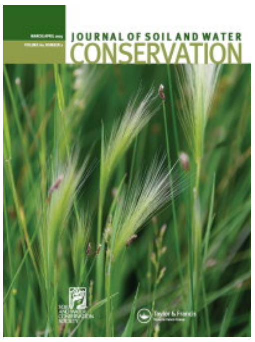

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A SECTION: CASE REPORT

Using on-farm demonstrations to foster adoption of microirrigation systems by smallholder melon farmers in Indonesia

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In Indonesia, enhancing agricultural output holds paramount importance for reducing poverty and ensuring food security. Presently, a significant portion of the impoverished population in Indonesia resides in rural areas and is engaged in agricultural activities. As of 2021, the number of people living in poverty in Indonesia is 10 million, 63% of whom are living in rural areas (Ralston and Tiwari 2020). A major challenge in poverty alleviation efforts is fostering inclusive rural development that involves the participation of land-constrained individuals (Yar and Yasouri n.d.; Yu et al. 2024). The average landholding per smallholder farmer in Indonesia is currently 0.5 ha per family. Given Indonesia's diverse precipitation patterns, some areas receive less rainfall while others face water scarcity, posing challenges for small-scale farming with high water requirements. Insufficient water access, particularly in arid regions with minimal rainfall, hinders the cultivation of certain crops. Droughts exacerbate water scarcity issues, diminishing agricultural productivity and jeopardizing farmers' livelihoods, particularly in impoverished rural regions.

To address these challenges, it is imperative to provide small-scale farmers with affordable irrigation systems. Specifically designed for water-scarce regions, these irrigation technologies should be affordable and require minimal capital investment (Bhatti et al. 2022), save on labor (Sabbagh and Gutierrez 2022), be easy to operate (Wang et al. 2023), and be capable of increasing production with limited land and water resources (Yang et al. 2023). Microirrigation systems, ideal for crops with wide spacing and high value, deliver precise water amounts directly to the root zone through a network of pipes, minimizing water loss and surface evaporation. Microirrigation is particularly suitable for sloped terrain, shallow soils, porous soils, and dry environments, as it reduces soil erosion and optimizes soil moisture for plant growth.

To disseminate these microirrigation techniques to small-scale melon farmers, this case study utilized field demonstrations as a key component of experiential learning, facilitated through extension programs and taking the form of Farmer Field School (FFS). This form was selected because field demonstrations have been effective platforms for showcasing agricultural technologies and encouraging the adoption of new practices among farmers (Singh et al. 2018). With a longstanding tradition in agricultural extension systems, demonstrations have proven instrumental in assisting farmers with local problem solving, and their structure creates diverse contexts conducive to the learning process (Ingram et al. 2018).

This case study was part of the Scientific Capacity Development Programme (CAPaBLE) project in the village of Salohe, located in the Sinjai Regency of Indonesia (Figure 1). The overarching goal of this project is to offer smallholder farm households opportunities to overcome drought and poverty by implementing sustainable intensive agricultural practices. These practices aim to enhance food security, dietary quality, and financial stability, with a particular focus on benefiting women and children, while also preserving or enhancing the natural resource base.

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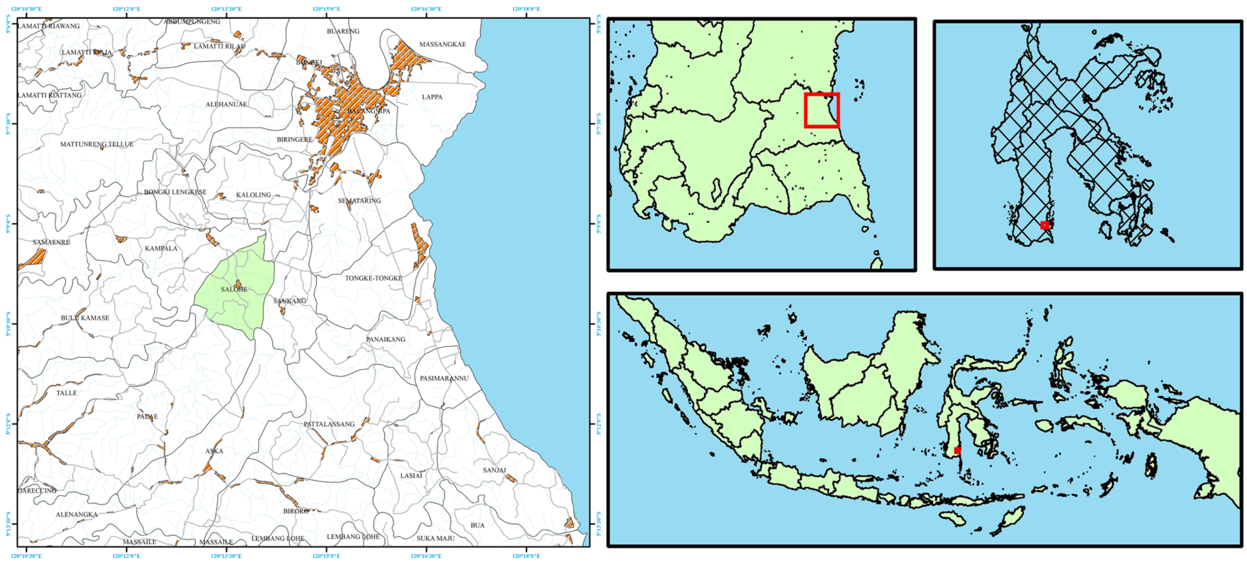
Figure 1. Location of Salohe village within Sinjai Regency, Indonesia.



ESTABLISHING AND CONDUCTING DEMONSTRATIONS FOR SMALLHOLDER MELON FARMERS

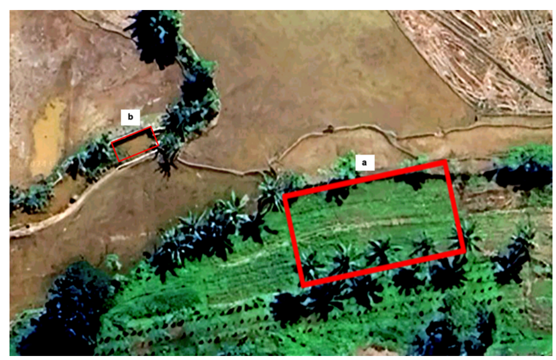
The demonstration took place in Salohe, which is situated approximately 136 km east of Makassar, the largest city in the eastern region of Indonesia. The majority (more than 90%) of smallholder farmers in this area engage in the cultivation of rice and horticultural products, which are vital for sustaining livelihoods in the region, and rely on traditional farming methods using basic equipment and irrigation systems, particularly crucial during dry seasons.

In selecting the demonstration fields for farm plots, the following key factors were taken into account to encourage farmers' participation:

1. Easily accessible sites for implementing microirrigation systems
2. Locations in areas that farmers could conveniently visit
3. Plots with level terrain or gently sloping land to ensure even water distribution using pipelines and emitters
4. Proximity to a water source, ideally a small pond or shallow well (Figure 2)

According to Alexopoulos et al. (2021), the success of field demonstrations in meeting their objectives was influenced particularly by early-stage organization of events, which focused on addressing farmers' needs and structuring activities effectively. Therefore, before designing our FFS format, we first held a Focus Group Discussion (FGD) to gather farmers' insights and assess their needs related to water scarcity in their village, their current knowledge and experience with microirrigation systems, and details for scheduling future meetings and their locations.

Figure 2. The plot location at point A, close to the water source at point B.



The FGD also introduced local farmers to the low-cost, sustainable microirrigation techniques being used in the demonstration plot and how they can optimize water usage, reduce operational expenses, and improve crop yields. Participants were encouraged to share their experiences, ask questions, and discuss potential barriers to implementing the demonstration's techniques, fostering a collaborative learning environment. By combining theoretical knowledge with practical insights, the FGD sought to empower farmers with the tools and confidence needed to implement these techniques on their farms, ultimately contributing to enhanced agricultural productivity and resource efficiency in the region.

The demonstration of microirrigation systems involved setting up three distinct systems: sprinkler irrigation, drip irrigation, and subsurface, ring-shaped emitters on melon crops grown across six raised beds. Figure 3 illustrates the layout of the microirrigation systems. Prior to implementation, farmers received training on how to use and upkeep these systems throughout a single melon-growing season. By demonstrating the three systems, farmers could observe firsthand the features, benefits, and potential drawbacks of each, enabling them to select the most appropriate irrigation method for their specific field conditions and requirements.

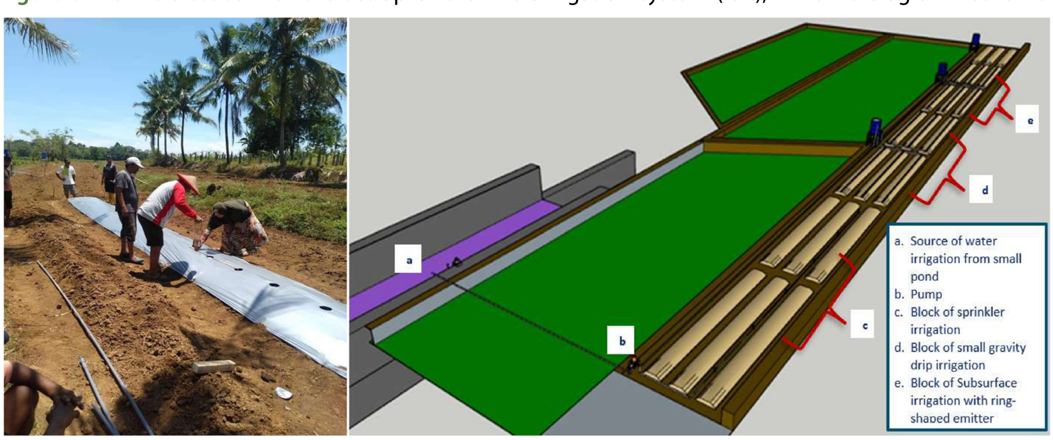
Farmers also received instructions on the proper methods for collecting soil and water samples, enhancing their understanding of the field's actual soil structure. Throughout the growing season, soil and water samples were gathered using an auger to reach depths ranging from the surface down to 50 cm. Aluminum ring samples measuring 10 cm in diameter and 5 cm in height were placed at six distinct depths. Analyzing the physical and chemical characteristics of the soil provided valuable insights for the planning and management of agricultural operations at the project site as well as helped farmers make informed decisions about their sites.

INSIGHTS INTO FARMERS' PERCEPTIONS OF POTENTIAL ADOPTION OF MICROIRRIGATION SYSTEMS

Over the course of the FFS program, 14 meetings were organized, engaging 21 melon farmers throughout the stages of planting, crop maintenance, and harvesting. At the conclusion of the program, an evaluation was carried out to gather feedback from the farmers regarding their experiences and the overall effectiveness of the FFS activities. This evaluation incorporated elements from two prominent frameworks: Kirkpatrick's evaluation model (Kirkpatrick and Kirkpatrick 2016) and Rogers's attributes of innovation (Rogers 2003).

According to Paul, Burman, and Singh (2024), the Kirkpatrick model has proven particularly valuable in assessing the effectiveness of training programs in rural contexts, as it systematically evaluates four key levels: reaction, learning, behavior, and results. For the FFS program, two of these levels (i.e., reaction and learning) were evaluated, as they offer practical and measurable insights into the short-term effects of the program's training. In addition, Rogers's attributes of innovation theory was applied as a theoretical lens to assess farmers' perceptions of the potential for adoption of the demonstrated microirrigation systems. Three out of five key attributes from this framework—relative advantage, compatibility, and complexity—were used. This dual-framework

Figure 3. Farmers assist with the set-up of the microirrigation system (left), which is diagrammed on the right.



approach helped us understand both the immediate outcomes of the training and the likelihood of longer-term adoption by the farmers. A questionnaire included 23 statements, with three to six statements representing each of the five variables, which participants answered using a five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5).

The evaluation revealed that the demonstration plot of microirrigation technologies was an effective approach for promoting their adoption (Figure 4). Farmers had the opportunity to directly observe and engage with the microirrigation technologies in practical farm settings, enabling them to select the technology best suited to their specific farm conditions. According to farmers, the content and materials of FFS were well designed, engaging, and easy to understand. They also noted that FFS created a supportive environment for peer-to-peer learning. This approach enabled them to grasp the advantages of microirrigation; gain the knowledge needed to design, install, and maintain microirrigation systems; and understand the costs involved in installation. Furthermore, farmers conveyed a positive perception of the innovation attributes of the microirrigation system (Figure 5). Regarding relative advantages, farmers observed firsthand how using microirrigation systems throughout planting and harvesting melons resulted in higher yields and significantly reduced water usage, and they conserved energy needed for watering crops. In terms of compatibility, farmers highlighted that microirrigation systems suited their horticultural fields well and did not interfere with their daily routines. As for complexity, farmers found the systems easy to install, with materials readily available locally, and simple to operate and maintain, with expert assistance easily accessible from extension offices when needed.

The demonstration plots also proved to be effective for disseminating new technologies to smallholder farmers, as witnessing a technology's performance helped them to build perceptions about its adoption. FFS helped farmers project further application and adoption of the microirrigation systems on their own farms. Additionally, FFS fostered knowledge-sharing among farmers, creating opportunities for the widespread dissemination of microirrigation techniques. Learning from fellow farmers proved particularly influential, as they shared common experiences and understood each other's perspectives. Singh et al. (2018) argued that a demonstration showcases how a practice could effectively address challenges faced by local farmers, and when supported by data from local field tests, this information could further highlight the practice's benefits for farmers.

CONCLUSION

The demonstration plot, integrated with FFS, facilitated a series of training sessions aimed at empowering smallholder farmers and enhancing their capacity to adopt sustainable agricultural practices in water-scarce areas such as Salohe. These included proper land preparation, optimal spacing, effective fertilizer and seed use, water and soil management,

Figure 4. Farmers' perceptions on the level of reaction and learning toward farmer field school.

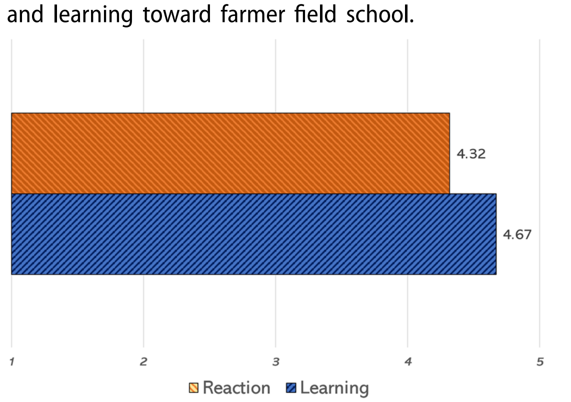
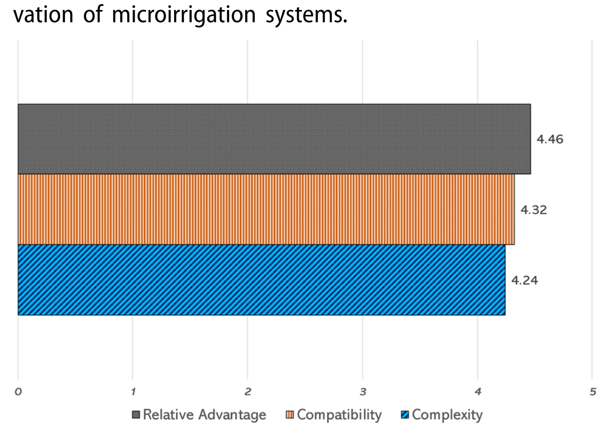


Figure 5. Farmers' perceptions on the attributes of innovation of microirrigation systems.



and pest and disease control, as well as preharvest, harvest, and postharvest techniques to promote positive changes in farming practices. This hands-on approach through demonstration plots served as a foundational step in equipping farmers with the knowledge and skills needed to adopt improved methods. The FFS approach has helped farmers analyze specific farming challenges and make informed decisions about necessary treatments. By incorporating participatory methods in activity design, ongoing advisory support, and the use of demonstrations, FFS effectively showcased low-cost, sustainable irrigation systems and motivated farmers to adopt these innovations and perhaps share them with others.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author(s).

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