Written Activity One

Design Your Own Farm

You are a new farmer in Australia and have just purchased a piece of land to start your farm. The land includes a mixture of crop fields, livestock pastures, and even an available area for a greenhouse. Your mission is to design a farm that uses the latest technology for efficiency, sustainability, and productivity. Remember, you are starting in Australia, a continent known for its diverse climate ranging from tropical rainforests to arid deserts and cool mountainous regions. Your farm design should consider these environmental factors.

Annotate the image on the next page.

Describe where your farm is located.

- Where in Australia is your farm located?
- What type of crops will you grow?
- What type of livestock will you keep, if any?

Overcoming Challenges and Application of Technology

What potential challenges or problems might your farm face (considering location, crops, livestock, climate change, etc.)?

- List and describe the technologies you will incorporate into your farm.
  Choose at least three from the following categories:
  - Internet of Things (IoT)
  - Big Data and Artificial Intelligence (AI)
  - Robotics and Automation
  - Vertical Farming and Hydroponics
  - Genetic Engineering
- Explain why you have chosen each technology and how it will benefit your farm in terms of productivity, sustainability, and efficiency.

Ethical Considerations

Discuss any potential ethical considerations or controversies related to the crops, animals, or technological innovations you use on your farm. How will you address these concerns?

Design Sketch

Draw a rough sketch of your farm layout. Show where and how each chosen technology will be implemented on your farm.

Remember, the goal of this activity is to create a sustainable, efficient, and productive farm by using the latest technology. Be creative, and remember to justify your choices based on the location of your farm and the types of crops and livestock you plan to produce.

Good luck, future farmers!

Written Activity Two

Question Time

Sustainable Farming

1. What is one method of farming that contributes to environmental sustainability in primary food production? Why is this method considered sustainable?

> One method of farming that contributes to environmental sustainability in primary food production is minimum tillage farming. This method is sustainable because it reduces soil disturbance during seedbed preparation and planting, conserving soil structure and biodiversity. It also leaves crop residues on the soil surface, which helps enhance water infiltration and retention, increase the organic matter content of the soil, and reduce greenhouse gas emissions. Furthermore, minimum tillage farming reduces fuel and labour costs by avoiding conventional ploughing or intensive tillage, contributing to economic sustainability. This practice helps to ensure long-term agricultural productivity without compromising the health of the environment.

Climate Change

2. How do human activities related to food production influence the levels of greenhouse gases in the atmosphere and potentially impact global warming?

> Human activities related to food production contribute significantly to releasing greenhouse gases, which are harmful to the environment.
>
> Carbon Dioxide (CO_2):
>
> - Burning fossil fuels (coal, oil, and natural gas) to produce electricity, gas, and petrol releases carbon dioxide.
> - Deforestation, clearing land for farming, add to CO_2 levels by reducing the number of trees that absorb carbon dioxide from the atmosphere.
> - When insects and plants decompose, bacteria release carbon dioxide into the air.
>
> Methane (CH_4):
>
> - Cows and sheep release methane through burping and flatulence.
> - Food waste, manure, and urine emit methane when they decompose in the absence of oxygen.
> - Flooded rice paddies provide an environment for methane-producing bacteria to thrive, leading to methane emissions.
> - Methane is also produced during the extraction of fossil fuels like coal.
>
> Nitrous Oxide (N_2O):
>
> - Nitrogen-based fertilisers used in crop and pasture production release nitrous oxide when applied to the soil.
> - Vehicle fuel consumption is another source of nitrous oxide.
> - Certain bacteria that break down human and plant waste also release nitrous oxide.

3. How does global warming and climate change impact primary food production in Australia?

> Increased bushfires due to rising temperatures and decreased rainfall can destroy crops, infrastructure, feed supplies, pastures, and livestock and disrupt food production. Bushfires can also cause power outages and road closures that affect dairy operations and delivery.
>
> Global warming is causing more intense and frequent floods and storms. Warmer atmospheric temperatures can hold more water, resulting in heavier, longer-lasting rainfall. In addition, melting ice caps and expanding ocean water leads to rising sea levels that can cause coastal flooding. These conditions can result in damaged irrigation equipment, erosion due to washed-away nutrient-rich topsoil, delayed cultivation and harvesting due to waterlogged land, and transportation issues affecting the selling of produce.

Rising temperatures also increase drought frequency and severity by evaporating more moisture from the soil and reducing rainfall in drier areas. Droughts limit water and pasture for livestock, forcing farmers to buy water and causing a decline in crop quality. Overcoming droughts and re-establishing a market presence can be challenging for farmers.

Finally, heatwaves, which are increasing in duration and frequency, can render some regions unfit for crop cultivation or livestock raising. High temperatures increase carbon dioxide levels, resulting in plants with lower mineral and protein levels. Crops such as maize, rice, and wheat yield less in temperatures over 30°C, and livestock production is also negatively affected. For instance, farmers may need to select cattle that can tolerate hot conditions but may not produce high-quality meat, and dairy cows may produce less milk.

Biodiversity

4. What is meant by the term "biodiversity"?

Biodiversity refers to the amount and variety of species living in a specific location. These organisms contribute to and form part of the ecosystem. Ecosystems require biodiversity to function effectively and help maintain the environment. Biodiversity helps to create balance within ecosystems.

5. Why is biodiversity important for the health of soil?

Biodiversity can be found in good-quality soils. This includes living organisms such as animals, bacteria, earthworms, and insects. These organisms feed off animal and plant residue, releasing waste that contains nutrients into the soil. These nutrients are absorbed by crops and plants, which animals and humans then consume. This nutrient cycle contributes to the overall health and productivity of the soil..

6. What factors contribute to a decrease in biodiversity?

Factors that contribute to a decrease in biodiversity include climate change and global warming, erosion, land clearing, and urbanisation, lack of crop diversity, and the use of pesticides. Climate change and global warming can cause events such as intense bushfires, droughts, heatwaves, floods, and storms, making it challenging for ecosystems to recover. Erosion can remove the nutrient-rich top layer of soil, reducing soil biodiversity. Land clearing and urbanisation decrease the natural habitat available for various organisms. A lack of crop diversity and the use of pesticides can negatively impact biodiversity in agricultural settings.

7. How can improving biodiversity in agriculture assist in addressing the impact of climate change?

Improving biodiversity in agriculture can create a more resilient ecosystem that can better recover and adapt to the impacts of climate change. A greater diversity of crops can help to maintain soil health, as different crops have different nutrient needs and can therefore help to maintain a balance of nutrients in the soil. Diverse agricultural systems are also more resilient to pests and diseases, reducing the need for pesticides and their negative impact on biodiversity. Furthermore, a diverse ecosystem is better able to recover from extreme weather events, such as those intensified by climate change.

8. How have health and nutrition concerns influenced the availability of different types of food in the market? Provide examples of specific food options that have emerged as a result of these concerns.

Health and nutrition concerns have influenced the availability of different food types in the market. For instance, the demand for organic produce has grown, leading to a wider range of organic fruits, vegetables, and grains. Similarly, the desire for GMO-free foods has prompted the introduction of more options. The trend towards additive-free and minimally processed foods has resulted in products with simpler ingredients. Functional foods fortified with beneficial nutrients have emerged. Other examples include plant-based dairy alternatives, reduced-sugar products, gluten-free foods, fortified options, prepared meal services, and protein-enriched choices.

Use of Fertilisers

9. What are the two types of fertilisers and what are they made from?

The two types of fertilisers are synthetic (or man-made) fertilisers and organic fertilisers. Synthetic fertilisers are composed of nutrients made from chemicals. Organic fertilisers, on the other hand, originate from natural sources such as crushed fish, dried blood, ground bone, manure, rock minerals, shells, small rocks, and wood chippings. Both types of fertilisers contain essential nutrients like nitrogen and phosphorus, which aid in producing a high-quality crop with strong growth.

10. How does the use of fertilisers impact the environment?

The use of fertilisers can have a significant impact on the environment. Risks associated with the use of fertilisers include an increase in gas emissions, which are produced during the production, transportation, and application of fertilisers and by bacteria in the soil that break down the fertiliser. Fertilisers can also lead to groundwater pollution if high concentrations of nitrate from the fertilisers seep through the soil and enter groundwater supplies. Furthermore, the phosphorous in fertilisers can lead to eutrophication, contaminating water supplies and potentially harming humans and animals. Lastly, adding excessive amounts of nitrogen-containing fertilisers can cause soil acidification, which decreases the availability of nutrients in the soil and leads to a decline in crop and plant production.

Use of Pesticides

11. What are some of the main reasons farmers use pesticides?

Farmers use pesticides for various reasons, including controlling insects, pests, and weeds, decreasing labour costs associated with managing pest infestations, improving profit margins, enhancing plant growth, reducing blemishes on crops, increasing crop yields, preventing disease and infestations, and reducing food wastage, as crops affected by pests are often discarded.

12. What are the potential environmental risks associated with using pesticides?

- The environmental risks associated with the use of pesticides include the creation of 'superbugs,' or insects that become immune to pesticides and pass this immunity onto their offspring, making them resistant to pesticide sprays.
- Pesticides can also decrease biodiversity by killing off non-target species such as beneficial insects like bees and butterflies, birds, fish, and plants.
- Pesticides may also pollute groundwater when they wash off crops in the rain or infiltrate into groundwater or water systems.

Use of Water

13. Why is water essential for farmers?

They need water to apply pesticides and fertilisers, to clean farm buildings, equipment, and animals, to grow crops, and to supply drinking water for animals and humans.

14. What is irrigation, and how does it contribute to salinity?

Irrigation is adding water to crops or plants to aid their growth. However, overuse of irrigation can contribute to increased salinity, a situation with an increased salt concentration in the soil or water table. Excess water from irrigation can seep into the water table, causing it to rise and bring salt. The salt remains in the soil and the water table after the surface water evaporates, leading to a high concentration of salt, which can harm plant growth and lower crop yields.

15. What environmental problems are associated with salinity?

> Salinity endangers wildlife through the loss of habitat, food, and water. It can disrupt ecosystems by causing salt contamination in waterways and freshwater habitats. Salinity can also lead to land degradation, such as erosion, and damage to infrastructure, including buildings, roads, and underground pipelines, and negatively impact water quality, including drinking water supplies and irrigation water. Finally, salinity can result in reduced quality and quantity of crop yields.

16. What strategies are farmers using in the Murray–Darling Basin to manage salinity and improve water management?

> These include regularly testing and monitoring salinity levels, maintaining irrigation equipment to prevent leakages, using technology like GPS navigation, drones, and computerised drip irrigation systems to deliver the right amount of water to crops at the right times, and reusing water from other farm production activities and excess irrigation water.

Choice of Crops

17. How is climate change influencing the choice of crops for farming in Australia?

> As a response, farmers are considering changing the type of crops grown or the animals raised to more sustainable alternatives to better adapt to these changing conditions and continue providing good quality food in sufficient quantities.

18. What are some environmental impacts of sugarcane production in Australia?

> Pesticides used to protect crops from pests and weeds often find their way into water sources, threatening marine life and water quality in places like the Great Barrier Reef.

19. How is technology aiding in the management of sugarcane crops in Australia?

> The CSIRO has developed an app to assist farmers in managing the amount of water and chemicals they add to their sugarcane crops. They have also supported farmers in using drones to track crop performance and determine if crops require fertiliser and pesticides. Additionally, a new breed of sugarcane, known as SRA28, has been developed, which is more disease-resilient and requires less pesticide application.

20. What are the benefits of growing and using saltbush as animal fodder?

> Saltbush has multiple benefits when used as animal fodder. It grows well in Australia's acidic, dry, and salty soils and doesn't require fertiliser or pesticides. It is also drought-resilient, high in energy and protein, and doesn't cause digestive problems in animals. Moreover, planting saltbush improves soil conditions and assists in lowering water table levels, reducing the impact of salination. Furthermore, it has been observed to enhance sheep production, with sheep feeding on saltbush producing more wool and gaining more weight.

21. How can seaweed farming potentially reduce the environmental impact of the beef industry?

> Seaweed farming has the potential to significantly reduce the environmental impact of the beef industry. Seaweed doesn't require additional water to grow, thereby reducing dependency on water supplies. Moreover, when cattle are fed seaweed, the methane they produce, which contributes to around 15% of the world's greenhouse gases, decreases by 99%. This suggests that seaweed farming and feeding it to cattle could play a significant role in mitigating the environmental footprint of the beef industry.

Biosecurity

22. What is biosecurity and why is it important in Australia?

Biosecurity refers to the measures taken to prevent the introduction, establishment, or spread of harmful organisms that transmit disease to animals and plants in a given area. In Australia, biosecurity is crucial to protect the biodiversity of its unique and fragile ecosystems. The introduction of foreign invasive species could have a devastating impact on Australia's environment, threaten the survival of native species, and potentially decimate the agricultural industry.

23. Why can invasive species threaten biodiversity more than habitat destruction and climate change in Australia?

Invasive species can reproduce quickly and out-compete native plants and animals for food, water, and space. This rapid proliferation and competition can lead to the displacement or extinction of native species, significantly impacting biodiversity. According to CSIRO, invasive species pose a greater threat to biodiversity in Australia than habitat destruction and climate change.

24. What risks can invasive species pose to the agricultural industry in Australia?

Invasive species pose significant threats to the agricultural industry in Australia. They can destroy a wide variety of plant species, causing extensive damage to crops. An example of such a pest is the fall armyworm, detected in Australia in 2020, known to destroy 350 plant species including maize, sorghum, wheat, and fruit and vegetable crops. If these pests go undetected, they could cause substantial harm to businesses, the economy, human health, and the environment. The Department of Agriculture is responsible for preventing such invasive species from entering Australia.

Written Activity Three

Australian Agriculture and Climate Change: Two-Way Street

Read the article at this link:

https://www.science.org.au/curious/policy-features/australian-agriculture-and-climate-change-two-way-street

1. How does climate change impact Australian agriculture and its ability to feed the nation?

   Climate change affects Australian agriculture by causing extreme weather events, changing rainfall patterns, and temperature variability. These factors can impact crop yields, livestock productivity, and overall agricultural productivity, potentially affecting the nation's ability to feed itself.

2. What environmental issues are associated with livestock production in Australia, and why are consumers seeking alternative protein sources?

   Environmental issues associated with livestock production in Australia include greenhouse gas emissions, water pollution from waste, land degradation, and deforestation for feed production. Consumers are seeking alternative protein sources due to concerns about the environmental impact of livestock production, animal welfare, and personal health considerations.

3. How does Australian agriculture contribute to climate change, and what are some examples of activities that lead to greenhouse gas emissions?

   Australian agriculture contributes to climate change through activities such as deforestation for agriculture, emissions from enteric fermentation in livestock, and the use of synthetic fertilisers. These activities release greenhouse gases, contributing to global warming and climate change.

4. What strategies do Australian farmers use to reduce the effects of climate change on agriculture, and how do these strategies benefit the environment and reduce costs?

   Australian farmers use strategies such as no-till agriculture, carbon sequestration in soils, precision farming techniques, and improved water management to reduce the effects of climate change on agriculture. These strategies benefit the environment by reducing greenhouse gas emissions, improving soil health, conserving water resources, and reducing input costs for farmers.

5. How do climate change and rainfall trends affect food prices in Australia, and how does it impact the availability and quality of certain foods?

   Climate change and rainfall trends can affect food prices in Australia due to their impact on agricultural productivity. Decreased rainfall and extreme weather events can lead to lower crop yields, increasing prices. Changes in the availability and quality of certain foods can also occur if their production is affected by climate-related factors.

6. What changes in culinary preferences have been observed among Australian consumers in response to the negative impact of agriculture on climate change?

   Changes in culinary preferences among Australian consumers include increased demand for plant-based protein alternatives. This shift is driven by concerns about the environmental impact of animal agriculture, animal welfare, and health considerations. Consumers are opting for plant-based and lab-cultured meat substitutes.

7. How are researchers addressing the impacts of climate change on Australian agriculture, and what innovative technologies and processes are being developed?

Researchers are addressing the impacts of climate change on Australian agriculture by developing innovative technologies and processes. These include genomics and biotechnology tools to breed climate-resilient crops and livestock, protected agriculture methods for energy-efficient and controlled environment farming, and using sensors for precise water and nutrient management.

8. How can genomics and biotechnology tools be used to breed crop varieties and livestock that are more climate resilient?

Genomics and biotechnology tools can be used to identify and select genetic traits that make crops and livestock more resilient to climate change. This allows for developing varieties that can withstand temperature extremes, drought, or pests, ensuring food production under changing climatic conditions.

9. How can sensors be utilised in agriculture to optimise water and nutrient usage?

Sensors can be utilized in agriculture to monitor soil moisture levels, nutrient content, and plant health. This data can be used to deliver water and nutrients to crops precisely, optimizing their usage and reducing waste. It helps farmers improve water and nutrient efficiency, leading to more sustainable farming practices.

10. What is the significance of investigating traditional Aboriginal food production systems in Australia for developing climate-adapted crops?

Investigating traditional Aboriginal food production systems in Australia is significant for developing climate-adapted crops as it provides knowledge about native plant varieties that have adapted to local climates over centuries. These traditional practices offer insights into crops that can thrive in changing climate conditions and contribute to the sustainability and resilience of agricultural systems.

11. What alternative food sources are being explored to replace animal-derived proteins, and how are they produced?

Alternative food sources being explored to replace animal-derived proteins include plant-based protein alternatives, laboratory-cultured meat, insect-based protein, and synthetic protein derived from yeast. These alternatives offer a more sustainable and resource-efficient way to meet protein demands while reducing the environmental impact of traditional livestock production.

12. How can technology, such as digital and biotechnologies, artificial intelligence, and robotics, contribute to mitigating the impact of climate change on agriculture?

Technology, such as digital and biotechnologies, artificial intelligence, and robotics, can contribute to mitigating the impact of climate change on agriculture. These technologies enable precision farming, data-driven decision-making, efficient resource management, and automation, leading to more sustainable and climate-resilient agricultural practices.

13. How can innovations and technologies in agriculture improve environmental sustainability within the food system, considering ethics and sustainability factors?

Innovations and technologies in agriculture can improve environmental sustainability within the food system by promoting efficient resource use, reducing greenhouse gas emissions, minimizing waste, and supporting local and regenerative farming practices. They can also enhance traceability and transparency in the supply chain, allowing consumers to make informed choices based on ethical and sustainable considerations. Additionally, technologies can facilitate the development of renewable energy sources, promote circular economy approaches, and support biodiversity conservation within agricultural systems.

Written Activity Four

Australia has relied on Agricultural Innovation

Read the article at this link:

https://theconversation.com/australia-has-relied-on-agricultural-innovation-to-farm-our-dry-land-well-need-more-for-the-uncertain-years-ahead-188597

1. What are some environmental risks associated with primary food production in Australia?

   Some environmental risks associated with primary food production in Australia include biosecurity threats, climate change impacts (such as uncertain water supplies and heat stress on livestock), nutrient runoff from excessive fertiliser use, and biodiversity loss.

2. How do farmers in Australia make choices about crops and animals for farming?

   Farmers in Australia make choices about crops and animals for farming based on factors such as climate suitability, market demand, resource efficiency, and environmental impact. They consider the suitability of different crops and animal breeds to the local climate, as well as market trends and consumer preferences.

3. What are the potential risks and impacts of excessive use of fertilisers, pesticides, and water in primary food production?

   Excessive use of fertilisers, pesticides, and water in primary food production can have several risks and impacts. These include soil degradation, water pollution, loss of biodiversity, harmful effects on human health, and economic costs associated with the increased expenses of these inputs.

4. How do innovations and technologies contribute to food security in Australia?

   Innovations and technologies contribute to food security in Australia by improving productivity and efficiency in farming practices. Examples mentioned in the article include agricultural sensors for real-time monitoring, drones for crop inspection and livestock management, robots for various farming tasks, and vertical farming techniques that optimize resource use and reduce food miles.

5. Evaluate the ethical and sustainability aspects of high-tech farming practices mentioned in the article.

   The ethical and sustainability aspects of high-tech farming practices mentioned in the article include reduced chemical usage, resource efficiency, and increased precision in input application. These practices can lead to decreased environmental impact, improved soil and water quality, and better overall resource management. However, it is important to carefully consider potential issues related to data privacy, job displacement, and the long-term environmental impact of certain technologies.

6. What are the current challenges to achieving environmental sustainability in Australia's food systems?

   Some current challenges to achieving environmental sustainability in Australia's food systems include biosecurity threats, climate change impacts, excessive use of fertilizers and pesticides, water scarcity, soil degradation, and the loss of biodiversity. Additionally, there are challenges related to optimizing resource use, minimizing food miles, and ensuring the affordability and accessibility of food.

7. Evaluate the potential of vertical farming as a pathway to improve environmental sustainability in food production.

   Vertical farming has the potential to improve environmental sustainability in food production by reducing water usage, minimizing land requirements, and decreasing the need for pesticides and herbicides. It can also reduce food miles by enabling local production in urban areas. However, the scalability, energy

requirements, and economic feasibility of vertical farming should be carefully evaluated to ensure its long-term sustainability and viability as a widespread practice.

Summary Activity

Sustainability in Primary Food Production

Part A – Climate Change, Biodiversity and Biosecurity

What is the main idea about this key knowledge & key skill? (Two or three sentences in your own words)
This key knowledge and skills focus on understanding and critically evaluating the environmental sustainability of food production in Australia. This includes looking at the use of resources such as water, fertilisers, and pesticides, the selection of crops and livestock, as well as the risks posed by biosecurity issues, climate change, and biodiversity loss. It also involves evaluating how innovations and technologies contribute to sustainability, examining issues within food systems to improve sustainability, and applying practical skills to make and understand sustainable food choices and preparation methods.
What is sustainable agriculture?
Sustainable agriculture is the practice of farming that minimizes negative environmental impacts, conserves resources, promotes biodiversity, and ensures long-term productivity while meeting food demand.
What is one key sustainable farming practice used in Australia?
Minimum tillage farming: Instead of conventional ploughing, crop residues are left on the soil surface, and specialised equipment creates small planting furrows or slots. Seeds or seedlings are directly placed into these slots, minimising soil disturbance. This practice is sustainable because it improves soil health, reduces soil erosion, enhances water infiltration and retention, increases organic matter content, decreases greenhouse gas emissions, and conserves resources such as fuel and labour. It promotes long-term agricultural sustainability by preserving soil structure, biodiversity, and fertility while maintaining or improving crop yields.
What does the term “climate change” refer to and why is it occurring?
The term "climate change" refers to the alterations in climate and weather patterns that occur because of global warming. Global warming is caused by the trapping of heat in the Earth's atmosphere due to the production of greenhouse gases. These gases, such as carbon dioxide, methane, and nitrous oxide, are released from various human activities, including burning fossil fuels, deforestation, and the use of certain agricultural practices. The accumulation of greenhouse gases leads to an increase in the Earth's temperature, resulting in climate change and its associated impacts on weather patterns, ecosystems, and human livelihoods.

What are the impacts of the following on primary food production in Australia?	
Bushfires	They can destroy animals, crops, buildings, farm infrastructure, livestock, and feed supplies. Power outages hinder dairy farmers, and road closures prevent transportation and spoilage of fresh produce, impacting food production and supply chains.

Floods and Storms	They can cause damage to irrigation equipment, waterlogged land, erosion, livestock losses, delayed cultivation and harvesting, and disruptions in transportation, leading to decreased crop yields and financial losses for farmers.
Droughts	Droughts result in water scarcity, reduced pasture availability, decreased crop quality and yields, livestock health issues, increased financial burdens, and difficulties in selling produce due to market disruptions, leading to food insecurity and economic losses.
Heatwaves	Higher temperatures can make certain regions unsuitable for crop cultivation, reduce crop yields, decrease nutritional quality, affect livestock productivity, and increase the risk of wildfires, leading to food shortages and economic losses for farmers.

What factors contribute to a lack of biodiversity?

Factors that contribute to a lack of biodiversity include climate change and global warming, which can disrupt ecosystems; erosion, which leads to the loss of biodiverse soil; land clearing and urbanization, which reduce natural habitats; and a lack of crop diversity in agriculture.

What are the risks in primary food production associated with a loss of biodiversity?

The risks associated with a loss of biodiversity include decreased ecosystem resilience, reduced adaptability to environmental changes, poor crop quality and nutrition, increased susceptibility to pests, compromised pollination, and impaired soil fertility, all of which can have detrimental effects on agricultural sustainability and food security.

What role does biodiversity play in ecosystem resilience and adaptation to environmental changes?

A diverse range of species in an ecosystem contributes to its stability and ability to withstand disturbances. Biodiversity enhances ecosystem services such as nutrient cycling, pest control, and pollination, which are essential for maintaining healthy and productive agricultural systems.

Diverse plant species also offer a broader range of genetic traits, which means plants might be more likely to adapt to changing environmental conditions, including climate variability.

In what way do biosecurity measures protect biodiversity in food production?

By preventing the introduction, establishment, or spread of harmful organisms, biosecurity measures help to minimise the risks posed by invasive species. Invasive species can have a detrimental impact on native flora and fauna, leading to a loss of biodiversity. By implementing strict biosecurity protocols at borders, farms, and other relevant areas, the likelihood of invasive species entering and disrupting ecosystems is reduced. This, in turn, helps to preserve the balance of species and promote the health and sustainability of biodiversity in food production systems.

Why do invasive species pose risks to the biodiversity of the agricultural industry in Australia?

Invasive species in Australia's agricultural industry pose risks by outcompeting native species for resources, disrupting ecosystems. They reproduce quickly, reducing native populations and biodiversity. They can introduce

diseases and pests, harming agricultural productivity. Strong biosecurity measures are crucial to protect agricultural biodiversity from these risks.

Part B – Use of Fertilisers, Pesticides and Water

What are fertilisers and why are they used in primary food production?	
Fertilisers are substances containing nutrients used in primary food production to promote plant growth and nourishment. They are applied to the soil or plants to improve fertility and ensure crops have enough nutrients. Fertilisers provide plants with nutrients like nitrogen and phosphorus, which are important for yield, and quality.	
What are the potential risks associated with the use of fertilisers regarding each of the following?	
Gas emissions	Gas emissions: During the production, transportation, and application of fertilisers, as well as the breakdown of fertilisers in the soil, gas emissions, including greenhouse gases, can be released, contributing to climate change.
Groundwater Pollution	Too much use or improper application of fertilisers can lead to the pollution of groundwater. Nitrate, a component of fertilisers, can move through the soil and contaminate groundwater supplies if high concentrations are present. This poses risks to human health if the polluted groundwater is used for drinking or domestic purposes.
Eutrophication	Fertilisers contain phosphorus, which can runoff into waterways. When phosphorus reaches a certain level in water, it can lead to eutrophication, causing excessive growth of algae, particularly blue-green algae. Increased algae levels can be toxic to aquatic life, disrupt ecosystems, and degrade water quality, affecting both wildlife and human use of water resources.
Soil acidification	Overapplication of nitrogen-based fertilisers can cause soil acidification. The excess nitrogen not absorbed by plants can leach into the soil, making it acidic. Soil acidification reduces nutrient availability, decreases plant growth, and reduces crop productivity. It also disrupts the soil's natural balance and can have long-term negative impacts on soil health and fertility.
What are pesticides and why are they used in primary food production?	
Pesticides are applied to plants or the surrounding environment to prevent or reduce pest infestations and diseases. Pesticides help to safeguard crop yields, reduce crop losses, and maintain the quality of agricultural produce. Pesticides play a vital role in ensuring food security, improving agricultural productivity, and meeting the demand for high-quality food.	
What are the potential risks associated with the use of pesticides with regard to each of the following?	
Pesticide-resistant insects	Creation of superbugs: Excessive use of pesticides can lead to the development of pesticide-resistant pests, known as superbugs. These pests have genetic traits that enable them to survive exposure to pesticides, leading to the need for stronger and potentially more harmful chemicals to control them.
Non-targeted species	Pesticides can have unintended impacts on non-targeted species, including beneficial insects, birds, fish, and plants. The indiscriminate use of pesticides can harm pollinators such as bees and butterflies, disrupt ecosystems, and reduce overall biodiversity.

Human health concerns	There is concern that pesticide residues may remain on food crops, which can pose risks to human health if consumed. Prolonged exposure or ingestion of pesticide residues may have adverse effects on human well-being, including potential toxicity and negative impacts on human development and overall health.
Pollution of water supplies	Pesticides can enter water sources through runoff or leaching, polluting rivers, lakes, and groundwater. This can contaminate drinking water supplies and harm aquatic ecosystems. Pesticide pollution in waterways can negatively impact aquatic life, disrupt ecological balance, and have cascading effects on the overall health of ecosystems.
In what ways do farmers use water in their agricultural practices?	
Farmers use water in agricultural practices for irrigation, livestock water supply, cleaning, crop protection, and drinking water. Efficient water management is important for sustainability.	
How do the following impact the environment and crop production?	
Irrigation	Excessive or inefficient irrigation practices can contribute to salinity issues. When water is applied in excess or improperly managed, it can lead to increased salt concentration in the soil or water table, resulting in salinity. This can have detrimental effects on the environment and crop production.
Salinity	Salinity can negatively impact the quality of water resources, disrupt ecosystems, and harm wildlife. It can also impair plant growth and reduce crop yields. High salt levels in the soil hinder water uptake by plants, leading to decreased nutrient absorption and impaired physiological functions. This can result in stunted growth, reduced crop quality, and economic losses for farmers.
List two ways farmers could use innovation and technology to use water wisely in primary production.	
Smart Irrigation Systems	Implementing advanced irrigation technologies, such as soil moisture sensors, weather data integration, and automated irrigation controllers. These systems enable farmers to monitor soil moisture levels in real-time and adjust irrigation schedules, accordingly, ensuring that crops receive the right amount of water at the right time, minimizing water wastage.
Precision Farming Techniques	Utilising precision agriculture technologies, such as remote sensing, drones, and satellite imagery, to gather data on crop health, soil moisture, and plant water requirements. This data can help farmers identify areas with specific water needs, allowing them to apply water more precisely and efficiently, optimizing water usage and minimizing water loss through runoff or evaporation.

Part C – Choices of Crops and Animals

How can the choice of crops ensure sustainable food production in Australia?	
Sugarcane	By adopting sustainable practices such as using new disease-resistant varieties, reducing pesticide use through integrated pest management, and implementing precision irrigation techniques. This helps to protect water quality, reduce chemical runoff, and preserve the Great Barrier Reef.

Saltbush	Growing saltbush as animal fodder offers a sustainable alternative for livestock feed. Saltbush is well-suited to Australia's arid conditions, requiring minimal water, fertilisers, and pesticides. Its ability to improve soil condition and lower water table levels also contributes to environmental sustainability.
Seaweed Farming	Seaweed requires no freshwater input and has minimal environmental impacts. Seaweed can be used as animal feed, biofuel, fertiliser, and food. Growing it can reduce greenhouse gas emissions, reduce methane production from livestock, and provide alternative food sources while promoting ocean health.
List two ways farmers could use innovation and technology in crop production.	
Precision Agriculture	This involves using GPS technology and IoT devices such as smart sensors and drones to gather data about their fields, which can then be analyzed by AI algorithms. The insights from these analyses can help farmers apply the exact amount of water, seed, and fertiliser needed for specific parts of a field, reducing waste and improving yield.
Robotics and Automation	This is another technology that's transforming food production. Robots are now used for various tasks, including planting, harvesting, and packing. They can work round the clock, thereby increasing productivity. Moreover, they can perform tasks with a high level of precision, reducing waste.
Identify four animals and explain how the choice of animals ensures sustainable food production in Australia.	
White Sheep Meat	These breeds are typically selected for their efficient feed conversion, adaptability to local climates, and suitability for grazing on pasture. They are quick to mature, their meat is high quality and they shed their fur in hot weather which means that they are easy to maintain. They can feed on native saltbush.
Alpacas	Raising alpacas for their fiber and meat can contribute to sustainable food production in Australia. Alpacas have a gentle impact on pastures, as they graze lightly and do not damage vegetation. Their fur/wool is a renewable and eco-friendly material, and alpaca meat is considered lean and nutritious.
Emu	Emus are native Australian birds that can be farmed for their meat and oil. Emu farming offers a sustainable alternative to traditional livestock production. Emus have low environmental impacts, require less water and feed compared to some livestock species, and can adapt to various climates.
Insects	Insects have a high feed conversion rate and require fewer resources compared to traditional livestock. By farming insects for human consumption, farmers can reduce greenhouse gas emissions, land use, and water usage. Insect farming can be done in controlled environments, such as vertical farms, making it an efficient and environmentally friendly approach to food production.
List two ways farmers could use innovation and technology in animal production.	
Automated Milking Systems	In dairy farming, automated milking systems can milk cows automatically and monitor milk quality and quantity. They can also track data related to cow health and productivity. These systems can increase efficiency, improve the quality of the milk produced, and provide valuable data that can be used to further improve farm operations.

Genetic Engineering	Another method to enhance animal production involves genetic engineering or editing, which allows scientists to alter the DNA of an organism. This technology could be used to improve specific traits of livestock, such as disease resistance or growth rates.

Exam Preparation

Multiple-Choice Questions (5 marks)

Choose the response that is correct or that **best answers** the question.

1. How does climate change impact crop production in Australia?

   a. Increased crop yields due to longer growing seasons.

   b. Decreased crop yields due to reduced water availability.

   c. Enhanced pest resistance resulting in improved crop productivity.

   d. Higher nutrient content in crops due to elevated atmospheric CO_2 levels.

   The answer is B.

   Decreased crop yields due to reduced water availability" is correct because climate change in Australia is expected to lead to more frequent and severe droughts, as well as changes in rainfall patterns. These conditions can result in reduced water availability for crops, leading to lower yields and productivity. Water scarcity affects the growth and development of plants, their ability to absorb nutrients, and their overall health. Therefore, decreased crop yields due to reduced water availability is a significant impact of climate change on agriculture in Australia.

2. Which of the following options best defines biosecurity?

   a. The practice of ensuring the security of biological research laboratories.

   b. The protection of biodiversity in natural ecosystems.

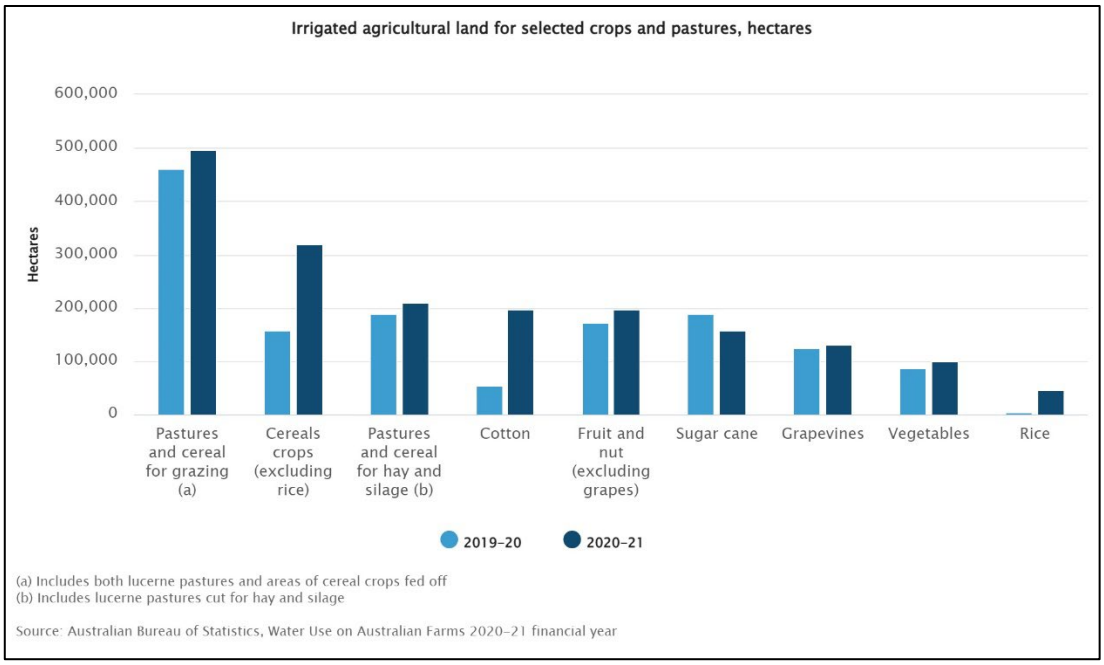
   c. The management of risks posed by biodiversity.

   d. The prevention, control, and response to the introduction or spread of harmful organisms.

   The answer is D.

   The prevention, control, and response to the introduction or spread of harmful organisms," best defines biosecurity. Biosecurity refers to a set of practices and measures aimed at minimizing the risks associated with the introduction, establishment, and spread of pests, diseases, and invasive species that can harm humans, animals, plants, and the environment

3. Study the graph below:



Which innovation in technology would help address the issue raised in the graph above,

a. Drones for crop monitoring

b. Virtual reality headsets for farmers

c. Smart irrigation systems

d. GPS directed, self-driving tractors

> The answer is C. Smart irrigation systems. According to the graph in source 1, water usage on farms in Australia has been increasing over the years. Smart irrigation systems can help address this problem by using sensors and weather data to optimize water usage and reduce waste. This technology can also help farmers save money on water bills and increase crop yields.
>
> While drones, virtual reality headsets, and self-driving tractors are all innovative technologies used in farming, they do not directly address the issue of water usage on farms.

4. All of the following promote biodiversity in the soil except:

a. Mulching and composting

b. Crop rotation

c. Pesticide use

d. Intercropping

> The answer is C. Pesticide use is not a practice that promotes biodiversity in the soil. Pesticides can harm beneficial organisms such as earthworms, beneficial insects, and microorganisms that contribute to soil fertility and overall biodiversity. They disrupt the natural balance of the soil ecosystem and decrease biodiversity.
>
> Answer A enhances soil health and biodiversity by providing food and habitat for organisms.
> Answer B prevents the buildup of pests and diseases, reduce soil erosion, improve soil fertility, and promote beneficial organisms.
>
> Answer D creates a diverse environment, enhancing nutrient cycling and providing habitat and food sources for soil organisms.

5. The Angus cow is a black, medium-sized breed known for its exceptional meat quality. It has a calm temperament, adaptability to various climates, high fertility, and efficient feed conversion. It is widely used in beef production worldwide.

Which of the following characteristics makes Angus cows a suitable breed for farming amidst rising global temperatures?

a. Angus cows have a black coat colour, which helps reflect sunlight and reduce heat absorption.

b. Angus cows possess a genetic adaptation that enables them to withstand higher temperatures.

c. Angus cows have a reduced metabolic rate, allowing them to cope with increased heat stress.

d. Angus cows require less water compared to other breeds, making them more resilient in water-scarce conditions.

> The correct answer B. Angus cows possess a genetic adaptation that enables them to withstand higher temperatures.

Short Answer Questions (15 marks)

Question 1 (3 marks)

Identify one climatic and weather condition that occurs because of climate change and explain its impact on food production in primary food production.

For 1 x 1 mark, the student needed to identify one climatic and weather condition that occurs because of climate change.

The following were possible answers: droughts, floods and storms, bushfires, and heatwaves.

For 1 x 2 marks, the student needed to explain its impact on food production in primary food production.

Any of the following answers were accepted.

Droughts (one of the points below was accepted)

- They result in water scarcity, leading to soil moisture deficits, reduced water for irrigation, and lower crop yields. The lack of water limits crop growth, causing stunted development and crop failure.
- Livestock farming is also affected due to limited drinking water and less pasture for grazing, resulting in reduced livestock productivity and increased financial burden on farmers.

Floods and Storms (one of the points below was accepted)

- Floods and storms cause a lot of rainfall, often causing waterlogging and soil erosion. This can lead to crop damage, delayed planting or harvesting, and even complete crop loss.
- Floods can wash away topsoil, which contains essential nutrients for plant growth, degrading soil fertility and affecting future agricultural productivity.
- Waterlogged conditions can suffocate plant roots, inhibit nutrient uptake, and promote the growth of diseases and pests.
- In livestock farming, floods and storms can cause livestock losses, damage infrastructure, and contaminate feed and water sources, posing significant challenges to the industry.

Bushfires

- Bushfires can lead to the destruction of crops, livestock, farm infrastructure, and machinery.
- Bushfires can cause long-term damage to soil health and fertility, affecting future agricultural productivity.
- Smoke and ash from bushfires can contaminate crops, making them unsuitable for consumption.

Heatwaves

- High temperatures can accelerate crop maturation, leading to reduced yields and poor crop quality.
- Heat stress can also result in wilting, leaf scorching, negatively impacting plant growth and productivity.
- Heatwaves can cause heat stress in animals, leading to reduced feed intake, decreased milk production, and even mortality.

Question 2 (2 marks)

Describe two important characteristics to consider when selecting livestock.

For 2 x 1 marks, the student needed to describe two important characteristics to consider when selecting livestock.

- Choosing animals that are well-adapted to the local climate conditions is crucial.
- Selecting animal breeds that have lower methane emissions per unit of production can help mitigate climate change.

Question 2 (4 marks)

Sugarcane cultivation often involves the application of fertilisers to ensure high yields and promote plant growth.

a. Explain how the one impact of the overuse of fertiliser on the environment. 2 marks

For 1 x 2 marks, the student needed to briefly explain how the overuse of fertiliser can impact the environment.

Either response below was accepted:

- Excess fertliser can run off into water where it can stimulate the growth of algae, which blocks the sunlight and leads to limited oxygen in the water. This destroys the marine life in the area.
- Synthetic fertilizers can lower the pH of soil and make it more acidic. Acidic soils can hinder plant growth and nutrient availability. It also affects soil microbial communities and beneficial organisms.

b. Explain how innovation and technology could be used to improve sustainability in primary food production. 2 marks

For 1 x 2 marks, the student needed to identify and explain one innovation and technology that can be used to improve sustainability in primary food production.

Some possible answers include:

- Big Data and AI are crucial in precision agriculture which involves using GPS technology. For example, GPS-enabled machinery can apply the exact amount of water, seed, and fertiliser needed for specific parts of a field, reducing waste, and improving yield.
- AI algorithms, often using machine learning, can analyse data collected by drones or satellites to monitor crop health. These algorithms can detect early signs of disease, pest infestation, or other issues. This allows farmers to take action before the problem causes significant crop loss.
- On-farm weather stations can collect data about local weather conditions like temperature, humidity, rainfall, wind speed, and solar radiation, which can help farmers plan their farming activities more effectively.
- Drones equipped with cameras and sensors can provide aerial imagery of fields, helping farmers monitor crop health, identify pest infestations or disease outbreaks, and assess the impacts of weather events.

Question 4 (6 marks)

Examine the relationship between biosecurity in Australia and biodiversity, highlighting their interconnectedness and the importance of maintaining both. 6 marks

Sample Response

The student made a statement about the relationship between biosecurity and biodiversity.

Biosecurity and biodiversity are closely interconnected but different.

The student defined the terms biosecurity and biodiversity.

Biosecurity refers to the measures taken to protect against the entry, establishment, and spread of pests, diseases, and invasive species that can harm human health, agriculture, and the environment. Biodiversity, on the other hand, refers to the variety and abundance of living organisms in a particular area, including plants, animals, and microorganisms.

The student explained how biosecurity supports biodiversity.

Biosecurity measures play a crucial role in safeguarding biodiversity by preventing the introduction and spread of harmful pests and diseases. Invasive species, if not properly managed, can have devastating effects on native plants and animals, leading to the loss of biodiversity. By implementing effective biosecurity measures, such as border controls, quarantine inspections, and early detection systems, Australia can protect its unique ecosystems and native species from the impacts of invasive species.

The student explained how biodiversity supports biosecurity.

On the other hand, biodiversity also supports biosecurity efforts. A diverse environment with a wide range of species is more resilient to the threats posed by pests and diseases. When a particular species is under attack

from a pest or disease, a diverse ecosystem can provide alternative resources and habitats for other species to survive and maintain ecological balance. Therefore, preserving biodiversity is crucial for enhancing the overall resilience of the ecosystem and its ability to withstand biosecurity challenges.

1 mark	2 marks	3 marks	4 marks	5 marks	6 marks
The response provides minimal or no discussion of the relationship between biosecurity and biodiversity in Australia.	The response identifies the relationship between biosecurity and biodiversity, but the discussion lacks depth and fails to highlight their interconnectedness and importance of maintaining both.	The response discusses the relationship between biosecurity and biodiversity in Australia, highlighting their interconnectedness and providing a reasonable explanation. The importance of maintaining both is adequately addressed.	The response discusses the relationship between biosecurity and biodiversity in Australia, highlighting their interconnectedness and providing a reasonable explanation. The importance of maintaining both is adequately addressed.	The response demonstrates a thorough understanding of the relationship between biosecurity and biodiversity in Australia. It provides a comprehensive explanation of their interconnectedness and convincingly highlights the importance of maintaining both.	The response goes beyond expectations by providing an exceptional analysis of the relationship between biosecurity and biodiversity in Australia. It offers nuanced insights, supported by relevant examples or evidence, and convincingly highlights the critical importance of maintaining both aspects in a compelling manner.