

2023 Scenathon results

Pathways for food and land-use systems in Norway



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

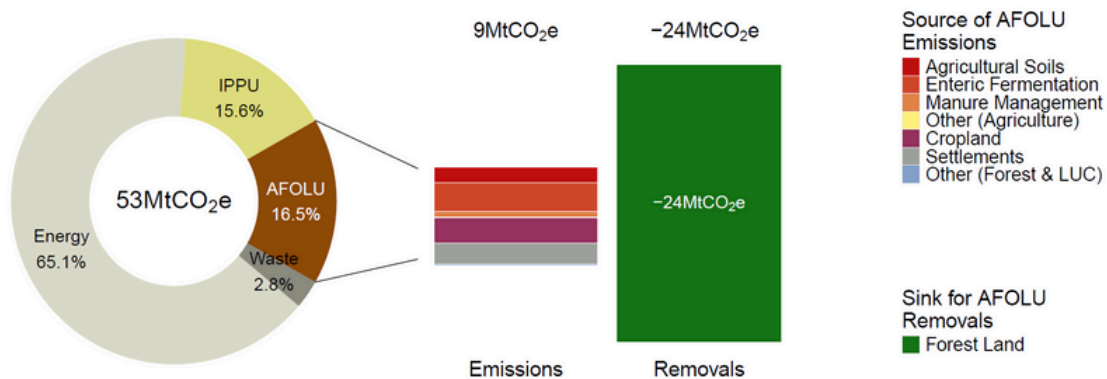
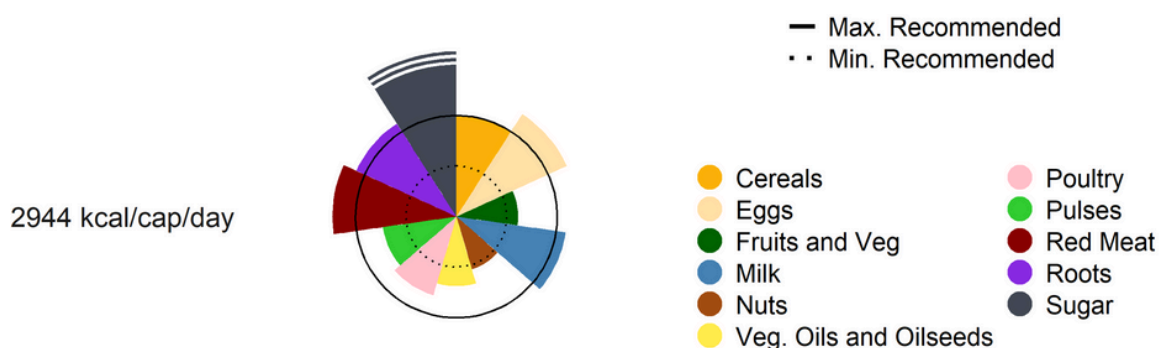








Figure 2. Daily average kilocalorie intake per capital per food category in 2020



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	Diet-related diseases	Reduce red meat (from 800 g/week (raw) to 350 g/week (prepared)) and dairy from 880 g/day to 350-500 g/day), increase fish intake from 30 g/day (raw) to 42-64 g/day (prepared), and fruit and vegetables from 300 to 500-800 g/day.
	Other food-related targets	Reduce food waste by 25% by 2025 and by 50% by <u>2030</u>
	Self-sufficiency	Increase self-sufficiency from 40% to <u>50%</u> & 75% consumption of nationally produced fruits <u>and</u> <u>vegetables</u>
 13 CLIMATE ACTION	Total GHG emissions reduction	Reduce GHG emissions by 55% by 2030 compared to 1990, and 90-95% by 2050. Climate neutrality by <u>2030</u> and become a low-emission society by <u>2050</u> .
	Agriculture GHG emissions reduction	Reduce GHG emissions by 5 Mt CO ₂ -eq over a 10-year period <u>2021-2030</u>
	Land use and land use change GHG emissions reduction	A ban on wetland conversion, increased use of capture crops, and use of biochar is estimated to reduce food production linked emissions by up to 1,375 Mt CO ₂ e by <u>2030</u> .
 15 LIFE ON LAND	Promote afforestation	Redirect harmful subsidies for building roads and logging in forest <u>areas</u> , albeit deforestation rates being <u>low</u> (assumption)
	Expand protected areas or 'Other effective area-based conservation measures'	30% protection and restoration of land and marine areas by <u>2030</u>
	Expand cropland area under agroecological practices	New strategy (2018-2030) is to stimulate organic production in line with <u>demand</u> .

SDG	Indicator	National Target
 15 LIFE ON LAND	Other biodiversity related targets	<ul style="list-style-type: none"> No species and habitat types shall be eradicated & improvement of the protection of threatened and near-threatened species and habitat types. A representative selection of Norwegian nature must be preserved for future <u>generations</u>
	Limit nitrogen use	Livestock manure must not exceed 17 kg of total nitrogen per <u>acre</u>
	Limit phosphorus use	A phosphorus limit of initially 3.0 kg of phosphorus per hectare per year, and then 2.1 kg of phosphorus per hectare per <u>year</u>
 14 LIFE BELOW WATER	Other than limit water use	Achieve good qualitative and quantitative status of all water bodies (including marine waters up to one nautical mile from <u>shore</u>)
 8 DECENT WORK AND ECONOMIC GROWTH	Farmers' income	Close the income gap for farmers

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.

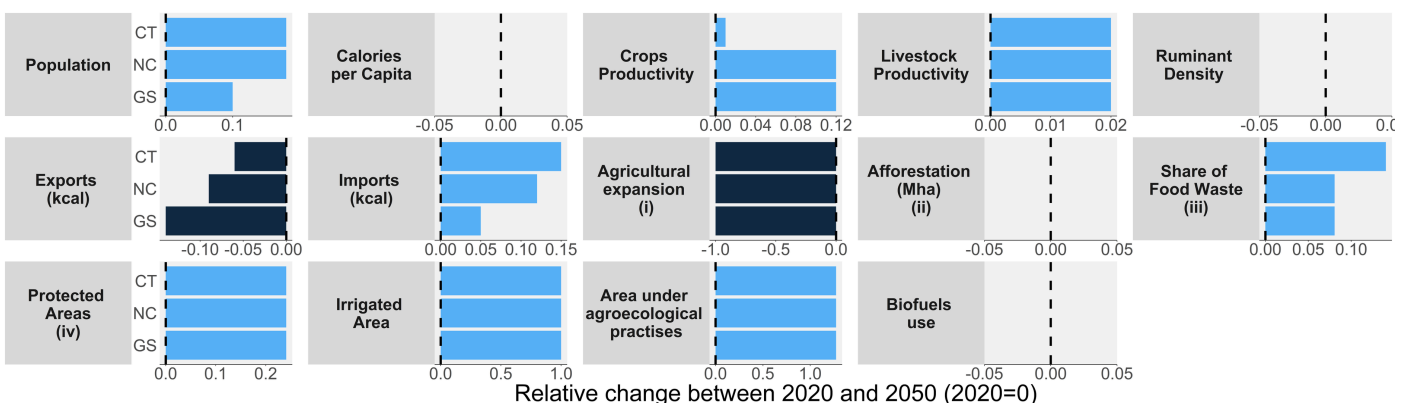
Pathway narratives

Current Trends: The OECD Environmental Performance Review of [2022](#) says that Norway has made progress towards green growth over the past decade. They highlight the heavy investments in technological investments and innovation to support the green transition. They also mention the widespread use of renewables, the electric vehicle adoption and the effort towards decarbonizing all transport sectors. However, they also point out areas for improvement and the multiple challenges faced by the country such as sustainable consumption patterns and biodiversity protection. In general, Norway has ambitious targets and commitments regarding the environment, but the actions and policies needed to meet these goals are not always in place or not in place yet.

National Commitments: The OECD Environmental Performance Review of 2022 says that Norway has made progress towards green growth over the past decade. They highlight the heavy investments in technological investments and innovation to support the green transition. They also mention the widespread use of renewables, the electric vehicle adoption and the effort towards decarbonizing all transport sectors. However, they also point out areas for improvement and the multiple challenges faced by the country such as sustainable consumption patterns and biodiversity protection. In general, Norway has ambitious targets and commitments regarding the environment, but the actions and policies needed to meet these goals are not always in place or not in place yet.

Global Sustainability: As Norway is one the countries with the most ambitious targets, the global sustainability scenario is very similar to the scenario “B) national commitments”.

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

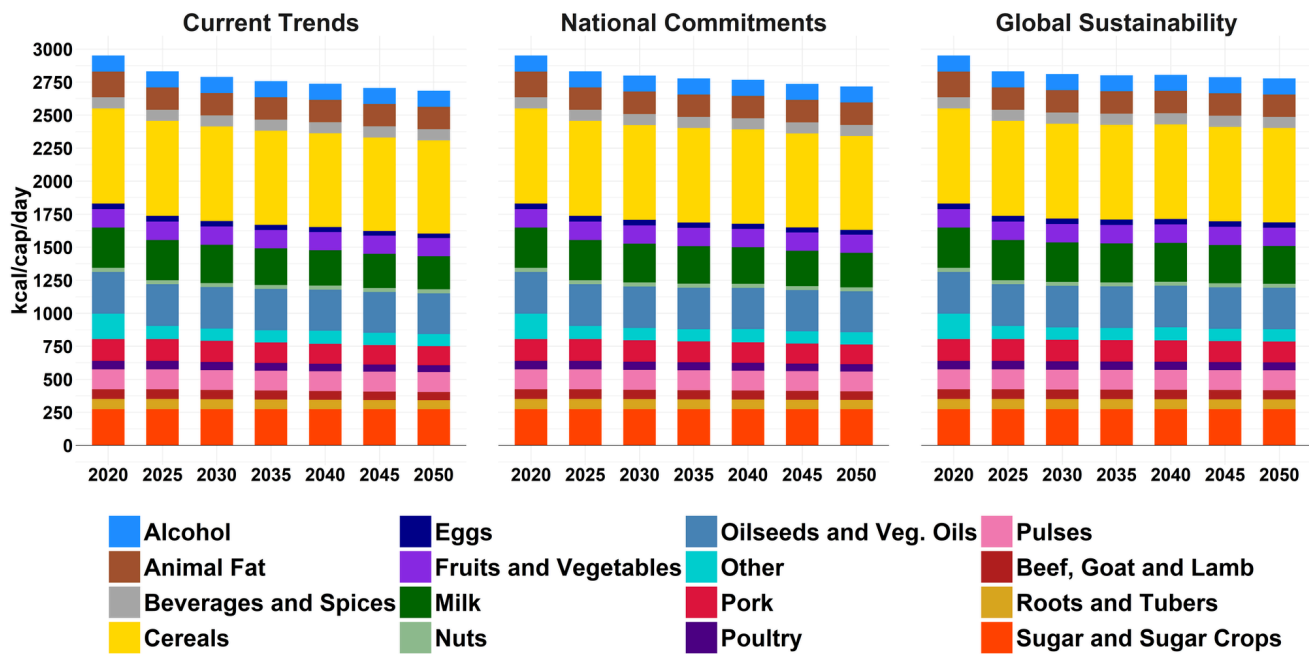


Figure 5. Comparison of the computed daily average kilocalorie intake per capital per food category across the three pathways and the prevalence of undernourishment in 2050

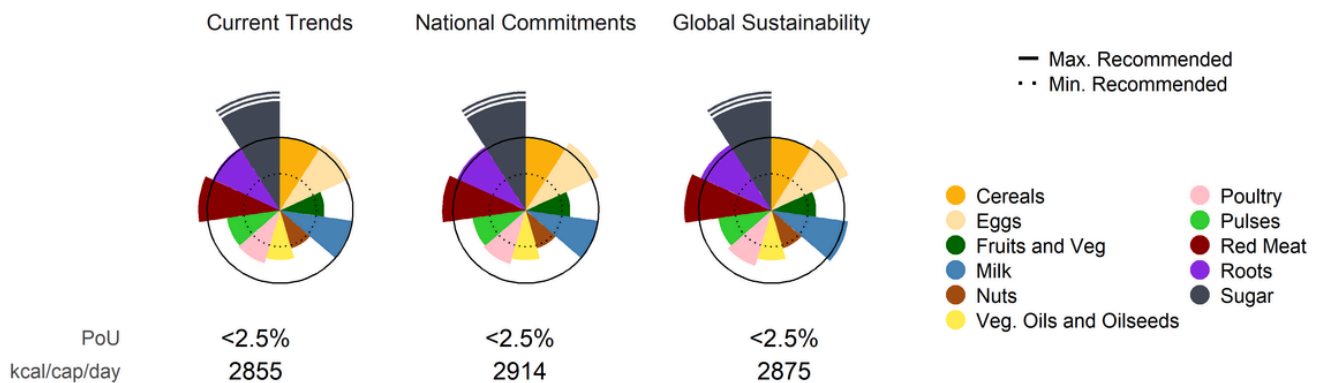


Figure 6. Evolution of land cover 2000-2050

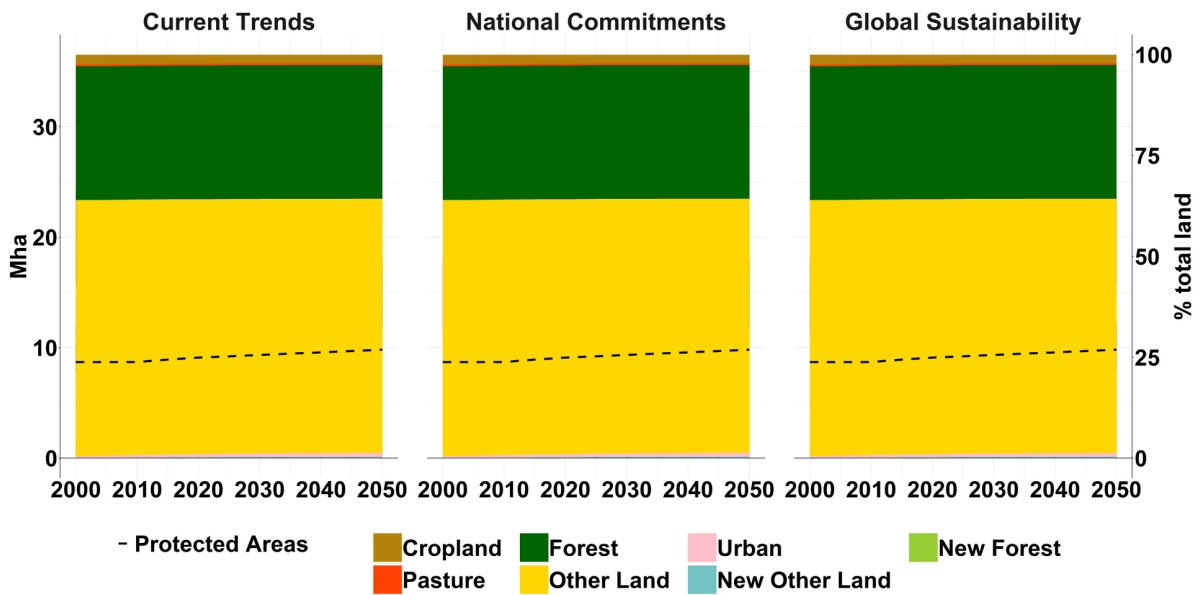


Figure 7. Evolution of the cropland composition 2000-2050

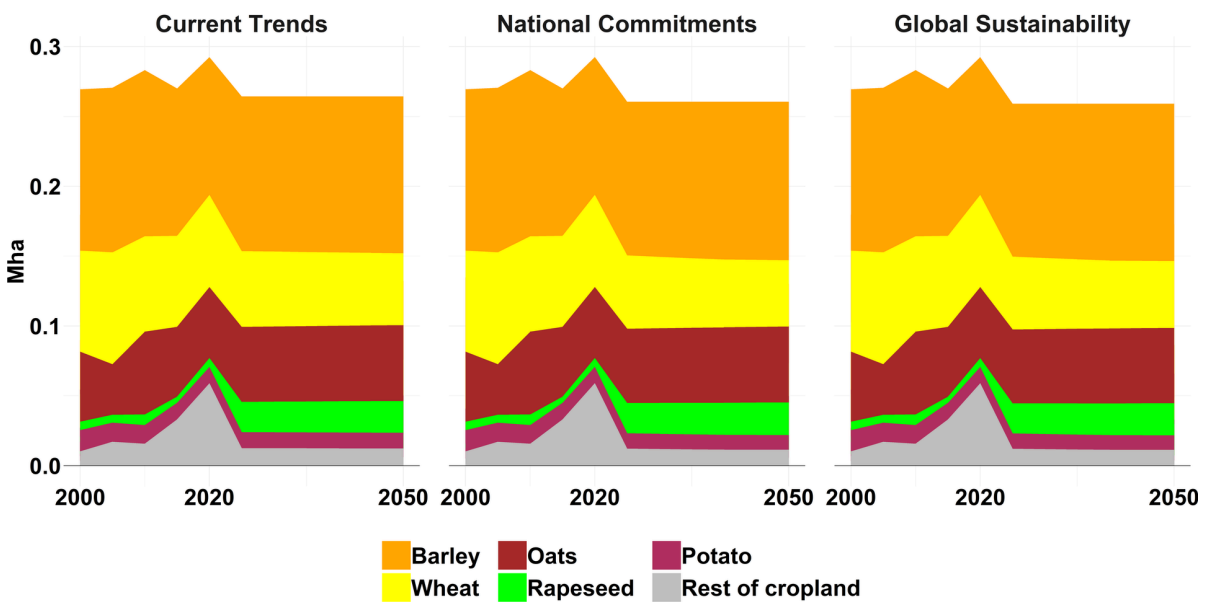


Figure 8. Projected AFOLU emissions and removals between 2020 and 2050 by main sources and sinks across pathways

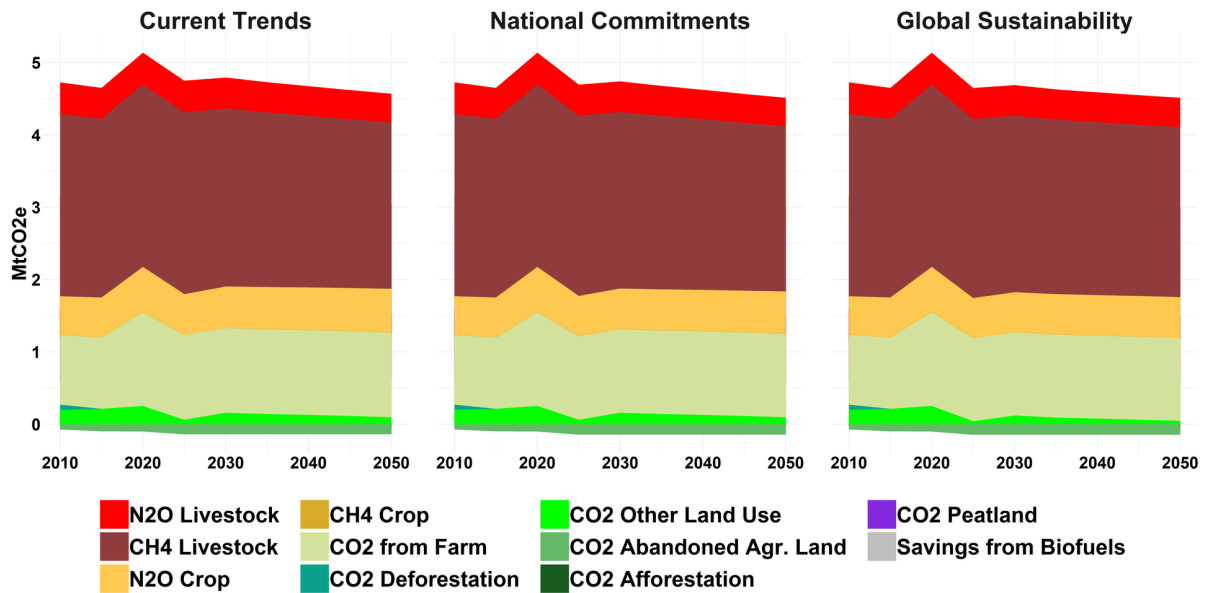


Figure 9. Share of cropland under agroecological practices

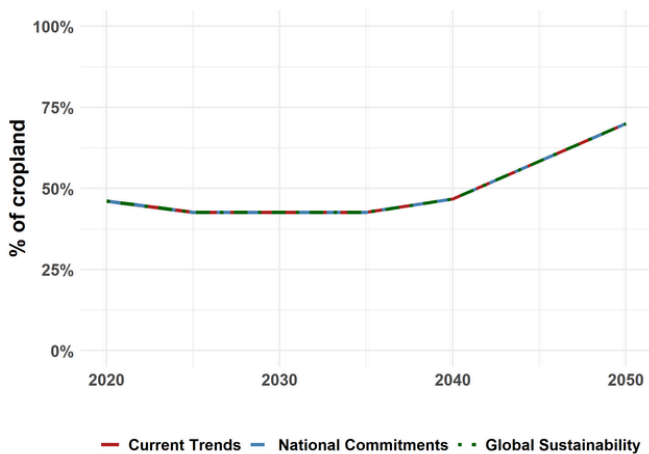


Figure 10. Total area of land where natural processes predominate (LNPP)

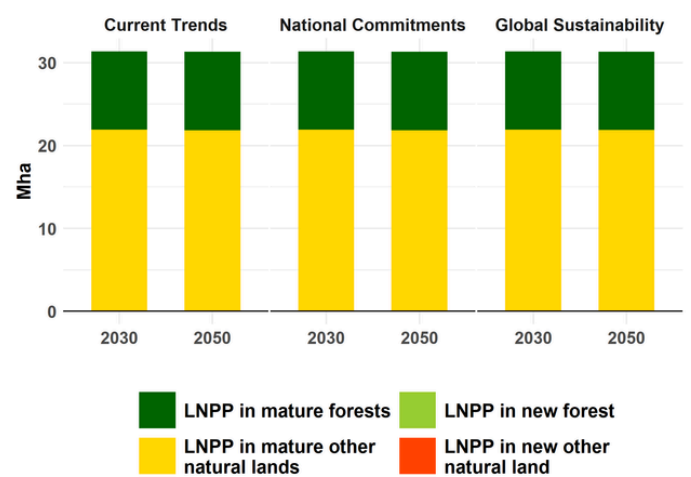


Figure 11. Nitrogen application

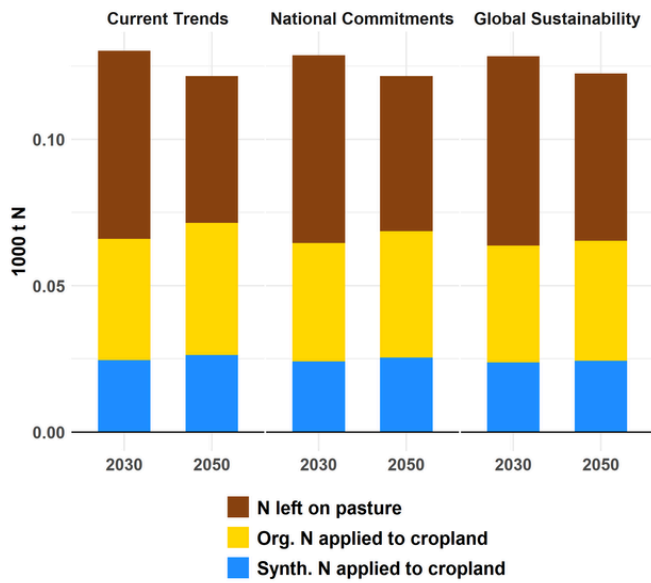
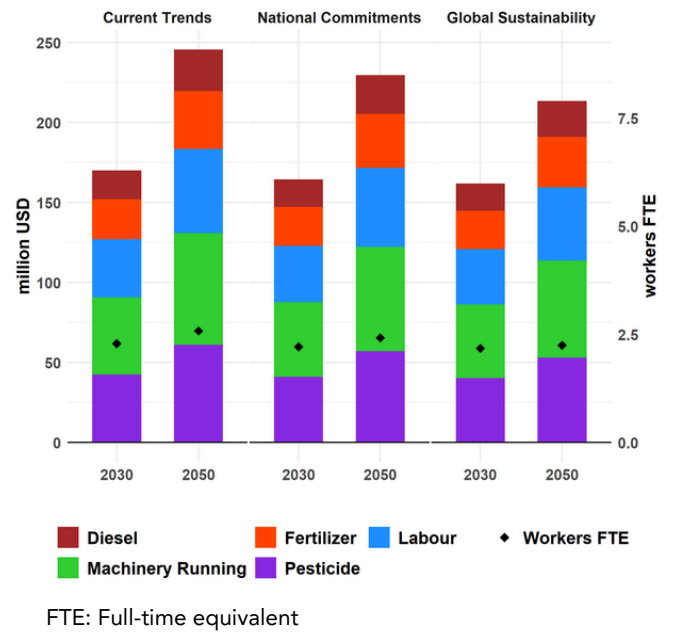


Figure 12. On-farm production costs



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	SSP2	SSP1	SSP1	
	1.2) Population	SSP2	SSP1	SSP1	
	1.3) Inflation	SSP2	SSP1	SSP1	
	1.4) Inequalities	SSP2	SSP1	SSP1	
2. Land	2.1) Constraints on agricultural expansion/deforestation	We assume no expansion of agricultural land beyond 2010 agricultural area levels. Agricultural land could expand into new areas, but largely this is constrained to areas on peat soils, and there are specific policies accepted and detailed to prevent this.	Same as A)	Same as A)	Statistics Norway - Area data The National Forest Assessment: Volume data
	2.2) Afforestation, and forest plantations targets	We do not expect afforestation/reforestation. The total forest area has not changed very much since 2007 (UNFCCC, 2020b) and we expect this trend to continue. From 2007, growth in standing cubic biomass has been reduced annually indicating that forest is reaching maturity.	Same as A)	Same as A)	National Inventory Submissions 2020. UNFCCC, 2020b SSB table 06288 SSB table 06289
	2.3) Urban and settlements area	Current trend (2011-2023): small increase in building areas for homes, cabins, and services (from 1.8 to 2.2% from 1990 to 2020) - Here we assume that this trend will continue as it is now, a small increase over time.	Attention to cabin areas, with the aim of slowing growth in these. Here we will assume a continued but reduced growth over time going towards an asymptotic but not reaching	Same as B)	Statistikkbanken Instructions for using Statbank - Land use and land cover Measure analysis for the forest and land use sector (LULUCF)

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
		Otherwise, densification in urban areas	zero. There is no fixed target for this, but a guestimate is a gradual decrease in growth down to 1% in 2040/2050 Otherwise, densification in slowly growing urban areas		
	2.4) Protected areas	Protected areas remain stable: by 2050 they represent 15% of the total land area. Recent findings show that while Norway is getting closer to the goal of protecting a representative share of Norwegian nature, a considerable number of threatened species are located outside protected areas in populated areas.	Following the Montreal-Kunming agreement 30% protection and 30% restoration by 2030 of combined marine and land areas.	Same as B)	Kunming-Montreal Global Biodiversity Framework Miljødirektoratet, 2We assume 020
3. Productivity and management	3.1) Crop productivity for the key crops	Apart from changes driven by the climate change scenario, no changes were made to crop productivity in Norway in the FABLE Calculator. Because the climate change scenarios did not include yields for the top three crops in Norway (barley, oats, and potatoes), the yields of these three are therefore the same in 2050 as in 2010. NOTE: Yields are highly dependent on weather - e.g., drought in summer, and heavy precipitation in autumn. That goes both for food crops and feed crops, with repercussions for meat production (e.g., early slaughter).	Same as A), but with slow increase in fruit and veg productivity, slowly closing yield gap in grain production. Crop production: increase in 75% of fruit and vegetable production from “3.5 to 5 per day”. The Norwegian share in fruit/veg production and consumption be increased by 50%	Same as A)	Statistics Norway - Data on grains Statistics Norway - Data on Fruit, veg Vegetable sector toward 2035 Yield gap change

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
	3.2) Cropland under agroecological practices	Stable around 5%. The national target for 15% organic produce by 2020 was abandoned.	The new strategy (2018-2030) is to stimulate organic production in line with demand. As no numerical target is available, we assume a small increase between BAU and the EU green deal target: a slow increase in organic production, to 10% in 2050.	Assume the EU Green Deal target of 25% of agricultural land under organic farming by 2030.	Statistics Norway - SSB
	3.3) Livestock productivity for the key livestock products	<p>Productivity for all meat (beef, pork, chicken, lamb: 15-20%), milk (30%) and eggs (34%) has increased since 1990 per animal. There are biological and technological limits to a linear continued increase.</p> <ul style="list-style-type: none"> - Milk is assumed to have reached a limit - Beef: 0.6% increase per year - Pork meat: 0.4% increase per year - Lamb meat: increase by 0.1% per year - Chicken meat: stable <p>Eggs: increase by 0.1% per year</p>	<p>Between 2021-2030, Norway has committed to reduce emissions from agriculture (mostly livestock) by 5 Mt, mostly through improved animal production (including methane blockers, better feed, fertilizer management, animal welfare), and without changes in animal numbers. Planned emission reductions over the 10-year period in agriculture itself are 2.6 Mt in total (around 6% down from 2021 level).</p> <p>For the period 2030-2050 there is no plan, but national climate commitments require the agricultural sector to approximately half its emissions by 2050 compared to 1990 – a task which is not possible without strong reductions in</p>	Same as B), and following Nordic Dietary Health recommendations, with reduced livestock production, extensification, and increased food grain and vegetable production.	<p>Statistics Norway - Data on animals Statistics Norway - Data on Meat: Landbruksdirektoratet- Data on eggs/milk</p> <p>Statistics Norway - The National Forest Assessment</p> <p>Farmers union climate agreement and climate plan (2021-2030)</p> <p>Norwegian Climate law and climate politics</p>

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
			livestock. We assume productivity remains stable.		
	3.4) Pasture stocking rate	By 2050, the average ruminant livestock stocking density is 5.82 TLU/ha.	Same as A), but with increased pasture use over larger area (extensive pastures, alpine meadows)	Extensification with a reduction in livestock, reduced stocking rate. Guestimate 3 TLU/ha	Uncertain - many farmers rent area in addition to owning - number of animals outside varies per season. Government Hurdal platform commits to increased extensive pasture use Consequences of New dietary guidelines for area, livestock, food production and climate
	3.5) Forest management	Productive forest area has increased since 1996, stable since 2007. Standing cubic mass increasing since 1990, annual growth rate stabilized since 2004. Assume stable standing biomass onward, with increased disturbances.	Same as A)	Uncertain. It comes back to the issue of grass vs forest. Forest has larger total (above+below ground) carbon, but lower albedo, and different species composition.	Landsskogtakseringen (ssb.no)
4.Trade	4.1) Share of consumption which is imported for key imported products (%)	Import agr. products are about 20% larger than exports, and total import and export has increased over time. Norway is mostly (90%) self-sufficient for animal products, around 75% for potatoes, 40% for grains and vegetables, and 10% for fruits. These numbers vary a bit between years. BAU assumes continuation accordingly	Increase (feed corrected) self-sufficiency from 40% to 50% (Hurdalsplattform) - see also 3.1	Reduce imports, increase national plant-based food production and production of feed, and reduce livestock.	Hurdalsplattform Resourcetrade.earth

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
	4.2) Evolution of exports for key exported products (1000 tons)	Increased from 2 Mt to 2.8 Mt for fish and seafood from 2000 to 2020, and from around 150 kt to around 300 kt for soybeans. In BAU we assume a continued increase with the same growth rate.	Decrease soy import (and export) (value unknown), increased self-sufficiency (40 to 50%)	Same as B)	FAO – Food balances
5. Food	5.1) Average dietary composition	Current average daily per capita calorie consumption = 2838 kcal (Hdir) 28% grains, 20% dairy, 13% meat, 1% eggs, 2% fish and seafood, 9% sugar, 7% oil and fats, 6% fruits and vegetables, 4% potatoes, 3% nuts and seeds, 7% rest (beverages, misc.). BAU assumes stabilization.	We assume Norway will follow the New Nordic Dietary Health recommendations: Reduce red meat (from 800 g/week to 350 g/week), dairy (from 880 g to 250-500 g/day), reduce alcohol, increase fish intake from 30 g/day to 42-64 g/day, and fruit and vegetables from 300 to 500-800 g/day by 2030.	We assume Norway will follow the New Nordic Dietary Environmental recommendations: Same as B) but reduce red meat to 200 g/week, and dairy to lower end of dairy range (250-500 g/day) intake.	Health directorate report (Hdir): Energy composition diet > 23,6 1000 TJ / 5442000 population = 1036036 kJ/person/year = 2838 kcal/person/day New Nordic Nutritional Recommendations (NNR22) for health and environment
	5.2) Share of food consumption which is wasted at household level	Around 48% of total food waste happens at consumption level. BAU assumes continuation of this same level.	20% reduction in 2020 compared to 2015 (failed, reached 15% in 2020) 30% reduction in 2025 compared to 2015 50% reduction in 2030 compared to 2015.	20% reduction in 2020 compared to 2015 30% reduction in 2025 compared to 2015 50% reduction in 2030 compared to 2015	FAO – Food balances Matvett – about food waste National calculation of the amount of food waste at the consumer level
6. Biofuels	6.1) Targets on biofuel and/or other bioenergy use	By 2050, biofuel production from rape oil increases by 8% compared to 2010. Norway has a plan to increase the share of biofuels – biodiesel and bioethanol – in fossil fuels, where the main policy tool is a mixing requirement for dealers. From 2023	Same as in A) By 2050, biofuel production from rape oil increases by 8% compared to 2010.	Same as in A) By 2050, biofuel production from rape oil increases by 8% compared to 2010.	Statistics Norway - Production and consumption of energy, energy balance and energy accounting Biofuel plans (Environmental Agency)

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
		the requirement is 17 % biofuels of which 12.5 % should be advanced biofuels (i. e. based on waste products, not crops). Currently, 75% of biofuel is advanced. The mixing requirement for aviation is 0.5% biofuels. The government has proposed a 6% biofuel mixing requirement for the maritime sector from autumn 2023.			National Regulations on restrictions on the use of chemicals and other products hazardous to health and the environment (the product regulations) https://blogg.sintef.no/sintefenergy-nb/status-biodrivstoff-2022/
	6.2) Targets on other non-food use	-	-	-	-
7. Water	7.1) Irrigated crop area	<p>The number of holdings with irrigation has decreased from 2000 to 2020 from around 14.5% to 12.6% (as proportion of holdings with crop production). The area with irrigation is limited to these holdings, and the area that can be irrigated in 2020 has decreased by 37% (as proportion of 2000 area)</p> <p>In BAU we assume this to be further reduced over time following the same trend.</p>	<p>Recent droughts have sparked discussions around adaptation and irrigation needs. The government recognizes the issue, but there is little commitment for increased support for this.</p> <p>Assumption: slow increase in climate adaptation support (irrigation and drainage) towards 2050.</p>	Same as in B)	Holdings and area with irrigation Holdings cultivating various crops and average area, by size of agricultural area in use Agriculture and Food Minister- Answers to written questions about drought preparedness