Australian sugarcane production and the role of agricultural extension officers – Student Worksheet

QUEENSLAND GOVERNMENT
Department of Agriculture and Fisheries

Sugar Research Australia

CQUniversity AUSTRALIA

Lesson 1: Introduction to Australia's sugarcane industry

The Australian Sugar Industry

Sugarcane is a large tropical grass that is grown by around 4,000 farms along the northeast coast of Australia. Australia exports over 80% of the raw sugar it produces to many countries including South Korea, Indonesia, Japan and Malaysia, worth over $2.5B to the Australian economy[1]. Australia is one the top five largest sugar exporters in the world, along with Brazil, India, Thailand and the European Union.

Sugarcane grows in well-draining fertile soils in warm climates with high rainfall or irrigation. In Queensland, the crop takes between 9-16 months to grow tall enough to harvest. Growth is slower in cooler climates like NSW, where it can take 18 to 24 months to grow[2]. Harvest occurs during the drier months of June to November. Once harvested, the cane is transported to a sugar mill for processing.

Watch this short video about how sugarcane is processed at a sugar mill:

[1] https://www.agrifutures.com.au/farm-diversity/sugarcane/

[2] http://www.canegrowers.com.au/icms_docs/271170_the-journey-of-the-jellybean.pdf

ACTIVITY #1

After watching the video, complete the following sentences:

Raw sugarcane is _____ to produce sugar _____

The remaining _____ material can be used as _____

Impurities from sugar juice are removed to produce a _____ through the process of _____

The syrup is separated from _____ using a _____ to produce raw sugar

Products and by-products of sugar

Sugarcane is one of the few plants in the world where almost the whole plant can be used, making it a highly renewable species. As you saw in the video, sugarcane can be used to produce sugar crystals, a sugar syrup called molasses, and the fibrous material can used as fuel for the mill, but there are also several other by-products of sugar that can be made.

ACTIVITY #2

Look at the images below and circle those that you think are made from sugar processing:

Animal feed

Toilet paper

Alcohol

Electricity

Biofuel

Fertiliser

Biogas

Biodegradable food packaging

Insulation

Image sources (L-R): Syngenta-us.com; medshop.com.au; sucrosenews.com/products; nicepng.com; sucrosenews.com/products; Simon Blackmore; sucrosenews.com/products; happyearth.org.uk; knaufnorthamerica.com

Sugar production cycle

Like many crops, cane needs to be monitored throughout the growing season to make sure the crop is healthy and to keep a look out for pests and diseases. Different inputs are applied to the crop throughout the growing cycle.

ACTIVITY #3

Here is a list of different stages of sugarcane production and inputs. Place these boxes in the correct order and write a short comment about why you chose your particular order:

Hint: Some stages can occur more than once during the growing cycle. Put each stage where you think fits best within the overall cycle.

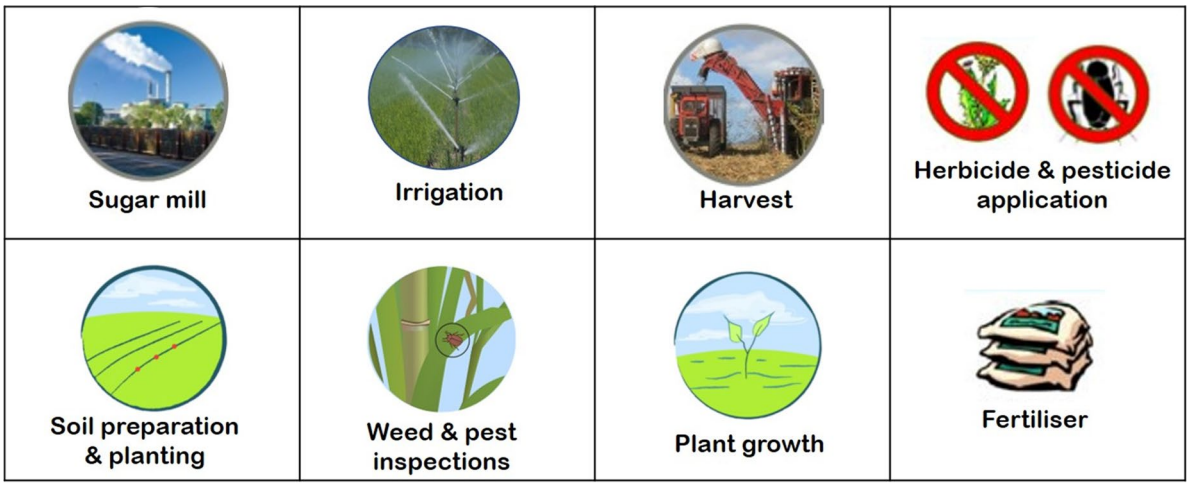

Image sources (L-R):CSR sugar; WA Department of Primary Industries and Rural Development; CSR Sugar; Simon Blackmore; Planet-lean.com; qld.gov.au Sugarcane Support Programs; Planet-lean.com; Simon Blackmore

No.	Stage	Reason
1		
2		
3		
4		
5		
6		
7		
8		

Did you know?

The cane toad, an exotic pest of QLD, was introduced to Australia to control the cane beetle, a native parasite of sugarcane that eats both the leaves and roots of the plant causing it to die. Using one animal species to reduce the numbers of another species is called biological control.

The cane toad flourished in the warm QLD environment, with an abundant food supply and not many predators. However, they failed to control the cane beetle because they are unable to climb to the tops of the sugar cane where the beetles live, and the cane crops did not provide good enough shelter for the toads to live.

Cane toads are now a declared invasive species and are a threat to many native animals including quolls and goannas due to their toxic skin. Some birds and animals have learned to avoid their poison glands, like crows who flip the toads over onto their backs to attack its poison-free underside, but toads still have too few predators to control their numbers.

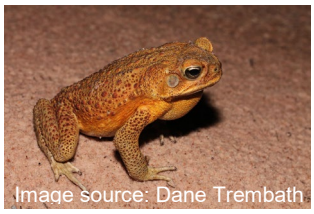

Image source: Dane Trembath

The impact of sugar production on the Great Barrier Reef

The main cane growing regions of Australia are in QLD, adjacent to the Great Barrier Reef (see map below[3]). The Reef is the world's largest coral reef and one of the seven wonders of the natural world. It is home to an abundance of marine life, including many endangered species such as Dugongs (Sea Cow) and large Green Sea Turtles. It is also a sought-after tourist destination and supports a large portion of Australia's tourism industry. Unfortunately, the health of the Reef is under threat from a range of natural and industrial sources, with poor water quality and pollution its greatest threat[4].

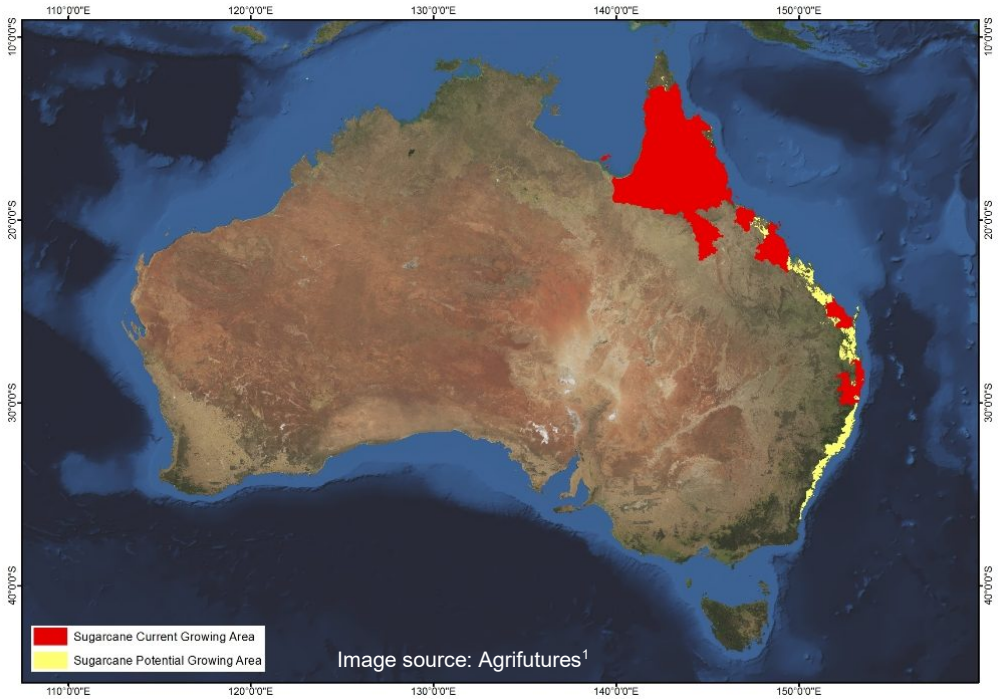

Image source: Agrifutures[1]

[3] https://www.agrifutures.com.au/farm-diversity/sugarcane/

[4] https://peerj.com/articles/4747/#supp-1

ACTIVITY #4

Brainstorm with a few of your classmates to come up with ideas as to where threats to the Reef originate from:

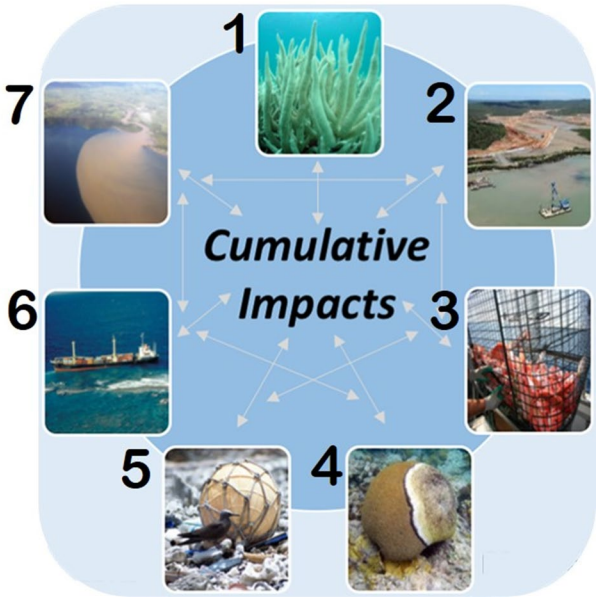

Image source: Zoe Richards[4]

1. Climate	
2. Industrial	
3. Commercial	
4. Marine life	
5. Pollution	
6. Transport	
7. Water quality	

Agriculture as a threat to reef water quality

Some of you may have identified agriculture as being a major threat to water quality as it is a source of pollution entering the Great Barrier Reef. This is mainly through a process called 'runoff', where any debris, sediment or excess chemicals from a crop are washed into creeks or streams following severe weather events, such as heavy rainfall, storms or cyclones, and eventually reach the Great Barrier Reef marine park[5].

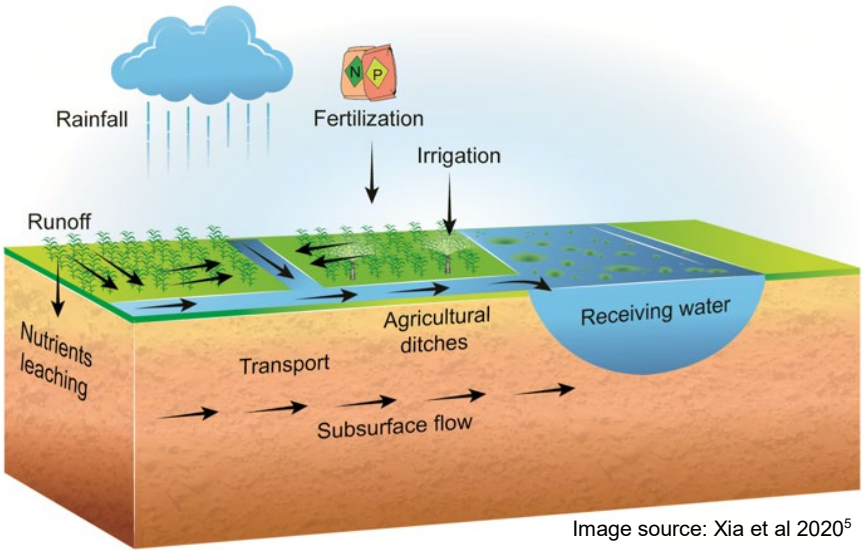

Image source: Xia et al 2020[5]

The effect of agricultural runoff contributing to Reef degradation was noticed in the early 1990's – more than 150 years' worth of traditional farming practices, increasing farm size and production inputs and outputs were affecting the health of the Reef.

Nitrogen is one of the main components in fertiliser. Traditionally, farmers applied a set amount of fertiliser across their paddocks. The excess that plants don't use can easily be washed away on the surface (runoff) or drained into the water table below the surface (leached). Both methods lead to excess nutrients entering waterways.

Excess nitrogen, phosphorus and chemicals in waterways can lead to an overgrowth of algae, known as an algal bloom, who use the nutrients as a food source. When algal growth is unrestricted, like in an algal bloom, they can produce toxins to protect themselves from being eaten by small animals – these toxins can be poisonous to humans, livestock and marine species.

Several species naturally eat algae as their main food source, for example, jellyfish and whales eat the algal species phytoplankton. Starfish are another species that eat algae, including the 'Crown of Thorns starfish', also known as COTS, which is a large starfish that preys upon coral. In natural numbers, they contribute to coral ecosystem biodiversity as they tend to eat fast growing coral giving the slower growing coral a chance to catch up, but in excessive numbers the starfish are unselective and tend to feed on all types of coral, consuming up to 10km^2 per year[6]. It is thought that a decline in natural predators from overfishing and an increase in algal blooms from nutrient runoff provides a constant food supply for juvenile starfish that would not naturally mature.

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[5] Xia et al 2020 Applied Biological Chemistry 63, 8; https://link.springer.com/article/10.1186/s13765-020-0493-6

[6] https://www.barrierreef.org/the-reef/threats/Crown-of-thorns%20starfish

Crown of Thorns starfish

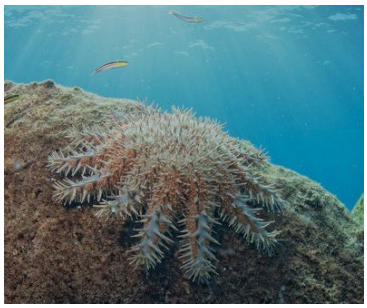


Image source: Great Barrier Reef Foundation

Coral are an important component of the Reef ecosystem, and affect the growth, reproduction and survival of many species that live there. Once coral has been attacked by COTS, they can take 10-20 years to recover, although this may even be longer if other harmful events occur, such as cyclones, poor water quality and bleaching caused by extended periods of warmer than normal sea temperatures[7].

Click on this link to watch a short video about what is being done to control COTS. Alternatively, type https://education.abc.net.au/home#!/media/525269/ into your web browser to watch the video.

ACTIVITY #5

After watching the video, learning about sugar production and its impact on the Great Barrier Reef, number the statements below in the order that they occur:

	Crown of Thorns feed on living coral tissue.
	Fertilisers containing nitrates and manure are used to promote sugar cane growth.
	Coral cover is dramatically reduced.
	Water runs off the land into creeks, rivers, and into the Great Barrier Reef.
	Algae are consumed by Crown of Thorns larvae.
	Tropical storms and heavy rains occur.
	Algae growth is stimulated by nitrogen derived from fertiliser and manure.
	Sugar cane is planted.
	Decreased coral cover disrupts the entire Great Barrier Reef coral system.
	Crown of Thorns larvae grow rapidly and settle.

Reversing the damage that's been done to Reef will take a big change to traditional farming practices to ensure the health of the Reef is maintained. In the next lesson you will learn about the innovative changes the sugar industry has put in place to look after the health of the reef and benefit their farms.

[7] https://www.aims.gov.au/docs/research/biodiversity-ecology/threats/cots.html

Lesson 1 Glossary

Algae – Species of organism that mainly live in aquatic environments. Algae exist in a range of shapes and sizes, from single cells to multicellular organisms, microscopic to macroscopic, and can take on leaf shapes, such as seaweed. Although they don't have true roots and stems like plants, they do use energy from the sun to make oxygen via photosynthesis.

Billets – A cutting approximately 40cm long taken from a previous cane crop used as a seed to grow a new crop.

Biological control – controlling a pest animal species by introducing another species that is a known predator of that pest species

Ecosystem – a unique balance of relationships between an environment and the organisms that lives within it.

Fertiliser – Nutrients applied to the soil to support healthy plant growth

Furrow – A long narrow and shallow trench in soil made by a machine to plant seeds or seedlings

Toxin – a poisonous substance produced within living cells or organisms

Lesson 2: Innovations in the sugar industry and the role of extension officers

Improving sugarcane farming practices

To reach the Australian government's target of reducing nitrogen pollution entering the Great Barrier Reef by 80% in 2050, innovative practice change is needed.

In the early 2000's, the sugar industry began investigating ways that they could decrease their impact on the reef. Traditional practices used in sugarcane production were reviewed for their impact on environmental sustainability.

ACTIVITY #1

Here is a list of some sugarcane farming practices that were reviewed for their environmental sustainability.

Brainstorm with a few of your classmates about what environmental impact these practices may have:

Traditional practice		Environmental issue
	Burning of leafy plant material from the sugarcane stalk before harvesting	
	Apply fertiliser on top of soil when plant growth is high enough to deter atmospheric losses	
	Repeatedly driving machinery over crop areas for planting, chemical and fertiliser application and harvesting	
	Clear vegetation around crops and waterways	
	Irrigation scheduled on a set cycle	

Image sources: Molly O'Dea; rataequipment.com; CaneGrowers; ABC Rural Marty McCarthy; WA Department of Primary Industries and Rural Development

The role of extension officers

Researchers, farmers and extensions officers worked together to come up with innovative changes that improved the sustainability of many cane farming practices. An Extension Officer is someone who works alongside farmers to advise them about new and successful innovations and help set up on-farm trials so farmers can see just how successful the changes are. Extension officers may get groups of farmers together to inform them about new and emerging research, how to implement best management practices to increase sustainability (including water quality) and production (e.g. the amount of sugarcane that a farmer can grow) and help them record water quality leaving their crops.

Let's hear from an adoption officer at Sugar Research Australia about her role.

Innovations in sugarcane production

Researchers, farmers and extensions officers are continually working to improve practices The following video shows some of the successful changes that have been implemented by industry.

F*or the purpose of this lesson, begin watching the video at 1:00 min and finish at 8:20 min.*

Australian sugarcane production and the role of agricultural extension officers

ACTIVITY #2

After watching the video, fill out the following table describing how each innovation has improved the sustainability of sugar cane farming:

Practice Innovations	How has this contributed to improved sustainability?
Trash blanketing	
Underground fertiliser application	
Controlled traffic farming	
Maintain vegetation around riparian areas	
Soil moisture meters	

Outcomes from innovation

While many farms are seeing improvements in the health of their farms and crops, the full benefits for the reef won't be realised for some time yet. The sugarcane industry, however, has recorded decreases in chemical and sediment runoff from their improved practices, with the following figures recorded over a 5-year period (measured from 2008-2014)[8]:

- Reduction of nitrogen by 47 tonnes per annum
- Reduction of phosphorus by 16 tonnes per annum
- Reduction of pesticides leaving the farm by 190 kg per annum

ACTIVITY #3

Choose one of the following activities to complete:

1. Imagine you are an extension officer working within the Sugarcane industry. Choose one or more innovative practice changes and create a poster for sugarcane farmers who have not yet implemented improved sustainability practices. Highlight the benefits of changing practices on production and environmental sustainability.

2. Discuss with your classmates other ideas about how to improve the sustainability of farming practices and/or the health of the Great Barrier Reef

Your turn to be an extension officer!

Like Molly, the extension officer you met earlier, you are going to undertake some trials to see the water quality differences between practices. Have a think about some of the practices discussed in this lesson and how you could set up a trial to investigate the water quality impacts. Next lesson we will discuss ideas and start setting up experiments.

[8] https://reefcatchments.com.au/land/project-catalyst-attracts-leading-ag-and-innovation-experts-to-mackay-and-whitsundays/

Lesson 2 Glossary

Ecosystem – a unique balance of relationships between an environment and the organisms that lives within it.

Extension officer – An agricultural advisor who works alongside farmers to advise them on relevant research and best practice guidelines to improve the sustainability and profitability of their farms.

Fertiliser – Nutrients applied to the soil to support healthy plant growth

Furrow – A long narrow and shallow trench in soil made by a machine to plant seeds or seedlings

Riparian area – The area alongside creeks, streams, gullies, rivers and wetlands. These areas are unique and diverse, and are often the most fertile parts of the landscape.

Stool – A collection of sugarcane shoots growing from a single parent cutting (known as a billet) that form a single sugarcane plant

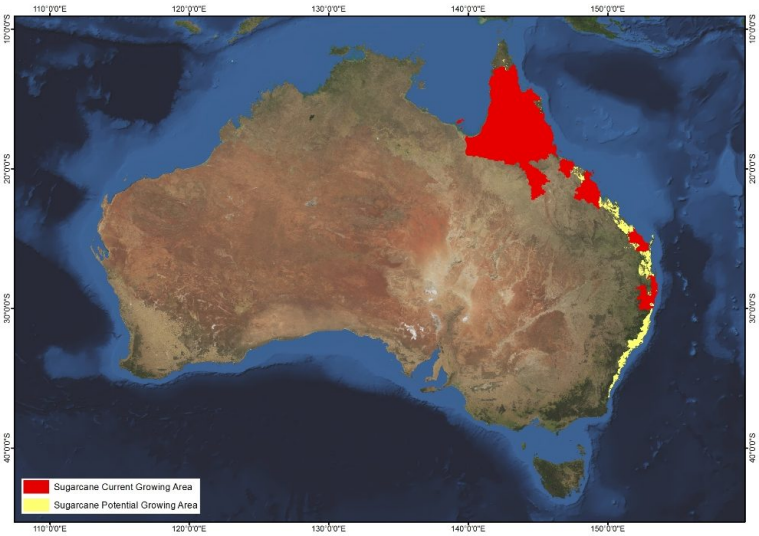
Lesson 3: Sustainable sugarcane farming practices

Sustainable sugarcane farming practices

Sugarcane (Poaceae Saccharum) is a tall tropical perennial grass that grows to between 2-4m high. Sugarcane is used to produce a range of food products including sugar, molasses and golden syrup[9].

Sugarcane is one of Australia's largest crops and accounts for a significant percentage of the crops produced in Queensland's coastal agricultural production areas, worth over $2.5B in exports each year[10].

Farming in such close proximity to the Great Barrier Reef means sugarcane farmers need to be extra careful about their farming practices to ensure they are having the smallest impact on the environment possible.



[9] https://www.agrifutures.com.au/farm-diversity/sugarcane/
[10] https://www.agrifutures.com.au/farm-diversity/sugarcane/

There has been a substantial increase in knowledge about how agricultural practices can have an impact on water quality. There are a number of potential actions that can be undertaken to reduce the amount of major pollutants such as sediments, nutrients and pesticides that flow into the environment, and better information is becoming available about the benefits and trade-offs of these changes[11]. Scientists and farmers are working hard together to become more environmentally, economically and socially sustainable.

In this unit of work, you are going to become a researcher, extension and communication officer! You are going to undertake a research trial to determine the water quality impacts of different farming practices and develop a plan for a farmer to improve their actions.

ACTIVITY #1

Match the sugarcane farming practice to the water quality risk

Instructions

Option 1 – Group based

- Students work in groups
- Each group is given one set of cards
- Students match the cards up – there are 14 areas of sugarcane management, each area has one lower and one higher water quality risk practice.
- Match the 2 practices together and then decide which practice is lower/higher water quality risk
- Discuss why practices are low/high water quality risk

Option 2 – Individual based

- Each student is given one card
- Students find the matching card. A good team work activity which will also promote discussion of water quality risk.
- Once students have matched all cards, discuss practices as a class.

You may find the glossary at the end of the lesson helpful to understand terms used in the cards

[11] https://www.reefplan.qld.gov.au/__data/assets/pdf_file/0024/46176/scsu-chapter-5-mgt-practices.pdf

Making a difference – Extension assisted outcomes case study


Photo by Jessica Johnston, North QLD Register

Brothers Sam and Michael Spina are third generation sugarcane farmers in Innisfail, QLD.

For the past 2 years they have been working with an extension program called 'Wet Tropics Sugar Industry Partnership' to implement low-risk environmental practices and they are starting to see the results.

The brothers are now using 20% less fertiliser while still growing the same amount of cane, which may result in an annual savings of approximately $80 per hectare.

They've changed many of their practices, including planting bean fallow crops to naturally increase the nitrogen levels in the soil, soil testing to identify what fertiliser is needed and where, using GPS assisted machinery to automatically adjust fertiliser rates depending on the soil type, and retaining grasslands and forming spoon drains adjacent to crops to slow water and allow sediment to settle before.

"Over the years cane growers have become a lot more aware environmentally - we're grassing our headlands, trash-blanketing, applying fertiliser underground, getting water samples." Commented Mr Spina, "If there is fertiliser coming off our paddocks, we want to know about it so we can fix it."

The changes the brothers have implemented without affecting their productivity is a win for farmers and the environment.

Replicating on-farm water quality trials in your classroom

Part of an Extension officer's role is to set up water quality experiments on-farm. This helps farmers know how much nutrient, chemical and sediment is being lost in runoff water so they can monitor how efficient their practices are – all of these elements cost farmers money as well as being detrimental to the environment, so it is in their best interest to minimize losses as much as possible.

This photo shows an on-farm water quality trial, where water traps are placed in between the sugarcane rows to collect any surface water runoff.

ACTIVITY #2

In groups of 3-4 you are going to create an experiment to test one set of sugarcane farming practices that affect water quality. We will provide you with some ideas, but you may like to come up with your own experiment.

Not in a sugarcane growing area? No problem, grow a crop relevant to your area such as wheat or sunflowers, or purchase a piece of lawn from the hardware shop! The same principles apply to any crop. You can also grow a different crop to speed up germination compared to sugarcane. You can also grow no crop (but it is not as fun!).

Look at the three experiment examples below. Discuss with your classmates which experiment you would like to replicate. Complete the table below listing which experiment you like the best and why – think about a trial that will easily replicate what happens on farm so that your results be useful for a farmer. Come up with a hypothesis about what you think will happen. You don't have to be restricted to the suggestions on your list, you may come up with your own experiment to test. Once you're finished, discuss with your class. You may even like to vote on which one everyone would like to do.

1. Compare nutrient loss in surface versus sub surface fertiliser application
2. Compare herbicide loss in runoff for herbicide applied only to sugarcane crop rows (band) versus application across the entire paddock (blanket)
3. Compare sediment runoff for soil that is minimally tilled (disturbed) versus cultivating the entire paddock
4. Come up with your own experiment to record nutrients, chemical and/or sediment leaving the paddock in runoff water (provide details on a separate sheet of paper to discuss with your teacher and class)

Exp	What you like about this experiment	What you don't like about this experiment	Hypothesis
1			
2			
3			
4			

Lesson 3 Glossary

Boomspray – machine used to most commonly spray weeds. It has a tank which is filled with chemical (e.g. pesticide) and a boom which has spray nozzles attached. The boom is raised above the height of the crop and covers several rows. It sprays out the chemical onto the crop.

Broadcast – scattered across the surface of the soil

Canegrub - larvae of a number of types of cane beetles. These larvae damage sugarcane by feeding on the plant roots.

Cover crop – a crop other than sugarcane grown between crops of sugarcane, often as a break crop. Cover crops have many benefits including soil health improvements and breaking disease and weed cycles.

Fallow – a period where no sugarcane is grown. This generally lasts for 6 -12 months after harvest and before the next crop of sugarcane is planted. A cover crop may be planted in the fallow.

GPS guidance - Global Positioning System (GPS) is a satellite-based navigation system that allows machinery to operate on the same path each time it enters the paddock.

Herbicide – a type of pesticide used to kill weeds.

Insecticide – a pesticide used to kill insects, such as canegrubs

Nitrogen – an important nutrient for both sugarcane growth and water quality. Nitrogen has many roles in plant growth including being an essential building block for proteins.

Pesticide – a chemical used to kill pests, which may include weeds and insects, but more commonly referring to pests such as canegrubs.

Phosphorus - an important nutrient for both sugarcane growth and water quality. Phosphorous has many roles in plant growth including being a main component in DNA.

Ratoon – sugarcane which has been harvested at least once. In the sugarcane industry crops are referred to as plant cane (not yet harvested), 1st ratoon (harvested once), 2nd ratoon (harvested twice) etc.

Residual – residual herbicides have an extended period of control (weeks or months). They do not break down as fast as herbicides, which are called “knockdowns”, such as glyphosate. Residual herbicides such as diuron often have water quality implications.

Residue – the left-over material after a crop is grown.

Row spacing – how far apart each row of sugarcane is. In the sugarcane industry it is common for row spacings to be between 1.5 and 2 meters.

Six Easy Steps Nutrient Management program – the process used to calculate the amount of fertiliser required. Find a copy of the guidelines for your area on Sugar Research Australia’s website.

Subsurface – below the surface of the soil

Tailwater – water from irrigation or rainfall that runs off the paddock can be collected in a ‘tailwater’ pit. It is like a small lake or dam and the water can be pumped out of the tailwater pit back onto the crops when needed.

Tillage – operations used to prepare the soil for planting which involve digging or turning the soil.

Trash blanket – the sugarcane material, mostly leaves, left over after harvest which acts like a blanket on top of the soil.

Wheel spacing – how far apart the wheels are on machinery.

Zonal – the area of the paddock where the sugarcane plant grows. Operations, such as tillage, only happens in the sugarcane "zone", in other words, where the sugarcane is growing (or will grow) but not between the sugarcane rows.

Lesson 4: Water quality experiment

It's experiment time!

By now you will have chosen your experiment and created a hypothesis about what you think might happen.

Because you only get to do this once, its really important to record as much data as you can throughout the experiment. Data might refer to recording measurements, such as the amount of water applied and the time taken to apply that water, but it also refers to the small details of what you do and see. Does the water soak in straight away or does it take a while to settle? Are there differences in the colour of water pooling on top? Documenting exactly what you do and how you do it is an extremely important part of research. A detailed method can help explain results as well as advise others on how to repeat the same experiment to get the same results.

Try and record as much as you can and take plenty of photos of your experiment because in the next lesson you'll be communicating your results to farmers.

Understanding your results

Once you've collected all of your data, complete the following activity to understand why you got the results you did.

ACTIVITY #1

Complete the following post-experiment questions, depending on which experiment you completed

General

1. Did the water soak in? Why/why not? What impacts does this have?
2. What impact would applying more, or less, water have?
3. Did the experiment go to plan? Why/why not?
4. If you were to repeat the experiment what would you change to improve the experiment?

Experiment 1 - Surface vs Sub-surface Fertiliser

1. Which treatment had more nitrogen loss? Why?
2. What practices could reduce nitrogen loss?

Experiment 2 - Band vs Blanket Herbicide

1. Which treatment had more 'herbicide' loss? Why?
2. What practices could reduce herbicide loss?

Experiment 3 - Minimal Tillage vs Full Cultivation

1. Which treatment had more soil loss? Why?
2. What practices could reduce soil loss?

Lesson 5: Communicating research

Communicating research

Hopefully you found some pretty impressive results from your experiments. Now what? Just as important as doing the experiment is telling everyone about it. Research communication is the ability to explain your research in a clear and understandable way, so that the public is well-informed. Good researchers need to be good communicators.

The first step is to document what you did so that others could repeat your experiment and get the same results (well, within reason! Soil type is just one factor that may affect results between replications of the same experiment). It also helps summarise what you did so that you can communicate your results easier.

A standard laboratory report contains several important sections. We've provided some suggested headings for you, but feel free to research what scientists would usually include in their laboratory reports. This information will be used to communicate your findings to the general public in Activity #2.

ACTIVITY #1

Write a laboratory report about one of your experiments that you would like to tell farmers about.

Here are some suggested headings:

Section	What to include
Title	What was the name of your experiment?
Authors	Include yourself and group members
Aim	What did you hope to achieve?
Hypothesis	Recap from Lesson 3. What did you think would happen?
Materials	What did you use?
Method	What did you do?
Results	What happened? What did you record?
Conclusion	What do your results mean? Was your hypothesis right?

Communication Officers

Often, businesses employ a communication officer to help promote the work that their company does. This might include news articles, newsletters, speeches and other marketing material. Let's hear from a communications officer in the sugar industry about their role:

Communicating your results to farmers

Now it's your turn to take on Sam's role as communication officer! How would you communicate the results of your experiment to farmers who are interested in learning about improving their current farming practices?

ACTIVITY #2

Create a fact sheet (or equivalent resource) that could be handed out to farmers which:

- Explains the experiment
- Discusses the results
- Provides suggestions for improving farming practices
- Includes your company logo and contact details if they would like more information

See below for an example

Example fact sheet[12]

2016 Paddock Case Study - Sugarcane

Managing nitrogen runoff from sugarcane in the Mackay Whitsunday region

About this case study

This case study demonstrates the effect of reduced nitrogen fertiliser rate and different row spacings on nitrogen losses. Increasing the time between fertiliser application and first runoff (allowing time for crop uptake and infiltration into the soil) is important to reduce applied nitrogen losses through surface runoff in ratoon cane crops. Un-degraded urea in runoff was a significant contributor to the runoff nitrogen loads.

Image: Runoff water as it passes through the flume where it is measured and sampled.

Key findings

- Moving from conventional to improved management practices (controlled traffic and to industry recommended nitrogen rates in Six Easy Steps) can reduce total nitrogen (N) lost in surface runoff by 32 per cent, with no change in net financial return.
- Every additional 21 days between nitrogen fertiliser application and first runoff, halves N loss (per cent of applied) to runoff.
- Un-degraded urea in runoff was a significant contributor to the runoff nitrogen loads.

Implications for management

Applying nitrogen fertiliser at current industry recommended rates (Six Easy Steps) and increasing the time between application and first runoff can have substantial environmental benefits whilst still maintaining economic returns and in some cases, achieving financial savings. Applying fertiliser at rates above recommendations leads to nutrients surplus to crop requirements. This increases the risk of these nutrients being lost to the environment in runoff, which is not cost effective. This is particularly important if significant rainfall producing runoff occurs soon after fertiliser application.

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Methods

A paddock monitoring site was established in the Sandy Creek catchment, south-west of Mackay in 2009. The site, on a Victoria Plains soil (cracking clay), has two 1.1 hectare treatment plots under different farm management practices. The first treatment plot has 1.6 metre row spacings and conventional nitrogen fertiliser rates (~200 kg N/ha); and the second with the improved management practices of 1.8 metre row spacing (controlled traffic farming system) with a Six Easy Steps (6ES) fertiliser application rates (~135 kg N/ha).

Rainfall, runoff, water quality, yield and farm operations were monitored across four ratoon crops from 2010 to 2014. Each plot was fitted with an automated surface water runoff sampling and monitoring station. Runoff samples were then analysed for suspended sediment and N, including dissolved inorganic N (DIN), dissolved organic N (DON), particulate N (PN) and urea, and total N (sum of DIN, DON and PN).

Results

Rainfall across the monitored years varied. It ranged from 3,190 millimetres between October 2010 and September 2011 (double the long term average) in the first ratoon to 1,390 millimetres between 2013 to 2014 over the fourth ratoon. The highest rainfall year had the highest N losses (average 11.5 per cent of applied N). Overall, the improved management practice treatment had an average 32 per cent less total N lost in runoff compared to the conventional treatment (Figure 1). Both treatments had similar proportional losses (Figure 2).

Figure 1: Annual nitrogen losses in runoff from ratoon crops under conventional and improved management practices at Victoria Plains, Mackay.

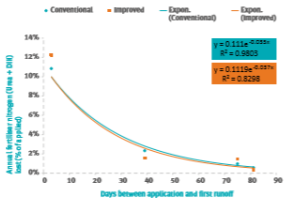

Figure 2: Annual fertiliser N (DIN and Urea, as a % of applied) lost in runoff from ratoon crops under conventional and improved management practices at Victoria Plains, Mackay.

It was observed, that for every additional 21 days between N application and the first runoff event, there was an approximate halving of N loss (DIN and urea) in runoff (Figure 2). Similarly, N loss (DIN and urea) was also halved for every additional 95 millimetres of rainfall (or irrigation) between application and first runoff.

Average yield across the cane cycle varied slightly, conventional treatment yield averaged 77 t/ha, while the improved management practice treatment averaged slightly less at 72 t/ha. A simple analysis of net returns (excluding irrigation, fertiliser other than N and fixed costs other than harvesting) showed both treatments averaged $2300/ha, with lower input costs for improved management practices offsetting slightly lower yields.

Authors

Stephen Donaldson and Ken Rohde, Queensland Department of Natural Resources and Mines, Mackay.

About the Paddock to Reef program

Paddock monitoring trials are conducted as part of the Paddock to Reef Integrated Monitoring, Modelling and Reporting (Paddock to Reef) program. For more information on the Paddock to Reef program and case studies, including references, please visit www.reefplan.qld.gov.au.

[12] https://www.reefplan.qld.gov.au/__data/assets/pdf_file/0018/46026/case-study-sugarcane-nitrogen-runoff-mackay-whitsunday.pdf