Geography Level 10

Chapter 1 — Biomes and food security

Attribution: Classbasics Pty Ltd, vwx.au

Aboriginal and Torres Strait Islander content has been excluded as accuracy cannot be guaranteed, and it is better to be respectful than cover the entire curriculum inaccurately.

Significant effort has been made to ensure this content is legal. Please send any areas of concern to admin@vwx.au with appropriate document/legal references so errors can be verified and changes be made.

NOT YET AUDITED — living document. This booklet is a pre-audit preview. Content, coverage and question quality have not yet been through the full estate audit cycle. Treat it as a draft: use it for planning and familiarisation, but expect corrections before the audited edition is released.

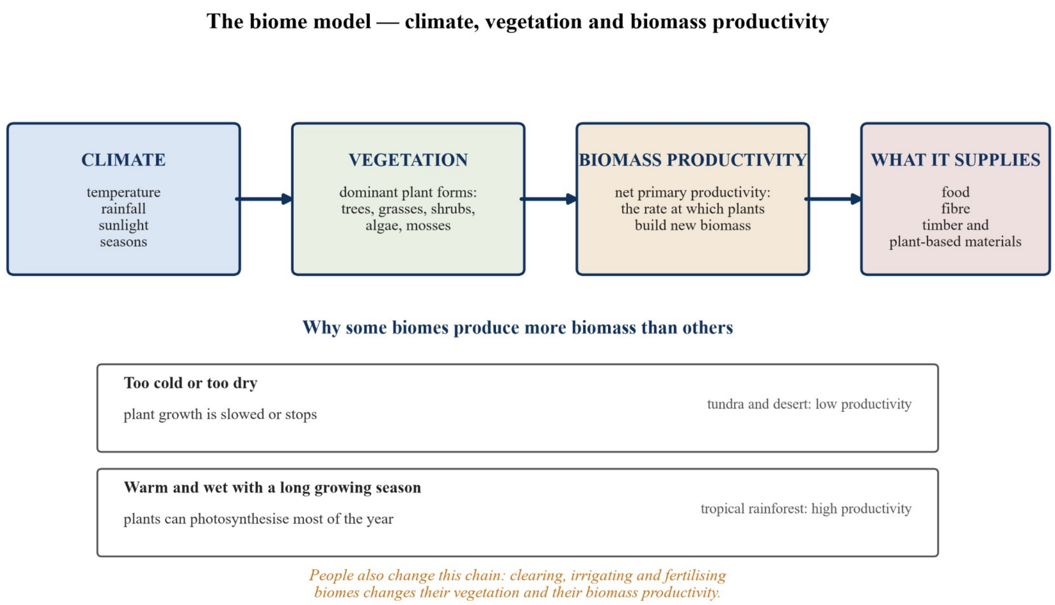
Biomes: distribution, characteristics, biomass productivity and the potential to produce food

Strand: Geographical Knowledge and Understanding · Sub-strand: Biomes and food security. Curriculum: `VC2HG10K01` — "the distribution and characteristics of biomes as regions with distinctive climates, vegetation and biomass productivity, and the potential to produce food." The elaborations are tagged at the end of each part as `VC2HG10K01.E01–E04`. Teaching sequence (teacher): one model (Figure 1) → two productivity readings (Figures 2–3) → distribution and characteristics (Figures 4–5) → the food question (Figures 6–7) → a real, dated production swing (Figure 8) → the ledger of human change (Figure 9). The examples, tasks and inquiry reuse the same nine figures.

Theory

What is a biome? A **biome** is a large region of the Earth with its own **climate** (the long-run pattern of temperature, rainfall and seasons), its own **vegetation** (the main kinds of plants that grow there), and its own **biomass productivity** — the rate at which new living material is made. The **biomass** of a biome is the mass of its living plant and animal material; biomass productivity is the rate at which that mass grows. The word comes from ecology: in the 1970s ecologists such as R. H. Whittaker grouped the world's vegetation into a small set of climate-matched classes (Whittaker 1975; Whittaker and Likens 1973), and it is that scheme — a human choice, not a law of nature — that supplies the names on our maps. Other schemes exist and draw different lines: some sort by plant structure alone, some by climate alone, some by satellite land cover. On the ground, one biome fades into the next over many kilometres, so every biome map — including the ones in this section — is a simplified model with useful edges, not a set of fences.

Figure 1 joins the three ideas into one chain. Climate decides which plants can grow; the vegetation stores biomass; and that biomass is the raw material of most of what people eat, wear and build with — food (grain, fruit, vegetables, meat from grazing animals), **fibre** (cotton, wool, flax) and plant-based industrial materials (timber, rubber, plant oils, biofuels — fuels made from plants). The figure also shows why some biomes produce more biomass than others: where it is too cold or too dry, plant growth slows or stops; where it is warm and wet with a long growing season, plants can build biomass most of the year.



Original model for this section (ClassBasics Geography 10). The chain runs left to right: climate → vegetation → biomass productivity → goods.

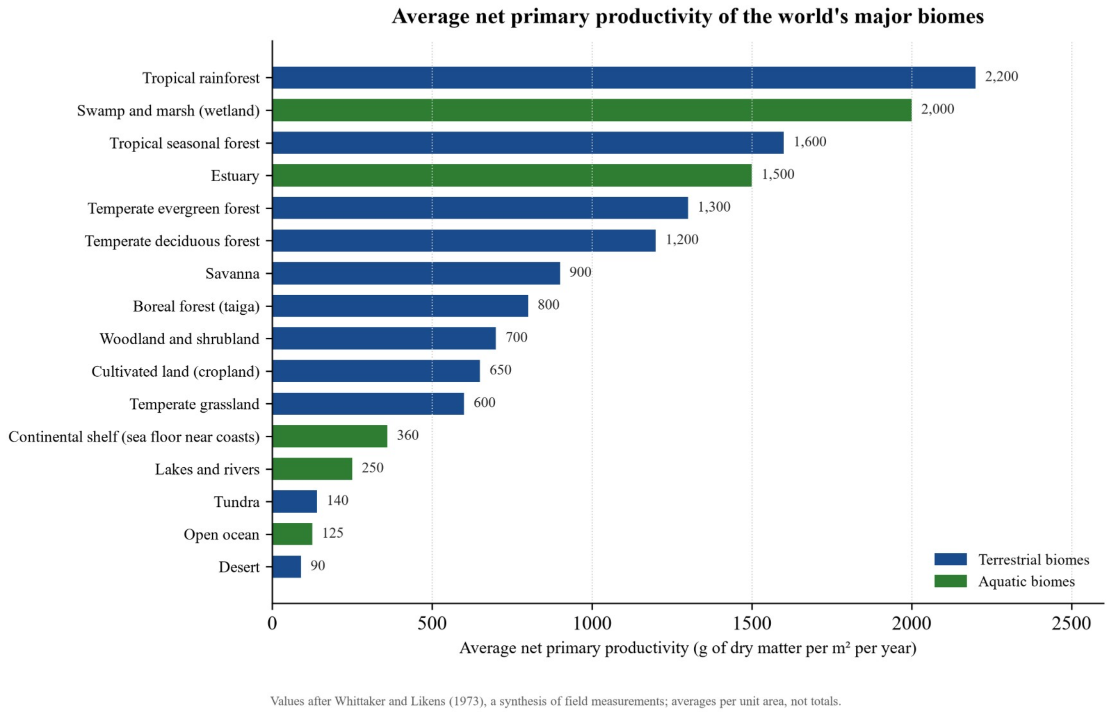
Flow model of a biome as a chain: climate sets the vegetation, the vegetation builds biomass at a rate called net primary productivity, and that biomass supplies food, fibre and plant-based materials; two boxes below contrast cold or dry biomes with low productivity against warm, wet biomes with high productivity

Figure 1 — The biome model. Climate, vegetation and biomass productivity pull in one direction: change the climate, or let people change the vegetation, and the whole chain changes.

The rate at which the plants of a biome build new biomass is called **net primary productivity (NPP)**: the mass of new plant growth left over each year after the plants have used some of the energy they capture to keep themselves alive. It is *primary* because plant growth comes first — every animal in the biome lives on it, directly or indirectly — and *net* because the plants' own use is subtracted. NPP is the ceiling on how much food, fibre and plant material a biome can supply, so it is the key measure of a biome's **potential to produce food**. It is measured either per unit area — grams of dry plant matter per square metre per year (g/m²/yr) — or as a yearly total for the whole biome.

(VC2HG10K01.E01)

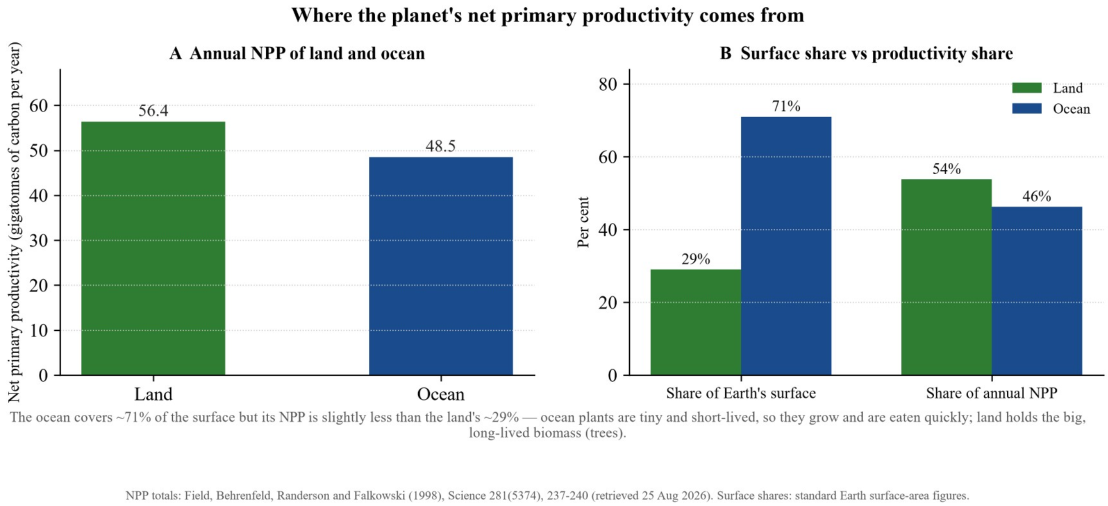
How productive are the biomes? Figure 2 ranks the world's major biomes by mean NPP. Warmth and water together mean high productivity: tropical rainforest (2,200 g/m²/yr), wetlands (2,000) and estuaries (1,500) sit at the top, while tundra (140), the open ocean (125) and deserts (90) sit at the bottom. Cultivated land — cropland — sits in the middle at about 650. The pairs do the explaining: a desert is hot but dry, a tundra is wet but cold, and both are near the bottom, whereas the hot **and** wet rainforest is at the top — so it is warmth *plus* water, and a long growing season, that drives biomass productivity.



Bar chart of mean net primary productivity of the world's major biomes in grams of dry matter per square metre per year, from tropical rainforest at 2,200 down through cultivated land at 650 to desert at 90, with land biomes in blue and water biomes in green

Figure 2 — Mean NPP by biome: how fast each square metre builds new plant matter. Warm and wet wins; cold or dry loses.

Figure 3 changes the question from "how fast per square metre?" to "how much in total?", because a biome's total NPP is its mean rate multiplied by its area. The land and the ocean turn out to be near-equals: land plants fix about 56.4 billion tonnes of carbon a year and ocean plants about 48.5 (Field, Behrenfeld, Randerson and Falkowski 1998). The surprise is the surface share: the ocean covers about 71% of the planet yet produces slightly *less* NPP than the land's 29%. Per square metre, land is roughly three times as productive. The reason is that ocean plants are microscopic and short-lived — they grow and are eaten within days — while land holds big, long-lived biomass in the form of trees.



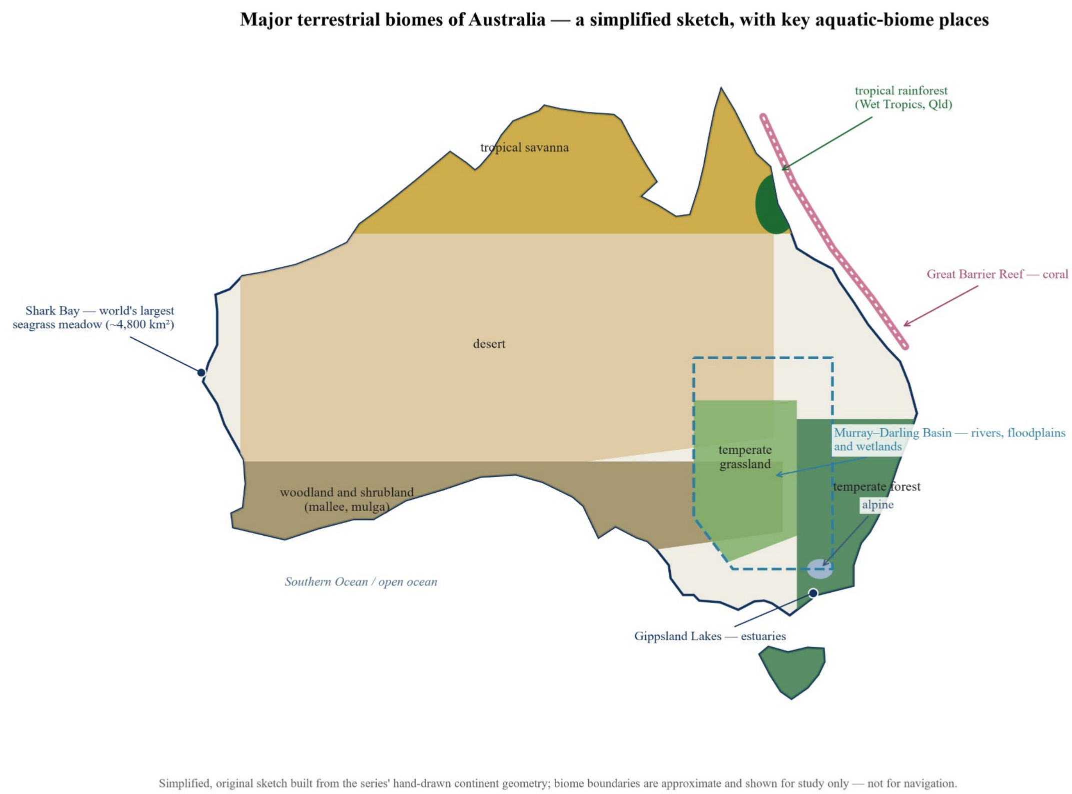
Two-panel chart: panel A, annual net primary productivity of land (56.4) and ocean (48.5) in gigatonnes of carbon per year; panel B, the ocean's 71 per cent share of Earth's surface against its 46 per cent share of annual net primary productivity, with the land's 29 and 54 per cent

Figure 3 — Land and ocean totals. The ocean wins on area but loses on rate, because its plants are tiny and short-lived.

(VC2HG10K01.E01, VC2HG10K01.E02)

Where are the biomes? Australia and the world. Because climate changes in broad bands away from the equator — hot and wet near it, dry around 20–30° of latitude, cooler towards the poles — the world's land biomes sit in broad bands too: rainforest near the equator, savanna and desert beyond it, grasslands and temperate forests in the mid-latitudes, and boreal forest and tundra towards the poles. Australia shows the same banding on a mostly dry continent (Figure 4). **Tropical savanna** (grassland with scattered trees) crosses the north; a small patch of **tropical rainforest** clings to the wet north-east coast of Queensland; the interior is **desert**, ringed by a wide belt of **woodland and shrubland** (mallee and mulga); the inland plains of the south-east carry **temperate grassland**, as on the western volcanic plains of Victoria; the wetter south-east, south-west and Tasmania carry **temperate forest**; and the **alpine** biome — Australia's cold equivalent of tundra — sits on the Australian Alps.

Australia's **aquatic biomes** are marked on the same map: the rivers, floodplains and wetlands of the Murray–Darling Basin; **estuaries**, where river and sea water mix, as at the Gippsland Lakes; the shallow, sunlit **continental shelf**, holding the Great Barrier Reef — about 2,900 reefs spread over about 344,400 km² (Great Barrier Reef Marine Park Authority) — and Shark Bay in Western Australia, with the world's largest seagrass meadow, about 4,800 km²; and the **open ocean** of the Southern Ocean. Figure 5 collects the climate, vegetation, mean NPP and an Australian example of each major biome in one table.



Simplified sketch map of Australia showing the tropical savanna across the north, a tropical rainforest patch on the north-east coast, desert in the interior, woodland and shrubland around it, temperate grassland in the south-east inland, temperate forest in the south-east, south-west and Tasmania, and an alpine patch in the Australian Alps, with the Great Barrier Reef, Shark Bay, the Gippsland Lakes and the Murray-Darling Basin marked as aquatic-biome places

Figure 4 — Australia's major terrestrial biomes (simplified sketch; boundaries are approximate), with key aquatic-biome places.

Characteristics of the major biomes

Biome	Typical climate	Typical vegetation	Avg. NPP (g dry matter/m^2/yr)	Australian example
Terrestrial biomes				
Tropical rainforest	Hot all year; very high rainfall	Tall, dense evergreen trees	2,200	Wet Tropics, north-east Qld
Tropical savanna	Hot; wet summers, dry winters	Grasses with scattered trees	900	Northern Australia (Top End, Gulf country)
Desert	Very low rainfall; hot days, cold nights	Sparse shrubs and spinifex grasses	90	Simpson and Great Victoria deserts
Woodland and shrubland	Semi-arid; unreliable rain	Shrubs, mallee and mulga	700	The Mallee, north-west Victoria
Temperate grassland	Warm summers, cool winters; moderate rain	Native grasses, few trees	600	Western volcanic plains, Victoria
Temperate forest	Reliable rainfall; mild to cool	Tall eucalypt forest (e.g. mountain ash)	1,200	Central Highlands, Victoria
Tundra and alpine	Very cold; short growing season	Mosses, lichens, low shrubs	140	Australian Alps
Aquatic biomes				
Rivers, lakes and wetlands	Varies with climate	Algae and water plants	250	Murray–Darling rivers; Gippsland Lakes (Vic.)
Estuaries	Mixing of river and sea water	Salt-tolerant plants; mangroves in the north	1,500	Gippsland Lakes; northern estuaries
Continental shelf (shallow sea)	Sunlit, nutrient-rich water	Phytoplankton, seaweed, corals	360	Great Barrier Reef, Qld
Open ocean	Sunlit surface layer; low nutrients	Microscopic phytoplankton	125	Southern Ocean off Australia

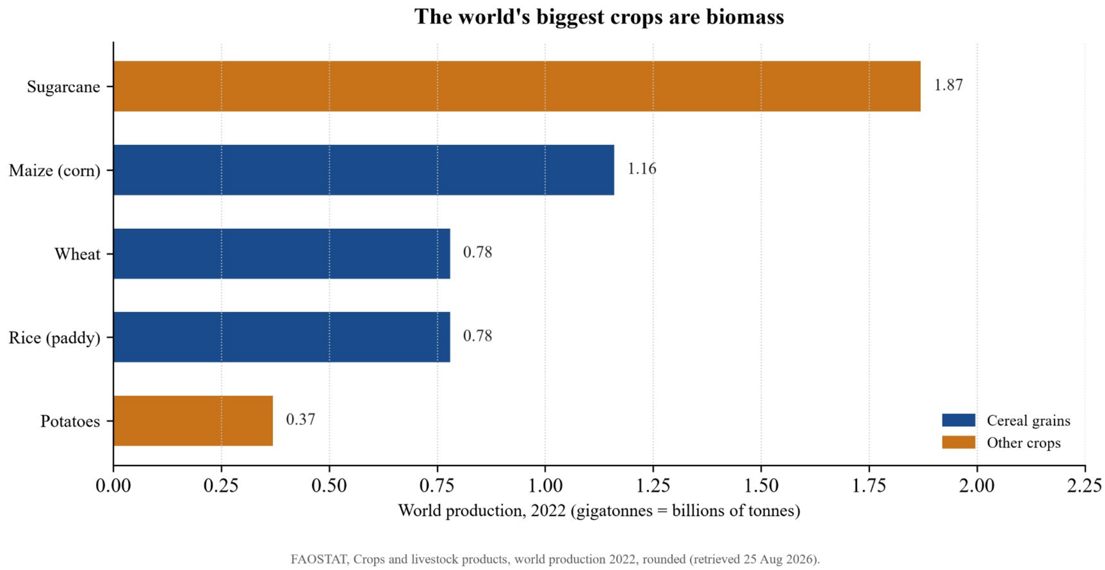
NPP averages after Whittaker and Likens (1973); examples are Australian. Boundaries and climates are simplified for study.

Table of the major terrestrial and aquatic biomes with their typical climate, typical vegetation, average net primary productivity and an Australian example, from tropical rainforest at 2,200 grams per square metre per year down to open ocean at 125

Figure 5 — Characteristics of the major biomes. Each row is one biome's climate, vegetation, productivity and Australian home.

(VC2HG10K01.E02)

Which biomes produce most of the world's food? Not the most productive ones by nature. Very little rainforest or wetland is farmed; the foods that feed the world are grown on the mid-ranking biomes that people have converted and managed. Figure 6 shows the five biggest crops by mass in 2022 — sugarcane (1.87 billion tonnes), maize (1.16), wheat (0.78), rice (0.78) and potatoes (0.37) — all of them grown on converted grassland, woodland and seasonal forest, or on irrigated patches of dry biomes. Figure 7 names the regions: the temperate grasslands of the North American Great Plains, the Eurasian steppe and the Pampas grow wheat, maize and beef; monsoon Asia's river floodplains grow rice — about 90% of the world's rice is grown in Asia (FAO); in Australia, the Murray–Darling Basin and the Western Australian wheatbelt grow wheat, rice, dairy, fruit and grain. The aquatic biomes add a second stream: in 2022 the world produced 223.2 million tonnes of fish and seafood, and for the first time more came from farming water — **aquaculture**, 130.9 million tonnes, over 90% of it in Asia — than from wild capture, 92.3 million tonnes (FAO, *The State of World Fisheries and Aquaculture*, 2024). So the answer to the question is: most of the world's food comes from modified grassland, woodland and seasonal-forest biomes, plus the coastal and shelf waters — the biomes whose flat land, workable soils and reliable seasons suit farming, rather than the biomes with the highest natural NPP.



Bar chart of the five largest world crops by production in 2022 in billions of tonnes: sugarcane 1.87, maize 1.16, wheat 0.78, rice 0.78 and potatoes 0.37, with cereals in blue and other crops in orange

Figure 6 — The world's biggest crops by mass, 2022. Every one is grown on a modified mid-NPP biome.

The biomes that produce most of the world's food

Food-producing region	Biome before or beneath farming	Main food outputs today
North American Great Plains (United States and Canada)	Temperate grassland (prairie)	Wheat, maize (corn), beef
Eurasian steppe (Ukraine, southern Russia, Kazakhstan)	Temperate grassland (steppe)	Wheat, sunflower
The Pampas (Argentina, Uruguay)	Temperate grassland	Beef, wheat, maize
Monsoon Asia (China, India, Indonesia, Vietnam, Thailand)	Tropical and temperate seasonal forest; river floodplains	Rice — about 90% of the world's rice is grown in Asia (FAO)
Murray–Darling Basin (Australia)	Temperate woodland, grassland and floodplain wetlands	Wheat, rice, dairy, beef, fruit and vegetables
Western Australia wheatbelt	Semi-arid woodland and shrubland	Wheat, barley, canola, sheep
Coastal waters of Asia	Coastal wetlands, mangroves, shallow seas	Aquaculture — Asia produces over 90% of the world's farmed seafood (FAO)
Continental shelves and upwelling zones (worldwide)	Marine biomes	Ocean-caught fish and seafood

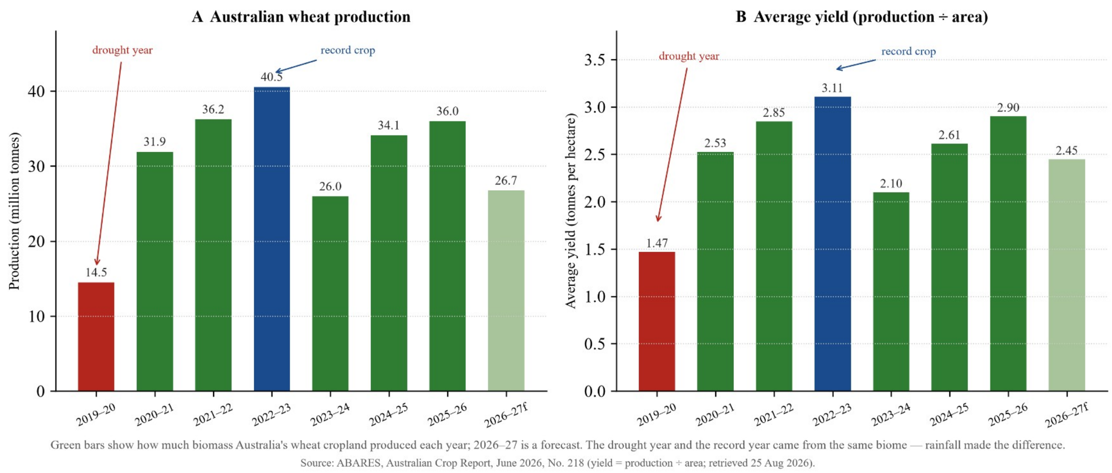
Compiled for this section: FAO (rice and aquaculture shares; retrieved 25 Aug 2026); regional extents are approximate.

Table of the world's main food-producing regions, the biome that stood there before farming, and their main food outputs today, from the North American Great Plains to Asian aquaculture and the world's continental shelves

Figure 7 — The biomes that produce most of the world's food: mostly converted grasslands and seasonal forests, plus the coastal waters.

(VC2HG10K01.E03)

The same biome, different years — and the ledger of change. Even a fully modified biome still answers to climate. Australian wheat is grown on the same cropland biome every year, yet in the drought year 2019–20 it produced 14.5 million tonnes at an average yield of 1.47 tonnes per hectare, while the record season 2022–23 produced 40.5 million tonnes at 3.11 tonnes per hectare (ABARES, *Australian Crop Report*, June 2026; Figure 8). Near Horsham in the Wimmera, where the average year brings only 379.3 mm of rain, the crop lives on the season's rain — so rainfall, the climate driver of NPP, swings the harvest. Irrigation lifts the ceiling instead: Australian irrigated rice averaged 11.0 tonnes per hectare in 2024–25, about three and a half times the record wheat yield, because water is supplied on demand. People raise a biome's food output by changing it — the curriculum names seven changes: vegetation clearance, the introduction of exotic plants and animals, drainage, terracing, cultivation, irrigation, and the application of agricultural chemicals. Every change buys a gain and pays a cost (Figure 9): clearing has put about 55% of Australia's land under farming (ABS Agricultural Census 2020–21) yet left less than 10% of Victoria's western volcanic-plain grassland remaining; irrigation helps the Murray–Darling Basin produce about one-third of Australia's food, yet is linked to salinity in parts of the Western Australian wheatbelt and to low river flows behind the Menindee fish kills of December 2018–January 2019; agricultural chemicals protect yields, yet their run-off reaches rivers and reefs. The geographical question is never "change or no change?" but "what was gained, what was paid, and does the gain last?"



Two-panel chart of Australian wheat, 2019-20 to 2026-27: panel A, production in million tonnes, lowest at 14.5 in the drought year 2019-20 and highest at 40.5 in the record year 2022-23; panel B, average yield in tonnes per hectare, from 1.47 to 3.11, with the drought year in red and the record year in blue

Figure 8 — The same cropland biome, different years. Drought 2019–20 and the record 2022–23 came from the same paddocks; rainfall made the difference.

Human changes to biomes for food — positive and negative consequences

Human change	Intended positive consequence	Observed negative consequences
Vegetation clearance	New cropland and pasture (~55% of Australia's land is now farming, ABS)	Habitat loss — less than 10% of Victoria's volcanic-plain grassland remains; soil erosion
Introduction of exotic plants and animals	New crops and pastures; biological control (Cactoblastis moths controlled prickly pear from 1926)	New pests — cane toads introduced 1936; rabbits compete with livestock
Drainage	Wet soils become usable for pasture and dairy	Loss of wetlands; poorer water quality downstream
Terracing	Steep slopes become level fields; less erosion (rice terraces across Asia)	High labour; disturbance during construction
Cultivation	Prepared seedbeds; weeds buried; better germination	Soil broken up: erosion and loss of soil carbon
Irrigation	Crops grow in dry country — the Murray–Darling Basin produces about one-third of Australia's food (MDBA)	Salinity (~1 Mha in the WA wheatbelt, NLWRA); low river flows; Menindee fish kills, Dec 2018–Jan 2019
Agricultural chemicals	Fewer losses to weeds, insect pests and disease	Runoff into rivers and reefs; GBR water quality remains a threat (GBRMPA); pesticide resistance

Examples sourced in the section record (src/1a_sources.md); the same change can help food production and harm the biome.

Table of the seven human changes to biomes for food — vegetation clearance, introduced exotic plants and animals, drainage, terracing, cultivation, irrigation and agricultural chemicals — with the intended positive consequence and the observed negative consequences of each, using dated Australian examples

Figure 9 — The ledger of change. Each row is one human change with its gain for food and its cost to the biome.

(VC2HG10K01.E04)

Worked examples

Example 1 — scaffolded

Use Figures 2 and 3. (a) Name the most productive land biome and the least productive land biome in Figure 2, and give their mean NPP values. (b) How many times larger is the rainforest value than the desert value? (c) From Figure 3, state the land and ocean shares of Earth's surface and of annual NPP. (d) Explain in one sentence why the land's share of NPP is bigger than its share of surface.

Working	Comment
(a) Most productive land biome: tropical rainforest, 2,200 g/m²/yr. Least productive land biome: desert, 90 g/m²/yr.	Read the bar chart; the legend separates land (blue) and water (green) biomes, so compare within the land bars.
(b) 2,200 ÷ 90 ≈ 24.4, so about 24 times larger.	"How many times" means divide, not subtract.
(c) Surface: land 29%, ocean 71%. Annual NPP: land 54%, ocean 46%.	Panel B gives both shares; keep each pair straight.
(d) The land holds big, long-lived plants (trees), while ocean plants are microscopic and eaten within days, so each square metre of land fixes about three times as much	The explanation is the rate-per-area difference behind the totals: 56.4 vs 48.5 billion tonnes from 29% vs 71% of the surface.

Working	Comment
carbon as a square metre of ocean.	

Example 2 — unscaffolded

The record Australian wheat crop of 2022–23 shows that human modification of biomes has removed the climate limit on food production. Evaluate this claim using Figure 8 and the biome model of Figure 1.

Run the model chain — climate → vegetation → biomass productivity — across the two seasons, then judge.

The swing. In 2019–20 the same cropland biome produced 14.5 Mt at 1.47 t/ha; in 2022–23 it produced 40.5 Mt at 3.11 t/ha. The area sown barely changed (about 9.9 to about 13.1 million hectares), so the near-tripling of production came from yield — from how much biomass each hectare built. In the Figure 1 chain, the link that changed between the two seasons is the first one, climate: more growing-season rain moved the vegetation's biomass productivity from the "too dry" box towards the "warm and wet" box.

The modification. The cropland itself is a human modification — cleared, cultivated, sown to bred varieties — and irrigation shows how far modification can lift the ceiling elsewhere (11.0 t/ha of irrigated rice in 2024–25 against 3.11 t/ha of record dryland wheat). Modification is real and powerful.

The judgement. But most Australian wheat is dryland, so its NPP still rides on the season's rain: production fell back to 26.0 Mt in 2023–24, and the 2026–27 season is forecast lower again, at 26.7 Mt, on a drier outlook. The claim therefore fails as written: modification moved the climate limit — it did not remove it. That is what "evaluate" requires you to show: the gain is real, and it still answers to the first box in the chain.

Practice questions

Scaffolded

Q1. In your own words, define (a) *biome*, (b) *biomass*, (c) *net primary productivity*.

Q2. Use Figure 4. Name the biome (a) covering most of northern Australia, (b) of the continental interior around the Simpson and Great Victoria deserts, (c) of the Australian Alps, and (d) two aquatic-biome places marked on the map.

Q3. Use Figure 5. (a) Which terrestrial biome has a mean NPP of 2,200 g/m^2/yr, and where is its Australian example? (b) Which biome has a mean NPP of 90? (c) Which *aquatic* biome in the table is the most productive, and what is its value? (d) Which biome's Australian example is the western volcanic plains of Victoria?

Q4. Use Figure 2. (a) Which is more productive, tropical savanna or boreal forest, and by how much? (b) Is cultivated land above or below temperate grassland? (c) Name one water biome more productive than cultivated land and one less productive.

Q5. Use Figure 3. (a) State the annual NPP of the land and of the ocean. (b) Which of the two covers more of Earth's surface? (c) Which of the two produces more NPP per square metre, and how can you tell from the two panels?

Q6. Use Figure 9. (a) Which human change made "new cropland and pasture"? (b) For irrigation, give one intended positive consequence and one observed negative consequence, each with its place or date. (c) Which row shows a change that brought both a pest problem and a successful biological control, and what were they?

Unscaffolded

Q7. "Most of the world's food comes from modified mid-ranking biomes, not from the biomes that are most productive by nature." Support this claim using Figures 2, 6 and 7.

Q8. The drought year 2019–20 and the record year 2022–23 grew their wheat on the same Australian cropland biome (Figure 8). Using the biome model of Figure 1, explain how one biome produced 14.5 million tonnes in one season and 40.5 million tonnes three seasons later.

Q9. Choose two terrestrial biomes from Figure 4's map of Australia. For each, use Figure 5 to explain how its climate and vegetation produce its NPP value.

Q10. Evaluate whether irrigating dry biomes to produce food is worth it, using the irrigation row of Figure 9 and one other row of your choice. Weigh the gains against the costs and reach a judgement.

Inquiry task

Your plate, your biomes. Choose three foods you eat in a normal week that were grown or raised in Australia (supermarket labels and "grown in" stickers are data). For each food, build one row of a table with: (a) the named region it most likely came from (for example the Wimmera, the Murray–Darling Basin, the Mallee); (b) that region's biome from Figure 4; (c) the biome's NPP class from Figure 2 (high, middle or low); (d) one human change from Figure 9 that makes production possible there; and (e) one gain and one cost of that change. Then write one closing sentence answering: *which of your three foods comes from the biome least suited to producing it, and which human change pushes that biome past its natural ceiling?* Include one statistic from this section in your table, and cite its source and date (all sources in this section were retrieved 25 August 2026).

Answers

Q1. (a) A biome is a large region of the Earth with its own climate, vegetation and biomass productivity. (b) Biomass is the mass of living plant and animal material in a region. (c) Net primary productivity is the rate at which plants build new biomass, after subtracting the energy they use to stay alive. **Q2.** (a) Tropical savanna. (b) Desert. (c) Alpine (tundra and alpine). (d) Any two of: the Great Barrier Reef, Shark Bay, the Gippsland Lakes, the Murray–Darling Basin. **Q3.** (a) Tropical rainforest; the Wet Tropics of north-east Queensland. (b) Desert. (c) Estuaries, 1,500 g/m²/yr. (d) Temperate grassland. **Q4.** (a) Tropical savanna, 900 against 800 g/m²/yr — 100 more. (b) Above (650 against 600). (c) More productive than cultivated land: estuaries (1,500 g/m²/yr). Less productive: lakes and rivers (250), the continental shelf (360) or the open ocean (125). **Q5.** (a) Land about 56.4, ocean about 48.5 billion tonnes of carbon a year. (b) The ocean (71% of the surface). (c) The land: it produces 54% of the NPP from only 29% of the surface. **Q6.** (a) Vegetation clearance. (b) Positive: crops grow in dry country — the Murray–Darling Basin produces about one-third of Australia's food; negative: salinity in parts of the WA wheatbelt, low river flows linked to the Menindee fish kills of December 2018–January 2019. (c) The introduction of exotic plants and animals: cane toads (1936) became a pest, while Cactoblastis moths controlled prickly pear from 1926. **Q7.** Figure 2 puts rainforest and wetlands at the top (2,200; 2,000) yet Figure 7 shows almost no food region sitting on rainforest; the big food regions sit on grassland and seasonal forest with mid-ranking NPP (cultivated land about 650), and Figure 6's five biggest crops are all grown on those converted biomes or on irrigated patches of dry ones. **Q8.** The first link of the chain, climate, changed: more growing-season rain in 2022–23 moved the same vegetation's biomass productivity from near the "too dry" box towards the "warm and wet" box, so each hectare built about 3.11 t instead of 1.47 t and total production rose from 14.5 to 40.5 Mt with little change in area. **Q9.** Answers will vary; a sound pair contrasts, for example, tropical rainforest (hot and wet all year, tall dense evergreen trees, 2,200) with desert (very low rain, sparse shrubs and spinifex, 90), linking warmth plus water to high NPP and dryness to low NPP. **Q10.** Answers will vary; a sound evaluation weighs dated gains (reliable crops in dry country; the Basin's one-third share of Australia's food) against dated costs (salinity, low flows, the Menindee fish kills), plus a second row (for example clearance: farmland gained, grassland habitat lost), and states a judgement about whether the gain lasts.

Inquiry task. Tables will vary; markers look for a named region, a biome consistent with Figure 4, a correct NPP class, one plausible change from Figure 9, one gain and one cost, a cited statistic with its date, and a closing sentence that names the least-suited biome and the change pushing past its natural ceiling (usually irrigation or clearance).

Fully-worked solutions

Q1. (a) A biome is a large region of the Earth with its own distinctive climate, vegetation and biomass productivity — one of ecology's climate-matched classes such as desert, savanna or temperate forest. (b) Biomass is the mass of living plant and animal material stored in a region's plants and animals. (c) Net primary productivity is the mass of new plant growth left each year after the plants have used some of the captured energy to keep themselves alive — the ceiling on what the biome can supply.

Q2. (a) Tropical savanna crosses the north. (b) Desert occupies the interior. (c) The alpine biome (tundra and alpine) sits on the Australian Alps. (d) Any two of the marked aquatic places: the Great Barrier Reef (continental shelf), Shark Bay (seagrass, shelf waters), the Gippsland Lakes (estuaries), the Murray–Darling Basin (rivers, floodplains and wetlands).

Q3. (a) Tropical rainforest, 2,200 g/m²/yr; Australian example: the Wet Tropics, north-east Queensland. (b) Desert, 90 g/m²/yr. (c) Estuaries, 1,500 g/m²/yr — above the open ocean (125), the shelf (360) and lakes and rivers (250). (d) Temperate grassland — the western volcanic plains, Victoria.

Q4. (a) Savanna 900 vs boreal 800 g/m²/yr: savanna is 100 g/m²/yr more productive. (b) Cultivated land (650) sits above temperate grassland (600). (c) A water biome above cultivated land: estuaries (1,500). A water biome below it: the open ocean (125) — lakes and rivers (250) and the continental shelf (360) also qualify.

Q5. (a) Land about 56.4 and ocean about 48.5 billion tonnes of carbon per year (Field et al. 1998). (b) The ocean, with about 71% of the surface. (c) The land. It supplies 54% of the NPP from 29% of the surface, so each square metre of land fixes roughly three times as much carbon as a square metre of ocean — the ocean's plants are microscopic and short-lived, the land's are big and long-lived.

Q6. (a) Vegetation clearance. (b) Positive: irrigation lets crops grow in dry country — the Murray–Darling Basin produces about one-third of Australia's food (MDBA). Negative: salinity (about one million hectares in the WA wheatbelt, NLWRA), low river flows, and the Menindee fish kills of December 2018–January 2019. (c) The introduction of exotic plants and animals: the cane toad, introduced in 1936, became a pest, while the Cactoblastis moth, released from 1926, controlled prickly pear — a gain and a cost in the same row.

Q7. Point 1: Figure 2's most productive biomes — rainforest (2,200), wetlands (2,000) — are rarely farmed, and cropland's own mean NPP (about 650) is mid-ranking. Point 2: Figure 7's food regions sit on temperate grassland (Great Plains, steppe, Pampas), seasonal forest and floodplains (monsoon Asia), and semi-arid shrubland (WA wheatbelt) — the flat, fertile, workable biomes. Point 3: Figure 6 confirms the output — the five biggest crops (sugarcane, maize, wheat, rice, potatoes) are all grown on those converted biomes, with the aquatic biomes adding the seafood stream. Hence the claim: the world eats from modified mid-ranking biomes, not from nature's most productive ones.

Q8. In the Figure 1 chain, the vegetation (cropland) and the modification (clearing, cultivation, sown varieties) were much the same in both seasons — the area sown moved only from about 9.9 to about 13.1 million hectares. The link that changed was climate: 2019–20 was a drought year, so the crop sat near the model's "too cold or too dry" box and each hectare built only 1.47 t; 2022–23 brought ample growing-season rain, moving the crop towards the "warm and wet" box, so each hectare built 3.11 t. Production = area × yield, so 14.5 Mt became 40.5 Mt. The same biome, two climates, two harvests.

Q9. Example pair. *Tropical rainforest (Wet Tropics, Qld):* hot and wet all year with a twelve-month growing season, so tall, dense evergreen trees photosynthesise continuously — the table's highest terrestrial NPP, 2,200 g/m²/yr. *Desert (Simpson and Great Victoria deserts):* very low rainfall with hot days and cold nights, so vegetation is sparse shrubs and spinifex with little leaf area to capture energy — NPP falls to 90. The contrast is the climate driver of Figure 1: warmth plus water sets the potential, dryness caps it. (Any two biomes argued the same way, climate → vegetation → NPP, earn full credit.)

Q10. Structure of a sound answer. Gains (irrigation): crops grow in dry country; the Murray–Darling Basin, much of it irrigated, produces about one-third of Australia's food; irrigated rice reaches about 11 t/ha against about 3 t/ha for dryland wheat. Costs (irrigation): salinity in parts of the WA wheatbelt, low river flows, and the Menindee fish kills of December 2018–January 2019. A second row (for example vegetation clearance: about 55% of Australia's land now farms, against less than 10% of Victoria's western volcanic-plain grassland remaining) shows the same ledger. Judgement: irrigation is worth it where water is available in most years and flows are managed for the river as well as the farm; on the driest margins, where low flows and salinity follow, the gain does not last. A stated, reasoned position either way earns the mark.

Inquiry task — one possible approach. *Row 1: wheat bread — Wimmera (Victoria); temperate grassland/woodland biome; middle NPP class; change: cultivation and clearance; gain: reliable grain in a dry climate; cost: native grassland reduced. Row 2: rice — Murray–Darling Basin (Riverina); semi-arid woodland and floodplain wetlands; low-to-middle NPP; change: irrigation; gain: about 11 t/ha of rice in a dry country; cost: low river flows. Row 3: milk — Gippsland; temperate forest and grassland; middle NPP class; change: drainage; gain: wet soils became usable dairy pasture; cost: wetlands lost and poorer water quality downstream.* Closing sentence: the rice comes from the biome least suited to producing it — a semi-arid basin — and irrigation is the change that pushes it past its natural ceiling. The cited statistic (for example "the Murray–Darling Basin produces about one-third of Australia's food — MDBA, retrieved 25 August 2026") anchors the table in a checkable source.

The environmental, economic and technological factors that influence crop production in Australia and worldwide

Curriculum link: `VC2HG10K02` — the environmental, economic and technological factors that influence crop production in Australia and worldwide. This section draws on elaborations `.E01` `.E02` `.E03` `.E04` `.E05`.

Every loaf of bread, bowl of rice and bag of sugar began as a crop in a paddock. But a crop does not simply “happen”. How much food a farm grows — its **crop production** — depends on a mix of natural conditions, money decisions and technology. In this section we study that mix in **Australia** and in **Indonesia**, a country in Asia that is also one of Australia’s most important trading partners.

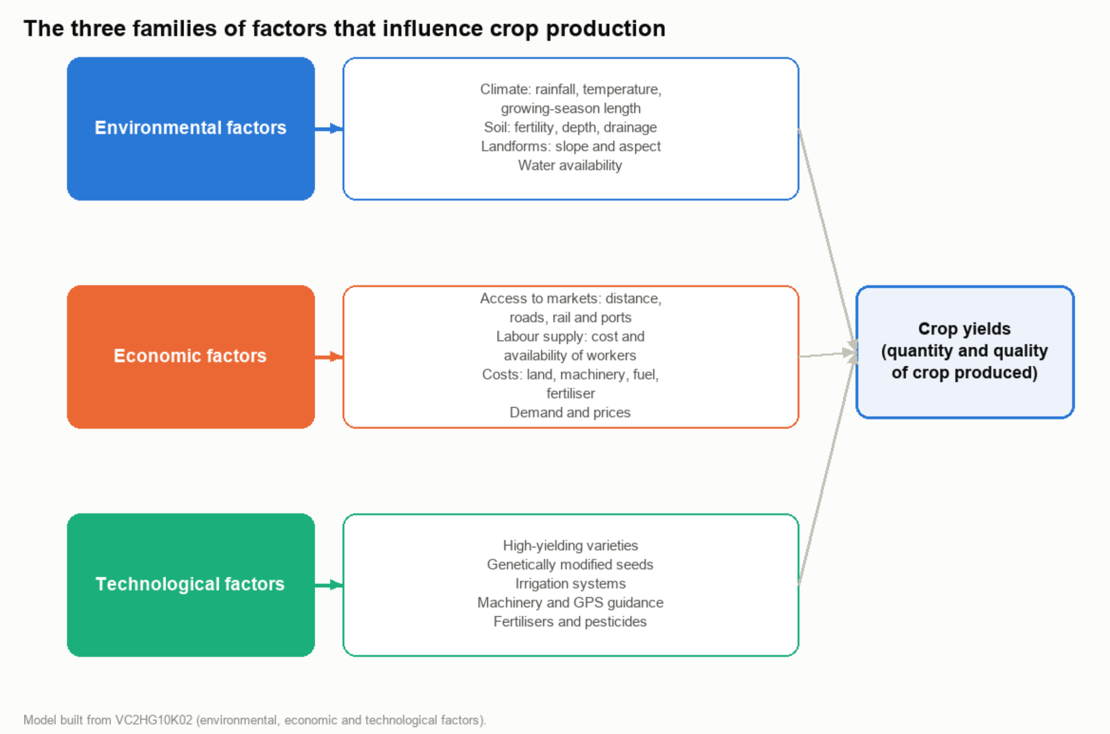
Before we start, three quick definitions you will use all through this section:

- A **crop** is a plant that people grow on purpose to eat, to feed animals, or to make things.
- The **yield** of a crop is how much of it is produced from a set area of land, usually measured in tonnes per hectare (t/ha).
- **Food security** means that people can regularly get enough safe, nutritious food to live a healthy life. Crop production is one of the main things that keeps a country food-secure.

Theory

The three families of factors

Geographers group the things that influence crop production into **three families of factors**. A **factor** is anything that helps decide how much, and how well, a crop grows.

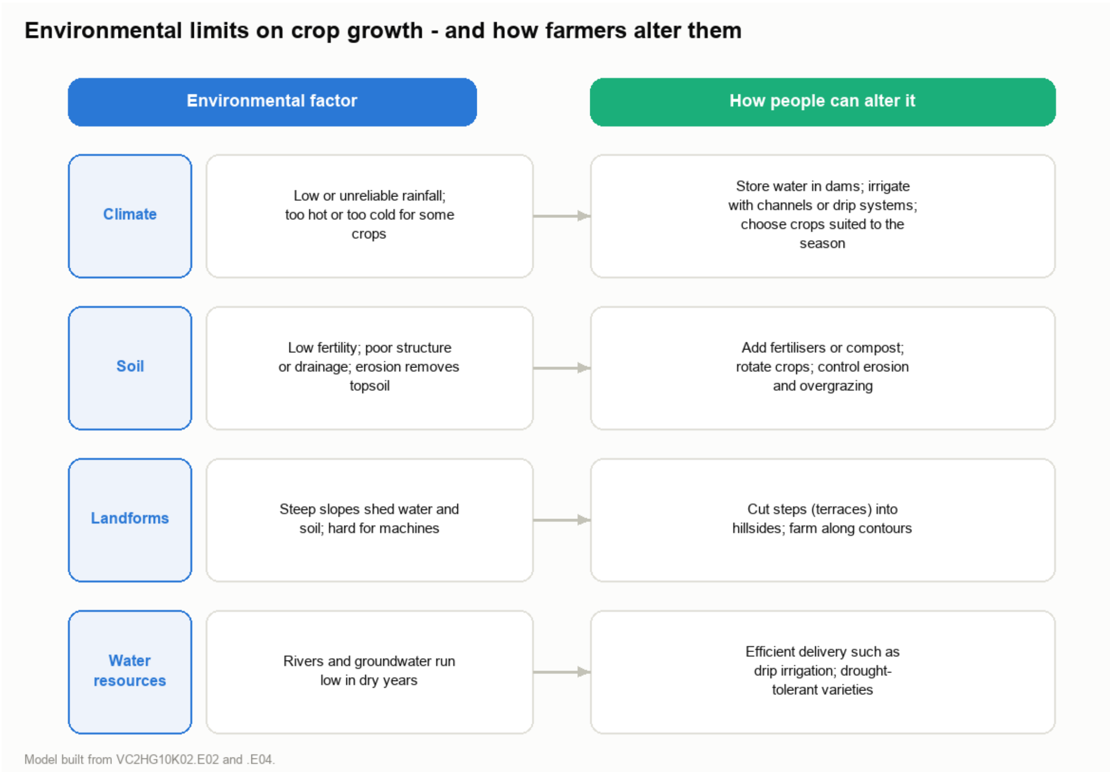


Three families of factors influencing crop production: environmental (climate, soil, landforms, water), economic (markets, labour, costs, demand) and technological (high-yielding varieties, GM seeds, irrigation, machinery, fertilisers).

No farm is controlled by just one family. A wheat farm in Western Australia and a rice farm in Indonesia both sit inside all three at once — the natural environment sets the stage, money and markets shape the choices, and technology decides how far people can push past the natural limits.

Environmental factors (what the land gives)

The **environmental factors** are the natural conditions a crop must live with: **climate**, **soil**, **landforms** and **water resources**. Each one can raise or lower a crop's yield.



Environmental limits on crop growth, and the ways farmers alter them: climate, soil, landforms and water on one side, and irrigation, fertilisers, terracing and efficient water use on the other.

- **Climate** — crops need the right temperature and rainfall at the right time of year. Wheat is a cool-season crop: in Australia it is planted in autumn and grows on winter rain, then ripens in the warmer, drier spring. Rice is a warm-season crop: in Indonesia it thrives on the hot, wet monsoon months.
- **Soil** — crops draw water and nutrients from the soil. Deep, fertile soil gives a higher yield than thin, poor soil.
- **Landforms** — flat or gently rolling land suits large machines, while steep land is hard to farm unless it is reshaped (see terracing below).
- **Water resources** — reliable water, from rain, rivers or groundwater, is the difference between a good season and a failed crop.

Crop production compared: Australia and Indonesia

Factor	Australia (wheat belt)	Indonesia (rice)
Main crop	Wheat - cool-season cereal, planted in autumn and harvested in early summer	Rice (padi) - warm-season crop grown in flooded paddies
Climate	Warm, dry to semi-arid; rainfall low and highly variable	Humid tropical; wet and dry seasons, monsoon rains
Landforms	Gentle plains and rolling land suited to large machines	Volcanic slopes; steep land farmed as stepped terraces
Water	Mostly rain-fed dryland; irrigation concentrated in the Murray-Darling Basin	Flooded paddies fed by rain, rivers and irrigation systems
Labour	Highly mechanised; few workers per farm	Labour-intensive; many steps still done by hand
Key tech-nologies	High-yielding varieties; GM canola and cotton; large machinery	High-yielding variety seeds; fertilisers; terracing
Markets	Most wheat exported by rail and ship; Indonesia the top market (2024-25)	Most rice eaten at home; a top world producer

Sources: ABARES; Murray-Darling Basin Authority; FAO/BPS; Australia-Indonesia trade reporting (all retrieved 2026-08-25).

Comparison table of crop production in Australia (wheat belt) and Indonesia (rice), covering main crop, climate, landforms, water, labour, key technologies and markets.

Notice how different the two places are. Much of Australia's wheat belt is **dry**, with low and highly variable rainfall, so farmers rely on stored soil moisture and, in places, irrigation. Indonesia is **humid and tropical**, with plenty of rain — but on steep volcanic slopes, so rice farmers reshape the land into terraces instead.

Economic factors (what the money decides)

The **economic factors** are the money-side decisions:

- **Accessibility** — how easily a farm can reach markets, by road, rail or port. A farm close to a grain port can sell cheaply; a remote farm pays more to move its crop.
- **Labour supply** — how many workers are available, and what they cost. Indonesian rice farming is labour-intensive, with many steps still done by hand. Australian wheat farming is highly mechanised, so a small number of workers farms a huge area.
- **Costs and prices** — the price of land, fuel, machinery and fertiliser, set against the price the crop will sell for. When wheat prices rise, farmers plant more; when fuel costs jump, profits shrink.

Technological factors (how people push past the limits)

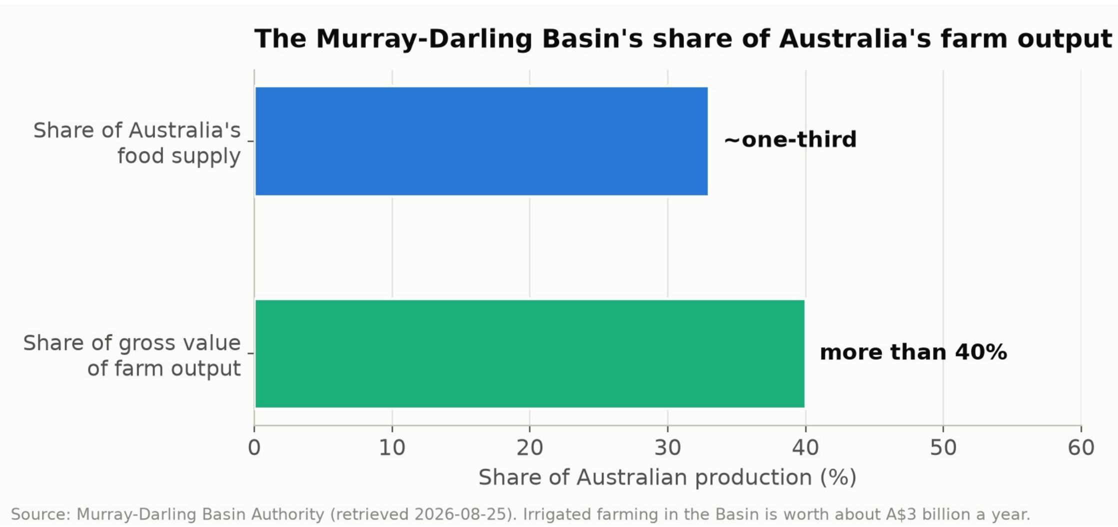
The **technological factors** are the tools and methods that raise yields or overcome environmental limits: **irrigation**, **high-yielding varieties**, **genetically modified (GM) seeds**, **machinery** and **fertilisers and pesticides**.

Genetically modified, defined: in this section, **genetically modified (GM)** is used in the sense of an organism whose genetic material has been changed using biotechnology, rather than by ordinary breeding. GM is a **contested** term — people weigh its benefits and risks differently — so we look at both sides fairly in the "Evaluate" box below.

Human alteration of biomes: Australia and Indonesia

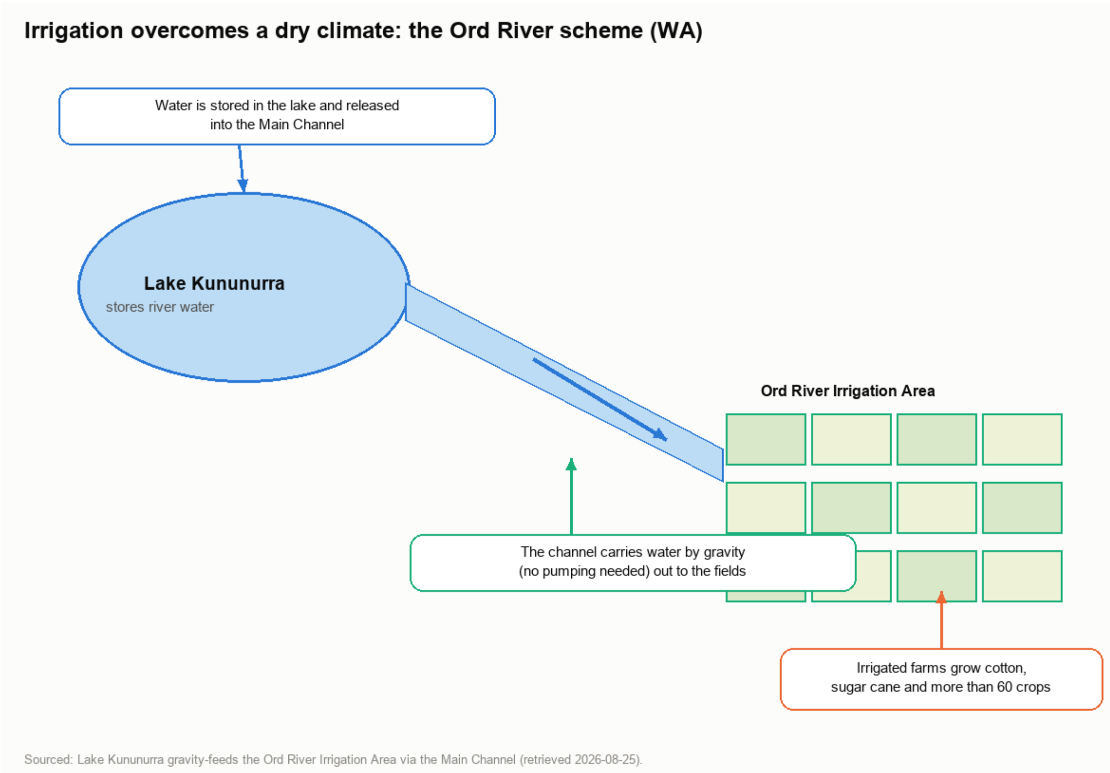
A **biome** is a large region with its own climate, plants and animals — for example a grassland or a tropical forest. Farming is one of the biggest ways people **alter** (change) biomes to grow food. Here is how that looks in our two countries.

Australia — irrigation beats a dry climate. Much of Australia is too dry for reliable cropping, so people bring water to the land. The **Murray–Darling Basin** is the heart of irrigated farming: it supplies about a third of Australia's food and over 40% of the gross value of farm output, with irrigated farming worth about A$3 billion a year.



Horizontal bars showing the Murray–Darling Basin's share of Australia's farm output: about one-third of the food supply and more than 40% of the gross value of farm output.

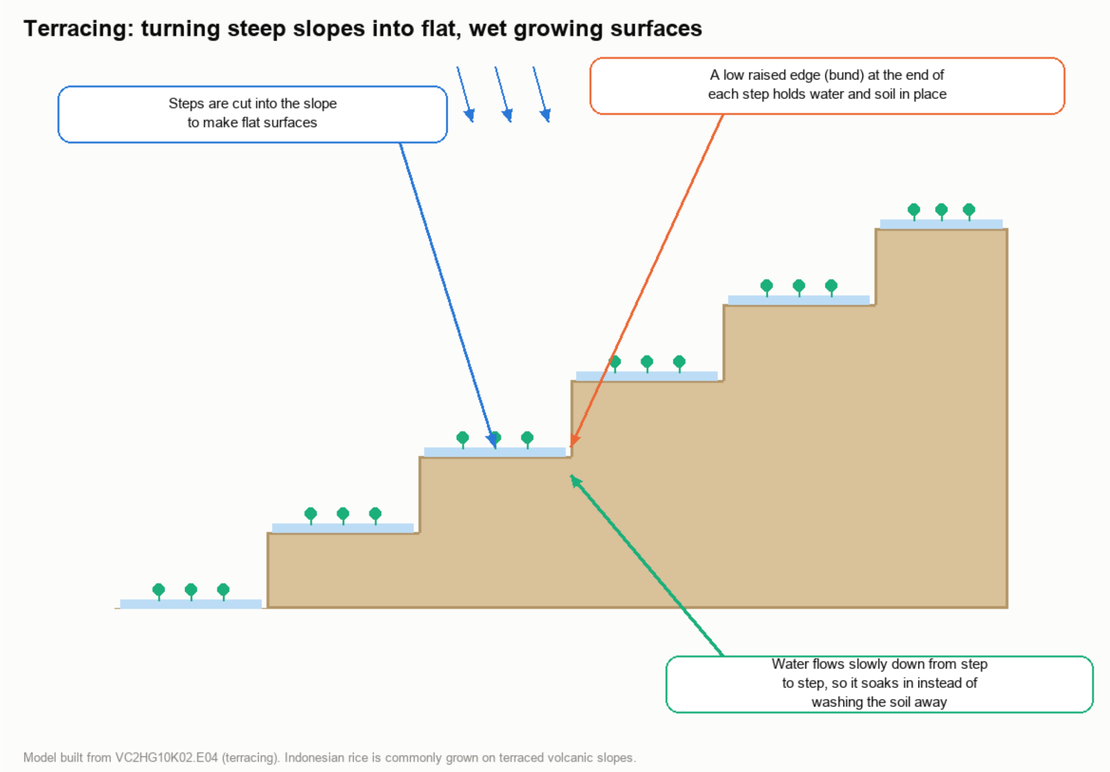
In the far north of Western Australia, the **Ord River scheme** shows the same idea in a tropical desert: water is stored in Lake Kununurra and flows by gravity along the Main Channel out to the fields, letting farmers grow cotton, sugar cane and more than 60 other crops where rainfall alone could not.



Labelled diagram of the Ord River scheme: Lake Kununurra stores water, the Main Channel carries it by gravity to irrigated farms growing cotton and sugar cane.

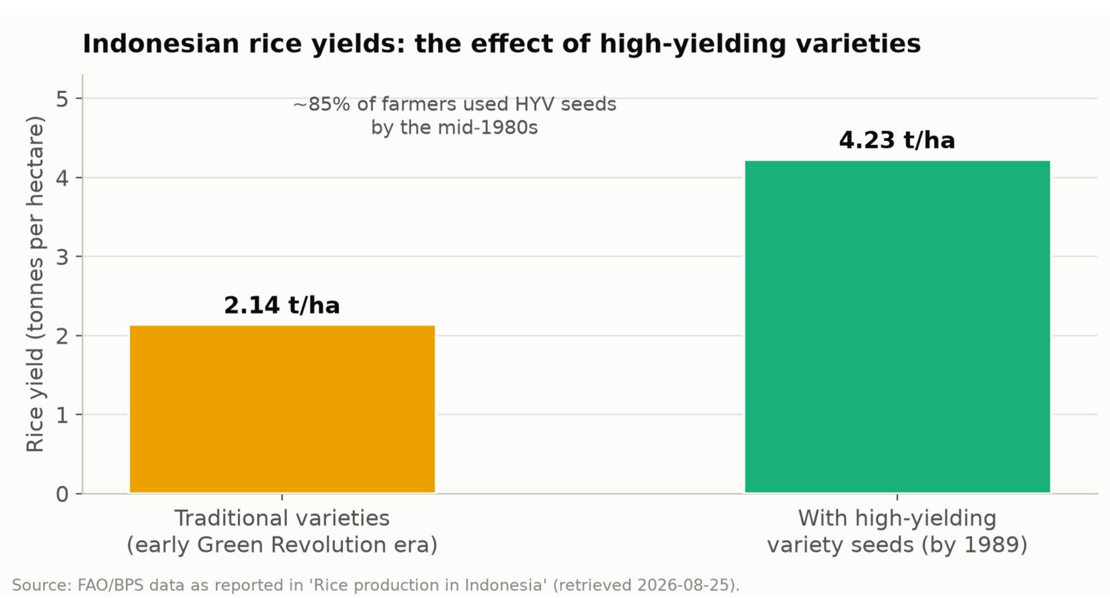
Other alterations raise yields too: **fertilisers** feed the soil, **pesticides** protect the crop, **high-yielding varieties** and **GM seeds** produce more grain per plant, and **controlling erosion and overgrazing** keeps the topsoil in place.

Indonesia — terracing beats steep land. On the volcanic slopes of Java and Bali, rice farmers cut steps, or **terraces**, into the hills. Terracing turns steep, erosion-prone slopes into flat, wet growing surfaces, so the land can feed far more people than it could naturally.



Labelled cross-section of terraced rice fields: steps cut into the slope hold flat, flooded surfaces, with raised edges that keep water and soil from washing away.

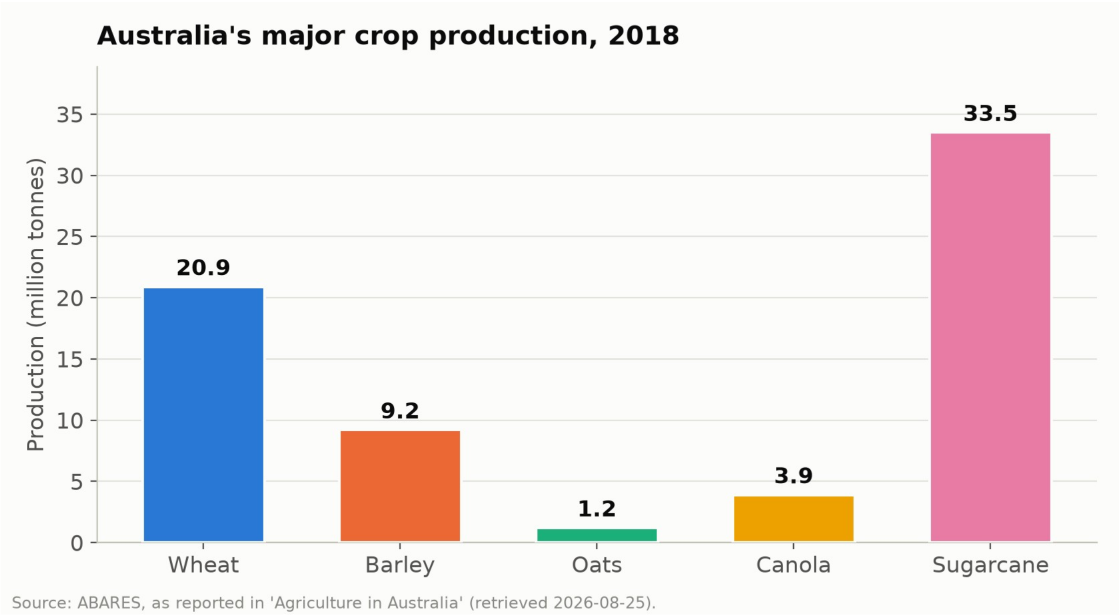
Indonesia's **high-yielding variety (HYV) seeds** — adopted by about 85% of rice farmers by the mid-1980s — more than doubled the yield of a paddy (a flooded field for growing rice), from about 2.14 to 4.23 tonnes per hectare.



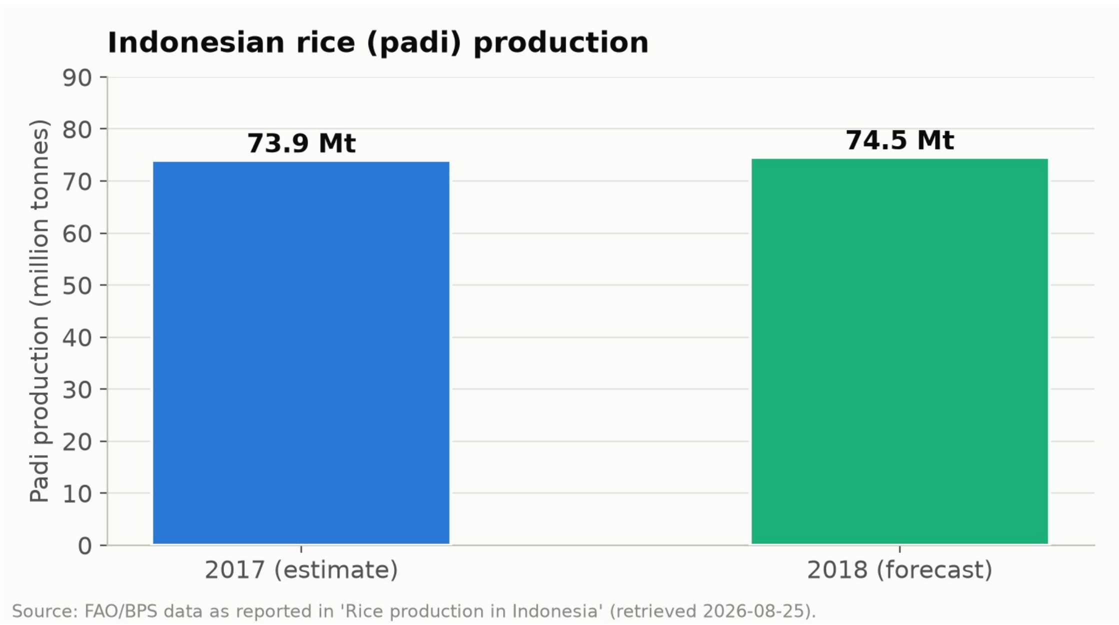
Bar chart of Indonesian rice yields: 2.14 tonnes per hectare with traditional varieties rising to 4.23 tonnes per hectare with high-yielding variety seeds by 1989.

Australia’s and Indonesia’s production in numbers

The data make the scale of each country’s cropping clear.

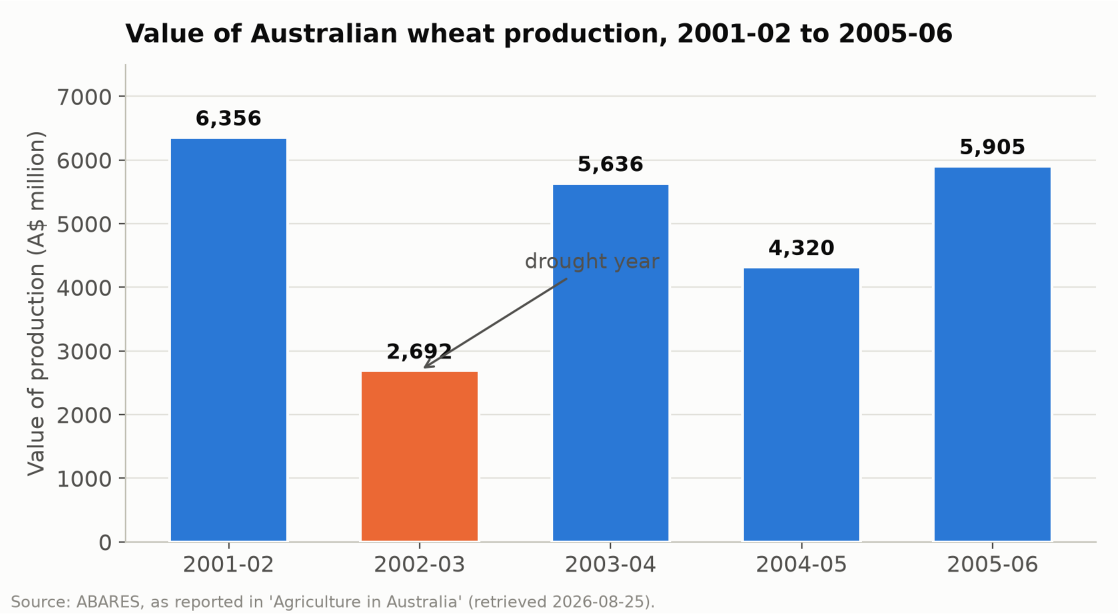


Bar chart of Australia’s major crop production in 2018: sugarcane 33.5, wheat 20.9, barley 9.2, canola 3.9 and oats 1.2 million tonnes.



Bar chart of Indonesian rice (padi) production: 73.9 million tonnes in 2017 and a forecast 74.5 million tonnes in 2018.

Australia grows **less total food** than Indonesia, but most of its wheat is **exported** — and Indonesia is Australia’s top wheat market. So the two countries are joined by trade as well as by farming.



Bar chart of the value of Australian wheat production from 2001-02 to 2005-06, showing a sharp fall to 2,692 million dollars in the 2002-03 drought year.

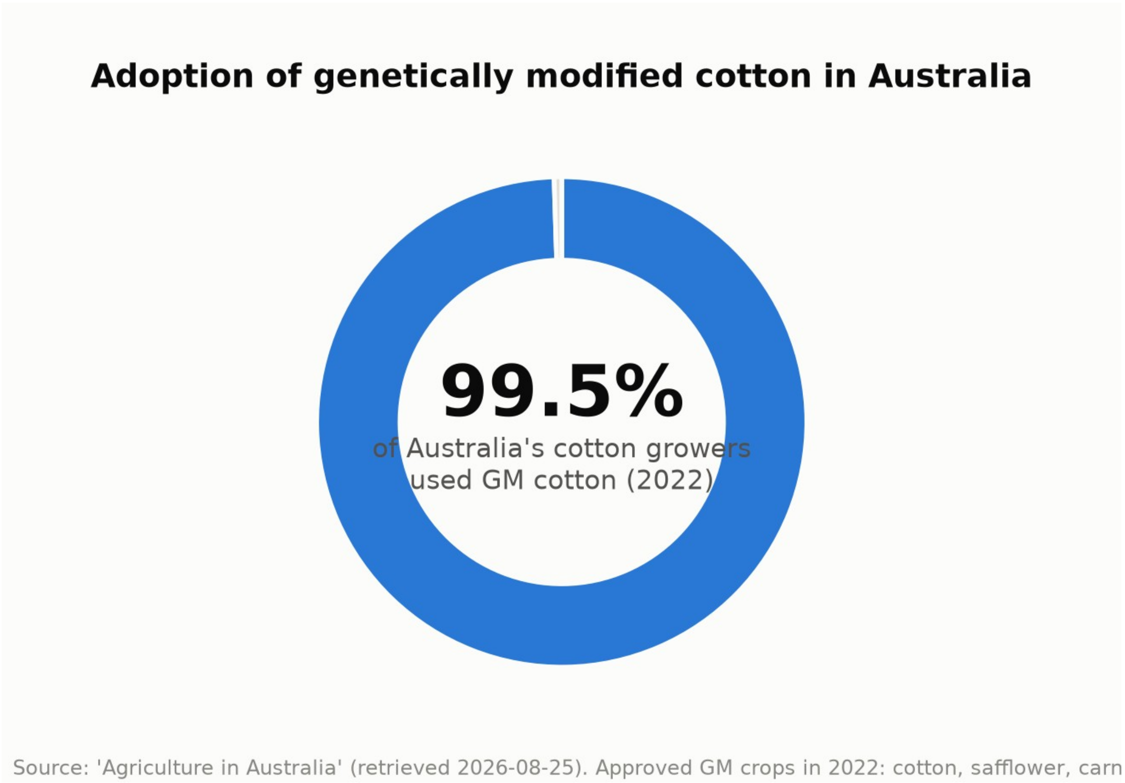
The wheat-value chart also shows why climate matters: in the 2002–03 drought year the value of the wheat crop fell to less than half of the year before. When the rain fails, production and income fall with it.

Evaluate: do innovations really remove environmental limits? (`.E05`)

Agricultural **innovations** — new ideas such as crop breeding and drip irrigation — have changed what can be grown, and where. But do they *remove* environmental limits, or only *reduce* them? Look at the evidence and weigh both sides.

- **They reduce limits.** Drip irrigation delivers water straight to the root, so crops can grow with far less water. HYV and GM seeds raise the yield of every hectare. Terracing makes steep land farmable. These all let people grow food where, or in amounts, nature would not allow.
- **They do not remove limits.** A drip system still needs *some* water, and a dam still empties in a long drought (the 2002–03 wheat crash shows this). Fertilisers and pesticides can damage soil and waterways if overused. So technology shifts the limits — it does not delete them.

GM, both sides. Supporters argue GM crops raise yields, cut pesticide spraying and help farmers through drought and pests — in 2022 about 99.5% of Australia's cotton growers used GM cotton. Critics argue GM seeds can be costly, can concentrate seed supply in a few companies, and their long-term effects need careful watching. Both views are reasoned; a good geographer can state each fairly before choosing a position.



Doughnut chart showing that about 99.5% of Australia's cotton growers used genetically modified cotton in 2022.

Worked examples

Example 1 — scaffolded

Use the chart of Australian wheat value (2001–02 to 2005–06) to describe how climate affects crop production.

Step	Working	Comment
1	Read the values: 6,356; 2,692; 5,636; 4,320; 5,905 (A$ million).	Always start by reading the data.
2	Find the change: 2002–03 (2,692) is far lower than 2001–02 (6,356).	A fall of more than half.
3	Link it to a cause: 2002–03 was a drought year.	Low rain → low yields → low value.
4	Conclude: rainfall (an environmental factor) strongly influences production.	Value tracks the rain.

Example 2 — scaffolded

Use the rice-yield chart to explain one technological factor that raised yields in Indonesia.

Step	Working	Comment
1	Traditional varieties: about 2.14 t/ha.	The starting yield.
2	With HYV seeds: about 4.23 t/ha (by 1989).	The new yield.
3	Difference: 4.23 − 2.14 = 2.09 t/ha — nearly double.	The size of the change.
4	Conclude: high-yielding varieties (a technological factor) roughly doubled the yield.	Technology raised the yield.

Example 3 — unscaffolded

The Ord River region in Western Australia has a hot, dry climate. Explain how one human alteration of the environment lets crops grow there.

Example 4 — unscaffolded

Give one **economic** factor and explain how it influences crop production in either Australia or Indonesia.

Practice questions

Scaffolded

Q1. Name the four environmental factors that influence crop yields.

Q2. Wheat in Australia is planted in autumn and grows on winter rain. Which environmental factor does this describe?

Q3. Which family of factors do “roads, rail and ports” belong to?

Q4. About 85% of Indonesian rice farmers used HYV seeds by the mid-1980s. What does “HYV” stand for?

Q5. Name the body of water that stores supply for the Ord River Irrigation Area.

Q6. Look at the 2018 crop chart. Which Australian crop had the highest production in tonnes?

Unscaffolded

Q7. Explain how terracing alters a steep landform so it can grow rice.

Q8. The Murray–Darling Basin supplies about a third of Australia’s food. Give one reason this basin is so important for farming.

Q9. Compare the labour used on an Indonesian rice farm with the labour used on an Australian wheat farm.

Q10. “Technology reduces environmental limits but does not remove them.” Use one example from this section to support this claim.

Inquiry task

Choose **one** crop from the 2018 Australian chart (wheat, barley, canola or sugarcane) and one environmental factor (climate, soil, landforms or water). In 4–6 sentences, explain how that factor influences the production of your crop in Australia, and name one technology farmers use to manage it. Support your answer with one figure from this section.

Answers

Q1. Climate, soil, landforms and water resources.

Q2. Climate (rainfall and temperature across the seasons).

Q3. Economic factors (accessibility to markets).

Q4. High-yielding varieties.

Q5. Lake Kununurra.

Q6. Sugarcane (33.5 million tonnes).

Q7. Terraces cut steps into a slope, making flat surfaces that hold water and stop soil washing away, so steep land can grow flooded rice.

Q8. It has river water for irrigation and productive soils, so it grows a large share of Australia's food and farm value.

Q9. Indonesian rice farming is labour-intensive (many steps by hand); Australian wheat farming is highly mechanised (machines, few workers).

Q10. e.g. Drip irrigation lets crops grow with little water, but still needs a water supply, so it reduces — not removes — the rainfall limit. (Other answers: terracing, HYV seeds.)

Fully-worked solutions

Example 3. The Ord River region is hot and dry, so rain alone cannot support crops. People altered the environment by building Lake Kununurra to store river water and the Main Channel to carry it by gravity to the fields. This **irrigation** supplies the water the climate does not, so cotton, sugar cane and other crops now grow there. The limit (low rainfall) is reduced, not removed — the farms still depend on the stored water.

Example 4. *Model answer (accessibility):* Accessibility is an economic factor. Australian wheat farms are often far from buyers, so grain is moved by rail to ports and shipped overseas; Indonesia, the top market, is reached by sea. Cheap, reliable transport raises the value of the crop and encourages production, while poor access would cut into profits and lower production.

Inquiry (model structure). A strong answer names a crop and factor, links the factor to the crop's needs (e.g. wheat needs winter rain), describes the effect on production (a dry year lowers yield and value), and names a technology (e.g. drought-tolerant varieties or irrigation), citing a figure such as the 2002–03 drought chart.

Sources (retrieved 2026-08-25)

- ABARES crop and commodity statistics (tonnage and value of Australian crops), as reported in *Agriculture in Australia*.

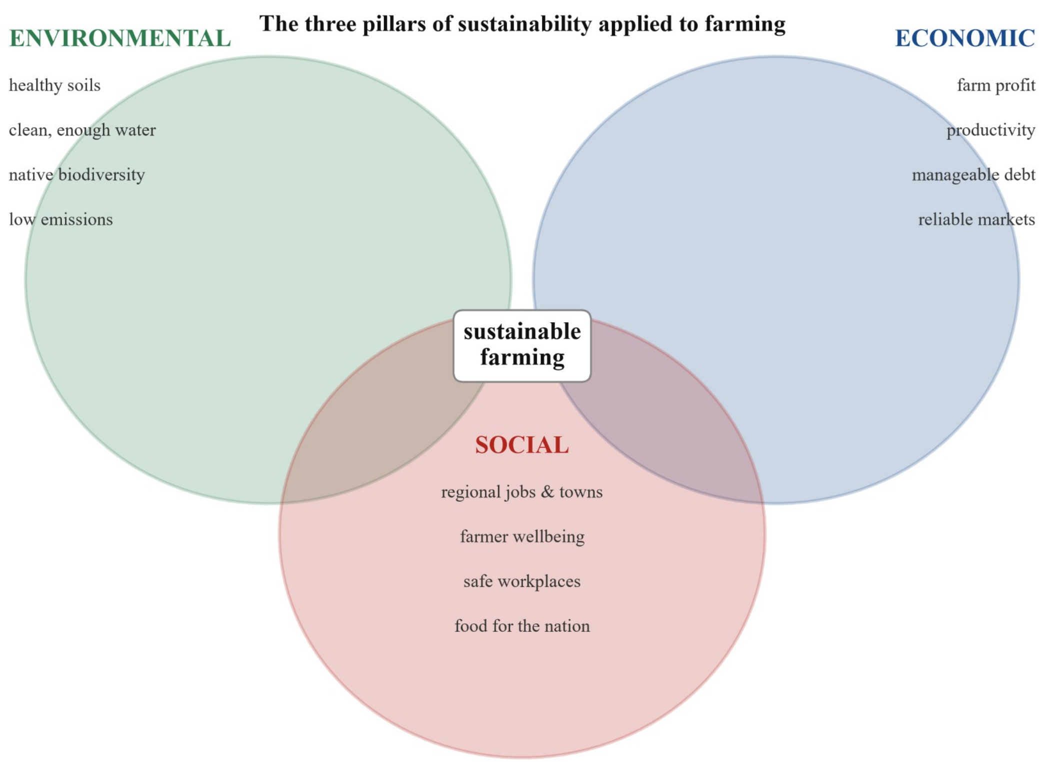
- Murray–Darling Basin Authority (Basin share of food supply and farm value), as reported in *Murray–Darling Basin*.
- FAO / BPS (Indonesian rice production and yields; HYV adoption), as reported in *Rice production in Indonesia*.
- Ord River irrigation facts (Lake Kununurra, Main Channel, crop range), as reported in *Ord River*.
- GM crop approvals and cotton adoption, as reported in *Agriculture in Australia*.
- Australia–Indonesia wheat trade (Indonesia as top wheat market, 2024–25), as reported in *Australia–Indonesia relations*.

The environmental, economic and social sustainability of farming in Australia

Curriculum link: `VC2HG10K03` — *the environmental, economic and social sustainability of farming in Australia*. This section draws on elaborations `.E01`, `.E02`, `.E03` and `.E05`.

Theory

What do we mean by "sustainable"? *Sustainability* is a **contested term** — different people use it in different ways, and which definition you choose changes what you count as success. In this section it is used in the sense given by the World Commission on Environment and Development (the Brundtland Commission) in *Our Common Future* (1987): meeting the needs of the present **without** reducing the ability of future generations to meet their own needs. Other definitions exist and are not interchangeable with this one. To make the idea workable, geographers assess farming against **three pillars at once — environmental**, **economic** and **social**. A farm that is profitable but ruins its soil, or that protects its soil but cannot pay its workers, is not sustainable, because one pillar fails.



A Venn diagram of three overlapping circles labelled environmental, economic and social, with the shared centre labelled sustainable farming. Each circle lists examples such as healthy soils, farm profit and regional jobs.

Why farming matters to Australia. Agriculture uses roughly **half of Australia's land area** (about 384 million of 769 million hectares) and is the **largest user of water**, especially in dry years. It feeds the nation, exports food and fibre, and supports many regional towns. Because farming touches so much land and water, how sustainably it is done shapes the environment, the economy and rural society all at once.

Agriculture uses roughly half of Australia's land area (about 384 of 769 million hectares)

Most agricultural land is used for grazing livestock on natural or modified pasture. Source: ABS, Land Management and Farming in Australia, 2020-21 (retrieved 2026-08-25).

A horizontal bar showing agriculture uses about half of Australia's land area, with the other half in forests, settlements and other uses.

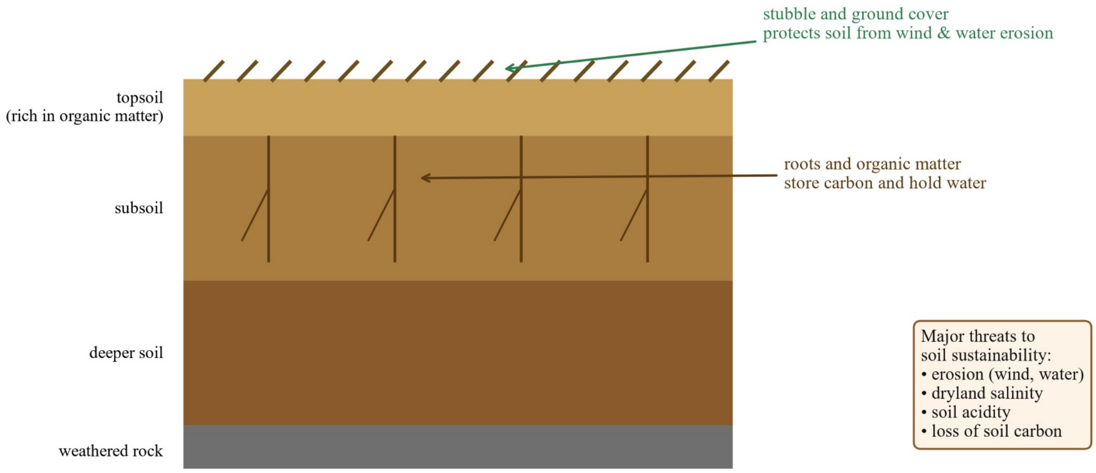
The environmental pillar (including soils)

How do we assess environmental sustainability? We cannot look at "the environment" all at once, so we use **indicators** — things we can measure that tell us whether the natural base is being kept or worn down. Useful indicators for farming include:

Indicator	What it tells us
Ground cover	Bare soil erodes; covered soil is protected from wind and water.
Soil carbon / organic matter	Stores water and nutrients; low carbon means weak soil.
Water use vs recharge	Using water faster than rain refills it is not sustainable.
Salinity and acidity	Rising salt or acid degrades soil and cuts what can grow.
Native vegetation / biodiversity	Remnant bush and healthy waterways support the farm and the wider landscape.

Soil sustainability. Australian soils are among the **oldest and most weathered on Earth**, so they are naturally thin in organic matter and nutrients. That makes them easy to damage and slow to rebuild. The main threats are **erosion** (by wind and water), **dryland salinity** (salt rising to the surface when deep-rooted native plants are replaced), **acidity**, and the **loss of soil carbon**. Keeping **ground cover** — stubble, pasture or trees — on the soil is the single most important protection.

A soil profile: ground cover and organic matter protect Australia's soils



Simplified diagram. Australian soils are among the oldest and most weathered on Earth, and are naturally low in organic matter.

A labelled soil profile showing topsoil, subsoil and weathered rock, with stubble and ground cover on top protecting against erosion, and roots and organic matter storing carbon and water. A box lists the main threats: erosion, salinity, acidity and loss of soil carbon.

Water sustainability. Much of Australia’s food is grown with **irrigation** — water applied to crops rather than left to rainfall. Irrigated regions such as the **Goulburn Valley** and **Sunraysia** in northern Victoria draw on rivers of the **Murray–Darling Basin**. The sustainability question is whether water is taken faster than the rivers and underground **aquifers** (water-bearing rock or sand) refill, and whether enough is left for towns, wetlands and native species. This is a genuinely **contested** issue, and both sides have strong reasons.

Agriculture is Australia's largest user of water, especially in dry years

Share of total water consumed (approximate, a dry year). Source: ABS, Water Accounts Australia (retrieved 2026-08-25).

A horizontal bar showing agriculture is Australia’s largest user of water, taking about 60% of the water consumed in a dry year, with households, manufacturing, mining and other users sharing the remaining 40%.

> **Hear both sides (a “steelman” is the strongest, fairest version of each argument) — two views on irrigation water.** *For more water for farms:* irrigation grows high-value food, creates jobs and keeps river towns alive; cutting water hard can hollow out communities. *For more water for the environment:* rivers and wetlands are the natural

base that farming and towns ultimately depend on; over-taking water causes salinity and **algal blooms** (sudden, harmful growths of algae that can poison water), and loses fish and bird habitat, which costs everyone later. A sustainable answer has to weigh **both** — enough water to keep farms and towns viable, and enough to keep rivers functioning.

Sustainable farming practices in Australia

Farmers have developed approaches that try to keep the environmental pillar strong while still producing. Three well-known ones are **conservation farming**, **regenerative agriculture** and **biodynamic farming**. Each is defined at first use below, because the terms are used differently by different groups.

- **Conservation farming** is a set of practices that disturb the soil as little as possible and keep it covered — for example **minimum tillage** (fewer passes with the plough) and **stubble retention** (leaving crop residue on the paddock). It is now common across Australia's grain belts.
- **Regenerative agriculture** goes further: it aims to actively **rebuild** soil health and biodiversity using rotations, cover crops and carefully managed grazing. Definitions vary between groups, but the shared goal is leaving the land better than it was.
- **Biodynamic farming** treats the whole farm as a self-contained living system, using composts and special preparations, and is often certified by bodies such as Demeter. It grows from ideas of Rudolf Steiner (1924). Some of its preparations have no proven scientific mechanism, so it is contested; its supporters value the whole-farm, low-input approach and the soil-building results. Present both the evidence and the claims fairly when you evaluate it.

Three sustainable farming practices used in Australia

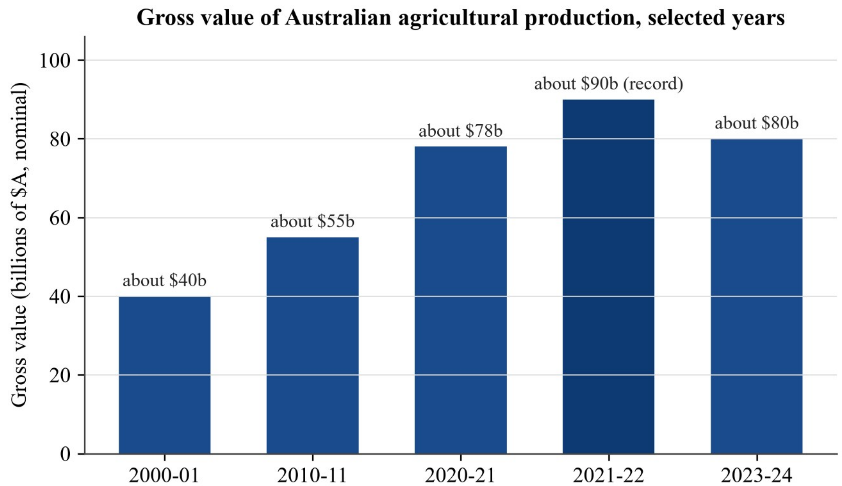
Practice	Main idea	Example advantage	Example disadvantage
Conservation farming	disturb the soil as little as possible; keep it covered (minimum tillage, stubble retention)	less erosion; soil stores more water and carbon	may need special machinery; weeds need new controls
Regenerative agriculture	actively rebuild soil health and biodiversity (rotations, cover crops, managed grazing)	improves soil and water over time; can cut input costs	benefits take years; results vary between farms
Biodynamic farming	treat the farm as a living whole; composts and preparations; often certified	avoids most synthetic inputs; builds soil organic matter	lower yields possible; certification is demanding

Definitions and certification vary between organisations. Compiled from ABARES and industry sources (retrieved 2026-08-25).

A table comparing conservation farming, regenerative agriculture and biodynamic farming, with a main idea, an example advantage and an example disadvantage for each.

The economic pillar

Farming must also **pay its way** to be sustainable. The **gross value of agricultural production** has grown over the long term, reaching a record of about **$90 billion** in 2021–22 before easing. But the value **jumps around with the seasons** — drought pushes it down and good rains pull it up — so a farm's economic sustainability depends on surviving the bad years, not just enjoying the good ones. Costs (fuel, fertiliser, water, debt repayments) and the prices farmers receive both matter.

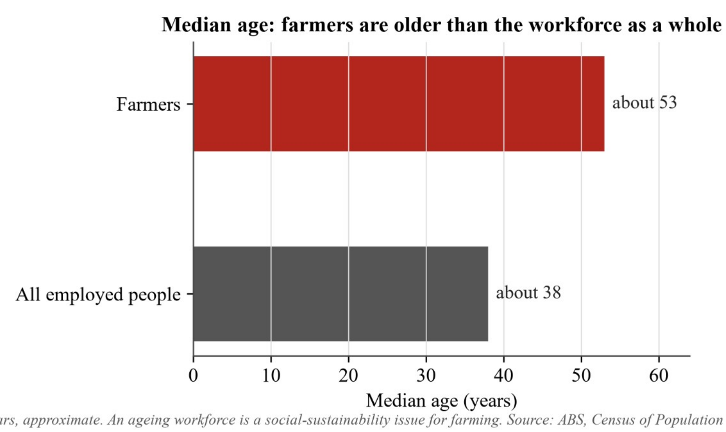


Values are approximate and vary with seasonal conditions (rainfall, drought, floods). Source: ABARES, agricultural commodities reporting (retrieved 2026-08-25).

A bar chart of the gross value of Australian agricultural production in selected years, rising from about $40 billion in 2000-01 to a record of about $90 billion in 2021-22, then easing to about $80 billion.

The social pillar

Farming also has to sustain **people**: the farmers and workers themselves, and the rural towns that depend on them. Social indicators include **jobs**, **farmer wellbeing**, **safe workplaces**, and whether young people see a future on the land. One clear social signal is that the **median age of farmers is well above the workforce average** — an ageing workforce raises the question of who will farm next.



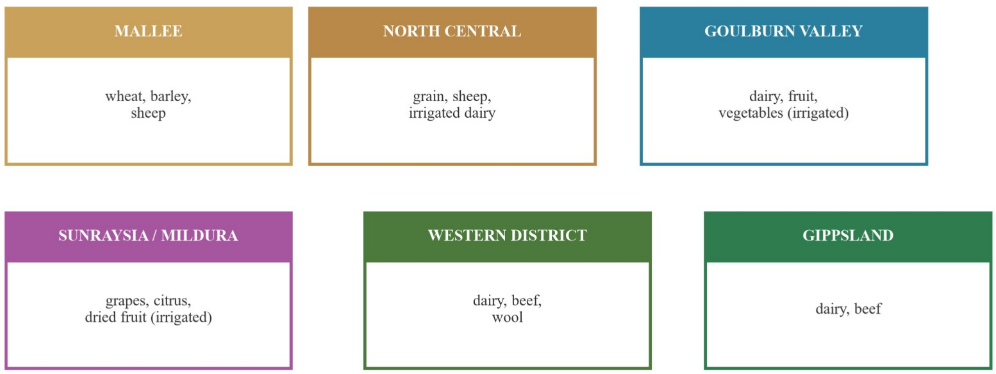
Median age in years, approximate. An ageing workforce is a social-sustainability issue for farming. Source: ABS, Census of Population and Housing, 2021 (retrieved 2026-08-25).

A bar chart comparing median age, showing farmers at about 53 years against about 38 years for all employed people.

Farming regions of Victoria

Different regions farm differently, because **climate, soil and water** change across the state. Irrigated regions near rivers grow dairy, fruit and vegetables; drier regions grow grain and run sheep. Knowing your own region helps you apply the three pillars to a real place.

Farming regions of Victoria (simplified sketch, not to scale)



Irrigated regions (such as the Goulburn Valley and Sunraysia) rely on rivers of the Murray-Darling Basin; drier regions depend on rainfall.

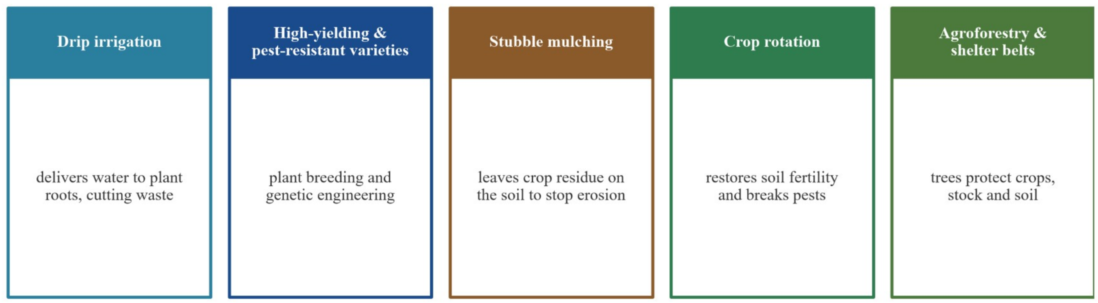
A simplified sketch of six Victorian farming regions, showing the Mallee and North Central for grain and sheep, the Goulburn Valley and Sunraysia for irrigated dairy, fruit, grapes and citrus, and the Western District and Gippsland for dairy, beef and wool.

Innovations that reduce environmental limits

Innovation has repeatedly lifted the environmental limits on what Australia can produce (elaboration `.E05`). Examples include:

- **High-yielding and pest-resistant varieties**, developed by plant breeding and genetic engineering, which produce more food per hectare and lose less to pests.
- **Drip irrigation**, which delivers water to plant roots and cuts waste compared with flood irrigation.
- **Stubble mulching**, which keeps residue on the soil to stop erosion and hold moisture.
- **Crop rotation** and **intercropping**, which restore fertility and break pest cycles.
- **Agroforestry and shelter belts**, where trees protect crops, stock and soil from wind.

Innovations that reduce environmental limits on food production



Each innovation helps farmers produce more food within environmental limits — for example by using less water, protecting soil, or resisting pests.

Five labelled tiles showing innovations: drip irrigation, high-yielding and pest-resistant varieties, stubble mulching, crop rotation, and agroforestry and shelter belts, each with a one-line explanation.

Worked examples

Example 1 — scaffolded (environmental sustainability, elaboration .E01)

A grain farm in the Victorian Mallee reports: 90% of paddocks keep stubble cover over summer; soil carbon is steady; water use is rainfall only (no irrigation); but soil tests show acidity slowly rising.

Evaluate the **environmental sustainability** of this farm.

Step	Reasoning
Pick indicators	Use ground cover, soil carbon, water use and acidity.
Read each one	Ground cover high (good); carbon steady (good); water = rainfall only, so no over-taking (good); acidity rising (warning).
Weigh up	Three of four indicators are strong, one is declining.
Judge	The farm is **mostly environmentally sustainable now**, but the rising acidity must be managed (for example with lime) or the soil pillar will weaken over time.

The key skill is using **several indicators together** and naming both the strengths and the warning sign — not giving a simple yes/no.

Example 2 — scaffolded (economic sustainability, elaboration .E03)

Use the gross value chart. Explain why a record year does not prove farming is economically sustainable.

Step	Reasoning
Describe the trend	Value rises over the long term, peaks in 2021–22, then eases.
Link to seasons	The ups and downs track rainfall — drought cuts output, good seasons lift it.
Define sustainability	Economic sustainability means surviving the **low** years, not just the high ones.
Judge	A record year shows what farming can earn in a good season; sustainability is shown by whether farms can cover costs and debt through the **bad** seasons too.

Practice questions

Scaffolded

Q1. State the three pillars of sustainability.

Q2. Define *sustainability* as used in this section, and name the report and year it comes from.

Q3. Match each environmental indicator to what it tells us: (a) ground cover, (b) soil carbon, (c) water use vs recharge — with (i) protects soil from erosion, (ii) stores water and nutrients, (iii) whether water is used faster than it refills.

Q4. Name two threats to soil sustainability shown in the soil profile figure.

Q5. For conservation farming, give one advantage and one disadvantage from the practices table.

Q6. Name two Victorian regions that rely on irrigation and two that rely mainly on rainfall.

Unscaffolded

Q7. Explain how stubble retention supports the **environmental** pillar of sustainability.

Q8. A dairy farm in the Goulburn Valley is profitable but draws irrigation water faster than the river refills it, and the local town reports the river is stressed. Evaluate the farm's sustainability using **two** pillars.

Q9. The median age of farmers is about 53 while the workforce average is about 38. Explain why this is a **social** sustainability issue for farming.

Q10. Choose **one** of regenerative agriculture or biodynamic farming. Evaluate one advantage and one disadvantage, and state why the term needs a clear definition before it can be assessed.

Inquiry task

Q11. Pick a farming area you know or can research (for example a region from the Victorian figure, or your local area). Using at least **two** environmental indicators, **one** economic indicator and **one** social indicator, assess how sustainable farming is there. Present your findings as a short paragraph or a simple table, and list the source of each piece of information. (This is a data and source task: use real sources such as the ABS or ABARES, or a local observation, and give a retrieval date.)

Answers

Q1. Environmental, economic and social. **Q2.** Meeting the needs of the present without reducing the ability of future generations to meet their own needs; World Commission on Environment and Development (Brundtland Commission), *Our Common Future*, 1987. **Q3.** (a)–(i), (b)–(ii), (c)–(iii). **Q4.** Any two of: erosion (wind/water), dryland salinity, soil acidity, loss of soil carbon. **Q5.** Advantage: less erosion and soil stores more water and carbon. Disadvantage: may need special machinery, and weeds need new controls. **Q6.** Irrigation: Goulburn Valley, Sunraysia (also North Central partly). Rainfall: Mallee, Western District (also Gippsland). **Q7.** Stubble keeps the soil covered, so wind and water cannot carry it away; it also holds moisture and adds organic matter as it breaks down, protecting the soil pillar. **Q8.** Economic pillar strong (profitable) but environmental pillar weak (over-taking water stresses the river); because one pillar fails, the farm is not fully sustainable as it stands. **Q9.** With farmers older than the workforce average, many will retire soon; if young people do not take over, rural jobs, skills and towns decline — a social problem. **Q10.** Answers vary; must give one advantage, one disadvantage and note the term is defined differently by different groups, so a clear definition is needed before judging.

Q11. Answers vary. Check that the student used two environmental, one economic and one social indicator, named the place, and listed sources with retrieval dates.

Sources

- Australian Bureau of Statistics (ABS), *Land Management and Farming in Australia*, 2020–21; *Water Accounts Australia*; *Census of Population and Housing*, 2021 — retrieved 2026-08-25.
- Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), agricultural commodities reporting — retrieved 2026-08-25. Values are approximate and vary with seasonal conditions.
- World Commission on Environment and Development, *Our Common Future* (1987) — definition of sustainability.

Note on scope: this section teaches the environmental, economic and social sustainability of farming in Australia through neutral Australian examples. All figures are drawn from the values they display; where values vary with season they are labelled approximate.

Constraints, including climate change, on the world’s capacity to sustainably feed projected future populations

> **Curriculum trace — VC2HG10K04:** *the environmental, economic and political constraints, including climate change, on the world’s capacity to sustainably feed projected future global populations*
>
> Draw-on elaborations (illustrative examples, not a checklist): **VC2HG10K04.E01** discussing the difference between extensification and intensification as ways of increasing food production to the level needed to feed future populations, and evaluating their sustainability · **VC2HG10K04.E02** evaluating environmental constraints on future food production from land degradation (e.g. soil erosion, salinity, acidification), industrial pollution, water scarcity and climate change · **VC2HG10K04.E03** evaluating the impacts on future food production from competing land uses, such as urban and industrial uses, mining, production of food crops for biofuels and livestock, and tourism · **VC2HG10K04.E04** reflecting on how poverty, government policies, conflict or trade barriers could negatively affect global food production and the future food security of many people · **VC2HG10K04.E05** explaining management strategies that restore the quality or diversity of agriculture in Australia; for example, improving the function of natural biomes and anthropogenic biomes, monitoring land management practices, improving the condition of the soil or building the capability of farmers · **VC2HG10K04.E06** generating ideas for a strategy to expand agricultural production in Australia; for example, marketing bush food such as herbs and wattle seed, investing in research, supporting farm innovations or developing the expertise of farmers

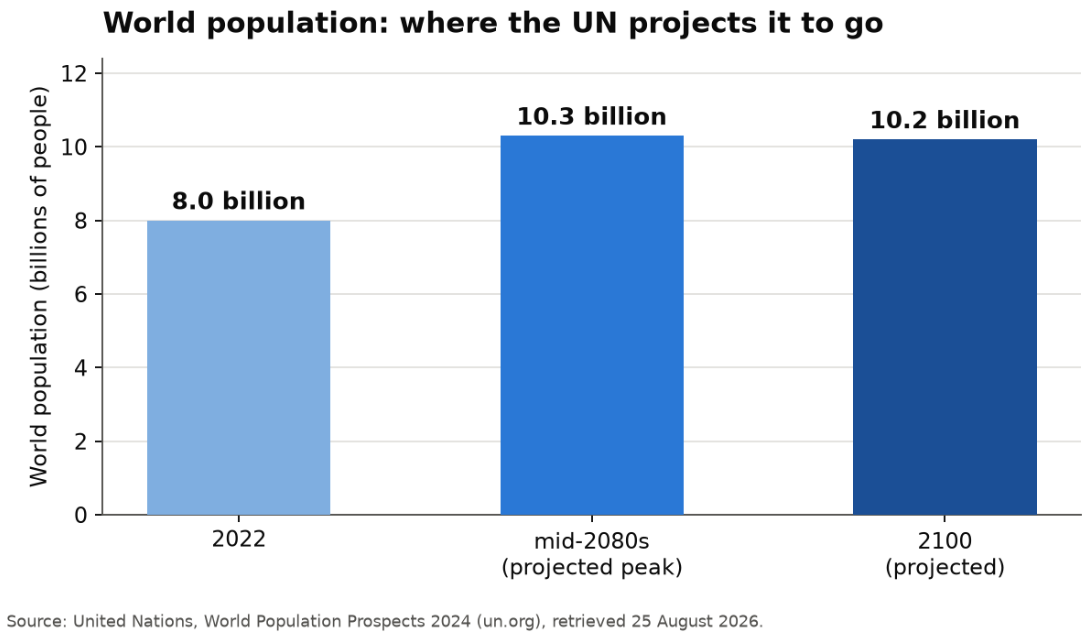
---

Theory

By 2050 the world will need roughly half as much food again as it uses today — and by the 2080s there may be more than ten billion of us. This section asks whether the world can grow that much food **sustainably**, and what stands in the way: the environment, money and markets, and politics.

More mouths, bigger appetites

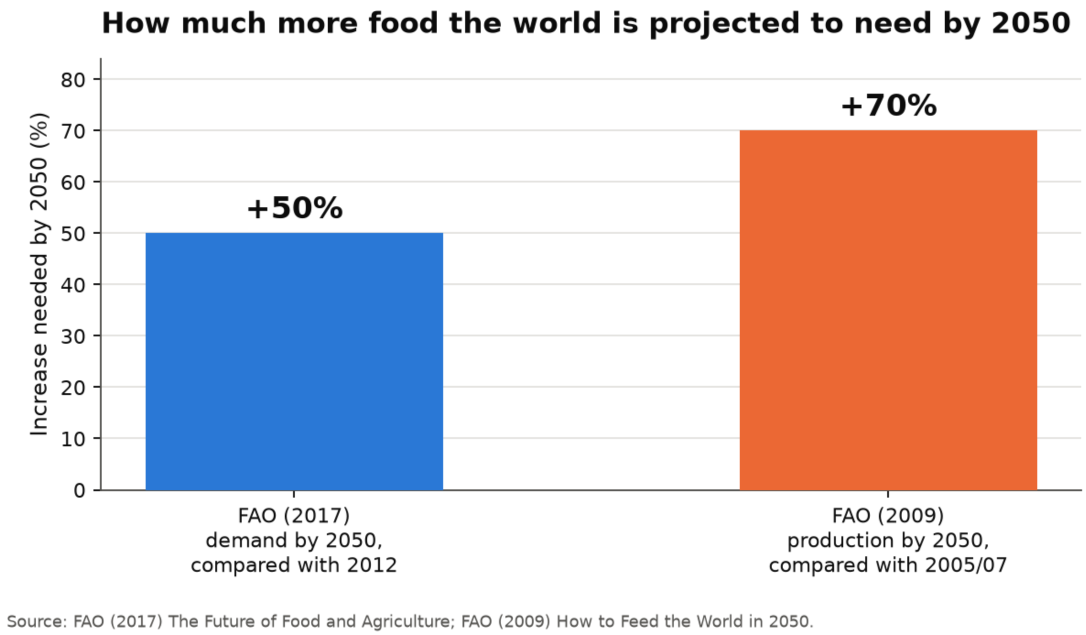
The world’s population reached 8 billion in 2022. The United Nations’ 2024 projection has it peaking at around 10.3 billion in the mid-2080s before easing to about 10.2 billion by 2100 — at its peak, roughly two billion more people to feed than today.



Bar chart of the UN world population projection: 8.0 billion people in 2022, rising to a peak of about 10.3 billion in the mid-2080s, then easing to about 10.2 billion in 2100

Numbers of people are only half the story. As incomes rise in many countries, more people can afford more meat and dairy, and meat and dairy take far more land, water and grain to produce than plant foods. At the same time, a share of cropland grows fuel or animal feed rather than food: **biofuels** such as ethanol made from sugarcane or biodiesel made from canola divert crops away from plates.

How much more food does that add up to? The Food and Agriculture Organization of the United Nations (FAO) has published two widely used estimates: about **50% more demand by 2050** compared with 2012, and about **70% more production by 2050** compared with 2005/07. The two figures use different base years, but the message is the same: world food production must jump by mid-century.



Bar chart of two FAO estimates of the increase needed by 2050: plus 50 percent demand compared with 2012 (FAO 2017), and plus 70 percent production compared with 2005/07 (FAO 2009)

What 'food secure' actually means

Geographers talk about **food security**: the FAO describes it as the situation in which all people, at all times, can get enough safe and nutritious food for an active, healthy life. Food security rests on four pillars, and all four must hold at once.

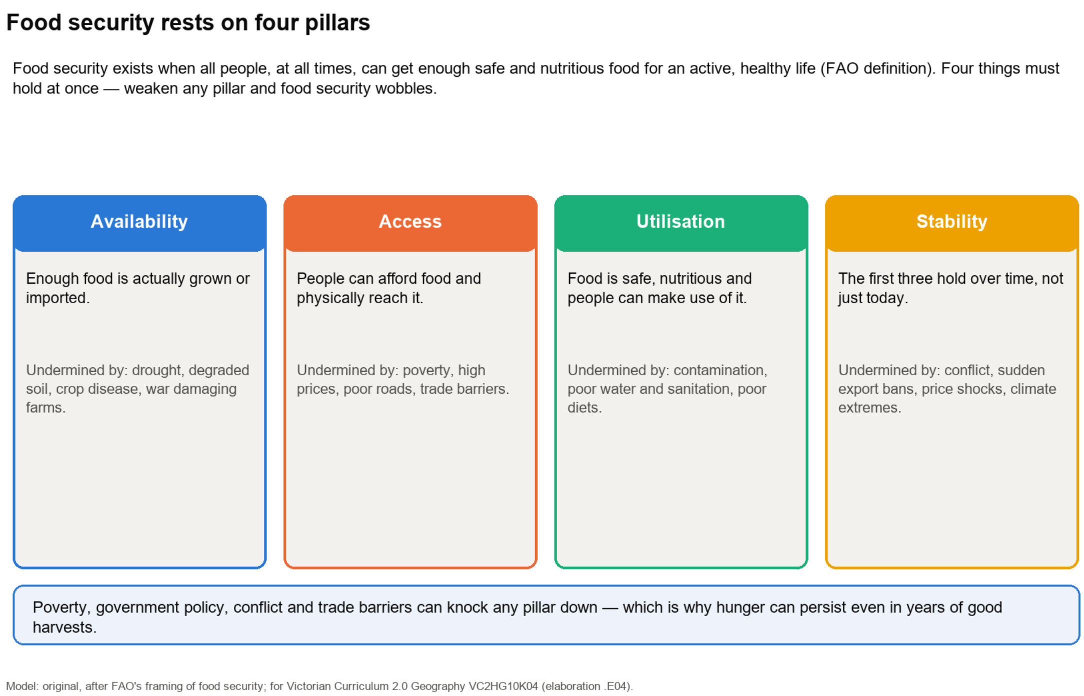
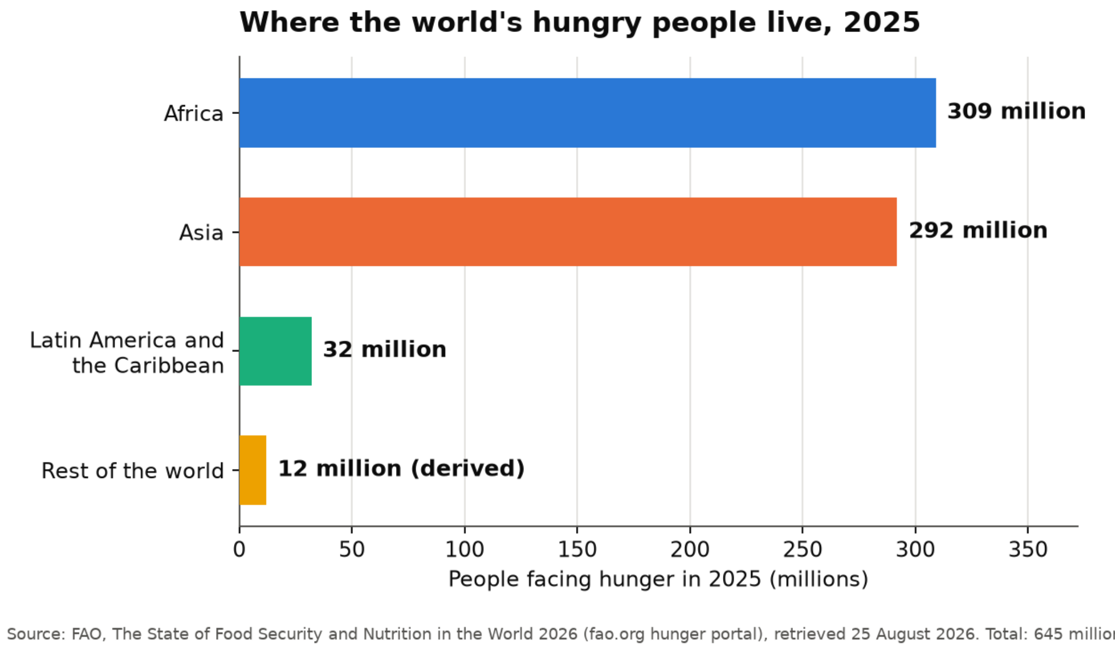


Diagram of the four pillars of food security: availability (enough food grown or imported), access (people can afford and reach food), utilisation (food is safe, nutritious and usable) and stability (the first three hold over time), each with a list of what undermines it

The pillars explain why hunger is not simply a production problem. A country can grow plenty of food and still have hungry people if prices put it out of reach, if roads or conflict block it, or if a sudden export ban makes supply unreliable.

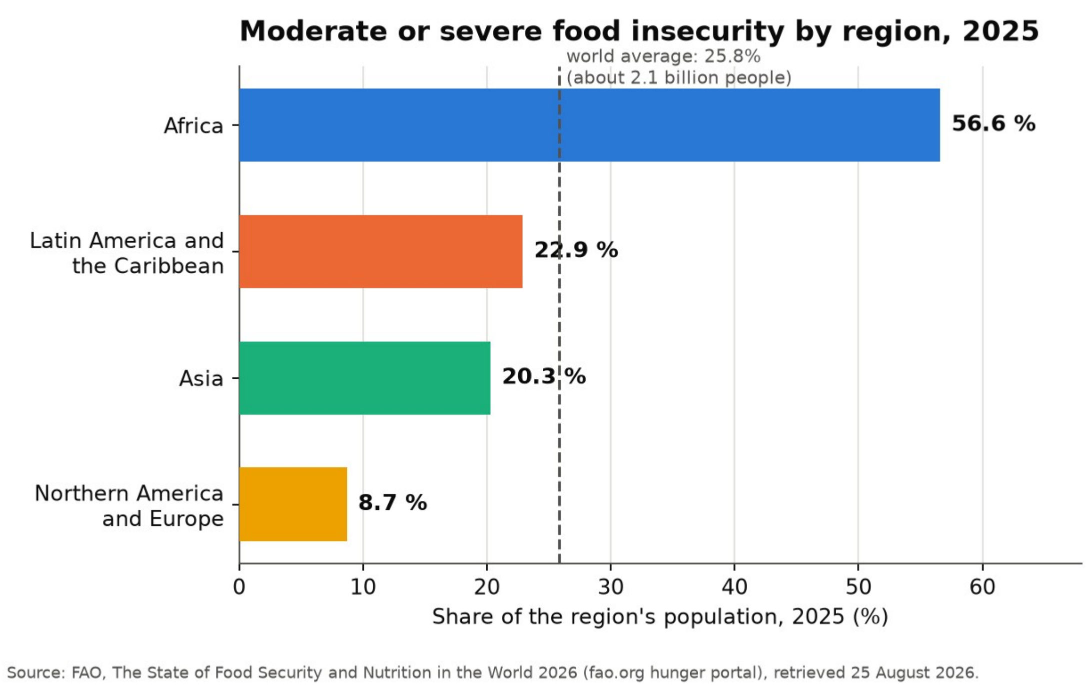
Hunger today

Before judging the future, look at the present. FAO's *The State of Food Security and Nutrition in the World 2026* (SOFI) estimates that about **645 million people — 7.8% of the world — faced hunger in 2025**, and that roughly 2.1 billion people (25.8%) lived with moderate or severe **food insecurity** — that is, they could not reliably get enough safe food. Around 2.7 billion people could not afford a healthy diet.



Horizontal bar chart of the number of people facing hunger in 2025 by region: Africa 309 million, Asia 292 million, Latin America and the Caribbean 32 million, rest of the world 12 million (derived), totalling 645 million

The regional pattern matters. Africa and Asia hold similar *numbers* of hungry people, but as a *share* of population, Africa's hunger rate is several times higher.



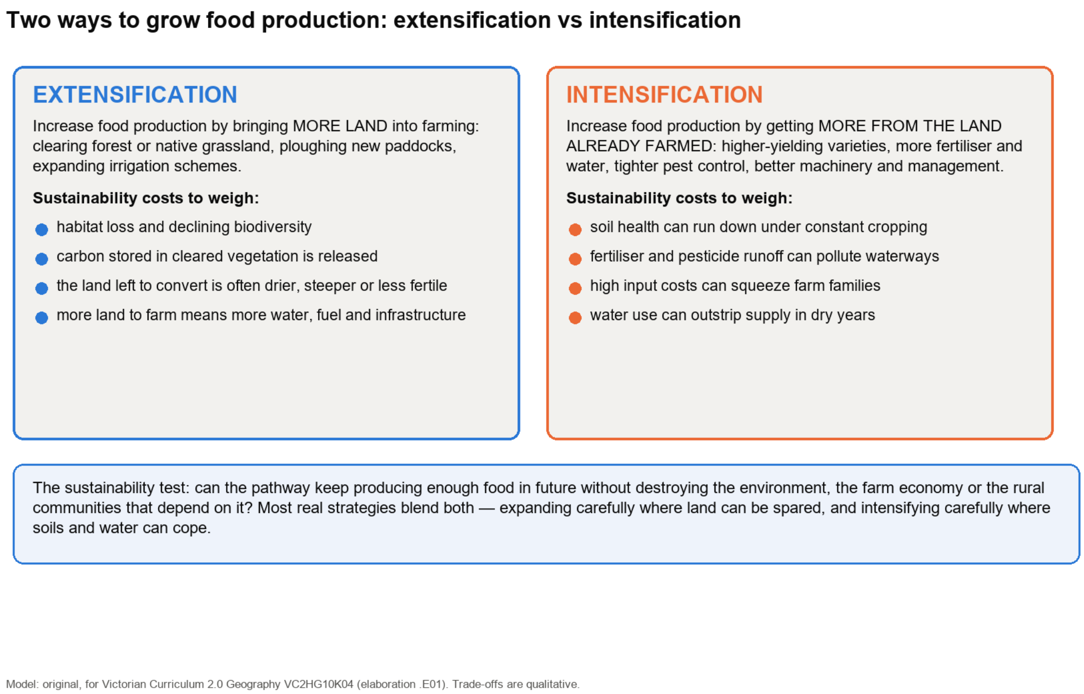
Horizontal bar chart of the share of each region's population facing moderate or severe food insecurity in 2025: Africa 56.6 percent, Latin America and the Caribbean 22.9 percent, Asia

20.3 percent, Northern America and Europe 8.7 percent, against a world average of 25.8 percent

Two ways to grow more food

There are only two levers for growing more food, and you need to know the difference.

- **Extensification** — growing more food by bringing *more land* into production: clearing native vegetation, draining wetlands, converting pasture or forest to cropland.
- **Intensification** — growing more food from the *same land* by lifting the **yield** (the amount of crop harvested per hectare): better seeds and breeds, fertiliser, irrigation, machinery and careful management.



Two-panel diagram comparing extensification (the same yield spread over more cleared land) with intensification (a higher yield from the same area of land), with a sustainability test strip asking what each option does to soil, water, native vegetation and the climate over time

Each lever has a sustainability price tag. Extensification can destroy habitat, worsen erosion and salinity, and release carbon stored in trees and soil. Intensification can overdraw rivers and aquifers, pollute waterways with fertiliser runoff, and wear soils out if they are pushed too hard. Done carefully — precise inputs, crop rotation, protected shelter belts — intensification can spare native land from the plough. Evaluating sustainability means asking: *could this keep working in fifty years without running down the soil, water and ecosystems it depends on?*

Environmental constraints

The environment sets the first limit on how much food can be grown. Four broad constraints do the most damage.

Four environmental constraints on future food production

Constraint	How it constrains production	Australian examples
Land degradation (soil erosion, salinity, acidification)	Soil that loses its structure, nutrients or freshness supports smaller harvests, and badly degraded land can be taken out of production altogether.	Salinity and erosion have damaged parts of Australia's cropping and grazing country, especially in dryland wheat belts and irrigated districts.
Industrial pollution	Airborne and waterborne wastes from industry can damage crops, foul soils and cut the quality of water available for irrigation.	In some regions industry and agriculture sit close together, and pollution control is needed to keep land and water farmable.
Water scarcity	Crops and livestock need reliable fresh water. In dry years there is less water to irrigate with, and production falls.	Much of Australia's food comes from irrigation along rivers such as the Murray and its tributaries; in drought, allocations are cut and harvests shrink.
Climate change	Higher temperatures, more heatwaves, shifting rainfall and more severe droughts and floods push crops and livestock outside the conditions they were bred for.	Declining winter rainfall across parts of southern Australia pressures the cropping regions that depend on it.

Content: Victorian Curriculum 2.0 Geography, VC2HG10K04 (elaboration .E02); examples are the section's own.

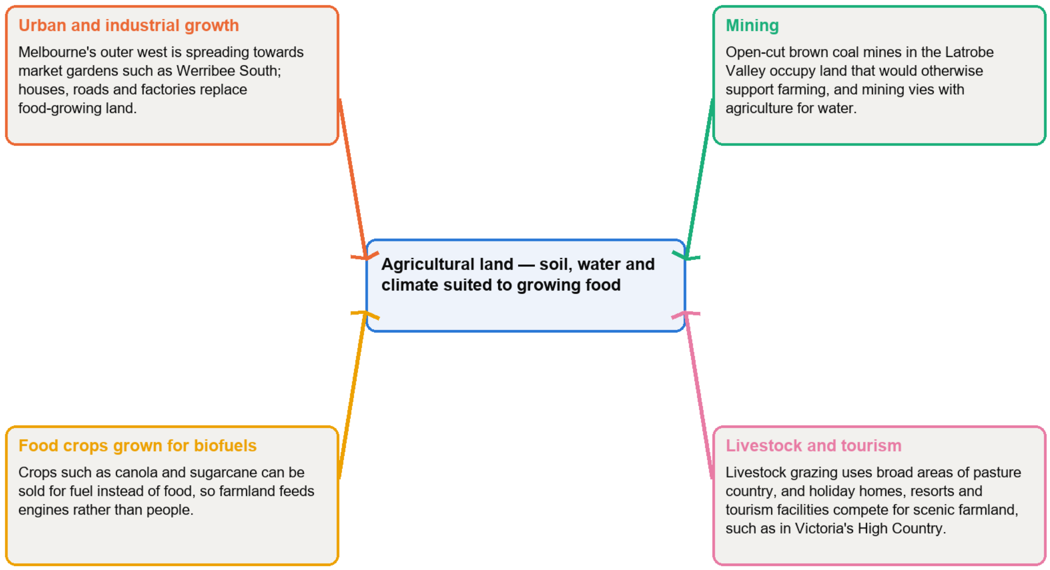
Table of four environmental constraints on food production — land degradation, industrial pollution, water scarcity and climate change — each with what it is and an Australian example, such as dryland salinity in parts of the Murray–Darling Basin and heatwaves and drought cutting crop yields

- **Land degradation** — the running-down of productive land. It includes **soil erosion** (wind and water carrying topsoil away, worst where ground cover is thin after drought or overgrazing), **salinity** (salt building up in soils and waterways, in places a legacy of past clearing that raised water tables, as in parts of the Murray–Darling Basin), and **acidification** (soils slowly turning more acid under some fertilisers, which is why growers apply lime to rebalance them).
- **Industrial pollution** — waste from mines, factories and cities fouling the soil and irrigation water that food production depends on.
- **Water scarcity** — not enough reliable water for crops: droughts, and rivers and aquifers drawn down faster than rain refills them. In dry years, water for irrigation in the Murray–Darling Basin is tightly rationed, and harvests shrink with it.
- **Climate change** — more intense heatwaves, shifting rainfall patterns, and harsher droughts and floods that cut yields, stress livestock and make good seasons harder to predict. (The science of *why* the climate is changing belongs to your Science lessons; geography asks what the change *does* to places, production and people.)

Competing land uses

Even productive farmland is not automatically kept for food. Other uses bid for the same land and water.

Other land uses compete with food production



Model: original, for Victorian Curriculum 2.0 Geography VC2HG10K04 (elaboration .E03). Victorian examples are the section's own.

Hub-and-spoke diagram showing four land uses competing with food production, each with a Victorian example: urban and industrial growth (Melbourne's outer west spreading towards the Werribee South market gardens), mining (Latrobe Valley brown coal mines), food crops grown for biofuels (canola and sugarcane sold for fuel), and livestock and tourism (grazing and holiday facilities in Victoria's High Country)

Every one of these trades has a logic — houses, jobs, fuel and holidays are valuable too — which is exactly the point: feeding future populations competes with other wants, and the competition is decided block by block, mine by mine, in real places.

Poverty, policy, conflict and trade

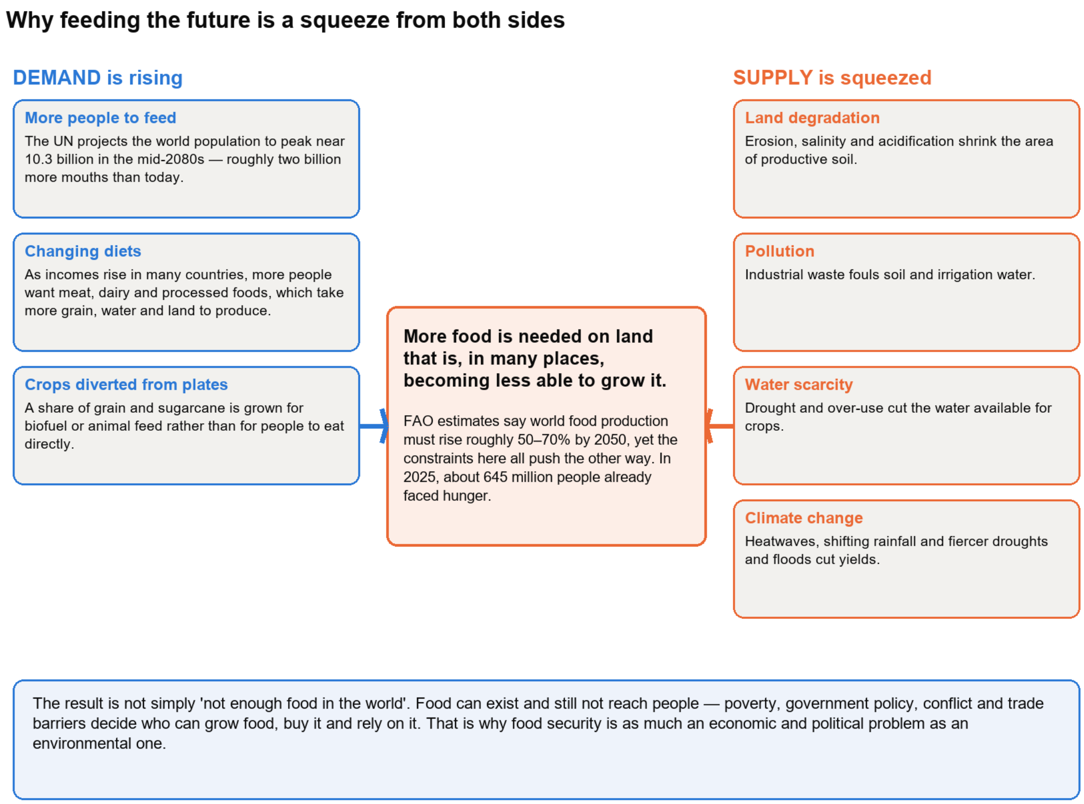
The environmental squeeze decides how much food *can* be grown; the economic and political layer decides who actually *gets* it.

- **Poverty** — hungry people are usually poor people. Food may sit in the market while those on the lowest incomes cannot afford it; poverty is why food insecurity tracks poor regions so closely.
- **Government policies** — subsidies, export bans and pricing rules can help or hurt. When a large exporter suddenly bans food exports to protect local supply, importing countries can face shortages and price spikes within weeks.
- **Conflict** — war destroys farms, blocks roads and closes markets. When Russia's 2022 invasion of Ukraine disrupted grain shipments out of Black Sea ports, wheat prices jumped and import-dependent countries far from the fighting felt the squeeze.
- **Trade barriers** — taxes on imports and quotas make food dearer and stop it moving from surplus regions to deficit regions.

This is why hunger can persist in years of good harvests: knock down any pillar — availability, access, utilisation or stability — and food security fails.

Putting the squeeze together

Stack the demand side against the constraints and the shape of the problem appears: more food is needed, on land and water that are, in many places, becoming less able to provide it.



Model: original, for Victorian Curriculum 2.0 Geography VC2HG10K04. Hunger figure: FAO SOFI 2026, retrieved 25 August 2026.

Model diagram with rising demand on the left (more people, changing diets, crops diverted to biofuels and feed) squeezing against constrained supply on the right (land degradation, pollution, water scarcity, climate change), producing pressure in the centre, with a bottom strip noting that poverty, government policy, conflict and trade barriers decide who can grow, buy and rely on food

Restoring Australian agriculture

Constraints are not a sentence; they are a management problem. Strategies that restore the quality or diversity of agriculture in Australia fall into four families.

Management strategies that restore Australian agriculture

Strategy family	What it looks like on the ground
Improve the function of natural and human-shaped biomes	Keep ground cover and shelter belts of trees to protect soil from wind; restore wetlands and creek-side vegetation so water is filtered and pollinators and pest predators have somewhere to live.
Monitor land management practices	Track ground cover, soil moisture and salinity over time; use satellite images, drones and on-ground checks to see whether paddocks, pastures and irrigation schemes are holding up or running down.
Improve the condition of the soil	Grow crops with little or no ploughing to cut erosion; apply lime to acidic soils; rotate crops and pasture; add compost or mulch to rebuild soil organic matter.
Build the capability of farmers	Training, advisory services, demonstration farms and farmer-to-farmer networks that help growers adopt better practices, plan for drought and take up new technology.

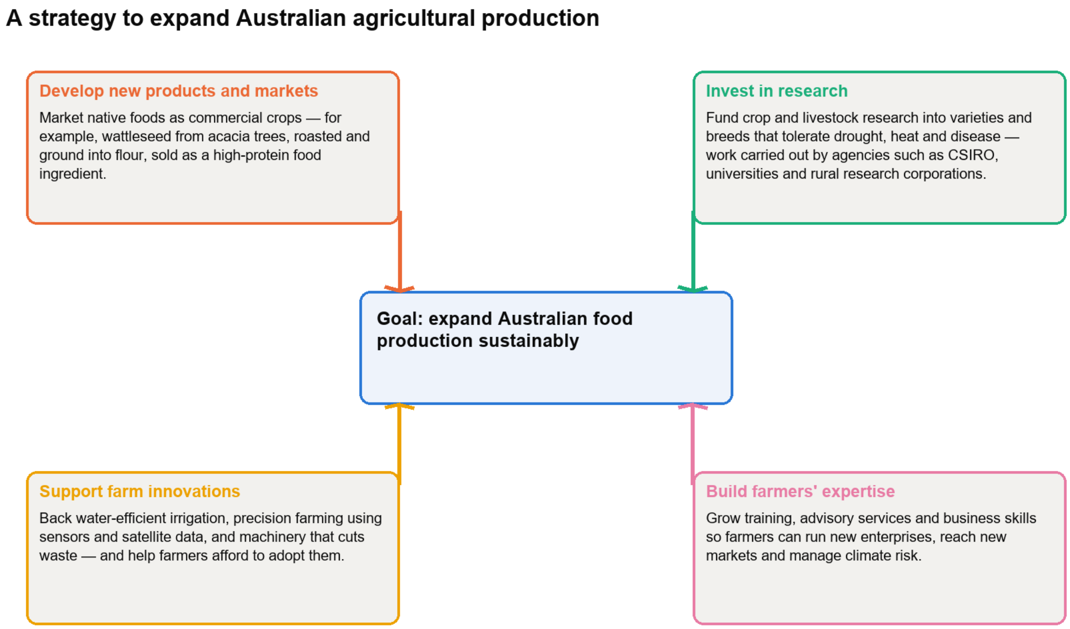
Content: Victorian Curriculum 2.0 Geography, VC2HG10K04 (elaboration .E05); examples are the section's own.

Table of four management strategy families that restore Australian agriculture: improving the function of natural and human-shaped biomes (ground cover, shelter belts, restored wetlands), monitoring land management (satellite images, drones, on-ground checks), improving the condition of the soil (minimum tillage, lime, rotation, compost) and building the capability of farmers (training, advisory services, demonstration farms)

Notice the mix: some strategies work on **natural biomes** (wetlands, creek-side vegetation, native shelter belts) and some on **human-shaped biomes** — the paddocks, orchards, plantations and irrigation districts that people have built over the landscape. Healthy versions of both keep farming viable.

Expanding Australian production

Restoring what exists is one half of the task; the other is expanding production sustainably — growing Australia’s contribution to feeding future populations.



Model: original, for Victorian Curriculum 2.0 Geography VC2HG10K04 (elaboration .E06). Examples are the section's own.

Hub-and-spoke diagram of a strategy to expand Australian agricultural production sustainably: developing new products and markets (wattleseed marketed as a commercial high-protein crop), investing in research (drought- and heat-tolerant varieties through agencies such as CSIRO), supporting farm innovations (water-efficient irrigation, precision farming with sensors and satellite data) and building farmers' expertise (training, advisory services, business skills)

Native foods are one example of a new product line: wattleseed — harvested from wattle (acacia) shrubs, roasted and milled into a nutty, high-protein flour — is marketed as a commercial crop and food ingredient, adding value and a sustainable source of nutrition without clearing new land. Research, innovation and expertise do the heavier lifting: varieties and breeds that tolerate drought and heat, irrigation and sensors that squeeze more crop from each drop of water, and farmers with the skills to run new enterprises and manage climate risk.

Worked examples

Example 1 — scaffolded

SOFI 2026 says about 645 million people faced hunger in 2025, and that this was 7.8% of the world's population. Use these two figures to estimate the world population, and compare your answer with the UN's 8 billion (2022).

Working	Comment
645 million is 7.8% of the world population.	The hunger figure is a *share* of a total — so the total can be worked backwards.
World population ≈ 645 ÷ 0.078 ≈ 8270 million ≈ **8.3 billion**.	Dividing by the decimal form of the percentage reverses it.

Working	Comment
UN figure: 8 billion in 2022; a little higher by 2025.	Our 8.3 billion (for 2025) sits just above the 2022 figure — the two independent sources agree.

The skill here is cross-checking: two different organisations' numbers telling the same story is what makes a claim trustworthy.

Example 2 — scaffolded

A made-up example to reason with (the numbers are chosen for clean working, not quoted data). A region grows grain on 1,000,000 ha at a yield of 4 t/ha. Demand for its grain rises by 50%. Compare the two classic responses and evaluate their sustainability.

Working	Comment
Current production = 1,000,000 ha × 4 t/ha = 4,000,000 t.	Production = area × yield.
New target = 4,000,000 × 1.5 = 6,000,000 t.	A 50% rise multiplies by 1.5.
Option A — extensification: at 4 t/ha, area needed = 6,000,000 ÷ 4 = 1,500,000 ha → clear 500,000 ha of new land.	The yield stays the same; the landscape pays.
Option B — intensification: on 1,000,000 ha, yield needed = 6,000,000 ÷ 1,000,000 = 6 t/ha.	The land stays the same; the management (and inputs) must lift.
Evaluate: Option A risks clearing native vegetation — habitat loss, erosion, salinity. Option B risks overdrawn water and fertiliser runoff — unless done with precise inputs, rotation and soil care.	Sustainability is judged by whether soil, water and ecosystems are left able to keep producing. Neither option is automatically sustainable; either can be done badly or well.

Practice questions

Scaffolded

Q1. Read the population projection figure. (a) State the UN's projected peak world population and when it is reached. (b) Explain in one sentence what happens to the projection after the peak.

Q2. Define *extensification* and *intensification*, and give one example of each from the theory section.

Q3. Read the food insecurity figure. (a) Which region had the highest share of its population facing moderate or severe food insecurity in 2025? (b) How does that region's share compare with the world average?

Q4. Using the environmental constraints table, match each constraint to the Australian example shown for it: (a) salt building up in soils, (b) heatwaves and harsher droughts cutting yields, (c) irrigation water rationed in dry years, (d) mine and factory waste fouling soil and water.

Q5. A country grows enough food for everyone, but a sudden export ban by its main supplier doubles the price of bread, and low-income households go without. Which pillar(s) of food security are weakened here? Justify with the pillar definitions.

Q6. A district's cropping soils have slowly become more acid and yields are slipping. Using the management strategies table, name the strategy family that responds to this, and two on-ground practices it includes.

Unscaffolded

Q7. 'Hunger is not mainly a production problem.' Use the four pillars of food security to argue for or against this claim, with at least two specific examples (economic or political) from this section.

Q8. Evaluate extensification and intensification as ways of reaching the 50–70% production rise projected for 2050. Which should Australia lean on more, and why? Refer to at least two environmental constraints in your evaluation.

Q9. Choose one competing land use from the Victorian examples (urban growth, mining, biofuel crops, or livestock and tourism). Analyse the trade-off: what does Australia gain from that use, and what does it give up for future food production?

Q10. Explain how climate change constrains the world's capacity to feed its future populations. Your chain of reasoning must link a change in conditions (e.g. rainfall, heat, extremes) to an impact on production, and name one way it also undermines an economic or political pillar of food security.

Inquiry task

Data task — charting world hunger (FAO, SOFI 2026). The table below reproduces the 2025 regional hunger figures used in this section.

Region	People facing hunger, 2025 (millions)	Share of region's population (%)
Africa	309	20.0
Asia	292	6.0
Latin America and the Caribbean	32	4.8
World	645	7.8

1. Draw an appropriate bar chart of the *share* column (not the head-count column), with a title, axis labels and units.
2. Describe the spatial pattern your chart shows. How does it differ from the pattern in the head-count column, and why can the two patterns tell different stories?
3. Explain the pattern using one environmental constraint and one economic or political factor from this section.

4. Identify which pillar of food security you judge to be weakest in Africa, and justify your choice in two to three sentences.

Answers

Q1. (a) About 10.3 billion people, reached in the mid-2080s. (b) After the peak the projection eases slightly, to about 10.2 billion by 2100 — population stops growing and begins a slow decline.

Q2. Extensification: growing more food by bringing more land into production, e.g. clearing native vegetation for cropland. Intensification: growing more food from the same land by lifting yield, e.g. irrigation, fertiliser and better seeds raising tonnes per hectare.

Q3. (a) Africa, at 56.6%. (b) More than double the world average of 25.8% — over half of Africa's population could not reliably get enough safe food.

Q4. (a) Land degradation (salinity). (b) Climate change. (c) Water scarcity. (d) Industrial pollution.

Q5. Access (people can no longer afford food) and stability (supply and prices were reliable until the ban, then were not). Availability of domestic food may be fine — the failure is in reaching and relying on food, which is exactly why the pillars must all hold.

Q6. 'Improve the condition of the soil'; practices include applying lime to acidic soils, and minimum tillage / crop rotation / adding compost to rebuild the soil (any two).

Q7. Model points: agree in part — production matters (environmental constraints can genuinely cut supply), but hunger persisting in good harvest years shows distribution is the deciding layer; examples: poverty pricing low-income households out of markets; conflict blocking roads and markets; export bans and trade barriers causing price spikes far from the shortage. A strong answer uses the pillar language (availability vs access/stability) and weighs both sides.

Q8. Model points: extensification alone would trade short-term output for long-term loss (clearing → erosion, salinity, habitat and carbon loss — it undermines the resource base); intensification can deliver the rise on existing land but must manage water scarcity and pollution (precise inputs, rotation, monitoring); conclusion should nominate a lean (most defensibly: careful intensification plus restoration strategies) and justify it against two named constraints, e.g. water scarcity and land degradation.

Q9. Model points (example, mining): gains — jobs, energy, export income; costs — land occupied that could support farming, water drawn or polluted that agriculture also needs, and a long rehabilitation tail before land returns to production. A strong answer names the specific place (Latrobe Valley) and weighs present economic benefit against future food-production capacity. Equivalent reasoning accepted for the other uses (e.g. Werribee South market gardens lost to Melbourne's western growth; canola/sugarcane sold for fuel rather than food; High Country farmland shifted to tourism).

Q10. Model chain: shifting rainfall / more intense heatwaves and droughts → lower yields and livestock losses in food-producing regions (availability) → smaller harvests and higher, more volatile prices → access weakened for poor households and stability weakened for import-dependent countries (as when the 2022 Black Sea disruption spiked wheat prices). Must be consequences, not climate mechanisms.

Inquiry. 1. Chart: bars of 20.0 / 6.0 / 4.8 (and optionally the 7.8 world reference), labelled axes with %, title naming 2025. 2. Pattern: Africa's *share* dwarfs the others even though Africa and Asia have similar head-counts; head-count reflects population size, share reflects how widespread hunger is — different questions ('where are the hungry people?' vs 'how likely is a person here to be hungry?'). 3. Explanation examples: environmental — drought, degraded soils and climate extremes cutting African harvests; economic/political — poverty limiting access, and conflict undermining stability in several countries. 4. Judgement with justification, e.g. stability (conflict and price shocks recurring) or access (poverty widespread) — accepted where the pillar definition is applied correctly to the data.

Sources

- Victorian Curriculum 2.0, Geography (VCAA) — content description VC2HG10K04 and elaborations .E01–.E06, retrieved 25 August 2026.
- FAO, *The State of Food Security and Nutrition in the World 2026* (SOFI 2026), hunger figures for 2025 via the FAO hunger portal, retrieved 25 August 2026.
- United Nations, *World Population Prospects 2024*, via un.org population pages, retrieved 25 August 2026.
- FAO (2017), *The Future of Food and Agriculture: Trends and Challenges*; FAO (2009), *How to Feed the World in 2050*, retrieved 25 August 2026.
- United Nations, Sustainable Development Goal 2 reporting (SOFI 2025 summary figures), retrieved 25 August 2026.