

Module: Insects as Food, Feed & Fertiliser

- **Subject:** Science* (*see cross-curriculum linkages)
- **Years:** 7-8
- **Curriculum Streams:**
 - **Science as a human endeavour:**
 - **Use and influence of science:** *examine how proposed scientific responses to contemporary issues may impact on society and explore ethical, environmental, social and economic considerations*
 - Year 7: [AC9S7H03](#)
 - Year 8: [AC9S8H04](#)
 - **Science Understanding:**
 - **Biological Sciences:** *use models, including food webs, to represent matter and energy flow in ecosystems and predict the impact of changing abiotic and biotic factors on populations*
 - Year 7: [AC9S7U02](#)
 - **Science Understanding:**
 - **Biological Sciences:** *investigate the role of classification in ordering and organising the diversity of life on Earth and use and develop classification tools including dichotomous keys*
 - Year 7: [AC9S7U01](#)

Curriculum linkages:

Content & activities will provide students opportunity to:

- *Examine how proposed **scientific responses to contemporary issues may impact on society and explore ethical, environmental, social and economic considerations***
- *Use models, including food webs, to **represent matter and energy flow in ecosystems and predict the impact of changing abiotic and biotic factors** on populations.*
- *Apply knowledge of how **biological diversity is ordered** and classification, specifically relating to the identification of insects.*
- **Cross-curriculum linkages*:** STEM elective units, Biology, Geography, Food & Fibre, Sustainability, First Nations & Indigenous learning, Design & Technology, Food Technology.

Module Aims:

- The following activities and content will provide a basis for students to consider **scientific responses to contemporary issues**. This includes: global food security; development of innovations and practices to that can benefit society & environment).
- Broader ecosystem considerations are introduced, including **energy flow and matter cycling** with regards to insect production (food, feed, fertiliser), and invites students to draw comparisons to existing practices in society and the environment currently (food systems, waste products, agricultural practices).

- This module content provides linkages from Year 7 Science Understanding content, including biological diversity classification, and energy flow and matter cycling in ecosystems.
- Gain understanding of the cross-cultural practices of using of insects for food, feed & fertiliser in different cultures across the world.

Key topics covered in module:

- **Food systems, sustainability & innovations**
- **Food security:** core societal issue
- **Impact assessments:** social, environmental, economic, ethical
- **Efficiency & resources:** Impact assessment links; innovations; energy flow & cycling of matter (ecosystems).
- **Understanding of global practices:** use of insects for food, feed & fertiliser from diverse examples.

Application to year groups: Content can be adapted for years 7-8 (*Science as a human endeavour: Use & Influence of Science*), or adapted other year levels (e.g., specific inquiry projects or case studies for years 9-10 and beyond).

Included: Background information guides, suggested activities & approaches, plus resource suggestions.

Graphical organisers represent useful resources for any of the tasks across this module.

Activity timings are flexible and at the discretion of the educator. These could span 1-2 activities per lesson, with the depth of content adaptable.

Module activities & flow: Sections of the module & activities can be used as discrete lesson content, and do not necessarily need to be taught in a linear manner. See **module content overview** below for outline.

Module Overview

- **Introduction: Insects as Food, Feed & Fertiliser**
 - **Concept: Entomophagy** (Activity x1)
 - Question session: class experiences & discussion
 - **Global Entomophagy: Where & what?** (Activities x2)
 - Activity: Regional map exercise
 - Question session: Why insects?
- **Social, Ethical, Economic, Environmental: Applied to insect production**
 - **Impacts: Background Understanding & Grouping** (Activity x1)
 - Question prompts (lead into activity)
 - Activity: Impacts – Benefits & Limitations (identify & group)
- **Food: Insect-based protein**
 - **Insect protein – food source overview** (Activity x1)
 - Question
 - Activity/ content coverage: lead class through comparison of food sources
 - **Considerations of producing insect protein** (Activities x2)
 - Activity/ discussion: Potential hazards of insects as a food source
 - Question: Regulations introduction
 - Activity/ discussion: Regulatory frameworks – identification & impact analysis

- Case Study – Australia’s insect industry
 - Australia’s Industry: Application & Analysis (Activities x3)
 - Activity/discussion: Industry spotlight – Black soldier fly (radio interview & reflection).
 - Activity: Case study/ industry spotlight
 - Activity: Strengths, weaknesses & risks of Australia’s edible insect industry
- Resources list

Introduction: Insects as Food, Feed & Fertiliser

- Concept: entomophagy
 - **Question for class:** What do you think ‘entomophagy’ means? (can briefly cover the origins/etymology of the word): *entomo-* (insect) & *-phagy* (to eat).
 - **This refers to the eating of insects (by all organisms):** insectivores (animals that primarily eat insects), plus omnivores (e.g., birds, mammals, reptiles). Insects also eat other insects (e.g., dragonfly is a predator of insects, eating various insects such as flies, mosquitoes, and butterflies for its food sources). Humans also eat insects!
 - **Additional uses of insects:** Beyond food, insects also represent a source of **feed** for animals (e.g., fish, livestock, poultry), and as a plant **fertiliser** from the insects’ waste.

Question: Experiences from the class

- **Question:** Has anyone eaten insects before?
 - What did they taste like?
 - What sorts of insects?
 - How were these prepared (raw/cooked/ flavourings)?
 - Where were you (location) when you tried this?
- **Question:** Is anyone aware of any insect products for sale? (e.g., cricket meal, whole insects).
 - **What** sorts of products?
 - **Where** did you see it for sale?
 - **What** are they used for?
 - **Why** might someone eat this? *Can link to local Tasmanian & Australia production – insect products are made locally too (covered later in this module with Australian business radio interview).*
- See prompt table of products from CSIRO on following page:

Edible insect products available globally¹⁸

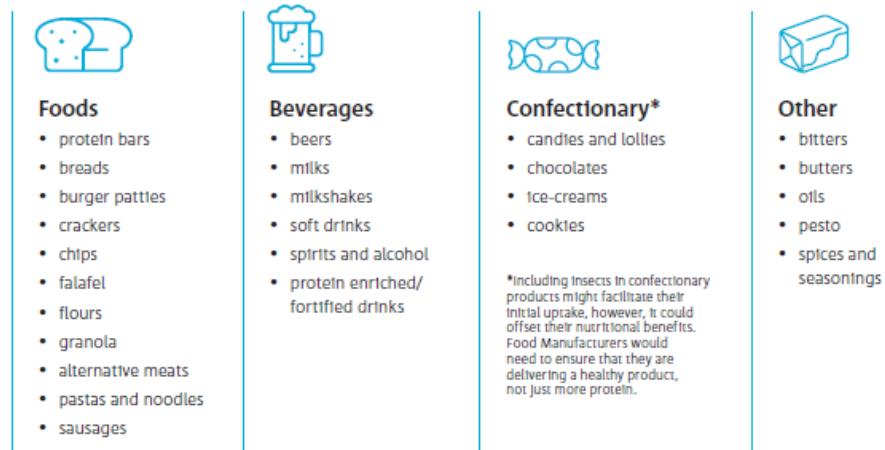


Figure 4: Types of edible insect products available globally.

Above: Diversity of consumable insect products available globally. Source : [CSIRO Edible insects](#) report (2021).

• Global Entomophagy: Where & what?

Some background information [source: CSIRO *Edible insects* report (2021)]:

- Globally, humans from many cultures have consumed insects for thousands of years as a nutritional food source. This is especially common in warmer climates and the tropics, where:
 - Over 2 billion people around the world currently eat insects in their diets
 - Over 2,100 different species of insects are consumed by humans globally
 - **Indigenous Australian culture:** Entomophagy has been practised by First Nations Peoples in Australia for tens of thousands of years. This includes native Australian Bogong moths, witjuti grubs & honey ants.
 - **Insight for class** to grow knowledge & understanding of biological diversity of consumed native insects:
 - The name **witjuti grub (also spelled witchetty or wichety)** is derived from the Pitjantjatjara language and has been loosely applied to **more than 20 different species of moths and beetles.**

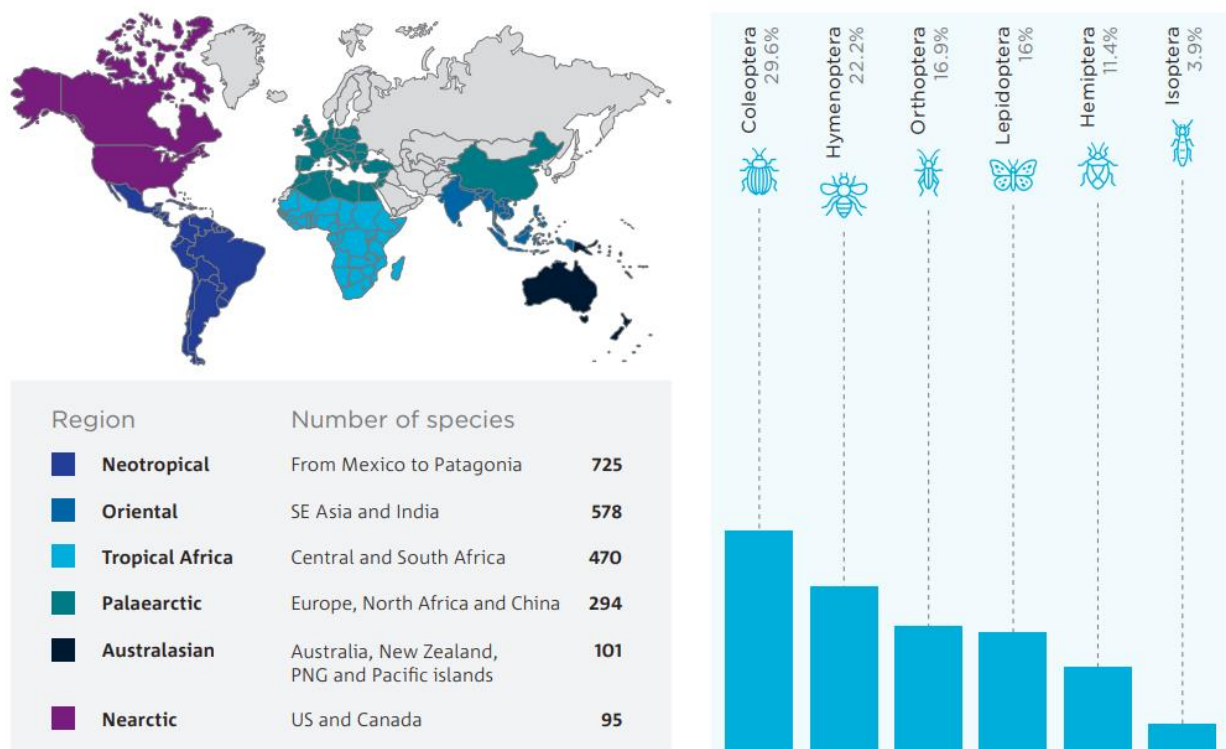


Figure 3: Number of insect species consumed around the world (left) and percentage of species consumed per insect order (right)¹⁷.

The above diagram sourced from the [CSIRO Edible insects](#) report (2021) highlights:

- the **numbers of insect species** recognised as being eaten by humans by global regions (left), and from the **total insect species consumed globally, the break-down percentage share (%)** of these insects by 'order' classification (right).

Activity: Regional Map & Insect Orders (optional):

Linkages to: regional variation (geographic location, environment, climate), human culture, plus biological diversity and their classification (Year 7: [AC9S7U01](#))

- Regional map:** What might the regional map seem to show us? (number of insect species consumed by region) What sort of factors might influence the # insect species consumed? (*Think: cultural practices; climate; social perceptions of eating insects*).
- Orders of insects:** Linking to classification of biological diversity:
 - Recap of the classification hierarchy** (if covered): Kingdom (Animalia), Phylum (Arthropoda), Class (Insecta), Order..., Family, Genus, Species.
 - What are the common names** of each of the orders shown? (class discussion, use shown icons as a guide). This shows a % value, all totalling 100% for the orders shown. There would be species within other orders of insects not shown.
 - Name a few insect examples for each order:** Give the Order & Family name, plus common name (small group/ class activity).

- **Resources for research:** Could use a simple online search with devices, or the CSIRO dichotomous key resource for this classification activity.*
 - [CSIRO insect key resource](#): (as featured in [TIA's Teacher Resource Booklet](#), version 3, 2020: *Name That Insect* – page 57). *Note: CSIRO are migrating their website & this resource content to a contemporary platform post 2020. Check CSIRO's website for updates.

Question: Why Insects? Framing the Global Context

Question: Why might we want to grow an alternative protein source in our diets (from insects) – and look to change our current diets and the diets of livestock?

Suggested format: Can use the below CSIRO table for guidance, with class discussions around this, including:

- Food security
- Cultural traditions
- Ethically-sourced food
- Environmental impacts
- Climate change

Examples from the **CSIRO's report** provides some 'triggers' or factors that promote the development of an alternative protein industry:

Feeding a growing population	- Limited capability of global food systems to feed 10 billion people by 2050. - Inequitable food distribution. - Need to improve global diets with easy access and high nutritional value foods (reduce ultraprocessed food consumption).
Culture and economy	- Need for ethically and sustainably produced foods. - Need to maintain cultural traditions in response to globalisation. - Need to acknowledge and protect First Nations knowledge.
Environmental impact	- Negative impacts on biodiversity caused by habitat clearance for agriculture. - Increase in greenhouse gas emissions and waste productions. - Resource intensive farming practises (i.e. energy, water, feed, fertilizers, pesticides, etc).
Climate change	- More frequent impacts of food systems by droughts, fires, storms, and floods, reducing profitability and sustainability. - Increased prevalence of pests and diseases. - Supply chain disruptions, highlighting the need for locally produced foods. - Lowers nutritional value of important food products.

Figure 1: Triggers for the development of an alternative protein industry.

Source: CSIRO's report- *Edible Insects: A roadmap for the strategic growth of an emerging Australian industry* (2021). Report can be found via: <https://research.csiro.au/edibleinsects/wp-content/uploads/sites/347/2021/04/CSIRO-Edible-Insect-Roadmap.pdf>).

Additional context: What factors are contributing to the growth of the insect protein industry?

The global insect industry has been steadily expanding, driven by factors such as:

1. **Food security – providing nutritional food for growing populations.** Due to the rapid increase in world population, the waste of food and resources, and non-sustainable food production practices, the use of alternative food sources is currently strongly promoted.
2. **The need for resilient and sustainable protein sources:** production of nutritional food in a sustainable manner. Impacts of changing environments also influences this: climate change impacts including drought and increasing weather extremes; reduction in arable land and the soil quality.
3. **Rising interest in alternative food options** (social & environmentally focussed), and
4. **Environmental awareness:** growing awareness of the environmental impact of traditional food protein sources (e.g., livestock farming).

Activity: Impacts- Background Understanding & Grouping

Intent: Students will be asked a series of introductory class discussion/ written prompt questions that can provide students and educators alike an understanding of the background understanding of the class, their perceptions, and their awareness of **social, ethical, environmental, and economic** factors linked to the core theme.

Core theme: Insects as food, feed & fertiliser

Objectives: Students will **identify** and **describe** ways that the commercial production of insects may benefit society and the environment, draw upon any pre-existing knowledge or experiences. Students will also **identify** accelerators and barriers to insect production (as a baseline look at their understanding- an initial look at the topic). Students will **consider global and local scales and issues facing these** when thinking of perceptions and awareness of social, environmental, ethical, economic factors.

Set-up: Educator could physically place the prompt terms on board/around classroom, or on a slide to guide student thinking. Terms: **social, environmental, ethical, economic**. If using the written sheets (e.g., tabulation) or large pieces of paper, prepare these and allocate resources accordingly. PowerPoint slides can present the prompting questions (below), or the concepts (if using the alternative 'sorting activity' format).

Format:

- Class discussion (identify/ list, discuss – write these on a central board/ document) discussing), or
- Small group activity (discussion, identification, list, allocation)
- **Table worksheet activity** – students can think of concepts that relate to insect production (see prompt questions by educator below), allocating these to the correct
- **Alternative: 'sorting activity'** - PowerPoint slide/s or physical cards printed with example Benefits (+) and Limitations (-) for students to sort into the different Social, Ethical, Environmental, Economic categories. Note: some concepts can fit multiple categories (e.g., overlap of Social, Economic, Ethical). Also provide students with the opportunity to suggest their own statements to add to the collection and classify these.

Activity Resources:

- **Table worksheet** for listing (alongside the class discussion/ small group). Example format:
 - Columns for different factors/impacts- **social, ethical, environmental, economic**.
 - Rows as different benefits (+) or limitations/barriers (-)
 - Individual written task or 1 x A3 table per small group for scribe/s.
- **Alternative (sorting activity):** PowerPoint slide/s or physical cards printed with example Benefits (+) and Limitations (-) for students to sort into the different Social, Ethical, Environmental, Economic categories.
- Pens/markers if using group work format.
- Written terms for visual display in learning space:
 - “social”, “environmental”, “ethical”, “economic”
 - Food, feed, fertiliser (optional prompt visible for class)

Example table*

*Graphical organisers of various forms can be used for this exercise & adapted to class

Insect Production: Impacts Analysis Activity	Social	Ethical	Environmental	Economic
Benefits (+) / Accelerators				
Limitations (-) / Barriers				

Class Question: Thinking of innovating to solve problems & its benefits to society:

- **Benefits/accelerators (+):** *Why might using insects as a food, feed or fertiliser be beneficial and attractive to society? Examples:*
 - **Social & ethical:** Can improve food security (the provision of sufficient & nutritional food) for growing populations globally. Several factors drive this ‘accelerator’ (cover these later in the nutrition part). These include:
 - High nutritional content (high protein, minerals, vitamins)
 - High conversion efficiency (conversion of energy into biomass)
 - Fewer resources are required to produce the food product (by mass) – e.g., water, land, feed.
 - **Ethical:** Ethics of consuming animals & treatment. Considerations of ethics behind consuming different types of animals.
 - Insects are **invertebrates** (no backbone), to fewer ethical considerations applied to insects compared to vertebrates (animals with a back-bone).

- People may consider these differences as a consumer - their 'consumer behaviours' – what they buy and eat.
- **Environmental & economic:** Insect's ability to feed on organic waste (from other agricultural or environmental sources)
- **Economic (+ social & ethical):** Development of insect food/feed/fertiliser production could increase the financial security of communities
 - Provide communities with alternative food/feed/fertiliser products that can give them flexibility and not solely reliant on a limited range of products (e.g., for food protein, or fertilising their crops).
 - E.g., potential for people to develop their own business to produce these products, or
 - Reduce producers' reliance on other agricultural feed sources for their livestock/aquaculture.
 - **'Circular economy'** benefits: This supports a resilient system that has benefits for business (economic), people (social, ethical), and the environment.
 - based on three principles & driven by design:
 - eliminate waste and/or pollution,
 - circulate products and materials (at their highest value), and
 - regenerate nature.

Class Prompt: Considering the flip-side, there can be **barriers** ('brakes') to this innovation being adopted:

- **Limitations/ barriers (-):** what sorts of factors may present or perceived (thought) that limits the progress of growing insects commercially for food, feed & fertiliser? **Examples:**
 - **Social: Perceptions-** edible insects may be perceived as an unappealing food source/ misconceptions and lack of understanding of the production/risks of consuming
 - **Social/ economic:** here may be regulatory requirements that may prevent or limit the production of insect products (in general, or a specific type of insect). This could be linked to health, quality control, biosecurity etc. (covered later in the module)
 - **Economic:** It may be expensive/ resource intensive for someone to start or run an insect production business (food, feed, fertiliser).

Food: Insect-based protein

Background: A key driver behind the growth in the global insect industry is the increasing demand for **insect-based protein**. Some information as background is provided below as to why.

- **Nutrition:** high source of protein, vitamins, and minerals.
- **Production efficiency & sustainability:** Insects offer a highly efficient and sustainable alternative to traditional protein sources **such as livestock as they require significantly fewer resources to grow**. [Source: Van Huis et al. FAO report (2013)].
- **Insects have a high food conversion ratio to produce the same amount of protein** [Source: Van Huis et al. FAO report (2013); CSIRO's report- [Edible Insects](#)].

Crickets example:

- To produce the **equivalent amount of protein**, crickets need:
 - *six times less* feed than cattle,
 - *four times less* than sheep, and
 - *half* that of pigs and chickens

[Source: Van Huis et al. [FAO report](#) (2013)].

Activity/ Content Suggestion: Show the below comparison of environmental impacts of various food sources

Introduce the below resource, leading class through each factor highlighting the differences and similarities of the food sources. The below diagram highlights insects* as a food source out-performs the other sources across the categories: edible portion, land (requirements to produce 100g protein), greenhouse gas emissions (per 100g protein), water requirements (to produce 100g animal weight), feed (needed to produce 1kg of each animal type), protein feed conversion efficiency (%).

(*Insect examples: meal worms and crickets).

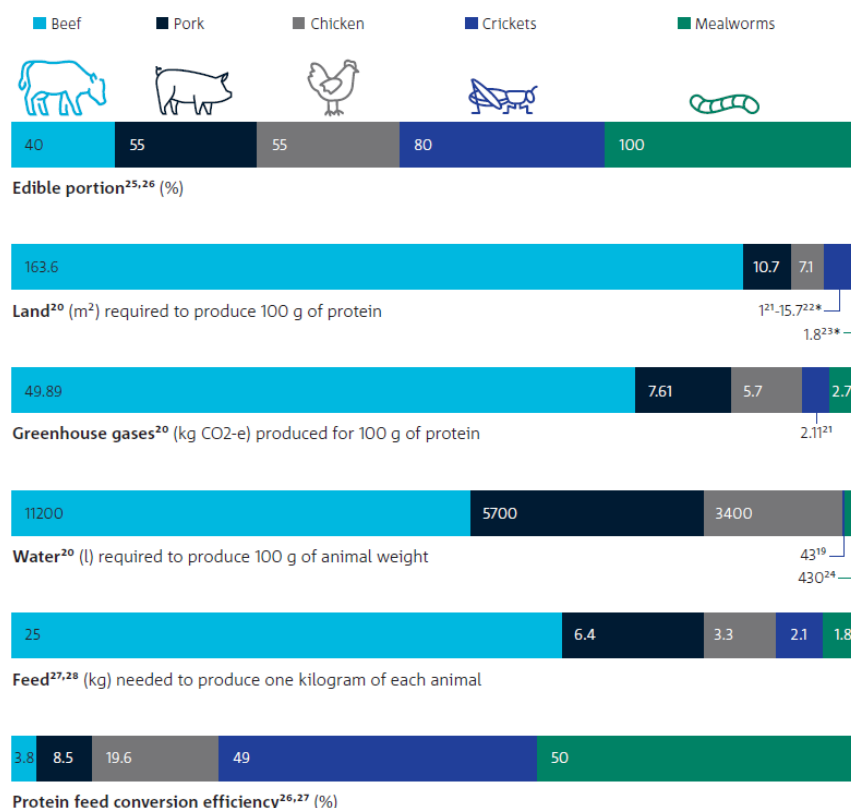


Figure 5: Environmental footprint of crickets and mealworms compared to conventional farmed animals.

*Land usage for crickets and mealworms is much lower than conventional farmed animals, since they can be stacked vertically other in industrial warehouses.

(Source: CSIRO's report - [Edible Insects: A roadmap for the strategic growth of an emerging Australian industry](#) (2021), page 8).

Class Question: Can you identify & describe any other benefits of insects as food? (*Hint: think about comparisons to other food sources, as mentioned above*) **Examples:**

- **Space efficiency** (insects typically require less space to be produced compared to other food sources livestock/fish sources of protein) – e.g., not in largescale paddocks requiring livestock food, water, fertiliser, drainage maintenance.
- **Additional benefits** for the insect grower: multiple uses/incomes – feed & fertiliser (if they want to/ variety of insect is appropriate for this). Use of waste as fertiliser (think of ecosystems with matter cycling). ‘Circular economy’ benefits.

Curriculum links note: This section of insect food, feed and waste includes environmental impacts of insect production (including feed required, CO₂ emissions, cycling of matter regarding waste), which can link to the following curriculum field:

- **Year 7: Science Understanding**
 - **Biology ([AC9S7U02](#)):** *Use models, including food webs, to represent matter and energy flow in ecosystems and predict the impact of changing abiotic and biotic factors on populations.*

Potential hazards: insects as a food source

- **As with any food we consume**, there needs to be **fundamental standards in the production, processing, and storing of food** for health and safety to ensure that it’s safe to eat.
- **Introducing edible insects into the human diet** means that we need to consider potential food safety hazards, which can be classified into three categories:
 - Allergens,
 - Biological hazards, and
 - Chemical hazards.
- Some examples are listed below:
 - **Allergens** – examples include:
 - **Protein allergies:** Some types of proteins present in edible insects, including arginine kinase, present a potential allergen source. Other common protein allergens linked to edible insects include α -amylase and tropomyosine.
 - **Contamination from other processing sources:** feed sources; ingredients in the manufacture of insect products (e.g., containing gluten or nuts).
 - **Biological hazards:**
 - Microbial hazards (e.g., bacteria) – in the rearing, processing, storing stages;
 - Parasite risk: parasite is an organism that lives and feeds in or on a larger animal (host). Insects may host a parasite, which may be carried into a human body if consumed.
 - Disease risk: potential ‘**zoonotic**’ risk (‘zoonic’ infectious diseases are those that are transmitted between animals and humans). In a wild environment, some parasites have

- evolved to take advantage of insects as transporters of them to infect other organisms (insects as 'vectors' or transporters).
 - Overall, this highlights the importance of good farming and processing practices are critical for breeding insects as a safe food.
- **Chemical hazards:**
 - Examples: residue from pesticides, herbicides, industrial processes, soil samples, other environmental sources (e.g., growing conditions/ substrate they are grown on).
- Note: **Consumption of wild insects** can significantly introduce multiple risks as consumers are exposing themselves to a wild ecosystem (versus a controlled, regulated environment for the growing of insects as seen in commercial production of insects).
- **Activity/ discussion opportunity:** Prompt students to think about some ideas of each safety hazards (leading one category to another), either as a small group activity (nominate one area each to a group, scribe/draw, report back to class), or whole-class discussion. Educator can shape background information further for each category. **Format:** Example: written mind-maps, lists, diagrams on the back of the previous activity's table etc. If dividing class into groups, can get students to report back to the whole class after a short discussion (e.g., 5 min).
 - **Importance of regulatory frameworks and legislations:** to address the above aspects with reliability, insects for human consumption are recommended to be sourced from reliable producers, meeting specific requirements using regulated processes.
 - **Regulatory frameworks** for insect production shape this (see next section).

Regulatory frameworks:

- **Australia has strong regulatory frameworks** for the growing and production of insects (insect industry).
- Regulations cover many aspects, including biosecurity (which species, where), rearing of insects, processing & storage.
- **Resource:** Australia's requirements for insect production (farming, food, feed) are outlined in the **AgriFutures report: [Australian Insect Industry RD&E Plan 2023-2028](#)** (2023), see pages 16-20 of the report.
- **Similarly to Australia, the European Union (EU)** also has strong regulatory foundations that have been significantly advanced in recent years. **Advances in this industry include:**
 - **Approval of insect protein for use in poultry and pig feed**, in addition to its existing use in aquaculture. (*EU Legislation: <https://ipiff.org/insects-eu-legislation/>*)
 - **New species approved:** In 2023, the EU Novel Food legislation expanded to approve two new insects for use in food products: the lesser mealworm and the partially defatted house cricket. (*EU Legislation: <https://ipiff.org/insects-novelfood-eu-legislation-2/>*)
 - Additionally, **frass (insect faeces)** was introduced into the EU fertiliser standard, further integrating insects into agricultural and food production systems. (*Insect frass as fertiliser: <https://ipiff.org/insects-frass/>*)

Question: What impacts might regulations (the presence or absence) have upon commercial production of insects as a food & feed source have?

Action/discussion suggestion: Think of each of these areas & list examples of how you think they may impact (impact: accelerator, neutral, limiter). (Think: social, ethical, economic, environmental).

Examples:

- **Impacts on society** that this may have:
 - **Social** perception: may benefit the perception of insects as an industry by society with regulations in place (e.g., may improve its perceived legitimacy, level of trust, health and safety in the broader community).
 - Regulations can impact the **economic** aspects- e.g., viability of someone starting a business as specific standards may be needed, such as particular licensing, storage, infrastructure including growing conditions etc.)

Case Study – Australia’s insect industry

Background of AUS insect consumption & production

- **Indigenous Australian** cultural practice examples:
 - Entomophagy has been practised by First Nations Peoples in Australia for tens of thousands of years.
 - Over 60 insect species have been identified as indigenous food sources, with these varying across geographic location and climates. These include native Australian Bogong moths, witjuti grubs & honey ants.
 - The name **witjuti grub** (also spelled witchetty or wichety) is derived from the Pitjantjatjara language and has been loosely applied to more than 20 different species of moths and beetles.
- The Australian (domestic) industry features both:
 - Insect producers (those farming the insects) and
 - Insect product manufacturers.
- **Species:** Most commercial insect industries in Australia are growing the following species for the human food, pet food (cats, dogs, reptiles) and animal feed (aquaculture, poultry):
 - **Black soldier fly (BSF)** (*Hermetia illucens*) – order diptera (flies)
 - **Cricket** (*Acheta domesticus*) – order Orthoptera (crickets/grasshoppers)
- **Regulatory context:** Australia has robust regulatory framework from which insects can be commercially/industrially produced. (e.g., the types of substrates for growing insects on or in, and then used as feed for livestock).
- **Activity: Play recording of AgriFutures’ radio interview resource:** “*The global potential of insects*” – AgriFutures Australia. <https://agrifutures.com.au/resource/the-global-potential-of-insects/> (22 min interview overall, but first 15 minutes provides great background of the Australian industry status, plus feed and waste/fertiliser outlets. An Australian business is interviewed, showcasing their black soldier fly products).
 - **Reflection** of the radio interview: e.g., class discussion, highlights from class, short written piece etc. **Discussion can lead into** Australian case study or analysis activities (below)

- **Application & Analysis Activities:**

Activities that specifically with alignment to the following curriculum stream:

- **Science as a human endeavour:** Use and influence of science
 - *examine how proposed scientific responses to contemporary issues may impact on society and explore ethical, environmental, social and economic considerations*
 - Year 7: [AC9S7H03](#)
 - Year 8: [AC9S8H04](#)
- **Case study or ‘industry spotlight’**
 - students could conduct a case study or ‘industry spotlight’ outlining an insect species or product created from insects within the Australian industry. This could be within any of the **food, feed or fertiliser** product areas.
 - This may include elements such as:
 - Specifying the insect/ product,
 - Origins & the biology of the insect/s (including any biosecurity considerations),
 - Farming conditions (using referenced industry examples, including business/s details),
 - Technologies used in the growing or production
 - Students identify, categorise, and describe the impacts of this production approach: social, economic, environmental and ethical considerations.
- **Analysis of factors for Australia’s edible insect industry**
 - Suggestion: Students select 1-2 of each (**strength, weakness or risk**) for Australia’s edible insect industry, providing an impact analysis of how these link to: social, economic, environmental or ethical considerations/impacts. Students can categorise these into the respective impacts.
 - They identify, categorise, describe and analyse how this may affect Australia.
 - **The below table may guide the S-W-R activity** (source: [CSIRO’s report](#) (2021)).

Strengths	Weaknesses	Risks
- Traditional usage by First Nations Peoples and biodiversity of Australian insects. - World class research and infrastructure in agriculture and biodiversity sectors. - Momentum created by ambitious early adopting insect businesses and farmers. - Global market demand for alternative proteins. - Agricultural innovation and proximity to Asian export market. - Ability of edible insects to withstand global disruptions in the food supply chain.	- Limited knowledge on biology, nutrition, farming, production, and safety of native species. - Australian population may be too small to support industry itself. - Neophobia (fear of new foods) and misguided public perceptions of insects. - Current insect food product costs are considered expensive due to high labour costs. - Lack of farming automation limits scalability of industry. - Limited funding to advance industry.	- Potential allergic reactions and sensitivities to shellfish and insect products³⁸. - Insects might carry biological and chemical contaminants or act as physical hazards affecting consumer's health³⁹. - Lack of funding, resources and buy-in from researchers, industry, and governments. - Potential for alternative plant-based foods preferred over insect derived products. - Media and community perpetuating insect stereotypes.

Figure 10: Summary of Australia's key current strengths, weaknesses, and risks in the emerging edible insect market.

(Source: CSIRO's report - [Edible Insects: A roadmap for the strategic growth of an emerging Australian industry](#) (2021))

- **Formats - Activities/tasks be adapted including for:**
 - Individual or group project work
 - Summative or formative assessments (e.g., educator-assessed, or peer-assessed)
- These activities can be presented in various ways, including: PowerPoint, poster, science communication presentation, written report.
- Length and requirements of the tasks to be informed by the educator.

Resources

Resources listed below may be useful for the status of insects as a food, feed & fertiliser source in Australia & globally. These are referred to throughout the module content and activities:

- **CSIRO report:** *Edible Insects: A roadmap for the strategic growth of an emerging Australian industry* (2021). Report can be found free online via: <https://research.csiro.au/edibleinsects/wp-content/uploads/sites/347/2021/04/CSIRO-Edible-Insect-Roadmap.pdf>
- **AgriFutures report:** *Australian Insect Industry RD&E Plan 2023-2028* (2023). Report can be downloaded free via: <https://agrifutures.com.au/pdf-view/?pdf=23-131.pdf&file=wp-content/uploads/2023/08/23-131.pdf>
- **AgriFutures report:** *Nutritional quality of edible insects and development of pet foods* (2022). Pet feed focus resource, including black soldier fly focus. Report can be downloaded free via: <https://agrifutures.com.au/wp-content/uploads/2023/01/22-152.pdf>
- **AgriFutures – radio interview:** “The global potential of insects” – AgriFutures Australia. <https://agrifutures.com.au/resource/the-global-potential-of-insects/> (22 min interview overall, but first 15 minutes provides great background of the Australian industry status, plus feed and waste/fertiliser outlets. An Australian business that is innovating is interviewed). Could link with the Australian case study on black soldier fly example.
- **FAO Reference:** van Huis, A. et al. (2013). *Edible insects: future prospects for food and feed security*. Food and Agriculture Organization of the United Nations. <http://www.fao.org/3/i3253e/i3253e.pdf>
 - **FAO Report:** Provides a review of studies on the environmental impact and resource efficiency of insect farming in terms of land use, water consumption, greenhouse gas emissions and feed conversion efficiency compared to livestock.
- **International Platform of Insects for Food and Feed (IPIFF)** – IPIFF is an EU non-profit organisation which represents the interests of the insect production sector towards EU policy makers, European stakeholders and citizens. Website contains various informative resources: Insects as Food & Feed, Resources & News. See: <https://ipiff.org/>