2023 Scenathon results

Pathways for food and land-use systems in Finland

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 Finland were developed by Heikki Lehtonen (Natural Resources Institute Finland - heikki.lehtonen@luke.fi), and Janne Rämö (Natural Resources Institute Finland)

Recommended citation
Lehtonen, H., and Rämö, J.(2024). FABLE Scenathon 2023 Pathways for food and land-use systems in Finland. Paris: Sustainable Development Solutions Network (SDSN). 10.5281/zenodo.11547103

National context

Finland

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 supports the remaining SDGs, underscoring its crucial role in fostering a sustainable future.

This document presents 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. Together with our modelling tools and methods, these results 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

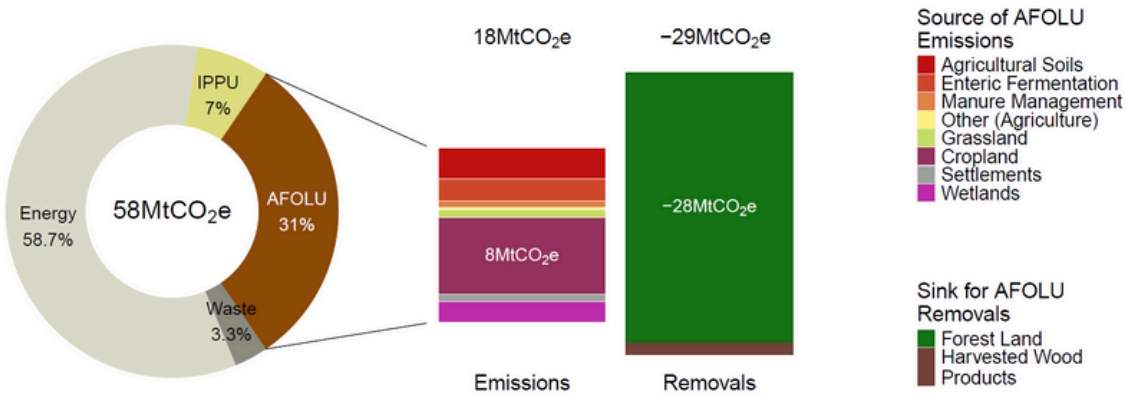
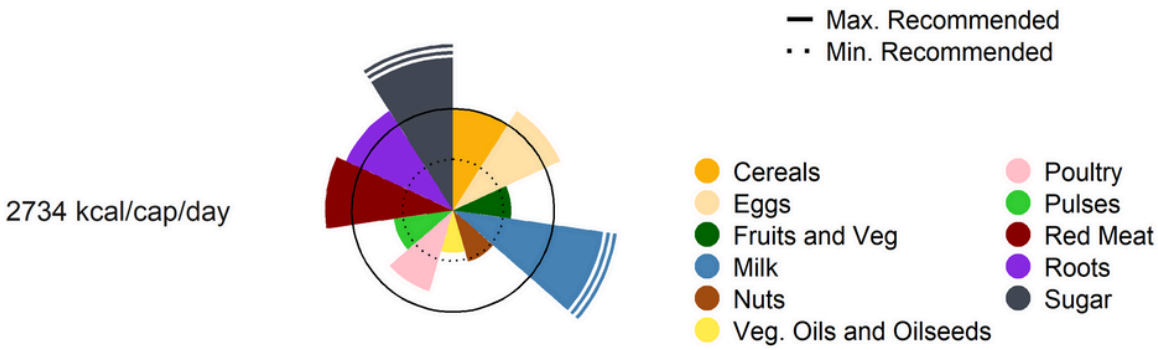


Figure 2. Daily average kilocalorie intake per capital per food category in 2020



National context

Finland

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-relared diseases	decreasing consumption of meat by 30% and dairy products by 20% and increasing consumption of fish and legumes.
	Overweight / obesity	Reduce the number of obese people by 1/3 by 2050
	Self-sufficiency	Maintain self-sufficiency in agricultural commodities produced in Finland
13 CLIMATE ACTION	Total GHG emissions reduction	Finland is climate neutral by 2035. No separate reduction targets per gas.
	Agriculture GHG emissions reduction	29% reduction in total agricultural GHGs (CO2, N2O, CH4; from "agricultural sector", LULUCF, agricultural land use); and CO2 from energy use in agriculture) between the period 2019-2035
	Land use and land use change GHG emissions reduction	MISU climate plan sets 3 Mt CO2 eq. reduction target on GHG emissions from LULUCF sector (irrespective of C sinks) 2020-2035, using additional measures
	Reduce or halt deforestation	Halt deforestation, e.g. by making farmland cleared from forest non-eligible to CAP (pillar 2, payments).
	Other climate mitigation related targets	Non-increasing imports of food and agricultural commodities as a whole, though imports and exports of some food items and agricultural commodities might increase
15 LIFE ON LAND	Reduce or halt loss of natural ecosystems	Reduce the loss of natural habitats close to zero by 2030
	Promote afforestation	50 000 ha of reforestation/afforestation by 2050
	Expand protected areas or 'Other effective area-based conservation measures'	25% of land area is protected by 2050
	Expand cropland area under agroecological practices	30-40% of crop area is cultivated using agroecological practices by 2050
8 DECENT WORK AND ECONOMIC GROWTH	Agricultural exports	Increasing agricultural exports
	Farmers' income	Avoid reduction in farmers' income
	Timber exports	Increase exports of materials from wood industry

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.

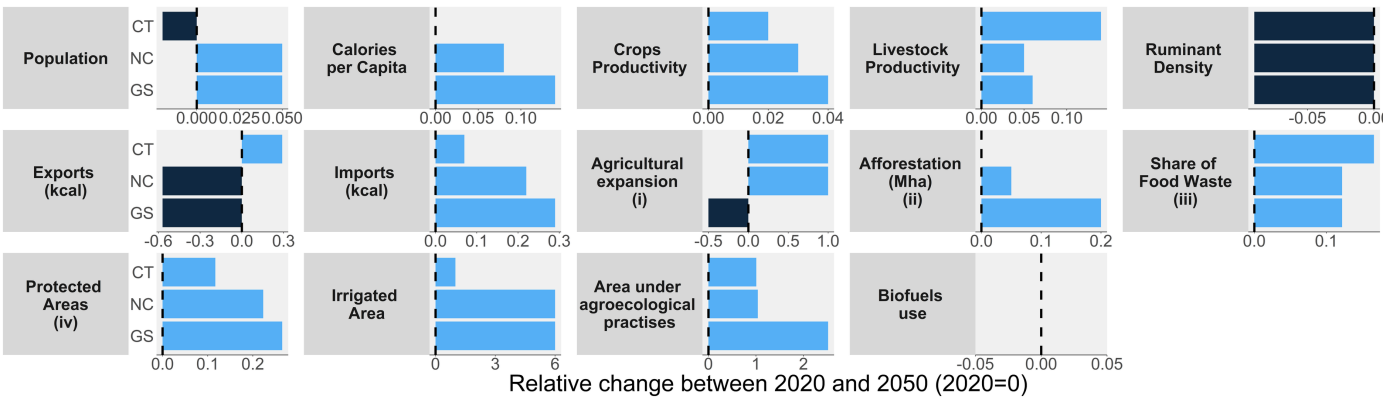
Pathway narratives

Current Trends: Based on a study made in 2020, several agricultural stakeholders, e.g., the food industry and farmers, believe that the demand for red meat and some dairy products is gradually but slowly decreasing. The beginning of these trends have been observed in recent years 2018-2022. Current trends in land use show some but limited progress in terms of GHG reductions or biodiversity.

National Commitments: There are policy documents on the commitments to GHG reductions in the agriculture and land use sector, and there is also a related action plan for reducing GHG emissions in the land use sector. There are confirmed concrete and funded actions for decreasing GHG emissions from agriculture. Overall, these actions will not lead to a sizable 29% GHG reduction target in 2020-2035 but may still lead to significant reductions (10-20%) in GHG emissions. Updated national and Nordic dietary recommendations suggest decreasing red meat and other livestock products and increasing fish and plant-based products and proteins. While there are few other policy measures and actions which could significantly change diets, the dietary recommendations, their dissemination and public campaigns on healthy sustainable diets may gradually lead to significant dietary changes up to 2040 and 2050.

Global Sustainability: In addition to the national actions and policies, there can be other actions e.g., private sector and value chains adopt sustainable production practices with implications on land use. There can also be targeted land use actions aiming to contribute to global sustainability targets related to GHG reduction, biodiversity, and water protection. Sustainable diets make significant progress in this scenario: All livestock-based foods will be consumed 33% less in 2050. Large changes in the use of peatlands take place and the use of peatlands in agriculture decreases by appr. 50% and the remaining use of peatlands is mainly perennial forage grasses, some on rewetted peatlands. This implies large reductions in GHG emissions and promotes water protection and biodiversity. Large diet change also leads to afforestation of agricultural lands in selected areas.

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

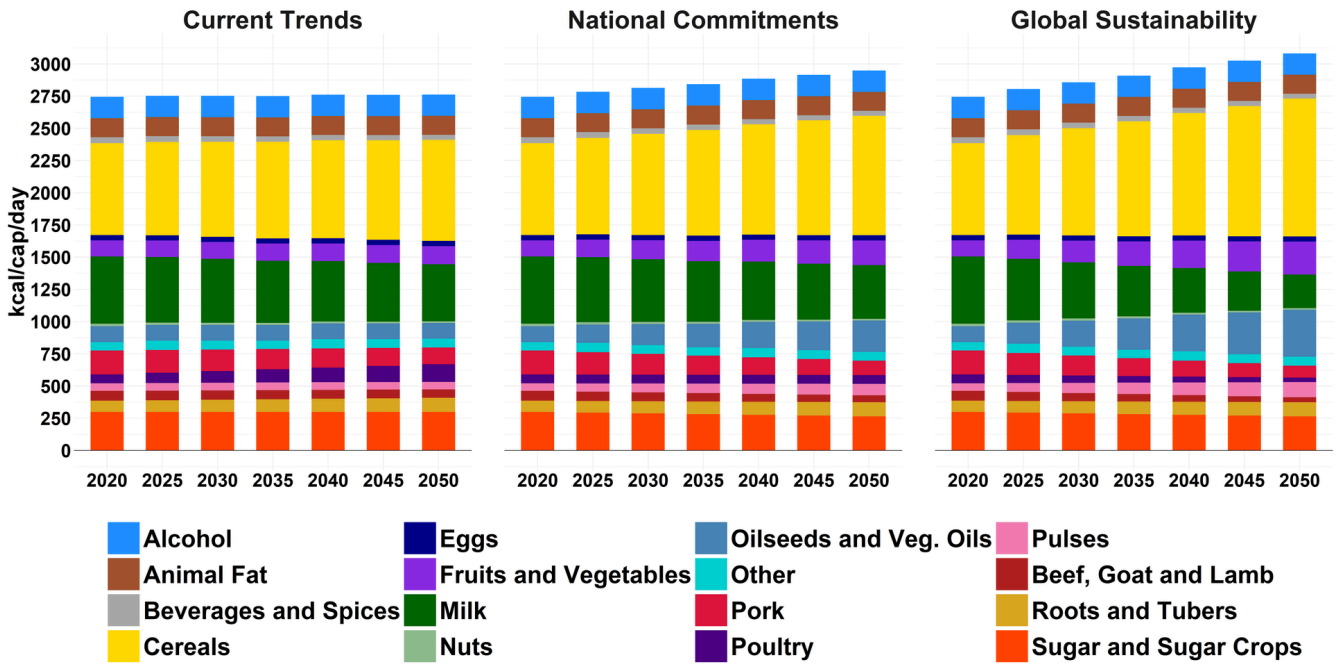


Figure 5. Comparison of the computed daily average kilocalorie intake per capital per food category across the three pathways and the prevalence of undernourishment in 2050

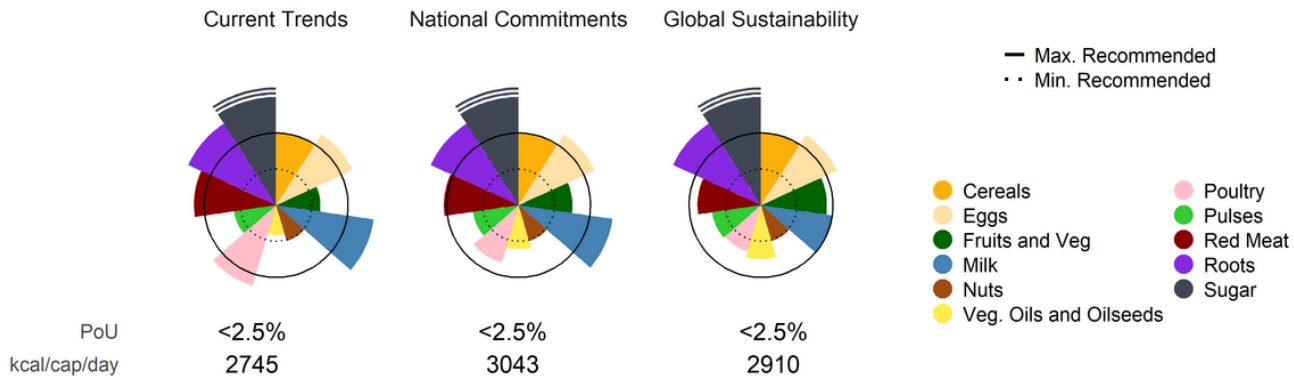


Figure 6. Evolution of land cover 2000-2050

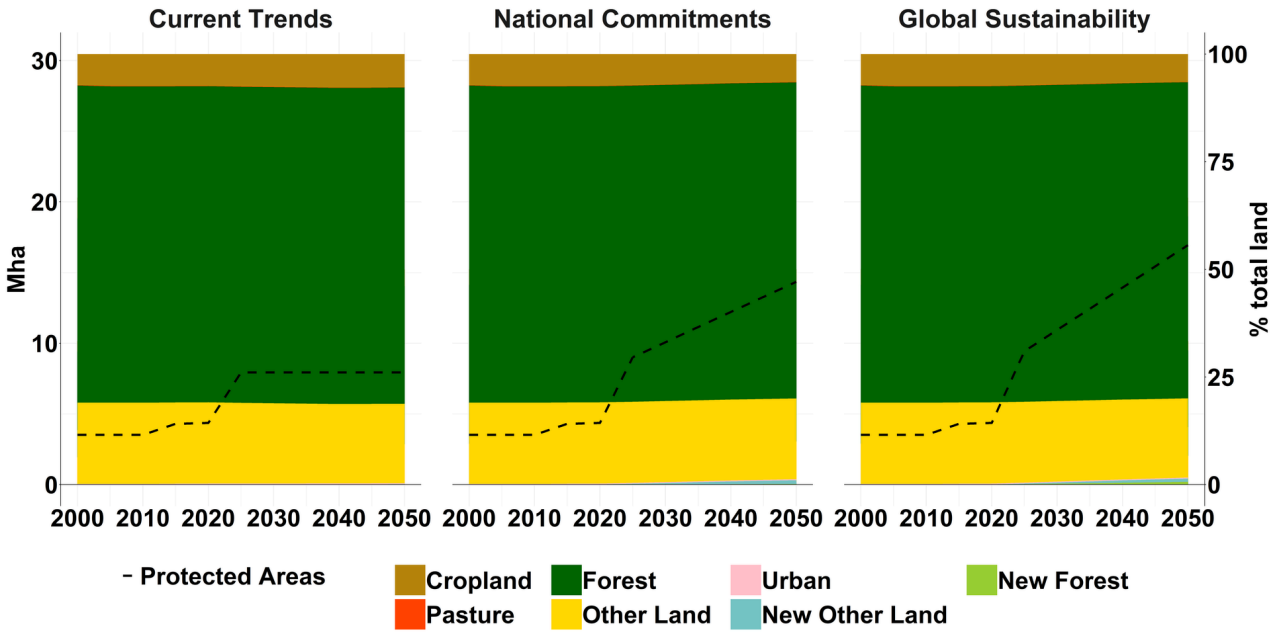


Figure 7. Evolution of the cropland composition 2000-2050

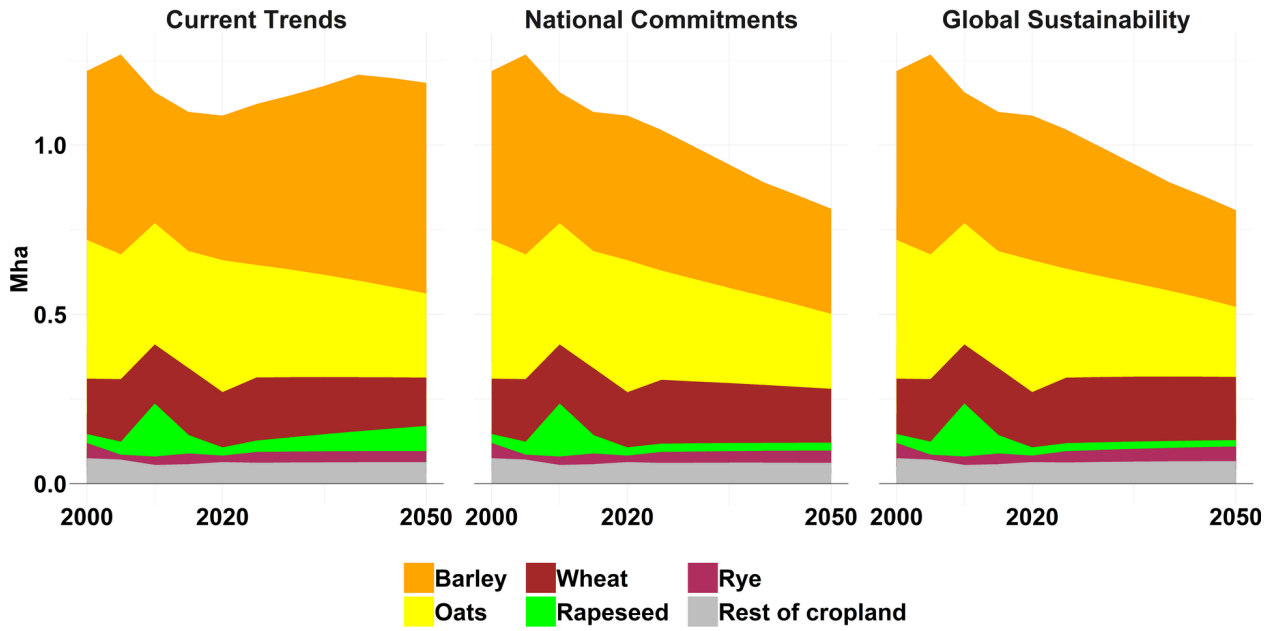


Figure 8. Projected AFOLU emissions and removals between 2020 and 2050 by main sources and sinks across pathways

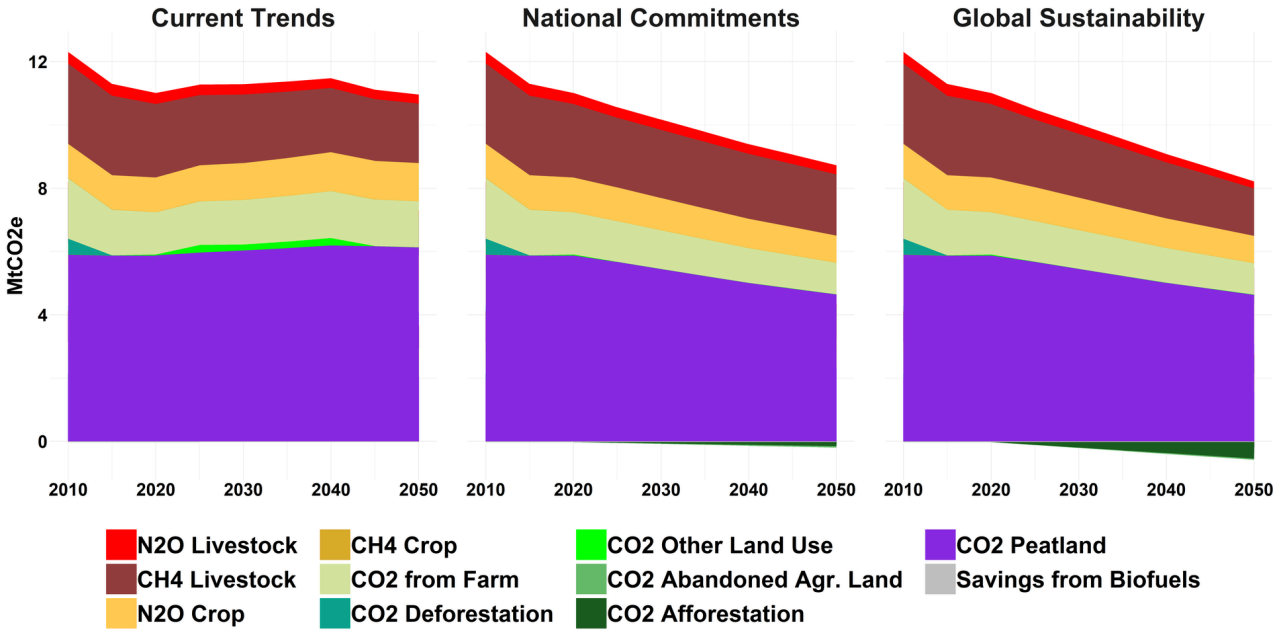
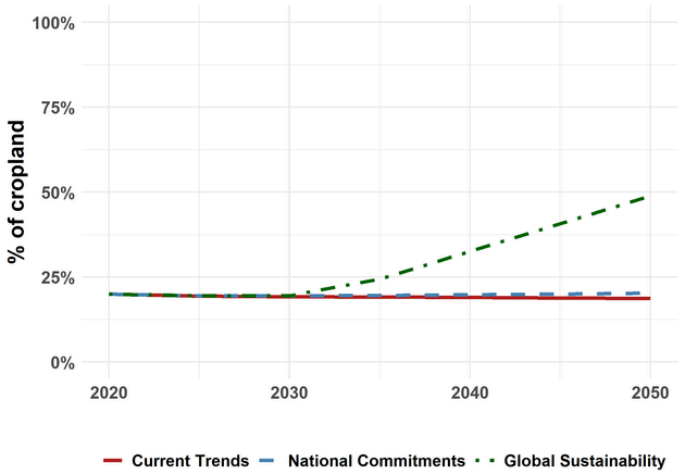


Figure 9. Share of cropland under agroecological practices



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)

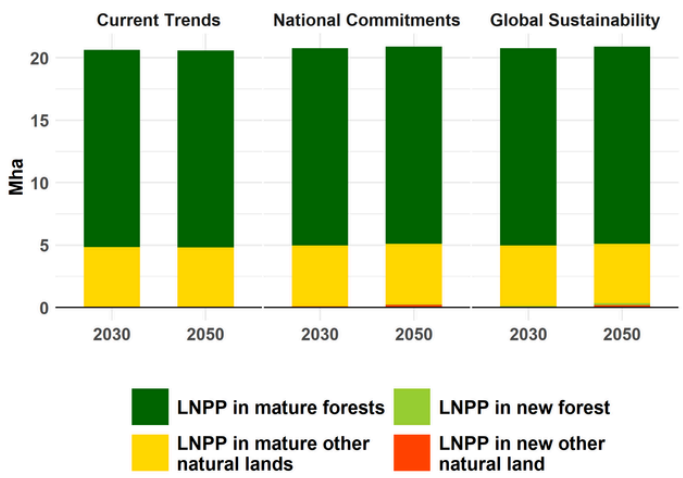


Figure 11. Nitrogen application

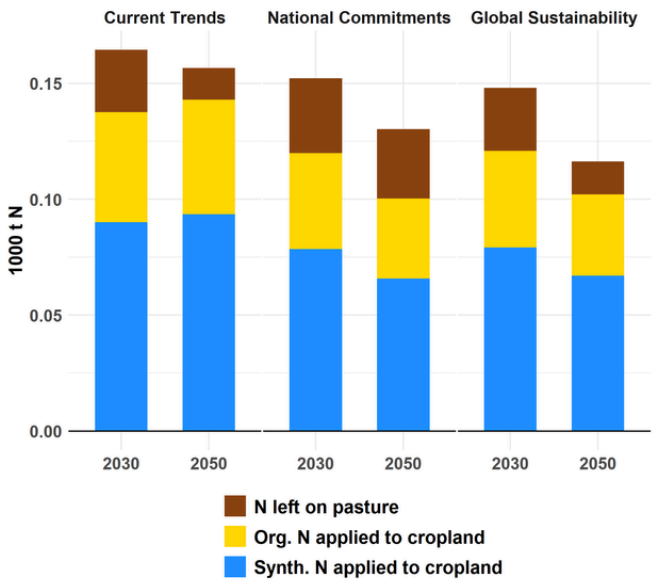
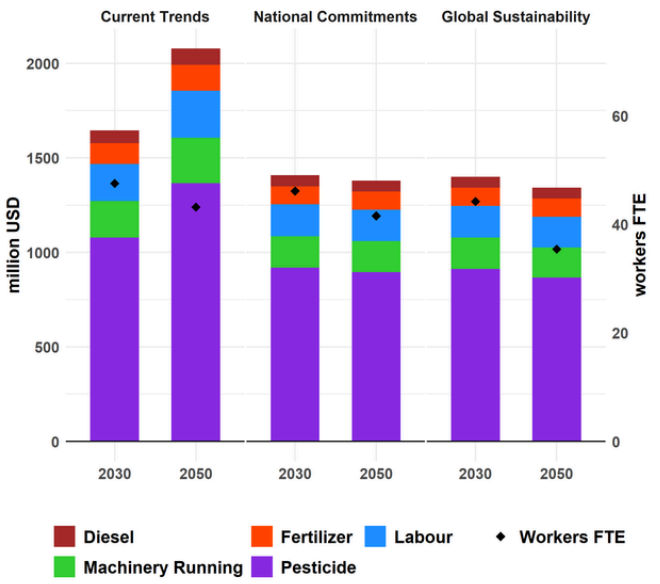


Figure 12. On-farm production costs



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	1% GDP growth per capita, likely due to structural problems e.g., aging population and reduction of people of working age.	1.5% GDP growth per capita.	2% GDP growth per capita.	Bank of Finland 2021. Finland's new long-term forecast suggests GDP growth will be more subdued.
	1.2) Population	Very stable population, according to the 2019 population forecast.	Stable population but non-decreasing workforce.	Slowly increasing workforce and stable or slowly increasing population.	Statistics Finland 2022. Population projection.
	1.3) Inflation	2-3%, 2% target by the European Central Bank.	2% per year.	2% per year.	Ministry of Finance 2023. Economic forecasts.
	1.4) Inequalities	Relatively low inequalities, but slowly increasing polarization and inequality between competitive rural centers and stagnating/deteriorating small urban centers and rural regions. Lack of skilled labor.	Cessation of polarization between regions and between urban and rural regions improved the availability of skilled labor.	Flourishing urban and rural regions, increasing sustainable nature-based industries. Improved availability of skilled labor.	Alueelliset kehitysnäkymät keväällä 2023 Nieminen, J. & Tolonen, S. 2023.
2. Land	**2.1)** Constraints on agricultural expansion/deforestation	No CAP pillar 2 farm payments are paid on new crop land area, cleared from forest land.	No CAP pillar 2 farm payments are paid on new crop land area, cleared from forest land.	No CAP farm payments are paid on new crop land area, cleared from forest land. Additional fee for all land clearance and deforestation activities.	CAP-suunnitelman toteutus käynnistynyt vaiheittain 1.1.2023 alkaen. Ministry of Agriculture and Forestry 2023.
	2.2) Afforestation, and forest plantations targets	We assume no afforestation.	We assume 50,000 ha reforested by 2050. There are no targets for afforestation, but there is a national plan and funding for afforesting idled (not agricultural) land.	We assume 200,000 ha target for cropland afforestation by 2050 (mostly from old pasture and feed production areas).	Government Report on the Climate Plan for the Land Use Sector states that there is a "soft goal" to afforest 3000-4000 ha annually. Ministry of Agriculture and forestry: Government Report on the Climate Plan for the Land Use Sector

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
	2.3) Urban and settlements area	The area under urban settlement increases and results in some forest loss.	Forest loss due to urban settlements is partly reduced by improved land-use planning.	Forest loss due to urban settlements is much reduced by improved land-use planning. Afforesting idled land and unutilized croplands leads to at least cessation of forest loss if not in increased forest area.	
	2.4) Protected areas	Protected areas increase little: 17% of the land area is protected in 2020, but 20% in 2050.	While the target is to protect 30% of the land area, the high costs of protection imply that 25% of the land area will be protected by 2050. The increase in protected area is most needed in southern Finland where land values and hence the costs of protection are high.	Close to 30% of the land area is strictly or partly protected, with significant and confirmed positive biodiversity gains.	EU Biodiversity Strategy. Ministry of the Environment.
3. Productivity and management	**3.1)** Crop productivity for the key crops	Crop productivity increases slowly because of new cultivars of crops developed and entering the market. The crop yield increases slowly because of climate change challenges which require also improved crop protection and crop rotation, improved soil structure, and drainage of fields. These are costly and realized slowly. Hence the crop yields increase slowly, if at all. Productivity increases somewhat in livestock production, due to bigger farm size and increased yields of dairy cows.	The challenges of climate change are recognized, and some proactive measures are taken to improve soil structure and drainage. Crop protection is developed in a chemical-free direction. Crop rotation and cropping become more diversified. However, the investments in all these take time and funding. Crop yields increase only 5-10% up to 2050. This also benefits productivity increase in the livestock sector.	The challenges of climate change are recognized, and large-scale proactive measures are taken to improve soil structure and drainage. Crop protection is developed in a chemical-free direction. Crop rotation and cropping become more diversified. Investment in all these takes time and money, and there is both public and private funding for the investments. Crop yields increase by 10-20% up to 2050.	Perrels, A et al. 2022. Kustannusarviointi ilmastonmuutokseen liittyvästä toimimattomuudesta (KUITTI). Valtioneuvoston selvitys- ja tutkimustoiminnan julkaisusarja 2022:37. 159 s. Lehtonen, H. & Rämö, J. 2022. Development towards low carbon and sustainable agriculture in Finland is possible with moderate changes in land use and diets. Sustainability Science 18, p. 425–439.

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
	3.2) Cropland under agroecological practices	There is a slow gradual increase in the diversity of crop rotations and regenerative farming gains more attention.	Diversity of cropping and crop rotations become increasingly adopted, though this development is slow due to high production costs and economic pressures which leads to the adoption of low-cost options for diversifications, e.g., the use of under-sown crops for guaranteeing permanent land cover. 30-40% of cropland is cultivated using agroecological practices.	Agroecological practices become widely spread and the food industry is requiring such practices. Agricultural policy is more encouraging in cropping diversification. Consumers value domestic agroecologically produced food. More than 50% of cropland is cultivated using agroecological practices.	Peltonen-Sainio, P., Jauhiainen, L. & Lehtonen, H. 2016. Land use, yield and quality changes of minor field crops: Is there superseded potential to be reinvented in northern Europe? PLoS ONE 11(11): e0166403. doi:10.1371/journal.pone.0166403
	3.3) Livestock productivity for the key livestock products	Milk yields of dairy cows increase appr. 0.8-1.0% per year. The carcass weights of all livestock increase very little. Developments in farm size and management increase labor productivity but little capital productivity	Milk yields of dairy cows increase appr. 0.8-1.0% per year. The carcass weights of all livestock increase very little. Developments in farm size and management increase labor productivity but little capital productivity	Milk yields of dairy cows increase appr. 0.8-1.0% per year. The carcass weights of all livestock increase very little. Developments in farm size and management increase labor productivity but little capital productivity	Lehtonen H. et al. 2020. Maatalouden ilmastotiekartta – Tiekartta kasvihuonekaasupäästöjen vähentämiseen Suomen maataloudessa. 131 s. ISBN 978-952-9733-54-5. Maa- ja metsätaloustuottajain Keskusliitto MTK ry. Helsinki.
	3.4) Pasture stocking rate	Stocking rates remain low due to low animal density (livestock units per overall agricultural land area). However, some bovine animals have a limited chance of pasturing due to increased costs and economic pressures at farms.	Stocking rates remain low due to low animal density (livestock units per overall agricultural land area), though there is some increase in pasturing. However, the incentives for a substantial increase in pasturing of bovine animals are few, and the costs of pasturing are higher than the expected revenues.	Stocking rates remain low, and pasturing has increased. Both public subsidies and price premiums paid for farmers by the food industry are needed for that. Increased pasturing and low stocking rates result in increased biodiversity, as evidenced in several studies.	

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
	3.5) Forest management	Little change in forest management despite much public debate on the need to reduce clear-cutting and to increase dead wood for biodiversity. Protected areas are increased slightly.	Clear-cutting is reduced in some areas while clear-cutting, combined with even-aged forest growing, still dominates. Deadwood has increased moderately. Some increase in protected areas.	Clear-cutting is significantly reduced in areas where other forest management is feasible. Still, clear-cutting and even-aged forestry is dominant in many areas. However, dead wood is significantly increased in all forests with positive implications on biodiversity. Protected areas have significantly increased. The harvested wood is reduced, and this has clear negative effects on the forest industry and the national economy. Some nature-based businesses, including tourism increase moderately and this compensates for part of the economic losses.	
4. Trade	**4.1)** Share of consumption which is imported for key imported products (%)	The share and value of food imports remain at the earlier levels. A large part of vegetables and fruits are imported.	The share and value of food imports would decrease slightly due to decreasing demand for meat (20% of beef is imported) and cheese (50% of cheese is imported). In addition, improved sustainability of domestic production is expected to make domestic products attractive to consumers. Increasing demand and productivity results in moderately increased production of vegetables, fruits, and legumes.	The share and value of food imports decrease significantly, 20-30%, because of a large reduction in meat and dairy product consumption and because of significantly increased domestic vegetable and fruit production.	A strong and committed Finland. Programme of Prime Minister Petteri Orpo's Government

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
	4.2) Evolution of exports for key exported products (1000 tons)	Exports of some commodities, e.g., meat, cheese, and grains, have increased only slightly.	There are (and have been) targets of increasing food exports by 50-100% up to 2035 but there are few means of promoting such targets. However, the sustainability and quality arguments and increased interest of the food industry in investing in exports may lead to a significant increase in food exports.	A large increase in exports is based on increased exports of many commodities and products (not low-valued staple commodities): Meat, cheeses, oat-based products, berry products, fish products, and some plant protein products.	A strong and committed Finland. Programme of Prime Minister Petteri Orpo's Government
5.Food	**5.1)** Average dietary composition	The demand for red meat was estimated to decrease by 20%, and the demand for dairy products by 15% in 2020-2035. However, the demand for poultry meat was estimated to increase by 10% in 2020-2035. The demand for plant-based proteins was also estimated to decrease gradually but slowly.	Consumption of all meat will decrease by 30% and all dairy products by 20% in 2020-2035. Consumption of fish and legume crops increases, even significantly, and the protein intake decreases only a little from initially high levels.	All livestock-based foods are consumed 33% less in 2050. Consumption of plant-based proteins and other plant-based products increase significantly. The calorie and protein intake decrease slightly, and the overall diet follows closely the dietary recommendations which include the climate change mitigation and biodiversity aspects.	Saarinen, M. et al. 2020. A controlled dietary change could produce climate benefits, improve nutrition, and maintain Finnish agriculture. Article Series of Government's analysis, assessment, and research activities 12/2020:8 p. Nordic Nutrition Recommendations (NRR) 2023. Integrating environmental aspects. https://pub.norden.org/nord2023-003/
	5.2) Share of food consumption which is wasted at household level	Current trends, as observed in the developments since 2015, indicate some progress, albeit limited, in reducing food waste in households. Most reductions in food waste have taken place in retail, restaurants, and catering. There are no more easy ways to reduce food waste and thus little	There is a national and EU-level target of reducing food waste by 50 % up to 2030. However, the means and resources for reducing food waste are limited. One could expect a 10-20% reduction in food waste, mainly due to increased awareness of consumers on food waste reduction.	Food waste will be reduced by 50% by 2050. This is challenging but possible if strong awareness and improved skills of consumers and improved infrastructure and facilities for food waste collection and processing/composting of food waste.	Saarinen, M. et al. 2020. A controlled dietary change could produce climate benefits, improve nutrition, and maintain Finnish agriculture. Article Series of Government's analysis, assessment, and research activities 12/2020: 8 p.

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
		reduction is expected in food waste.			
6. Biofuels	**6.1)** Targets on biofuel and/or other bioenergy use	There are few explicit actions for increasing biofuels. Burning wood residues for energy is gradually decreasing due to biodiversity concerns and implied efforts to increase dead wood in forests. Some limited increase in biogas production is expected using manure and grass biomass as input.	Biomass from agricultural land for biofuel remains very small and limited due to e.g., EU REDD+ regulation which discourages biofuels from being produced on agricultural land. The energy transition in Finland is based on massive building of wind energy and some solar energy. A significant increase in biogas production, using manure and grass residues as input, is expected but currently, public subsidies are required for profitable investments, and this limits the biogas expansion.	Biogas production has gradually increased from low levels to a major activity of livestock farms which use manure and grass forage remaining as input. The gas is sold to traffic fuel, and it is also used for electricity generation at farms, thus supporting food security. N and P recycling is significantly increased due to biogas.	Koljonen et al. 2020. Hiilineutraali Suomi 2035 - Skenaariot ja vaikutusarviot. 150 s. VTT Technical Research Centre of Finland. VTT Technology, No. 366. An English abstract: "Carbon neutral Finland 2035 – Scenarios and impact assessments". Miettinen, A. et al. 2022. Hiilineutraali Suomi 2035. Maatalouden lisätoimenpiteiden ja ruokavaliomuutoksen päästövähennysvaikutukset. http://urn.fi/URN:ISBN:978-952-380-500-2
	6.2) Targets on other non-food use	No targets for non-food use of biomasses produced on agricultural or forestry land.	There are no explicit targets for non-food use of agricultural or forestry biomasses.	Crops cultivated on re-wetted agricultural peatlands become increasingly demanded as non-food products, e.g., fibers used for construction materials, and textiles.	Koljonen et al. 2020. Hiilineutraali Suomi 2035 - Skenaariot ja vaikutusarviot. 150 s. VTT Technical Research Centre of Finland. VTT Technology, No. 366. An English abstract: "Carbon neutral Finland 2035 – Scenarios and impact assessments".

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY	Justification
7. Water	**7.1)** Irrigated crop area	Little change in irrigated crop areas, which are few (<1% of agricultural land) and limited to vegetable, berry, and some part of potato production.	The irrigated crop area is expected to increase slightly due to the goal of enhancing productivity and the increasing frequency of droughts. There are no explicit national targets for irrigation. Some increase in irrigation is expected from increased controllable sub-surface drainage of peatlands with reduced GHG emissions and provide possibilities for increasing the ground-water table, especially if surface water is available and can be pumped to the sub-surface water pipelines during the critical weeks of the growing period. However, only 10,000 - 30,000 ha of such areas can be expected since there is currently limited funding available for subsidizing such investments and for subsidizing annual costs of higher water (enhancing the quality of surface water and reducing GHGs).	Irrigation increases significantly due to increased production of vegetables and grain legumes for food. The grain legumes in particular, require some irrigation during the critical weeks of the growing season. This increases legume yields and the role of legumes in crop rotations. Surface water can be used for that while the quantities of irrigated water are kept moderate, thus major environmental risks are not expected due to increased irrigation.	CAP-suunnitelman toteutus käynnistynyt vaiheittain 1.1.2023 alkaen. Ministry of Agriculture and Forestry 2023.