2023 Scenathon results

Pathways for food and land-use systems in Germany

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 Germany were developed by Livia Rasche (Universität Hohenheim - livia.rasche@uni-hamburg.de), Uwe Schneider (University of Hamburg), and Jan Steinhauser (International Institute for Applied Systems Analysis).

Recommended citation
Rasche,L., Schneider, U., and Steinhauser, J. (2024). FABLE Scenathon 2023 Pathways for food and land-use systems in Germany. Paris: Sustainable Development Solutions Network (SDSN). 10.5281/zenodo.11547130

National context

Germany

Contents

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

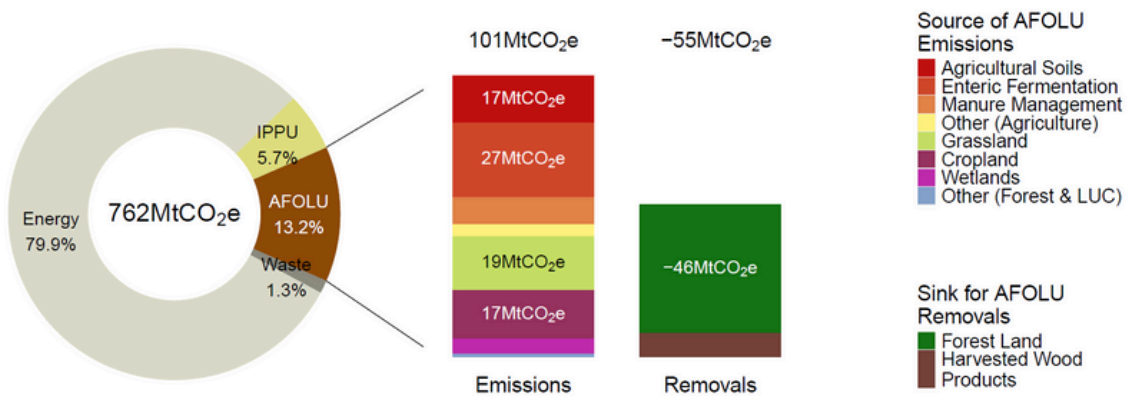
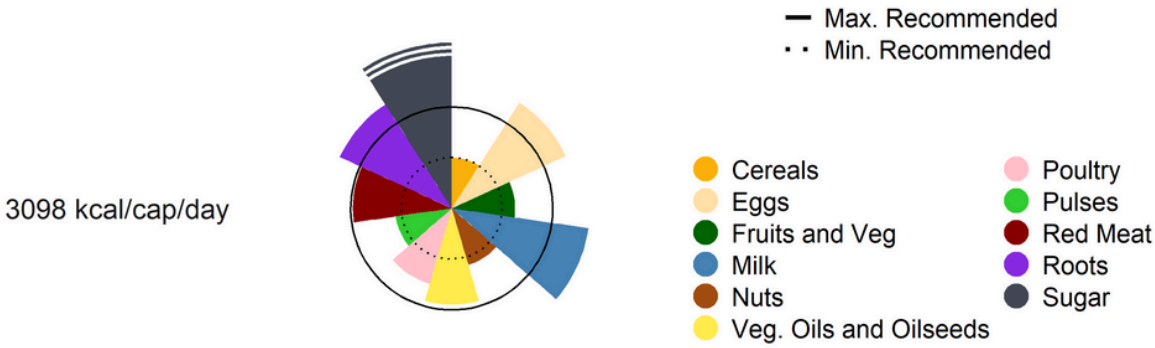


Figure 2. Daily average kilocalorie intake per capital per food category in 2020



National context

Germany

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.
2 ZERO HUNGER	Overweight/ obesity	Halt the rise in obesity among adults and reduce the prevalence of overweight and obesity among children and adolescents.
	Diet-related disease	Reduce the burden of non-communicable diseases, including obesity, diabetes, and cardiovascular disease.
	Other food related targets	Reduce the consumption of red meat, sugar, and animal fats by 15% by 2030 and substitute with plant-based calories (compared to 2018)
	Self sufficiency	Maintain the current level of self-sufficiency.
13 CLIMATE ACTION	Agriculture GHG emissions reduction	Keep annual emissions at or below 56 Mio. t CO2e until 2030 (a reduction of 36% by 2030).
	Land use and land use change GHG emissions reduction	Increase LULUC carbon uptake to 25 million tons CO2e by 2030 and 40 million tons in 2045.
	Total GHG emissions	Reduce emissions by at least 55% by 2030, compared to 1990 levels, and reach net-zero emissions by 2045.
15 LIFE ON LAND	Promote afforestation	Maintain current forest area - 1/3 of Germany.
	Reduce or halt the loss of natural ecosystems	No expansion of agricultural areas, but also no widespread abandonment.
	Expand protected areas or 'Other effective area-based conservation measures'	Minimum of 30% of terrestrial areas will be protected by 2030
	Expand cropland area under agroecological practices	Convert 30% of agricultural land to organic farming and agroecological practices by 2030.
	Reduce or halt use of agrochemicals and other agricultural practices that harm biodiversity	Reduce the use of pesticides by 50% until 2030 compared to 2016-2020.
14 LIFE BELOW WATER	Water related targets	Increase the energy efficiency of irrigation technology.
8 DECENT WORK AND ECONOMIC GROWTH	Agricultural exports	Reduce exports of beef, pork, and milk by 25% by 2050 compared to 2010.

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.

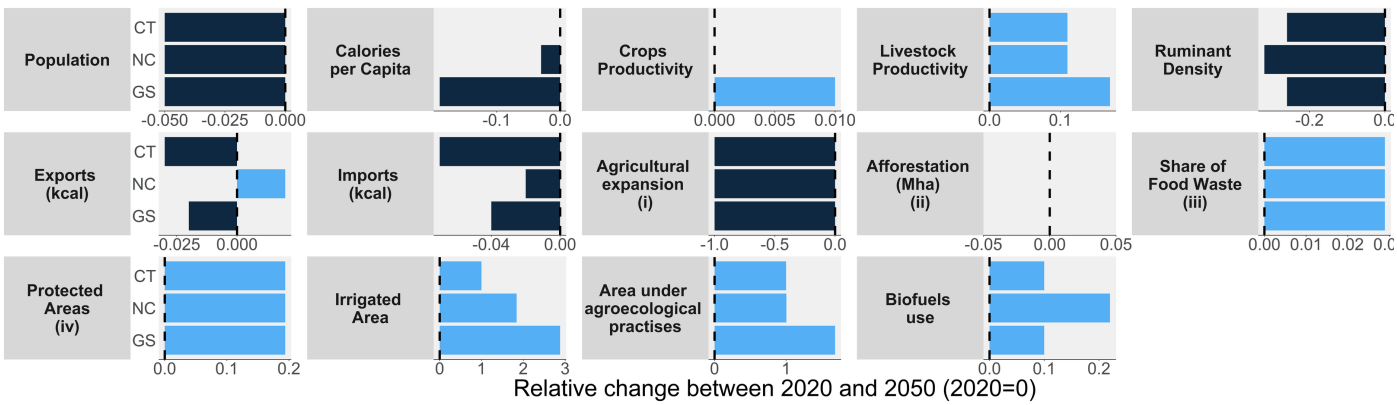
Pathway narratives

Current Trends: The current trends pathway depicts a business-as-usual scenario where current trends are continued, or values stay at the same level as 2015. No change is assumed for diets, imports, exports, share of protected areas, and share of agroecological practices. For a reduction in food waste, crop and livestock productivity, and ruminant density, a continuation of the currently observed trends is assumed.

National Commitments: The pathway depicts the plans pledged by the German government for the agricultural sector. The plans include an increase in organic agricultural area to 30% by 2030, a reduction of livestock density to 2 units per ha, a change in diet with a 15% reduction of sugar and red meat, a rapid 50% decrease in food waste until 2030, a reduction of soy imports and red meat and milk exports, an increase in protected areas to 50% by 2050, and zero biofuel demand by 2030. It is unclear if these plans align with national commitments to reduce GHG emissions.

Global Sustainability: It shows an ambitious change in policies and efforts is assumed, without some of the policies envisioned in the national pathway. The changes include a change in diets towards the EAT-Lancet planetary health diet, a 50% reduction of food waste by 2030, a reduction of soy imports and red meat and milk exports, an increase in protected areas to 50% by 2050, a higher than observed increase in crop and livestock productivity, and an increase in agricultural area under agroecological practices to 70% of the total agricultural area.

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

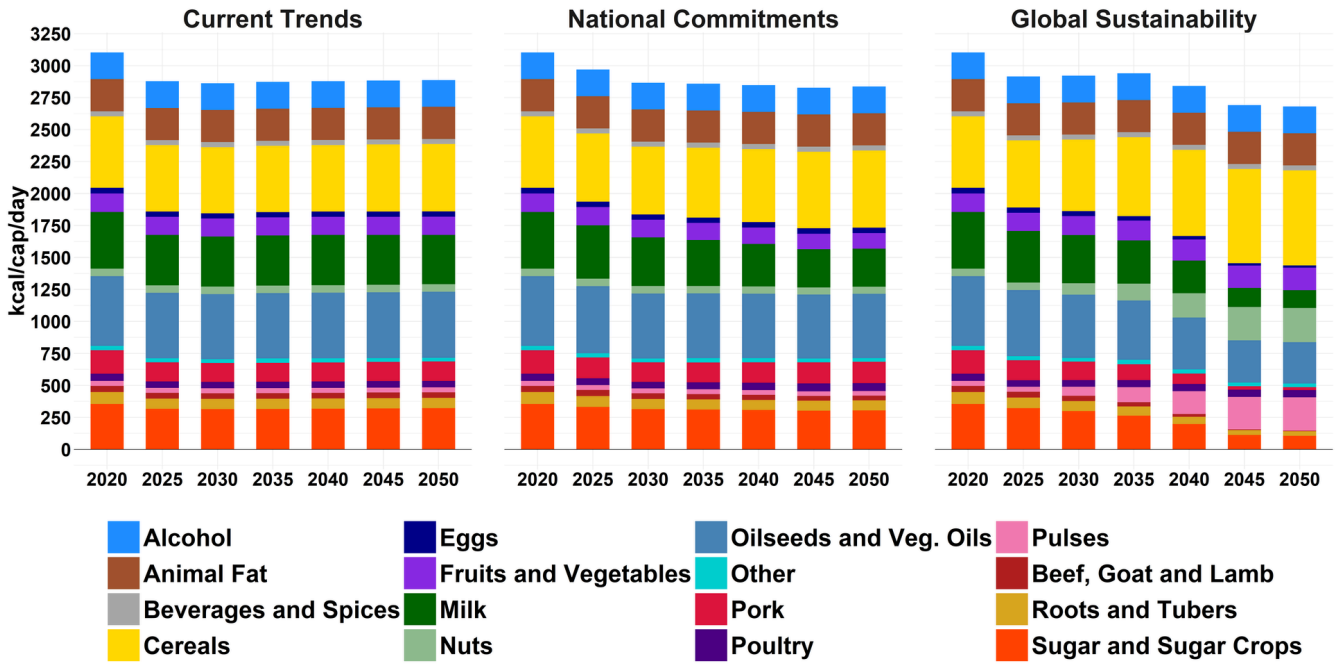


Figure 5. Comparison of the computed daily average kilocalorie intake per capital per food category across the three pathways and the prevalence of undernourishment in 2050

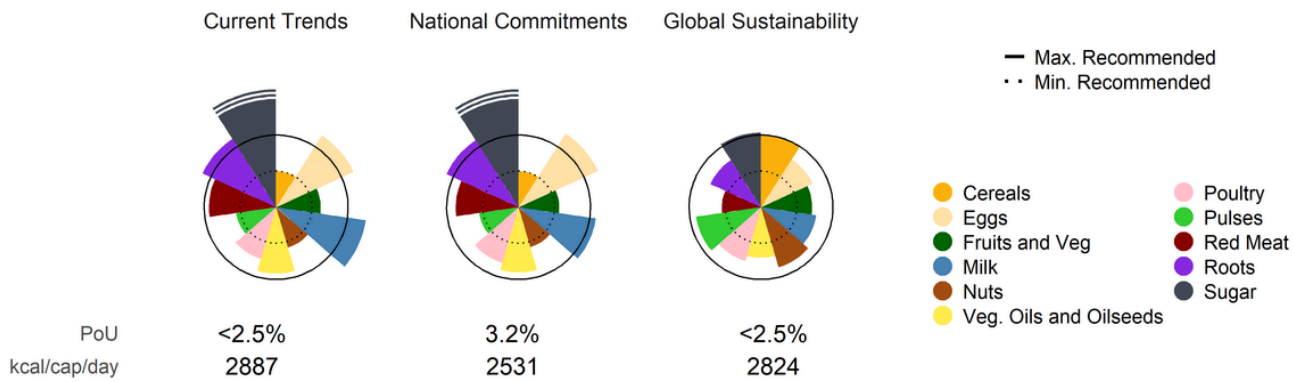


Figure 6. Evolution of land cover 2000-2050

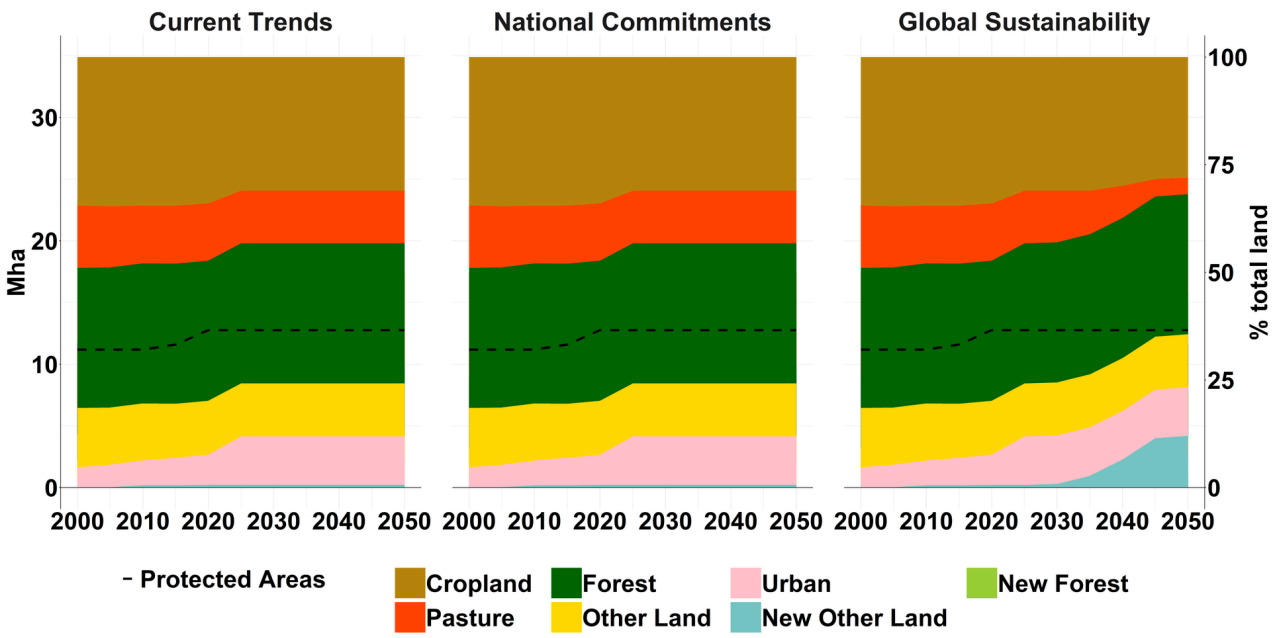


Figure 7. Evolution of the cropland composition 2000-2050

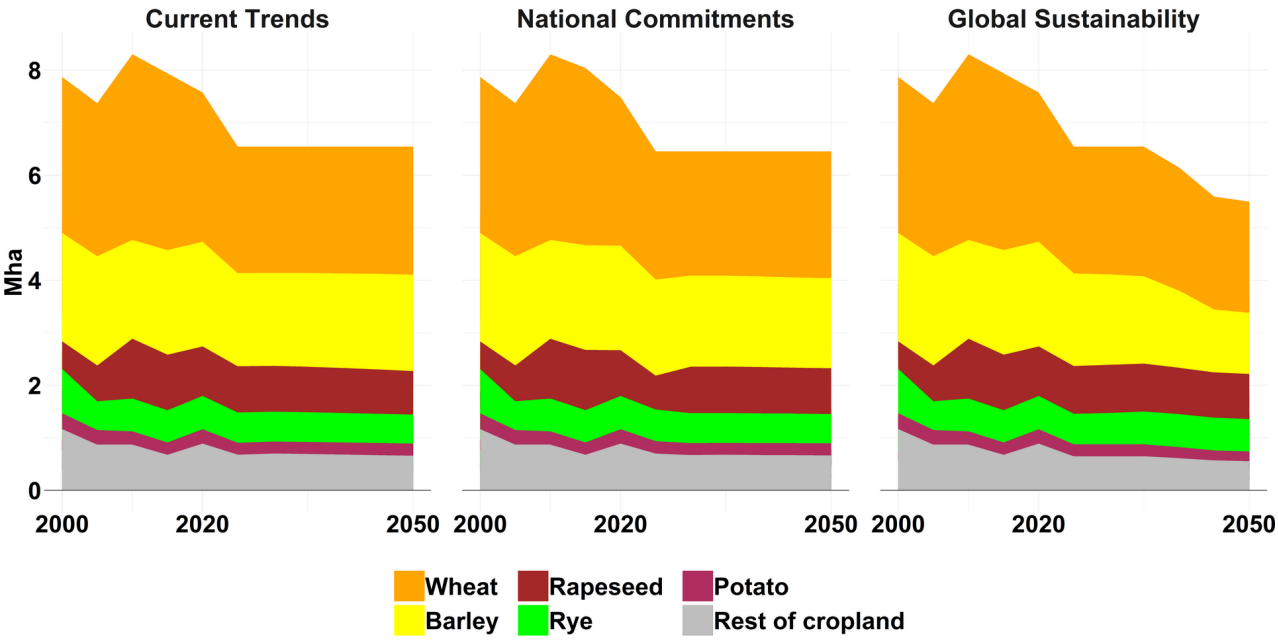


Figure 8. Projected AFOLU emissions and removals between 2020 and 2050 by main sources and sinks across pathways

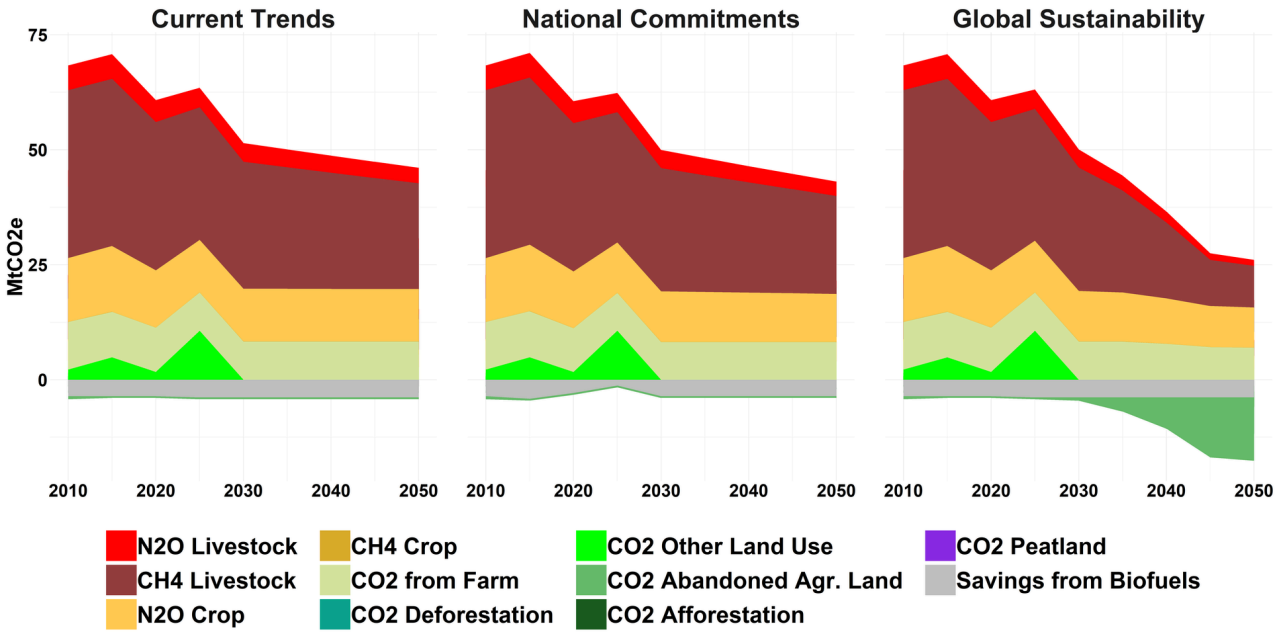
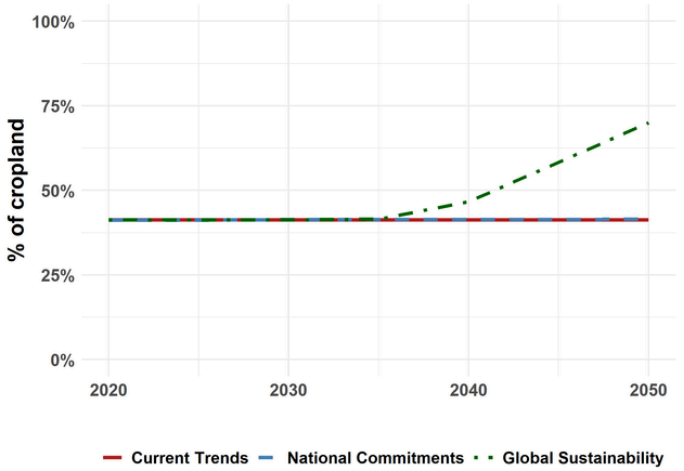


Figure 9. Share of cropland under agroecological practices



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)

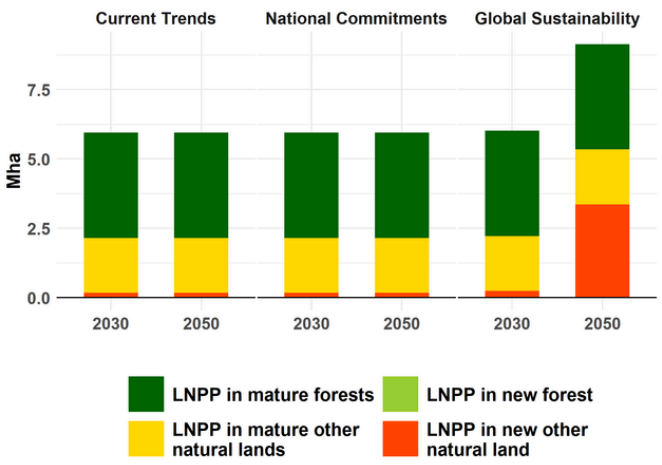


Figure 11. Nitrogen application

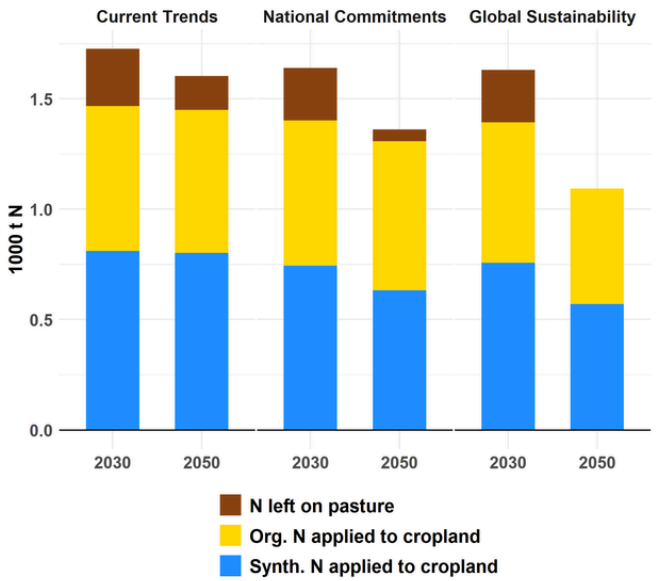
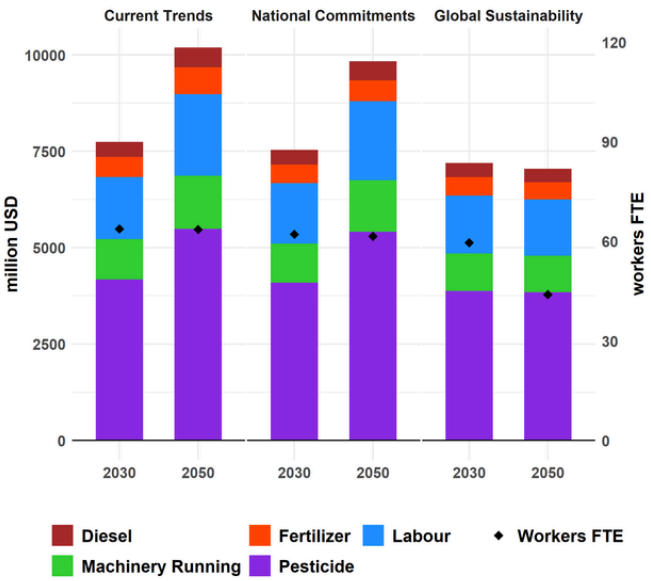


Figure 12. On-farm production costs



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	GDP variation 2020-2050: 1.5 (SSP2)	Same as CT	GDP variation 2020-2050: 1.6 (SSP1)	Publicly available projections based on socioeconomic change scenarios
	1.2) Population	79 million inhabitants in 2050 (UN medium scenario)	Same as CT	Same as CT	Publicly available projections based on socioeconomic change scenarios. Choice of scenario based on Statistisches Bundesamt.
	1.3) Inflation	Increase by 57% between 2020 and 2050	Same as CT	Same as CT	Due to a lack of other data, prices under inflation change are based on the average yearly CPI change in the 2000-2020 period
	1.4) Inequalities	-	-	-	-
2. Land	**2.1)** Constraints on agricultural expansion/deforestation	No productive land expansion beyond the 2010 value	Same as CT	Same as CT	Klimaschutzprogramm der Bundesregierung
	2.2) Afforestation, and forest plantations targets	No afforestation/ reforestation target	Same as CT	Same as CT	Germany's afforestation goals focus on other countries Klimaschutzprogramm der Bundesregierung
	2.3) Urban and settlements area	The urban share of total population increases from 81% in 2020 to 90% in 2050	Same as CT	Same as CT	Publicly available projections based on socioeconomic change scenarios (SSP (IIASA), UN-ESA (2017))
	2.4) Protected areas	No expansion of protected areas beyond the current approx. 25%	Global Biodiversity Convention (min 30% by 2030)	Global Biodiversity Convention (min 30% by 2030)	BMZ. The core area of German development policy.
3. Productivity and management	**3.1)** Crop productivity for the key crops	Between 2020 and 2050, crop productivity decreases from 8.7 to 8.3 t/ha for maize and from 7.2 to 6.9 t/ha for wheat, stays constant at 40 t/ha	Same as CT	Between 2020 and 2050, crop productivity increases from 8.7 to 10.6 t/ha for maize, from 40 to 76 t/ha for potato, from 3.9 to 5.9 t/ha for rape,	Based on extrapolations of historic growth; growth assumption is more conservative for Current Trends and National Commitments pathways, and more optimistic for Global Sustainability.

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
		for potato, and increases from 65 to 73 t/ha for sugar beet and 3.9 to 5.1 t/ha for rape		from 65 to 86.6 t/ha for sugar beet, and decreases from 7.2 to 7.1 t/ha for wheat	
	3.2) Cropland under agroecological practices	No expansion of cropland under agroecological practices beyond the current share	30% of total cropland under agroecological practices by 2030	70% of total cropland under agroecological practices by 2030	Coalition agreement between SPD, Bündnis 90/Die Grünen and FDP
	3.3) Livestock productivity for the key livestock products	Between 2020 and 2050, the productivity per head increases from 0.1 to 0.15 t/head for beef cattle, from 7.4 to 9.4 t/head for dairy cattle, and from 0.9 to 1.5 t/head for pigs	Same as CT	Between 2020 and 2050, the productivity per head increases from 0.1 to 0.19 t/head for beef cattle, from 7.4 to 12.2 t/head for dairy cattle, and from 0.9 to 1.9 t/head for pigs	Based on extrapolations of historic growth; growth assumption is more conservative for Current Trends and National Commitments pathways, and more optimistic for Global Sustainability.
	3.4) Pasture stocking rate	A decline from 2.5 animal units per ha pasture to 2.3 between 2010 and 2050	A decline from 2.5 animal units per ha pasture to 2.0 between 2010 and 2050	Same as CT	National pathway: There is a tentative plan by the government and environmental organizations to enforce the organic farm maximum stocking rate on conventional farms.
	3.5) Forest management	-	-	-	-
4. Trade	**4.1)** Share of consumption which is imported for key imported products (%)	Constant import shares	Import share of soy cake reduced by 50% by 2050 compared to 2010	Import share of soy cake reduced by 50% by 2050 compared to 2010	Following a more sustainable diet, as outlined in the National Reduction and Innovation Strategy for Sugar, Fats, and Salt in Processed Foods, there may be changes in the production and key imports/exports of certain food products. Imports of soybeans may increase, even though they are already at a high level (100% import). This increase could be due to the shift towards a more sustainable diet. Conversely, imports of soy cake may decrease because of reduced demand. This is based on the assumption that even though there is a small amount of locally produced

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
					soy, including soy cake as a byproduct, demand reductions are likely to affect imports.
	4.2) Evolution of exports for key exported products (1000 tons)	Constant exports	Exports targets of beef, pork, and milk reduced by 25% by 2050 compared to 2010	Exports targets of beef, pork, and milk reduced by 25% by 2050 compared to 2010	For exports, we assume global shifts towards more sustainable diets and local production of animal products. Consequently, we assume that milk, pork, and beef exports will decrease by 25%.
5. Food	**5.1)** Average dietary composition	By 2050, the average daily calorie consumption per capita will be 3,193 kcal and composed of 25% cereals, 9% dairy, 10% red meat, 3% other meat, 21% oil and fat, 12% sugar, 5% fruits and vegetables, 0.4% pulses, 2% nuts, 3% roots and tubers	By 2050, the average daily calorie consumption per capita will be 3,193 kcal and composed of 25% cereals, 9% dairy, 8% red meat, 4% other meat, 23% oil and fat, 10% sugar, 5% fruits, and vegetables, 0.5% pulses, 2% nuts, 3% roots and tubers	By 2050, the average daily calorie consumption per capita will be 2,348 kcal and composed of 29% cereals, 5% dairy, 1% red meat, 4% other meat, 16% oil and fat, 4% sugar, 7% fruits and vegetables, 10% pulses, 10% nuts, 1% roots and tubers	The National Reduction and Innovation Strategy for Sugar, Fats, and Salt in Processed Foods
	5.2) Share of food consumption which is wasted at household level	Reduces by 50% by 2050 compared to 2010	Reduces by 50% by 2030 compared to 2010	Reduces by 50% by 2030 compared to 2010	National Food Waste Reduction Strategy
6. Biofuels	**6.1)** Targets on biofuel and/or other bioenergy use	Biofuel demand accounts for 53% of total rape production and 3% of total wheat production by 2025	No crops will be used for biofuel after 2030	Same as CT	National pathway: in January 2023 the Federal Minister of Agriculture proposed a tentative plan to reduce the share of biofuel to 0% by 2030.
	6.2) Targets on other non-food use	-	-	-	-

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
7. Water	**7.1)** Irrigated crop area	No increase	Increase by 2% between 2020 and 2050	Increase by 5% between 2020 and 2050	We were not able to find quantitative projections. Qualitative statements indicate that more farmers aspire to irrigate their lands but may not get water rights due to water shortages in some regions. Rising irrigation costs expected in 2024 may reduce profitability. The prognosis is that the irrigated areas will increase at a slower pace, compared to previous years, only in a few Bundesländer. We used conservative values accordingly. Sources: Erträge sichern im Klimawandel: Landwirte haben stärker investiert. Agrarheute. / Kosten für Bewässerung in Landwirtschaft steigen. Proplanta. / Zur Zukunft der Bewässerung – Grundsatzbeitrag. Landwirtschaftskammer Niedersachsen.