

# Sugar Cane

One Plant, Many Products

YEARS 5 - 8

SCIENCE, DESIGN & TECHNOLOGY, GEOGRAPHY



Primary Industries Education  
Foundation Australia



CANEGROWERS

# Sugarcane

## One Plant Many Products

**Unit Focus:** Cane growers produce more than just sugar. From cattle feed to garden mulch, sugarcane has many uses throughout our community.

You can find more educational resources at: [Canegrowers.com.au](http://Canegrowers.com.au)



## Lesson 1: All About Sugarcane

### What is sugarcane?

Sugarcane is simply a big tropical grass and is similar to the bamboo that grows in the tropics. The cane grows from two to six metres high with strong, jointed, fibrous stalks that store carbohydrates in the form of sucrose (a type of sugar). The sucrose is stored in the stalk internodes which are the sections of stalk between the “bumps” or nodes.

Sugarcanes belong to the grass family, Poaceae, an important plant family that includes wheat, rice, and sorghum.

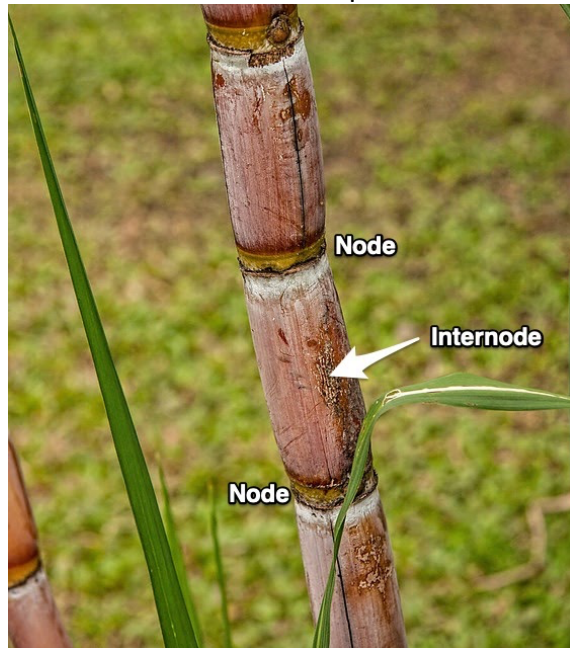
Approximately 70% of the world’s sugar is produced from sugarcane. The remaining 30% is made mainly from sugar beets.

### Did you know?

100ml of juice squeezed from sugarcane contains approximately 13g of sugar. That’s almost 3 full teaspoons of sugar. The rest is mainly water.

In Australia, some sugarcane growers can produce up to 12 kg/m<sup>2</sup> of raw cane grown.

If we say that an average 1kg of raw cane stalks contains up to 1L of juice or approximately 130g of sugar, we get roughly 1560g of sugar per m<sup>2</sup> harvested. This can vary depending on the place, season, the soils and a range of other factors.



### Activity 1A

Answer the following question in your Learning Journal. Show your working.

1. If the average cane field is 1,000,000 m<sup>2</sup>, approximately how much raw sugar could be grown based on the information above?



### Activity 1B

Answer these questions about the video, "Sugarcane - Paddock to Plate".  
<https://youtu.be/tyNDJHkLyrE>

1. Where is sugar made in the plant?
2. What do growers plant to grow sugarcane?
3. What 3 things does it need to grow?
4. What is 1 stool of sugarcane?
5. When the cane is harvested, what is it cut into?
6. What months are harvest time?
7. Why do you need to get harvested cane to the mill as quickly as possible?
8. Where do the billets go once they've been dropped at the receiving station?
9. What is used to fuel the mills boiler furnaces?
10. How are the sugar crystals separated from the molasses?
11. During refining, what is added to remove impurities?

### Where is sugarcane grown in Australia?

Growing sugarcane requires a tropical or subtropical climate such as that found in many parts of coastal Queensland or northern New South Wales.

Sugarcane can be found growing along the 2,100 kilometres of coastline between Mossman in far north Queensland and Grafton in northern New South Wales. Sugarcane growers manage some unique and spectacular landscapes, animal life and waterways.

Many cane growing families live close to rainforests and the Great Barrier Reef. Because of their proximity, they can spend their free time outdoors swimming and fishing. As the local area is important to them too, they go out of their way to consistently improve their farming practises and environmental management.

Growers, like all Australians, are working hard to keep the land in excellent condition for their children and grandchildren to enjoy for many generations to come.



### Why is sugarcane important for Australia?

Cane growing and sugar production has been around for over a hundred years in Australia. During that time it has undergone many changes as technology and research improved how cane was grown and harvested. The sugarcane industry has helped build many coastal towns and is the main source of income for many towns to this day. The production of sugar provides jobs for many people throughout the supply chain from farm to your plate.

Sugarcane is one of Australia's most important rural industries and is worth around \$1.5 - \$2.5 billion to the Australian economy every year.

- Watch <https://youtu.be/PqbjtDAfLsw> - Growing up on a cane farm

### Why is Australia a world leader in the sugarcane industry?



The Australian cane growing sector is one of the most progressive agricultural industries in the world. Huge amounts of time and energy have been channelled into technology, research, and development to improve farming practices. The result is a crop that is high in yield with minimum environmental impact.

Australia's sugarcane growers have worked hard to become leaders in responsible and sustainable farming. Using the latest technology, they are constantly improving their farming practices to reduce soil erosion and protect nearby waterways and the oceans. Their aim is to grow more cane, protect the natural resources, their children's heritage, and of course, the nearby Great Barrier Reef.

These aims drive the farming industry towards world's leading results.

For example, currently they are trying to increase cane and sugar yields by improving harvesting and by reducing cane and juice losses as cane passes through the harvester. Growers are continually striving to improve the efficiency and productivity of their cane harvesting and transport practices.

- Watch <https://youtu.be/trp6l01y-2U> - Environmental stewards



## Lesson 2: Making Sugar

### How does sugarcane “make” sugar?

As sugarcane grows, it stores its food as sugar in its stalks. To grow successfully and produce this sugar, the cane needs strong sunlight, fertile soil and access to water. It needs at least 1.5 m of rainfall each year or access to water through irrigation. The sugar is made in the leaves of the sugarcane plant through a natural process called photosynthesis. Photosynthesis occurs when a plant, using energy from the sun, transforms carbon dioxide ( $\text{CO}_2$ ) and water ( $\text{H}_2\text{O}$ ) into oxygen ( $\text{O}_2$ ) and glucose (sugar).

The plant absorbs water through its roots and  $\text{O}_2$  from the air through the pores in its leaves. Sugar is created when this process is combined with the help of a substance called chlorophyll. Chlorophyll is green and gives plants their colour. It allows plants to absorb the sun's energy more readily. In the same way that animals store fat, the sugarcane plant stores energy that it doesn't need.



This extra energy is sugar, and it is stored as sweet juice in the plants' stalks. To get the sugar, sugarcane stalks are harvested when ripe and factories known as mills and refineries extract the juice and turn it into sugar crystals.

### Growing sugarcane on the farm

The complete cane paddock to plate cycle contains multiple steps from the planting of the cane through to the packaging of the sugar ready for us to use. In this video you'll get a complete overview of the process from Mackay Sugar.

- Watch <https://youtu.be/EytZKEMDS3A> - Australia's biggest cane farm



## 1. Planting

Sugarcane is grown by replanting part of a mature cane stalk. Growers cut some of the fully grown cane stalks into lengths called setts. These setts are planted by special machines, which drop them into furrows, add fertiliser and cover them with soil.

- Watch <https://youtu.be/-qjVUUXeQUE>– Planting cane

## 2. Growing

To grow successfully, sugarcane needs strong sunlight; fertile soil; and enough water (at least 1.5 metres of rain each year or access to irrigation). New shoots grow from buds on the joints of the setts. These shoots break through the soil surface between two and four weeks after planting. Each set can shoot up to 12 stalks, forming what is known as the stool of sugarcane. In warm and sunny Queensland, it takes nine to 16 months to grow a cane crop. Growth is slower in cooler climates like NSW, where it can take up to 18 - 24 months to grow a cane crop. Typically, a cropping cycle comprises one plant crop and 3 to 4 ratoon (regrowth) crops. When ripe, the cane is usually about 2 to 4 metres tall.

- Watch <https://youtu.be/5jYgY2hJpn8> - Cane growing

### Activity 2A

1. Using paper, make an actual height illustration of a fully grown sugarcane stool.
2. Stick it on your wall and take a full length photo of you standing next to it to illustrate the difference in heights.
3. Include the photo in your Learning Journal.

## 3. Harvesting

Heavy-duty machines called cane harvesters cut the cane stalks off at their base. As they move down each row, the leaves are stripped off the cane by the harvester and dropped back on the ground to mulch the paddock. Meanwhile the cane is collected and cut into shorter 30 cm length pieces known as 'billets'. A second machine called a cane haulout drives alongside the harvester to collect the billets. In Australia, sugarcane is harvested annually during the drier months of June through to November. As harvesting cannot be done in heavy rain, growers are very dependent on fine weather.

## 4. Getting cane to the mill

To minimise sugarcane deterioration and juice evaporation, sugarcane must be transported to a sugar mill within 16 hours of being harvested. Once full, the cane haulout drives across the paddock to the road, where it unloads its contents either into a semi truck (for road transport) or mill bins at local sidings on the nearest purpose built cane railway track (for train transport). The sugar mills operate a rail network of nearly



4000 km of narrow-gauge rail lines to get cane from the paddock to the mill quickly and cost effectively.

### Activity 2B

1. Using this website, <https://railwayvideos.club/cane-trains/> complete the following tasks:

- Which train do you like the design of and why?
- Using a map of Queensland, mark where each of the towns and/or mills mentioned on the page are located. Make sure you label them clearly.
- Add your answers to your Learning Journal.

## Converting cane into sugar products

### 5. Milling

Sugar mills crush the cane to extract and separate the sucrose (sugar) from the water, impurities and plant fibre contained in the billets. Using a computerised scheduling system, the sugarcane is monitored as it moves through a four step milling process.

- *Weigh and Record* Sugarcane is weighed and processed at automatic cane-receiving stations as soon as it arrives at the mill.

- *Chop and Shred* The billets are then tipped into a cane carrier and transported to the shredder where they are chopped and shredded into fibrous material. This process ruptures the juice cells.



- *Crush* The cane material is then crushed as it is fed through a series of mills. Three large rollers arranged in a triangle formation separate the juice from the fibrous material. This process separates the juice from the bagasse, which is a fibrous material used as fuel to run the mill's boiler furnaces.

- *Heat and Cool* The juice is pumped away for processing into raw sugar. It is cleaned to remove impurities and thickened into a syrup by boiling off excess water. It is then seeded with tiny sugar crystals in a vacuum pan and boiled until sugar crystals have formed and grown. These crystals are separated from the molasses they're floating in using centrifuges that are like giant spin dryers. The crystals are then tumble-dried and stored in large bins until they are sent to storage or for refining.





## 6. Refining

Australian mills produce 'raw' sugar, a product not to be confused with the raw sugar that we use to sweeten hot drinks. 'Raw' sugar from the mill is refined until it is suitable for human consumption and for use as an ingredient in the manufacture of food and drinks.

At the refinery, the 'raw' sugar crystals are washed and dissolved in hot water. Carbon dioxide and lime are added to the melted 'raw' sugar to remove impurities. Any remaining colours and impurities are removed as the sugar is filtered. The pure, clean sugar is boiled in a vacuum pan and seeded with fine sugar crystals. Sugar, as we recognise it, forms by "growing" as crystals from the fine sugar crystals. When the crystals are large enough, they are tumble dried to remove moisture. The dried sugar is then graded into sizes and packaged for delivery to customers.

**Mythbuster:** *White sugar is NOT bleached. A number of chemical agents are introduced to sugar syrup to assist in removing impurities. What's left at the end is pure white sugar crystals.*



## Lesson 3: Other Products From Milled Cane

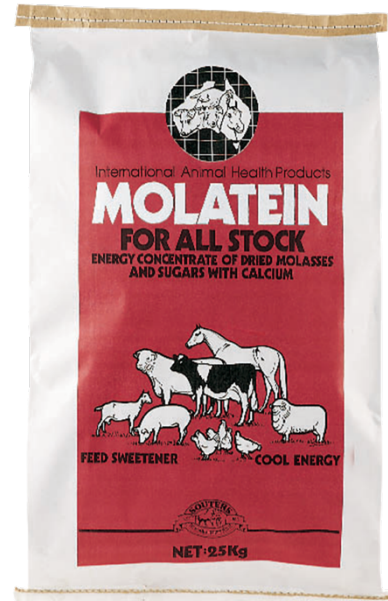
### Molasses

Another common product from sugarcane is molasses. Molasses is a dark syrup that is separated from raw sugar crystals during the milling process. It is often used in cooking foods such as baked beans, marinades, and deserts like pecan pie as well as a raw material for producing ethanol and rum.

Farmers also use it as an animal feed supplement. Molasses is very sticky, which can help to make feed mixture consisting of grain and other additives easier to eat for livestock. As molasses is normally used as an energy supplement, it is important to understand that it's low in other nutrients like protein. When its energy is balanced with added nutrients like Urea, it becomes an excellent supplement for cattle.

Molasses can also act as a catalyst for dairy cows to help increase their milk production. It can help strengthen the overall bone structure of livestock and improve weight gain for cattle.

Molasses usage is flexible, which means you don't necessarily need to add it to a specific kind of feed mixture; both fresh and dry sources can be supplemented with molasses to boost up your livestock meals.



#### Activity 3A

1. Find 1 recipe that you would like to try or have eaten that contains molasses.
2. Write out the recipe in your Learning Journal.

#### Activity 3B

1. Visit a grocery store or complete this task online.
2. Find and photograph/collect images of as many molasses brands as possible.
3. Add them to your Learning Journal.

### Bagasse to fuel the mills

At the sugar mill, the sugar is taken out of the stalk through a crushing process. The left over fibre from the stalk is called **bagasse**.



Bagasse is often used to power a sugarcane mill. This means that the sugarcane can make electricity as well as sugar. As the cane provides its own processing energy, it means we don't need to rely on fossil fuel to power the mill and also we have less wastage. Sugarcane is the only crop in the world that can do this.

The bagasse or fibre residue from the stalks can also be used as a fertiliser on cane farms and gardens just like sugarcane mulch. There are other specialised uses where it can be made into plastics, clothing and pharmaceuticals.

### Activity 3C

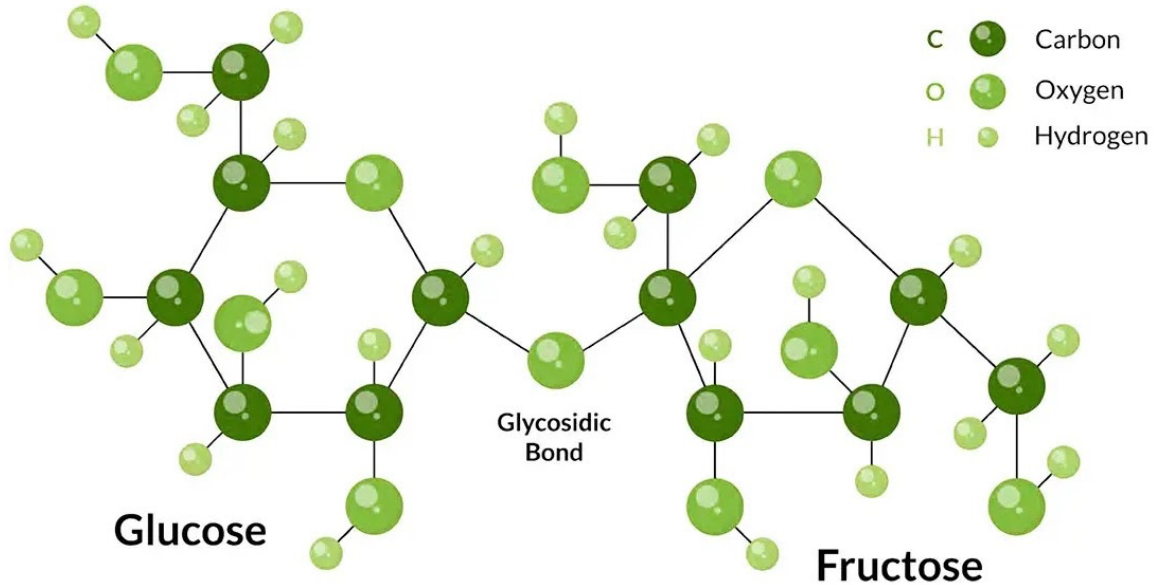
Answer the following questions in your Learning Journal.

1. What is the history of the word: bagasse?
2. What is the equivalent energy value of 1 ton of dry bagasse when used as fuel?
3. Roughly what is the percentage of cellulose in bagasse?
4. What other products can be made from bagasse?
5. How are bagasse food packaging products made?



## Lesson 4: So Many "Sugars" But Not All For Eating

### The chemical composition of sugar



### Why so many types of sugar?

In the culinary arts, the word "sugar" refers to crystallised sucrose that is derived either from sugarcane or sugar beets.

Chemically, sucrose is a disaccharide, just like maltose (which comes from grain) and lactose (which comes from milk).

Sugar provides sweetness, and it also performs a number of interesting functions in baking. For instance, sugar slows down the formation of gluten in wheat flour, which means baked goods will tend to be softer, with a finer texture, the more sugar they contain.

Because of the way it turns brown (known as caramelisation) when heated, sugar gives colour to baked goods.

Sugar also has a property called hygroscopy, which means it attracts and retains moisture. This helps baked goods stay fresher longer, since the presence of sugar helps prevent the ordinary drying out, or staling, of breads, cakes, and so on.

And of course, sugar is the food for the yeast organisms that cause breads to rise.



While there is no standard labelling system for sugars, other than the various ways individual manufacturers choose to label their products, we can classify sugars by the size of their grains, and/or by the degree of refining they have been subjected to.

#### Activity 4A

1. Are the following sugar myths true or false? Why?
2. Add your answers into your Learning Journal. You could start at this link: [sugar.org.au](http://sugar.org.au)
  - Natural sweeteners are much healthier for you than sugar.
  - Sugar is as addictive as drugs.
  - Sugar causes cavities in your teeth.
  - We need to eliminate sugar from our diet.

#### Activity 4B

1. Using the link below as a guide, collect photos of popular types of sugars from around the world. Try to find sugar varieties that you're not familiar with.
2. <https://www.thekitchn.com/a-complete-visual-guide-to-sugar-ingredient-intelligence-213715>
3. Add the information you find into a table in your Learning Journal.
4. Include the sugar's name, photo, where it's popular and a short description.



## Lesson 5: Value Added Cane Products

A value-added product is any product that has been changed using additional actions (e.g. bananas can be made into banana flour) or combined with other things to raise its overall value or to make a completely new product (e.g. raw wool used to make doonas).

Some value-added products can be obvious, such as leftover apples from a big harvest which are processed into juice and sold. Others we don't think about as much.

For example, did you know that growers make and sell mulch from the left-over sugarcane leaves that are stripped from the stalks during harvest? Let's learn about two value-added products made from sugarcane.

### Mulch - improves soil and prevents erosion



Many Australians enjoy gardening. Our warm weather allows us to spend a lot of time outdoors enjoying our backyards.

After harvesting, the leaf of the cane is left over. Whilst some of the stalks may be used as bagasse, some farms and mills have seen the value in turning this leaf waste product into garden mulch. It is made by breaking the leaves of the sugarcane plant into smaller pieces in a hammer mill.

These days it's quite common to use it on gardens to protect and improve the soil, cut down on weeds, and to hold water.

It helps to:

- Add nutrients and soil structure - as it composts and decomposes it adds soil carbon, creating a healthier soil for growing.
- Save water - mulch retains moisture in the soil by lowering the rate of evaporation, saving water.
- Increase soil biology - cane mulch has loads of microbial bacteria that grow naturally within it. As they mix with the soil it creates a perfect environment for worms to grow and multiply.
- Environmentally friendly - because it's produced from cane farming waste products it is environmentally sustainable, while making more money for local growers.



### Activity 5A

1. Watch the following videos then answer the following questions.
  - <https://www.abc.net.au/gardening/factsheets/mulch/9430092>
  - Making sugarcane mulch: <https://youtu.be/am1M0Ou0TO8>
2. Add your answers to your Learning Journal.
  - What is sugarcane mulch?
  - How is it made?
  - How much waste does it save?
  - What value to the industry?
  - How can we use it around our homes?

### Activity 5B

1. Watch this video and solve the following problems: Sugarcane Mulch in Your Garden - How to Use it and Application Rates <https://youtu.be/8iCJs-wwlZM>
2. Based on the video, work out how many bags of sugarcane mulch you would need to buy to cover the following gardens.
  - A square garden with one side of 33m.
  - A circular garden with a radius of 13m.
  - A rectangular garden with length of 15m and a width of 12m.



## Ethanol - cleaner emissions, cleaner hands

### What is ethanol?

Among its many uses, ethanol, ethyl alcohol, is the intoxicating part of beer, wine and other alcoholic drinks. It can also be used as a biofuel alternative in many countries across the world and is commonly referred to as alcohol in hand sanitisers

It can be made from liquids and fruits that all contain one key ingredient: sugar. Ethanol from sugarcane can be made by using either fresh sugarcane juice or by the fermentation of cane sugar, which contains sugar granules made from sugarcane. If you add yeast to the liquid, it can be turned into sugarcane alcohol through the simple chemical process of fermentation. Ethanol is one of the by-products of the fermentation chemical reaction; the other is carbon dioxide.

### How does fermentation happen?

Fermentation is the process for making any type of liquor and occurs when sugar comes in contact with yeast. Yeast, which are single-celled microorganisms that belong to the fungus family, eat the sugar and digest it anaerobically. During their digestion which occurs in the absence of oxygen, yeast produces two products: ethanol and bubbles, which are made of carbon dioxide.

### Practical Activity 5C

1. Watch the following experiment: <https://youtu.be/FYCICHVT00M>
2. Try the experiment yourself and see if your results match those in the video. Maybe try using different coloured balloons.
3. Take photos of the different stages and record your results in your learning journal.
4. When you've finished your experiment, make sure you dispose of the liquid in your bottles carefully.
5. **Warning:** Do not drink or taste it

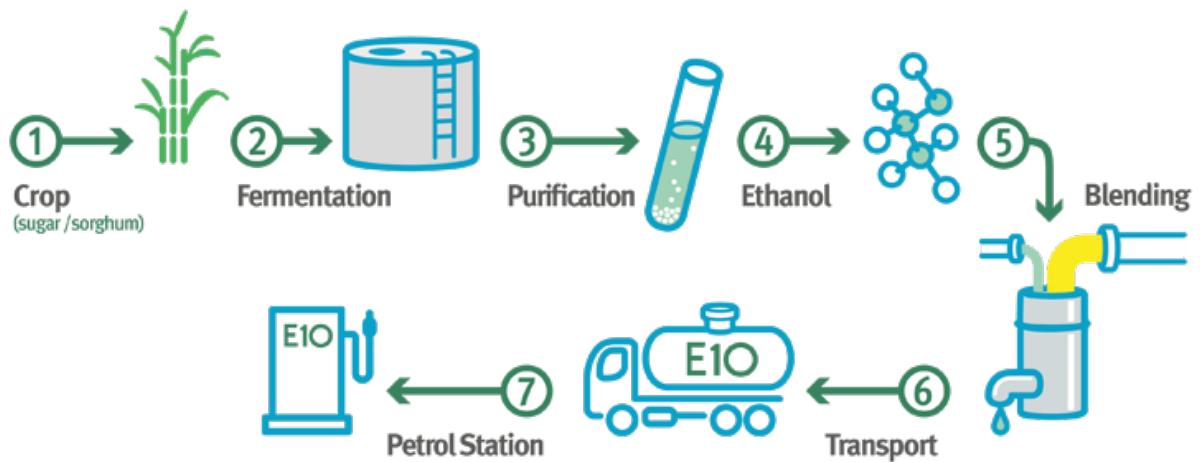
### How is it made from sugarcane

The ethanol production diagram below shows the steps from field to fuel station. Not all ethanol produced goes into fuels. At Stage 4, raw ethanol is sold to other manufacturers who in turn make it into hand sanitiser and many other products that we use in our daily lives.





You'll find it in items like spray cleaners, beauty products, hairspray, mouthwash, perfumes, windscreen wiper fluids, Windex, moist towelettes and baby wipes.



### Activity 5D

1. Using PowerPoint or Slides, reproduce the diagram above using images from magazines, photos or from online. Include a short description of each step of the process.
2. This link will help you: <https://www.qld.gov.au/transport/safety/road-safety/e10-fuel/environment>
3. Add to your Learning Journal

### How is ethanol used in our daily lives?

Most people see ethanol used in two main places, in petrol/fuel and in hand sanitiser.

NOTE: Since ethanol is a toxic chemical and also a solvent cleaner, you should **never drink it** as it can put you in a coma (ethanol poisoning) and lead to death.

We use ethanol to add oxygen to gasoline which helps it burn more efficiently, reduce air pollution and cut emissions. Ethanol can also help reduce greenhouse gas emissions when compared to burning petrol by itself. It burns more efficiently than any other liquid biofuel available today to consumers.

Ethanol can also enhance a vehicle's performance. It is a high-octane fuel that generates more power in higher compression engines.

It is now a major fuel source in many countries. Brazil has been making ethanol from sugarcane in order to reduce its dependency on oil which they need to import from overseas, and they have become the second highest producer of ethanol.



Learn more: <https://www.racq.com.au/cars-and-driving/cars/owning-and-maintaining-a-car/facts-about-fuels/ethanol>

### Activity 5E

1. Using the Petrol Spy app (<https://petrolspy.com.au>), choose a city near you and compare the prices of E10, 94 and 98 petrol at ten different petrol stations across all parts of the city.
2. Save the data in a spreadsheet.
3. Graph your resulting data to group the E10 data, 94 data, 98 data together.
4. Which fuel was the cheapest? Buy how much on average?
5. Add your graph to your Learning Journal.

## Hand Sanitiser

### How does hand sanitiser work?

Technically, most of the popular hand sanitisers are made from forms of alcohol like ethanol, ethyl alcohol (the same chemical found in wine, beer, and liquor) or isopropanol, which is found in rubbing alcohol. These can inactivate many types of viruses and bacteria, which can end up in killing them.

- Watch <https://youtu.be/UjQ6HSq3UIk>.

That said, ethanol and isopropanol above only comprise around 70 percent of the active ingredients in hand sanitiser. The rest of the ingredients are added to give the liquid it's gel-like consistency, moisturising properties, and its floral smell. In some cases, manufacturers might even add some foul-tasting chemicals to the mixture to deter you from potentially taking a drink (Do not do this!).

These mixtures are typically advertised as "killing 99.99 percent of germs." In lab conditions, they can nearly eradicate certain strains of bacteria, but not all of those commonly found on your hands. Nevertheless, they do a pretty good job especially when you don't have access to soap and water to wash with.

- Watch [https://youtu.be/oCl6gl2\\_Zl4](https://youtu.be/oCl6gl2_Zl4).



Bacteria can't develop extra strong protective shells against being killed by alcohol, so it's ok to keep on squirting the aloe-scented sanitiser all year long. The bad news? It doesn't physically clean dirt and grime from hands. For that, you'll have to stick to old-fashioned soap and water.

### Activity 5F

1. Read the article “Bush businesses take up call to boost hand sanitiser supplies” about how a local business was using local sugarcane to make sanitiser during the early days of the COVID pandemic.  
- [PDF](#)
2. Answer the following questions.
  - Who are Husk Distillers and where are they based?
  - What did they use as a base for the production of liquid sanitiser?
  - Why did they decide to produce sanitiser instead of their usual products?
  - What fragrance did they use?
  - What is the name of the company founder?
  - Aside from the production of sanitiser for the community, what benefits were there for the business?
3. Write your answer in your Learning Journal

### Activity 5G

1. Using a real shop or online, list the ingredients to five different brands of hand sanitiser.
2. If your online shop doesn't show the ingredients, do a Google search for the “brand name label” and read the image.
3. (<https://shop.coles.com.au/a/national/product/dettol-instant-hand-sanitiser-pump>)
  - How many contain ethyl alcohols?
  - What do the sanitisers have in common?
  - What is different about each?
4. Write your answer in your Learning Journal



## Lesson 6: Future Cane

### Sustainable sugarcane growing

Australian cane growers are doing remarkable things when it comes to protecting and caring for their environment and the Great Barrier Reef.

- Watch <https://youtu.be/zH7SdF-ghEg> - Sugarcane in Queensland

### Technology in cane growing - precision farming

For many years they have been involved in an amazing array of projects and trials. Growers have also designed and implemented innovative and creative solutions, to improve productivity and profitability and reduce the impact of farming on the environment.



Here are some examples of how growers are using technology to improve their cane growing methods:

- Three Tully growers are trialing new satellite technology to address crop yield variations within their farms. They hope it will be a win-win for their businesses and the environment. The imagery will be used to identify areas with higher or lower yields in an attempt to tailor fertiliser rates within a cane block to improve profits and reduce runoff of chemicals into the local waterways.
- A Burdekin cane grower is combining the cost-saving power of high efficiency pumps with solar generated power, to slash thousands off his quarterly bills and undergo an upgrade of his farm's irrigation network. This will allow him to use less water, draw less electricity from the grid and make his farm more efficient.
- Australian growers have been at the forefront of developing and embracing new technologies for well over 100 years. They're always trying to get better results from their cropping and their machinery yet protect the environment for future generations at the same time.



### Activity 6A

Watch these two videos and take notes about the farming methods, machines used, and what has changed / improved over time.

- Watch Video 1: <https://youtu.be/KqX4K1E8NOM> - old footage
  - Watch Video 2: <https://youtu.be/clbRdZ9x7Q4> - cropping technology over time
1. Write a brief report that discusses the differences between early farming machinery and the technology that growers have access to now. You must cover these topics: efficiency, results, time savings, and improved crop growth.
  2. Add your report to your Learning Journal

### Activity 6B

1. Watch the following three videos.
  - Watch <https://youtu.be/FLh4wWw76kc> - Soil moisture probes
  - Watch <https://youtu.be/Xtux9OqUmP8> - GPS controlled traffic systems
  - Watch <https://youtu.be/6qBimHNDiMs> - Drone use
2. In the three videos, we saw some technology that growers are using to manage, improve and grow better cane. Imagine you had a complete robotics and AI lab available to you and all of its scientists.
  - Design the ultimate “robot cane grower” that could be used by growers within the next five years. Here is a list of sensors that you would have access to [https://en.wikipedia.org/wiki/List\\_of\\_sensors](https://en.wikipedia.org/wiki/List_of_sensors)
  - Draw a technical diagram of your robot explaining all its features.
  - List and explain what your robot does, how it does it and how that will help grower become more efficient and produce a more sustainable and high yield crop. You can present your information as a:
    - detailed report (min 500 words),
    - or a multimedia presentation
    - or animation
  - Add your information to your Learning Journal.

### Extension Activity

3. If you have access to 3D CAD and 3D printers, create a three-dimensional model of your “robot cane grower”. Model it using 3D CAD then slice it to send to your 3D printer.

