EVALUATE VARIOUS FARM PLANNING TECHNOLOGIES AND METHODS TO SUPPORT GROWERS IMPROVE THEIR FARM LAYOUT AND DESIGN

Research Topic 1: Site Selection Layout and Drainage

Trial number: SA01SEQ-01

CONTENTS

INTRODUCTION

Farm planning is a decision-making process which involves the organisation and management of limited resources to realise specific business goals. Farm planning involves selecting the most profitable course of action from amongst all possible alternatives.

The ultimate objective of farm planning is to maximize the net income of the farmer through improved resource use. Farm planning helps the farmer examine existing resources, compare past experiences and identify the various needs for the operation. A farm plan is a programme of total farm activities. An optimum farm plan will satisfy all the resource constraints at the farm level and yield the maximum profit. A good farm plan has flexibility to account for changes in the environment.

This demonstration will evaluate a number of technologies and methods available to improve the farm planning process and support the layout, design and location of farm blocks and infrastructure such as drains, bioreactors, etc.

HYPOTHESIS

Various farm planning technologies will enable growers to undertake better farm layouts to improve management of soil erosion, drainage and crop agronomy.

OBJECTIVE

Demonstrate various technologies to help growers make better on-farm decisions in their farm planning process.

Evaluate the outcomes of using this technology to reduce soil erosion through better location of drains and other infrastructure.

METHOD

Location and grower

The soil erosion and electromagnetic (EM) survey components of this demonstration was undertaken in collaboration with Piñata Farms located in Wamuran, South East Queensland. The farm owners Stephen and Gavin Scurr and their family have been growing and packing pineapples and other crops in the area for eighty years.

The LiDAR component of this demonstration was undertaken in collaboration with Sandy Creek Pineapple Company located in Glasshouse Mountains, South East Queensland. The farm owner and manager Sam Pike and his family have been growing and packing pineapples and other crops in the area for over one hundred years.

USE OF SATELLITE AND DRONE IMAGES

Dates

Phase One

- February 2019 - Grower identified, site selected, and trial planned.
- March 2019 - block cultivated, pre-plant pesticide and nutrition applied.
- April 2019 – infrastructure located and built, field bed-formed, site planted, and treatments applied.
- October 2019 - erosion data collected and assessed.
- April 2020 - erosion data collected and assessed.

Crop details

The trial site has followed a previous crop of 73-50 hybrid which was taken to plant crop harvest only due to poor health. The previous crop harvested below industry standards in Spring 2018 with major issues of Phytophthora root rot, nematode, black beetle/white grub, and natural flowering.

The site had a red sandy loam soil which was prepared to standard industry conditions with good soil tilth, no crop residue and good soil moisture with a soil pH of 4.3. The average slopes of the block are 2 - 3%. The block was grown using industry standard production practices.

Figure 1: Trial location prior to contour draining (left) and soil opened up to assist drying out (right).

Description

For the duration of the trial the site was under 'drought like' conditions, receiving well below average annual rainfall. Historically the site had experienced major problems with soil erosion. The grower was keen to implement cross-drains but required better information to identify the best locations for these to minimise soil erosion.

The farm planning process began with a **satellite image** supplied to the grower. The satellite image of the farm assisted the grower to roughly locate the position of contour drains, large primary drains, bioreactor and silt traps. An **in-field** survey was conducted using traditional survey equipment (a level and staff). The infield survey was able to identify variations in slope enabling the grower to determine the distance down slope to identify the locations of the contour drains. This was undertaken within each block. Once the contour drains were located across the blocks, the pathway of each contour drain was mapped out on a one percent gradient. Silt traps and bioreactors were then located in the areas where the contour drains consolidated the surface water flow.

The location and construction of the contour drains were identified as the treatment within this demonstration. Within the treatment, monitoring and evaluation of soil erosion was undertaken at 'edge of field' (sample Point 1A), within the contour drains (sample Point 2A) and within the silt traps (sample Point 3A). A bioreactor was located and constructed under the advice of the Queensland Department of Agriculture and Fisheries (DAF). The bioreactor was a 'bed' bioreactor and had a width of three metres and a length of thirty metres. DAF field officers had installed several bioreactors across Queensland.

The 'Standard practice' had no contour banks and was left as it had been farmed previously.

Monitoring and evaluation of soil erosion for the standard treatment was located at: 'edge of field' (sample Point 1B) and at the silt traps (sample point 3B).

Figure 2: Satellite image of the Pates Road farm located in Wamuran. (Yellow lines indicate the planned position of the contour banks).

Figure 3: Satellite image of the Pates Road farm after construction of contour drains.

ELECTROMAGNETIC SCANNING OF FIELD

Integration of other farm planning technologies and methods

The integration of other farm planning technologies into a pineapple production system e.g. soil electromagnetic (EM) scanning and satellite imagery would be useful for growers to locate farm infrastructure such as drains, silt traps, bioreactors, etc.

Electromagnetic induction (EM)

Electromagnetic induction (EM) is used to characterise the spatial variability of soil properties to assess soil salinity, soil types, soil water content and flow patterns, assessing variations in soil texture, compaction, organic matter content, soil pH and determining the depth to subsurface horizons, stratigraphic layers or bedrock.

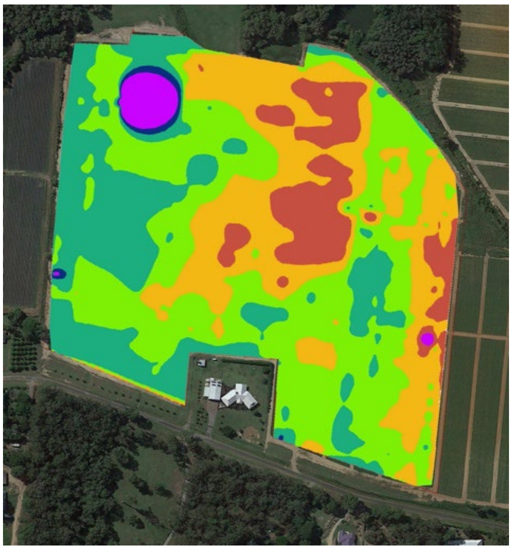

Figure 4: Electromagnetic (EM) image of a Piñata pineapple farm in South East Queensland.

The Electromagnetic (EM) map of a pineapple field belonging to Piñata Farms in South East Queensland (Figure 4) indicates variations of soil moisture due to differences in soil type. Although the grower does not have variable rate application equipment, using the information contained in the map he was able to manage the tillage operations and pre-plant pest and disease applications differently based on different shaded areas on the map. In the light and darker green areas on the map, soil moisture was higher therefore attracting more intensive deep tillage operations such as deep ripping and disease control by lowering soil pH. The purple areas on the map, indicated natural springs seeping to the surface from the water table. Here the grower will look at more longer-term measures such as underground drains to alleviate accumulated water.

The electromagnetic maps were created by DataFarming based in Toowoomba. DataFarming electromagnetic scanners measure variations in the soil using a non-contact machine to a depth of 0.50 m and 1.2 m in the soil profile. Ideally, growers can combine electromagnetic maps with soil nutritional analysis data. This information can enable variable rate soil applications such as injection at planting (see injection at planting demonstration brief).

The electromagnetic unit easily installs behind vehicles (on the towball hitch) and automatically logs data when moving around paddocks and displays in the cab in real time (see images below). The data is then processed by DataFarming.

This technology would be useful for example for growers in Yeppoon to map and quantify the severity of salinity across their farms. Farmers can hire the unit for $4/ha. DataFarming can also provide digital platforms to integrate satellite imagery of the crop into variable rate machinery operations for pre- and post-plant foliar fertiliser and pesticide applications.

Figure 5: Electromagnetic (EM) unit used to scan the soil (left and right).

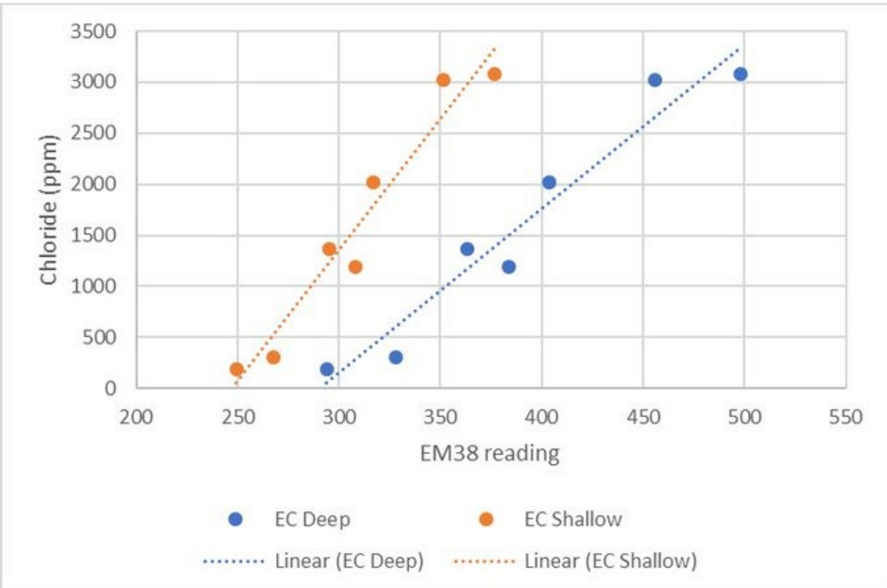

Figure 6: Electromagnetic (EM) readings of chloride salts at various depths and concentrations.

WATER FLOW ACCUMULATION MAP

<u>Water flow accumulation from satellite imagery</u>

Flow accumulation is an essential data set for many hydrological and topographic analyses such as watershed delineation. The water flow accumulation map performs a cumulative count of the number of pixels that naturally drain into outlets. The operation can be used to find the drainage pattern of a landscape and show the movement of water from one location to another.

Figure 7: Water flow accumulation map of a pineapple farm in South East Queensland.

A flow accumulation map constructed from a LIDAR survey technology indicates the consolidation and movement of water across the surface layers of the soil profile. Using the information contained in the map a pineapple grower in South East Queensland was able to identify the consolidation of water across the soil surface and the degree by which water moved across the farm. This information enabled him to determine the best direction of the blocks, location of drains, silt traps and bioreactors and to determine the requirement for any 'land levelling' operations to eliminate low spots not visually evident. The water flow accumulation and many other maps are generated from satellite imagery supplied by the Queensland Department of Environment and Science using external contractors and supplied through the Growcom South East Queensland Water Quality project. This information and service is free for growers to access. For further information or access to the maps please contact Growcom South East Queensland Water Quality project officers (see Growcom website – www.growcom.com.au).

RESULTS

This demonstration looked at various technologies to support growers make better on-farm decisions in their farm planning process including better location of drains, contour banks and other infrastructure.

<u>Soil erosion component of demonstration</u>

From satellite imagery supplied to the grower, an in-field survey was undertaken to strategically locate contour banks, silt traps and a bioreactor across the farm. The infield survey was able to identify variations and slope enabling the grower to determine the distance down the slope to identify the locations of the contour drains. This was undertaken within each block. Once the general area of the contour drain was located across the blocks, the pathway of each contour drain was mapped out on a one percent gradient. Silt traps and bioreactors were then located in the areas where the contour drains consolidated the surface water flow.

The results indicated the locations of the contour drains were successful in mitigating soil erosion and off-farm deposition of soil. After the first 20mm of rainfall, the contour drains and silt traps reduced soil movement and erosion by up to three times compared to standard practice (see figures 8, 9 and 10).

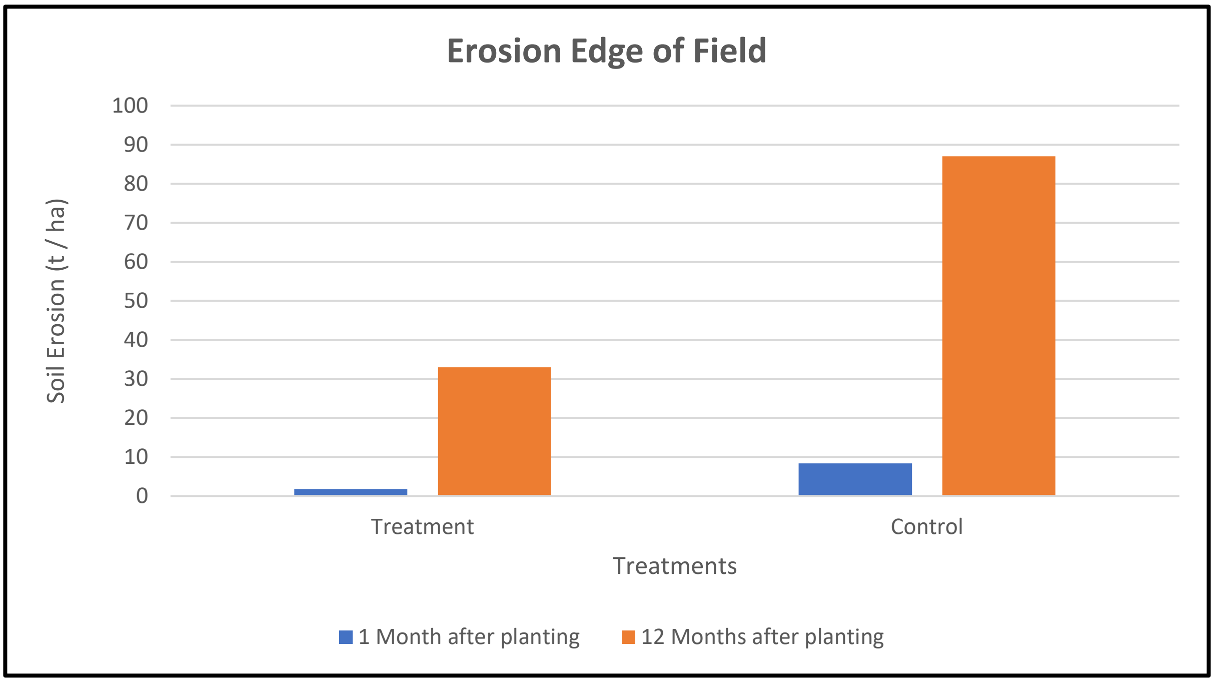

Figure 8: Soil erosion – edge of field (see Figure 2 - 1A and 1B).

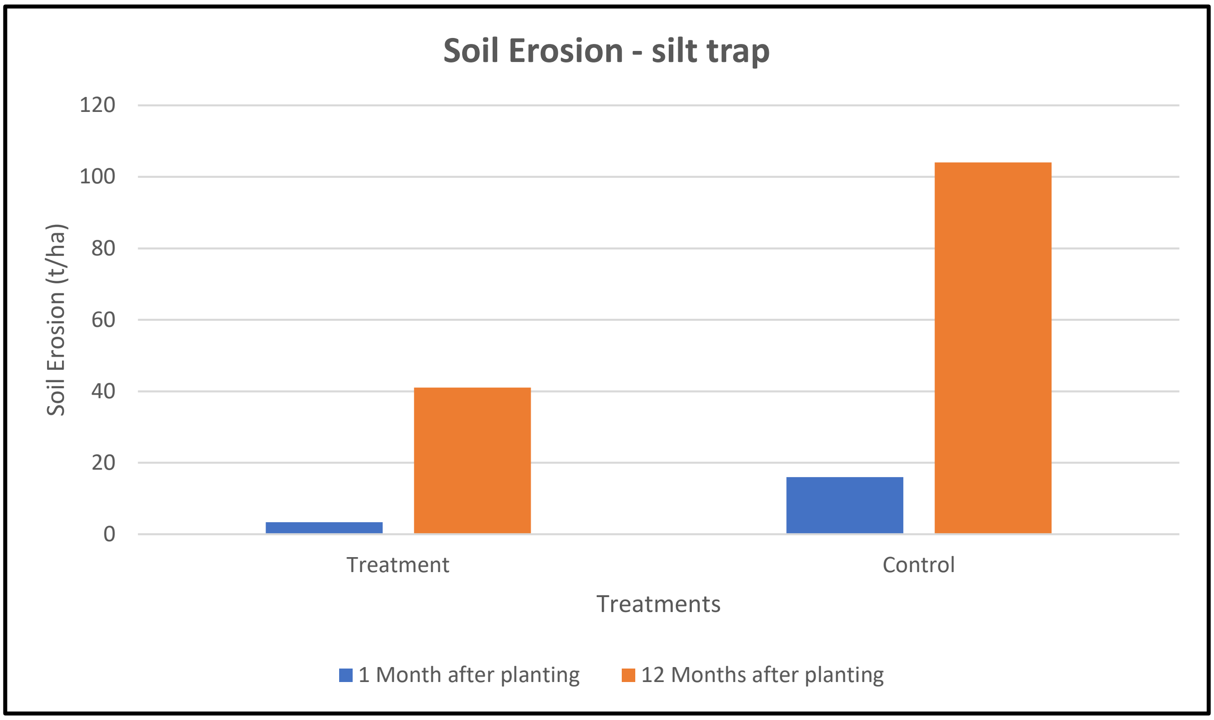

Figure 9: Soil erosion – silt trap (see Figure 2 - 3A and 3B).

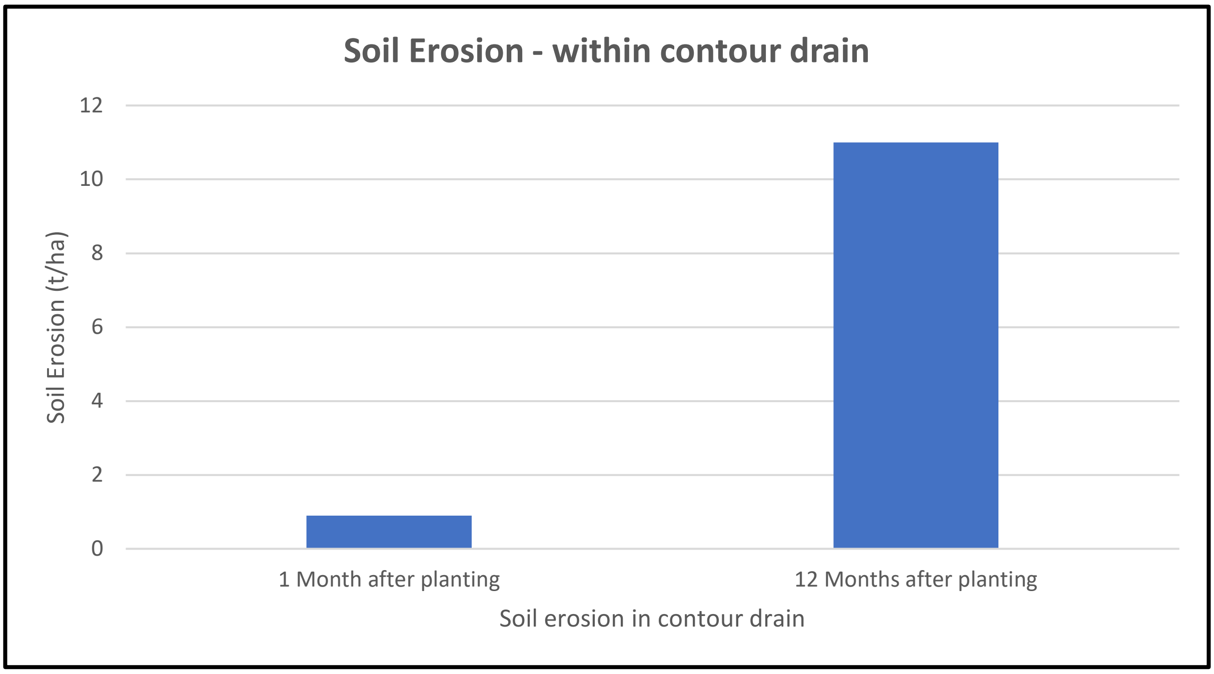

Figure 10: Soil erosion – within the contour drain (see Figure 2 - 2A).

Figure 11: Soil erosion sites: Contour drains at three months (left), contour drains at six months (middle) and standard practices at six months (right).

Over the six months following the first flush of rainfall, the treatments with contour drains had substantially less erosion than standard practice. This can be seen in the amount of soil erosion captured in the contour drains and silt traps (see figures 8, 9 and 10).

The soil captured in the contour drains can be easily cleaned out at any point in the growing cycle of the crop. The width of the contour drains is wide enough to be accessed by a grader. The soil in the contour drain can be shifted onto the contour bank. The great advantage of the contour drains has been to maintain the majority of the soil within the block.

Figure 12: Bioreactor site: Bioreactor after set up (left) and erosion after first rainfall (right).

Immediately, after the first flush the bed bioreactor installed by DAF was rendered ineffective. This was the result of insufficient design for the water intake located at the top of the bioreactor which restricted water flow into the bioreactor instead diverting it around the bioreactor bed and exacerbating soil erosion.

DISCUSSION

This demonstration examined the potential of satellite imagery, LiDAR technology (for water flow accumulation maps) and Electromagnetic soil scans to support growers make better on-farm decisions for farm planning through better layout of blocks including the location and establishment of contour banks. The improved layout reduced soil erosion. An EM survey assisted the grower to make farm management decisions about ground preparation and pest and disease control.

This trial has highlighted the potential of different technologies to enable and support better farm planning and decisions.

The treatment that included contour drains and silt traps resulted in substantial reductions in erosion compared to standard practices. The infrastructure constructed through the farm planning process reduced soil erosion by up to three times compared to standard industry practice. The average cost to construct a contour drain was $1,500 per hectare. Most of this cost is from labour and diesel for growers that have graders or grader blades attached to their tractors. The average cost to construct a silt trap is $1,200 per hectare which consists of labour and diesel for earth moving equipment. The total cost of the bioreactor was $2,500 for labour and diesel cost for the excavator, and wood chip.

ADOPTION AND IMPACT

There is great potential for various technologies to support growers make better on-farm decisions through their farm planning process. This demonstration investigated the potential of satellite imagery, LiDAR technology (for water flow accumulation maps) and Electromagnetic soil scanning. These are some of the many different technologies now available to support growers. It will require further research by industry agronomists and growers to integrate these technologies into farm planning processes.

CONCLUSIONS

Results from the evaluation indicate great potential for new technologies to achieve better agronomic outcomes for industry. A farm planning process has the potential to utilise several different technologies to support more precision farming operations. It is important to keep evaluating new technologies and their application whilst working with relevant companies to make these products commercially available and cost effective for the pineapple industry.

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