2023 Scenathon results

Pathways for food and land-use systems in Australia

FABLE CONSORTIUM

About FABLE

The Food, Agriculture, Biodiversity, Land-Use, and Energy (FABLE) Consortium is a collaborative initiative to support the development of globally consistent mid-century national food and land-use pathways that could inform policies towards greater sustainability. The Consortium brings together teams of researchers from 24 countries and international partners from the UN Sustainable Development Solutions Network (SDSN), the International Institute for Applied Systems Analysis (IIASA), the Alliance of Bioversity International and CIAT, and the Potsdam Institute for Climate Impact Research (PIK). https://www.fableconsortium.org/

About the authors

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Our food and land-use systems are critical for staying within our planetary boundaries and the Earth's system resilience. Among the six Transformations required to achieve the Sustainable Development Goals (SDGs), the fourth Transformation—focusing on food, land, and water—is crucial. This Transformation is key to achieving SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land). Moreover, it significantly supports the remaining SDGs, underscoring its crucial role in fostering a sustainable future.

In this document, we present the results of the 2023 'Scenathon', a modelling exercise by the FABLE Consortium exploring three alternative futures for national and regional food and land-use systems. The term 'Scenathon' stands for 'a marathon of scenarios' and refers to FABLE's iterative process for ensuring that national and regional pathways have coherent trade assumptions and align with global sustainability targets (see the 2024 Sustainable Development Report for more information).

Through these long-term pathways, we can identify trade-offs and synergies between different goals and see the impact of various actions, as well as key levers for guiding sustainable development policies through 2030 and 2050. These results, together with our modelling tools and methods, are designed to support decision-making and the development of better policies and targets to drive the transformation of our food and land-use systems.

Figure 1. Historical share of GHG emissions from Agriculture, Forestry, and Other Land Use (AFOLU) to total AFOLU emissions and removals by source in 2020

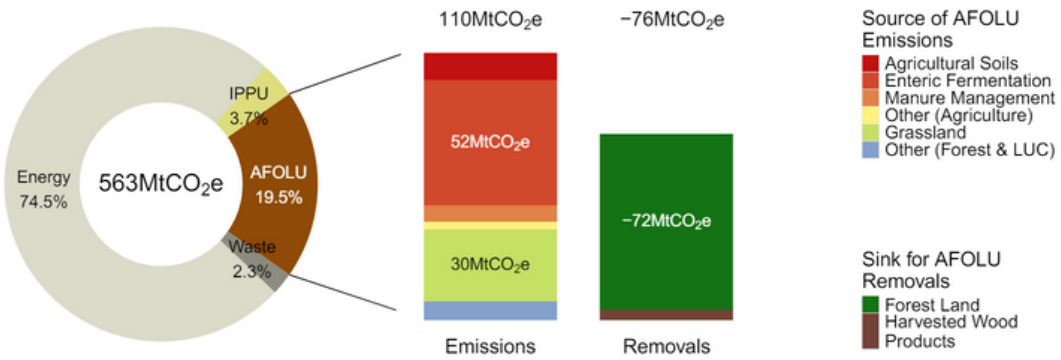
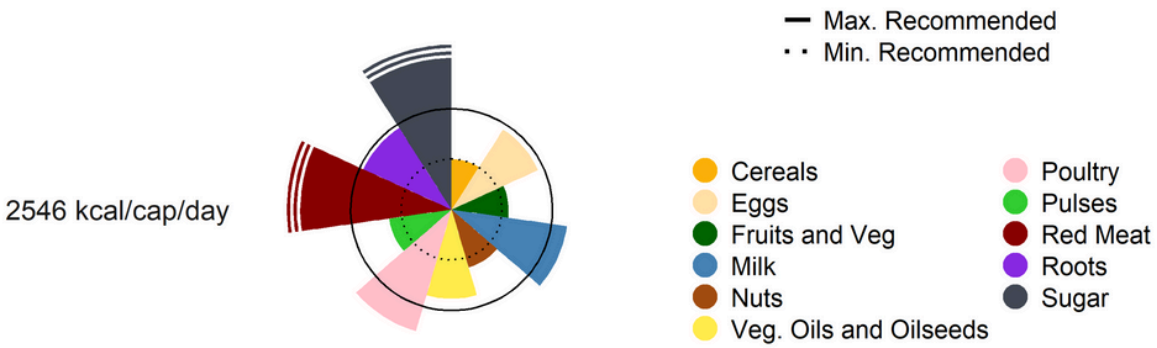


Figure 2. Daily average kilocalorie intake per capital per food category in 2020



National context

Australia

This table summarizes national targets for food and land use, derived from national commitments, policies, and strategies. It provides an overview of the country's current ambitions to transform its food and land-use systems. Where countries lacked quantitative national targets, we have estimated targets based on qualitative pledges.

SDG	Indicator	**National Target** (OS) Official source, (A) Assumption by the team.
	Agriculture GHG emissions reduction	67.43 Mt CO2e by 2030 (A)
	Total GHG emissions reduction	43% below 2005 levels by 2030. Emissions budget for 2021-30 is 4,381 Mt CO_2e. This is a target of 354.04 MT CO2e by 2030 (OS)
	Land use and land use change GHG emissions reduction	-30.77 Mt CO2e by 2030 (A)
	Other climate mitigation related targets	Reduce methane emissions by 30% by 2030. (OS)
	Expand protected areas or 'Other effective area-based conservation measures' (OECMs)	Protecting 30% of Australian land and sea area by 2030 (OS)
	Agricultural value	To exceed $100 billion in farm gate output by 2030 (OS)

Model

Using the open-access FABLE Calculator and the FABLE decentralized modelling infrastructure, we have developed three alternative pathways —Current Trends, National Commitments, and Sustainable Pathway— to explore the impact of various practices and policies on achieving sustainability targets through 2050. We compare our results with targets across food security and nutrition, GHG emissions reduction, forest and biodiversity conservation, and sustainable use of water, nitrogen, and phosphorus.

For each of these pathways, we have established various assumptions regarding the evolution of several model parameters. These parameters include population growth, dietary patterns, food waste, food import and export levels, crop and livestock productivity, agricultural expansion, afforestation, livestock density, protected areas expansion, post-harvest losses, biofuel demand, urban expansion, agricultural practice coverage, and irrigation area expansion. These assumptions detail the extent to which these factors will drive changes in food and land systems from 2020 to 2050.

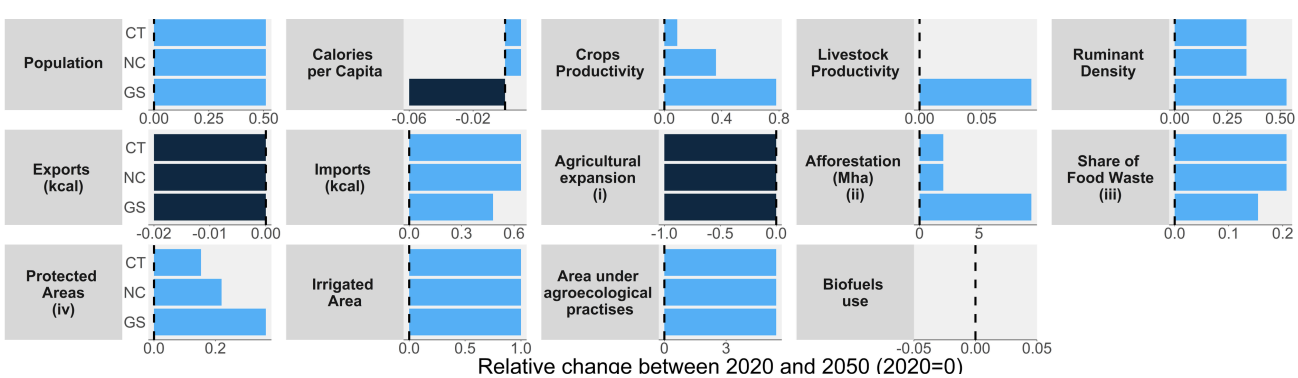
Pathway narratives

Current Trends (CT): This scenario corresponds to the continuation of trends observed over the last 20 years and assumes little change in the policy environment. It is characterized by high population growth (from 26 million in 2020 to 38 million in 2050), significant constraints on agricultural expansion, a low afforestation target, on-trend productivity increases in the agricultural sector, and no change in diets. These and other important assumptions are justified using historical data, experts' advice, and results from integrated science assessment models. This CT Pathway is embedded in a global GHG concentration trajectory that would lead to a radiative forcing level of 6 W/m2 (RCP 6.0), or a global mean warming increase likely between 2°C and 3°C above pre-industrial temperatures, by 2100. Our model includes the corresponding climate change impacts on crop yields by 2050 for corn, millet, nuts, rapeseed/canola, rice, soybean, sugarcane, sunflower, and wheat.

National Commitments (NC): This scenario investigates the sustainability impacts of the ongoing trajectory of policies and practices in Australia. The scenario reflects a significant national focus on emission reduction targets and modest or limited policy implementation or commitments in other areas. This scenario builds on current trends for areas where there are no explicit policies or targets and assumes full implementation of long-term policies or commitments e.g., Nationally Determined Contributions.

Global Sustainability (GS): This represents a future in which significant efforts are made to adopt sustainable policies and practices that are consistent with higher-than-trend productivity growth and correspond to a high boundary of feasible action. Similar to the CT Pathway, we assume that this future would result in high population growth and no agricultural expansion. However, the Sustainable Pathway assumes higher agricultural productivity growth, higher carbon sequestration via afforestation and regrowth, adoption of more sustainable diets, and lower blue water footprint than under the CT Pathway. This corresponds to a future based on the implementation of new ambitious policies that support farmers in achieving greater yields at lower environmental costs and enable the development of negative-carbon technologies to bridge the gap between what industry can achieve in emission reductions and the net-zero emissions target. The GS Pathway is embedded in a global GHG concentration trajectory that would lead to a lower radiative forcing level of 2.6 W/m2 by 2100 (RCP 2.6), in line with limiting warming to 2°C.

Figure 3. Assumptions on the levers for change in each pathway



Notes: (i) Results are expressed in code, taking the value 1 for 'Free expansion scenario', -0.5 for 'No deforestation' and -1 for 'No Agricultural expansion'. (ii) Results are expressed in a net increase rather than relative change. (iii) Results are expressed % of consumption that is wasted. (iv) Results are expressed in % of total land in 2050.

Figure 4. Computed daily average intake per capita over 2000-2050

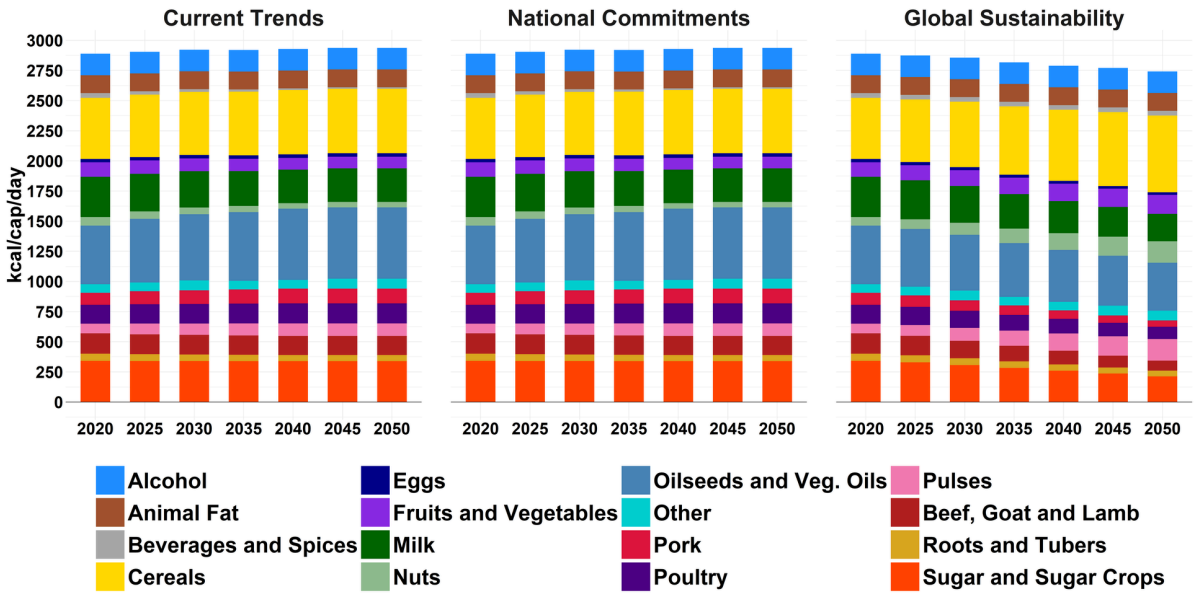


Figure 5. Comparison of the computed daily average kilocalorie intake per capital per food category across the three pathways and the prevalence of undernourishment in 2050

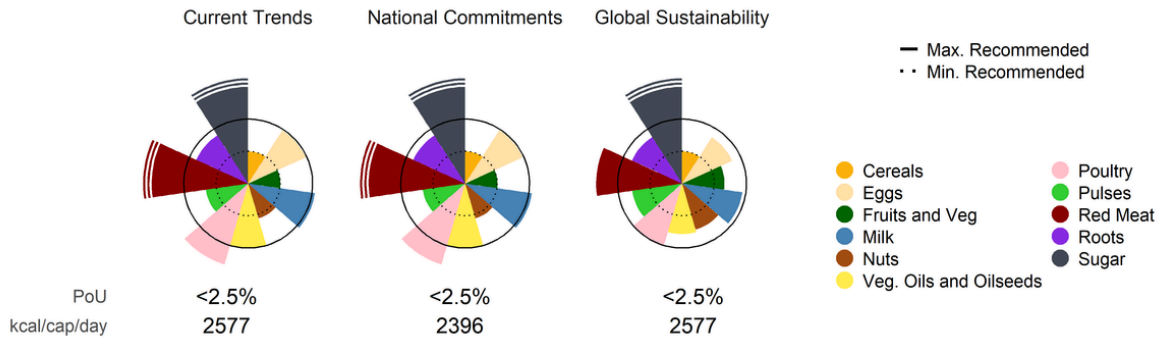


Figure 6. Evolution of land cover 2000-2050

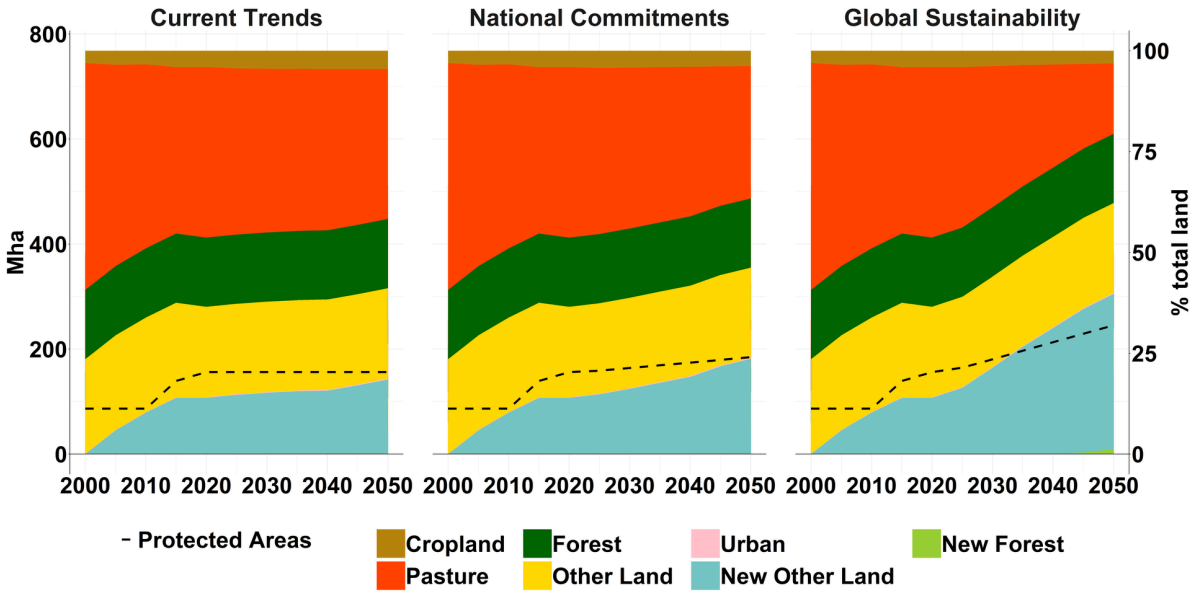


Figure 7. Evolution of the cropland composition 2000-2050

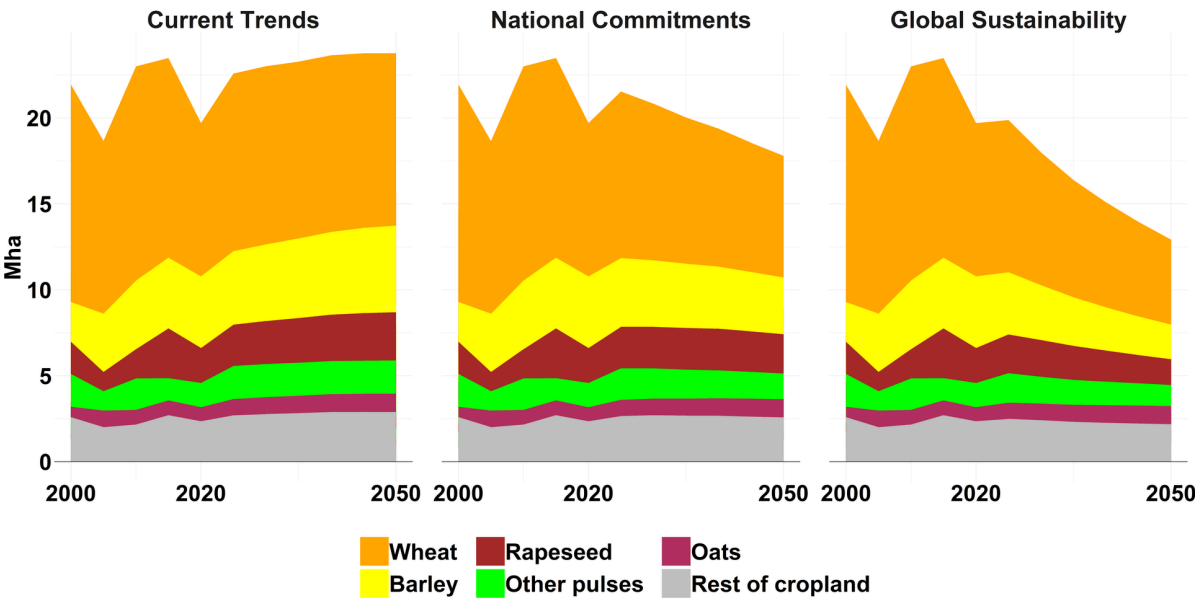


Figure 8. Projected AFOLU emissions and removals between 2020 and 2050 by main sources and sinks across pathways

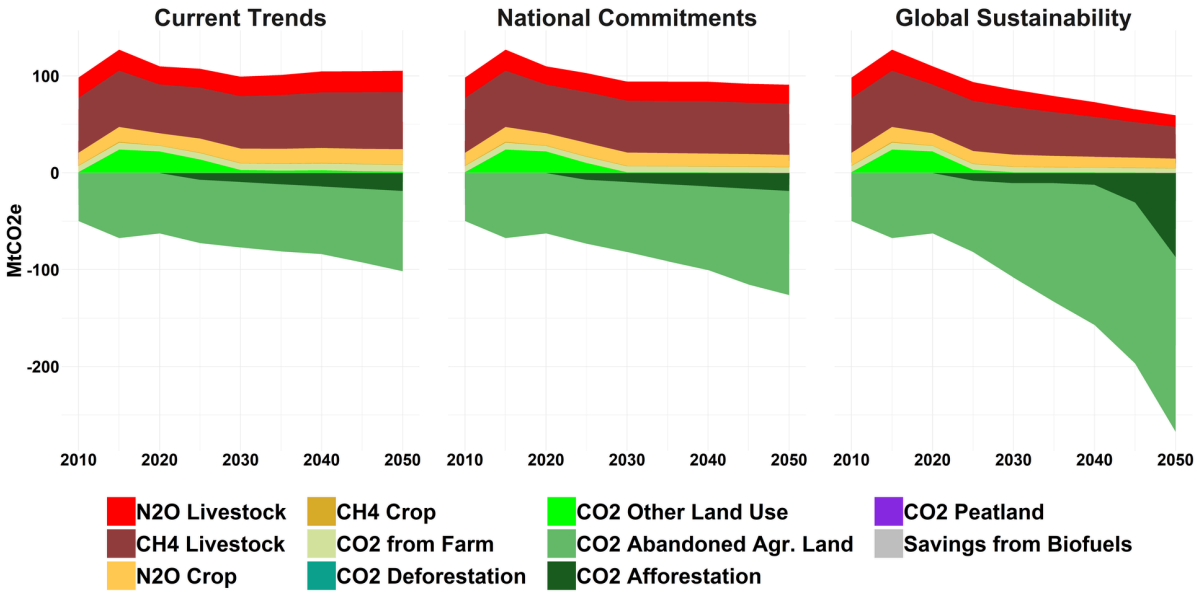
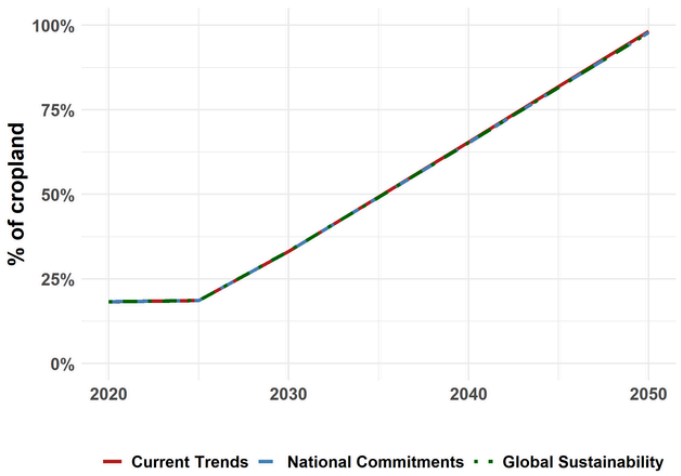


Figure 9. Share of cropland under agroecological practices



Agroecological practices included: Cover crops, cultivar mixtures, diversified farming systems, embedded natural, organic farming, no/minimal tillage.

Figure 10. Total area of land where natural processes predominate (LNPP)

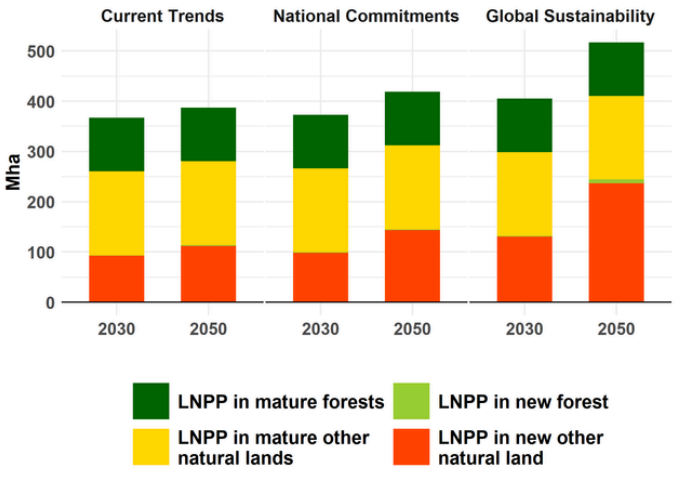


Figure 11. Nitrogen application

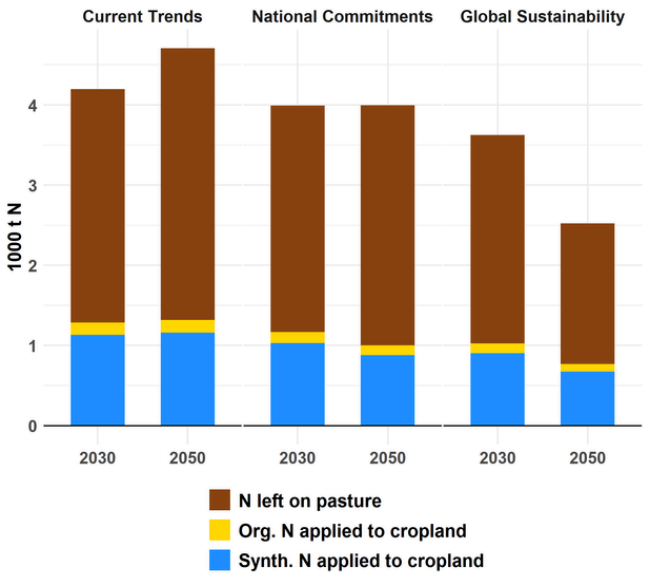
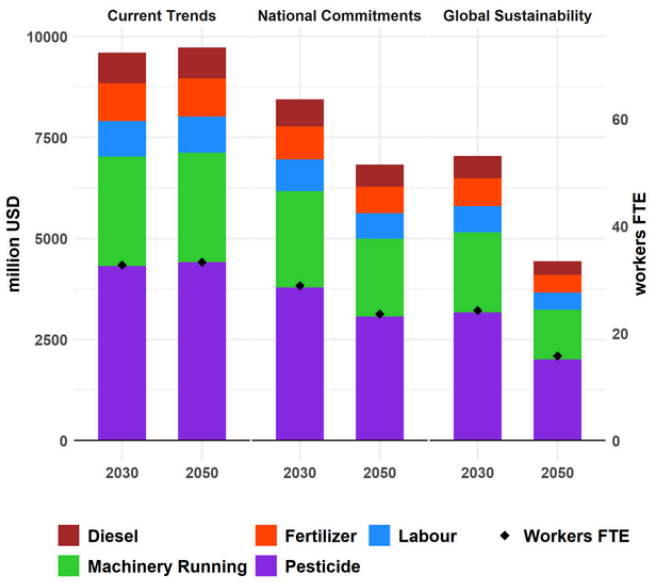


Figure 12. On-farm production costs



FTE: Full-time equivalent

For more detailed results and visual data, visit www.scenathon.org

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
1. Macroeconomics	**1.1)** GDP per capita	4.3% increase per year	4.3% increase per year	4.3% increase per year	IGR- Australian Intergeneration Report 2023.
	1.2) Population	2.04% increase per year	2.04% increase per year	2.04% increase per year	IGR- Australian Intergeneration Report 2023.
	1.3) Inflation	Current prices in 2010 USD	Current prices in 2010 USD	Current prices in 2010 USD	Inflation is not modelled
	1.4) Inequalities	-	-	-	-
2. Land	**2.1)** Constraints on agricultural expansion/deforestation	No productive land expansion beyond the 2010 value	No productive land expansion beyond the 2010 value	No productive land expansion beyond the 2010 value	Previous CSIRO publications and National Farmers Federation roadmap to 2030 and National Commitment to 30% land and sea protection
	2.2) Afforestation, and forest plantations targets	3.128 million hectares afforested by 2050	3.128 million hectares afforested by 2050	10.53 million hectares afforested by 2050	**Current trends and National Commitments:** Forest regrowth estimates based on data from the Australian State of the Forest report. Forest regrowth estimates based on data from the Australian State of the Forest report, including a federal target to incentivize planting one billion trees in forestry projects (0.4 - 1 million hectares) by 2030. Sustainability: Australian National Outlook 2019. Carbon and environmental plantings under "Green and Gold" scenario (RCP 2.6) range from 9.41 million hectares (mha) to 18.45 mha. Carbon plantings range from 8.14 mha to 14.93 mha, under the GFDL-ESM2M and NorESM1-M GCM projections respectively.
	2.3) Urban and settlements area	Increase of 86% from 2020 to 2050	Increase of 86% from 2020 to 2050	Increase of 86% from 2020 to 2050	IGR- Australian Intergeneration Report 2023.Reported percents are taken from the Calculator Table S.23 column LM
	2.4) Protected areas	No change	Protecting 30% of Australian land and sea area by 2030	Linear extrapolation of the commitment to protect	National Commitment to 30% land and sea protection

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
				30% of Australian land and sea area by 2030	
3. Productivity and management	**3.1)** Crop productivity for the key crops	Yield gap: 54%	Yield gap: 40%	Yield gap: 20%	There are no national commitments in terms of yield gap, and even measurements of yield gap are limited to some of the major broadacre crops. 80% closure of yield gap amounts to what was considered feasible in the Yield Gap Australia project.
	3.2) Cropland under agroecological practices	Large-scale adoption of advanced farming practices, generating a 15% increase in yields.	Large-scale adoption of advanced farming practices, generating a 15% increase in yields.	Large-scale adoption of advanced farming practices, generating a 15% increase in yields.	Progression towards closing the year-on-year yield gap consistent with the adoption of advanced farming practices such as controlled traffic, yield mapping, soil testing-guided fertilizer programs, improved cultivars, and early sowing (all these seen widespread adoption between 2000-2020), as well as future increased use of long-coleoptile varieties and better strategizing around crop rotations and opportunistic cropping. This is consistent with the Australian Farmers Federation's objectives to increase the productivity of the sector.
	3.3) Livestock productivity for the key livestock products	1% increase per year	1% increase per year	1.5% increase per year	Based on historical trends in the agricultural productivity sector as modeled in the Australian National Outlook 2019.
	3.4) Pasture stocking rate	0.92% increase per year	0.92% increase per year	1.38% increase per year	Rates of change based on business-as-usual stocking rate growth between 1980 and 2010, calculated with data from Meat and Livestock Australia (2019).
	3.5) Forest management	-	-	-	-
4. Trade	**4.1)** Share of consumption which is imported	No changes to historical shares of imported food	No changes to historical shares of imported food	No changes to historical shares of imported food	The share of total consumption that is imported increases in response to domestic population growth.

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
	for key imported products (%)				Historical trends in Australian trade data from 1986 to 2016 (FAOSTAT, 2019), and endogenous changes driven by trade assumptions in the Calculator indicate that the quantity of fruit and vegetable imports doubled from 2015 to 2050. Import value for other commodities remains at 2015 levels.
	4.2) Evolution of exports for key exported products (1000 tons)	No changes in export tonnage by 2050	Doubling export tonnage by 2050	Doubling export tonnage by 2050	Based on statistical projections with FAOSTAT (2019) 1986-2016 data that suggest that under historical trends the value of Australian exports by 2050 could be around 1.6 times the 2015 value. Changes in total factor productivity due to technological development allows Australian exports to remain globally competitive. Increases in food demand from the Asian region also contributes to the increase in Australian exports beyond current trends.
5. Food	**5.1)** Average dietary composition	Major changes. Increased consumption: by 94% fruits and vegs, 82% eggs, 53% fish, 47% cereals. Decreased consumption: by 63% pulses, 56% nuts, 31% red meat	No significant changes in diets.	No significant changes in diets.	Target values for the National healthy diet are similar to the values in the FAO calibration year, i.e., there is no change in the diet in this scenario. The Fat diet changes are well aligned with current trends but not so much of an increase in fat consumption.
	5.2) Share of food consumption which is wasted at household level	No change	No change	20% decrease	Same share as in 2010 (Based on Baljelj etal. 2014 - compounded waste from current consumption is 29.7%)
6. Biofuels	**6.1)** Targets on biofuel and/or other bioenergy use	Undefined	Undefined	Undefined	Need to update table S20 to define the National scenario. According to ARENA to reach global trends in biofuel production to 2060, Australia needs a 40-fold expansion of the domestic biofuels

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
					industry. This would allow the production of 20 gigalitres per year. However, that information may be useful for the sustainability scenario. There are no current policies focused on boosting biofuel production.
	6.2) Targets on other non-food use	No change	No change	No change	
7. Water	**7.1)** Irrigated crop area	same irrigated harvested area as in 2010	same irrigated harvested area as in 2010	same irrigated harvested area as in 2010	