



2023 Scenathon results

Pathways for food
and land-use systems
in the USA



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

The pathways for food and land-use systems in the USA were developed by Grace C. Wu (UC Santa Barbara - gracecw@ucsb.edu), Justin Baker (North Carolina State University (NCSU)), Gordon McCord (University of California San Diego (UCSD)), Christopher Wade (RTI International)

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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

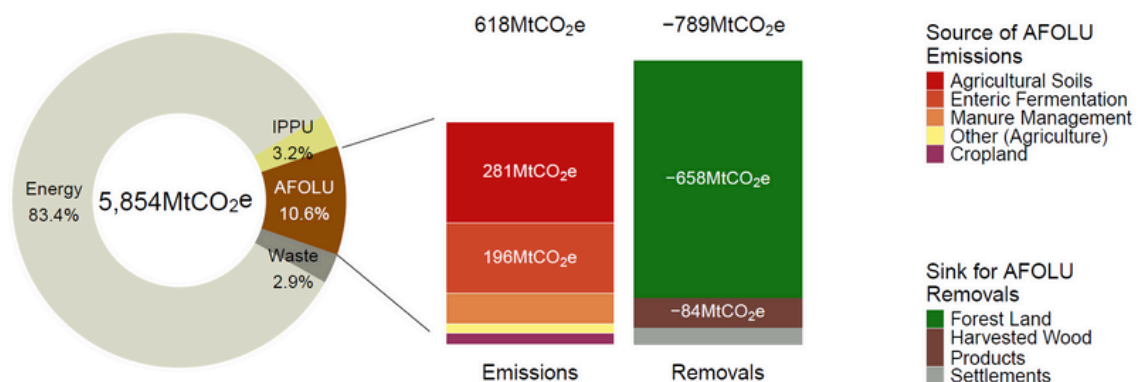
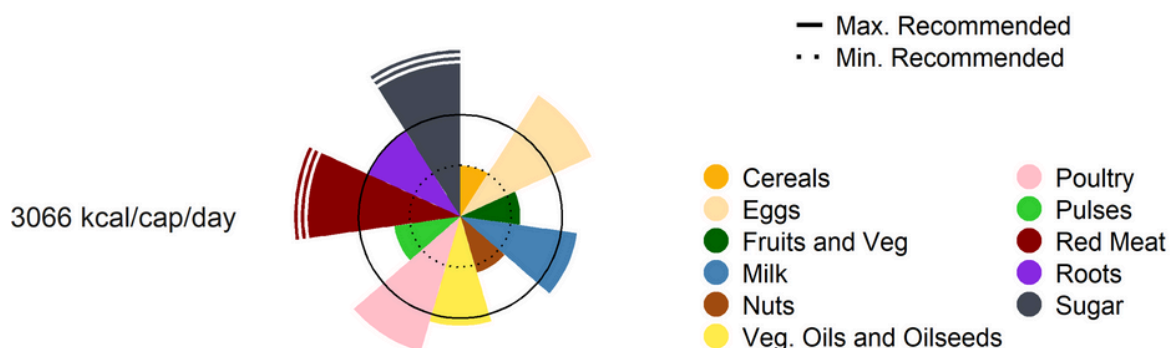





Figure 2. Daily average kilocalorie intake per capital per food category in 2020



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
 2 ZERO HUNGER	Food-related targets	Food Waste: 50% reduction by 2030 compared to BAU <u>levels</u>
 13 CLIMATE ACTION	Total GHG emissions reduction	Net zero by <u>2050</u>
	Land use and land use change GHG emissions reduction	About 250 MtCO ₂ LULUCF sink over <u>BAU</u>
 15 LIFE ON LAND	Promote afforestation	Mid-century strategy <u>report</u> had a range of 20-40 million ha of reforestation; no target exists in the updated, Long-Term <u>Strategy</u> of the US
	Expand protected areas or 'Other effective area-based conservation measures' (OECMs)	30% by 2030 (from current 11% - Executive order by President Biden)

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.

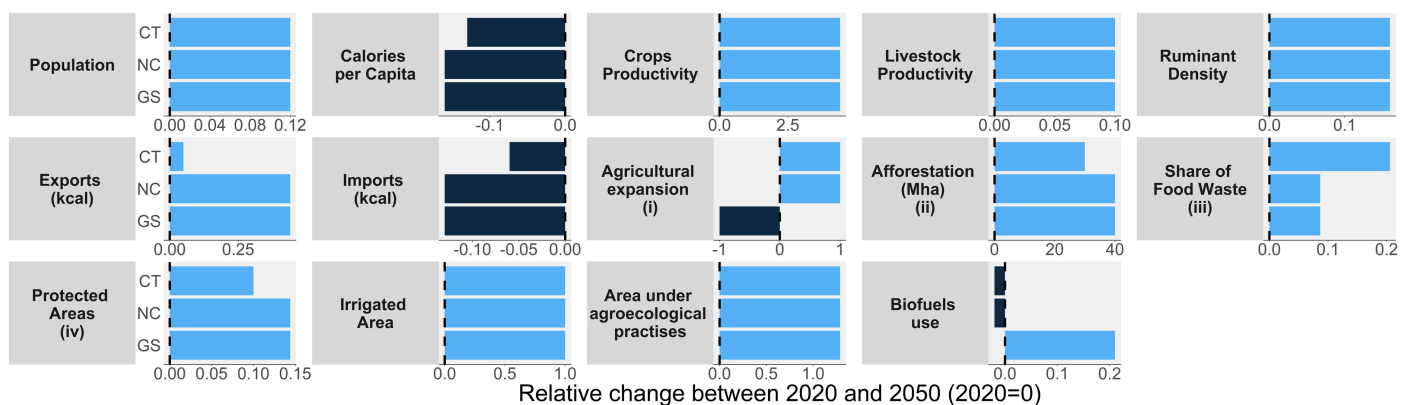
Pathway narratives

Current Trends: This pathway is designed primarily to account for the newly implemented Inflation Reduction Act's (IRA) benefits for climate investments in the AFOLU sectors. Since these benefits are allocated for each activity type, we use FASOM results of a \$20/tCO₂ carbon price as an imperfect proxy for IRA benefits.

National Commitments: This pathway was designed to follow the US Long Term Strategy (LTS) for climate change mitigation, which is the US's official updated/latest submission to the Paris Climate Agreement. We also adopt the USDA and Human Health Service's recommended "Healthy US style diet".

Global Sustainability: We increase the ambition of the National Commitments pathway by not allowing for additional expansion of agricultural lands, reducing post-harvest losses, and phasing out corn ethanol (replacing with second generation biofuels).

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.

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

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

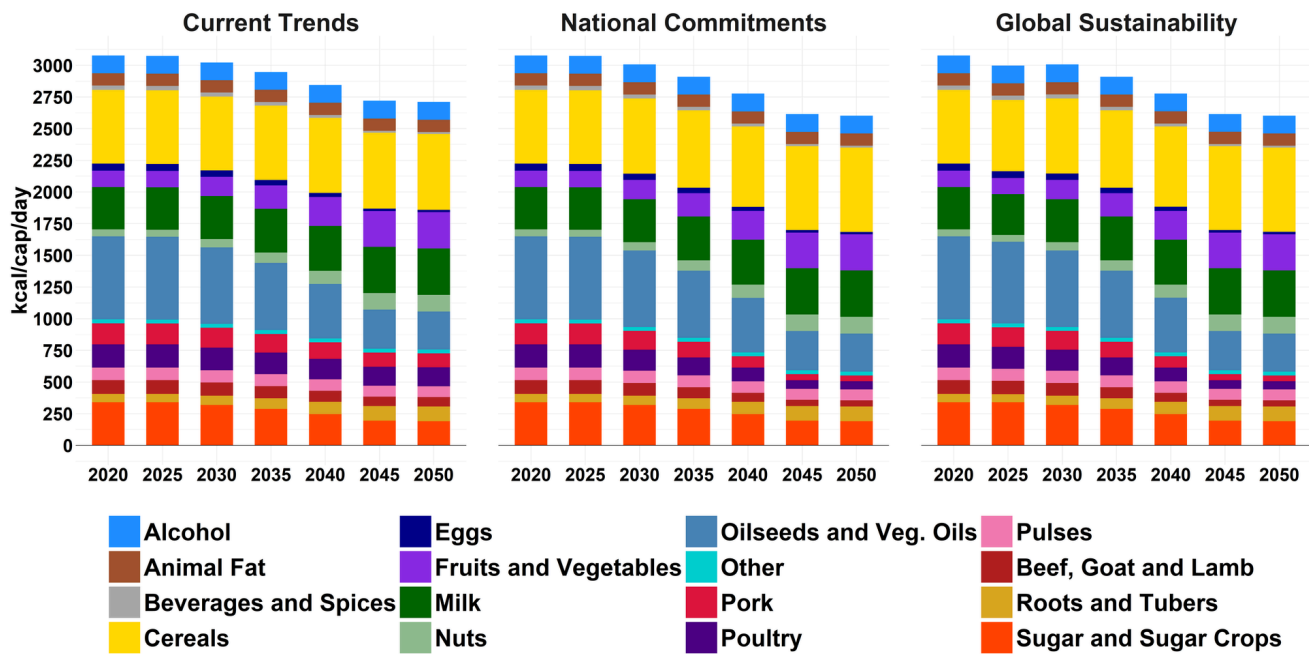


Figure 5. Comparison of the computed daily average kilocalorie intake per capital per food category across the three pathways and the prevalence of undernourishment in 2050

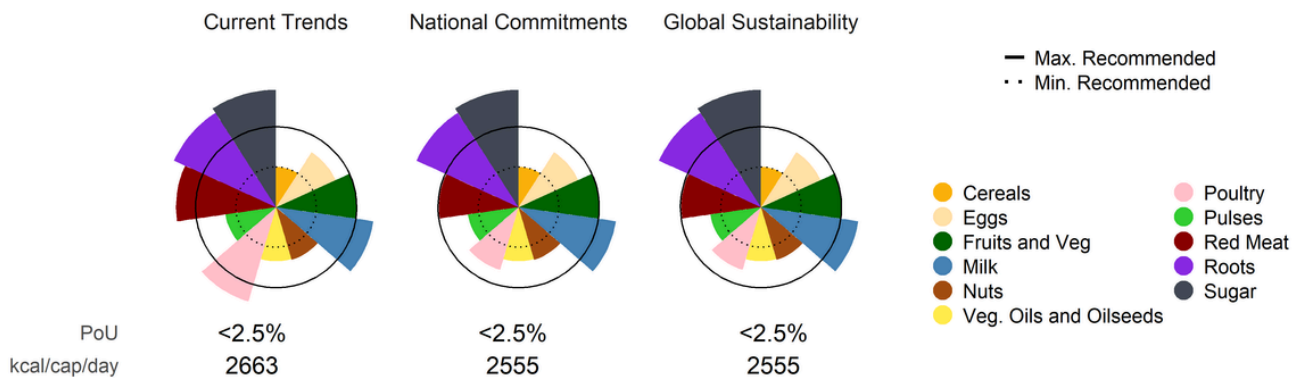


Figure 6. Evolution of land cover 2000-2050

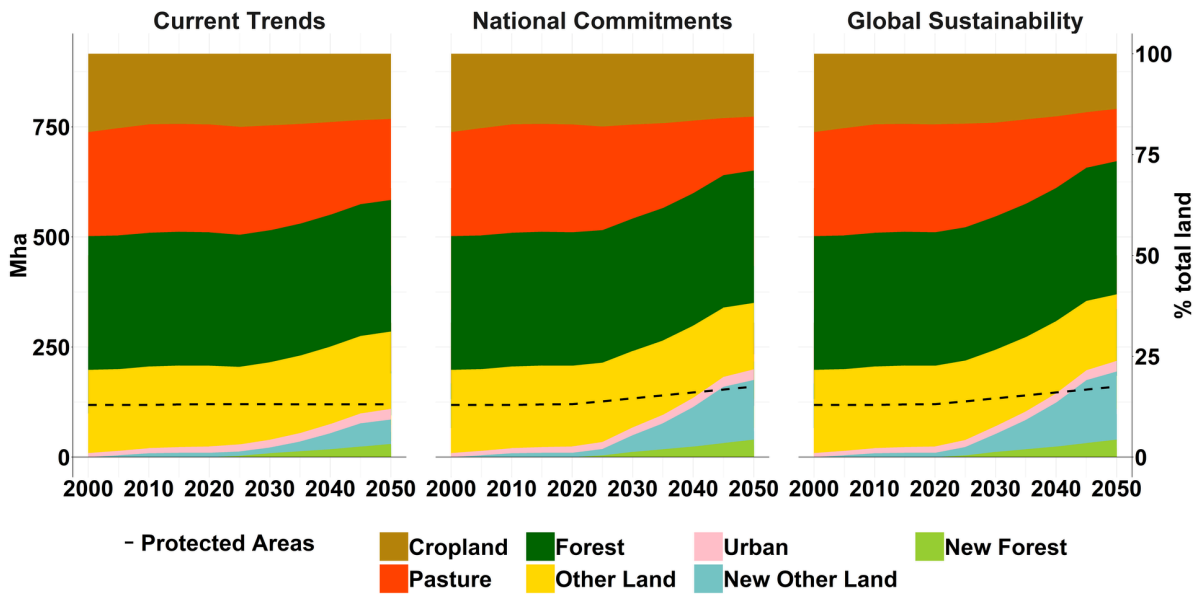


Figure 7. Evolution of the cropland composition 2000-2050

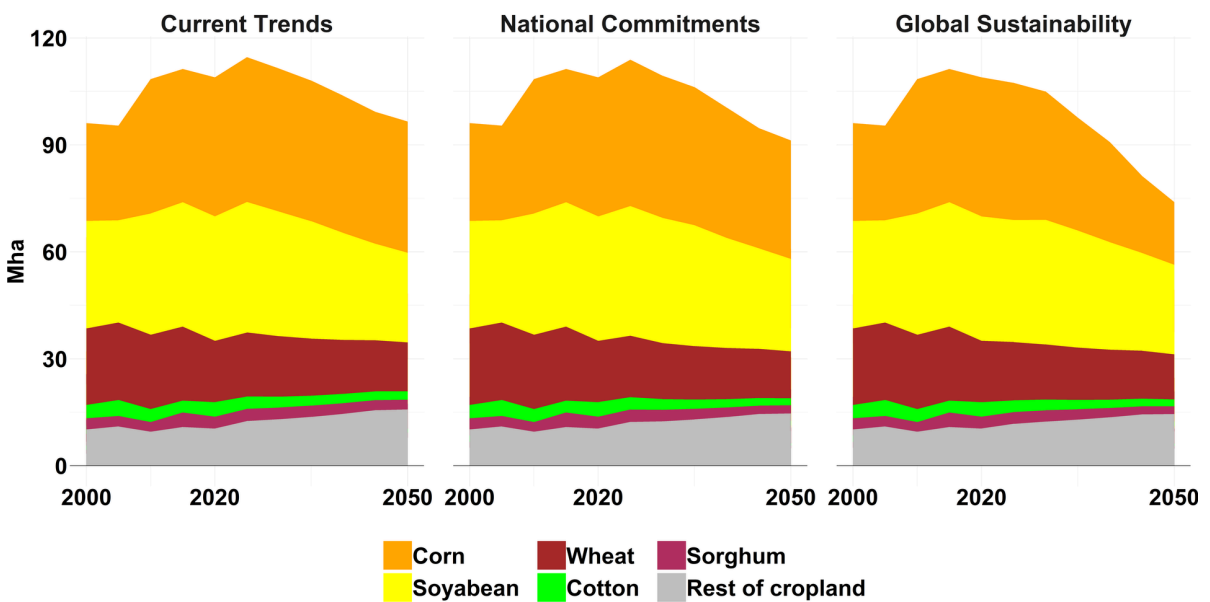


Figure 8. Projected AFOLU emissions and removals between 2020 and 2050 by main sources and sinks across pathways

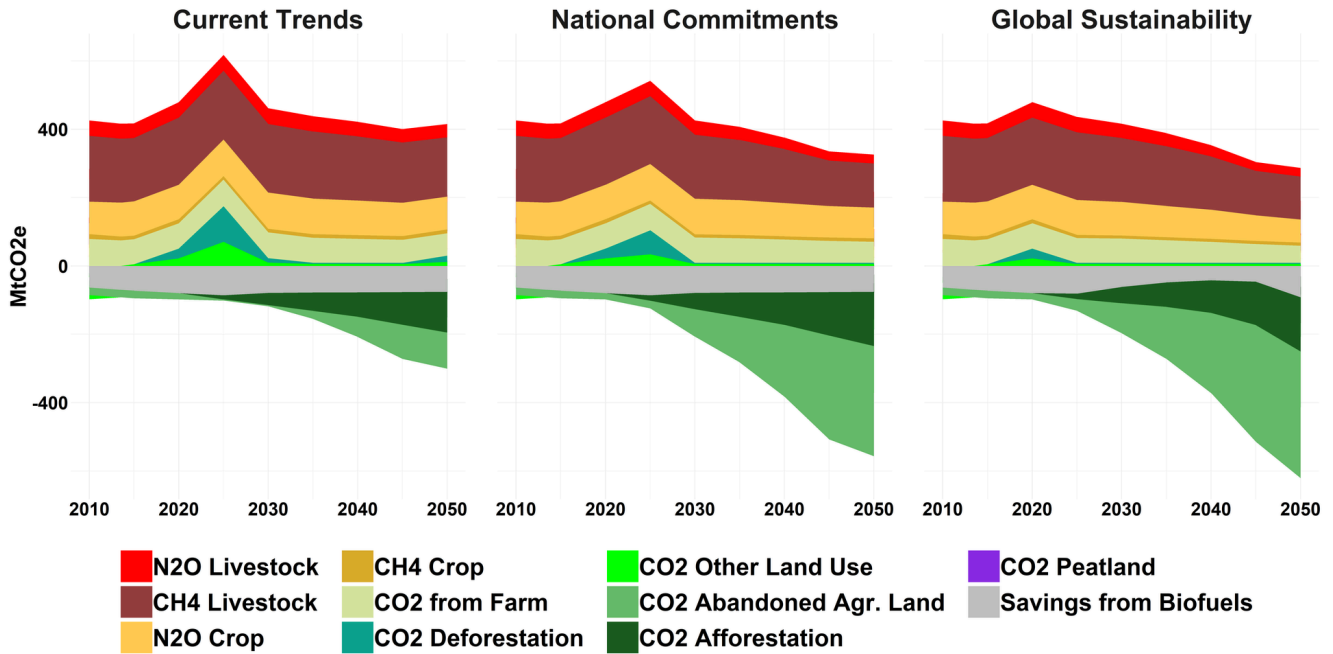
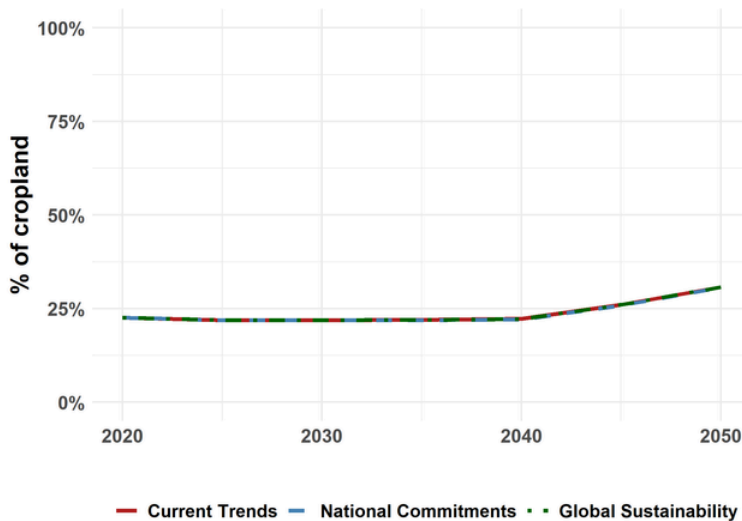


Figure 9. Share of cropland under agroecological practices



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)

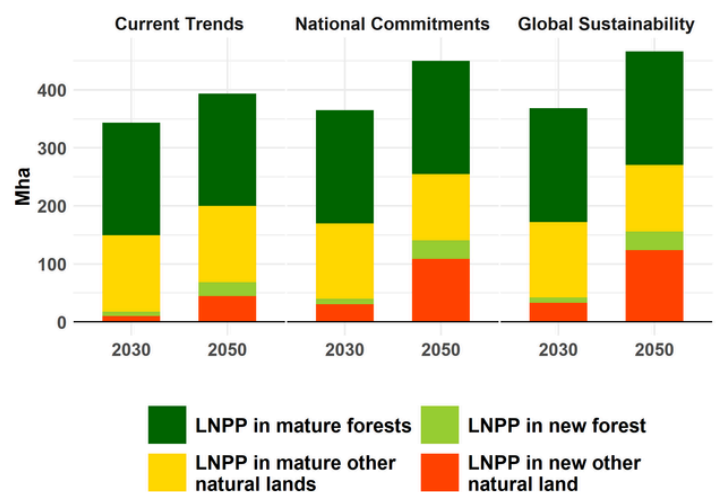


Figure 11. Nitrogen application

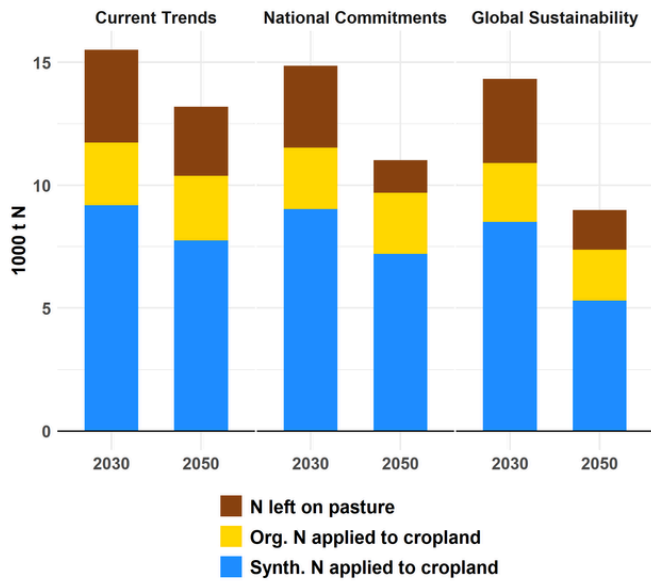
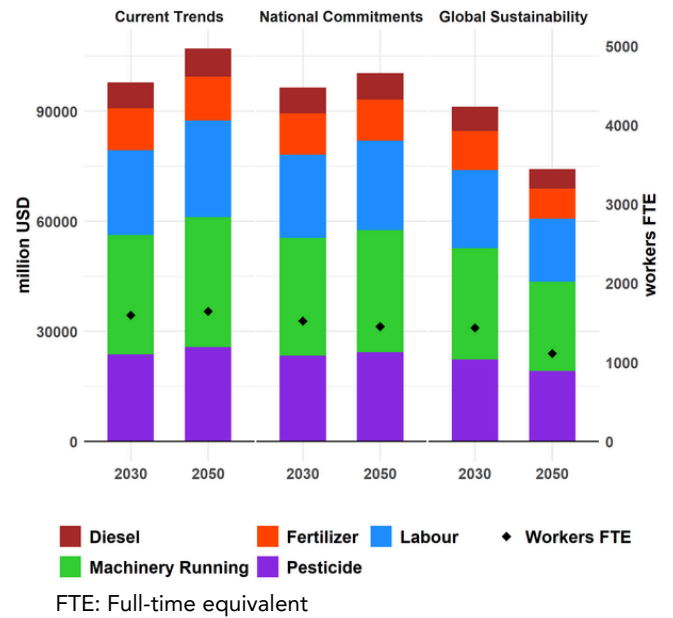


Figure 12. On-farm production costs



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	23% increase between 2020 and 2050	23% increase between 2020 and 2050	23% increase between 2020 and 2050	-
	1.2) Population	About 400 million people by 2050 (SSP2)	About 400 million people by 2050 (SSP2)	About 400 million people by 2050 (SSP2)	-
	1.3) Inflation	Increase by 50% between 2020 and 2050	Increase by 50% between 2020 and 2050	Increase by 50% between 2020 and 2050	-
	1.4) Inequalities	-	-	-	-
2. Land	2.1) Constraints on agricultural expansion/deforestation	No constraint on the expansion of the agricultural land beyond protected areas	No constraint on the expansion of the agricultural land beyond protected areas	No expansion of agricultural land	-
	2.2) Afforestation, and forest plantations targets	30 million ha	30 million ha	40 million ha	US Long term strategy
	2.3) Urban and settlements area	Increases 12% per year, so 95% increase between 2020 and 2050	Increases 12% per year, so 95% increase between 2020 and 2050	Increases 12% per year, so 95% increase between 2020 and 2050	-
	2.4) Protected areas	No change	30% of total area by 2030	30% of total area by 2030	Executive Order Sec. 216. Conserving Our Nation's Lands and Waters. (a) The Secretary of the Interior, in consultation with the Secretary of Agriculture, the Secretary of Commerce, the Chair of the Council on Environmental Quality, and the heads of other relevant agencies, shall submit a report to the Task Force within 90 days of the date of this order recommending steps that

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
					the United States should take, working with State, local, Tribal, and territorial governments, agricultural and forest landowners, fishermen, and other key stakeholders, to achieve the goal of conserving at least 30 percent of our lands and waters by 2030."
3. Productivity and management	3.1) Crop productivity for the key crops	11% increase by 2050 for corn 40% increase for soy 60% increase by 2050 for wheat	11% increase by 2050 for corn 40% increase for soy 60% increase by 2050 for wheat	11% increase by 2050 for corn 40% increase for soy 60% increase by 2050 for wheat	Consistent with FASOM runs
	3.2) Cropland under agroecological practices	Mixed - 20% organic farming by 2050 - 30% no/minimal tillage by 2050 - 30% embedded natural by 2050	Mixed - 20% organic farming by 2050 - 30% no/minimal tillage by 2050 - 30% embedded natural by 2050	Mixed - 20% organic farming by 2050 - 30% no/minimal tillage by 2050 - 30% embedded natural by 2050	IRA includes incentives for various climate-smart ag practices IRA
	3.3) Livestock productivity for the key livestock products	Between 2020 and 2050, the productivity per head increases: - 10% for beef - 40% for chicken - 37% for eggs - 54% for milk - 2% for pork	Between 2020 and 2050, the productivity per head increases: - 10% for beef - 40% for chicken - 37% for eggs - 54% for milk - 2% for pork	Between 2020 and 2050, the productivity per head increases: - 10% for beef - 40% for chicken - 37% for eggs - 54% for milk - 2% for pork	
	3.4) Pasture stocking rate	0.42 TLU/ha in 2020 to 0.45 TLU/ha in 2050	0.42 TLU/ha in 2020 to 0.45 TLU/ha in 2050	0.42 TLU/ha in 2020 to 0.45 TLU/ha in 2050	
	3.5) Forest management				

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
4. Trade	4.1) Share of consumption which is imported for key imported products (%)	The share of total consumption which is imported stays constant at the following between 2020 and 2050: - beef: 2% - vegetables_other: 26% - fruit_other: 52%	The share of total consumption which is imported stays constant at the following between 2020 and 2050: - beef: 2% - vegetables_other: 26% - fruit_other: 52%	The share of total consumption which is imported stays constant at the following between 2020 and 2050: - beef: 2% - vegetables_other: 26% - fruit_other: 52%	
	4.2) Evolution of exports for key exported products (1000 tons)	Exports adhere to FASOM \$20/tCO2 scenarios for the following crops - 10% reduction in corn - no change for soy, wheat, beef, eggs, and milk - 10% increase in pork - 30% increase in chicken	Exports adhere to FASOM \$20/tCO2 scenarios for the following crops - 10% reduction in corn - no change for soy, wheat, beef, eggs, and milk - 10% increase in pork - 30% increase in chicken	Exports generally increase by 50% between 2020 and 2050 for corn, soy, wheat, pork, and chicken. Exports for beef increase by 100% by 2050	
5. Food	5.1) Average dietary composition	By 2050, the average daily calorie consumption per capita is 2640 kcal and composed as: 22% cereals, 14% dairy, 7% red meat, 8% other meat, 13% oil and fat, 7% sugar, 11% fruits and vegetables, 3% pulses, 4% roots and tubers	By 2050, the average daily calorie consumption per capita is 2535 kcal and composed as: 26% cereals, 14% dairy, 4% red meat, 5% other meat, 15% oil and fat, 7% sugar, 11% fruits and vegetables, 3% pulses, 5% roots and tubers	By 2050, the average daily calorie consumption per capita is 2535 kcal and composed as: 26% cereals, 14% dairy, 4% red meat, 5% other meat, 15% oil and fat, 7% sugar, 11% fruits and vegetables, 3% pulses, 5% roots and tubers	Dietary Guidelines for Americans
	5.2) Share of food consumption which is wasted at household level	No reduction compared to 2020 level	Reduces by 50% compared to 2020 level	Reduces by 50% compared to 2020 level	US Environmental Protection Agency. US 2030 Food Loss and Waste Reduction Goal
6. Biofuels	6.1) Targets on biofuel and/or other bioenergy use	Targets adhere to FASOM \$20/tCO2 scenarios: 30% of total corn production, 60% of total rapeseed oil production, 20% of total soyoil production by 2050	Targets adhere to FASOM \$20/tCO2 scenarios: 30% of total corn production, 60% of total rapeseed oil production,	Biofuel demand accounts for 0% of total corn production, 56% of total rapeseed oil production, 20% of total soyoil production, and 100% of total switchgrass and miscanthus production by 2050	Global sustainability scenario follows the central pathway of this net zero US study

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
			20% of total soyoil production by 2051		
	6.2) Targets on other non-food use	-	-	-	-
7. Water	7.1) Irrigated crop area	No growth between 2020 and 2050	No growth between 2020 and 2050	No growth between 2020 and 2050	-