages. When you log in, the bar opens on the farmer linked to your own login if there is one, otherwise on the first farmer in the list.

2.3.3 Help and support

The 'Help' button in the top bar opens three options:

- **'Cromptal Guide':** opens this guide in a new browser tab.
- **'What's new':** recent changes to Cromptal, newest first.

- **'Report a problem':** describe the problem under 'What went wrong?' and click 'Send report'. The report reaches the Coptimal team with the page you were on, your organization, your role and your email address, so the team can reply.

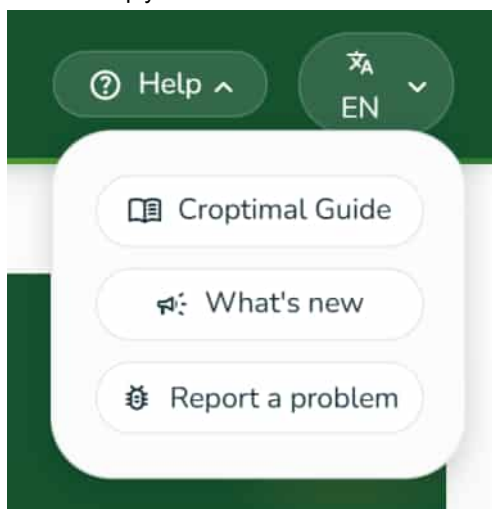


Figure 6. The 'Help' menu in the top bar.

2.3.4 Interface language

The button at the far right of the top bar shows the current language as a short code, such as EN. Click it to choose English, Nederlands (Dutch), Français (French), Español (Spanish), नेपाली (Nepali) or العربية (Arabic). Coptimal saves the choice to your account, so it stays the same the next time you log in. In Arabic the layout reads right to left and the menu moves to the right side.

The interface language only changes what you see in the dashboard. The language of a farmer's messages is set per farmer, with 'Preferred Language' on the 'Farmers' page.

2.4 Overview page

After logging in you land on the 'Overview'. For the farmer selected in the top bar, it shows which fields need water today and how much.

The green panel under 'Irrigation advice' gives one headline for all the farmer's fields, such as 'Water 1 of 6 fields today' or 'No irrigation needed today'. The second number counts all the farmer's fields, including fields without a crop. When every field that needs water is advised in mm, the line below adds up the amounts, for example 'About 0.5 mm across your fields'. Under the headline, each field shows its own status: the amount to irrigate in minutes or mm, 'no water needed' or 'no advice yet'. The headline 'No advice yet' means no field has had advice today or in the two days before. 'No active crops' means no field has an active crop; add a crop to start the advice (see Adding a crop to a field). A line at the bottom of the panel reads 'No rain expected this week' when the five-day forecast for the selected field has no rain, and 'Rain on the way' when the forecast rain adds up to 15 mm or more.

- **Previews:** when one of the farmer's fields has no active crop, 'Planting Guide' shows the three crops that suit that field best this month, with their scores; click 'Open Planting Guide' for the full ranking. 'Crop Explorer' shows how many crops the library holds, with six example crops; click 'Browse all crops' for the full library. 'Weather' shows the next five days at the field selected in the top bar; click 'Open weather forecast' for the 'Weather' page.
- **Field cards:** a field with a crop shows the crop and its latest advice; click 'Open irrigation advisory' for the full advice on the 'Irrigation Advice' page. A field without a crop, or whose crop is past its 'Expected Harvest Date', reads 'No crops found for this field.' and gets an 'Add crop' button (see Adding a crop to a field). The arrow in the top-right corner of a card ('Go to field') opens that field on the 'Fields' page.

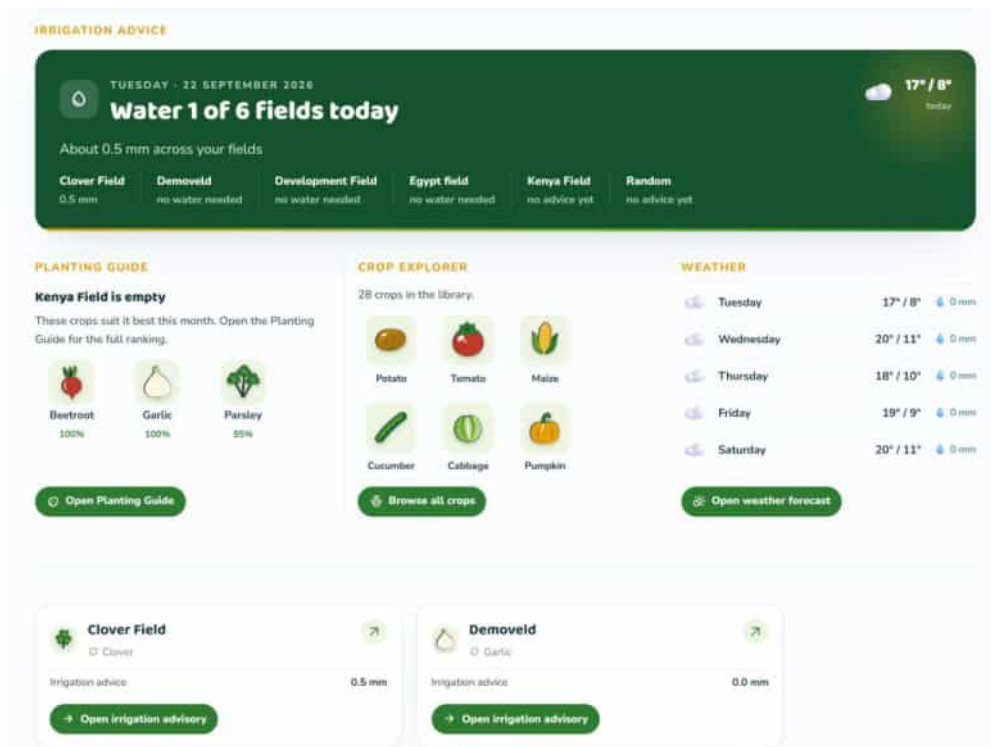


Figure 7. The 'Overview' page: today's irrigation advice, the previews and the field cards.

2.5 Irrigation Advice page

The 'Irrigation Advice' page shows the daily advice for one field in detail: the field selected in the top bar (see Finding your way around).

1. In the top bar, select the farmer and the field.
2. Click 'Irrigation Advice' in the menu. From the 'Overview' you can also click 'Open irrigation advisory' on a field card.

On the left, the page shows today's advice, how it is built, a 'Weather forecast' for the next five days (for hourly detail, open the 'Weather' page) and the 'Advice history'. On the right are the 'Field location' map and the farmer, field and crop details.

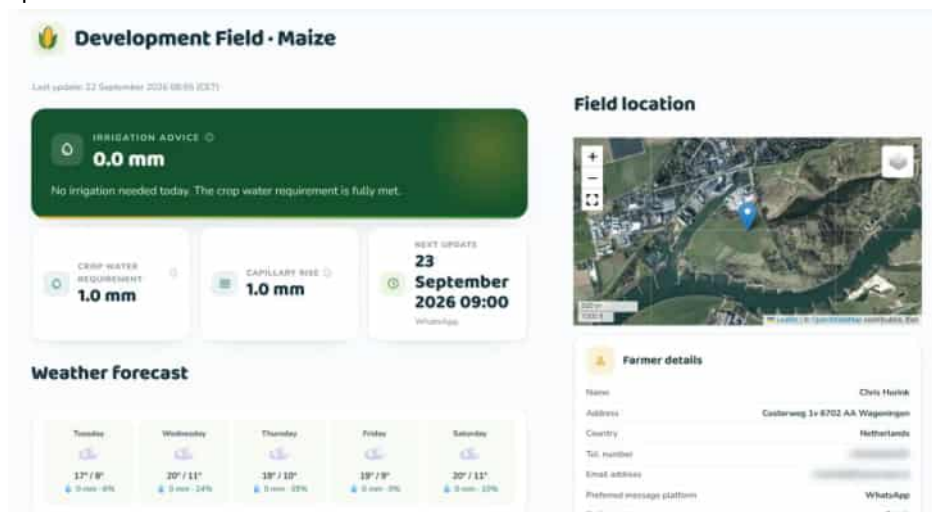


Figure 8. The 'Irrigation Advice' page: today's advice, how it is built and the five-day forecast (left), the field location and farmer details (right).

2.5.1 Today's advice

The green 'Irrigation advice' box shows the latest advice in large type: an irrigation time for fields advised in minutes ('45 minutes', or '1 hr 25 min' for one hour or more), or millimeters of water for fields advised in mm ('2.5 mm'). 'Last update', just above the box, gives the date and time of that advice in the farmer's 'Timezone'. Under the number, a sentence puts the advice in words, for example 'Moderate irrigation recommended. Apply about 45 minutes.' The sentence also uses the rain forecast and can start with 'Hold off on irrigation.' The farmer adjusts the number in the box for the rain measured with a rain gauge (see Applying the advice in the field). If the box shows 'Not available', there is no advice for this field yet, or today's calculation failed (see How is the advice created?). While Cromptal is still retrying, the page keeps showing the previous advice, so always check the 'Last update' date.

2.5.2 What is behind the number

The tiles below the green box show what the advice is built from and when the advice is next updated. Hover over the (i) icon next to a label for a short explanation.

- **'Crop water requirement'**: the water the crop uses today, ET_0 times the crop coefficient (K_c) for its growth stage, rounded to the nearest 0.5 mm. Shown for fields advised in mm.
- **'Capillary rise'**: water drawn up from the groundwater into the root zone (see Crop water requirement theory). Shown for fields advised in mm when the capillary rise is above zero. The advice in the green box is the 'Crop water requirement' minus the 'Capillary rise', never below zero. When the capillary rise covers the whole requirement, the box shows 0.0 mm and the sentence 'No irrigation needed today. The crop water requirement is fully met.'
- **'Next update'**: the date and time when the advice is next updated, at the farmer's 'Preferred Advice Time', with the message platform below it. The tile is hidden once the crop is past its 'Expected Harvest Date'.

For fields advised in minutes, Cromptal subtracts the capillary rise before it turns the net water need into minutes, and the green box shows the resulting minutes. For drip, the minutes include the 'Initialization time (minutes)', so a drip field always gets at least that time, even on a day it needs no water.

2.5.3 Advice history

'Advice history' plots the field's daily advice over time. For fields advised in minutes it shows the advised minutes; for fields advised in mm it shows the 'Crop water requirement', with 'Capillary rise' and 'Irrigation advice' as extra lines where capillary rise applies. The line starts again at the 'Sowing Date' of each new crop. Hover over a line to see the date and the value.



Figure 9. The 'Advice history' chart of a field advised in mm with a groundwater depth: 'Crop water requirement', 'Capillary rise' and 'Irrigation advice'.

2.5.4 Field details

On the right, 'Field location' shows the field on a satellite map. Below it, the cards 'Farmer details', 'Field information' and 'Crop information' list what Coptimal has stored about the farmer, the field and the crop. For a field advised in mm, 'Irrigation type' reads 'Daily water balance'. When the advice looks wrong, check the crop in the page title and these cards first: a wrong location, crop, sowing date, soil type or groundwater depth gives wrong advice. For advice in minutes, also check the irrigation specifications on the 'Fields' page.

2.5.5 When the harvest date has passed

The advice for a crop runs until the day before its 'Expected Harvest Date'. From the day after that date, an amber bar at the top of the page asks whether the crop is still growing or has been harvested. Click 'Update harvest' to open the 'Update crop harvest' dialog, and choose one of its two options:

- **'Still growing?'**: pick a 'New expected harvest date' after today and click 'Extend growing window'. Advice resumes within about five minutes if today's 'Preferred Advice Time' has already passed (the farmer then also gets the message), otherwise at the 'Preferred Advice Time'. Advice then continues until the day before the new date, and stops earlier once the days since sowing exceed the total length of the crop's growth stages by more than 25% (see How is the advice created?).
- **'Already harvested?'**: click 'Mark as harvested'. Coptimal records today as the harvest date and removes the crop from the field. Give the next crop a 'Sowing Date' after today.

A field without a crop shows 'No crops found for this field.' Click 'Add crop for this field' to add the next crop (see Adding a crop to a field).

2.6 Applying the advice in the field

Every day at the farmer's 'Preferred Advice Time', Coptimal sends one message per field with an active crop (see How is the advice created?). The message names the field and gives the irrigation time in minutes plus the matching volume in liters or, for fields advised in mm, the millimeters of water to irrigate. This is the same advice as in the green 'Irrigation advice' box on the 'Irrigation Advice' page.

The farmer adjusts the advice for the rain measured with a rain gauge. For advice in minutes, the farmer uses a precipitation conversion table for their irrigation system, which gives the irrigation minutes that each amount of rain replaces. Teach the farmer these steps:

1. Write down the irrigation time in the advice, in minutes.
2. Read the rain gauge and write down the rain in millimeters.
3. In the precipitation conversion table, look up how many irrigation minutes this rain replaces.
4. Subtract the rain minutes (step 3) from the irrigation minutes (step 1). The result is the irrigation time for today. If the result is zero or less, no irrigation is needed today.

For advice in mm, the farmer subtracts the millimeters of rain in the rain gauge from the advised millimeters. The result is the amount of water to irrigate today. If it is zero or less, no irrigation is needed today.

The advice already accounts for capillary rise. If the field has a 'Groundwater depth (cm)', Coptimal subtracts the capillary rise before it sends the advice, in minutes and liters as well as in millimeters, so the farmer adjusts the advice for rain only (see How is the advice created?). A message with 0.0 mm means that no irrigation is needed today.

Tip for extension workers: on the 'Irrigation Advice' page, the sentence under the advice uses the rain forecast. If the rain in the five-day 'Weather forecast' adds up to at least 15 mm and rain is forecast for today, tomorrow or the day after, the sentence starts with 'Hold off on irrigation.' The farmer still adjusts each day's advice for the rain measured in the rain gauge. The sentence appears on the dashboard, so go through it with the farmer when you discuss the advice.

2.7 Weather page

The 'Weather' page shows the weather at the field selected in the top bar. Open it from the menu, or click 'Open weather forecast' on the 'Overview'. The data comes from the weather service Open-Meteo. All times are local to the field.

The 'Right now' box shows the current temperature, wind, humidity, UV index, cloud cover and rain, today's high and low, and the sunrise, sunset and daylight length. It also lists up to three warnings for the next five days, most urgent first, for example frost, strong wind, heat and strong sun, or rain. The warnings use the same limits for every field and crop. When there is nothing to flag, the box reads 'Calm conditions, nothing to flag right now.'

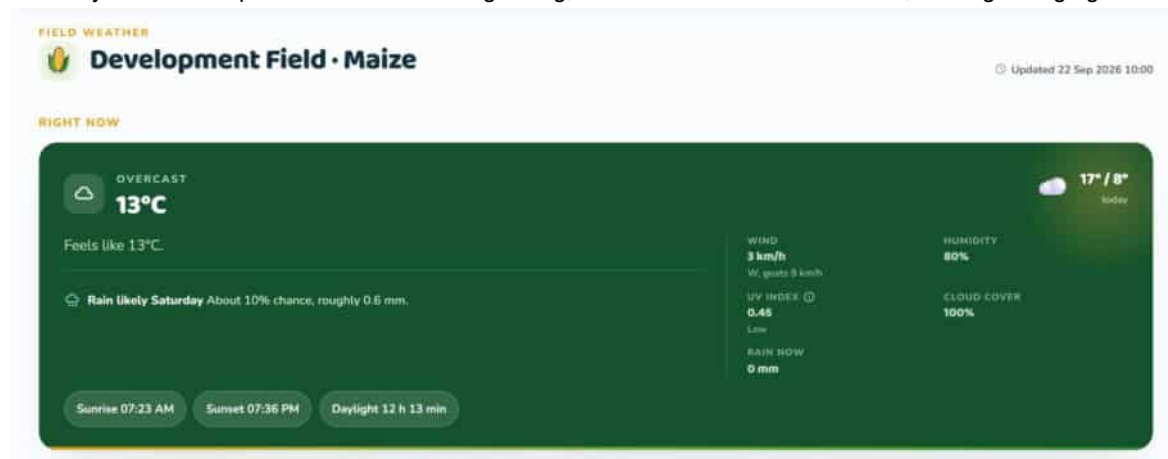


Figure 10. The 'Right now' box on the 'Weather' page: current conditions, warnings, sunrise and sunset.

'Next 24 hours' starts with a line such as 'Good irrigation window: 10:00 to 19:00'. This is the longest stretch of at least two daylight hours with wind below 15 km/h, gusts below 25 km/h, a rain chance below 20% and no forecast rain. If there is no such stretch, the line reads 'No good irrigation window in the next 24 hours.' The dashed vertical line in the graph marks the current time. The buttons under the graph switch between 'Temperature', 'Rain chance', 'Rain amount', 'Wind' and 'Solar radiation'.

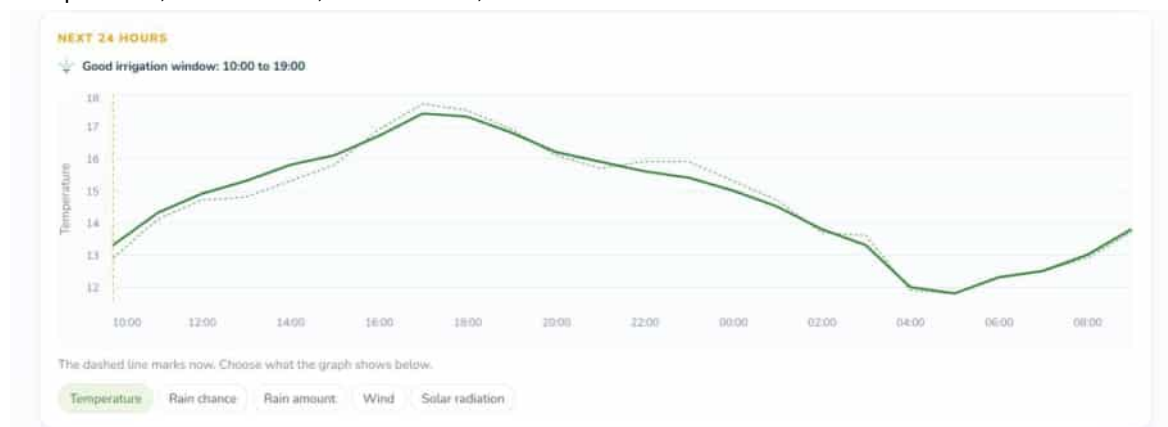


Figure 11. 'Next 24 hours' on the 'Weather' page, with the irrigation window.

The 'Weather forecast' card has a tile for each of the next five days, starting with today, with the high and low temperature, the expected rain and the rain chance. The gold number on each tile is the 'Reference water use (ET0) per day' (see Crop water requirement theory). The irrigation advice starts from today's ET0 forecast: Cromptal multiplies it by the crop coefficient (Kc) to get the 'Crop water requirement'. The page shows the latest forecast, and the advice uses the forecast at the farmer's 'Preferred Advice Time', so today's tile can differ from the value the advice used. If the forecast was not available at that time, the advice used satellite data instead (see How is the advice created?).

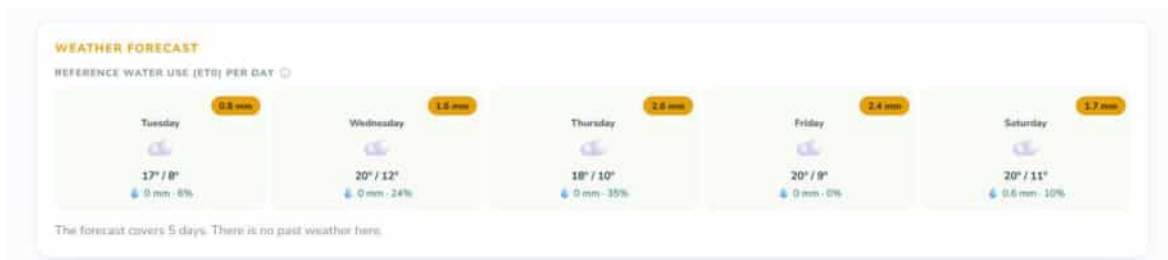


Figure 12. The five-day 'Weather forecast' with the daily 'Reference water use (ET0) per day'.

2.8 Planting Guide

The 'Planting Guide' ranks the crops by how well they suit the selected field's climate and soil for a sowing month you choose, and shows how each score is built up. Use it with the farmer when deciding what to plant next.

1. In the top bar, select the farmer and field, then click 'Planting Guide' in the menu.
2. Under 'Select Sowing Month', click the month the farmer wants to sow. The page opens on the current month, and the ranking updates as soon as you pick another month.
3. Click a crop card on the left to see its details on the right.
4. If the field has no crop, or its crop is past its 'Expected Harvest Date', a button such as 'Add Beetroot to Kenya Field' at the top of the crop's details opens the 'Add new crop' dialog with that crop filled in (see Adding a crop to a field).

Crops are listed best first. Each card shows a rating and the 'Expected harvesting Month' for that sowing month. The score runs from 0 ('Not suitable') to 1 ('Optimal'), with 'Poor', 'Moderate' and 'Good' in between. The details show:

- **At the top:** the rating, a one-line summary and the 'Sow' and 'Harvest' months. When soil salinity, soil pH or potassium is the 'Limiting factor', an action follows, such as 'Improve drainage', 'Adjust soil pH' or 'Add potassium'.
- **'Why this score':** the overall 'Suitability' score, then one bar per factor with your field's value and the crop's optimal range. When a factor holds the score down, the lowest one is flagged as the 'Limiting factor', with a note on whether it can be managed: temperature cannot, soil salinity partly, soil pH and potassium can.
- **'Planting calendar':** the 'Best sowing' months (the months with the highest score) and the 'Sowing window' (the other months that score 'Good' or 'Optimal'). A 'Best sowing' month can still rate 'Poor' or 'Moderate': select it under 'Select Sowing Month' to see its rating.
- **'Temperature fit':** the field's monthly 'Daytime max' and 'Night min' drawn over the crop's 'Optimal range' and 'Tolerated range'. A month where the 'Daytime max' rises above the 'Optimal range', or the 'Night min' drops below it, lowers the temperature score; outside the 'Tolerated range' that month scores zero for temperature. Only the months from sowing to harvest count.

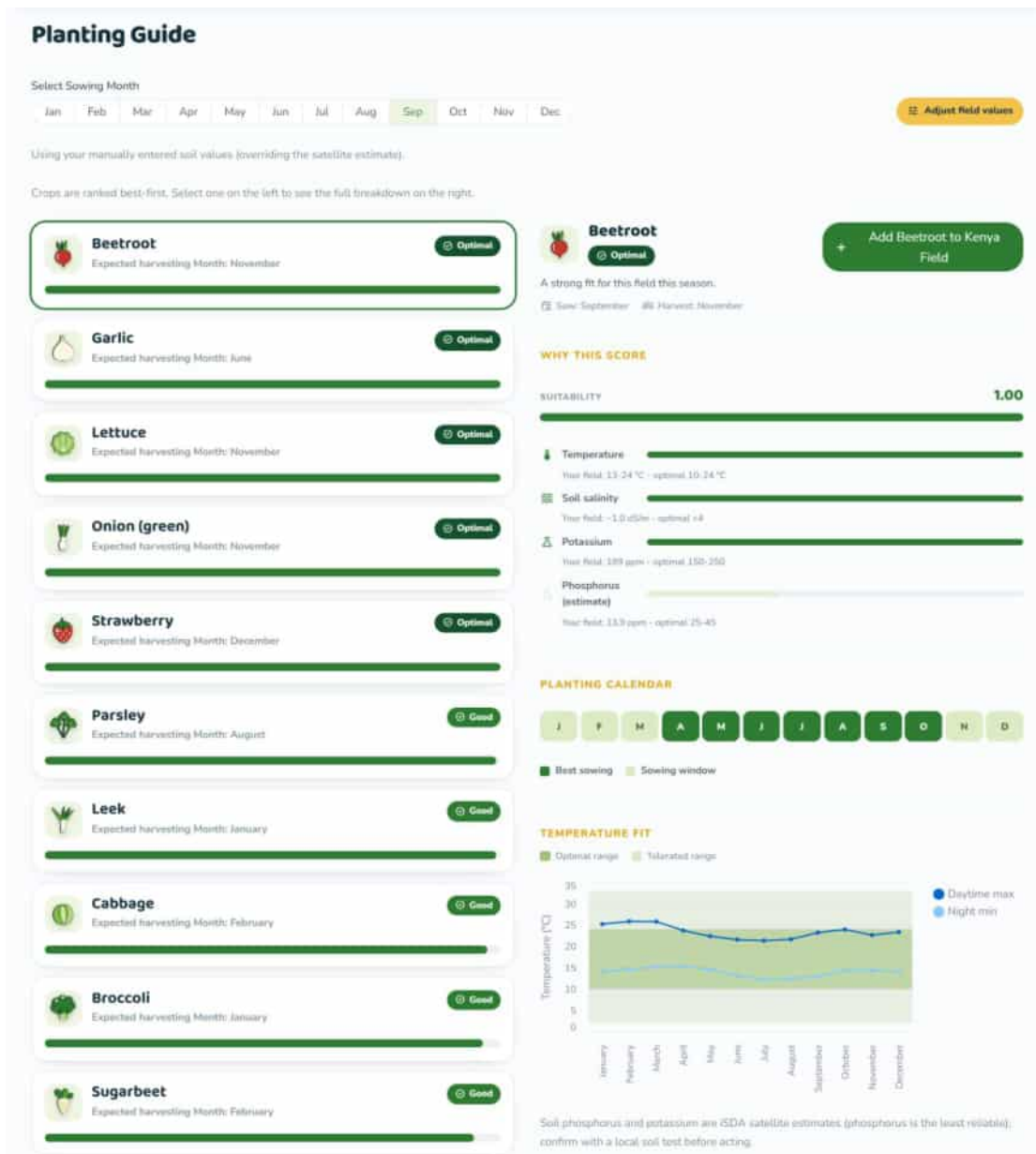


Figure 13. The 'Planting Guide': crops ranked for the chosen sowing month (left) and the selected crop's details (right).

2.8.1 What the score is based on

Croptimal fetches the climate and soil data for the field's coordinates when you create the field, and again when you change its coordinates. While the data is being prepared, the page shows a message instead of the ranking. If the page says crop suitability cannot be calculated, check the field's 'Latitude (decimal degrees)' and 'Longitude (decimal degrees)' on the 'Fields' page.

- **Temperature:** the average daytime maximum and night minimum for each month over 2011 to 2020 (ERA5-Land). A month between sowing and harvest that is too hot or too cold for the crop lowers the score.
- **Soil salinity:** an estimated salinity class from a global satellite-based map (2016), shown as an approximate value in dS/m.

- **Soil pH, potassium and phosphorus:** satellite estimates for the top 20 cm of soil from iSDAsoil, which covers Africa. Low potassium can be corrected with fertilizer, so it lowers the score by at most 15%. Phosphorus is shown as 'Phosphorus (estimate)', for information only.
- **How they add up:** temperature, soil salinity and soil pH are combined so that one poor factor pulls the whole score down, and a factor at zero makes the score zero whatever the others score. Soil salinity and soil pH count for the crops that have limits set for these factors. 'Why this score' shows a bar for each factor that applies to the crop on this field.

If the farmer has a soil lab report, click 'Adjust field values' to the right of the months under 'Select Sowing Month'. The field opens on the 'Fields' page: enter the measured values under 'Adjust soil values' and click 'Update Field' (see Editing or deleting a field). The 'Planting Guide' then uses these values instead of the satellite estimates for this field and shows 'Using your manually entered soil values (overriding the satellite estimate).' For a field outside Africa, soil pH, potassium and phosphorus come from the values you enter here.

2.8.2 Using the result with the farmer

- **Soil values:** the satellite soil values are estimates. Confirm them with a local soil test before the farmer adjusts the soil pH or adds fertilizer.
- **Harvest month:** the 'Expected harvesting Month' follows from the crop's 'Growth length' in the 'Crop Explorer'. When you add the crop, enter the date the farmer expects to harvest (see Adding a crop to a field).

3 Managing farmers, fields and crops

This chapter covers the pages where you set up and maintain what the advice is built on: the crops, the fields and the farmers, and the people who can log in.

3.1 Crop Explorer and crops

A crop links a crop type (such as garlic or cabbage) to one of the farmer's fields, with a sowing date and an expected harvest date. A field can have one crop at a time. Crops can follow each other on the same field, but their sowing-to-harvest periods cannot overlap. If a farmer grows two crops side by side, make two fields.

'Crop Explorer' in the menu is the library of every crop Croptimal can advise on.

- **Search and filter:** use the search box, or the filter buttons 'Cereal', 'Vegetable', 'Fruit' and 'Other'.
- **Details:** click a crop's card to open 'Crop details', with its 'Kc initial', 'Kc mid-season' and 'Kc end' (see Crop water requirement theory) and its 'Growth length'.
- **Missing crop:** click 'Request a crop', enter the 'Crop name', add a note if needed and click 'Send request'. The request goes to the Croptimal team. If the farmer needs the crop soon, also email c.hurink@futurewater.nl.

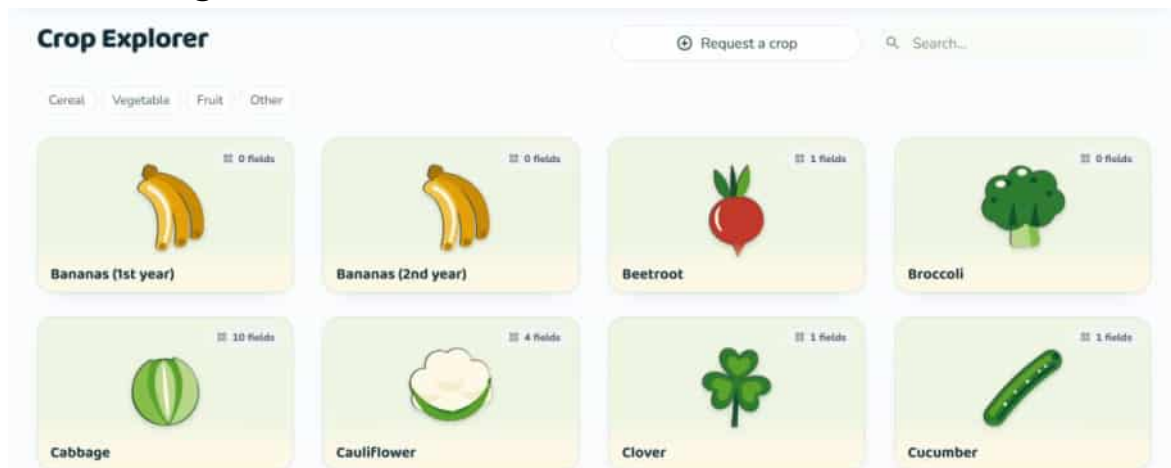


Figure 14. The 'Crop Explorer': 'Request a crop', the search box, the filter buttons and the crop library.

3.1.1 Adding a crop to a field

Open the 'Add new crop' dialog from the page you are working on: 'Add crop to field' in a crop's 'Crop details' on the 'Crop Explorer', 'Add a crop on this field' on the 'Fields' page, 'Add crop' on a field card on the 'Overview', 'Add crop for this field' on the 'Irrigation Advice' page, or the 'Add [crop] to [field]' button on the 'Planting Guide'.

1. Check 'Select Farmer' and 'Select Field'. They start on the farmer and field selected in the top bar; from an 'Overview' field card, on that card's field.
2. Check the 'Crop Type'. It is filled in if you came from the 'Crop Explorer' or the 'Planting Guide'. Otherwise it starts on the first crop in the list, so always pick the right one.
3. Pick the 'Sowing Date' carefully: Croptimal uses it to find the crop's growth stage and today's Kc value. The date is written out under the picker, so you can check that you did not swap day and month.
4. Check the 'Expected Harvest Date'. Croptimal fills it in from the 'Sowing Date' and the crop's 'Growth length'; if it stays empty, enter it yourself. Change it to the date the farmer expects to harvest, and do this last: changing the 'Sowing Date' or 'Crop Type' afterwards replaces the date you set.
5. Optionally add a 'Comment', then click 'Create Crop'.

Croptimal saves the crop when both dates are set, the 'Expected Harvest Date' is after the 'Sowing Date', and the dates do not overlap another crop on the field. Otherwise it shows a message saying what to change. The

sowing and harvest days both count: give the new crop a 'Sowing Date' no earlier than the day after the previous crop's 'Expected Harvest Date'.

Set the 'Expected Harvest Date' with care: the advice runs until the day before it (see How is the advice created?).

The 'Add new crop' dialog box is shown. It includes the following fields and values:

- Select Farmer:** Chris Hurink
- Select Field:** Kenya Field
- Crop Type:** Beetroot
- Sowing Date:** 01/10/2026 (1 October 2026)
- Expected Harvest Date:** 01/01/2027 (1 January 2027)
- Comment:** (empty text area)

A green 'Create Crop' button is located at the bottom of the dialog.

Figure 15. The 'Add new crop' dialog, with the 'Expected Harvest Date' filled in from the 'Sowing Date'.

3.2 Fields

A field stores the location, soil and irrigation setup of one plot. A farmer can have several fields, and each field gets its own advice. The 'Fields' page (in the menu under 'Manage') shows the field selected in the top bar:

- **'Active crop':** the crop with the latest 'Sowing Date' on the field, shown up to and including its 'Expected Harvest Date'. A crop added in advance for the next season shows here straight away (see Editing or deleting a crop). The card shows the sowing date, expected harvest date and comment, with the buttons 'Edit crop' and 'Add a crop on this field'. A field without an active crop shows 'No crops found for this field.' and the 'Add a crop on this field' button.
- **'Crop history':** the field's earlier crops, newest first, with their sowing and expected harvest dates.
- **'Field location':** a satellite map of the farmer's fields, centered on the selected field. Each field has a marker: click a marker to see the field's name.
- **'Field settings':** the field's details in three groups, 'Name and location', 'Soil and groundwater' and 'Irrigation setup', which you edit here (see Editing or deleting a field).
- **'Other fields':** the farmer's other fields. Click one to switch to it.

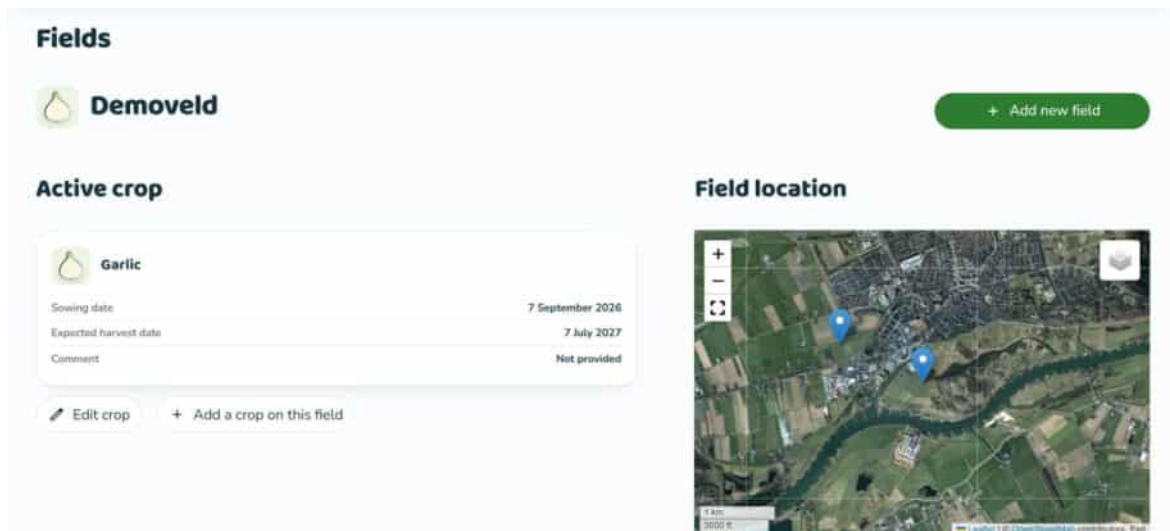


Figure 16. The 'Fields' page: the 'Active crop' on the left, the 'Field location' on the right.

3.2.1 Adding a field

1. Select the farmer in the top bar, open 'Fields' and click 'Add new field' at the top right. Check that 'Select Farmer' shows the right farmer.
2. Enter a 'Field Name' that the farmer recognizes: it appears in every message. The name must be unique in all of CROPTIMAL, across all farmers and organizations. If you see 'Field with this name already exists.' after clicking 'Create Field', add the farmer's or the village's name.
3. Enter the 'Latitude (decimal degrees)' and 'Longitude (decimal degrees)'. In Google Maps, right-click on the field and click the coordinates at the top of the menu to copy them (see the figure below). Google Maps gives the latitude first and the longitude second: enter each number in its own box. Double-check them: CROPTIMAL uses this location for the weather data behind the advice and for the 'Planting Guide'.
4. Optionally, enter the 'Groundwater depth (cm)': the depth of the groundwater below the ground surface. CROPTIMAL calculates the capillary rise from this depth and the 'Soil Type', and subtracts it from the crop water requirement (see Crop water requirement theory). Leave the box empty if you do not know the depth.
5. Select the 'Soil Type'. It starts at 'Sandy loam'. Together with the groundwater depth, the soil type sets the capillary rise (Table 1).
6. Select the 'Advisory Type'. It starts at 'Evapotranspiration (in mm)', which gives the farmer the advice in millimeters of water: skip to step 9. With 'Irrigation (in min)', CROPTIMAL turns the advice into an irrigation time in minutes, based on the irrigation specifications.
7. Select the 'Irrigation Type': 'Drip' or 'Sprayer'.
8. Enter the irrigation specifications. Each box starts at its lowest allowed value (0.1, or 1 for whole numbers), so check and fill in every box. For a sprayer, enter the 'Flow rate (L/h)' of one sprayer. For drip, enter:
 - a. 'Effective bed width (meters)': the width of the bed used for growing crops.
 - b. 'Emitter spacing (meters)': the distance between the emitters on a drip line.
 - c. 'Number of driplines per bed': the number of drip lines on one bed.
 - d. 'Total drip line length (meters)': the length of all drip lines on the field together.
 - e. 'Initialization time (minutes)': the time the system needs to reach full capacity. CROPTIMAL adds it to the advised time.
 - f. 'Emitter flow rate (L/h)': the flow per emitter. Ask the drip system supplier if you do not know it.
9. Click 'Create Field'. CROPTIMAL saves the field and fetches climate and soil data for its location, which the 'Planting Guide' uses. The dialog closes when this is done.

10. If this is the farmer's first field, the page opens on it. Otherwise, select it in the top bar or under 'Other fields'. The 'Field location' map is centered on the selected field: check that the marker in the center sits on the right plot, and click it to see the field's name. Then click 'Add a crop on this field' (see Adding a crop to a field).



Figure 17. Finding a field's coordinates in Google Maps by right-clicking on its location.

For advice in minutes, Cromptal calculates the irrigated area from the irrigation specifications (see Frequently asked questions). For a sprayer it uses a fixed wetted circle of about 93 m², so you enter the flow rate of one sprayer.

Add new field

Select Farmer
Chris Hurink

Field Name
North plot

Latitude (decimal degrees) 51.96000 Longitude (decimal degrees) 5.66000

Groundwater depth (cm) 120

Soil Type
Sandy loam

Advisory Type
Irrigation (in min)

Irrigation Type
Drip

Effective bed width (meters) 1.2 Emitter spacing (meters) 0.3

Number of driplines per bed 2 Total drip line length (meters) 400.0

Initialization time (minutes) 5 Emitter flow rate (L/h) 1.6

Create Field

Figure 18. The 'Add new field' dialog, with advice in minutes for a drip system.

3.2.2 Editing or deleting a field

1. Select the farmer and the field in the top bar and open 'Fields'.
2. Scroll down to 'Field settings'. The inputs work as when adding a field. For a field without a groundwater depth, 'Groundwater depth unknown' is ticked: untick it to enter a depth. To remove a groundwater depth, tick 'Groundwater depth unknown'. If you change the 'Advisory Type' to 'Irrigation (in min)', fill in every irrigation specification.
3. Click 'Update Field' at the bottom of 'Field settings'. You see 'Field updated.' If you changed the coordinates, Crootimal fetches the climate and soil data again.

Under 'Adjust soil values' you see the 'pH', 'Soil salinity (dS/m)', 'Potassium (ppm)' and 'Phosphorus (ppm)' that the 'Planting Guide' uses for the field: the satellite estimate, or the measured value where one was saved. A box is empty when there is no satellite estimate for the field's location and no measured value was saved. If the farmer has a soil lab report, enter the measured values and click 'Update Field'. To return to the satellite estimates, click 'Reset to satellite data' and then 'Update Field'.

To delete the field, click 'Delete Field' at the top of 'Field settings'. The dialog shows the field's name: check it, then click 'Yes, delete field', or 'Cancel' to keep the field. This cannot be undone, and the advice for the field stops.

The screenshot shows the 'Field settings' form. At the top right is a 'Delete Field' button. The form is divided into sections: 'NAME AND LOCATION' with fields for 'Field Name' (Dernoveld), 'Latitude (decimal degrees)' (51.95780), and 'Longitude (decimal degrees)' (5.65840); 'SOIL AND GROUNDWATER' with 'Soil Type' (Sandy loam), 'Groundwater depth (cm)' (90), and a 'Groundwater depth unknown' checkbox; 'Adjust soil values' (expanded) with input fields for pH, Soil salinity (dS/m) (1.00), Potassium (ppm), and Phosphorus (ppm), and a 'Reset to satellite data' button; and 'IRRIGATION SETUP' with 'Advisory Type' (Evapotranspiration (in mm)) and an 'Update Field' button at the bottom.

Figure 19. The 'Field settings' section of a field, with 'Adjust soil values' open.

3.2.3 Editing or deleting a crop

1. Select the farmer and the field in the top bar and open 'Fields'.
2. Under 'Active crop', click 'Edit crop'. The 'Edit crop' dialog shows the field and the crop at the top.
3. Change the 'Crop Type', 'Sowing Date', 'Expected Harvest Date' or 'Comment', and click 'Update Crop'. The 'Expected Harvest Date' must be after the 'Sowing Date'. When you change the dates, make sure they do not overlap another crop on the field.

To delete the crop, click 'Delete Crop' in the same dialog, then 'Yes, delete crop', or 'Cancel' to keep the crop. This cannot be undone, and the advice for the crop stops.

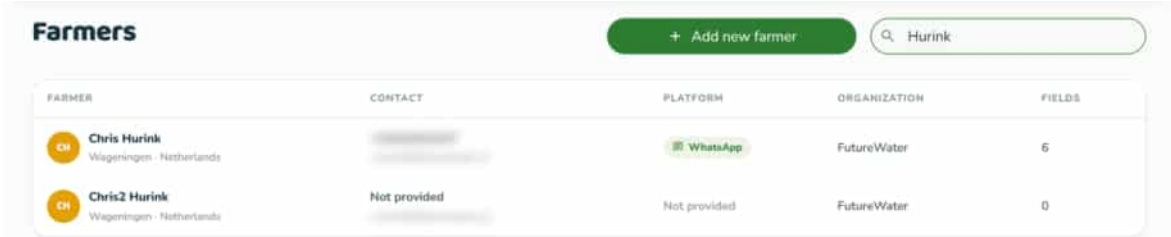
A crop moves from 'Active crop' to 'Crop history' the day after its 'Expected Harvest Date'. If it is still in the ground, extend it with 'Update harvest' on the 'Irrigation Advice' page (see When the harvest date has passed).

A crop added in advance for the next season becomes the 'Active crop' straight away, and the current crop moves to 'Crop history', so make any changes to the current crop before you add the next one. The advice for the current crop continues until the day before its 'Expected Harvest Date', and the advice for the next crop starts on its 'Sowing Date'.

Entered a wrong crop type or date? Correct it with 'Edit crop'. For a crop on the wrong field, delete it and add it again on the right field.

3.3 Farmers

The 'Farmers' page, under 'Admin' in the menu, lists the farmers of your organization with their contact details, message 'Platform' and number of 'Fields'. Type in the search box to filter the list by name, city or country.



FARMER	CONTACT	PLATFORM	ORGANIZATION	FIELDS
 Chris Hurink Wageningen - Netherlands		 WhatsApp	FutureWater	6
 Chris2 Hurink Wageningen - Netherlands	Not provided	Not provided	FutureWater	0

Figure 20. The 'Farmers' page, filtered with the search box. Click a row to edit that farmer.

3.3.1 Adding a farmer

1. On the 'Farmers' page, click 'Add new farmer'. 'Organization' is already filled in with your organization.
2. Enter the 'First Name' and 'Last Name' (the only required entries) and select the 'Country'. The address is optional.
3. Enter the 'Phone Number' in international format: a plus sign, the country code and the number, for example +977 for Nepal or +31 for the Netherlands. Use only digits and spaces after the plus sign. Coptimal sends the advice messages to this number.
4. Enter the 'Farmer Email (optional)' if you have it. If the farmer will log in to the dashboard, use the email address they log in with.
5. Set the 'Preferred Message Platform' to 'WhatsApp'. It starts at 'None', which shows the advice in the dashboard only and keeps 'Timezone', 'Preferred Advice Time' and 'Preferred Language' grayed out.
6. Select the 'Timezone' so the advice arrives at the right local time. It starts at UTC, so always change it. The time zones are listed by region and main city, such as 'Asia/Kathmandu' for Nepal or 'Europe/Amsterdam' for the Netherlands: type that city, not the farmer's own town.
7. Set the 'Preferred Advice Time': the local time at which the farmer wants to receive the advice.
8. Select the 'Preferred Language': the language of the farmer's messages. With WhatsApp you can choose English, Arabic, French, Nepali or Dutch.
9. If the farmer also logs in to the dashboard, select their user under 'Related Farmer User Account (optional)'.
10. Click 'Create Farmer'. If a name is missing, or the phone number or email address is not in a valid format, the dialog shows an error: correct the entry and click 'Create Farmer' again.

The top bar still shows the farmer you were looking at before. Select the new farmer there before you add their first field (see Adding a field).

Add new farmer [X]

Organization [dropdown]

First Name [text] Last Name [text]

Street Name [text] ZIP Code (optional) [text]

Street Number [text] City [text]

Country [dropdown: Afghanistan]

Phone Number [text] ⓘ

Farmer Email (optional) [text]

Preferred Message Platform [dropdown: None] ⓘ Preferred Advice Time [dropdown: 08:35]

Timezone [dropdown: UTC] Preferred Language [dropdown: English]

Related Farmer User Account (optional) ⓘ

Choose an option [dropdown]

Create Farmer

Figure 21. The ‘Add new farmer’ dialog. ‘Timezone’, ‘Preferred Advice Time’ and ‘Preferred Language’ stay grayed out while ‘Preferred Message Platform’ is ‘None’.

3.3.2 Editing or deleting a farmer

1. On the ‘Farmers’ page, click the farmer’s row to open the ‘Edit farmer’ dialog. Use the search box first if the list is long.
2. Change what you need. The inputs are the same as when adding a farmer, but the related user is called ‘Related User (optional)’ here.
3. Click ‘Update Farmer’ to save.

A farmer who is already set up with SMS also has the option ‘SMS’ under ‘Preferred Message Platform’ when you edit them, with English or Nepali as ‘Preferred Language’.

To delete a farmer, open their row and click ‘Delete Farmer’. Confirm with ‘Yes, delete farmer’, or click ‘Cancel’ to keep the farmer. This cannot be undone. Cromptal stops the advice and the messages for all fields of a deleted farmer.

3.4 Users

Users are the people who can log in to the Cromptal dashboard. Each user belongs to one organization and has one role. Managers find the ‘Users’ page under ‘Admin’ in the menu and create the users of their own organization.

A user is different from a farmer: the farmers on the ‘Farmers’ page receive the advice messages, and users log in to the dashboard. A farmer who also uses the dashboard needs a user with the role ‘Farmer’. Cromptal links this user to the farmer through a matching ‘Farmer Email (optional)’ or through ‘Related Farmer User Account (optional)’ (see Farmers).

3.4.1 User roles

The role decides what a user can see and change. Every role only sees data from its own organization, and a farmer only sees their own farm. All roles have the main pages in the menu ('Overview', 'Irrigation Advice', 'Weather', 'Planting Guide', 'Crop Explorer' and 'Fields') and can edit their own account.

Table 2. Permissions for each user role.

Role	Menu pages	Can add	Can edit
Manager	Main pages, 'Farmers' and 'Users'	Farmers, fields, crops and users	All farmers, fields, crops and users; can delete users
Extension worker	Main pages and 'Farmers'	Farmers, fields and crops	All farmers, fields and crops
Farmer	Main pages only	Fields and crops on their own farm	Their own fields and crops

The 'Filter by role' buttons on the 'Users' page also show 'Super user' and 'Super viewer'. These roles are reserved for FutureWater staff.

3.4.2 Adding a user

1. In the menu, under 'Admin', click 'Users', then click 'Invite user'. 'Organization' is already filled in with your organization.
2. Enter the 'First Name', 'Last Name' and 'Email'. The email is the address this person will log in with, so check it carefully.
3. Choose the 'Role' (see User roles). It starts on 'Farmer', so change it when you add a colleague.
4. Choose the 'Interface language', the language the dashboard is shown in for this user. It is required.
5. Click 'Create User'. If the email address is not valid or another user already has it, the dialog shows an error: correct the 'Email' and click 'Create User' again.
6. Tell the person they can now log in at <https://croptimal.app/> with this email address (see Logging in).



Figure 22. The 'Invite user' dialog as a FutureWater account sees it, with 'Organization' still empty. For a manager, 'Organization' is already filled in.

3.4.3 Editing or deleting a user

1. On the 'Users' page, find the person with the search box or the 'Filter by role' buttons, and click their row.
2. In the 'Edit user' dialog, change the 'First Name', 'Last Name', 'Role' or 'Interface language'.
3. Click 'Update User' to save.

To change someone's login email, ask them to change it on their own 'Account' page (see Account), and leave the 'Email' in the 'Edit user' dialog unchanged.

To delete a user, open their row and click 'Delete User'. Confirm with 'Yes, delete user', or click 'Cancel' to keep the user. The deleted user loses access to the dashboard the next time they open or reload it. To give them access again later, invite them again with the same email address.

3.5 Account

The 'Account' page holds your own details. To change them:

1. Click your name at the bottom of the menu.
2. Change your 'First Name', 'Last Name', 'Email' or 'Interface language'. 'Organization' and 'Role' are grayed out: ask your manager if your role needs to change.
3. Click 'Save account settings'. You see 'Account information updated successfully.' and the dashboard switches to the language you chose.

Figure 23. The 'Account' page, opened by clicking your name at the bottom of the menu.

If you change your 'Email' here, you log in with the new address from then on, and your login codes go to it. Check the new address carefully before you save.

To log out, click 'Logout' at the top right of the 'Account' page.

4 General remarks

4.1 Frequently asked questions

Answers to frequently asked questions from farmers:

Table 3. Frequently asked questions from farmers and their answers.

Question	Answer
<i>“Why is the advice different every day?”</i>	The weather changes every day: hot, sunny, dry or windy days need more water than cool, cloudy days. Croptimal uses the weather forecast for that same day, and the crop coefficient (Kc) changes as the crop grows.
<i>“The advice seems too low/high”</i>	On the ‘Fields’ page, check the field’s coordinates, ‘Soil Type’, ‘Groundwater depth (cm)’ and irrigation specifications under ‘Field settings’, and the crop and its sowing date under ‘Active crop’. The minutes assume the flow rate entered for the field, so also check the equipment for blocked emitters or sprayers and pump problems. After rain, the farmer lowers the advice by the rain measured with the rain gauge (see Applying the advice in the field). A drip field always gets at least its ‘Initialization time (minutes)’. Advice in minutes includes a margin for water losses (about 22% for drip, 20% for sprayers) and is rounded up to whole minutes.
<i>“I didn’t get my message today”</i>	On the ‘Farmers’ page, check that the ‘Phone Number’ is in international format (+ and the country code), that ‘Preferred Message Platform’ is ‘WhatsApp’ or ‘SMS’, and that the ‘Timezone’ and ‘Preferred Advice Time’ are correct. For a farmer on ‘SMS’, check under ‘Field settings’ on the ‘Fields’ page that the ‘Advisory Type’ is ‘Irrigation (in min)’. Check that the phone has internet and free storage. Check that the crop’s ‘Expected Harvest Date’ is after today: the advice runs until the day before it. If the crop is still growing, set a later date: on the harvest date itself with ‘Edit crop’ on the ‘Fields’ page, and from the day after with ‘Update harvest’ on the ‘Irrigation Advice’ page (see When the harvest date has passed).
<i>“I got a message that no advice could be calculated today”</i>	Croptimal could not calculate the advice, even after retrying until three hours past the ‘Preferred Advice Time’. The dashboard then shows ‘Not available’ for that day. For advice in minutes, check under ‘Field settings’ on the ‘Fields’ page that every irrigation specification is filled in with a value above zero. If this happens several days in a row, use ‘Report a problem’ in the ‘Help’ menu.
<i>“What if I have multiple fields?”</i>	Each field gets its own advice and its own message. You can add as many fields as needed on the ‘Fields’ page.
<i>“What if I have multiple crops on a field?”</i>	Each field in Croptimal holds one crop at a time. Add a separate field for each crop with ‘Add new field’ on the ‘Fields’ page, and enter the irrigation specifications of that part of the plot. Each crop then gets its own advice.
<i>“How is the field area calculated in Croptimal?”</i>	Croptimal calculates the irrigated area from the irrigation specifications. For drip: irrigated area = ‘Total drip line length (meters)’ × ‘Effective bed width (meters)’ ÷ ‘Number of driplines per bed’. For a sprayer the area is fixed at about 93 m ² , a circle with a 5.45-meter radius.
<i>“How can I stop the messages?”</i>	On the ‘Farmers’ page, click the farmer’s row, set ‘Preferred Message Platform’ to ‘None’ and click ‘Update Farmer’. Croptimal keeps calculating the advice, so you can still follow it in the dashboard. Messages also stop on the crop’s ‘Expected Harvest Date’, and when you delete the crop, the field or the farmer.

4.2 Need help? Contact us.

Something not working in the dashboard? Click ‘Help’ in the top bar, choose ‘Report a problem’, describe the problem under ‘What went wrong?’ and click ‘Send report’ (see Help and support).



Report a problem ×

Tell us what happened. The page you are on and your organisation are sent along, so you do not have to explain where you were.

What went wrong?

▶ Send report

Figure 24. The 'Report a problem' dialog.

Is a crop missing from Croptimal? Click 'Request a crop' on the 'Crop Explorer' page, enter the 'Crop name' and click 'Send request' (see Crop Explorer and crops).

For technical issues or questions, contact Chris Hurink, Geospatial Data Engineer at FutureWater: c.hurink@futurewater.nl.

Annex B – Site Selection Report

FIELD VISIT AND SITE APPROVAL REPORT

Project: Smart Sprayer – Efficient Terrace Irrigation in Nepal
Implementation Period: Winter Season 2025–2026
Target Crop: Cauliflower
Date of Report: 03 November 2025
Prepared by: Jan Nederstigt - Practica

1. INTRODUCTION

As part of the Smart Sprayer piloting program for the 2025–2026 winter cropping season, all proposed field sites in Putalibazar and Bheerkot municipalities were visited and assessed between October 9 and October 15, 2025.

The visits aimed to confirm the suitability of the selected fields for integrating the Smart Sprayer system with cauliflower cultivation, focusing on water source reliability, field accessibility, and farmer readiness.

Site selection was very well done by the CRRC team. Farmers were well informed and cooperative, showing strong interest in participating in the trial.

All location were found suitable for the pilot except the field of Dinu Khanal in Bheerkot-8; This site was not feasible because the two separate terraces are less than 12m wide. This makes operation of the Smart Sprayer difficult.

2. SITE SUMMARY

Bheerkot Municipality

Ward	Farmer / Site	Contact	Field Area	Water Source	Remarks
7	Kashiram Regmi	9869150206	550 sq m	Perennial spring ('Kathako padhero')	Suitable for pilot; direct source available
5	Rishiram Tiwari	9827522847	~1500 sq m (3 ropani)	Perennial spring via tank and pipe	Good pressure, tank available
5	Dambar Aryal	9846813895	1.5 ropani	Community tanks (15,000–30,000 L)	Reliable discharge, easy access
5	Padam Pani Pageni	-	>1 ropani	Same community tank	Suitable; maize/cucumber residues

8	Dinu Khanal	9846712409	~1 ropani	17,000 L tank fed by perennial source	Field consists of two small terraces; operating the Smart Sprayer is not possible. Not to be included in the pilot.
8	Bhagyodaya - Secondary School		800 sq m	Perennial small spring	Selected for pilot with Smart Sprayer + existing electric pump

Putalibazar Municipality

Ward	Farmer / Site	Contact	Field Area	Water Source	Remarks
10	Shyam Adhikari	9846073876	1000 sq m	Perennial spring (pipe-fed)	Suitable; plans for 1000 L tank
10	Bijaybandu Aryal	9846073334	1 ropani	Perennial spring (pipe-fed)	Suitable
10	Umakanta Adhikari	9846073356	1000 sq m	Perennial spring (pipe-fed)	Suitable
10 (Kanchi bazar)	Khadananda Adhikari	9856052400	600 sq m	Perennial spring (pipe-fed)	Suitable
10 (Kanchi bazar)	Govinda Adhikari	9846006888	650 sq m	Perennial spring (pipe-fed)	Suitable

3. WATER SOURCE VERIFICATION

All field water sources were tested for discharge capacity.

- Most sites showed a minimum flow rate of 550 liters per hour at field level, sufficient for Smart Sprayer operation.
- In cases where the minimum flow rate is not met, the farmer can still participate in the pilot. In such cases, the actual measured flow rate will be entered into the Croptimal app instead of using the standard rate.

4. OBSERVATIONS

- The CRRC team's site selection ensured that all fields are appropriate in terms of water access, terrain, and farmer engagement.

- Farmers were informed and motivated, understanding the purpose and benefits of the Smart Sprayer pilot.
- Water sources are reliable and perennial, with flow rates meeting operational requirements.
- The Bhagyodaya Secondary School site in Bheerkot is confirmed as a demonstration and training site, using an electric pump already installed on-site.

5. CONCLUSION

All proposed sites in Putalibazar and Bheerkot municipalities have been visited, verified, and approved for the Smart Sprayer pilot during the 2025–2026 winter cauliflower season. The combination of suitable field conditions, reliable water sources, and engaged farmers ensures an excellent foundation for successful piloting and demonstration.

Annex C – Farmer Focus Group Discussion Report

Focus Group Discussion Report

Smart Sprayer

Efficient Terrace Irrigation in Nepal



Prepared by: Climate Resilience Research Center

Date: 12/01/2026

Executive Summary

This Focus Group Discussion (FGD) report presents findings from two FGDs conducted in Putalibazar and Bheerkot municipalities under the project “Smart Sprayer: Efficient Terrace Irrigation in Nepal.” The FGDs aimed to understand farmers’ existing irrigation practices, identify challenges related to water and labor, and assess perceptions, usability, and expectations regarding the Smart Sprayer technology.

A total of 21 farmers participated in both FGDs (12 from Putalibazar and 9 from Bheerkot), including Smart Sprayer system users and non-users, with representation of both male and female farmers engaged in terrace-based agriculture. The discussions followed a participatory approach, incorporating agro-ecosystem mapping, perception comparison between users and non-users, and barrier hotspot mapping, alongside guided group discussions.

Findings show that prior to the Smart Sprayer system, farmers relied heavily on traditional irrigation methods such as manual hose irrigation, portable sprinklers, and surface irrigation. These methods were widely perceived as labor-intensive, time-consuming, and inefficient, particularly during the dry season when water availability is inconsistent and water sources are often distant from cultivated fields.

Farmers reported strong satisfaction with the Smart Sprayer system, highlighting significant reductions in irrigation time and labor, improved water use efficiency, and ease of operation once installed. Participants estimated water savings of around 50 percent and time savings of 50 to 80 percent per irrigation cycle. SMS-based irrigation advice was generally trusted and understood, especially among users, although farmers emphasized the need for advice to better reflect local field conditions.

From a gender and social inclusion perspective, the Smart Sprayer system reduced the physical burden of irrigation and enabled women to irrigate fields independently once trained. Youth involvement was noted, particularly in supporting digital aspects of the technology. However, several challenges were identified, including limitations in sprayer design for small and uneven terraces, difficulty relocating the sprayer across plots, high upfront cost, and uncertainty regarding repair and maintenance services.

Overall, the FGDs confirm that the Smart Sprayer system addresses critical irrigation challenges in terrace farming systems, while also highlighting the need for design adaptation, capacity building, and stronger institutional coordination.

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1. Introduction

1.1. Background of the project

Agriculture in the mid-hill regions of Nepal is characterized by terrace-based farming systems that are highly dependent on timely and efficient irrigation. However, many smallholder farmers continue to rely on traditional irrigation practices that are labor-intensive, water-inefficient, and difficult to manage during the dry season. Limited access to reliable water sources and the lack of appropriate irrigation technologies further exacerbate these challenges.

The project “Smart Sprayer: Efficient Terrace Irrigation in Nepal”, funded by Partners for Water subsidy scheme under Netherlands Enterprise Agency and implemented by Climate Resilience Research Center (CRRRC, Nepal), FutureWater (the Netherlands) and Practica (the Netherlands), aims to address these issues by introducing a climate-smart irrigation solution that improves water use efficiency, reduces labor requirements, and supports sustainable agricultural production in terrace farming systems. The Smart Sprayer technology combines controlled irrigation with SMS-based advisory support to guide farmers on irrigation timing and duration.

1.2. Rationale for conducting the FGD

Focus Group Discussions (FGDs) were conducted to gain an in-depth understanding of challenges related to irrigation, water availability, digital readiness and technology uptake of farmers and their perceptions toward overall Smart Sprayer technology. The FGDs provided a platform for farmers to share their experiences, concerns, and suggestions, allowing the project team to capture community-level insights that may not be evident through quantitative tools alone.

The FGDs also aimed to generate qualitative evidence to inform project learning, adaptive management, and monitoring of key performance indicators (KPI's) related to technology adoption, water use efficiency, and social inclusion.

1.3. Objectives of the FGD

The specific objectives of the FGDs were to:

- Assess current irrigation and water use patterns and challenges among farmers
- Assess digital readiness, technological uptake and trust in Smart Sprayer technology and SMS-based irrigation advice
- Understand farmers’ perceptions and overall acceptance of the Smart Sprayer technology
- Explore gender and youth involvement in irrigation practices
- Gather expectations, feedback, and suggestions to improve project implementation

2. Methodology

2.1. FGD design and approach

A participatory approach was used to conduct two FGDs in Putalibazar and Bheerkot municipalities. Both FGDs followed the same facilitation process, discussion guidelines, and participatory activities to ensure consistency across locations. The discussions were designed (Figure 1) to promote open dialogue, collective reflection, and experience sharing among participants, allowing for an in-depth understanding of irrigation practices, technology use, and perceived impacts of the Smart Sprayer system. The details of these steps are described later in this chapter.

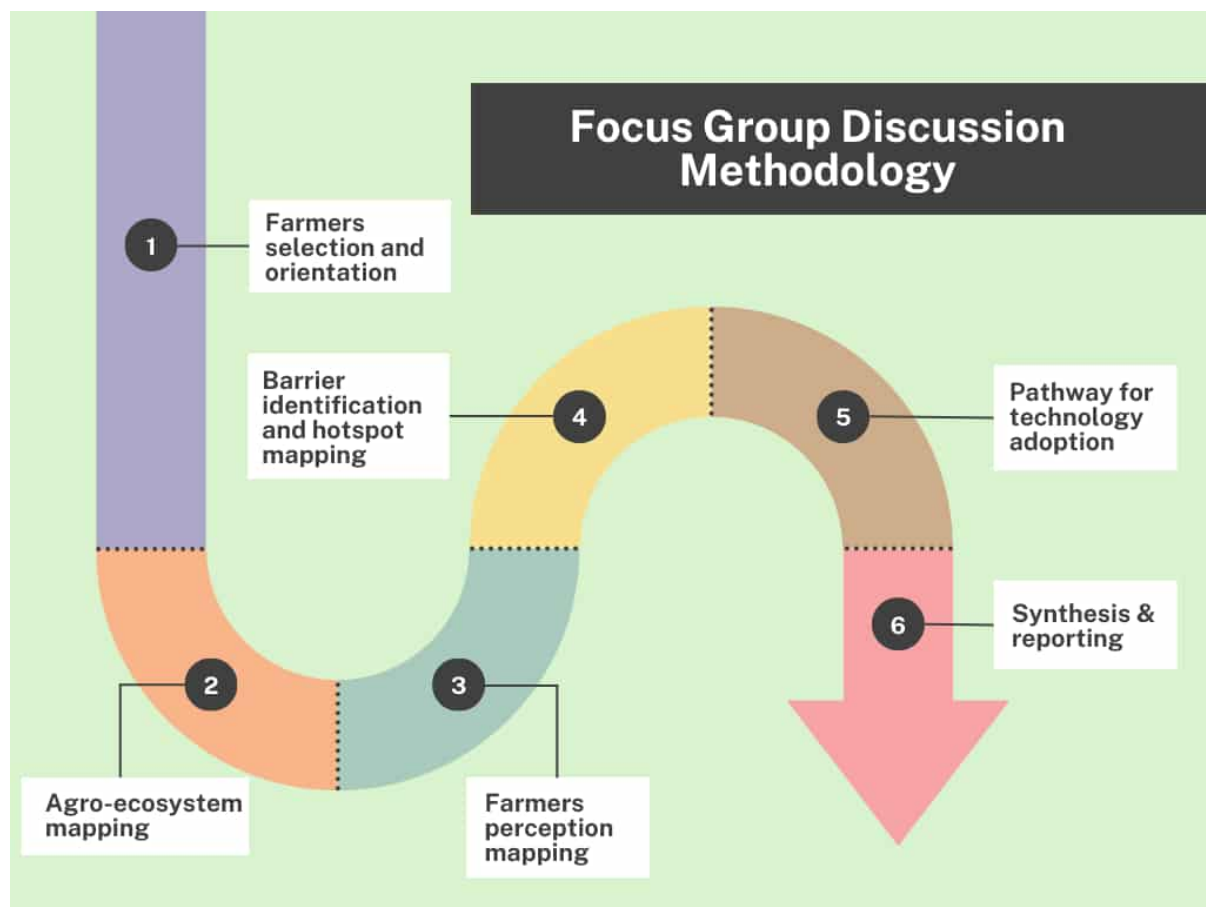


Figure 1: FGD design and analysis

2.2. Participants selection

Participants were selected in coordination with local stakeholders to include:

- Farmers currently using the Smart Sprayer system.
- Farmers not using the Smart Sprayer but engaged in dry season vegetable cultivation.
- Smallholder and semi-commercial farmers practicing terrace farming.
- Local level representatives from Wards¹.

¹ Wards are the smallest administrative units in Nepal

- Technical agricultural experts from Municipality and Agricultural Knowledge Center.

This diverse participant composition facilitated comparisons between users and non-users, gender perspectives, technical and non-technical expertise, as well as policymakers and practitioners, resulting in a broad range of viewpoints.

Table 1: Farmers profile based on different categories

Municipality	Sprayer Users (Male)	Non-users (Male)	Non-users (Female)	Total
Putalibazar	5	2	5	12
Bheerkot	4	2	3	9
Total	9	4	8	21

A total of 21 farmers from Putalibazar and Bheerkot municipalities participated in the FGDs (Table 1), including both Smart Sprayer users and non-users, with representation of male and female farmers engaged in terrace-based vegetable cultivation. Participants were primarily smallholder and semi-commercial farmers growing vegetables and cereals under terrace farming systems. Women were mainly represented among non-user groups, while Smart Sprayer users were predominantly male. Most participants were economically active adults aged 30–65, with a smaller number of older farmers included. Education levels ranged from basic literacy to secondary schooling, and digital literacy varied, with younger and male participants generally demonstrating greater confidence in using mobile-based technologies.

2.3. Facilitation process

The FGDs were facilitated by the technical experts from CRRC. The FGD session began with participant introductions and brief ice-breaking activity to create a comfortable discussion environment. This was followed by participatory exercises and guided discussions using semi-structured questions. Facilitators ensured balanced participation, encouraged contributions from both male and female participants, and documented key points, consensus, and differing views.

2.4. Participatory activities conducted during FGDs

To enhance engagement and generate detailed qualitative insights, the following participatory activities, guided by the CRRC technical experts, were conducted in both FGDs:

- Activity 1 (Agro-ecosystem mapping): Participants were asked to collectively map their households, agricultural fields, nearby water sources, irrigation routes, and storage facilities. A brief open discussion was held after this activity.
- Activity 2 (Perception mapping of Smart Sprayer use, users vs non-users): Participating farmers were divided into two groups (a) farmers using Smart Sprayer and (b) farmers using traditional irrigation practices. All the farmers were asked to choose the two best options among the 5. Following the selection, farmers were asked to openly elaborate why they choose those two options. The non-users shared their views based on their perception and observation.
- Activity 3 (Barrier identification and hotspot mapping): Farmers were asked to share their perceptions of key barriers in adopting the Smart Sprayer system, including cost, technical skills, market access, and water availability. Each farmer selected a percentage (scaled from 0–100%) for each barrier and placed a sticky note in the

corresponding area. A brief open discussion followed to summarize key learnings from the activity.

- Activity 4 (Pathway for the Smart Sprayer technology adoption): This activity explored farmers' readiness to adopt the Smart Sprayer and their experiences with digital irrigation support. Participants shared how comfortable they felt using the technology, their ability to read and interpret SMS-based irrigation messages, and any challenges or concerns related to digital tools. Farmers discussed changes in water use and irrigation time after adopting the Smart Sprayer and reflected on whether the technology helped reduce water use and labor requirements. They also shared their level of trust in the irrigation recommendations received through SMS and how these recommendations had performed in practice. The discussion further captured farmers' perceptions of the Smart Sprayer, including features that motivate or discourage adoption, potential risks, and suggestions for improving the design. Participants also discussed existing institutional support, training needs, and expectations for future farming, including how improved water availability could influence crop choices and how the project could best support the community.

2.5. Tools and guides used

The following tools were used during the FGDs:

- Semi-structured FGD checklist and discussion guide
- Participatory mapping and ranking exercises
- Chart paper, markers, and sticky notes
- Group discussion and experience sharing

2.6. Ethical considerations

Participants were informed about the purpose of the FGDs, and verbal consent was obtained prior to participation. Permission was sought for note-taking and recording of discussions. Participation was voluntary, and confidentiality of participants' responses was maintained throughout the process.

2.7. Location and duration of FGD

The FGDs were conducted at community-level locations convenient for participants. For Putalibazar, FGD was conducted at Sitaladevi Suntala Sankalan Kendra, Rangkhola on 12th December, 2025 and for Bheerkot it was conducted in the hall of Bhagyodaya school on 16th of December, 2025. Each session lasted approximately 2.5 to 3 hours, including participatory activities and open discussions.

3. Key findings

This section presents the consolidated findings from two Focus Group Discussions conducted in Putalibazar Municipality and Bheerkot Municipality on different dates. The responses and perceptions shared by farmers from both locations have been combined and synthesized, with common patterns and key differences reflected where relevant.

3.1. Traditional irrigation practices and water use

Farmers in both municipalities reported that they relied heavily on traditional irrigation practices prior to the introduction of the Smart Sprayer. Common methods included manual hose irrigation, portable sprinklers that needed to be frequently shifted across fields, and surface or flood irrigation for crops such as rice, wheat, and maize. Participants indicated that irrigation decisions are largely based on experience rather than calculated crop water requirements.

Irrigation is consistently described as labor-intensive and time-consuming, particularly during the dry season when water availability becomes limited. Participants emphasized that significant physical efforts are required to manage irrigation under existing practices.



Figure 2: Water source, field, access to road and market mapping in Putalibazar. Group A (figure left) is for the farmers using Smart Sprayer system and group B (figure right) for the farmers not using Smart Sprayer system.

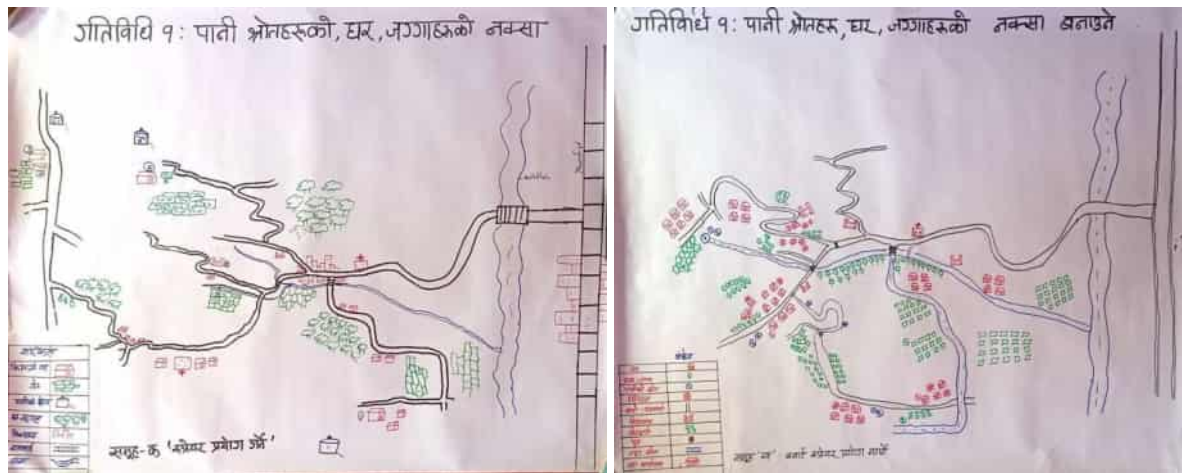


Figure 3: Water source, field, access to road and market mapping in Bheerkot. Group A (figure left) is for the farmers using Smart Sprayer system and group B (figure right) for the farmers not using Smart Sprayer system.

The Activity 1 (Agro-ecosystem mapping) showed that water sources were often located far from cultivated fields, requiring additional effort for water transport and storage (Figure 2 and Figure 3). Some farmers in Putalibazar specifically highlighted the need for storage tanks to make available water usable for irrigation. Across both FGDs, most participants identified inconsistent water availability as a persistent challenge affecting agricultural productivity.

3.2. Perceptions of Smart Sprayer users and traditional farmers

The result of the activity 2 (Perception mapping of Smart Sprayer use, users vs non-users) shows a strong positive perception and overall satisfaction with the Smart Sprayer system across both municipalities. Better and more uniform irrigation with reduced water usage was ranked first in both Putalibazar and Bheerkot (Table 2). From the perspective of non-users, the Smart Sprayer is perceived as a water-efficient technology, as they observed that farmers using the Smart Sprayer system applied noticeably less water compared to those relying on traditional irrigation practices (Figure 4 and Figure 5). In both municipalities, ease and comfort of Smart System use received a second rank, suggesting a consistent assessment that the technology is user-friendly across sites. Interestingly, in line with the experiences of farmers using the Smart Sprayer system, non-users also perceived the system to be easy and comfortable to use. Farmers highlighted that after the sprayer is installed and put into operation, only minimal monitoring of irrigation time is required, substantially reducing the need for constant supervision. Most of the farmers expressed that irrigation can be completed more quickly and with less physical effort, making the technology especially beneficial during the dry season. Confidence in recommending the Smart Sprayer to other farmers ranked third in Putalibazar and fourth in Bheerkot, reflecting fair endorsement in both locations. Notably, the option “*Smart Sprayer is not useful*” received the lowest rank (zero votes) in both sites, indicating minimal negative perception and reinforcing the overall positive reception of the technology across both study areas.

Table 2: Ranking of the options

Perception of farmers	Rank Putalibazar	Rank Bheerkot
Easy and comfortable to use	2	2

Saves time and labor	1	3
Better and uniform irrigation with less water usage	1	1
Smart Sprayer is not useful	4	5
Confident to recommend to other farmers	3	4

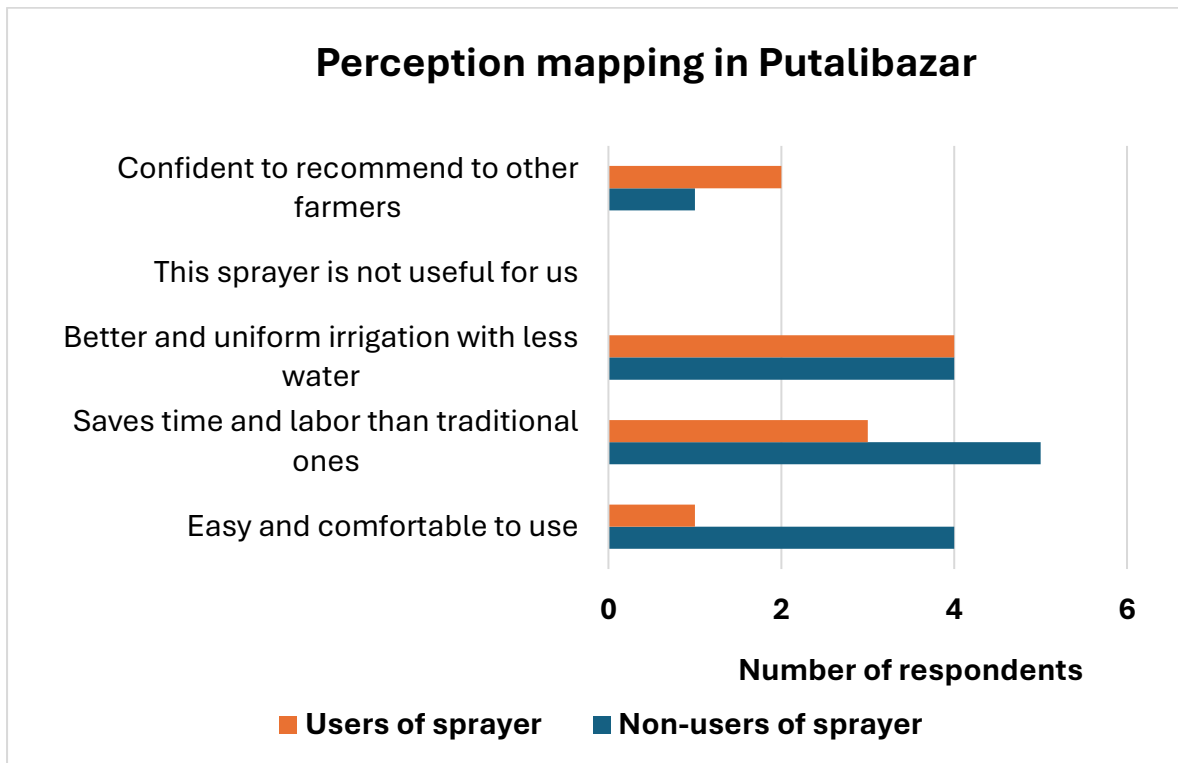


Figure 4: Perception mapping of the farmers using Smart Sprayer system compared to the farmers not using the system in Putalibazar

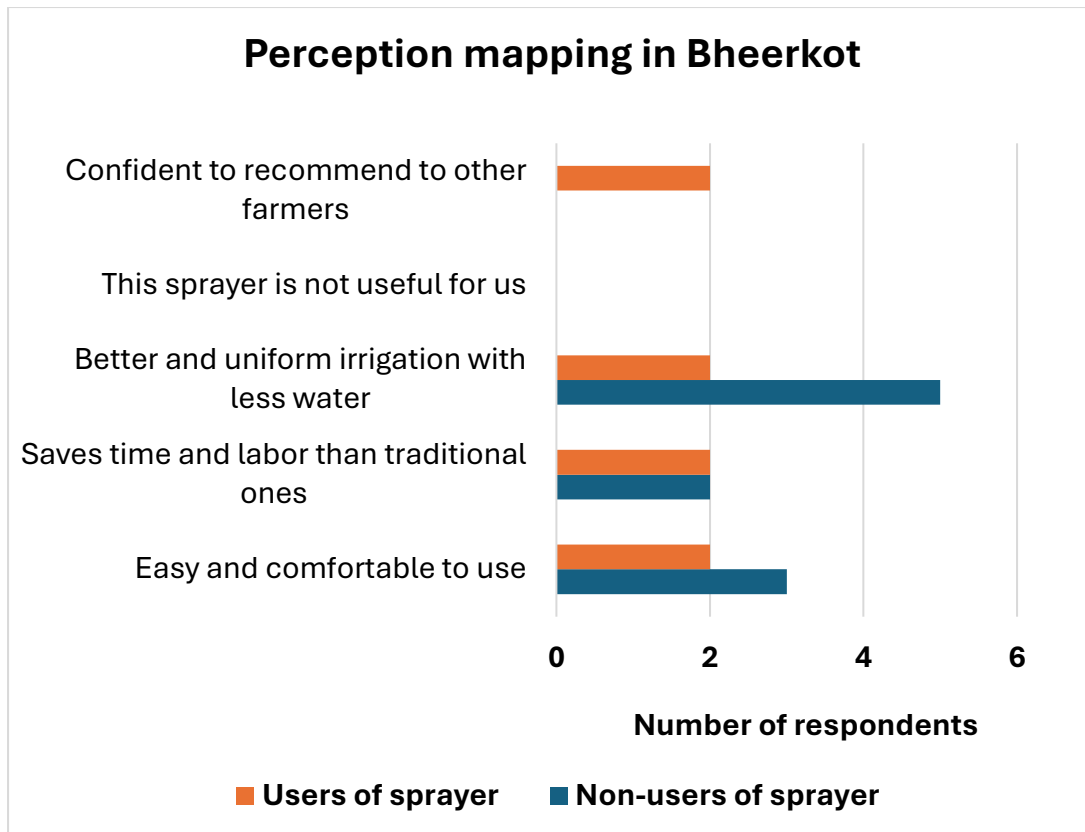


Figure 5: Perception mapping of the farmers using Smart Sprayer system compared to the farmers not using the system in Bheerkot

3.3. Barriers in adopting Smart Sprayer Technology

The different barriers in adopting the sprayer technology as per the farmers:

3.3.1. Cost of the Smart Sprayer system

Farmers expressed cost as an important concern during the activity 3 (Barrier identification and hotspot mapping). Cost ranked first in Putalibazar (average score 81%) and second in Bheerkot (66%), showing that affordability of the Smart Sprayer remains a significant barrier (Figure 6). Most farmers expressed concern that the Smart Sprayer system is more expensive than their existing irrigation methods, including hoses and portable sprinklers. Although farmers recognized that the sprayer saves time and water, the initial capital investment is high and difficult to manage in particular for smallholder farmers. In addition to the initial purchase cost, farmers expressed concern that repair, operation, and maintenance expenses could become costly over time, especially given the lack of clear information on after-sales technical support. During the discussion, farmers shared that they would prefer the availability of individual sprayer parts at affordable prices in local markets so that minor damage or wear could be repaired without high costs. Uncertainty around repair pricing and access to local servicing further increased farmers' perception of financial risk associated with adopting the Smart Sprayer technology.

3.3.2. Market-related constraints

While the technology improves irrigation efficiency, reduces labor, and ensures better water use, its impact on farmers' livelihoods is closely tied to market conditions. Market-related challenges

emerged as the most prominent barrier in Putalibazar (77%) and ranked second in Bheerkot (74%). During the group discussion, farmers highlighted several market-related challenges for the adoption of the Smart Sprayer system. Most farmers expressed concerns about low market prices of the crops, which can limit profitability even when crop yields increase. The lack of cold storage facilities further constrains them, forcing the sale of yield quickly, often at lower rates. Farmers also highlighted out their dependence on middlemen, which reduces the potential earnings. Additionally, competition from agricultural products from other districts and India was highlighted as a challenge, making market access unpredictable and potentially lowering returns.

Farmers emphasized that while the Smart Sprayer can enhance production, its full benefits would only be realized if accompanied by improved market access, fair pricing, and supportive infrastructure.

3.3.3. Water resources and availability during the dry season

Water availability, especially in the dry season, is identified as a continuing challenge. The average scores for this barrier were 47.9% in Putalibazar and 55.6% in Bheerkot, indicating that water availability remains a moderate but persistent challenge across both municipalities.

During the discussion, farmers explained that water sources are often located far from cultivated fields and are not reliable throughout the year. Seasonal variability, reduced water flow during dry months, and the absence of adequate storage facilities were highlighted as key issues. Farmers noted that although the Smart Sprayer supports more efficient water use, its effective operation still depends on access to a minimum and reliable water supply. This suggests that improvements in irrigation technology need to be complemented by better water storage and source management, particularly during the dry season.

3.3.4. Technical readiness and skills required Technical readiness and skills required to operate the Smart Sprayer system were discussed during Activity 3. The average scores for this barrier were 47.5% in Putalibazar and 40% in Bheerkot, indicating that technical skills were perceived as a moderate constraint rather than a major barrier in both municipalities.

During the discussion, farmers shared that understanding the basic operation of the Smart Sprayer and following SMS-based irrigation messages becomes easier after practical orientation. However, some operational aspects, such as relocating the sprayer across terraced fields and handling minor technical issues, were noted as areas where additional support would be helpful. Farmers emphasized the importance of hands-on training, clear operational guidance, and access to local technical assistance to build confidence and reduce dependency on external support.

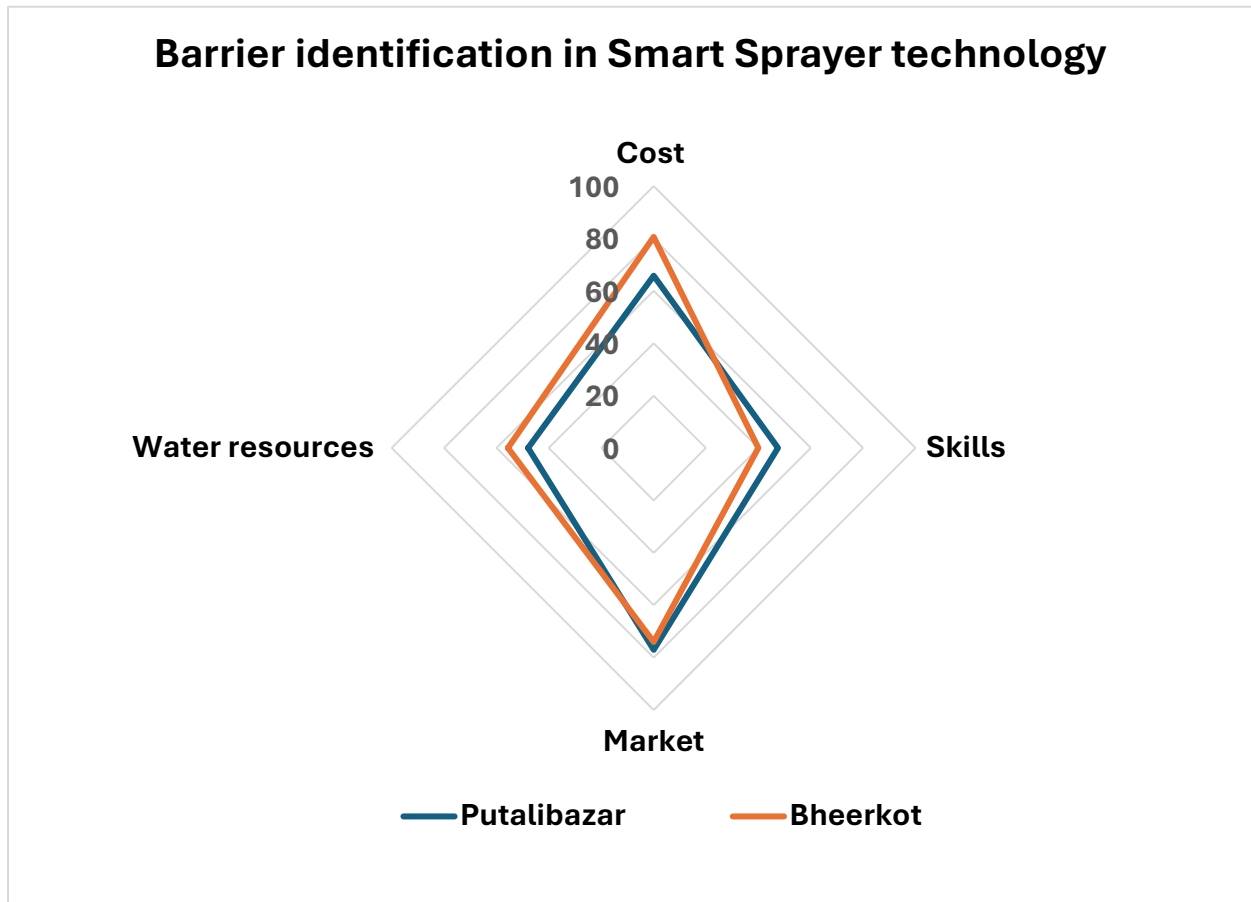


Figure 6: Barrier identification in smart sprayer technology in Putalibazar and Bheerkot

3.4. Pathway for the Smart Sprayer technology adoption

The outcomes of the semi-structured questionnaire and interactive discussion session are presented below:

3.4.1. Technology use and digital readiness

All farmers using Smart Sprayer system, reported that they could read and understand the SMS messages, as the messages are delivered in the Nepali language. However, some farmers indicated that the data collection and filling sheets (rain gauge and tensiometer) are not straightforward and require some calculation/technical skills and regular monitoring. Male household members were generally more comfortable with digital aspects of the technology compared to the women highlighting the need for more structured trainings for women. Additionally, in some cases, farmers do not receive timely and full SMS messages.

The Smart Sprayer System does not account for the soil condition. One participant explained that irrigation needs differ between lowland (khet) and upland (bari) fields, especially where paddy was previously cultivated. In such fields, soil tends to remain compact and retain moisture for longer, meaning the recommended irrigation amount may sometimes be higher than required.

Despite these concerns, most of the farmers highlighted that the SMS recommendations were reliable and useful in guiding irrigation practices. Regarding the physical operation of the Smart Sprayer, farmers mentioned that relocating the sprayer between plots is easier when two people are involved, mainly due to uneven terraces and slope conditions. However, they clarified that this does not prevent use, as a single person can still manage the system when needed. Overall, the Smart Sprayer was perceived as simple and easy to use across both municipalities.

*"I trust the advice since it provides us an estimate of irrigation that is required for our soil"
"It is going to be fruitful as it is an advanced technology"*

"I find it easy to use the irrigation messages because they are in Nepali"

3.4.2. Water use efficiency and time saving

Following the adoption of the Smart Sprayer, farmers reported noticeable reductions in both irrigation time and water use.

"I have saved 50% of the water" "I have saved 50% of time" "Smart Sprayer saves me time and effort for other activities"

"Because irrigation takes less time, plants can absorb nutrients better"

Although these estimates are based on self-reported perceptions rather than direct measurements, farmers expressed strong confidence that the Smart Sprayer has improved water use efficiency. Farmers also reported that the technology does not cause stress to crops and contributes positively to soil moisture management.

3.4.3. Gender and social inclusion

Farmers reported that traditional irrigation methods previously required the involvement of multiple household members. With the introduction of the Smart Sprayer, irrigation activities can now be managed by a single person in many cases. Farmers indicated that women are able to irrigate fields independently once they are familiar with the operation of the sprayer.

"With use of Smart Sprayer irrigation requires less physical energy, so I can do it myself"

Youth involvement was also noted, particularly in reading SMS messages and supporting technical aspects of the technology. Overall, farmers reported that the Smart Sprayer has made irrigation easier and less physically demanding for women and has encouraged greater participation of younger household members.

3.4.4. Stakeholders & institutional support

Farmers expressed the need for additional support to complement the Smart Sprayer technology. These included the provision of pipes, water storage tanks, plastic tunnels, and other basic agricultural infrastructure. Farmers emphasized the need for stronger support from municipalities and relevant institutions to enhance productivity.

Some farmers shared experiences of receiving drip irrigation support in the past, which was not effective due to the absence of plastic tunnels. Farmers also expressed interest in receiving training on climate-smart agricultural practices such as vermicomposting and mushroom cultivation. Overall, farmers were optimistic that the Smart Sprayer would contribute to higher production, improved yields, and more efficient dry-season farming.

4. Way forward

4.1. Conclusion

The Focus Group Discussions conducted in Putalibazar and Bheerkot provided a clear and grounded understanding of farmers' irrigation practices, challenges, and experiences with the Smart Sprayer technology in terrace-based farming systems. The discussions confirmed that traditional irrigation methods are labor-intensive, time-consuming, and poorly suited to managing limited and inconsistent water availability, particularly during the dry season. Across both municipalities, farmers recognized the Smart Sprayer as a practical solution that improves irrigation efficiency, reduces physical labor, and supports more informed decision-making through SMS-based advisory services delivered in the local language. The FGDs also highlighted positive social outcomes, including reduced workload for women, greater participation of youth, and increased confidence in managing irrigation at the household level.

At the same time, the FGDs emphasized that the effectiveness and sustainability of the Smart Sprayer depend on factors beyond the technology itself. Key barriers related to cost, repair and maintenance uncertainty, water availability, market access, and institutional support continue to influence adoption decisions. Farmers consistently viewed the Smart Sprayer as one important component within a broader farming system rather than a standalone solution. The central message emerging from the FGDs is that long-term impact will require continued technical guidance, affordable and locally accessible servicing options, complementary infrastructure such as water storage, and stronger coordination with local institutions and markets. When integrated within such a supportive ecosystem, the Smart Sprayer has strong potential to contribute to more efficient, inclusive, and climate-resilient irrigation practices in the mid-hill regions of Nepal.

4.2. Recommendations

Based on the FGD findings and analysis, the following recommendations are proposed:

1. Technical recommendations

- Modify the Smart Sprayer design to include adjustable height and arm length suitable for small and uneven terraced plots.
- Explore options for multiple or modular sprayer units to reduce the burden of frequent relocation across fields.
- Improve irrigation coverage for rectangular or irregular field shapes to minimize the need for manual follow-up irrigation.

2. Capacity-building recommendations

- Provide regular hands-on training, with special focus on women and non-users, to strengthen confidence in operating the technology independently.
- Develop simple user manuals or visual guides to support farmers during operation and troubleshooting.

- Continue orientation on SMS-based irrigation advice, incorporating local field conditions such as land type and cropping history.

3. Institutional and programmatic recommendations

- Strengthen coordination with municipalities, Agricultural Knowledge Centers (AKCs), and other local institutions to ensure follow-up support, repair, and maintenance services.
- Link the Smart Sprayer intervention with complementary infrastructure support such as water storage tanks, pipes, and protective tunnels.
- Integrate additional climate-smart agriculture trainings, including vermicomposting and mushroom cultivation, as requested by farmers.

Annexes

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Figure 7: Perception Mapping on Smart Sprayer use for Putalibazar and Bheerkot



Figure 8: Barrier identification and hotspot mapping for Putalibazar and Bheerkot



Figure 9: Group photo with the farmers of Putalibazar and CRRC team



Figure 10: Interaction with farmers of Putalibazar



Figure 11: Group photo with farmers of Bheerkot and CRRC team



Figure 12: CRRC team helping farmers with agro-ecosystem mapping



Figure 13: Farmers' involvement in perception mapping of smart sprayer use

Annex D – Sprayer Factsheet and Manual

SMART SPRAYER

The Smart Sprayer is an irrigation technology that combines a mechanical sprinkler system with the digital irrigation advisory tool Cromptal. It has been developed specifically for smallholder farmers. The sprayer has been developed to deliver uniform irrigation under low-pressure conditions. The fully mechanical rotating system operates solely on water pressure, enabling farmers to irrigate effectively without the need for pumps, motors, or external energy sources. The system is designed to reduce farmers' workload by simplifying irrigation practices. Combined with Cromptal the aim is to use water more efficiently.



FEATURES

- Suitable for small plots
- No pumps or electricity required
- Uniform water distribution
- Easy to assemble and move

TECHNICAL SPECIFICATIONS

- Sprayer diameter: 10.90 m
- Irrigated area: Approximately 93 m²
- Flow rate (all holes open): 700–1000 L/h
- Flow rate (half of the holes closed): 450–700 L/h



SMART SPRAYER

GENERAL INFORMATION

The Smart Sprayer operates effectively in areas with low water pressure and functions as a rotating sprinkler irrigation system. The holes in the outer two sections of the arms are oriented horizontally, allowing the sprayer to rotate solely through water pressure. As a result, the system operates fully mechanically and does not require pumps, motors, or external energy sources. Its lightweight and simple design allows the sprayer to be easily moved between fields and operated by a single person. To increase durability and long-term use the structure is designed in such a way that components can be repaired or replaced without specialised tools. Cromptal is a digital advisory tool that calculates crop water requirements based on remote sensing data, crop growth stages, and crop specifications. By integrating this information with the flow rate of the sprayer, it determines the number of minutes that irrigation should be applied. Farmers receive daily text messages with irrigation advice.



ASSEMBLY

STEP 1: SETTING UP THE BASE

- Place the aluminum tripod (1.1) on a stable, level surface.
- Position the cylindrical disc (1.2) on top of the tripod.

STEP 2 – INSTALLING THE CENTRAL VERTICAL TUBE

- Insert the vertical tube (2.1) into the center of the tripod.
- Slide the black plastic sleeve with the built-in spirit (2.2) level over the vertical tube.
- Slide the water inlet (2.3) on the bottom of the vertical tube.
- Insert the additional support pole (2.4) into the ground to stabilize the vertical tube inside the tripod.

STEP 3 – CONNECTING THE WATER SUPPLY

- Insert the water supply tube (3.1) into the lower black plastic component.
- Attach the filter (3.2) to the water supply tube using the hose adapter (3.3) to filter incoming water.

STEP 4 – MOUNTING THE GREEN VERTICAL TUBE

- Push the small plexiglass tube (4.2) into the green vertical tube (4.1), if this is difficult use a rotating and pushing motion.
- Attach the wires (4.3) to the top of the green vertical tube. These wires will later on support the sprayer arms.
- Slide the tube green vertical tube (4.1) over the central vertical tube (2.1).

STEP 5 – ASSEMBLING AND ATTACHING THE SPRAY ARMS

- Attach the sections of the sprayer arms (5.1/2/3) to both sides of the green vertical tube (4.1). First the first sections, then the second and then the third. Place a white foam ring (5.4) between each arm section before connecting them to prevent leakage.
- Attach the wire (4.3) that is connected to the green vertical tube to the third section of the arm.
- Make sure the holes of the first arm face upwards and on the second and third arm horizontally

COMPONENTS LIST- SMART SPRAYER

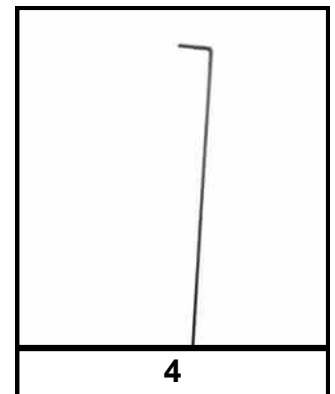
1 BASE AND SUPPORT

1. Aluminum tripod
2. Cylindrical top disc (mounted on top of the tripod)



2 CENTRAL STRUCTURE

1. Central vertical tube
2. Black plastic sleeve with built-in spirit level
3. Lower black plastic fixing ring
4. ground support pole



3 WATER SUPPLY SYSTEM

1. Water supply tube
2. Water filter
3. Threaded hose adapter (20 mm)
4. Water valve



4 ROTATING FRAME

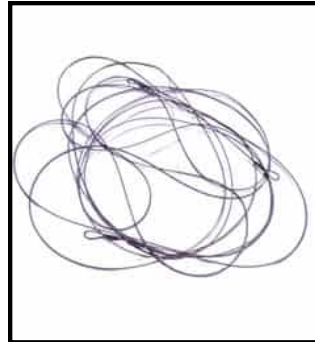
1. Green vertical tube
2. Plexiglass tube
3. Support wire for spray arms



1



2



3

5 SPRAYER ARMS

1. Spray arm section 1 (largest diameter and with upward-facing holes)
2. Spray arm section 2 (middle diameter with horizontally oriented holes)
3. Spray arm section 3 (smallest diameter with horizontally oriented holes)
4. White foam sealing rings (between spray arm sections)



1/2/3



4

6 OPTIONAL COMPONENTS

1. tube closing rings



1

USERS EXPERIENCES

In October 2025, field testing of the Smart Sprayer was initiated on nine pilot farms in Syangja district (Gandaki province), Nepal. This section presents the experiences and observations of some of those farmers.



Field size: 256 m²



Crop: cauliflower



Water flow: 765 L/h

"With this system I save a lot of time compared to sprinkler irrigation or irrigation with the hose. Also it disturbs the soil and plants less compared to sprinkler irrigation. However, the main advantage is covering more area with less water."



Field size: 253 m²



Crop: cabbage



Water flow: 631 L/h

"Before I used to irrigate using open canals, now with the Smart Sprayer I use my water more efficiently. I use less water and the water is distributed better."



Field size: 500 m²



Crop: cauliflower



Water flow: 498 L/h

"This system saves a lot of time, I do not need to wait anymore or move around with pipes, sticks and sprinkler irrigation. Once it is installed, I can let it run and even turn it off from my house."

Annex E – Mid-Term Report

Midterm Review Report

Smart Sprayer

Efficient Terrace Irrigation in Nepal



Submitted by: Climate Resilience Research Center

Submitted to:

Date:

Executive summary

This Mid-Term Review assesses progress, early outcomes, and implementation experience of the Smart Sprayer project implemented in selected wards of Putalibazar and Bheerkot municipalities in Syangja district. The project addresses dry-season irrigation challenges in Nepal's mid-hills by introducing a low-pressure, mobile irrigation technology combined with satellite-based digital irrigation advisory services to improve water use efficiency, reduce labor burden, and strengthen climate-resilient irrigation management.

The review covers project implementation during the first half of the project period up to January 2026. Findings are based on monitoring of key performance indicators, field observations, consultations with participating farmers, and discussions with municipal officials, agriculture technicians, ward representatives, and Agricultural Knowledge Centre officials conducted during mid-term review programs. At this stage, monitoring focuses on qualitative assessment of trends and early signals of change rather than full quantitative impact measurement.

Results indicate that the Smart Sprayer performs well under low-pressure conditions and is well suited to terrace-based farming systems. Farmers reported improved irrigation uniformity and the ability to irrigate larger areas using less water. Preliminary monitoring and farmer estimates suggest approximately 50 percent reduction in water use per irrigation event and 40–50 percent reduction in irrigation-related labor and time. The integration of digital irrigation advisory services has supported improved understanding of irrigation timing and crop water requirements, with increasing farmer confidence in using SMS based recommendations.

Farmer perceptions of the technology are largely positive, with users describing it as practical, reliable, and appropriate for local farming conditions. Farmers anticipate improved production outcomes, although yield data will be validated at endline. Financial constraints, particularly high initial investment costs, were identified as a key barrier to wider adoption, highlighting the importance of municipal support mechanisms and subsidies.

Institutional engagement has been strong, with municipal officials and agriculture stakeholders expressing interest in integrating the technology into climate-friendly agriculture programs and future municipal budgets. Youth involvement within farming households emerged as an enabling factor for digital learning and technology use. Key challenges identified at mid-term include the need for design adaptation for smaller plots, varying levels of digital literacy, and clearer institutional coordination for long-term support.

Overall, the mid-term review concludes that the project is progressing well and is on track to achieve its intended outcomes. The remaining implementation period provides an opportunity to consolidate learning, strengthen adoption, and prepare for the endline evaluation, which will quantify productivity and economic impacts.

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1. Introduction

1.1. Project background and rationale

Agriculture in the mid-hills of Nepal is largely dependent on rain-fed terrace systems, with limited access to reliable irrigation during the dry season. Conventional irrigation methods are labor-intensive, inefficient under low water pressure, and often result in over or under irrigation. These constraints limit dry-season vegetable production, contributing to food insecurity and missed income opportunities.

The Smart Sprayer project is designed to address these challenges by introducing a low-pressure, mobile irrigation technology combined with satellite-based digital advisory services. This study aims to improve water use efficiency, reduce labor burden, and strengthen farmers' capacity to manage irrigation in a climate-resilient manner.

1.2. Objectives of the midterm review

The objectives of the midterm review are:

- Monitoring and evaluation (M&E) of key performance indicators (KPIs)
- Document early outcomes and stakeholder perceptions
- Identify implementation challenges and risks
- Generate learning to inform course correction and scaling during the remaining project period

2. Methodology

2.1. Review period and coverage

The mid-term review covers project implementation activities conducted during the first half of the project period conducted on 26th December at Putalibazar with 14 participants and on 20th January with 9 participants in Bheerkot, focusing on selected areas of Putalibazar and Bheerkot municipalities in Syangja district.



2.2. Monitoring of the key performance indicators

The KPI M&E is conducted to assess progress, identify implementation strengths and challenges, and re-adjust the project implementation to ensure the specific objectives are met at the end of the project. Mid-term review focused on the M&E of key KPIs aligned with the project's objectives and theory of change. The indicators were selected to capture both technical performance, financial viability, social adaptability and institutional collaboration. Key indicators included water use efficiency and perceived water savings, time and labor savings associated with irrigation activities, adoption and usability of the Smart Sprayer technology, farmer capacity related to irrigation management and use of digital advisory tools, institutional engagement and support from local governments. KPI M&E methodology included a combination of farmer consultations, field observations, group-discussion, and feedback from municipal and agriculture officials.

2.3. Data sources and methods used

Different types of following data sources were used:

- Focus group discussion programs conducted in both municipalities
- Consultations with participating farmers

- Key informant interviews and discussions with municipal officials and agriculture technicians
- Review of project monitoring records and field observations

2.4. Stakeholders consulted

Following stakeholders were consulted during the program:

- Farmers using Smart Sprayer technology
- Mayors and municipality officials of both municipalities
- Agriculture technicians of both municipalities
- Agricultural Knowledge Centre (AKC) officials
- Ward chairpersons
- Chief Administrative Officers

3. Implementation progress to date

Project implementation during the first half of the reporting period has focused on establishing a strong technical foundation for the Smart Sprayer. Activities were implemented in a phased and structured manner, emphasizing stakeholder engagement, appropriate site selection, technology customization, and capacity building to ensure relevance and usability at the farmer level.

Table 1: Key activities implemented

Activities	Main Output Achieved
Stakeholder consultation and coordination	Municipal alignment secured; pilot wards finalized
Ward, site, and crop selection	Suitable terraces and priority vegetable crops identified
Smart Sprayer customization and installation	Systems installed and operational in selected farmer fields
Digital irrigation advisory integration	SMS-based irrigation recommendations initiated
Farmer training and technical backstopping	Farmers trained on operation, maintenance, and advisory interpretation
Focus Group Discussions (FGDs)	Farmer feedback on performance, usability, and challenges documented
Field monitoring and KPI tracking	Early data collected on water savings, labor reduction, and adoption trends
Mid-Term Review programs	Municipal-level review meetings conducted; lessons and adjustments identified

3.1. Activities implemented

- Stakeholder consultation and coordination

Initial implementation began with consultations involving municipalities, ward representatives, Agricultural Knowledge Centre officials, and local agriculture technicians. These consultations helped align project objectives with local priorities, clarify roles and responsibilities. Engagement with local governments also supported identification of suitable farmers and fields for pilot implementation.

- Field and crop selection

A systematic selection process was followed, starting with ward selection based on irrigation needs, accessibility, and interest from local authorities. Within selected wards, fields were identified considering terrace layout, water availability, slope conditions, and suitability for low-pressure irrigation systems. Crop selection focused primarily on vegetables cultivated during the dry season, with consideration given to future diversification.

- Field visits by a team from Future water and Practica

International team of experts from FutureWater and Practica visited Syangja from Netherlands to visit the project sites and help in the testing of the Smart Sprayer. The project team met the farmers to understand the irrigation problems and also their perceptions on new technology.

- Customization and installation of Smart Sprayer systems

The Smart Sprayer technology was customized to suit local field conditions, including terrace size and water pressure constraints. Installation was carried out in close coordination with farmers to ensure correct placement, ease of operation, and safe storage. Farmers were directly involved during installation to strengthen ownership and practical understanding of the system.

- Integration of digital irrigation advisory tools

Digital advisory services were introduced as a core component of the intervention. These services draw on satellite data, weather information, and field-level inputs such as tensiometers and rain gauges. Irrigation advice was communicated to farmers through SMS platforms, enabling timely and need-based irrigation decisions. Early emphasis was placed on helping farmers understand and trust the advisory messages.

- Training and capacity building

Orientation sessions and hands-on guidance were provided to farmers on the operation and maintenance of the Smart Sprayer, interpretation of digital messages, and basic record keeping. These activities aimed to build confidence in using both the physical technology and associated digital tools. Capacity building was approached as a continuous process rather than a one-time activity.

- Performance monitoring and follow-up

Initial monitoring focused on observing system use, identifying operational challenges, and documenting farmer feedback. Field observations and informal follow-ups helped identify early signs of water and labor savings and provided insights into areas requiring further technical support.

3.2. Activities planned for the remaining period

The activities that are required for the remaining period are as follow:

- Continue performance monitoring across different crop stages
- Conduct additional technical trainings to strengthen operation and maintenance of the Smart Sprayer and digital advisory services
- Develop farmer-level and supplier-level business cases to assess economic viability and scaling pathways
- Expand dissemination and engagement activities to reach more farmers, municipal officials, and development partners
- Conduct a final evaluation and document lessons learned toward the end of the project

4. Outcomes

4.1. Key findings

4.1.1. Technical performance and innovation

The initial outcomes so far demonstrated strong technical performance under field conditions in both Putalibazar and Bheerkot municipalities. Designed to operate under low-pressure conditions, the Smart Sprayer system so far showcased that it is well suited to terrace-based farming systems in the mid-hills, where conventional irrigation methods often perform poorly. Farmers reported more uniform water distribution across terraces, reducing both over-irrigation and water stress in crop fields. This indicates good alignment between the technology design and the physical conditions of the project area.

Improved water use efficiency emerged as one of the most significant technical outcomes at mid-term. Farmers reported that a larger area could be irrigated using substantially less water compared to traditional practices. (Figure 1) Preliminary estimates suggest approximately 50 percent reduction in water use per irrigation event. In parallel, irrigation-related labor and time requirements is reduced by an estimated 40–50 percent, as irrigation could be completed more quickly and with less physical effort.

The system's flexibility and adaptability were highlighted by both farmers and technical stakeholders. While current application focuses mainly on vegetable crops, there is strong interest in extending use to other crops such as onion, garlic, and maize, particularly during early growth stages. The multi-crop applicability may enhance the relevance of the technology across diverse farming systems and strengthens its potential for broader adoption beyond the pilot sites.

A key innovation of the project is the integration of digital irrigation advisory services with the Sprayer. Farmers received irrigation recommendations based on satellite data, weather information, and field-level measurements through SMS platforms. Though digital engagement remains at an early stage, many farmers reported improved understanding of irrigation timing and crop water requirements. The ability of farmers to receive, interpret, and apply digital advice represents an important step toward climate-smart and data-informed farming practices in the mid-hills.

(Figure 1) Overall, M&E of KPIs shows a clear positive trend from baseline to mid-term. While end-of-project targets have not yet been reached, mid-term results indicate strong momentum in technical performance, user capacity, and innovation uptake.

Key performance indicator

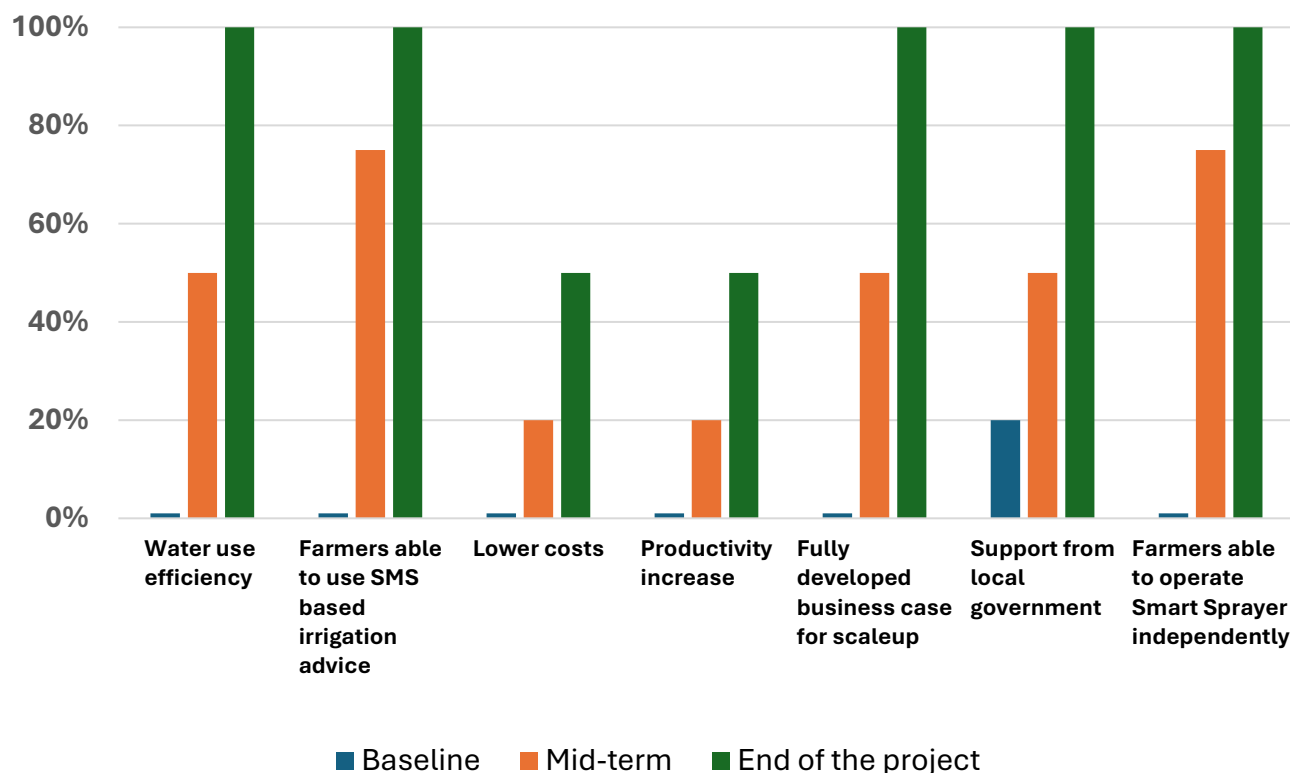


Figure 1: Progress of key performance indicators at midterm

4.1.2. Farmer perceptions and adoption

Overall, farmers expressed a high level of satisfaction with the Smart Sprayer technology. Farmers described the technology as reliable, practical, and well suited to their farming conditions. The ability to irrigate according to actual crop requirements rather than fixed schedules was seen as a major improvement over traditional practice.

Farmers reported expectations of increased production due to better irrigation management, although full yield data will be available only at the end of the project. Importantly, farmers emphasized that visible benefits from early adopters could encourage other farmers to adopt the technology, suggesting strong potential for peer-driven diffusion.

At the same time, farmers highlighted financial considerations as a key factor influencing adoption. While they recognized the long-term benefits of the technology, many farmers expressed the need for subsidies or other forms of municipal support to address the high initial cost of irrigation infrastructure. This feedback underscores the importance of institutional engagement in facilitating equitable access.

4.1.3. Institutional engagement and policy alignment

Engagement with local government institutions has been a notable strength of the project. Officials from Agricultural Knowledge Centre, municipal agriculture departments, ward leadership, and municipal administration actively participated in mid-term review programs and discussions.

In Putalibazar, officials emphasized that irrigation remains a critical priority for farmers and viewed the Smart Sprayer as a timely and relevant solution. The technology was considered suitable for inclusion in climate-friendly agriculture programs and potentially scalable through municipal planning mechanisms. In Bheerkot, municipal representatives expressed interest in incorporating the technology into future budget programs following further discussion with political leadership.

Local officials also acknowledged the importance of increased field-level engagement. In response to farmer requests for more frequent visits and technical support, municipal representatives committed to allocating time for on-site follow-up, indicating growing institutional ownership.

4.1.4. Social inclusion and youth engagement

Social inclusion and youth engagement emerged as important cross-cutting themes during the mid-term review. Stakeholders emphasized the role of youth and children within farming households in supporting digital learning and technology use. Younger family members often assisted farmers in understanding SMS advisories, using mobile phones, and maintaining basic records.

At the same time, stakeholders highlighted the need to ensure inclusiveness for smallholder and semi-commercial farmers. Suggestions were made to further refine the design of the technology so that it can be effectively used on smaller plots, thereby expanding access and benefits to a broader range of farmers.

4.2. Challenges

Despite positive progress, several challenges were identified during the mid-term review.

4.2.1. Technical challenges

The challenges included limitations related to plot size and site selection. Very small or irregularly shaped terraces may require design modifications to ensure optimal system performance. The aluminum arms are somewhat fragile and require careful handling, shifting the sprayer to different plots is relatively easier for males than females, the flow lower than 500lit/hour isn't quite suitable for the sprayer to function properly and also there is lack of a proper manual for using the sprayer.

4.2.2. Financial challenges

Financial challenges were frequently raised by farmers, particularly related to the initial cost of irrigation equipment. Without subsidies or financial support mechanisms, adoption by resource-constrained farmers may remain limited.

4.2.3. Institutional challenges

There is a strong need for clearer commitments and coordination mechanisms between local stakeholders including municipalities, wards, local entrepreneurs, civil societies and farmers for long-term sustainability and scaling. Clearer articulation of post-project roles and responsibilities will further strengthen institutional continuity.

4.2.4. Adoption-related challenges

There were varying levels of digital literacy among farmers. Some farmers requested continued capacity building training and regular follow-up by the project team in future to build confidence in both the technology and advisory tools.

4.3. Sustainability and scaling potential

4.3.1. Commercial viability

Initial outcomes of Smart Sprayer feasibility so far demonstrate promising results and strong potential for sustainability and scaling. From a commercial perspective, the technology offers clear economic benefits through water savings, reduced labor costs, and anticipated productivity gains. Further cost optimization and development of local supply chains could enhance affordability.

4.3.2. Municipal ownership and budget integration

Municipal ownership represents a key pathway for sustainability. Expressions of interest from municipal officials to integrate the technology into future budget programs indicate favorable conditions for institutionalization. Continued engagement with political leadership will be essential to formalize these commitments.

4.3.3. Alignment with climate-smart and digital agriculture initiatives

The project aligns closely with climate-smart agriculture and digital agriculture initiatives at local and national levels. By promoting efficient water use and data-informed decision-making, the intervention supports broader policy objectives related to climate resilience, resource efficiency, and agricultural modernization.

5. Conclusion

The mid-term review finds that the Smart Sprayer project is progressing well and delivering promising early outcomes. The technology is technically viable, context-appropriate, and positively received by farmers and local institutions in both Putalibazar and Bheerkot municipalities.

With continued technical refinement, strengthened institutional engagement, and targeted financial support mechanisms, the project is well positioned to achieve its intended outcomes. The endline evaluation will be critical to quantify productivity and economic impacts. The remaining implementation period provides an important opportunity to consolidate learning, strengthen adoption, and lay a strong foundation for scaling and long-term impact.

6. Annex



Figure 2: Farmers and stakeholders attending the midterm review program in Putalibazar



Figure 3: Mayor of Putalibazar delivering his speech



Figure 4: Stakeholders and farmers attending the midterm program in Bheerkot



Figure 5: Chief administrative officer (7th level) delivering his speech



Figure 6: Group photo of stakeholders, farmers and CRRC team during the midterm program in Bheerkot

Annex F – Market Research Report

Final Report

Supply chain and market analysis for the Smart Sprayer application in Nepal



Submitted by
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I BACKGROUND

Irrigation in Nepal, as a public good is mainly regulated by the government institution. It is less of an individually consumable product and more of a system, dependent on external factors like water availability and related infrastructures. The Department of Irrigation (DoI) under the Ministry of Energy, Water Resources and Irrigation (MEWRI) and the Department of Local Infrastructure Development and Agriculture Roads under the Ministry of Local Development (MoLD) are in charge of most large irrigation projects — such as surface irrigation systems, ground water, lift irrigation systems, and deep tube wells — including their operation, construction, and maintenance.¹

Most irrigated land in Nepal gets water through small surface water irrigation systems categorized as farmer-managed irrigation system (FMIS) or agency-managed irrigation systems (AIMS) built on demand and administered by Water Users' Association as per Irrigation Policy Guidelines. The Department of Agriculture (DoA) under MoALD is responsible for smaller FMIS and non-conventional irrigation systems, including drip, pond irrigation, rainwater harvesting, treadle pumps, electric pumps, and sprinklers.

Private companies like -Nepal Krishi Company, BTL Pvt. Ltd., and Nepal Thopa Sichai provide irrigation solutions and technologies (e.g., solar irrigation, drip, sprinkler, and pond plastic). But, sellers of these irrigation technologies are small and primarily located in district capitals and major regional cities and lack proactive marketing activities.

Despite overall irrigation infrastructure, only about 25 % of arable land has year-round irrigation coverage, with the rest still primarily rain-fed. The ongoing Sixteenth Five Year Plan aims for significant increases in year-round irrigation coverage to 50 % by 2029.

The National Irrigation Policy 2080 (2023/2024) is the government's most recent overarching policy for guiding irrigation development in Nepal. It aims to expand irrigation coverage, improve service delivery, strengthen institutions, and increase agricultural productivity through sustainable water management. National Irrigation Policy, 2080, emphasizes efficient water use, modernization of irrigation, and climate resilience. Similarly, Agriculture Development Strategy (ADS, 2015 -2035), promotes water-saving technologies and commercialization whereas Climate Change Policy & NAP, recognizes micro-irrigation as a climate adaptation tool for drought and rainfall variability.

Many local governments have their own micro-irrigation operational guidelines. They allocate annual budget lines for irrigation support with provision for partial capital subsidy (often 50–70%) for micro irrigation technologies like drip kits, sprinkler sets and pipes, filters and tanks. Micro-

¹ Pradhan and Belbase, 2018.

irrigation is mainly used for vegetables, fruits, and high-value crops, typically on plots of 0.1–0.5 ha.

The first experiments and demonstrations of micro-irrigation technologies such as drip and sprinkler systems began in Nepal in the late 1980s and 1990s, through research institutions and development NGOs focused on water-use efficiency and increasing yields. International Development Enterprises (IDE Nepal) played a transformative role from the early 1990s by promoting and adapting low-cost micro-irrigation technologies for smallholders².

The Government of Nepal, started promoting micro-irrigation technologies including drip and sprinkler systems through the Non-Conventional Irrigation Technology Project (NITP) under broader irrigation development programs during the Tenth Five-Year Plan, particularly in mid-hills and areas not served well by conventional schemes. By the 2000s, Micro-irrigation gained broader popularity among smallholders. Most of the micro-irrigation tools (pipes, drip kits, micro sprinklers) are locally manufactured or available even in remote locations. The Federal governance framework empowers provincial and local governments to implement small and micro-irrigation initiatives.

The Irrigation system in Nepal faces some key challenges as follows:

- Due to water scarcity and limited capacity of smallholder producers, irrigation facilities are mostly consumed by commercial farmers only
- Imported irrigation systems (equipment) are expensive and may not fit into the local context, whereas locally produced systems- like drip-irrigation are still at their rudimentary level requiring upgradation
- Repair and maintenance services and required infrastructures are non-existent
- Coordination amongst government agencies and with local groups is often difficult
- Irrigation systems are not adequately resilient to draught and flood adding to maintenance and repair cost
- Smaller investment like micro-irrigation systems are not a priority of financial institutions for funding as their focus is more at large projects

²<https://abhiyandaily.com/news/7589/16-22-january-2012-development-special-ide-leading-micro-irrigation-revolution-in-nepal>

2 OBJECTIVE OF THE STUDY

The Smart Sprayer project, funded under the Partners for Water (PVW 2025) programme, aims to improve water security and productivity in Nepal's mid-hills through:

- The Sprayer, a low-pressure rotating irrigation system for hilly terrain.
- The Cromptal application, a digital irrigation advisory tool using satellite data and weather forecasts.

On this backdrop, Climate Resilience Research Center (CRRC) is conducting pilot testing of both the technologies in Putalibazaar and Bhirkot Municipality of Syangja through research plot testing on Cauliflower and Cabbage with 10 farmers in coordination with local stakeholders.

To prepare for the scale-up of the piloted technologies after the project, a concise, practical market and supply chain analysis is commenced to identify how the Sprayer and Cromptal can be sustainably introduced and scaled in Nepal, focusing on farmer affordability, private sector engagement, and government support mechanisms.

3 METHODOLOGY

A focused, mixed-method approach was used to assess the market and supply chain of the Sprayer and Cromptal employing Desk Review, Survey and KIs, Observations and Field Visits. The desk review focussed on understanding the irrigation service ecosystem in Nepal and ongoing programs (like National Agriculture Modernization Program) whereas respondent specific checklist/questionnaire was developed for capturing information, perception and current practices at the farmers' level (both Smart Sprayer users and Non-users), Retail Seller/ Agrovets, Wholesalers, Importers, local Financial Institutions/ Cooperatives and the Local Governments.

Based on the information gathered from the observations and interviews, the market aspect of the Smart Sprayer and Cromptal was carried out. In addition, the feedback and inputs from Practica/ Future Water and CRRC were recorded and addressed while developing the report.

4 LIMITATIONS OF THE STUDY

Since the number of samples is small (N=10), the assessment has used the qualitative aspect to assess the Sprayer & Cromptal. During the process, a comparative analysis approach to systematically compare Sprayer and Cromptal to assess characteristics mainly- Usability/ Efficiency, User Experience / Adoption, Market Access & Support Ecosystem and Pricing / Economic Feasibility with other similar technologies.

This has provided a benchmark for Smart Sprayer, and support recommended actions for pricing and development of a robust supply/ market plan for commercial operation.

7. Report on "Supply chain and market analysis for the Smart Sprayer in Nepal"

5 INTRODUCTION TO THE SPRAYER

5.1 Sprayer

The Sprayer is a fully mechanical rotating sprinkler irrigation system specifically designed for small and medium-sized farms operating under low water pressure conditions. Suitable for small plots, it requires no pumps, motors, or electricity, operating solely through water pressure. The system discharges water through 56 precision-drilled holes positioned along multi-sectional sprayer arms, enabling uniform water distribution across a diameter of 10.9 meters and covering approximately 93 m² per setup. With a flow rate ranging from 700–1000 liters per hour (all holes open) and 450–700 liters per hour (half holes closed), it allows flexible water management based on crop needs and water availability.

Technically, the Sprayer consists of an aluminum tripod base, central vertical tube with built-in spirit level, rotating green vertical tube assembly, and three-section sprayer arms supported by tension wires. The outer arm sections are horizontally oriented to generate rotation purely from hydraulic force, eliminating the need for external energy sources. Lightweight and modular in design, the system is easy to assemble, disassemble, and transport between plots. Key salient features include low-pressure functionality, efficient water use, reduced labor requirement, minimal soil and crop disturbance, filtration of incoming water, and adaptability to existing farming practices—making it a cost-effective and farmer-friendly irrigation technology.

5.2 Croptimal

Croptimal is a smart irrigation advisory platform developed by FutureWater that provides farmers with daily, field-specific irrigation recommendations through SMS or WhatsApp. Based on internationally recognized FAO crop water requirement principles, the platform integrates satellite-derived weather data, crop type, crop growth stage, and irrigation system characteristics to estimate crop water demand and translate it into simple irrigation recommendations expressed in minutes of irrigation. Designed primarily for smallholder farmers, Croptimal enables more efficient water use, improves irrigation scheduling, and supports increased agricultural productivity through timely and practical decision support. Further illustration of the application is provided in Figure 1.

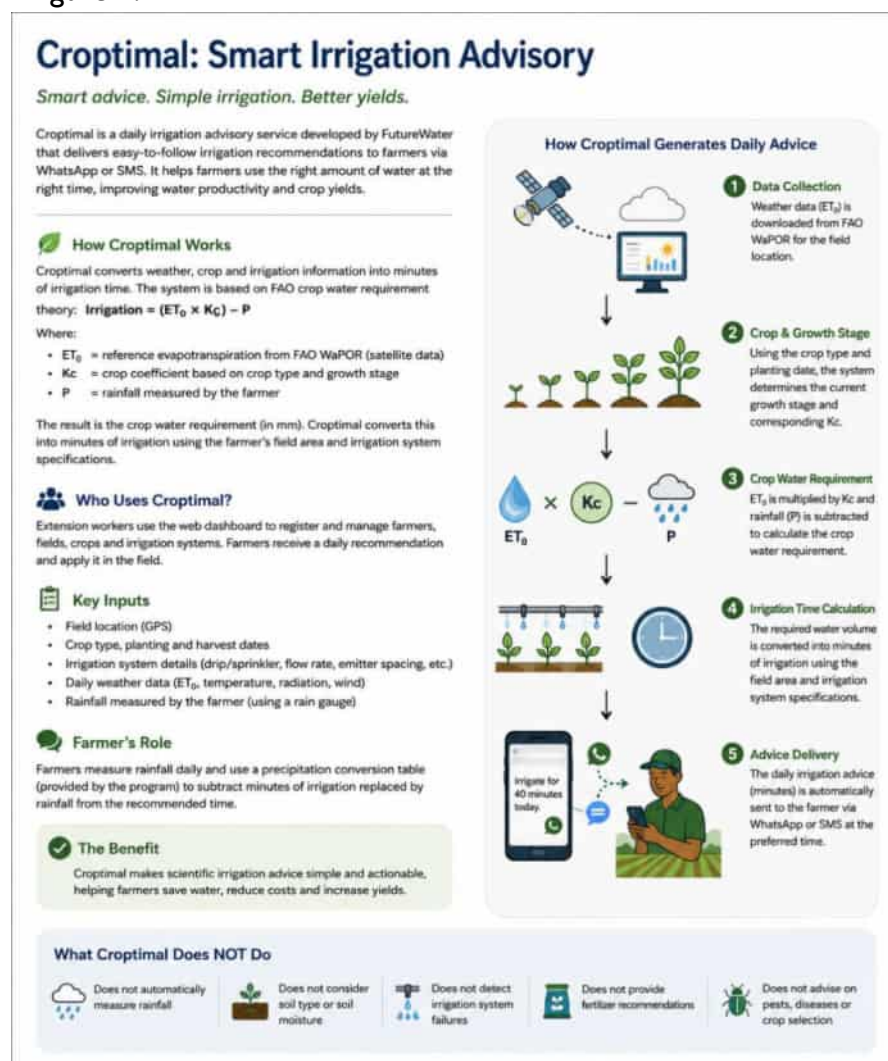


Figure 1: Schematic of how Croptimal Application functions

Source: Adapted from Technical Guide, Croptimal (Feb, 2026)

6 KEY OBSERVATIONS AND HIGHLIGHTS

6.1 Use of Smart Sprayer

During the field visit, it was found that Smart Sprayer is used by all the farmers (mainly semi-commercial³ and a few commercial) for vegetable farming (Cauliflower and Cabbage). The farmers employ overhead tanks or combine with the Solar Pumps for using the Smart sprayer.

The irrigation time and volume of water for irrigation are guided by the timely messaging from Short Messaging Services (SMS) disseminated by Cromptal. However, it is to be noted that while farmers reference the SMS, they also employ their traditional knowledge to ensure that the irrigation is as per the crop needs and soil conditions. It was observed that the record of the irrigation schedule is kept by almost all the farmers.

6.2 Farmers Perception

The respondent farmers expressed their views that they have received better irrigation area coverage by employing the Sprayer (up to 12 meters). They were ecstatic about the performance of the Sprayer pertaining to the specific volume and uniform water flow. This has helped them to stop leaching of nutrients due to excess water in their fields, and the nutrients were evenly available to the crops. The Smart Sprayer is best suited for their condition as it optimizes the water use, and farming is possible with less water supply benefitting them in their current scarce water supply condition.

Due to the systematic process and user-friendly mechanism, they responded that Smart Sprayer is time-saving and requires less monitoring. The labour requirement is also low for the technology as it could be easily handled by a single person, and even be handled by women.

A Surprise Factor the team encountered was a farmer reporting that the technology has scared the monkeys coming to the plots. Though this could not be taken as a permanent or long-term solution for the prevailing high Human Wildlife Conflict cases in Nepal, nonetheless the minimization of the damages otherwise by the Monkeys would have done to the crops is apparently noticeable.

³ Semi-commercial vegetable farming in Nepal refers to a market-oriented farming system where households produce vegetables both for household consumption and for sale, using improved inputs and practices, but below fully commercial scale (Generally 0.1 to 0.5 ha under vegetables ($\approx$ 2–10 ropani in Hills; slightly larger in Terai) Note: ADS and NAMP do not fix a strict land size, but this range is widely used by MoALD projects, local governments, and development partners Source: Government of Nepal, ADS 2015–2035; NAMP Guidelines, MoALD

6.3 Production and Supply of Sprayer

Currently the Sprayer is produced in Rajkot, India from where it is supplied to Nepal. The supply chain of the sprayer currently follows a simple as the producer produces and supplies it to the Nepali counterpart via Rupaidia, Nepalgunj Boarder.

This step-by-step cost build-up process for 20 units of the Sprayer, starting from production in India through to the final customer price in Nepal- prepared in consultation with the Smart Sprayer importer from Nepal accounting the practical and field level experiences. The calculation captures direct production costs, logistics and clearance expenses, statutory taxes, service-related provisions, and sequential profit margins across the value chain to determine the end-user price per unit. Accounting the current supply route, the calculations are shown below:

Table 1: Cost Per Unit Calculation for 20 Units of Sprayer

Cost Per unit calculation in NPR (20 Units of Smart Sprayer)			
S.N	Particulars	Cost	Remarks
A. Production and Custom Clearance Costs			
1	Production Cost in India	160,000	For 20 units in Rajkot (NPR 8000 / Unit)
2	Transportation Cost (till Nepal Boarder)	6,800	2 Euros / Unit
3	Loading /Unloading Cost	2,500	Labor Charge
4	Indian Custom	5,000	Overhead Expenses
5	Parking Charge	1,000	Per day
6	Nepal Custom	5,000	Overhead Expenses
7	Custom Tax	8,000	5% Custom tax
Price at the Custom Clearance Level		188,300	
8	Insurance Charge	3,766	2% of the total value (NPR 188,300)
9	Freight Charges	50,000	Transportation from Boarder to Syangja
10	Handing Charges	4,000	Lump sum
11	Warranty/ Guarantee Services	9,415	5% of the total product value (NPR 188,300)
12	Importers Gate Price (Before Profit)	300,566	
13	Profit at Importer Level	53,041	15% Margin at the Importer level
Importers Gate Price (After Profit)		353,607	Per unit cost - NPR 18,785
14	Dealer/ Retailer Margin	88,402	20% of the total value
Dealer/Retailer Level Price		442,009	Per unit cost - NPR 22,100
15	Value Added Tax	57,461	13% added to the total value
Customer Level Price		499,470	Per unit cost - NPR 24,974

II. Report on “Supply chain and market analysis for the Smart Sprayer in Nepal”

The first stage includes production and customs clearance costs, covering base production cost, transportation from India to the Nepal border, loading/unloading, Indian customs, parking charges, Nepal customs, and a 5% customs tax—resulting in the total price at the customs clearance level. The second stage adds post-clearance expenses such as insurance (2% of total value), freight from the border to Syangja, handling charges, and warranty/guarantee services (5% of product value), leading to the importer’s gate price before profit. A 15% importer margin is then applied to determine the importer’s selling price. In the third stage, a 20% dealer/retailer margin is added, followed by 13% VAT, culminating in the final customer-level price. Overall, the calculation captures direct production costs, logistics and clearance expenses, statutory taxes, service-related provisions, and sequential profit margins across the value chain to determine the end-user price per unit.

The calculations show that the per unit of Sprayer at Retail Level in Syangja costs NPR 24,974 at current market prices.

Note: This is the calculation based upon using the Custom service in Rupaidia (Nepalgunj) boarder and the price may vary (decrease due to the geographical proximity) if the supply is conducted through Sunauli (Bhairahawa) or Jogbani (Biratnagar) Boarder.

Similarly, there is a chance of cost reduction if bulk supply of the Sprayer is carried out because of the fixed costs of transportation and others.

6.4 Social Context

On the social context, one of the pertinent issues is labour migration from Nepal- a significant socio-economic phenomenon, driven primarily by limited domestic employment opportunities and the prospect of higher-paying jobs abroad⁴. Amongst the migration population, the male population is overwhelmingly dominant, which comprises around 90% of the total foreign-bound workers seeking.⁵

Male migration in agriculture shifts women's roles, increasing their workload and responsibilities as they often become de facto farm managers, but also increases greater time burden, drudgery, and challenges in accessing resources, creating a complex mix of increased burden and opportunity⁶.

Thus, Smart Sprayer is one of the solutions which does not have any reported negative consequences and could be promoted as climate friendly and has comparatively better life span.

⁴ https://link.springer.com/chapter/10.1007/978-3-031-34194-6_5

⁵ <https://nepaleconomicforum.org/opportunities-and-challenges-of-migration-for-nepal/>

⁶ <https://www.sciencedirect.com/science/article/abs/pii/S0149718925000709>

In addition, in a scenario where there is rising labour shortage the sprayer could be single-handedly operated by women.

6.5 Supply Chain Analysis of Irrigation Technologies in Nepal

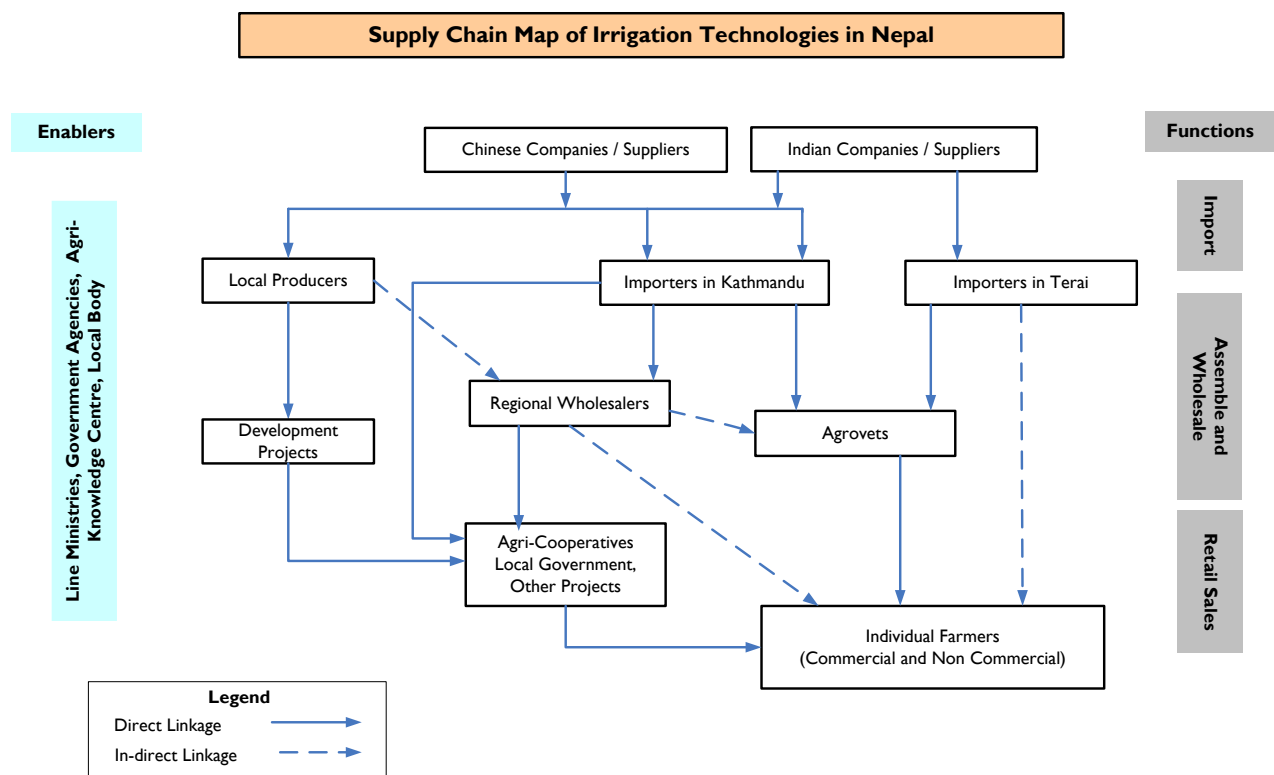


Figure 2: Supply Chain Map of Irrigation Technologies in Nepal

The similar technologies based upon the functions of the sprayer, found in the Nepalese market are mainly Sprinklers, other similar Sprayers and Drip irrigation parts that are mainly procured from India and China. The imported Chinese products are aggregated in Kathmandu, whereas the Indian products are imported from the Terai border cities (Biratnagar, Birgunj etc.) from where they are distributed to major cities (including Pokhara) that acts as a regional hub for dissemination of such irrigation tools.

In addition to these importers, there are local companies that produce other irrigation technologies by assembling technology parts. The local companies supply the products either to the development projects or the regional level wholesalers. The local agrovets receive the technologies through importers from Kathmandu or Terai region or regional wholesalers (like in Pokhara) as per the need.

In general, the individual farmers purchase the technology mainly from the agrovets or regional wholesalers at the market rate. They also receive the technologies through their cooperatives/ local government/ development projects through a subsidized rate (in the range 50-80%).

In the diagram above, the bold line represents direct linkage or frequent transactions whereas dotted lines are the non-frequent or occasional transactions.

The import and supply of the irrigation technologies for Nepal are conducted by few firms- namely Dahal Trading (Nepal China Agriculture Centre), Jay Kisan Trading, Narayani Agri Trade etc. In addition, there are a few small suppliers in Birgunj, Biratnagar and Bhairahawa who provide Indian items to the hubs. During the conversation with one of the importers, it was found that they supply about 150K units yearly all over Nepal. Even though there is no exact data, rough estimates show that about 500-600K units annually in total are sold in Nepal.

Table 2: Technology Types and Profit Margins at Sales Level

S.N.	Technology Type	Percentage Margin (importer)	Percentage Margin (wholesaler)	Percentage Margin (retailer)	Retail Price (NPR)
1	Sprinklers	15-20%	30-35%	30-35%	150 to 165,000 +
2	Irrigation Pipes	15-20%	20-25%	20-25%	7,000+

The majority of the products sold by the retailers to the farmers are Sprinklers and Drip Irrigation pipes. The retail price range of the widely used Sprinkles (3 hole-design) range from NPR 150 (EUR 0.9) and above - which can go up to NPR 165,000 (1,000 Euros) for metal sprinkler with stands. Similarly, the pipe for drip irrigation of 300 meters costs more than NPR 7,000 (EUR42).

The importers, wholesalers and retail sellers shared that the profit margin for these materials is around 15-20% at each value chain level. However, the assessment calculations derived that it is up to 35% of the total price, depending on the technology type.

7 COMPARISON WITH OTHER IRRIGATION TECHNOLOGIES AND PRACTICES

The team assessed the available widely used similar irrigation technology/ practices (Earthen Canals, Sprinklers and Drip Irrigation) to the Smart Sprayer in the following attributes to compare their aspects as shown below:

Table 3: Comparison of Different Irrigation Technologies

Attributes	Earthen Canals	Sprinklers	Drip Irrigation	Smart Sprayer
Usability/ Efficiency	Suited for high water requirement context. Needs high water flow and continuous source Regular Maintenance	Outdoor Needs medium but continuous water flow Average Life Span – 2 years	Mainly used in Tunnel Farming Medium water requirement Average Life Span – 5 years	Outdoor Needs medium but continuous water flow Life Span - TBD
User Experience / Adoption	Labour extensive (High) Needs continuous monitoring	Labour Extensive (Medium) Needs continuous monitoring	One-time fixation Labour Extensive (Medium) Less monitoring required	Low Labour usage Low monitoring effort
Market Access and Support Ecosystem	Indigenous practice, requires minimal support Support available	Established Market Chain Spare parts/ technical support available	Established Market Chain Spare parts/ technical support available	Yet to be developed
Pricing / Economic Feasibility	High set-up cost (Labour, construction materials)	Cheap plastic technology available (Starts from NPR150)	Initial set up cost – Medium (NPR 7000 and ++ for 300 meters)	A bit higher compared to other similar options - NPR 24,974, but has edge over others.

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7.1 Earthen Canals

The earthen canals require a continuous high volume of water supply and flow. It is highly labour-intensive as it needs to be continuously monitored and requires regular maintenance. These canals are constructed on the basis of indigenous or experiential knowledge with minimal technical support and require high set-up costs for intake construction, canal digging and making distribution channels. In addition, the distribution system is prone to climatic and other externalities, ultimately demanding higher person-days to ensure its functionality and operations.

One of the high risks while using this practice is over irrigation, leaching nutrients and degrading the soil conditions causing a negative impact on the overall crop productivity.

7.2 Sprinklers

Sprinklers are suited for irrigation in outdoor plots and require continuous water supply with uniform flow. The traditional sprinkles used by Nepalese farmers are plastic-made, containing 3 to 8 holes and can irrigate up to maximum 3-4 meters. The Labour requirement for using Sprinkles is also high since it needs to be continuously shifted within the fields and checked for clogging due to impurities. Regarding the market support system, being a commercially traded product, it has established market chain with readily available spare parts or new units.

Even though the price of the Sprinkles seems low, it has a short life span - of maximum 2 years due to frequent wear and tear from exposure to the environment and direct sunlight.

7.3 Drip Irrigation

This technology is mainly used in tunnel or greenhouse farming, which is mainly practiced by commercial farmers for large-scale production. The process of setting up drip irrigation is labour-intensive initially, and it can work with a medium water supply volume. The drip irrigation requires less monitoring after one-time fixation for the originally intended crop, and the average life span of the pipes is around 5 years. Spare parts and technical support are commercially available for this technology, including the rural setting.

However, the limiting factors of the drip irrigation are that the cost of the pipes used for the drip irrigation is comparatively high, and is not appropriate for the open field.

7.4 Sprayer

The technology has a larger coverage area and is found to be best suited for outdoors. The uniformity of the water flow and distribution is its major added value. Farmers have shared that the Sprayer could be used for other crops like Maize, Wheat etc. till the crop height is 1-1.5 meters. The labour requirement for the Sprayer is low as it does not need continuous monitoring once fixed, and employing a few Sprayers will significantly reduce the effort of moving within the plots.

However, there are some ambiguities in the technology regarding the product life-span, support system, pricing and overall productivity, which will be addressed as results are derived from the ongoing trial phase. The assessment has also recommended a few suggestions below that could be taken as a reference for future perusal.

The salient features of this technology are that it can work in water-scarce areas with even distribution of water, stop nutrition leaching, and the added irrigation directives from the bundled Cromptal app, was seen enhancing crop productivity (Cabbage and Cauliflower) significantly (more than 100%).

8 COMPARISON OF CROPTIMAL WITH OTHER DIGITAL AGRI-SERVICES

Nepal's digital infrastructure, services and usage have increased rapidly, yet the reach of last-mile communities is limited. Pertaining to agriculture sector the country has seen a rise in the agri-digital technologies and apps, yet the use is not widespread due to several factors like low digital literacy, relevancy, effectiveness etc. of the services. The most common digital services in Nepal through apps and digital platforms are related to seeds, fertilizer, soil mapping, market information, weather updates, digital payments, networking and capacity building activities from both government and development projects.

Table 4: Comparison of Agri-digital Services

Attributes	Croptimal	Geo Krishi ⁷	Super Krishak ⁸	Smart Krishi ⁹
Core Support	Irrigation	Agri-extension / Advisory Services	Farming Guide	Networking
Type of Service	Tailor-made for users on irrigation advisory	A planning tool, farm management solutions, advisory services, market access, climate services, notifications, and alerts	Training, Games, Market Prices, Expert Advice, Weather Services, Soil Testing, Networking	Package of Practices, Daily Price, Success/failure stories and News, Library, reports and E-books, Live weather info, Q/A session, Agricultural farm contact details
Unique Feature	Personalized SMS service	GeoKrishi platform is geotagged, enabling location-specific, precise, and customized recommendations for individual farms based on their micro-properties	Training and Gamification for enhancing learning	Networking platform for the farmers

⁷ <https://geokrishi.farm/>

⁸ <https://ghampower.com/innovations/super-krishak-app/>

⁹ <https://www.merokrishiguru.com/>

Irrigation Service	Provides irrigation instruction for specific plot on weather, crop growth stage and exact location of the plot.	Provide general information on type of irrigation, its procedure, crop suitability and requirements (tools and machines). The app also provides generalized irrigation directives to few specific vegetable crops.	It provides weather updates and Crop-wise general “Package of Practices”, that includes watering needs, timing, soil suitability).	Not clear instruction on irrigation but has learning contents on different topics related to crops that has information on water and soil
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The trending apps in the agri-digital sphere of Nepal are Geo Krishi, Super Krishi and Smart Krishi and have their own set of propositions as tabulated above. These apps have a wider focus and target to cater entire farmer segment with the generalized contents.

One of specialties of Cromptal is targeting a specific pain point of the farmers regarding irrigation directives on smart Irrigation and Crop Suitability Advice. The users receive up-to-date, field-level recommendations on crop selection, planting schedules, and irrigation management—all tailored to local conditions and continuously refined as new data becomes available. This seamless integration bridges the gap between data-driven modelling and on-the-ground agricultural decision-making.

As one of the major challenges in regard to agri-digitalization is the low digital literacy of users, Cromptal addresses the issue with its short messaging services in local simple language. This reduces the complications at users’ level by eliminating the overwhelming information flow.

9 DISCUSSION AND SYNTHESIS

9.1 Stakeholders Perception and Views

9.1.1 Local Municipalities

The local government of Bhirkot and Putalibazzar Municipalities have expressed their view that they are aware about the ongoing Smart Sprayer piloting in the area, yet are to see how it operates and the impact it brings at the farm level and productivity.

Since these municipalities have been providing irrigation technologies (irrigation pipes and others) to the farmers through their annual budgeted program (up to 2 million NPR), they iterated that it would be continued for strengthening the agriculture sector.

Upon inquiry regarding partnerships, they committed that once the results are out from the ongoing trial, they will be scrutinizing the positives from and looking forward to collaborate for promotion of the Smart Sprayer in subsidized approach.

They recommended that the plan for the next phase of trial - to pilot the technologies in the Government-owned plots that can act as a demonstration site for farmers and other stakeholders to observe how the Smart Sprayer works and its effectiveness. Upon its validation, they look forward to promoting the sprayer through their own annual programs.

Another possibility of partnership in Nepal could be partnerships with Government led national level programs like National Agricultural modernization Program implemented through provincial and local agriculture offices.

9.1.2 Agrovets/ Irrigation Technologies Retail Seller

On the commercial front, Agrovets/ Tech Suppliers are yet to see the technology and its benefit, but expressed their view that they are willing to be part of the supply chain once the trial results are out and the production is ready for commercial market.

They also shared their thought that farmers will be willing to invest in the Sprayer (up to NPR 10K) if they believe it will add value to their production.

9.1.3 Cooperatives and Financial Institutions

The key highlights from the consultations with the local agri-cooperatives and financial institutions helped to understand the local context in terms of the financial support system prevalent in the area and Syangja District. It was found that the smallest ticket size of the loan for group/individual

through Savings and Credit/Multipurpose Cooperatives and other financial institutions in general is NPR 50K, which is way higher than the expected cost of Smart Sprayer.

However, they suggested that such technologies could be supplied through local agri-cooperatives or farmers' groups to simplify the supply chain, as the farmers purchase other inputs like seed, fertilizers etc. from the local agri-cooperatives/ saving credit groups. This could be another revenue source for the institution and convenience for the purchasing farmers.

9.2 Farmers View

9.2.1 Technical Performance

The respondent farmers shared that Smart Sprayer is beneficial as per its envisioned purpose, yet if possible few tweaks could be made in the design. The recommendation includes developing an adjustable version of the sprayer. Apparently, the arm length of the Smart Sprayer is fixed, due to which there are unreached areas in plots while irrigating in rectangular or uneven shape plots. This will also be useful to semi-commercial farmers possessing tiny plot size.

Another recommendation from the farmers' front is that employment of the Smart Sprayer should be looked through a combined system perspective rather than individual unit -incorporate with solar pumping, overhead tanks or similar provision. This will show that the investment on Smart Sprayer system will be actually much more than sprayer itself. By showing this fact, they open the possibilities of getting such as a subsidy from the local government or projects.

9.2.2 Productivity and Disease Incidence

The farmers were vocal that there will be increase in the productivity after having this irrigation system from the initial days. This is backed up by the recent comparative analysis of productivity data among smart sprayer users (experiment plots) and other irrigation technology users (control plots).

The results from the analysis showed that substantial productivity gains were achieved by the trial plots over the control plots for both crops. The productivity of Cabbage from 40.3 tons/ha¹⁰ in the control plots to 85.7 tons/ha in the trial plots. Likewise, Cauliflower productivity increased by around 116%, improving from 34.7 tons/ha¹¹ in the control plots to 75.1 tons/ha in the trial

¹⁰ It is already nearly 3 times higher than the Syangja district average productivity 15.10 MT/Ha (Statistical Information on Nepalese Agriculture, 2080/81)

¹¹ It is already more than 2 times higher than the Syangja district average productivity 15.50 MT/Ha (Statistical Information on Nepalese Agriculture, 2080/81)

plots. These results indicate that the trial interventions more than doubled the productivity levels of both crops compared to other irrigation practices used in the control plots.

Mr. Rishi Ram Tiwari, a lead farmer from Bhirkot -5 emphasized the importance of providing farmers with access to modern irrigation technologies. After adopting the smart sprayer technology, he observed a significant **increase in production**. Additionally, the technology enabled him to **double the cultivated area under cauliflower** compared to the previous year, primarily due to improved irrigation efficiency.

He reported being able to irrigate nearly **twice the land area** as before. He noted a **reduction in aphid (locally known as “Lahi”) infestation** in cauliflower when using the technology. The use of this technology minimizes human movement within the field, thereby **reducing soil compaction** and contributing to better soil health. Mr. Tiwari indicated that the technology is **suitable for crops like chilli**, but less effective for **spreading or vine crops such as pumpkin and gourds**.

Mr. Khandananada Adhikari another lead farmer from Putali Bazar Municipality reported a production of approximately **2700 Kg quintals of Cauliflower per ropani (0.05 Ha)**. He did not observe any **significant difference** in disease infestation with the use of the technology. The technology was found to be useful for a range of crops including **leafy vegetables, brinjal, wheat, and maize**, particularly up to **a crop height of around 3 feet**.

Both farmers highlighted that access to **affordable and locally available irrigation technologies** is critical for scaling adoption. While the technology shows clear benefits in terms of **productivity, water efficiency, and labor reduction**, its **cost and local availability** remain key. Farmers expressed willingness to adopt the technology if priced within NPR 5,000–7,000 and made available in local markets.

9.2.3 Product Cost

The farmers expressed their views that Smart Sprayers should be provided through a subsidy model (50% subsidy) in this initial stage. The recommended price range shared were is NPR 3000-4000 /- at the farmers' level (after 50% subsidy). They also shared about their willingness to invest in the technology once assured the benefits. Taking the current calculated prices without subsidy (NPR 24,974), there is a need to lower the production and supply cost so that it could penetrate at wider level.

9.2.4 Cromptal SMS Messaging

During the FDG conducted with the project farmers on Dec 2025 by CRRC, the farmers reported strong satisfaction with the Smart Sprayer system, highlighting significant reductions in

irrigation time and labor, improved water use efficiency, and ease of operation once installed. Participants estimated water savings of around 50 percent and time savings of 50 to 80 percent per irrigation cycle.

Similarly, from a gender and social inclusion perspective, the Smart Sprayer system reduced the physical burden of irrigation and enabled women to irrigate fields independently once trained. Youth involvement was noted, particularly in supporting digital aspects of the technology. However, several challenges were identified, including limitations in sprayer design for small and uneven terraces, difficulty relocating the sprayer across plots, high upfront cost, and uncertainty regarding repair and maintenance services.

Overall, the Smart Sprayer system was found to address critical irrigation challenges in terrace farming systems, while also highlighting the need for design adaptation, capacity building, and stronger institutional coordination.

Farmers were provided with pre-prepared conversion tables based on their field-specific flow rates, allowing them to convert rainfall (mm) measured through rain gauges into irrigation time (minutes) and adjust the SMS recommendations accordingly. While the system was generally understood and manageable after explanation, its use in practice was mixed. Some farmers could apply the tables independently, but most relied on support from the CRRC team for accurate interpretation. Even with the tools available, many farmers preferred to rely on their own experience when deciding irrigation duration, often using the advisory as a general guide rather than strictly following the calculated adjustments.

Since the messaging from Cromptal on a specific plot of land was different even they were few meters apart, the farmers were not sure how the irrigation directive was derived. In that context a beneficiary farmer shared that when he followed the irrigation instruction his plot was waterlogged. Thus, explaining the farmers on the data generation process and making the Cromptal more suitability to the local scenario is recommended.

Spread of the word: Power of Social media

“After my son put the video of a working Smart Sprayer in TikTok, there were lot of curiosity around it. The people started to ask me about the technology, its pricing and where could it be purchased. It was surprising that without any promotion or advertisement the organic reach was more than to more than 900,000 people.”

Pyam Narayan Adhikari - Rangkhola, Syanja

10 RECOMMENDATIONS

The practical actionable recommendations for the promotion of Smart Sprayer/ Croptimal in Syangja and similar areas of Nepal suggested by this assessment are as follows:

10.1 Accessible Opportunities

The project needs to capitalize the current momentum and should look to prioritize low-hanging fruits before moving to more complex interventions.

Till now, the piloting is conducted independently in farmers plot and it will require joint piloting with the Local Governments and Agriculture Knowledge Centers (AKCs) for endorsement. Representatives from the local government (both Bheerkot and Putalibazaar) during the study visit shared their willingness to provide their plots for piloting. Through this collaboration the demonstration of the Sprayer will reach to wider mass, generate trust at the general public level and generate data and supporting information that could be used by the local government to endorse the technology.

As the nature of the Smart sprayer is a micro irrigation technology it is suitable to the local and provincial governments as per their mandate and focus compared to Federal government's focus on medium to large irrigation schemes.

At the second stage, it can explore possible collaboration with, provincial governments and NGOs/INGOs working with small farmers. The potential organizations that could be approached for pitching and the details are provided in the table below:

Table 5: Potential Organizations for Collaboration

S. N.	Organization/ Programs	Type of Organization	Irrigation Related Activities	Website
1	iDE Global, Nepal	INGO Contact: Menila Kharel mailto:nepal@ideglobal.org	Works on micro irrigation activities	https://www.ideglobal.org/country/nepal
2.	Centre for Rural Technology, Nepal (CRT/N)	Not for profit company	Engaged in developing and promoting appropriate rural technologies	https://crtnepal.org/
3	National Agriculture Modernization Project	Government Project (Ministry of Agriculture & Livestock Development)	Works primarily on medium and large irrigation facilities	https://pmamp.gov.np/

4	Resilient High Value Agriculture Programme (R-HVAP)	Government Program (Ministry of Agriculture & Livestock Development)	Works on value chain activities of high value crops like vegetable and fruits	https://rhvap.moald.gov.np/pages/introduction-1/
5	International Water Management Institute (IWMI) Nepal	Non-profit, Global Research Organization Contact: Manohara Khadka Country Representative Email: m.khadka@cgiar.org #9841214815	IWMI been working in Nepal since 1986, focusing on sustainable water management, climate resilience, and rural development. The institute collaborates with government bodies, research institutions, NGOs, and local communities to tackle water challenges through evidence-based policies and inclusive solutions	https://www.iwmi.org/where-we-work/nepal/
6	Practical Action	INGO Bikram Rana Email: bikram324@gmail.com #9858050783	Practical Action in Nepal Under its area of focus – “Food Systems” commits to pursue sustainable agriculture that benefits both people and the planet.	https://practicalaction.org/where-we-work/asia/nepal/
7	Finn Church Aid	INGO Bidyanath Bhurtel #9841303292	FCA Nepal has joined an ambitious new programme promoting climate resilient agriculture in Nepal with a whole-society approach.	https://www.kirkonulkomaa.napu.fi/en/ajankohtaista/blogi/in-nepal-climate-resilience-starts-with-society/
8.	Local Adaptation to Climate Change	Sanna-Leena Rautanen – Team Lead Email: sanna-leena.rautanen@cowater.com	Bilateral Finland–Nepal programme operating in Karnali and Sudurpashchim Provinces. Includes climate adaptation, landscape management, livelihoods, and inclusive WASH. The project integrates water resources management, sanitation, forest conservation, and climate resilience	

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10.2 Development of a Business Case

This is the foremost and important stage in the business model rollout prior to creating value of the offered technology. Based upon the assessment, this study recommends the following:

- **Value Proposition:** “An environmentally friendly, farmer-friendly and time-saving irrigation technology that boosts productivity, saves water, and strengthens climate resilience.”
- **Target Market:** Semi or commercial vegetable farmers with a business mindset
- **Geographical Focus:** Farmers residing in hills and areas having water shortages

10.3 Product Customization and Pricing

The technical recommendation requested by most of the farmers is to make the arm of the Sprayer adjustable so that it can be shortened to 3-4 meters to reach every part of the plot.

Since the Sprayer is not commercially available till date, the cost of each unit should be adjusted for the Nepalese market. Current calculations show that the Maximum Retail Price (MRP) of each unit of the Smart Sprayer is NPR 24,974 at Syangja including all the production, taxes and supply related costs while producing and importing from India.

The study recommends the cost of the Sprayer to be less than NPR 5,000 (30 EUR) at farmers' level. In the later stage, when the product is commercialized, the cost could be up to NPR 10,000 (60 EUR) at the start. However, the cost should be dependent upon the type of material used, life-span, margins at sellers' level and other supply-associated costs.

Since, there is a huge difference between the cost of the Smart Sprayer and expectation of the farmers, product customization such as reducing arm length or reducing costs through production or supply chain efficiencies needs to be carried out.

10.4 Promotion and Outreach

The essential information needed for the promotion of Smart Sprayer/ Cromptal is the efficiency and productivity analysis data from the ongoing trial. Based on the information, the following measures are recommended for the promotion of the technologies.

Champion farmers: The farmers who are selected for the trial have the image of progressive individuals, and their recommendation would be a great factor in promotions and commercialization of Smart Sprayer/Cromptal. However, they should be clearly explained about the end-results showing the benefits and the features so that they can act as the connectors between the supply and demand.

Local Governments: With their provision of annual subsidy, developmental projects and technical expertise, local governments could be catalytical for wide-spreading the technologies. A trial in partnerships with them will help them to gain their confidence in the products that can also influence their voice while designing the agri-technology support programs and activities with other government agencies and projects.

Leveraging Social-Media: The rise of Facebook Reels and TikTok is increasing with the internet penetration and access to smartphones in rural areas of Nepal. Especially, TikTok is a popular platform in Nepal (due to its features like user-friendly, two-way interaction etc.) and is used by the rural population, the promotions and marketing of Smart Sprayer will exponentially grow if this platform is constantly leveraged.

10.5 Potential Business Model

Based upon the field-level consultations and synthesis of the information, the study team recommends a mixed business model for promotion of the Smart Sprayer and Cromptal as described below.

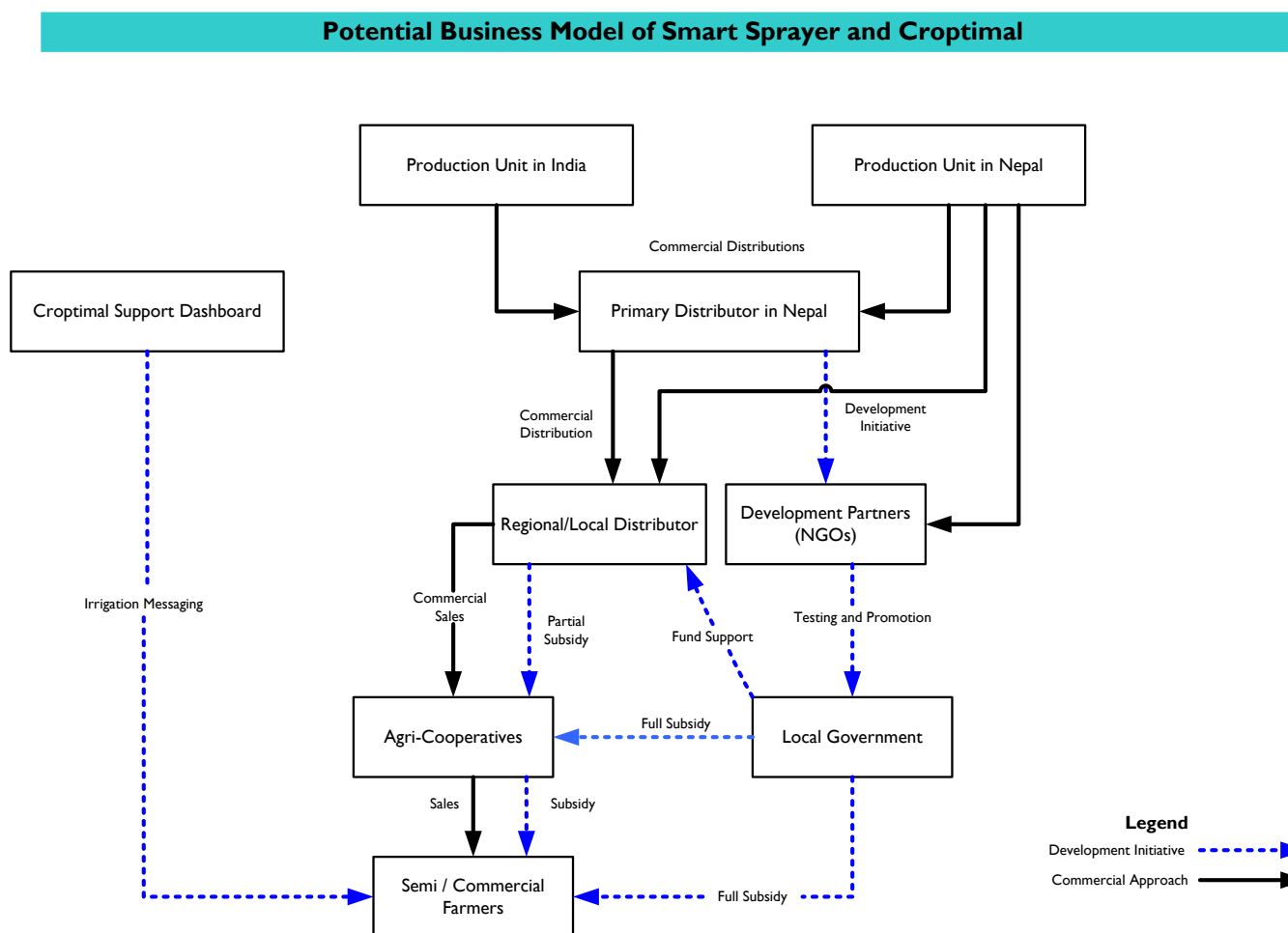


Figure 3: Supply Chain Map of Irrigation Technologies in Nepal

The business model of the technologies should look both - the developmental and commercial aspects for product promotion, mass penetration and commercial sales.

After the production of the Sprayers (either in India or Nepal), the units could be supplied to the primary distributor. In the case of production in Nepal, the producing company itself can act as the distributor and supply it for both development initiatives and commercial purpose.

Pathway I: Development Initiative

For the development initiative, NGOs are the key as they act as a bridge between the producer and the local governments. The local NGOs acting as a development partner can support the local government for further trial and demonstrations to aware the farmers, promote the product, increases the outreach at grassroots level.

At the government front, micro-irrigation schemes supported by Local Government, can provide support as per demand of farmers. Once the local government/ government agencies are convinced on the technology they can subsidize the sales in partnership with regional/local distributor or agriculture cooperatives or the farmers group. As per the current mechanism, the government can also directly reach to the individual farmers as per their current partial or full subsidy mechanism.

Another approach to integrate the SmartSprayer and Cromptal with the developmental initiative is to integrate with existing projects such as the multiple use water systems implemented by projects like Sustainable WASH for all (SUSWA), The Local Adaptation to Climate Change (LACC) Project etc.

Pathway II: Commercial Approach

This is a second pathway to follow the development initiative, after there is enough awareness or promotion regarding the Smart Sprayer. The supply chain in this model will be simple and similar to current practice. The primary distributor supplies the unit to regional/local sellers through which agri-cooperative or individual farmers purchase the units.

The Cromptal service can be used as the value addition segment of the Smart Sprayer in both the pathways and reach directly to the farmers in line with the current model.

10.6 Production and Supply

In future, as the demand of the Smart Sprayer in Nepal increase, it is recommended to conduct a detailed specialized assessment for the production of the Smart Sprayer and its supply system for a low cost and lean production system to meet the local need. Analysing the current production mechanism, cost factors, tax provisions, after-sales support and customization features, an informed decision could be made whether the production could be started / assembled in Nepal or is beneficial to import the units from India.

If the production is started in Nepal, it will give two benefits - namely increase in confidence of the users/ sellers as they will have knowledge about the product production/ supply process and provide opportunities for after-purchase services in terms of spare parts, technical support and branding.

To look at the potential producers of Smart Sprayers in Nepal, the study has conducted an initial analysis of a few Nepalese companies working in the sphere of development of irrigation and related technologies. In the matrix below, a comparative analysis and recommendation in terms of their activities, strengths and value addition for the promotion of Smart Sprayer/ Croptimal is conducted.

Table 6: Potential Companies for Collaboration

Potential Companies for Production of Smart Sprayer in Nepal					
S.N.	Institution	Introduction	Major Activities	Value Addition	Website/ Contact
1	Nepal Innovation Centre (NIC)	National Innovation Center Nepal a non-profit sharing organization is dedicated to develop the culture of research, technology and innovation in Nepal.	Provides a platform to take the new methods, ideas, or products out to the marketplace/life for nation development.	Agriculture is one of the focus sectors of NIC For research and innovation. NIC has designed and tested useful tools, so as to shift farming from traditional to smart.	https://nicnepal.org/
2	Nepal Thopa Sichai Pvt Ltd	NTS is a certified agro-technology manufacturer and marketer, offering a diverse portfolio of premium agricultural products.	Provides service of modern technology import and distribution. specializing in manufacturing and providing comprehensive solutions in the field of irrigation systems, plastic pipes, and agriculture.	Support Nepalese Agriculture Mechanization and Commercialization by manufacturing and supply quality agriculture tools/equipment and machines in comparatively low price.	https://ntsgroup.com.np/
3	Dahal Trading Concern (Nepal China Agriculture Center)	Dedicated to advancing agricultural practices and empowering farmers by bridging the gap between traditional farming techniques and modern agricultural technologies.	Introduces advanced agricultural technologies and practices from around the world, particularly from China, India and other countries.	Specializes in providing high-quality agricultural products, tools, and services that cater to the diverse needs of farmers, agronomists, and agricultural enterprises through commercial operations.	https://ncac.com.np/

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Amongst the currently operating businesses in Nepal, the study has identified these three institutions as the potential partners that can facilitate the production, promotion and supply of Smart Sprayer/ Cromptal in Nepal. The assessment for potential companies should include thorough examination of issues on Patent & Rights, Cost Structure, Supply mechanism, Ownership & Stake, Promotion & Marketing Roles etc. for having a clear partnership model for commercial production and promotion.

10.7 Market Projections

10.7.1 Subscription Model

While consulting with the farmers, they were not so comfortable about the subscription service from Cromptal. Instead, they thought it will work better if it is a bundled-up service with the sprayer. It was evident that the farmers did not want any complication on the services they use and opt for one time investment.

This is in line with previous experience, as several agri-apps (mentioned above in the report) have introduced the premium/ subscription model which were not greatly welcomed by the farmers and are not successful till date.

Thus, it might be too early in Nepal to go with service like the subscription or premium model in agriculture related apps or services. This study recommends to continue the trial in partnership with many local governments and generate enough evidence for better outreach and promotion.

10.7.2 Recommended Model

Even though it is too early to conduct the market projections for the Smart Sprayer given its cost aspect, trial results and acceptance by the farmers, this study recommends to have a reverse method for having an initial target based upon the numbers available.

Table 7: Setting Targets for Market Projection

Geographic Area	No. Households Growing Vegetables (at least 0.01 Ha, 0.25 Ropani)	Assuming 30% are semi-commercial / commercial farmers)	Notes
Nepal (National)	1,977,571	593,271	Vegetables include, cauliflower, cabbage, tomato etc.
Gandaki Province	285,123	85,537	
Syangja District	28,490	8,547	

Source: National Sample Census of Agriculture Nepal 2021/22 District Summary (By Province)

As shown in the table above, if the project targets modest number of 5%, it would reach to 427 semi/ commercial vegetable farmers in Syangja District whereas the target would reach to 4,277 units if the whole Gandaki district is targeted.

Thus, at the later stage of the project, for commercial intervention a detailed financial modelling carried out accounting the target that could be set against the possible cost items under production, promotion & marketing and supply. By doing so the number of units to sell for making the supply chain sustainable and self-sustaining could be identified.

In the long run, the focus of the smart sprayer would be along the major highway corridors (hilly areas) like BP Highway, Madan Bhandari Highway (Dharan to Hetauda), Kathmandu to Mugling and Mugling to Pokhara. These are the vegetable production pocket areas where this could be aligned with the Government's high value crop promotion projects like Resilient High Value Agriculture Programme (R-HVAP) implemented by Ministry of Agriculture and Livestock Development.

II ANNEXURE

II.1 List of Respondents

S.N.	Name	Respondent Type/ Organization	Address
1	Khadananda Adhikari	Vegetable Farmer (Smart Sprayer User)	Rangkhola
2	Bijay Aryal	Vegetable Farmer (Smart Sprayer User)	Rangkhola
3	Umakanta Adhikari	Vegetable Farmer (Smart Sprayer User)	Rangkhola
4	Prem Adhikari	Vegetable Farmer (Smart Sprayer User)	Rangkhola
5	Laxman Adhikari	Vegetable Farmer (Smart Sprayer User)	Rangkhola
6	Rishi Ram Tiwari	Vegetable Farmer (Smart Sprayer User)	Bheerkot
7	Prakash Aryal	Vegetable Farmer (Smart Sprayer User)	Bheerkot
8	Padam Pangen	Vegetable Farmer (Smart Sprayer User)	Bheerkot
9	Rama Regmi	Vegetable Farmer (Smart Sprayer User)	Bheerkot
10	Ran Singh Rana	Bhagyodaya Secondary School	Bheerkot
11	Surya Rijal	Kamana Agrovet	Putalibazaar
12	Prakash Adhikari	Vegetable Farmer (Smart Sprayer Non-user)	Rangkhola
13	Ram sharan Poudel	Vegetable Farmer (Smart Sprayer Non-user)	Rangkhola
14	Pursottam Lamsal	Arati Agriculture Machinery	Putalibazaar
15	Madan Aryal	Aryal Agrovet	Waling, Syangja
16	Raju Subedi	Unnati Agrovet	Pokhara
17	Durga Dahal	Dahal Trading Concern	Kathmandu
18	Mina Thapa	Vegetable Seller	Putalibazaar
19	Yam Kumari Rinjali	Nawa Jyoti Agriculture Cooperative	Putalibazaar
20	Sunita Malla	Nawa Jyoti Agriculture Cooperative	Putalibazaar
21	Shanta Dhakal	Royal Multipurpose Cooperative Society	Putalibazaar
22	Tulasi Ram Regmi	City Mayor	Putalibazaar Municipality
23	Susma Paneru	Agriculture Officer	Putalibazaar Municipality
24	Nisha Bashyal	Agriculture Officer	Putalibazaar Municipality
25	Sujana Poudel	Agriculture Officer	Bheerkot Municipality
26	Madan KC	Agriculture Officer	Bheerkot Municipality

11.2 Questionnaire

Farmer Satisfaction Survey

A. Basic Information

A1. Name of farmer (optional):

A2. Location (municipality/ward):

A3. Type of farming practiced:

☐ Subsistence ☐ Semi-commercial ☐ Commercial

A4. Main crops grown:

A5. Size of irrigated land (ropani/ha):

B. Current Irrigation Practice

B1. What irrigation technologies are you currently using? (Specify)

- ☐ Sprayer
☐ Canal irrigation
☐ Drip irrigation
☐ Sprinkler irrigation
☐ Lifting pumps (diesel/electric/solar)
☐ Others (specify): _____

B2. How long have you used this technology?

☐ <1 yr ☐ 1–3 yrs ☐ >3 yrs

B3. Have you tried the recently introduced Sprayer?

☐ Yes ☐ No

C. Satisfaction with the Technology

S.N.	Attributes	Ratings (1-5)	Indicators
1	Affordability of initial cost / maintenance		Economic Feasibility
2	Reliability of water delivery		Efficiency/ Productivity
3	Water-use efficiency		Efficiency/ Productivity
4	Ease of installation and operation		User Experience and Adoption
5	Frequency of breakdowns		Technical Performance
6	Availability of spare parts/ local technician		User Experience and Adoption
7	Compatibility with terrain/crops (yield/quality)		Technical Performance
8	Convenience and Time saved		User Experience and Adoption
9	Training received		Market Access & Support Ecosystem
10	Overall Satisfaction / Value for money		User Experience and Adoption

D. Comparison with Other Irrigation Options

D1. How do you rate this sprayer compared with previous irrigation method (Better / Same / Worse) in the following dimensions:

- a) Cost of operation b) Ease of Operation c) Water efficiency d) Yield & crop performance

35. Report on “Supply chain and market analysis for the Smart Sprayer in Nepal”

D2. What do you like most about this technology? (Open Ended)

.....

D3. What problems do you think this Sprayer has that makes you consider switching back to original technology or discarding it? (Open Ended)

E. Behaviour Insights and Purchase

E1 How did you first hear about the technology?

■ Local NGO/CBO ■ Local Government ■ JTA ■ Local Shops ■ Others

E2 How did you get this Sprayer?

■ As a Grant ■ Subsidy ■ Credit ■ Others

E3. Would you buy this technology again?

■ Yes ■ No ■ May be ■ Only use it if provided for free

E4. What price range do you consider fair for this technology?

.....

E5. What do you think is the best option for purchasing this?

■ Self Financing ■ Through Cooperative ■ Through Shops ■ Others

E6. What do you think is the best payment model for sales of this product?

■ Upfront payment ■ Lease Model ■ EMI/Partial Payment ■ Group Purchase

F. Way forward

F1. What are the features in the sprayer you think that should be improved? (Open Ended)

.....

KII - Supply Chain Actor Mapping Questionnaire (Importers, Sellers, Similar Digital Service Providers etc.)

- What are the types of products or services your business is offering with regard to the irrigation technologies/ digital services?
- Explain your business activities [sales and post-sales support etc.]? Including the price structure of the technology and services (in percentage)? Volume?
- What is your relationship with the users and other market players? Explain the business processes? Purchase from whom? Where do you sell? Cash or credit? Payment terms?
- Where do you see bottlenecks in the mentioned technology/ service available? [understand the problem along with the causes of that problem]
- Do you know about the sprayer/croptimal or have you seen it being used? If yes, what do you feel about it? What are the things you liked or disliked about it?
- Do you like to be part of the supply chain (selling, technical support etc.) of the sprayer or croptimal? What do you think will be the factors that will help you to decide your involvement in these technologies? Pls explain (economic, technology, service factors etc.)
- Any comments/ Suggestions?

KII- Policy and Support mechanism (Government, Non-Government, Similar Digital others etc.)

- Could you please explain about your projects and operations?
- Can you explain about the different agri-inputs services and irrigation/digital services you have been providing support?
- Do you provide irrigation technologies/digital services support (or subsidy) the farmers? If yes, describe about the technology.
- How are the efficiency and efficacy of the technology/services you have provided? Are there any rooms for improvement in those?
- How do you complement your support with the government support programs? (if applicable)
- Do you know about the sprayer/croptimal or have you seen it being used? If yes, what do you feel about it? What are the things you liked or disliked about it?
- Is there any possibility of collaboration in your ongoing interventions in terms of Sprayer/ croptimal and service support? (if they haven't seen or heard about these explain what it is about)
- What do you think will be the factors that will help you to decide your involvement in these technologies? Pls explain (economic, technology, service factors etc.)
- Any comments/ Suggestions?

KII - Financial Institutions (Commercial banks, microfinance institutions and cooperatives)

- What are the existing loan products or services your institution is offering with regard to the irrigation technologies?
- What is the loan request process, required documents and time period?
- Interest rates and repayment period for agriculture related loans?
- Do you have provision for a special subsidy on interest in agriculture related loans?
- Any comments/ Suggestions?

11.3 Photos



Annex G – Pilot Project Proposal



Pilot Project Proposal

Smart Sprayer: Efficient Terrace Irrigation in Nepal

June 2026

Background

Feasibility study

Over the past year, a consortium of FutureWater (NL), Practica (NL), and the Climate Resilience Research Centre (Nepal) has been conducting a feasibility study on the Smart Sprayer, addressing water scarcity in the mid-hills of Nepal (Syangja district).

By combining highly uniform irrigation with tailored irrigation advice, the system aims to reduce water use, increase yields, and prevent nutrient leaching. It integrates a low-pressure mini-pivot (Sprayer) with a smart advisory service via SMS and WhatsApp (Cromptal). The feasibility study is supported by the Dutch Enterprise Agency (Partners for Water programme).

Farmers face water shortage during the dry winter season but with the Smart Sprayer they are empowered to increase their produce and revenue. Food security is typically a challenge during this dry period, the crops are therefore in high demand.

Unique characteristics of the Smart Sprayer:

- ✓ High uniformity of applied water, therefore efficient with water
- ✓ Water savings through irrigation advice in minutes by SMS/WhatsApp
- ✓ Low pressure operation - can work on gravity or with small pumps
- ✓ Lightweight and easy to relocate

The study is progressing well and is nearing completion. The 10 participating farmers in Putalibazar and Bheerkot municipality are currently finalizing the harvest of their winter crops. Farmers report improved ease of use, water efficiency, and excellent crop yields. Key outcomes:

- Time savings: a major benefit reported by all farmers.
- Water savings: farmers report to save water as a result of the uniform application of irrigation water and the irrigation advice received by SMS daily. They highlighted that a larger area can be irrigated with less water compared to conventional practices, which is particularly important under increasing water scarcity.
- Gender: as women carry out much of the fieldwork, the Smart Sprayer's lightweight design and ease of operation make irrigation less physically demanding and more accessible for them.
- Production: farmers indicated that the technology could contribute to increased production by ensuring timely and need-based irrigation and noted that visible benefits may encourage wider uptake among other farmers in the community.
- Soil and nutrients: maintains soil structure by preventing runoff, eliminating splash erosion, and reducing nutrient leaching.

Next steps:

1. Finalise and analyse data on Smart Sprayer performance, crop yields, and user experiences
2. Improve the design of the sprayer based on farmer feedback, with a focus on usability, robustness, and ease of operation
3. Reduce production costs through local sourcing and design optimization
4. Strengthen the irrigation advisory service to ensure it is reliable and accessible

For reference you can find the following documentation in the annexures:

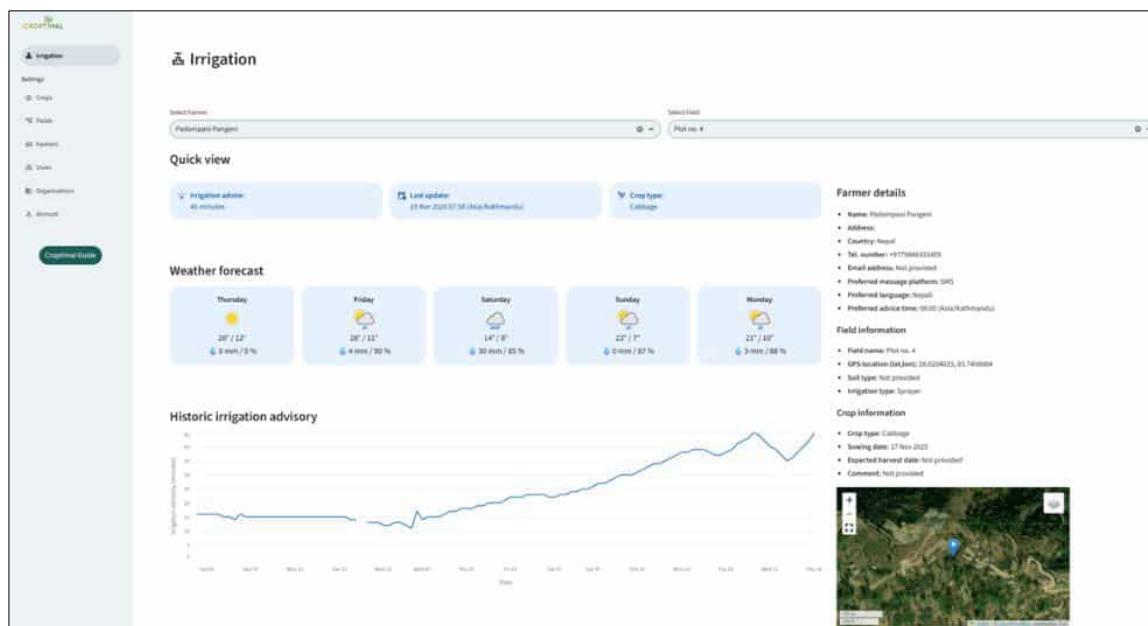
Annex 1: Factsheet and manual: technical details of the Smart Sprayer

Annex 2: List of deliverables, made available upon request

The following videos are readily accessible on YouTube:

- Final results of the Feasibility Study:
<https://youtu.be/UKfbjbbaBTQ?si=xLzjDjcZDUQdwFJi>
- Cromptal | डेटाद्वारा सञ्चालित स्मार्ट सिंचाइ सल्लाह (Nepali)
<https://www.youtube.com/watch?v=BNear0IF5PQ>
- Cromptal | Smart Irrigation Advice Powered by Data (English)
<https://www.youtube.com/watch?v=VznztUv-w>
- Interim Project Video (February 2026)
<https://www.youtube.com/watch?v=91EU3clzOcQ>





Pilot Project

Proposal

The successful feasibility study shows the immense potential of the Smart Sprayer technology in Nepal. Not only for the mid-hills but also for the Terai and other regions. The consortium aims to test the Smart Sprayer technology on a large scale as part of a pilot project. For the pilot project we aim to test the Smart Sprayer with 50-100 farmers. This pilot project is required to make the technology ready for uptake by the Nepalese agricultural sector.

Objectives of the pilot project:

- Validate the Smart Sprayer at scale under real farming conditions, ensuring reliable performance with minimal need for troubleshooting
- Ensure the irrigation advisory software is robust, scalable, and ready to serve a large number of farmers
- Validate and strengthen the supply chain for commercial introduction, building on existing local distribution and service networks

Site and farmer requirements:

- Water source: spring, water tank or pump with a discharge of at least 400 L/hr.
- Elevation difference of >2 meters between field and water intake when using spring water
- Farmer to have access to a cell phone to receive SMS (or WhatsApp)
- Minimum width of terraces of 8 m.

Foreseen activities during the pilot project:

- Local government and stakeholders capacity building and participation
- Procurement of materials and equipment
- Travel by local NGO and by international experts
- Knowledge transfer, support, and monitoring
- Project closure with recommendations for market penetration and subsidy schemes.

Pilot project funding and institutional needs:

- 50-100 participating farmers
- Local government (municipality) supporting the project and engaging in capacity building
- Potential co-financing by local governments
- Cost estimate can be made upon formalising pilot project with number of farmers involved, location, stakeholders.
- Tentative planning of pilot project per below.

Tentative Planning		2026					2027					
#	Activity	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	Inception: field visit, farmer and site selection											
2	Pilot Phase: sowing, smart sprayer deployment, testing											
3	Harvest: collect crop parameters + farmer experience											
4	Capacity building and monitoring: local gov + farmers											
5	Reporting, closure and recommendations											

For more information, please contact us:

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Annex 1

Smart Sprayer factsheet and manual

SMART SPRAYER

The Smart Sprayer is an irrigation technology that combines a mechanical sprinkler system with the digital irrigation advisory tool Cromptal. It has been developed specifically for smallholder farmers. The sprayer has been developed to deliver uniform irrigation under low-pressure conditions. The fully mechanical rotating system operates solely on water pressure, enabling farmers to irrigate effectively without the need for pumps, motors, or external energy sources. The system is designed to reduce farmers' workload by simplifying irrigation practices. Combined with Cromptal the aim is to use water more efficiently.



FEATURES

- Suitable for small plots
- No pumps or electricity required
- Uniform water distribution
- Easy to assemble and move

TECHNICAL SPECIFICATIONS

- Sprayer diameter: 10.90 m
- Irrigated area: Approximately 93 m²
- Flow rate (all holes open): 700–1000 L/h
- Flow rate (half of the holes closed): 450–700 L/h



SMART SPRAYER

GENERAL INFORMATION

The Smart Sprayer operates effectively in areas with low water pressure and functions as a rotating sprinkler irrigation system. The holes in the outer two sections of the arms are oriented horizontally, allowing the sprayer to rotate solely through water pressure. As a result, the system operates fully mechanically and does not require pumps, motors, or external energy sources. Its lightweight and simple design allows the sprayer to be easily moved between fields and operated by a single person. To increase durability and long-term use the structure is designed in such a way that components can be repaired or replaced without specialised tools. Cromptal is a digital advisory tool that calculates crop water requirements based on remote sensing data, crop growth stages, and crop specifications. By integrating this information with the flow rate of the sprayer, it determines the number of minutes that irrigation should be applied. Farmers receive daily text messages with irrigation advice.



ASSEMBLY

STEP 1: SETTING UP THE BASE

- Place the aluminum tripod (1.1) on a stable, level surface.
- Position the cylindrical disc (1.2) on top of the tripod.

STEP 2 – INSTALLING THE CENTRAL VERTICAL TUBE

- Insert the vertical tube (2.1) into the center of the tripod.
- Slide the black plastic sleeve with the built-in spirit (2.2) level over the vertical tube.
- Slide the water inlet (2.3) on the bottom of the vertical tube.
- Insert the additional support pole (2.4) into the ground to stabilize the vertical tube inside the tripod.

STEP 3 – CONNECTING THE WATER SUPPLY

- Insert the water supply tube (3.1) into the lower black plastic component.
- Attach the filter (3.2) to the water supply tube using the hose adapter (3.3) to filter incoming water.

STEP 4 – MOUNTING THE GREEN VERTICAL TUBE

- Push the small plexiglass tube (4.2) into the green vertical tube (4.1), if this is difficult use a rotating and pushing motion.
- Attach the wires (4.3) to the top of the green vertical tube. These wires will later on support the sprayer arms.
- Slide the tube green vertical tube (4.1) over the central vertical tube (2.1).

STEP 5 – ASSEMBLING AND ATTACHING THE SPRAY ARMS

- Attach the sections of the sprayer arms (5.1/2/3) to both sides of the green vertical tube (4.1). First the first sections, then the second and then the third. Place a white foam ring (5.4) between each arm section before connecting them to prevent leakage.
- Attach the wire (4.3) that is connected to the green vertical tube to the third section of the arm.
- Make sure the holes of the first arm face upwards and on the second and third arm horizontally

COMPONENTS LIST- SMART SPRAYER

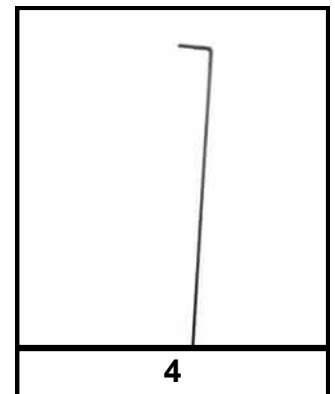
1 BASE AND SUPPORT

1. Aluminum tripod
2. Cylindrical top disc (mounted on top of the tripod)



2 CENTRAL STRUCTURE

1. Central vertical tube
2. Black plastic sleeve with built-in spirit level
3. Lower black plastic fixing ring
4. ground support pole



3 WATER SUPPLY SYSTEM

1. Water supply tube
2. Water filter
3. Threaded hose adapter (20 mm)
4. Water valve



4 ROTATING FRAME

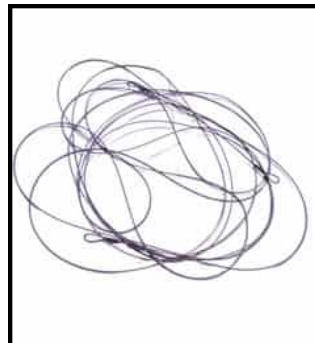
- 1.Green vertical tube
- 2.Plexiglass tube
- 3.Support wire for spray arms



1



2



3

5 SPRAYER ARMS

- 1.Spray arm section 1 (largest diameter and with upward-facing holes)
- 2.Spray arm section 2 (middle diameter with horizontally oriented holes)
- 3.Spray arm section 3 (smallest diameter with horizontally oriented holes)
- 4.White foam sealing rings (between spray arm sections)



1/2/3



4

6 OPTIONAL COMPONENTS

- 1.tube closing rings



1

USERS EXPERIENCES

In October 2025, field testing of the Smart Sprayer was initiated on nine pilot farms in Syangja district (Gandaki province), Nepal. This section presents the experiences and observations of some of those farmers.



Field size: 256 m²



Crop: cauliflower



Water flow: 765 L/h

"With this system I save a lot of time compared to sprinkler irrigation or irrigation with the hose. Also it disturbs the soil and plants less compared to sprinkler irrigation. However, the main advantage is covering more area with less water."



Field size: 253 m²



Crop: cabbage



Water flow: 631 L/h

"Before I used to irrigate using open canals, now with the Smart Sprayer I use my water more efficiently. I use less water and the water is distributed better."



Field size: 500 m²



Crop: cauliflower



Water flow: 498 L/h

"This system saves a lot of time, I do not need to wait anymore or move around with pipes, sticks and sprinkler irrigation. Once it is installed, I can let it run and even turn it off from my house."

Annex 2

List of deliverables

1. Site Selection Report
2. Farmer Focus Group Discussion Report
3. Mid-Term Report to donor of feasibility study
4. Cromptal Technical Guide
5. Supply chain and market analysis for the Smart Sprayer & Cromptal in Nepal
6. Feasibility Study Final Report