SMART IRRIGATION FOR SIPHONLESS SYSTEMS #2

RESOURCES FOR COTTON GROWERS ON SIPHONLESS LAYOUT DESIGNS, IMPLEMENTATION AND AUTOMATED MANAGEMENT USING SMART IRRIGATION TECHNOLOGIES

IMAGE: GRANT OSWALD

CRDC COTTON RESEARCH AND DEVELOPMENT CORPORATION | CottonInfo

DEVELOPED BY SYNTIRO AGRICULTURAL SERVICES PTY LTD

Selecting and implementing a smart irrigation system

Selecting the right smart irrigation technologies requires careful assessment of farm readiness and thorough suitability assessment of available technologies and suppliers. What works for one operation may not suit another. Factors such as farm size, irrigation frequency, layout, labour availability, management capacity, and connectivity all influence which system is most appropriate and ensure ongoing success.

This factsheet outlines the critical success factors and farm readiness assessment to guide system selection, describes the key components and desirable features to look for, and provides a staged implementation approach to build confidence and maximise return on investment.

This factsheet is part of the Smart Irrigation for *Siphonless Systems* series. For background on smart irrigation concepts, components, benefits and challenges, see *Factsheet 1: Introducing Smart Irrigation for Siphonless Systems*. For a comparison of current suppliers, see *Factsheet 3: Smart Irrigation Supplier Self-Assessment*.

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Figure 13: It is important to get your check infrastructure installed correctly when developing a siphonless system. Ensure the drive mechanism/ actuator is suitable for remote and automated controllers before investing.

To read about a practical example on farm, see the *Case study: ~~Scaling Smart Irrigation – learnings from early adopters~~.*

CRITICAL SUCCESS FACTORS

Before investing in smart irrigation, assess your readiness and plan your approach carefully. The following six steps will guide you through this process.

Optimise Layout → Farm Readiness Assessment → Visit Farms → Evaluate Potential Suppliers → Stage Implementation → Review & Optimse Management

1. **Optimise layouts and inlet/outlet infrastructure:** Get your layout and inlet/outlets right first and know how the field irrigates. See A guide to siphonless layouts factsheet series for more information on siphonless layouts, key concepts, planning and design considerations and system development. Undertake at least 1 season of manual irrigation to understand how to optimise irrigation for the layout (soil infiltration, flow rates, irrigation time etc.) and consider what sensors and location could assist with monitoring progress.
2. **Farm Readiness assessment:** review the Farm Readiness assessment (below) to determine if smart irrigation is right for your farming business.
3. **Grower Testimonials:** Visit other growers who have smart irrigation technologies during an irrigation event. Hear their experiences and try programming or at least viewing their dashboard if available.
4. **Supplier evaluation:** Evaluate whether suppliers understand your specific system requirements and can provide long-term support, including warranty coverage, technical backup and call out costs for repairs and maintenance. Clarify with suppliers that system features are demonstrated in a commercial farming operation, or if they are still under development, or in the pipeline. This can avoid overpromising and under-delivering. A supplier self-assessment is provided in Appendix 2.
5. **Staged implementation approach:** A staged implementation approach is recommended. Start with sensing and monitoring, progress to remote irrigation control in pilot fields, and only then enable full automation features if desired. Limit your first season to a few fields while you learn the system and build confidence. Only once satisfied with performance, consider adoption across the farm.
6. **Review and optimise management:** Invest time in the first season refining sensor placement, thresholds, and management practices. Conduct annual pre-season maintenance and updates to ensure the system continues meeting your needs. Check back to the goals you set in the farm readiness assessment.

Get your siphonless layout right and know how it works before considering automation or remote irrigation control. Technology won't solve fundamentally flawed layouts.

#2 | Selecting and implementing a smart irrigation system

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Optimise Layout » **Farm Readiness Assessment** » Visit Farms » Evaluate Potential Suppliers » Stage Implementation » Review & Optimse Management

FARM READINESS ASSESSMENT

Use this assessment to evaluate your operation's readiness and identify areas that may need attention before proceeding with smart irrigation technologies.

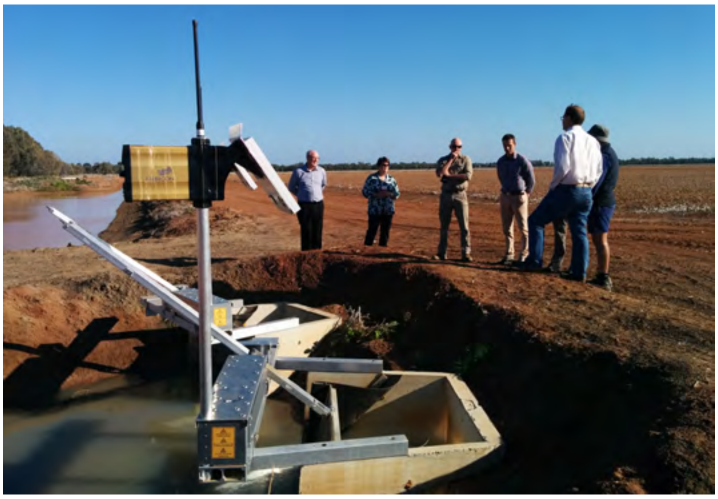

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Figure 14: There are many factors to consider before selecting a smart irrigation system. It is important to ensure the farm layout, and management is ready for adoption, before visiting other farms to get first hand insights on their adoption journey.

- *Irrigation performance:* Ensure you understand how your pumps operate, and siphonless fields irrigate, with at least one season of manual irrigation to understand water pressures and flow rates, run times and tailwater management before adding technology. Remember, smart irrigation will not solve poor field design issues.
- *Key problems to solve:* With an established performance baseline, identify specific challenges you're trying to address (i.e. labour challenges, difficulty managing multiple fields simultaneously, excessive tailwater, or night-time irrigation disruption). Understanding these bottlenecks helps select appropriate technology and set realistic expectations. Understand what you want to achieve: Ask yourself what specifically you want to get out of this undertaking. Be as explicit as possible. Write down your goals and reality check if this is possible with smart irrigation systems.
- *Future farm plans:* Consider your 3–5-year plans when selecting systems. If planning new field developments, design for remote or automated control from the start (easier than retrofitting). Consider scalable communication systems that can expand if needed. Ensure flexibility for different irrigation enterprises (e.g., ponding for rice, winter cereal management). If succession planning is on the horizon, engage the successor.
- *Attitude and skills:* Smart irrigation requires time and patience to master, plus baseline digital literacy with apps and data platforms. Select user-friendly systems that new operators can learn, with good supplier support for knowledge transfer. If key staff, or the next generation aren't willing to invest time to learn the system or struggle with technology, implementation is unlikely to succeed. Consider who will manage the system long-term, ensure they're engaged in the selection process, and build knowledge redundancy i.e. don't let one person be the only expert. Expect significant time investment in the first season.
- *Inlet/outlet infrastructure:* If upgrading inlet/outlets during a layout re-design, engage smart irrigation suppliers before making the final decision – some inlet/outlets and drive types are easier and cheaper to control remotely and automate than others.
- *Make it reversible:* install hardware and such that it can be removed, and the system will still operate should you decide smart irrigation is not right for you or your farm.
- *Cost considerations:* Factor all costs; equipment, installation, electrical work, and ongoing expenses including subscription fees for platforms, connectivity costs, battery replacements, and maintenance. When assessing financial viability, use conservative water and crop productivity benefits, but factor in opportunity cost of time and lifestyle benefits as this is often the greatest return.
- *Grower Testimonials:* Visit other growers who have smart irrigation technologies during an irrigation event. Hear their experiences and try programming or viewing the dashboard if available.

Optimise Layout | Farm Readiness Assessment | Visit Farms | Evaluate Potential Suppliers | Stage Implementation | Review & Optimse Management

VISIT FARMERS WITH SMART IRRIGATION TECHNOLOGY

Before committing to a system, visit multiple growers who have invested in smart irrigation. Be sure to visit during an irrigation event to see the system in operation. Ideally, visit a farm with the same siphonless layout as yours.

When visiting, ask to:

- View the dashboard and how the grower monitors irrigation progress remotely.
- Try programming a simple schedule or viewing sensor data firsthand.
- Understand what has and hasn't worked, and what they would do differently next time.
- Ask about supplier support — how responsive are they when something goes wrong?

Contact your regional extension officer to put you in touch with early adopters of smart irrigation. Alternatively, suppliers should be able to connect you with growers running their systems. If a supplier cannot provide references or arrange a farm visit, treat that as a red flag.

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Figure 15: Attending field days or other growers with smart irrigation systems is a great way to identify solutions that may be appropriate for your business.

Optimise Layout » Farm Readiness Assessment » Visit Farms » **Evaluate Potential Suppliers** » Stage Implementation » Review & Optimse Management

SELECTING SYSTEM COMPONENTS AND DESIRABLE FEATURES

This section draws on learnings from early systems and adopter experience to guide growers through the key considerations and questions to ask during the selection of smart irrigation technologies.

Service support is crucial for smart irrigation success. Access to technical support for troubleshooting or alternate solutions can prevent small issues becoming big problems. Before evaluating specific system components, assess the service offering and reputation of potential suppliers.

Key considerations:

- *Reputation and track record:* As smart irrigation is still emerging in cotton, suppliers vary in maturity. Visit operating systems and talk to current users about their service experience before committing
- *Geographic coverage:* A supplier with nearby presence is advantageous when issues arise. Check which cotton regions the supplier currently services and where technicians are based.
- *Support availability:* Understand what support is available (24/7 on-call, business hours only, or somewhere in between) and at what cost.

An 'ideal' smart irrigation system for one grower or field may not suit another; however, there are several desirable qualities of a smart irrigation system and associated supplier service offerings. This is captured in the 'Gold Standard Features' of smart irrigation- however these are suggestions, not prescriptions. See ~~Appendix 2~~ for a supplier self-assessment or current offerings.

Figure 17: Linear actuator-based control solution designed to open and close inlet/outlets. Commonly these are used for smaller structures. In this case; Bluetooth and telemetry are used for communication, whilst other solutions on the market have buttons and screen to access basic-timer functionality without telemetry.

GOLD STANDARD FEATURES:

Growers receive training at installation including maintenance and troubleshooting procedures. A wide variety of resources are available for troubleshooting as well as timely access to field technician when required. After hours support with a swap-and-go service available when devices need repair.

Do they offer troubleshooting guides, video tutorials, online support tools (AI chat bots, FAQ's) or a swap- and- go facility nearby if devices malfunction?

Actuators and Controllers

Controllers and actuators work together to physically open and close inlet/outlet structures based on commands or pre-programmed schedules. The actuator is the mechanical unit that executes the physical movement; the controller is the electronics and communication layer that tells it what to do.

Controllers and actuators control various drive mechanism; Linear actuators push or pull infrastructure open and closed and are used for smaller (generally <30 ML/d) siphonless inlet/outlets. Rotating elbows are used in Smart Siphon systems, where a common cable connects up to 150 elbows that rotate simultaneously into or out of the water to start or stop flow. Actuators also open and close pipe-based outlets such as butterfly valves, ball valves, and gate valves — commonly to control on-farm storage outlets and recycling systems. Winch cable and direct drive mechanisms are often used on larger overshot (weirs) and undershot (slides) inlet/outlet infrastructure.

Key Considerations

- *Compatibility:* Ensure compatibility with existing inlet/outlet types (e.g., screw gates, slide gates, butterfly valves, overshot weir gates) and drive mechanisms (e.g., winch cable, pneumatic, rack and pinion/direct drive). Not all suppliers have off-the-shelf solutions for every configuration, though most can custom-make adaptations. Ask about lead times and additional costs for custom solutions.
- *Opening control:* Multi-stage opening capability (e.g., 0%, 25%, 50%, 75%, 100%) provides flexibility for managing flow rates (required for ponding rice) and preventing washouts, especially with high flow overshot inlets/outlets. Some actuators/controllers only support fully open or fully closed positions, which limits your water management options.
- *Manual override:* When technology fails, backup options are essential. Check whether control devices have manual buttons on the unit, Bluetooth control via phone when nearby, or easy removal for manual inlet/outlet operation. This becomes critical during communication or controller failures.

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Figure 18: Example of solar powered outlet controller with wired water height sensor and manual override buttons in event of communication failure.

GOLD STANDARD FEATURES:

Self-powered devices that fit your existing inlets/outlets without modification. They don't impede machinery operations, offer multi-stage opening, have both remote and manual override control options, and match your operational needs (portable vs. permanent installation). Infrastructure is robust, reliable and built to withstand harsh environmental conditions and wildlife.

- *Portability vs. security:* Lightweight, easily detachable devices provide flexibility to move between fields (reducing upfront investment if not all fields are cropped each season) but may be more susceptible to theft. Heavy, permanent installations offer better security but less flexibility.
- *Physical dimensions:* Tall devices can interfere with machinery, particularly boom sprayers. Some operators have collided with inlet/outlet controllers, leading to replacement and repair costs, delays to application and wasted chemicals. Understand device height and whether lower-profile designs are available while maintaining connectivity and functionality.
- *Power supply:* Most devices are solar powered with battery backup. Check battery warranty, expected lifespan, and ease of replacement. Ensure installation locations will receive sufficient solar radiation year-round.
- *Environmental durability:* As with all smart irrigation infrastructure, devices must withstand irrigation season conditions (water exposure, temperature extremes, dust, and UV radiation). Check IP ratings for water and dust resistance, and operating temperature ranges– particularly for communication equipment.

Pump Control Integration

Remote pump control capabilities can integrate with inlet/outlet control systems, enabling coordinated control of both water delivery (pumps) and water distribution to fields without needing to travel to pump sites.

Key Considerations:

- Pump Checks: Evaluate pump system energy efficiency and ensure pump is operating within pump curve. See WATERpak Chapter 1.8.
- Control method: Ensure appropriate control; direct wired control to pump starter, wireless relay system, or integration with existing Variable Speed Drive (VSD) or throttle control. Wireless systems offer flexibility but depend on network reliability.
- Pump types supported: Verify compatibility with your specific pump configuration (submersible, centrifugal, diesel/electric drive).
- *Safety features:* Ensure fail-safe mechanisms (e.g., pump stops if communication lost), low-pressure shutoff, overload protection, dry-run prevention to reduce chance of costly faults.
- *Installation compliance:* Electrical works will require qualified electrician installation. Understand these requirements and compliance obligations upfront.
- *Monitoring & alert capabilities:* Remote visibility of pump status (running/stopped/fault), flow rate, pressure, run hours, and energy consumption can alert you to any issues.
- *Multiple pump management:* For multiple pumps, ensure the system can coordinate their operation (e.g., staged starting, load balancing).

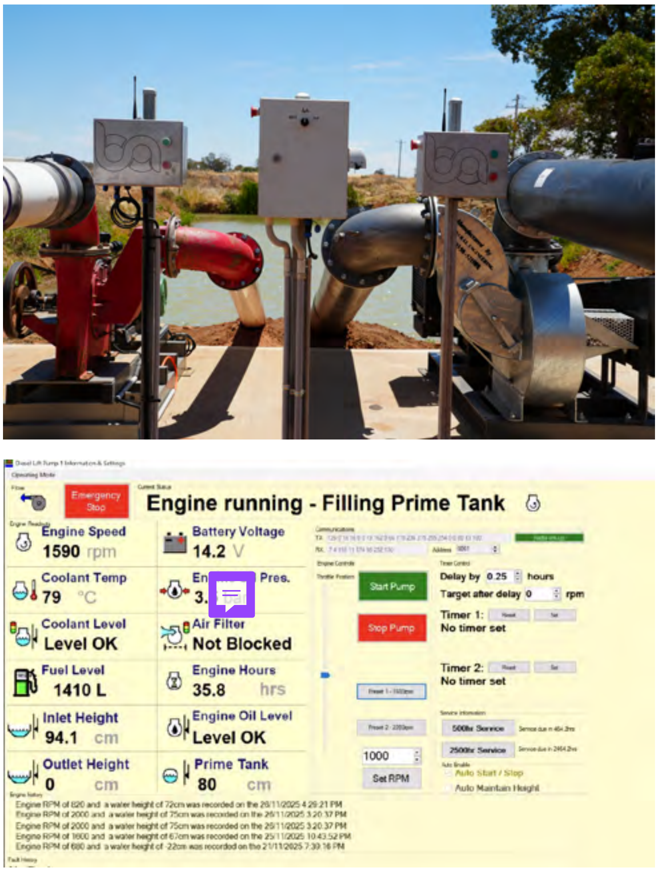

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Figure 20: Top: Example of remote pump controller with manual override buttons. Bottom: Example of user interface for monitoring pumper operations.

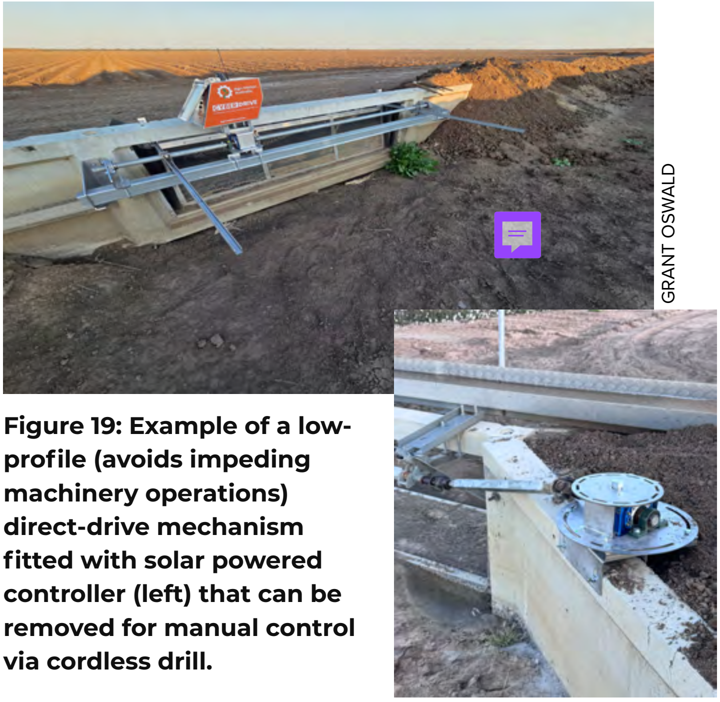

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Figure 19: Example of a low-profile (avoids impeding machinery operations) direct-drive mechanism fitted with solar powered controller (left) that can be removed for manual control via cordless drill.

GOLD STANDARD FEATURES:

Integrated pump control coordinates with inlet/outlet operations, includes fail-safe mechanisms and other safety features and provides detailed monitoring data.

Sensors

Sensors provide the data that informs irrigation decisions from simple water height monitoring during an irrigation event to comprehensive soil moisture and weather data for irrigation scheduling.

Sensor types and function:

Not all sensors are necessary for basic remote irrigation control. Water monitoring sensors are typically essential, while others are optional enhancements.

- *Water monitoring sensors* (wet/dry or water height) in channels or basins monitor irrigation progress and can trigger inlet/outlet actions.
- *Soil moisture sensors* indicate root zone water status for irrigation scheduling decisions.

» *Crop sensors* provide plant stress parameters for irrigation scheduling decisions.
» *Weather stations* enable evapotranspiration-based irrigation scheduling.
» *Flow meters* measure water volumes at field or supply channel level.

Sensor integration options:

Understanding how sensors integrate with your system is critical for long-term flexibility. There are three main approaches, each with different trade-offs outlined in Table 2.

» Proprietary (closed) sensors: Manufactured by your smart irrigation provider and only work with their system. Offer plug-and-play setup and single-vendor support but lock you to that provider.
» Open proprietary sensors: Manufactured by your smart irrigation provider but designed with open APIs/protocols so they can communicate with competitor farm management systems. This gives flexibility to switch providers while keeping sensors.
» 3rd party open sensors: Made by other manufacturers and integrate with multiple platforms through APIs or open-source platforms. These offer maximum flexibility but may require API configuration and involve multiple manufacturers for support.

Key Considerations:

» *Compatibility:* When evaluating suppliers, understand whether their sensors are proprietary (closed or open) or if they support 3rd party integration. Key questions include:
  • Can 3rd party sensors trigger automated actions (pump or inlet/outlet control), or only provide monitoring data?
  • What happens to your sensor investment if you switch smart irrigation providers?
  • Is there a cost for 3rd party sensor integration?
» *Visibility and height:* Many sensor communication devices are quite tall to achieve reliable connectivity. Some operators have collided with sensors using boom sprayers, leading to replacement costs, application delays, wasted chemical, and repair costs. Understand device height and whether lower-profile designs are available while maintaining connectivity.
» *Communication range and reliability:* Wireless sensors must achieve reliable communication with controllers or gateways. Understand typical

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Figure 21: In field water height sensor.

Aspect	Proprietary (Closed)	Open Proprietary	3rd Party
Compatibility / integration	Only manufacturer's system / platform	Own system + competitors via API if compatible	Multiple platforms via APIs if compatible
Setup	Plug-and-play within own system	Easy with own, config needed for others	Requires API configuration
Support	Single vendor	Manufacturer supports hardware, limited support for competitor integration	Multiple vendors
Flexibility	Locked to provider	Can switch providers but keep sensors	Maximum flexibility
Best For	Investing in smart irrigation system with no existing devices and seeking simplicity	As per proprietary (closed), and can switch providers in future	Already have 3rd party devices or prefer competitor's offering

Table 2: Overview of proprietary (open/closed) and 3rd party sensor considerations.

communication range under field conditions (not just line-of-sight specifications). What happens if a sensor loses communication-does the system alert, continue with last known value, or fail to a safe default?

- *Portability and installation:* Fixed installations are more robust but inflexible. Portable sensors can be moved between fields but may be more susceptible to damage or theft. Installation method (push-in, auger-in, permanent mounting) affects ease of setup and relocation.
- *Power:* Most sensors are solar + battery or battery-only. Consider battery life, replacement costs, ease of replacement, and whether solar panels receive adequate sunlight year-round.
- *Understanding the data:* Whether soil, water, or crop parameters, it's important to understand what the sensor measures, what the readings mean, in what units, and the noise/uncertainly level. For example, water height seems simple, but is the threshold 30cm above field level (furrow or hill) or concrete check level? Is it measured in cm or mm? Getting units and thresholds wrong can waste water or reduce crop performance. Ensure you're comfortable with the parameter interpretation before relying on it for automated decisions.
- *Sensor placement:* Sensor location dramatically affects data quality. Water sensors need to be positioned where they accurately represent field conditions, not just convenient mounting spots. For automated systems, incorrect placement or threshold settings can be disastrous (e.g., premature opening or over-irrigation causing water logging or blow outs).
- *Sensor robustness:* Sensors must withstand irrigation season conditions (water exposure, temperature extremes, dust and UV radiation. Ensure manufacturers have quality control and standards in place, especially if being mass produced. Check IP ratings for water and dust resistance, and operating temperature ranges.

The main communication methods used in cotton based smart irrigation systems are cellular (4G/5G, and Low-power cellular protocols (Cat-M1, NB-IoT)), LoRaWAN, Radio (RF). Wi-Fi, wired, and satellite communication can also be used

Figure 22: An infield sensor provides data to inform irrigation decisions.

Communication network

The communication network transmits data and commands between field devices (controllers, sensors, pumps) and the control system. Reliable communication is a requirement for monitoring, and essential for remote control and automation. Without it, the devices become expensive manual inlet/outlet.

Understanding communication types

Repeaters, gateways, and access points are used to extend range or manage signals from devices to the central platform. The main communication methods used in cotton based smart irrigation systems are cellular (4G/5G, and Low-power cellular protocols (Cat-M1, NB-IoT)), LoRaWAN, Radio (RF). Wi-Fi, wired, and satellite communication can also be used, however are not common in the industry. Each has distinct characteristics that make them suitable for different farm situations, as outlined below, with main communication systems detailed in Table 6.

- **Cellular systems** use mobile phone networks, relying on existing cellular towers rather than farm-owned infrastructure. This includes standard 4G/5G data as well as low-power cellular protocols (Cat-M1 and NB-IoT) designed specifically for IoT devices — offering longer battery life and better coverage in marginal signal areas. Ongoing data costs can add up for multiple devices, however this is an advantage when trialling smart irrigation or using only a few devices.
- **Low Power Wide Area Network** e.g. LoRaWAN (Long-Range Wide Area Network) is designed for low-power, long-range communication, making it suitable for large farms with many devices. It requires a LoRa gateway to receive signals from field sensors and forward them to the control system.
- **Radio (RF)** networks use short-range signals between nearby devices, ideal for farms with line-of-sight and limited area. They usually require a local receiver to collect the data from the field devices.
- **Wi-Fi** works well for fields or devices close to a shed or central hub. It requires at least one Wi-Fi Access Point (AP) on the farm, and repeaters can be added to extend the range across larger areas.
- **Satellite** connections provide coverage in remote areas without phone service. They need a satellite dish or terminal on the farm to communicate with orbiting satellites, but costs are higher, and data transfer is slower.
- **Wired systems** are reliable and fast but expensive to install and maintain over long distances. They do not require towers or base stations, as the data travels along physical cables.

Key considerations

- *Connectivity availability:* Test signal strength in potential device locations. If cellular coverage is poor or unreliable, alternative communication methods (LoRaWAN, radio, Wi-Fi) will be required, adding infrastructure costs.
- *Number of devices and scale:* SIM-card equipped devices are cost-effective when deploying only a few controllers (e.g., trialling on 1-3 fields). However, annual SIM costs add quickly with several devices, and ongoing connectivity is often cheaper with a single communication gateway (e.g., LoRaWAN, Wi-Fi, or Radio) serving multiple devices.
- *Infrastructure complexity:* 1-2 communication towers or gateways on the farm are relatively simple to manage. However, multiple communication repeaters across the farm increase the number of devices to service and maintain, require avoidance with machinery, and add troubleshooting complexity ('Which repeater/tower is down?').
- *Line-of-sight and terrain:* Radio (RF) and some Wi-Fi systems require clear line-of-sight between devices and receivers/repeaters. Undulating terrain, tree lines, and buildings can create communication shadows. LoRaWAN and cellular are less sensitive to line-of-sight but still affected by terrain and distance.

Feature	Cellular (e.g. 4G/5G, Cat-M1, NB-IoT)	LoRaWAN	Radio (RF)
Typical Range	Network dependent (tower coverage)	2-15 km (terrain dependent)	1-5 km line-of-sight – can mesh to relay devices
Data Capability	Cellular (4G/5G): Video, high-res images, sensor data, control commands. Cellular LPWAN (Cat-M1 / NB-IoT): Sensor data, control commands	Sensor data, control	Sensor data, control
Scalability (# devices)	High (but gets costly)	High (100s per gateway)	Medium (limited by bandwidth)
Install Cost	$	$$	$$
Ongoing Cost	$ – $$$	$	$
Best Suited For	Trial deployments (few devices); reliable cellular coverage; high bandwidth (image / video) requirements	Large farms with many distributed devices (100s-1000s)	Medium-distance point-to-point links;

Table 6: Generic comparison of communication systems currently used in smart irrigation systems.

- *Communication reliability:* "Handshake" systems confirm devices have received and executed commands. Simpler systems send commands without a "Handshake" verification. The confirmation "Handshake" prevents situations where commands are lost, and outlet changes do not occur.
- *Fail-safe behaviour:* During communication outages, devices can either continue with the last command, revert to default (typically closed), or maintain position. Understanding this behaviour is essential for preventing disasters.
- *Remote diagnosis:* Advanced platforms show device health (last contact, signal strength, battery status) and pinpoint failed infrastructure remotely and can alert users. Field hardware is notorious for failing after electrical storms, and remote diagnosis allows rapid testing of equipment. The ability to see which device, repeater, or gateway has failed remotely saves significant time and frustration.
- *Backup communication:* Alternative communication capability, (i.e Bluetooth control when near devices), ensures continued operation if the primary network fails.

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Figure 23: LoRaWAN communication tower.

Control System

The control system is the central platform that collects sensor data, processes information, makes or executes irrigation decisions, and issues commands to field devices. It's 'brain' of your smart irrigation system.

Key considerations

- *Operating architecture:* cloud-based systems offer convenient remote access but are problematic during internet outages. Local/ hybrid systems can continue operating when internet fails with pre-accepted commands stored on the device (although remote monitoring may be unavailable). Understanding what functionality remains during outages is critical for irrigation continuity.
- *Uptime and reliability:* Understand how often devices: senses data/device status information (e.g. checks water depth every 5 or 30 mins, open/ closed), uploads information to platform (e.g. every 5 or 30 mins, or when change is detected), and time to send command and acceptance.
- *Decision-making capabilities:* Basic systems operate on timers only. Advanced systems respond to sensor thresholds (water height, soil moisture) and support multi-sensor decision rules (e.g., close inlet/outlet if water height OR maximum time reached). Most cotton growers currently use remote control rather than full automation but having automation capability provides future flexibility.
- *Alert functionality:* Alert types (water thresholds, device malfunctions, battery low, communication failures), delivery methods (text, app, email), customisation options, and priority levels (critical vs standard) determine alert effectiveness.

GOLD STANDARD FEATURES:

The best communication option is the one that is reliable. This will depend on farm connectivity, number of devices, and their distribution across the property. Ideally, the least repeaters, gateways and access points, the better.

CRITICAL STEP: Always test connectivity with suppliers' equipment before committing – don't rely on cellular coverage maps or your phone experience.

- *Remote diagnostics and monitoring:* Systems with proactive diagnostic health monitoring (battery status, communication quality, last contact) can alert user and supplier to potential issues. Remote monitoring can reduce adverse outcomes and unnecessary travel to the field.
- *Software updates and maintenance:* Update frequency and type determine operational disruption. Remote over-the-air updates are convenient but must avoid interrupting irrigation events. Note that software providers often push updates early hours of the morning, however irrigation event could still be occurring. Some software providers have systems in place to check if events are programmed before sending over the air updates.
- Manual in-field updates ensure immediate verification but are time consuming if frequent. Automatic rollback capability to previous version when updates fail prevents devices becoming non-functional.
- *Data management:* Data storage location (local, cloud, hybrid), retention period, backup frequency, and recovery processes affect long-term usability. Confirm grower ownership of data and ability to export in standard formats (CSV, Excel) for analysis or integration with other farm software.
- *Security measures:* Protect against unauthorised system access with data encryption during transmission and storage, authentication methods, and access controls. Security becomes particularly important with remote control capabilities.

GOLD STANDARD FEATURES

Hybrid operating architecture for redundancy, responds in near real-time, can integrate multiple sensor types and 3rd party data, multiple decision rules, provides remote diagnostics and proactive device health monitoring and alert system, has proven reliability with minimal downtime and software updates.

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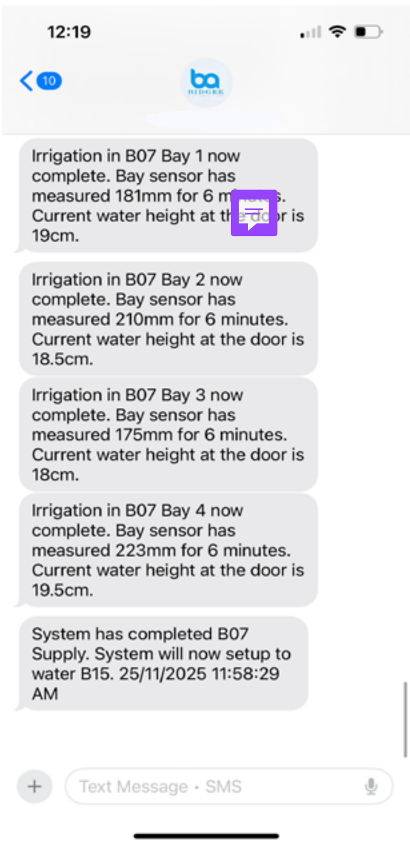

Figure 24: Example of Text message alerts. These can be set to update user of irrigation progress, or only in the event of issues.

A well-designed interface makes the difference between a system you use confidently and one that sits idle because it's too frustrating

User Interface

The user interface is how you interact with your smart irrigation system. It includes the apps, web portals, and on-device controls that let you monitor status, issue commands, and configure platform settings. A well-designed interface makes the difference between a system you use confidently and one that sits idle because it's too frustrating.

Key considerations

- *Platform types:* Most suppliers offer both mobile apps (iOS/Android) and web interfaces, however, check to see compatibility and satisfaction with your phone/tablet/computer. Is the mobile app an afterthought or a well designed tool with full control features? On-device control (physical buttons, screens, or Bluetooth) provides backup when phone/internet fails.
- *Ease of setup:* Default templates for common field configurations (e.g., 4-bay layout with sequential watering based on sensors triggering cascade of control commands) accelerates setup. Device cloning capability (copying settings to identical fields) also saves significant time. Intuitive navigation with key functions accessible

within 2-3 clicks reduces frustration.

- *Visual customisation and field mapping:* Field boundary import saves mapping time. Dashboard customisation (pinning frequently used functions, hiding unused features), meaningful device naming, grouping by field/property or colour coding device locations on maps (e.g., inlets/outlets coloured blue when open) enables easy visual checks.
- *Multi-user functionality:* Farm staff often need system access with different permission levels (admin, manager, operator, viewer). Granular permissions allow appropriate access for contractors or casual staff without full system control. Simultaneous login capability prevents conflicts when multiple users access the system concurrently.
- *Data and reporting:* Historical data graphing (water levels, run times) over customisable timeframes enables pattern identification and system optimisation. Automated irrigation reports can summarise water use, run times and data export capability (CSV, Excel, PDF) support good record-keeping and analysis.
- *Integration capabilities:* Integration with farm management software, weather data sources (BoM), satellite imagery, or remote sensing platforms consolidates information in unified interfaces.

GOLD STANDARD FEATURES:

Both mobile app and web interface have full functionality across device types, intuitive design with helpful templates, visual field mapping with field boundary import capability, and colour-coded status, device setting cloning, multi-user capability with permission controls, multiple alert options, local control backup options, and data export capability.

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Figure 25: Colour coded dashboard enables easy visual checks of device status.

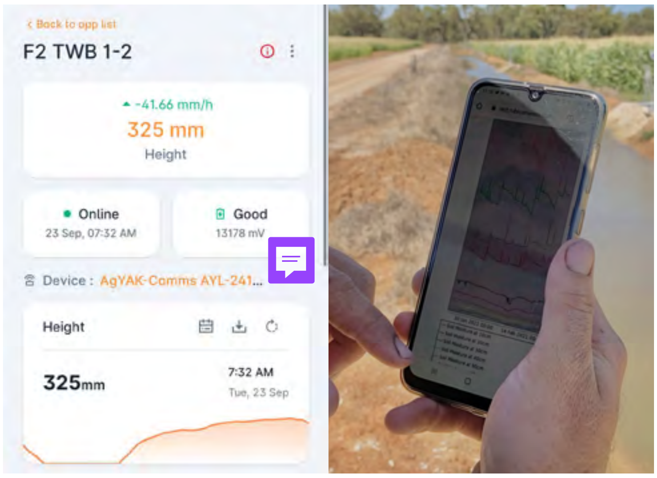

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Figure 26: Left: App showing water height sensor data. Photo credit Grant Oswald.
Right: App showing soil moisture information.

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IMPLEMENTING A SMART IRRIGATION SYSTEM

Successful smart irrigation adoption requires staged implementation rather than whole-farm deployment.

STAGE 1: SENSING AND MONITORING

Before investing in full remote control or automation, start with sensing and monitoring technologies. Water height sensors with text alerts in channels or at inlets/outlets when water has reached the end of a bay or when channels are critically low/high provide immediate benefit of reduced travel to field to monitor progress. This also helps identify optimal sensor placement before piloting remote control.

STAGE 2: CHOOSE PILOT FIELDS FOR REMOTE IRRIGATION CONTROL

Start with time-based pump or inlet/outlet controllers or an automation system run as a remote-control (grower decides; technology executes commands). Select fields with known irrigation performance (at least one season manual irrigation on current layout), relatively uniform characteristics, good connectivity. Build trust in the technology and ensure you understand system behaviour before enabling automation.

STAGE 3: SELECT AUTOMATION FEATURES

After several successful remote control irrigation events, gradually enable automated features. Start with simple single-rule automation (e.g., “Close inlet/outlet when water height reaches 30 cm”) and monitor closely for 2-3 events. Add multi-condition rules and additional sensor integration as confidence builds. Continue monitoring all automated events remotely and be ready to intervene manually. Refine thresholds and rules iteratively based on outcomes.

Note - not all fields are suitable for automated control - some may remain better as remote control.

STAGE 4: SCALING ADOPTION

If satisfied with pilot field performance through a full season, expand strategically in subsequent seasons. Prioritize fields with frequent irrigations, remote locations, proven layouts, and good connectivity. Apply optimal sensor placement lessons from pilot fields, replicate successful threshold settings and automation rules, and use device cloning features to accelerate setup. Consider communication infrastructure economies of scale when expanding.

Optimise Layout » Farm Readiness Assessment » Visit Farms » Evaluate Potential Suppliers » Stage Implementation » Review & Optimse Management

REVIEW AND OPTIMISE MANAGEMENT

Implementing a smart irrigation system is not set and forget. It is important to review and document learnings for next season. Off-season is a good time to undertake any maintenance and updates to the systems.

First season learning

- *Document what works:* Note optimal sensor placement locations, effective water height thresholds for different field types, and device settings that delivered best results. This is required when expanding or troubleshooting.
- *Share knowledge:* Ensure all relevant staff understand the system. Document the procedures because if only one person knows how it works the operation becomes vulnerable when they're unavailable or leave the business.
- *Measure benefits:* Track labour hours, fuel use, energy savings, and any crop performance or water efficiency improvements. Without numbers, justifying expansion or identifying what needs fixing is difficult.
- *Evaluate performance:* After the first full season, objectively assess whether the system delivered expected benefits and if supplier support is adequate. Revisit your goals set in the farm readiness assessment. Address issues before deciding to expand to more fields or discontinue if it doesn't suit the operation.

Ongoing management

- *Annual pre-season checks:* Test devices, update firmware, replace batteries, verify connectivity. Complete before, not during a critical irrigation event.
- *Refine settings:* Adjust sensor thresholds and automation rules based on previous season performance. Different crops or soil types may need different parameter settings.
- *Stay informed:* Monitor new features from your supplier and competitors, consider adding sensors or data sources if they solve specific operational challenges, and evaluate whether the system continues to meet evolving operational requirements.
- *Share experience:* Maintain open communication with suppliers and provide honest feedback. Participate in grower groups to share experiences and learn from others as collective knowledge strengthens industry adoption and helps avoid common pitfalls.

CONCLUSION

Smart irrigation technologies can deliver significant labour and lifestyle benefits, but success requires careful preparation, staged implementation and realistic expectations. Many cotton growers with "automation" are using remote control rather than full automation as this delivers most of the benefits while maintaining oversight and building trust.

Site-specific and management factors should guide system selection. Start with optimising field layout, understanding irrigation performance and assessing farm readiness for smart irrigation. Visiting other growers during irrigation events provides insights into system use and associated benefits and limitations. Evaluating farm needs and the solutions offered by technology suppliers is essential. When implementing, start with sensing and monitoring technologies, then pilot remote irrigation control of a few fields. Once comfortable, progress to automation on a few fields before scaling across the farm.

For a comparison of current supplier offerings to assist with selection, see the Smart Irrigation Supplier Self-Assessment.

CASE STUDY: SCALING SMART IRRIGATION – LEARNINGS FROM EARLY ADOPTERS

TO COME 11 JUNE

INTRODUCTION

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DRIVERS BEHIND HEADING DOWN THE AUTOMATION PATH

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STEPS IN ADOPTING SMART IRRIGATION

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LEARNINGS ALONG THE WAY

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BENEFITS OBSERVED

Text

Where to next?

Footnotes

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CONTRIBUTORS:

Matt Champness led the project and developed the smart irrigation content, with review and editing of siphonless system design content. **Harriet Brickhill** developed the siphonless systems content and provided review and editing of smart irrigation technologies content. **Glenn Lyons** provided technical input and review of siphonless system content.

Syntiro Agricultural Services Pty Ltd

#2 | Selecting and implementing a smart irrigation system

Cotton Info

GLOSSARY

Naming conventions differ between regions and have changed as systems have evolved. Where multiple terms exist, bold text indicates terminology used within this document.

API (Application Programming Interface): A set of rules and protocols that allows different software applications to communicate with each other. In smart irrigation, APIs enable sensors from different manufacturers to share data with control platforms.

Automated Irrigation: Systems where the decisions about when to open/close inlets/ outlets or start/stop pumps are made automatically by the supervisory system based on sensor data and programmed rules, without requiring human intervention for each action.

Bay: A section of a down the slope field that is separated by banks running from supply end to tail drain.

Basin: A section of a field where there is no or minimal slope along the furrow, that is separated by banks running from end to end.

Bankless Channel/bankless head ditch: Used in GL Bays & Basin systems. A below field height levelled area that is filled prior to water entering furrows. It acts as the supply and drain. Drainage is through a check structure into the next stepped bay or basin.

Bankless Side Channel: Used in Rollover Bankless. A below field height channel that runs in the same direction as the furrow and supplies water to a bankless channel at each end of the furrow.

Bankless Check: Drop board, rubber door or gated pipe that controls the passage of supply water from bay to bay – or basin to basin.

Command: An instruction sent from the supervisory system or user interface to a controller, directing it to perform an action (e.g., open outlet, close valve, start pump).

Communication Network: The connectivity layer that transmits data and commands between field devices (controllers & sensors) and the supervisory system. May use cellular, LoRaWAN, radio, or Wi-Fi.

Controller: A device that opens and closes irrigation infrastructure (inlets, outlets, valves) based on commands from the supervisory system or direct user input. May include motor/actuator mechanisms and control electronics.

Cross Fall: lateral slope across the field (as opposed to down the slope of the furrow).

Dispersion Pond/ distribution basin / distribution bay/ dispersion basin/ pontoon area: Used in PTB systems. Below field height levelled area between head ditch and furrows that is filled prior to water entering furrows. This is only a supply and is at the upper end of the field.

Gateway: A device that receives data from field sensors or controllers using one communication protocol and translates it for transmission to the supervisory system using another protocol. Common in LoRaWAN and radio networks.

GL Bays: A siphonless system consisting of terraced bays stepping down the landscape with furrows running perpendicular to the natural slope. Water is supplied via bankless channels, with tailwater reused between adjacent bays.

Handshake: A communication protocol where the receiving device confirms it has received and executed a command. Provides verification that actions have been completed successfully.

Head Ditch: The main supply channel for the field, which enables supply via manual hand siphons, small pipe through bank or large pipe through bank. This controls water head height.

Level Basin/ flat bays, flat flat, beds in bays, bankless channel: A siphonless basin system with zero or minimal slope (typically flat or 0.01% down slope) along furrow length. Water enters and drains through bankless channels at each end of the furrows. Field is divided into terraced basins stepping down the landscape.

LoRaWAN (Long Range Wide Area Network): A low-power, long-range wireless communication protocol designed for IoT devices. Requires a LoRa gateway on the farm and is well-suited for large farms with many distributed sensors and controllers.

Offtake: Primary point of delivery from the irrigation scheme/river.

Outlet: An overarching term for a structure used in irrigation systems to control the flow of water. Includes inlets and check structures.

Pipe through Bank (PTB)/ Large PTB, Pontoon: A siphonless system where large diameter gated pipes (250-750mm) are installed through the head ditch bank to deliver water to a dispersion pond. Water then flows simultaneously into multiple furrows (typically 12-96 furrows per pipe). Field slopes down to taildrain.

Platform: The software system (web-based or app-based) that provides the user interface for monitoring and controlling smart irrigation equipment. May include data visualization, scheduling tools, and alert management.

Protocol: A set of rules defining how data is transmitted between devices in a communication network. Different protocols (e.g., LoRaWAN, Modbus, MQTT) have different characteristics for range, power consumption, and data capacity.

Radio (RF): Short-range wireless communication between nearby devices using radio frequency signals. Typically requires line-of-sight and may use mesh networks where devices relay signals to extend range.

Remote Irrigation Control: Irrigation systems where human operators make decisions about when to irrigate and manually trigger actions (open/close outlets, start/stop pumps) through a remote interface (app or web platform), without travelling to the field. Differs from automation where the system makes decisions.

Repeater: A device that receives and retransmits signals to extend the communication range of a wireless network, particularly important for large farms or areas with terrain obstacles.

Rollover / Rollover Bankless: A siphonless basin system where furrows follow the natural slope direction (allowing machinery to “rollover” from one basin to the next). Requires very flat terrain (<0.04% slope). Uses bankless side channel and bankless channels for water supply and drainage.

Sensor: A device that measures physical parameters (water height, soil moisture, weather conditions, flow rate) and transmits data to the supervisory system to inform irrigation decisions.

Sill: The point in the bay where the field slope changes to a negative slope.

Siphonless Irrigation: Surface irrigation systems that deliver water at high flow rates from an inlet to a below-field-level area where water spreads evenly before entering all furrows simultaneously, eliminating the need for hand-placed siphons and 2-meter rotobucks.

Smart Irrigation: An umbrella term for advanced irrigation technologies that use real-time data and automation to optimise irrigation management. Includes sensing/monitoring, remote control, and automated irrigation systems.

Small Pipe Through the Bank (Small PTB): A system using permanent 75-90mm pipes installed through the head ditch at consistent levels. Still requires 2m rotobucks. Variations include stepped set, double head ditch, and smart siphon configurations. See Chapter 1, Section 4 for detailed descriptions

Supervisory System: The central control or decision-making system that processes sensor data, interprets field conditions, and triggers controller actions (opening or closing infrastructure).

Supply Channel: A channel that carries water throughout the farm to supply the head ditch or fields.

Supply Inlet: a structure that allows water to enter the system, usually from the supply channel

Tail drain: Tail drains remove run-off from the field created by both irrigation and rainfall events.

Tail drain Checks: Drop board, rubber door or gated pipe that controls the passage of tailwater from bay to bay.

Tail drain Outlet: Drop structure and pipe that passes the tailwater to the recycling system.

Tailwater Backup (TWB): The slope at the tail drain end of the field is reduced to allow tailwater to back up slower furrows. This backed-up water is then drained and reused in the subsequent bay.

Terraced Basin: A basin system configuration where basins step down the landscape with minimum 15cm vertical drop between each basin level. Used in both Level Basin and Rollover systems.

Time-based Controller: A controller that operates on pre-programmed time schedules to open/close infrastructure or start/stop pumps. May lack sensor feedback beyond basic fail-safe protection.

User Interface: The platform (local buttons/screen, Bluetooth connection, mobile app, or web portal) where operators monitor system status, view data, and control irrigation equipment manually or remotely.