Subsurface Drainage Project

Hosts: Preston Family and Allison Family

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KEY MESSAGES

- Despite a challenging season, the yield gain from implementing sub-surface drainage equated to a 1 tonne/ha yield benefit.
- Subsoil drainage is a waterlogging solution that requires substantial upfront investment from growers, with estimated fully "installed" costs around $13,500/km*.

Background:

Waterlogging is a common problem within the southwest region of Western Australia (WA), particularly in the wetter months of winter and typically occurs when rainfall exceeds the ability for soils to drain away soil moisture. Under these conditions, the excess water within the root zone creates anaerobic conditions (conditions without free oxygen) and prevents the plant from performing gaseous exchange with the atmosphere or biological activities with the oxygen in the soil, air & water (DPIRD 2019). Left unmanaged, waterlogging can lead to soil structural decline and has the potential to create nutrient deficiencies & toxicities (such as Iron & Manganese toxicity), create root death/reduced plant growth, or result in the death of the plant (DPIRD 2019).

Overall, it has been estimated that approximately 3 million hectares of land within the southwest agricultural region of WA has moderate to very-high susceptibility to waterlogging or inundation, which represented an estimated annual opportunity cost of $35m between 2009/10 to 2013/14 (DPIRD 2019).

There are methods available that farming operations can utilise to minimise and mitigate against the effects of waterlogging, including the use of either surface water management or subsurface water management methods. Surface drainage/management options available to growers include options such as raised beds, evaporation basins, & interceptor drains, while subsurface options include slotted pipe, mole drains & pumping options.

Preston Drainage Site - Methodology

In January 2021, Stirlings to Coast Farmers collected elevation data for the Preston drainage trial paddock utilising high-accuracy RTK GPS equipment. This data was collected in 12 metre swaths and processed through a mapping platform to create elevation maps, contour maps (in 5cm, 10cm, 20cm & 50cm contours), watershed, flow-direction, streamflow, and accumulation (ponding) maps. In conjunction with the 2020 harvest yield maps, this data was utilised to help plan drainage designs focused on managing accumulated ponding and intercepting water movement.

February 2021 saw the installation process begin at the Preston Family Farm with the sub-surface drainage contractors – Drainage Downunder – laying the pipework. The process involved trenching a path before burying the slotted pipe at depth, laying a limestone rubble on top of the pipe, before covering the pipe/rubble with soil. The slotted pipe installed is bare (without a sock), 100mm wide, ribbed, with incisions throughout the whole length. Installed depths varied across the demonstration sites, with buried depths ranging from 500mm below the soil surface through to depths of approximately 1200mm. Pipework was laid to ensure that there was sufficient fall for the water to drain to the waterway located at the southern edges of the drainage site (Figure 1). A control region was left adjacent to the eastern side of the drained trial plots, to be utilised as a comparison point against the drained region. This part of the paddock (control) also has a medium-high risk of susceptibility to waterlogging.

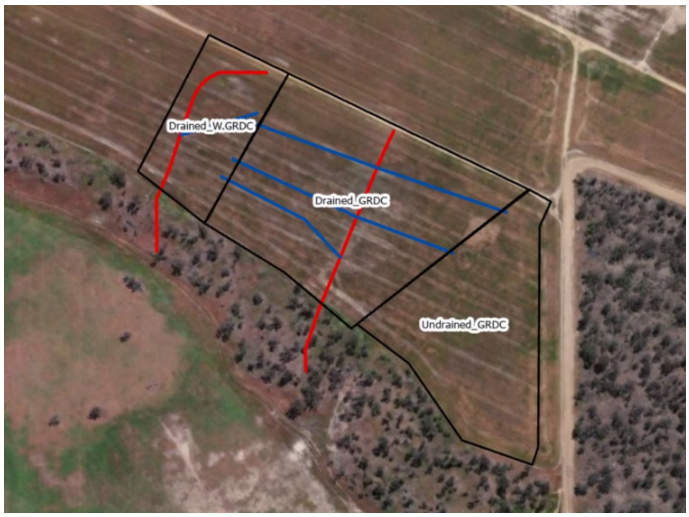

Figure 1: Preston Drainage Site trial layout, comprising buried 100mm wide slotted pipework.

The paddock was sown to Flinders barley on the 11th May 2021 at 100kg/ha into exceptional soil moisture, with some regions of the paddock inaccessible to vehicles without getting bogged. Throughout the year, we monitored differences in plant biomass (NDVI) and yield in lieu of plant and nutritional measurements.

Preston Farms Results & Discussion:

2021 was a well above average year for rainfall across the membership zone. It was also the first year for our installed pipework at the Preston GRDC and SCF Sub Surface Drainage Site, located approximately 100km North-West of Albany. With nearly 750mm of rain falling throughout the year and approximately 530mm of that amount falling within the growing season, it was well above the yearly rainfall average of 480mm. Rainfall data was collected by the on-site weather station and was plotted against the local average [Silo Rainfall] data for the previous 20 years. Overall, it ended up being a 99-percentile year at the drainage site (Figure 2).

Throughout the early growth stages the barley crop was underwater for a considerable amount of time, which led to some challenges in managing in-season weed control and plant nutrition (Figures 3 & 4). There were also noticeable differences in trafficability across the drained and undrained regions of the trial, with the drained regions remaining more trafficable for significantly longer than what was experienced in the control/undrained regions of the paddock.

Following seasonal NDVI values throughout the 2021 growing season, we found that higher NDVI values were observed along where the drainage lines were installed, as represented in the southern green regions of Figure 5. These regions, when assessed at tillering, also had up to 30% more tillers overall in the drained region in sections compared to that observed in the control region. Overall, the control region laying to the south-eastern edge of the paddock tracked lower in NDVI values throughout the whole growing season.

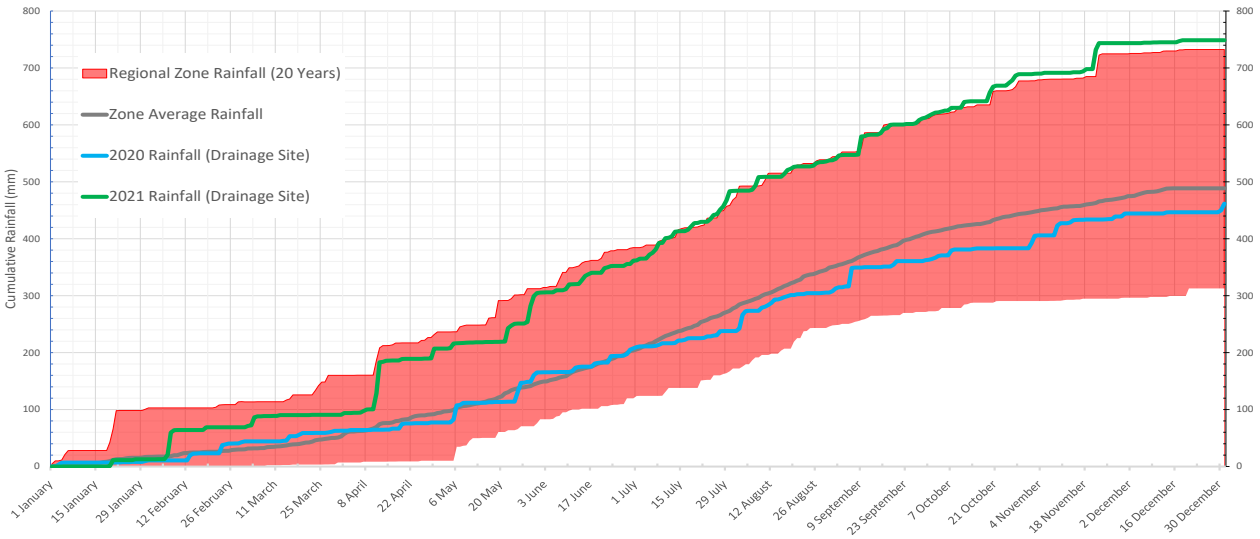

Figure 2: Site rainfall data for 2020 (blue), and 2021 (green), against regional local average range (red).

* Pricing is dependent upon a wide range of factors including rubble costs, purchasing and size of pipe utilised, size of drainage application, mobilisation costs, ground conditions & soil-types, and equipment availability. Please contact drainage contractor.

Figure 3: Waterlogging throughout the growing season, top - 1st June 2021, bottom - 7th July 2021.

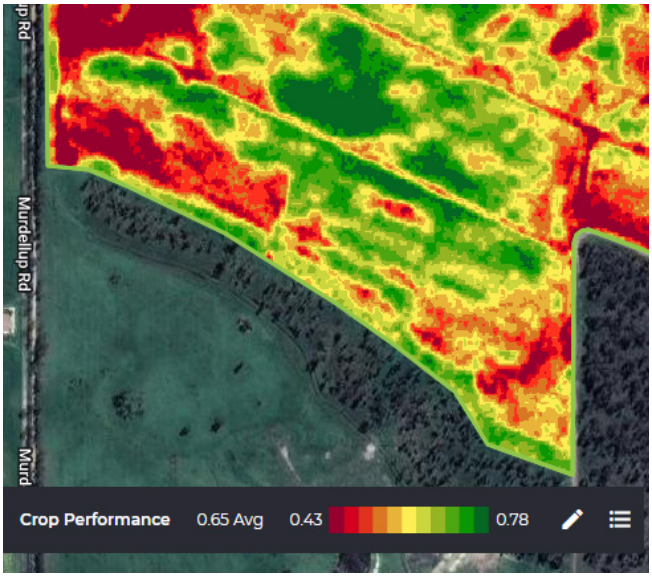

Figure 4: NDVI imagery collected on 12th August 2021 outlining higher biomass on the southern edge of the paddock, where the drainage lines have been installed.

In mid-December 2021, the paddock was harvested by the Preston family. Overall, yields were approximately 1 t/ha higher in the drained regions (3.2 – 3.29t/ha) compared to the control treatment (2.21 t/ha) in a 99-per-centile year. Two additional areas were also assessed at harvest, dubbed the "control controls". That is, where there is no drainage installed and where it is unlikely to suffer from waterlogging. These areas across medium and high-performing soil landscapes represent what the maximum potential yield might be, should an area not express the yield penalty effects from waterlogging. When we compare the drained GRDC trial regions against the medium-performing control "control", we see that there is a potential yield opportunity of an extra 410-500kg of yield per hectare, should waterlogging be effectively managed. Should the drained soil type be more reflective of a high-performing soil, then a potential yield opportunity of up to an additional 2.8t/ha is available.

2021 was an interesting first year to host the subsurface drainage trial, and it certainly left SCF staff with quite a few questions regarding nutrient management in paddocks so wet you could not physically walk on, and as to whether there was sufficient pipework installed to be reflective in the capability of managing such high rainfall

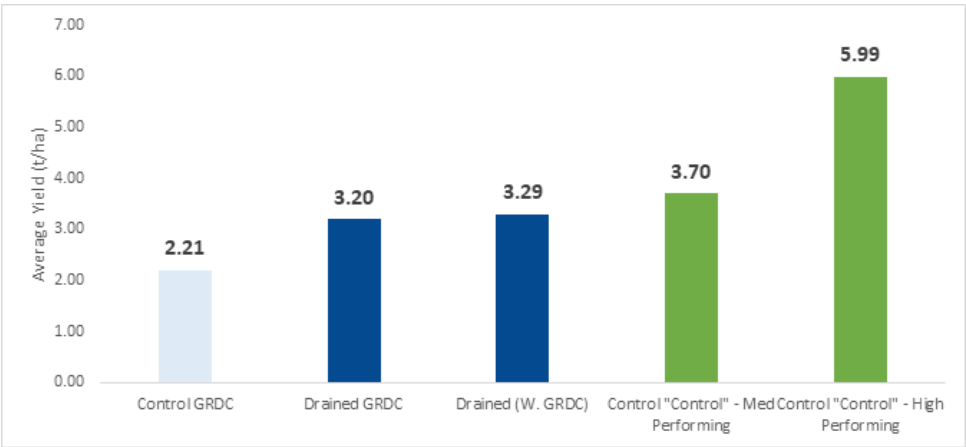

Figure 5: Final grain yields (t/ha) recorded at the Preston family sub-soil drainage site in 2021.

intensity seasons. Overall, we saw a positive yield benefit through the implementation of subsurface drainage in an outlier season. The question remains whether these yield differences between the drained and undrained will be evident in upcoming seasons across a wide range of seasonal conditions.

With installation costs in the order of approximately $13,500 per kilometre*, getting the installation locations of pipework perfected will be critical to ensure that the economic efficiency of subsurface drainage is maximised. Some back of envelope calculations for the remaining regions of the paddock currently estimate that there is the potential for a payback period of approximately 3.8 years to occur, pending similar grain pricing and yield differences as in 2021.

Amerillup Pastoral Company – Second demonstration site commencing 2022

In 2022, Stirlings to Coast Farmers successfully applied for a second demonstration site, which was installed at the Allison family farm, located in Perillup, west of Mount Barker. With mapping activities conducted in early January 2022, installation of the initial sub-surface drainage work was implemented in late January and early February. Previously sown to barley in 2021, this paddock will be sown to canola in mid-April, with field measurements conducted throughout 2022 and 2023. Stay tuned to follow the progress of the Perillup drainage site and its learnings over the next two growing seasons.

Figure 6: Subsurface drainage installation layout for the Allison family drainage trials.

Reference: DPIRD. 2019. "Waterlogging: The Science." Department of Primary Industries & Regional Development,. Last Modified 29 May 2019. Accessed 10 January 2020. https://www.agric.wa.gov.au/waterlogging/waterlogging-western-australia.

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