Moving to smart irrigation automation control systems for aerobic rice production. A case study.

Irrigation automation and internet wireless communication technology was tested and showcased at the Rice Research Australia Pty Ltd (RRAPL) experimental station in the 2022/23 and 2023/24 rice growing seasons.

In the first year of study, irrigation automation technology was tested in a 5-ha bankless channel site with 12 bays where rice was produced under aerobic (not ponded at any stage of the crop) and strategically ponded water management (ponded only at microspore stage when there is risk of low temperatures) (Figure 1). In these irrigation strategies and field layout, a bay must be watered during hours (depending on the soil properties) and then drained to provide water to the subsequent bay. Irrigation frequency is significantly higher than in the traditional rice water management in which bays are ponded during large part of the growing season and thus, it was the perfect scenario to test the irrigation automation technology proposed within the project. The site was also used as an experimental site to run variety trials for other projects.

Figure 1 *Demonstration site at RRAPL where irrigation automation technology was tested to manage irrigation water in twelve 0.4-ha bays.*

The site was provided with a Wi-Fi network before the start of the growing season. Apart from testing the irrigation automation gear, our research team pushed the limits of commercially available wireless communication technology in this rice growing season to assess whether good internet coverage was possible for large commercial farms. Internet at the site was provided by Starlink satellite service. The Starlink antenna was installed in a shed with access to power in the south of the farm ~1.7 km away from the experimental site and internet shared with a Wi-Fi station (referred as Wi-Fi pod hereafter) equipped with a (omnidirectional) Wi-Fi radio capable of covering an area of ~250 hectares. The Wi-Fi radio was configured in MESH to spread the Wi-Fi signal towards a second Wi-Fi pod located ~800 m away from the shed. Three more Wi-Fi pods (five in total) were deployed in the farm separated ~800 m from each other to provide an area of ~958 ha with internet coverage (Figure 2).

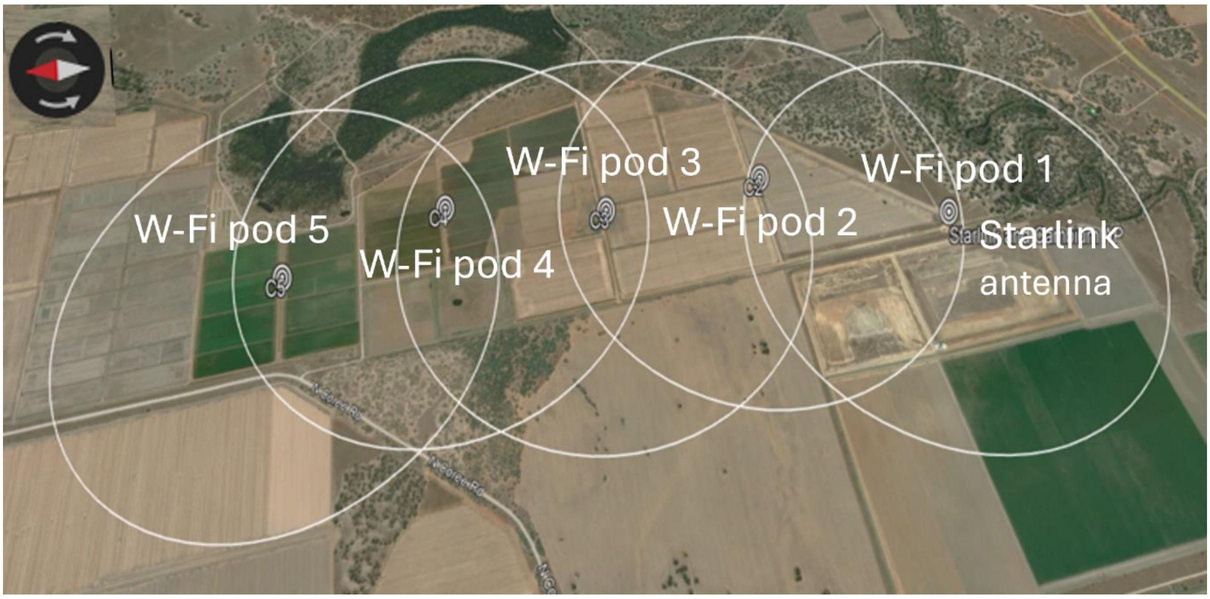

Figure 2 *Illustration of the Wi-Fi MESH network at RRAPL consisting of a Starlink antenna to provide the site with internet and five Wi-Fi pods to spread the signal over ~958 ha.*

The site was equipped with a total of 14 MILCast bay outlets of which the two located at the channel were tarp inserts and the rest stainless-steel slide doors in which water flows under the door. The core of the automation technology used by the project team was developed for home automation purposes but adapted for farm and irrigation automation by our research team. All the outlets were equipped with smart Wi-Fi switch controllers (named '*Alfies*') connected to actuators and a 12V battery and solar panel to remotely control the water flow between bays. Custom floats equipped with Wi-Fi sensors were installed to monitor the water level within bays (Figure 3). Through the free mobile phone app (eWeLink), water managers at the RRAPL experimental station were able to monitor the state of the outlets of all bays and remotely control (open/close) them.

The 2022/23 rice growing season ended with more than 25 irrigation events per bay successfully managed with the irrigation automation technology. The MESH configuration tested to provide with internet an area of ~958 ha was stable and only on one occasion an issue with the Wi-Fi network caused by strong winds in the site that put down one of the Wi-Fi pods affecting the Wi-Fi network was reported. To avoid this issue happening in the future, the base of the Wi-Fi pod (UTE tyre filled with concrete) was increased in size to improve the stability of the structure.

The good performance of the wireless internet network and the automation technology tested in the 2022/23 rive growing season let managers of the RRAPL experimental site to (i) make use of the experience acquired within the project in the first year of study on wireless internet connectivity for large open areas and move into building their own on-site Wi-Fi network to provide the farm with internet, and (ii) adopt the automation technology to automate irrigation of an ~22 ha field in the 2023/24 rice growing season.

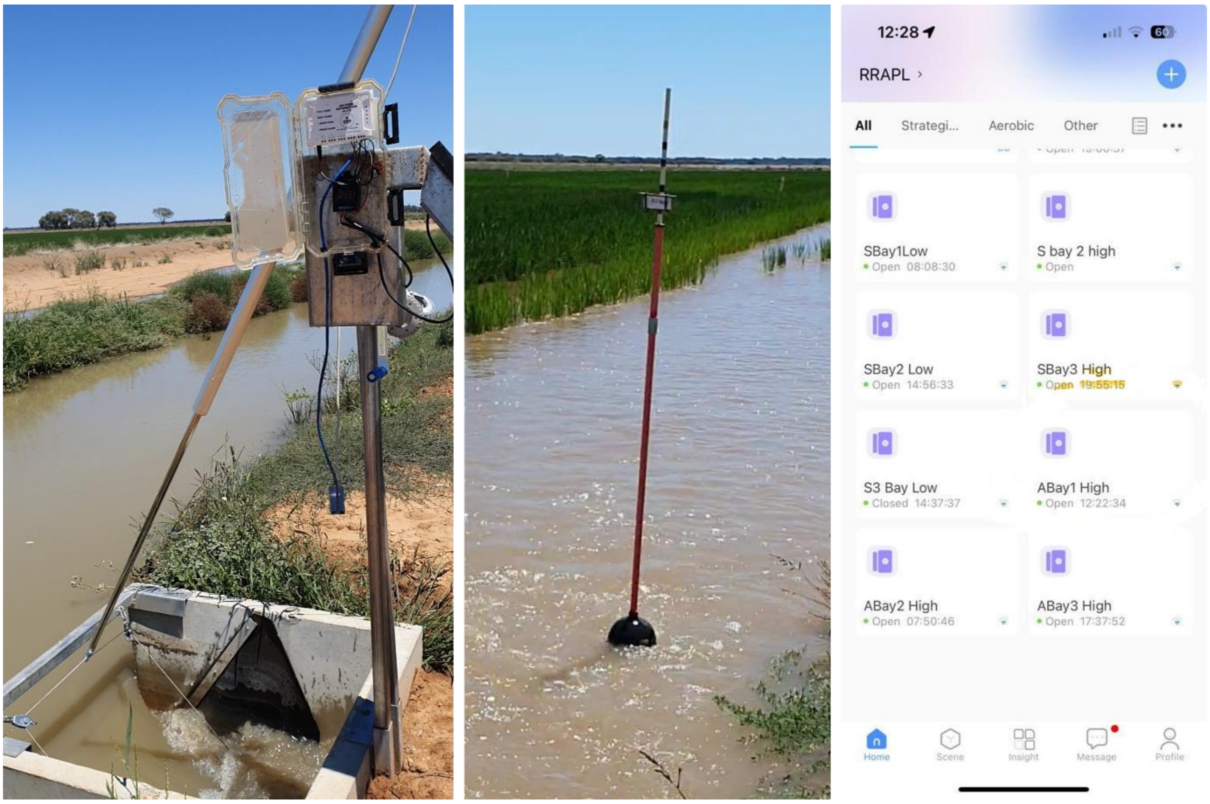

Figure 3 *Illustration of the automated tarp insert outlet in the channel of the site (left), float used in one of the bays under aerobic rice strategy (middle), and the eWeLink app used to monitor and control the outlets.*

In the second year of activities within the project, the irrigation automation technology was tested and showcased in a site with six 0.8-ha bays (eight automated outlets in total; Figure 4). The same automation approach (*Alfies* connected to actuators and floats) used in the previous rice growing season were used. In this case, however, floats with one Wi-Fi sensor were installed in bays under aerobic rice production while floats with two Wi-Fi sensors to define the lower and higher water level desired thresholds were used in bays under a traditional and strategically ponded irrigation management. Information obtained from the floats (when low or high water level thresholds were reached) was used to open or close the outlets to let or stop water flow, respectively, when needed.

Like in the first growing season of study, the irrigation automation technology proposed in the project worked well and information provided by floats was useful to manage (open or close) outlets from each bay remotely. Full automation of the irrigation process was also trialled on the larger 22ha automated field across 4 bays where outlets were open or closed based on the floats (high or low water level thresholds).

Figure 4 *Experimental site in the 2023/24 rice growing season with six bays and eight automated outlets where several (nitrogen rate and nitrogen rate x variety) trials were being conducted.*

Taking home messages

This two-year case study demonstrated that home automation technology that is currently experiencing a boom worldwide can be adapted to field conditions provided a reliable Wi-Fi communication network is available at farms. The project successfully provided internet coverage to an area of 958 ha using commercially available wireless communication technology, testing the limits of the equipment. This technology provides an opportunity for farmers to provide internet coverage for whole farms, which is the first step in the process to move from conventional irrigation systems to smart irrigation systems. RRAPL transition to a farm Wi-Fi hotspot for automated operational management within the life of the project is an example of the interest seen in this technology by the industry.