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

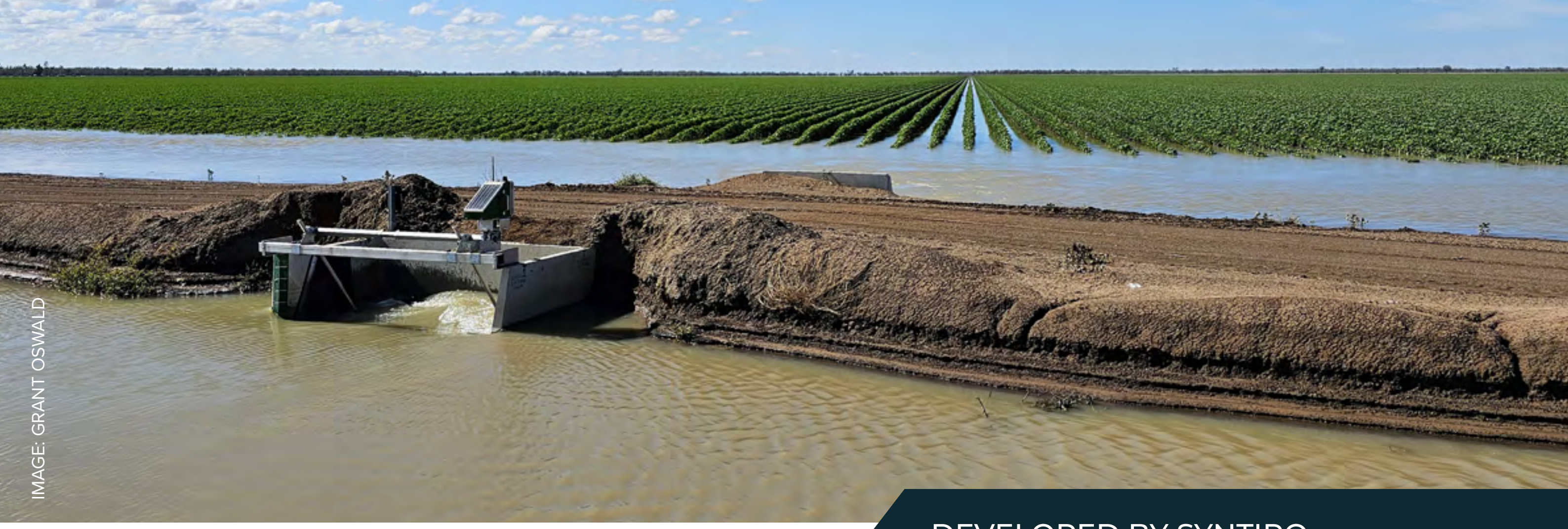

IMAGE: GRANT OSWALD

DEVELOPED BY SYNTIRO AGRICULTURAL SERVICES PTY LTD

CASE STUDY: Getting the most from your Siphonless System

TAILWATER BACKUP AND INLET SPACING

Two of the most common factors affecting irrigation efficiency in siphonless systems are tailwater management and inlet spacing. Getting this right at the design stage has a significant impact on water use, pumping costs, and irrigation run times. This factsheet explains the benefits of tailwater backup and uses a worked example to illustrate the consequences of insufficient flow from poor inlet spacing, and the gains from incorporating tailwater backup into the design for a pipe through the bank system.

Advantages of tailwater backup

Siphonless systems that have tailwater back up incorporated in the design have many advantages over a siphon system. For an overview of which system types include tailwater backup, see Factsheet 2: Types of Siphonless Systems.

- Reduced tailwater losses through continuous re-use through bays

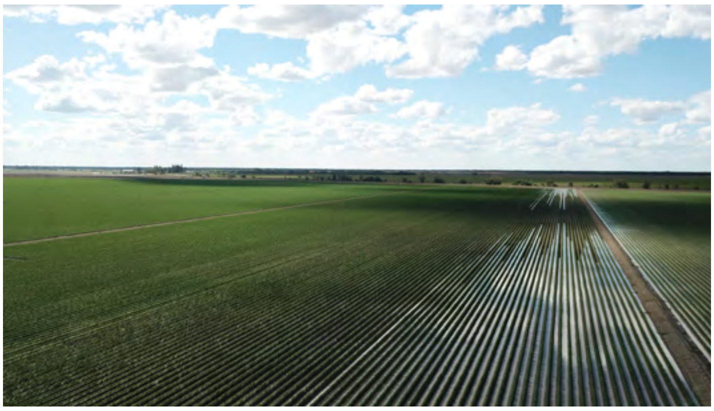

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Figure 12: Example of Tailwater Backup to improve water efficiency, reduce application time, silt and trash buildup in tailwater recycling and reduce time to irrigated farm.

- Application time is reduced due to the high flowrate and the reuse of tailwater. The tailwater runoff reduction accelerates the speed of the irrigation event.
- Silt buildup in the tailwater recycling system is reduced. Silt build-up in a siphon system and

PTB system is a result of scouring in the last 50m of the furrow as the water accelerates down the batter into the tail drain.

- Trash accumulation in the tailwater recycling system is reduced due to the reduced tailwater volume.

A worked example for Pipe Through the Bank (PTB) layouts

This example shows the impact spacing inlets too far apart in a PTB layout, and quantifies the benefits of incorporating TWB. All bays are supplied with 50ML/day flow, have 1000m furrow length and soil water deficit is 60mm. Scenarios are extrapolated across a 400ha farm.

Result:

Increased run times with insufficient flow:
Increasing inlet spacing from 144m to 176m with same flow rate reduces irrigation advance rate from 49 ha/day to 42 ha/day. For a 400ha farm the whole farm irrigation time is extended from 8.2 days to 9.5 days and the total water delivery is increased from 411ML to 473ML. The extended runtime increases tailwater from 41% to 49% and is likely to increase deep drainage losses.

Inlet spacing and tailwater backup have a significant impact on whole-farm irrigation efficiency.

Benefit of tailwater backup: In Scenario C, when tailwater backup is included in the design of a PTB system, the tailwater volume decreases from 5.94 ML to 1.78 ML, and the irrigation run time is shortened to 5 hours. The irrigation will advance at a rate of 69 ha/day compared to 49ha/ day. An irrigation cycle on a 400ha farm will be completed in 5.8 days with a total of 289ML of water delivered.

Where to from here?

Inlet spacing and tailwater backup have a significant impact on whole-farm irrigation efficiency. Getting these decisions right at the design stage is critical to maximising the return on your siphonless investment. See the Siphonless Irrigation Factsheet Series for more information on successful siphonless planning and development.

Scenario A: PTB with adequate flow
Supply of 50 ML/day to a 144m wide section (14.4 ha), with run time of 7 hours.

Scenario B: PTB with inlet spacing too far apart and insufficient flow
The same 50ML/day supply across 176m wide section (17.6ha). bay is 22% wider. If uniformity is unchanged the irrigation time would be 8.55 hr, but the reduction in even flow rates between furrows would add another 1.5 hours. Total run time is 10 hours.

Scenario C: Pipes with Tailwater Backup
Supply of 50ML/day to a 144m wide section (14.4 ha) with tail water back up. The back up of tailwater reduces the run time from 7 to 5 hours.

	Section Width (m)	Bay size (ha)	Run time (Hrs)	Profile Refill (deficit x area) (ML)	Applied volume (run time/24 x flow) (ML)	Tailwater Volume (applied volume-profile refill) (ML)	Advance rate (24hr / run time x bay size) (ha/day)	Farm irrigation time (400ha / advance rate) (days)	Farm water delivery (50ML/day x farm irrigation time) (ML)
A	144	14.4	7	8.64	14.58	5.94 **(41%)**	49	8.2	411
B	176	17.6	10	10.56	20.83	10.27 **(49%)**	42	9.5	473
C	144	14.4	5	8.64	10.42	1.78 **(17%)**	69	5.8	289

Table 1: A Worked example for PTB layouts on inlet spacing and advantages of tailwater backup

Footnotes

[1] Small PTBs still require two-meter rotobucks. Whilst offering labour saving benefits, they retain most similarities to manual hand siphon systems and therefore are excluded from general siphonless system comparisons in this guide.

[2] Siphonless irrigation guide. Smarter Irrigation for Profit, 2019.

[3] Grower Case Study 'Norwood' Moree. CottonInfo, 2024.

[4] Siphonless irrigation guide. Smarter Irrigation for Profit, 2019.

[5] Siphonless irrigation guide. Smarter Irrigation for Profit, 2019.

[6] Siphonless irrigation guide. Smarter Irrigation for Profit, 2019.

[7] Irrigation systems, designs and scheduling options. GVIA. 2022.

[8] Grower Case Study 'Norwood' Moree. CottonInfo, 2024.

[9] Bankless channels- Bullamon Plains. More Profit Per Drop. 2011.

[10] WATERpak a guide for irrigation management in cotton and grain farming systems. CRDC. 2012.

ACKNOWLEDGEMENTS:

This content is part of a series developed by Syntiro Ag with funding from the Cotton Research and Development Corporation.
The authors gratefully acknowledge the irrigation consultants, cotton growers, and industry representatives who shared their experience and insights on siphonless irrigation systems and smart irrigation technologies. Thanks to Michael Naylor, Darrell Fiddler, Lou Gall, Michael Scobie & Cathy Phelps for their contributions. Their practical knowledge has been invaluable in developing this resource.
Special thanks to the irrigation technology suppliers who participated in the self-assessment process and provided technical information about their systems and services.

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.

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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.

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