What Does a Grains Scientist Do? Case Studies

TEACHER GUIDE

LESSON 1

YEAR 7–10

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LESSON 1

What Does a Grains Scientist Do? Case Studies

LEARNING AREA

Design and Technologies (Year 7–10)

AUSTRALIAN CURRICULUM CONTENT

Analyse how people in design and technologies occupations consider ethical and sustainability factors to design and produce products, services and environments **(AC9TDE8K01)**

Analyse how food and fibre are produced in managed environments and how these can become sustainable **(AC9TDE8K04)**

Analyse how people in design and technologies occupations consider ethical, security and sustainability factors to innovate and improve products, services and environments **(AC9TDE10K01)**

Analyse and make judgements on the ethical, secure and sustainable production and marketing of food and fibre enterprises **(AC9TDE10K04)**

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LESSON OBJECTIVE

Students will learn about innovations and technologies in the cropping industry. They will view source materials that are focused on developing new varieties of productive plants in a changing climate, and technologies that generate data to enable improved risk management and crop decision-making by producers.

LESSON OVERVIEW

Activity 1.1 – Case Study One: Breeding Wheat for a Changing Climate (20 minutes)

Activity 1.2 – Case Study Two: Frost Mapping a Future Management Tool (20 minutes)

Activity 1.3 – Case Study Three: Heat Tolerant Wheat (20 minutes)

Resources and Equipment

ACTIVITY 1.1 – Case Study One: Breeding Wheat for a Changing Climate

1. **Worksheet 1.1a – Case Study One: Breeding Wheat for a Changing Climate** (Mind map activity)
2. Access to computer/digital device
3. Breeding wheat for a changing climate (10:06)

ACTIVITY 1.2 – Case Study Two: Frost Mapping a Future Management Tool

1. Access to computer/digital device
2. Frost Mapping a Future Management Tool (6:51)
3. **Worksheet 1.2a – Case Study Two: Frost Mapping a Future Management Tool** (Question and answer activity)

ACTIVITY 1.3 – Case Study Three: Heat Tolerant Wheat

1. Heat Tolerant Wheat: improving yield through heat tolerance (6:06)
2. **Worksheet 1.3a – Case Study Three: Heat Tolerant Wheat** (Bookmark activity)

Lesson Guide

ACTIVITY 1.1 – Case Study One: Breeding Wheat for a Changing Climate

Students learn about breeding wheat and other crop varieties to be more tolerant of changing Australian climatic conditions.

1. Provide students with digital devices and ask them to view the source material Breeding wheat for a changing climate (10:06). Students scroll to the 'play' icon in the source material and listen for any innovations or areas targeted to improve plant production during changing climatic conditions.
2. Students use the mind map on **Worksheet 1.1a – Case Study One: Breeding Wheat for a Changing Climate** (Mind map activity) to identify up to five genetic targets being researched in the cropping industry as ones that can combat factors of concern.

   Answers

ACTIVITY 1.2 – Case Study Two: Frost Mapping a Future Management Tool

Students learn about technologies aiming to improve producers' knowledge about trends of damaging frost events on their farms and the significance of this technology to the grain industry.

1. Provide students with digital device access and ask them to view the source material Frost Mapping a Future Management Tool (6:51).
2. Students respond to the questions on **Worksheet 1.2a – Case Study Two: Frost Mapping a Future Management Tool** (Question and answer activity) during the video.

   Answers

ACTIVITY 1.3 – Case Study Three: Heat Tolerant Wheat

Students learn about innovation in breeding wheat that is increasingly tolerant to heat.

1. Provide students with digital device access and ask them to view the source material Heat Tolerant Wheat: improving yield through heat tolerance (6:06), which is focused on breeding heat tolerant wheat.
2. Distribute **Worksheet 1.3a – Case Study Three: Heat Tolerant Wheat** (Bookmark activity). Students create three bookmarks, summarising the main points of the case study, to educate other students about innovation in breeding wheat.

   Answers
3. Cut out and laminate bookmarks.

Images courtesy: GRDC

Answers

ACTIVITY 1.1 – Case Study One: Breeding Wheat for a Changing Climate

WORKSHEET 1.1a – Case Study One: Breeding Wheat for a Changing Climate (Mind map activity)

Answers will vary depending on individual student responses, but may include:

- Increasing carbon dioxide levels.
- Increased warming.
- Decreasing water availability.
- Increasing yield.
- Increasing quality.
- Increasing disease resistance.
- Increasing coleoptile length to improve drought resistance.
- Locating dwarfing genes.
- Targeting early vigour, increasing leaf area and biomass.
- Increasing water use efficiency.
- Finding awnless wheat varieties.
- Targeting heat stress genes.
- Targeting frost resistance genres.

ACTIVITY 1.2 – Case Study Two: Frost Mapping a Future Management Tool

WORKSHEET 1.2a – Case Study Two: Frost Mapping a Future Management Tool (Question and answer activity)

1. 20-40.
2. It creates a lot of work each month to download the data.
3. To rapidly identify where a crop has been exposed to a damaging frost.
4. Red is above zero degrees Celsius. Blue is below zero degrees Celsius.

(Answers for Worksheet 1.2a continued following page...)

Answers (continued)

5. Data has geographic components – a latitude and longitude or a place on a map.
6. Temperature behaviour across variable terrain on a frosty night.
7. Ebs and flows of temperature.
8. 3.2 degrees Celsius.
9. Farmers would have a single weather station to transmit temperatures to a central point. When a minimum temperature is received, it generates maps of temperatures on a farm.
10. Frost-damaged plant tissues.
11. Make immediate crop management decisions, such as cutting a damaged cereal crop for hay and planning longer-term farming system strategies. Farmers can take certain crops out of a zone, select variable rates of seeding, and change varieties used on the farm.

ACTIVITY 1.3 – Case Study Three: Heat Tolerant Wheat

WORKSHEET 1.3a – Case Study Three: Heat Tolerant Wheat (Bookmark activity)

Answers will vary depending on individual student responses, but may include:

- Climate is increasingly warming.
- Experiencing increased heat shock.
- Finding diversity for heat tolerance and providing this to breeders.
- Using genomic selection technology to combine genes and establish estimated breeding values.
- Breeding time is reduced from five to six years to two to three years.
- Looking worldwide for genotypes with desirable qualities.
- Using heat chambers and greenhouses in testing phases.
- Looking at genes that control flowering and grain filling, which are controlled by different genes.
- Using drones to take a snapshot of data across field trials.

References

- Corporation, Grains Research and Development Corporation (2013, February 7). *Heat stress tolerance of wheat*. Grains Research and Development Corporation. https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2013/02/heat-stress-tolerance-of-wheat#:~:text=Heat%20stress%20is%20a%20key

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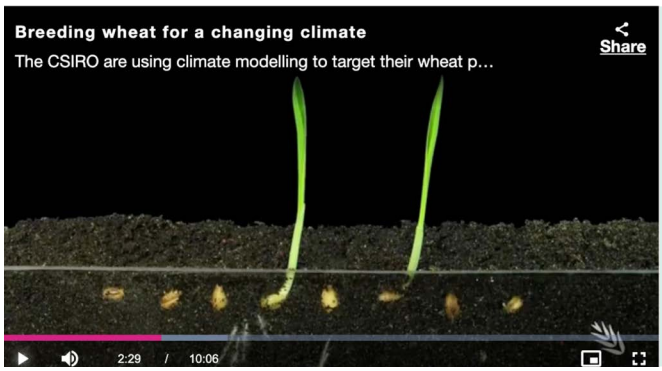
- Grains Research and Development Corporation. (2019, July 24). *Frost Mapping a Future Management Tool*. www.youtube.com. https://www.youtube.com/watch?v=Pbmnwj23rf4&t

- Grains Research and Development Corporation. (2022, November 10). *Heat Tolerant Wheat: improving yield through heat tolerance*. www.youtube.com. https://www.youtube.com/watch?v=6nDjDdO-IWY

Case Study One: Breeding Wheat for a Changing Climate

Scan the QR code or click on the link to scroll and view the video on breeding innovation and technology in the grain industry. Identify up to five genetic traits or target areas discussed in the video and record them in the mind map.



Breeding wheat for a changing climate (10:06)
https://grdc.com.au/news-and-media/news-and-media-releases/national/2020/october/wheat-researchers-progress-quest-for-better-adapted-cultivars

Genetic traits or target areas

1.
2.
3.
4.
5.

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Case Study Two: Frost Mapping a Future Management Tool

Scan the QR code or click on the link to view the video focused on innovation and technology in the grain industry.

Frost Mapping a Future Management Tool (6:51)
https://www.youtube.com/watch?v=Pbmnwj23rf4

Read the information below before answering the questions on the following page.

Frost effect on the plant

'White' frost occurs when the air around the plant is moist and the temperature around the plant is zero or below. Ice crystals form on the surface of the plant. The water in between plant cells freezes and draws water out of surrounding cells to form more ice. When the frost melts slowly (i.e. in winter), the damage is minor, and the plants repair themselves to fight another day. The visual effect is similar to drought stress as plants can temporarily appear wilted. In spring, the thawing can be rapid and damage can be severe.

'Black' frost occurs when the temperature drops below zero but the surrounding air is dry (i.e. drought conditions). Ice can't form on the plant surface and the water between cells freezes quickly and forms large crystals. These large crystals 'pop' holes in the cells causing permanent damage. Once thawed, plant parts affected immediately look floppy, spongy and discoloured. If that plant part happens to be a flower or a developing ovary, the result can be detrimental to yield.

(Modified from GRDC, 2014)

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Case Study Two: Frost Mapping a Future Management Tool (cont.)

Answer the following questions about frost mapping as a management tool.

1. Typically, how many loggers are needed in a paddock for frost detection?

2. Identify the problem with this.

3. Identify the aim of the frost management tool.

4. What do the red and blue colours on the map indicate to producers?

5. Describe what is meant by spatial data.

6. When the data was animated, what did it illustrate?

7. Identify some of the data that the animation showed.

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Case Study Two: Frost Mapping a Future Management Tool (cont.)

8. What was the difference in temperature between the regional weather station and the on-farm loggers?

9. Explain how this technology might be used in practice.

10. What does electromagnetic spectrum technology recognise and assess?

11. Highlight the advantage to producers of combining these two technologies.

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Case Study Three: Heat Tolerant Wheat

Scan the QR code or click on the link to view the video focused on the development of heat tolerant wheat varieties.

Heat Tolerant Wheat: improving yield through heat tolerance (6:06)
https://www.youtube.com/watch?v=6nDjDdO-IWY

Heat stress

Heat stress is a key abiotic stress affecting crop and cereal production in all regions of the Australian wheat belt. Heat stress can have significant effects on grain yield and productivity, with potential losses equal to and potentially greater than other abiotic stress, such as drought and frost.

(GRDC, 2013)

Flanker wheat heads just before harvest in December 2018, which was a very dry season. (Image courtesy: GRDC)

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Case Study Three: Heat Tolerant Wheat (cont.)

Create bookmarks by summarising three important aspects about heat tolerant wheat on the bookmark templates below.

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