Turning conventional irrigation systems into smart irrigation control systems for rice production. A case study.

In this case study, irrigation automation technology was showcased in a 30-ha bankless channel rice field at Gogeldrie during the 2022/23 rice growing season and adopted by the farmer who invested in new equipment in the subsequent season.

In summer 2022, a Wi-Fi station (referred as Wi-Fi pod hereafter), consisting of a router with a SIM card and a (omnidirectional) Wi-Fi radio capable of covering an area of ~250 hectares powered by a battery and solar panel was installed to provide the site with a Wi-Fi network (Figure 1). Bruno-Altin (90 cm x 80 cm) concrete outlets of five bays with tarp inserts were equipped with smart Wi-Fi switch controllers (named '*Alfies*') connected to actuators to remotely control the water flow between bays (Figure 2). Custom floats equipped with Wi-Fi sensors were installed to monitor the water level within bays.

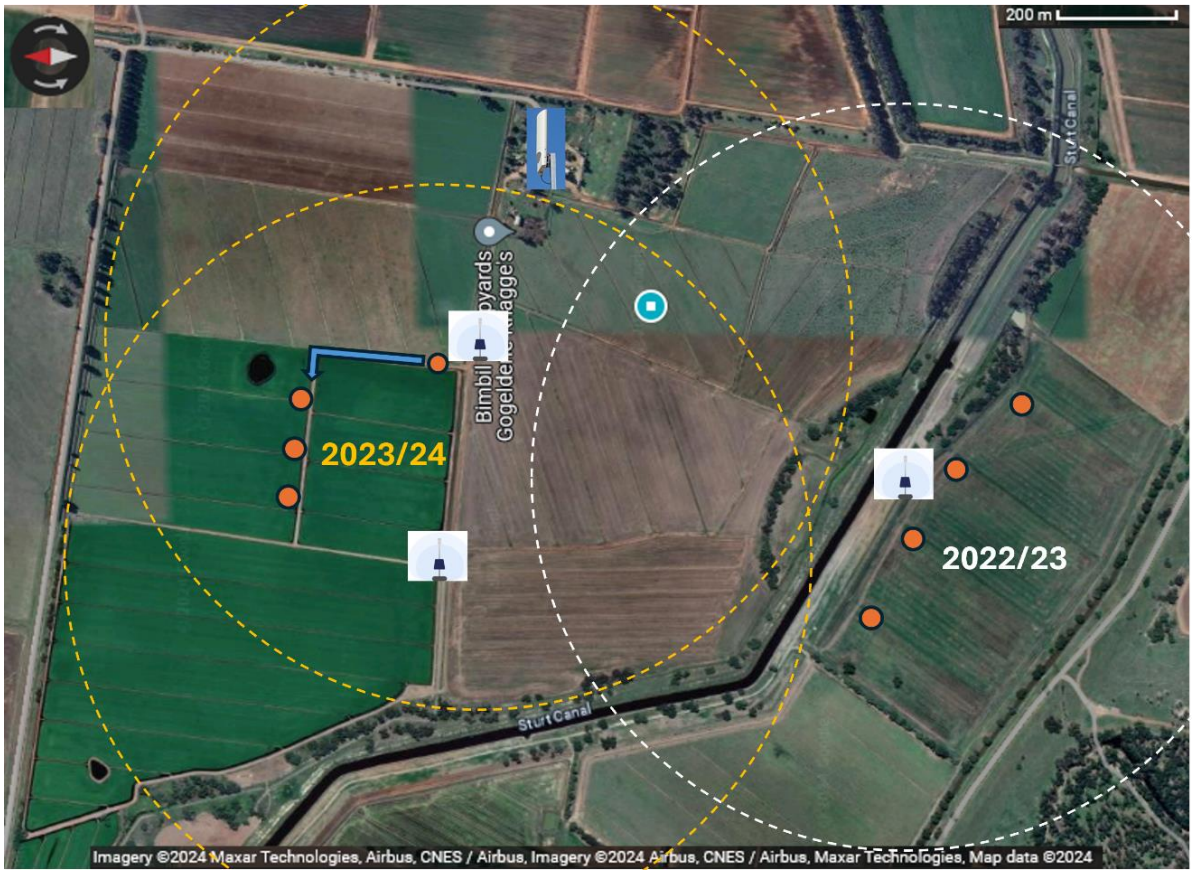

Figure 1 *Illustration of the farm at Gogeldrie where bays were equipped with irrigation automation technology in the 2022/23 and 2023/24 rice growing seasons. Location of the Wi-Fi antenna and Wi-Fi pods and its coverage for each growing season is shown. The red dots indicate outlets equipped with the smart Wi-Fi controllers 'Alfies', actuators, and floats aside to manage irrigation water based on water level on bays.*

During the 2022/23 rice growing season, the farmer was introduced to the Wi-Fi automation technology that was mainly used to monitor the state of the outlets and

remotely control (open/close) them from a free mobile phone app (eWeLink). This enabled him to familiarise with the technology and the phone app needed to control and programme the *Alfies* to automate irrigation water management. At the end of the rice growing season there was good feedback from the farmer, who showed interest in continuing with the case study in the 2023/24 season and invest in the technology to expand the Wi-Fi coverage at the farm to be able to automate other fields in the future.

Figure 2 *Illustration of a float (left), automated stainless steel slide door (middle) and automated tarp insert door (right) used in the case study.*

The field used for the case study in 2022 was not planted with rice in the second season of study. Part of the equipment used in the previous rice growing season was moved to the new site at the north of the farm to automate water management in four bays (Figure 1). Due to the proximity of the field with the house where NBN internet connection was available (east side of the farm; Figure 1), the approach followed in the 2023/24 growing season for the internet communications differed from that followed in the previous year when a single Wi-Fi pod was used. Making use of the NBN internet connection available at the house, a Wi-Fi radio antenna was installed ~10 m above the ground to spread the signal towards a W-Fi pod about 400 m away located close to the field to automate. This Wi-fi pod shared the internet connection (mesh configuration) with a second Wi-Fi pod located 400 m away to ensure there was good Wi-Fi coverage at the site to connect to Alfies and Wi-Fi sensors (Figure 1).

A stainless-steel slide door equipped with an *Alfie* was used in the concrete outlet of the channel to feed the first bay (Figures 1 and 2). The rest three outlets consisted of tarp

inserts and automation technology that was used in the previous growing season. A float with sensors at two positions was installed in each bay and used to set up desired high and low water level thresholds (Figure 2). Following the manuals developed within the project, the farmer was able to build new floats and slightly modify the design of the automated outlets to make them fit in the outlets of the new field.

A problem in the NBN internet connection that affected Gogeldrie in January 2024 caused an internet outage at the farm for a couple of days. Even though the Wi-Fi network was still available, not having internet connection precluded the possibility to remotely control the outlets during this period. To solve this issue and showcase the flexibility of the communication equipment in locations with mobile phone coverage such as the farm where the study was conducted, a router with a SIM card was installed in one of the Wi-Fi pods which meshed with the second Wi-Fi pod to extend the Wi-Fi signal. With the Wi-Fi network and internet connection available again at the site, *Alfies* and Wi-Fi sensors were back online and ready to be programmed to work together.

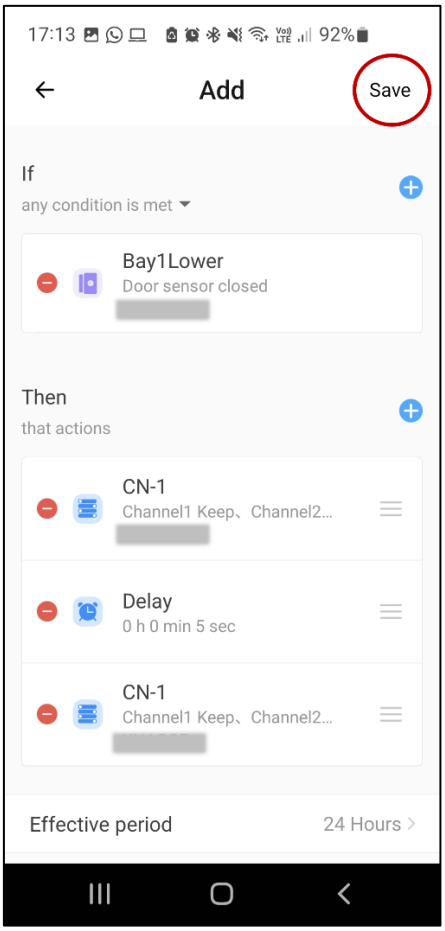

Figure 3 *Screenshot of a 'scene' created in the eWeLink app to open the outlet of Bay 1 when the low sensor of the float indicates water level in Bay 1 reached the lower threshold imposed.* ***If*** *'Bay1Lower' sensor indicates water level has dropped and reached the threshold,* ***then*** *'CN-1' outlet will start opening to let water flow into the bay and stop after five seconds. The higher the time the outlet remains in opening process the higher the water flow entering the bay and quicker the process to reach the desired level of water in the bay.*

Following a manual developed within the project, the farmer along with a member of our team programmed the outlets to open/close based on the water level at each bay monitored with the floats. An example of the 'scene' created in the phone app eWeLink to link the floats with the outlets is shown in Figure 3.

The floats were used to set the desired high and low water level thresholds at each bay and trigger the outlets to open or close in order to let or stop water to flow into bays, respectively. Once floats from each bay were linked to their respective outlets, irrigation at the site was fully automated for the last couple of weeks before draining the bays.

Figure 4 *Illustration of the farm at Gogeldrie where bays were equipped with irrigation automation technology in the 2024/25 rice growing seasons. Location of the Wi-Fi Point to MultiPoint antenna (in the farmhouse) and Wi-Fi pod and its coverage is shown. The red dots indicate outlets equipped with the smart Wi-Fi controllers 'Alfies' (orange circles), and floats (blue squares) aside to manage irrigation water based on water level on bays.*

For the 2024/2025 rice growing season, we evaluated a new farm's Wi-Fi system. While still using the same Wi-Fi pod from the previous season, they were connected in omnidirectional Point to MultiPoint topology (Figure 4). It was also integrated a Starlink internet connection. This new setup proved to be just as reliable and strong as before, but it was simpler to configure and to install and maintain in the field. The most significant

advancement was the full automation of rice bay irrigation, with the floats and 'Alfies' (smart controllers) working together seamlessly.

At the beginning of the season, the farmer set a required water level for each bay covering ~22 hectares. Once the floats detected that this level was reached, the 'Alfies' automatically managed the water flow to next bays. The farmer only needed to define when irrigation should start, and the automation performed all actions. This automation also helped the farmer understand the ideal irrigation duration for each bay. By the second half of the season, the farmer decided to adjust the automation to deliver water based on time, and the system continued to work automatically with the same efficiency. Next season farmer wants to expand the automation, and he is assembling more equipment to be ready for the next season.

Taking home messages

This three-year case study demonstrated that current Wi-Fi communication and automation technology for irrigation management is ready to be adopted at commercial farm scale. It provides the functionality of either monitor the water level of bays and control outlets remotely from a phone app without the need for visual inspection or automate the irrigation process without the need for any intervention. The cost of the technology is affordable and it is expected to decrease due to the significant investment in development of automation technology that our research team adapted to farm conditions. Proof of this is the good feedback received from the farmer in this case study and the interest in expanding the Wi-Fi coverage at the farm to increase the level of automation in coming years.