EVALUATION OF DIFFERENT METHODOLOGIES TO MANAGE SOIL EROSION.

Research Topic 1: **Site Selection Layout and Drainage**

Research Topic 5: **Management Erosion and Sedimentation**

Trial number: SA01WB-02 and SA05WB-02

CONTENTS

INTRODUCTION

The pineapple industry is located in the coastal areas across Queensland for its warm climate, well-drained soils and limited exposure to cold winters and frost. There are a number of risks associated to these coastal regions due to their close proximity to sensitive environmental areas such as the Great Barrier Reef and Moreton Bay Marine Park. These coastal areas are renowned for their tropical climates with high annual rainfalls and predominantly sandy loam soils which are more prone to erosion.

The key issues of concern is off-farm deposition of sediment, pesticide and nutrient. Sediment is the key component which has been identified as a primary element impacting aquatic species and their habitats. Sediment deposited onto reefs can smother corals and interfere with their ability to feed, grow, and reproduce. Sediment can also act as a carrier for pesticide such as Diuron. Pesticides such as Diuron directly kill marine vegetation such as sea grasses which are the fundamental parts of the food chain. Excessive nutrient such as nitrogen can give rise to vegetative species that have a negative impact in aquatic environments such as blue green algae. It is important for pineapple farmers to manage the movement of soil and water across the farm and to capture and treat run off.

This demonstration focuses on fundamental soil erosion management strategies to mitigate soil loss infield and outfield with focus on block layout and drain stabilisation.

HYPOTHESIS

Block layouts and drain stabilisation products which slow water velocity, manage water flow and protect the soil surface will reduce soil erosion and better capture sediment on the farm.

OBJECTIVE

To quantify the amount of soil erosion using different block layouts and observe different erosion preventative strategies to manage surface water flow and mitigate off-farm sediment deposition in outfield areas across the farm.

METHOD

Location and grower

Littabella Pines Pty Ltd located on South Littabella Road, Yandaran north of Bundaberg was chosen as a project collaborator for their close proximity to Littabella Creek which flows approximately 8 km before reaching the ocean and the Great Barrier Reef marine park.

The farm owners and principal collaborators are John and Linda Steemson. The Steemson family have been growing sugar cane, pineapples and other small crops for many years in the Yandaran area and are the first pineapple operation to be reef certified in the Growcom Hort360 program.

The demonstration site is the first collaborative partnership led by the Pineapple Environmental Team (PET) with Growcom, Department of Agriculture and Fisheries (DAF), Burnett Mary Regional Group (BMRG) and Australian Pineapples (AP). This is part of a greater research site with numerous other demonstration trials.

DATES

Demonstration activities were undertaken as follows:

- May 2019 - site selected, land prepared for planting and pre-plant pesticide and nutrition applied.
- June 2019 - bed-formed, planted and phase one demonstrations applied.
- Oct 2019 – phase two treatments installed.
- Feb 2020 - assessment undertaken phase 1 and observations phase 2.
- October 2020 - assessment undertaken phase 1 and observations phase 2.
- June 2021 - assessment undertaken phase 1 and observations phase 2.
- Jan 2022 - assessment undertaken phase 1 and observations phase 2.
- Apr 2022 – plant crop harvest completed.

CROP DETAILS

The total demonstration site is 3.5 ha consisting three different block layouts draining directly into three outfield drains. The total site was planted with smooth cayenne on a sandy loam soil type to a depth of 0.3 to 0.4 m with a heavy clay subsoil. The site is a westerly facing aspect with a varying 0.5 to 1.5% slope.

Figure 1: trial site - prior to treatments

DESCRIPTION

Phase one

The demonstration consisted traditional industry standard bed geometries on 1.5 metre bed centres, 0.3 metre bed heights and two rows of pineapple planted 0.5 metres apart. The three treatments were laid out in following ways:

Treatment 1A - beds planted up and over slopes with no contour banks or drains (standard practice),

Treatment 1B– beds planted with the contours on a 1-2% slope, and

Treatment 1C – beds planted down slope with contour drains / banks located across the 1-2% slope.

Treatment 1A (standard) Treatment 1B Treatment 1C

Figure 2: phase one treatments.

Phase two

The demonstration consisted a comparison of traditional industry standard drain constructed directly down the slope, stabilised drain utilising geofabric and gabian basket levy banks and jute mesh with planted vegetation. The three drains were constructed in following ways:

Treatment 2A consisted industry standard practices planted downslope with no coverage or stabilisation of the drain. A reinforced silt trap at the bottom of the drain was constructed to capture sediment.

Treatment 2B consisted an open drain stabilised by geofabric, segregated by three gabian basket levy banks with a silt trap located at the bottom.

Treatment 2C consisted an open drain stabilised by jute mesh as a ground cover then planted with a vegetative crop of sorghum. The drain then emptied into a sediment pond at the bottom.

Treatment 1A (standard) Treatment 1B Treatment 1C

Figure 3: phase two treatments.

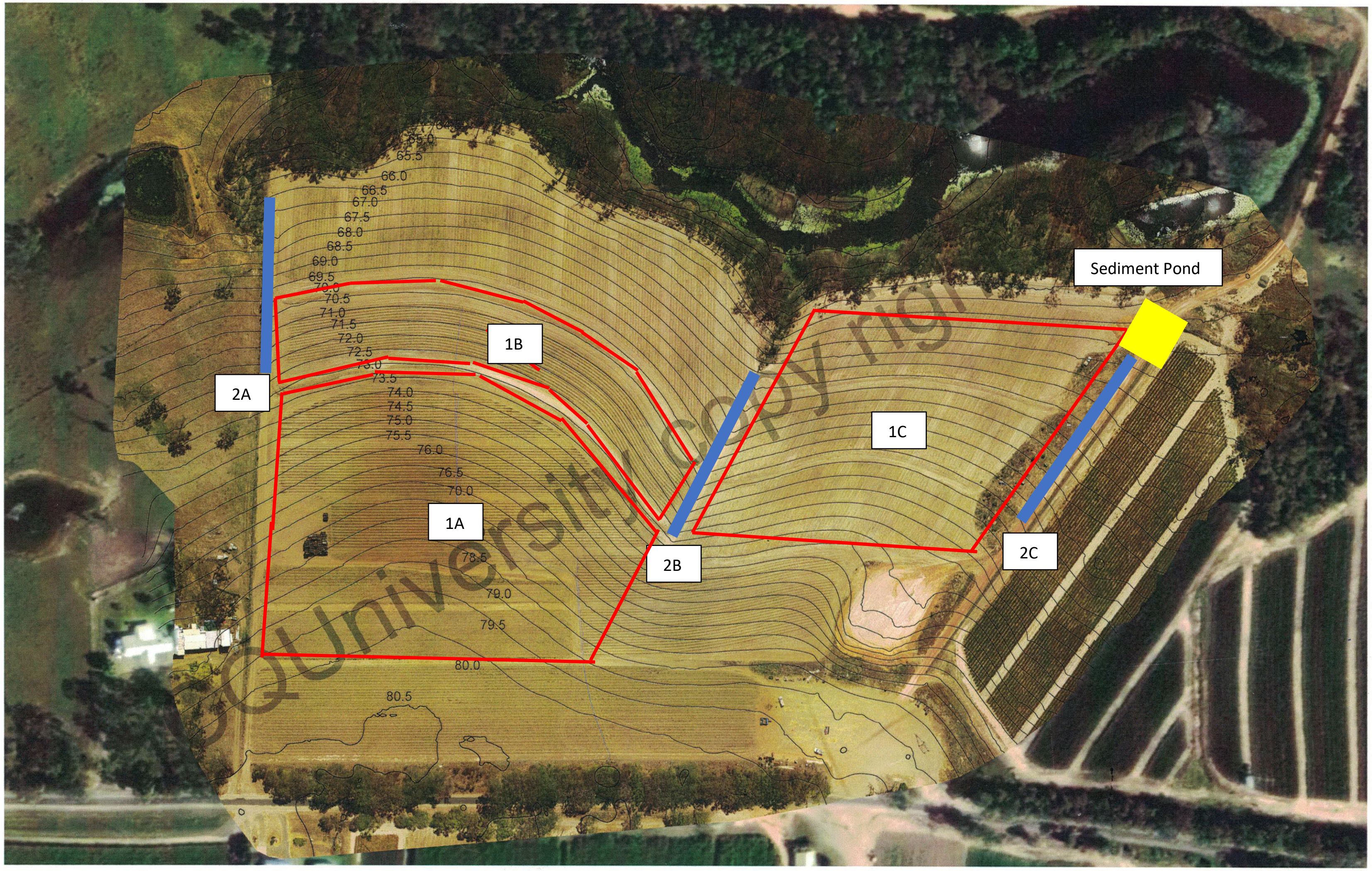

Figure 4: Contour map of trial location (image courtesy of Central Queensland University).

RESULTS

Phase One

Soil erosion levels were measured using metal troughs buried at the edge of the pineapple fields in each treatment. Two metres of plastic sheeting were laid on the surface of the ground and seed beds leading into the troughs. The plastic sheeting allowed unobstructed flow of water and sediment directly into the troughs. The troughs captured water at each rainfall event and once the water had evaporated the sediment remained in the trough.

Weather conditions throughout the demonstration were periods of prolonged drought from April to October and monsoonal rainfall from November to March. The Bundaberg region received only 30% of its annual rainfall in 2019 to late 2021. From November 2021 to Spring 2022 the weather transitioned from the dry El Nino conditions to tropical La Nina with heavy rainfall and minor flooding.

The following results is cumulative soil erosion measured in equivalent tonnes per hectare up to plant crop harvest:

Table 1: Phase one soil erosion results

Treatment	Soil Loss
1A - Standard	111
1B - Contour planting	44
1C - Contour Bank	71

Key Points:

- Significantly high amounts of soil erosion in the standard practices, lowest soil erosion in pineapples planted along the 1% contour and moderate soil erosion in pineapples planted down slope with contour drains / banks across the block.

- The block planted down slope with contour drains / banks sediment has captured the majority of soil erosion within the contour banks / drains.

- Clear, visible signs of waterlogging were observed in the treatment with pineapples planted along the 1% contour with potential for phytophthora root rot. However, this may assist those pineapples in the dry conditions.

Figure 5: Treatment 1A - high amounts of sediment collected in catchment troughs..

Figure 6: Treatment 1B - low amounts of sediment and evidence of water logging in field.

Figure 7: Treatment 1C – moderate amounts of sediment in catchment troughs.

Phase Two

Treatment 2A consisted industry standard practices with no coverage or stabilisation of the drain. Observations over the 12 month period indicated severe scouring has occurred 40 - 60cm down to the hard rock and clay layers within the soil profile. The drain has limited capacity to retain any sediment and will continue to scour further over future rainfall events. A reinforced silt trap at the bottom of the drain was constructed to capture sediment but has not had the capacity to retain all of the erosion coming off the catchment area. High levels of sediment have overflowed the silt trap and left the farm.

Figure 8: Treatment 2A - scouring within drain at 12 months (left). Drain one month after installation (right).

Treatment 2B consisted an open drain stabilised by Geofabric, segregated by three gabian basket levy banks with a silt trap located at the bottom. The catchment area emptying into this drain is from beds planted up and over slopes with no contour banks (standard practice). Within this treatment a high level of erosion from the catchment area has been contained by the gabian basket levy banks. The containment of the sediment has primarily occurred above each of the gabian basket levy banks which require continual maintenance.

Figure 9: Treatment 2B - Sediment captured behind levy bank (left). Sediment removed from primary drain (right).

Treatment 2C consisted an open drain stabilised by Jute Mesh as a ground cover then planted with a vegetative crop of sorghum. The drain then emptied into a sediment pond at the bottom. The catchment area emptying into this drain consisted beds planted down the hill with contour drains across the slope. Within this treatment moderate levels of sediment were captured in the drain, however a good volume of sediment over-flowed into the sediment pond moving around the planted vegetation.

Figure 10: Treatment 2C - eroded soil captured on jute mesh (left). Vegetated drain at 12 months (right).

DISCUSSION

Improving the quality of water flowing to the coastal wetlands and estuarine ecosystems are critical to enhancing their natural resilience and ability to recover from effects of off-farm sedimentation, and nutrient and pesticide loading. It is critical for pineapple farmers to play an active role in reducing impacts of farming practices on water quality. Implementing sustainable practices to reduce sediment, nutrient and pesticide entering waterways is important. Protecting the soil surface, controlling runoff and removing sediment from runoff water are fundamental keys to managing water quality (Haase, 2019).

Phase One

The industry standard layout performed the least of the three block layouts. Beds planted up and over slopes is most commonly used across the industry and primarily focuses on row direction aligned to a north-south orientation for uniform crop growth. It is a low cost layout but has limited ability to manage soil erosion. Using this type of block layout additional soil management practices are required such as planting or placing plants in the inter-row, use of soil stabilisers etc. These practices add substantial cost and have their limitations.

Beds planted along contours on a 1-2% slope are the most difficult to establish due to the complexity of forming beds across a slope to ensure the correct angles are achieved. This cannot be done with Global positioning systems (GPS). It is difficult to maintain bed uniformity with beds sloping or angled downhill due to the angle of machinery at bed forming. The potential for waterlogging is risk and will exacerbate phytophthora root rot and 'wet feet' if the slope is below 1-2%.

Beds planted down slope with contour drains / banks across the block on a 1-2% slope will capture the majority of soil eroded within the contour banks / drains. This type of layout allows growers to align beds to a north-south orientation for uniform crop growth. This layout is simple to construct and cost-effective. The contour banks and drains are formed using grading equipment most commonly found on farm. The contour banks and drains are the width of this equipment and can be used to cost effectively clean and remove silt at any point throughout the cross cycle. This is often a limiting factor in smaller drains that require high manual labour and cost. The shape of the contour drains are wide and flat which disperses run-off water and minimises erosion. The contour banks stop run-off water moving from higher sections of the block into lower sections inhibiting accumulated water flow and build-up of sedimentation in the lower parts of the blocks.

Phase Two

Treatment 2A - Standard industry drain

The industry standard drain performed the least of the three drain designs. Maintenance requirements were substantially high due to the constant erosion and resultant scouring. These types of drains will further erode wider and deeper with continued rainfall events. In some areas where water consolidated, sediment would fill the drain reducing the overall functionality. The simplicity and low cost of construction was an advantage however the lack of surface stabilisation provided no protection against erosive damage from runoff water. The potential for major farm disruptions and crop damage during substantial rainfall events created a high risk (Griffin, 2019).

Treatment 2B – Gabian basket levy banks and geofabric for soil stabilisation
Drains constructed with gabian basket levy banks and geofabric for soil stabilisation gave the best reductions in sediment losses off farm. The success of this type of drain was the gabian basket levy banks which acted as a barrier to slow water as it moved down gradient but not significantly limit water from exiting the block. It is critical the strategic placement of levy banks is needed to maximise the drain effectiveness. These drains were most effective at capturing large volumes of sediment in high rainfall events however consisted high cost, elaborate construction and were labour intensive. Extra care was needed when cleaning out sediment traps due to geofabric lining, making the process more time consuming. The concept can be modified and simplified to reduce costs and labour (e.g. gabion basket weirs replaced with rock strips) (Griffin, 2019).

Treatment 2C – Jute mesh and vegetative planting for soil stabilisation
Drains constructed with jute mesh and vegetative planting for soil stabilisation is a simple, low cost construction process. Reductions in sediment loss off farm using vegetative coverage is very successful. However, earthmoving equipment is required to sculpt drain and labour to lay the jute mesh lining. The jute mesh has a limited lifespan of approximately 12 months. Soil stabilisation with vegetation takes time to grow before it can be effective for erosion control. It is important to understand soil and seed loss can occur before vegetation can establishment. Vegetative drains can harbour weeds, be a vector for pests and disease and may require management to avoid potential flow concentrations. Jute mesh lining alone would also be effective for short term erosion control. Other materials (e.g. carpet) can be used in place to assist soil stabilisation and vegetation establishment (Griffin, 2019).

ADOPTION AND IMPACT

Pineapple production systems in Queensland have a legacy of soil erosion and sediment loss issues which have led to land degradation and contributed to water quality decline of stream and river networks adjacent to cropping areas. This is primarily a function of susceptible soil types and intensive crop management practices which are prone to erosion. Previous research and industry development in this area has delivered a range of options and strategies for use in controlling soil erosion and sediment losses. These have struggled to be realised and implemented by growers who consistently aim to maintain cost competitive practices which result in optimal fruit tonnage and yield. Sustainable land management practices which have potential to manage soil erosion, but do not limit crop yield and are economically viable are critical to grower adoption (Haase, 2019).

The different bed layouts and drain options in this demonstration have varying applications and different costs depending the individual farming situation. While these options proved to be effective, there are differences in certain aspects of their construction, ongoing performance and maintenance which make them more suited to different circumstances dependant on a range of factors. While these systems have proven to be effective, there should *not* be a sole reliance on individual practices to reduce off-farm sedimentation. Each farm needs to develop a number of soil management strategies to reduce sediment losses in-field at the source of erosion and out-field before leaving the farm (Haase, 2019).

CONCLUSIONS

It is important the pineapple industry continues to play an active role in reducing impacts of farming practices on water quality. Sustainable farming practices are critical is reducing sediment, excess nutrients and chemicals moving off-farm and into local waterways. This demonstration has highlighted simple refinements to current practices to manage soil erosion more effectively. With greater emphasis on sustaining the Great Barrier Reef and Moreton Bay Marine Park is critical for industry to continue farming in these catchments now and into the future.

REFERENCES

GRIFFIN, L. (2019) Department of Agriculture and Fisheries – *Case Study: Erosion and sediment control options for pineapple production systems.*

HAASE, M. (2019) Growcom – *Case Study: Erosion and sediment control options for pineapple production systems.*

ACKNOWLEDGEMENTS

Pineapple Environmental Team (PET) – Organising the collaboration of key stakeholders and overall planning of the demonstration site.

Littabella Pines (John and Linda Steemson) – Commercial pineapple production farm in Yandaran able to provide site for trial of in-field and edge of field soil and sediment loss control options.

Burnett Mary Regional Group (BMRG) – Providing technical and networking support for implemented trials on practice change for improved reef water quality outcomes.

Department of Agriculture and Fisheries (DAF) – Delivering on-site measurement and monitoring of practice change treatments implemented.

Growcom – Delivering industry communication support and BMP assessment via Hort 360.

Central Queensland University (CQU) – Provision to capture and process geospatial drone imagery.