

2023 Scenathon results

Pathways for food and land-use systems in Nepal



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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 2000

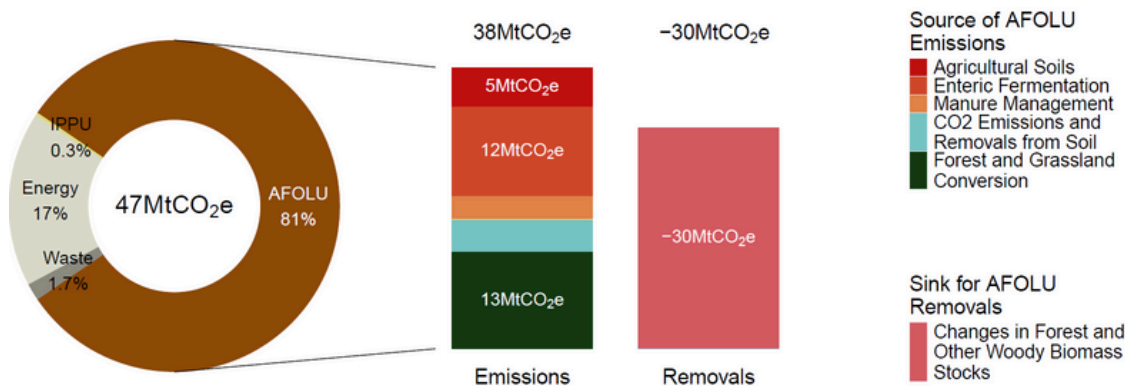
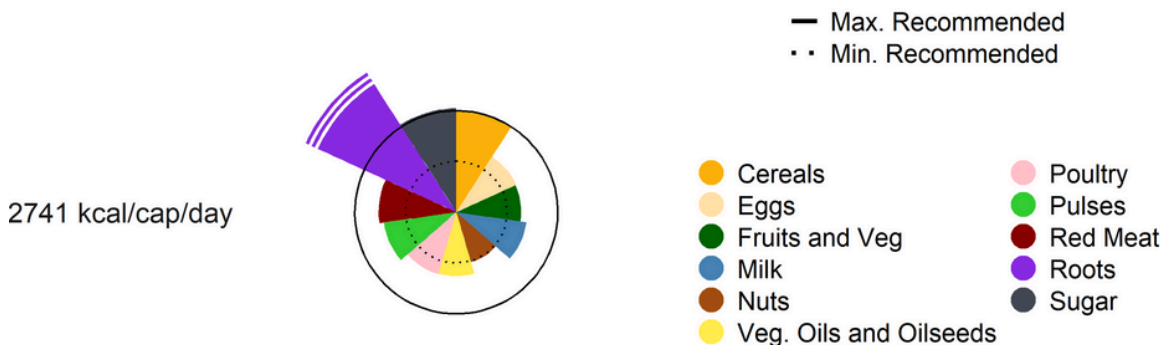







Figure 2. Daily average kilocalorie intake per capital per food category in 2020



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 (Source here)
2 ZERO HUNGER 	Undernourishment	Projected to be 14.0% by 2025 and 3% by <u>2030</u> .
	Overweight / obesity	By 2025, overweight individuals (aged 15 – 69) will be 12.0%, dropping to 7.2% by <u>2030</u> .
	Diet-related diseases	<u>Population</u> below minimum dietary energy: 22.8% 2015, 4.6% by 2030. Underweight prevalence: 11% 2015, 10% by 2030. Stunting prevalence: 35% in 2015, 15% by 2030.
	Other food-related targets	Post-harvest loss reduced from 15% in 2015 to 1% in 2030. (ii) Food loss index for cereals dropped from 10% in 2015 to 2% in 2030. (iii) Per capita food grain production increased from 320 Kg in 2015 to 530 Kg in 2030.
	Self-sufficiency	By 2020, aiming for zero trade deficit in food grains, and targeting a trade surplus of 0-5% by 2025 and <u>2030</u>
13 CLIMATE ACTION 	Total GHG emissions reduction	Achieve net-zero emissions by 2045
	Agriculture GHG emissions reduction	CH4: 735.23 Gg in 2025; 796 Gg in 2030. N2O: 37.4 Gg in 2025; 39.8 Gg in 2030. CO2: 27046.9 Gg in 2025; 29063 Gg in 2030.
	Reduce / halt deforestation	Zero deforestation by 2030
15 LIFE ON LAND 	Promote afforestation	Additional forest plantation: 5000 hectares annually from 2025 onwards Keep 45% of the country's area forested by 2030. Sustainably manage 50% of Terai and Inner Terai forests, and 25% of middle hills and mountain forests by <u>2030</u> .
	Expand protected areas or 'Other effective area-based conservation measures'	Protected mountain ecosystems: 67.8% in 2015; 69.3% in 2025; 70% in 2030 Conservation area (forest included): 23% in 2015; 23% in 2025 and 2030.
8 DECENT WORK AND ECONOMIC GROWTH 	Agricultural exports	By 2030, we assume 1.3 times the maximum historical exports from 2000-2020. Potential exports include Lentils, Cardamom, Wheat and <u>Tea</u>
14 LIFE BELOW WATER 	Limit water use	Limit water use to 20% of the water resource in 2030. Round the year irrigated land in total arable land: 40% in 2015; 66.7% in 2025; 80% in 2030.
	Limit N and P use	Fertilizer use: 97 kg/ha in 2015, 99 kg/ha in 2025, and 100 kg/ha in 2030

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.

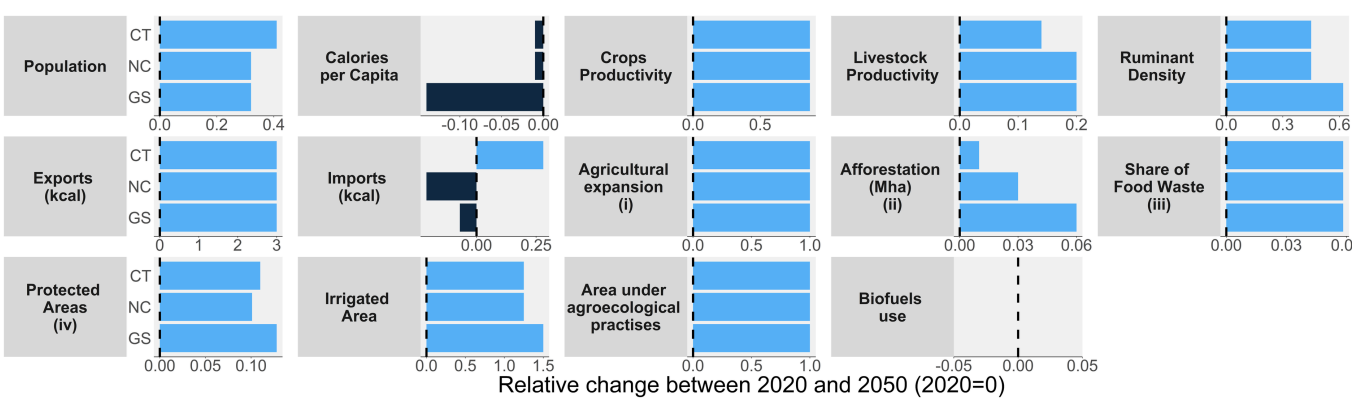
Pathway narratives

Current Trends: Represents a low-ambition trajectory primarily shaped by historical trends and existing policies, offering a glimpse into a future heavily reliant on the current level of implementation and enforcement.

National Commitments: Attempts to predict how food and land systems will evolve if national strategies, pledges, and targets concerning climate, biodiversity, and food systems are met. This is based on a review of policy documents that describe the national climate and biodiversity strategies, the UN food system pathway, the national dietary guidelines, and other relevant policy documents for food and land systems.

Global Sustainability: Identifies additional actions to help closing the gap between the collective outcome of the National Commitments pathway and the global sustainability targets. There may be large overlaps between the ‘National commitments’ pathway and the Global Sustainability pathway, depending on how ambitious country teams and local stakeholders think the current national commitments are.

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

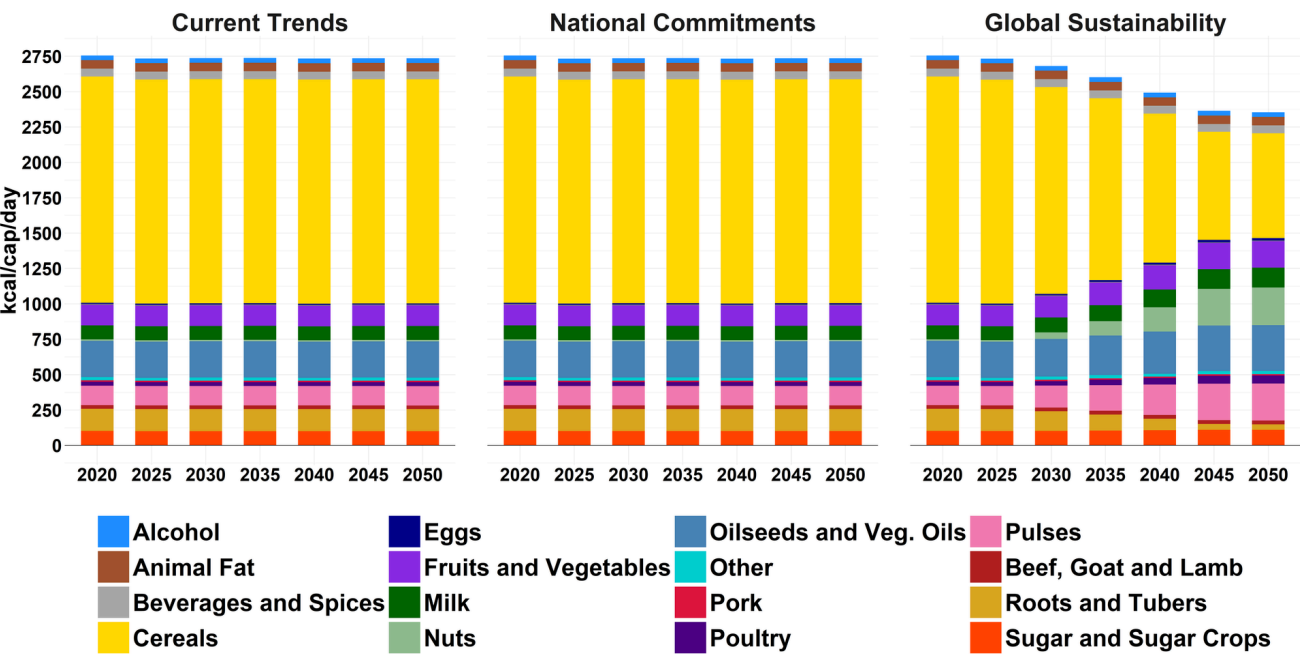


Figure 5. Comparison of the computed daily average kilocalorie intake per capital per food category across the three pathways and the prevalence of undernourishment in 2050

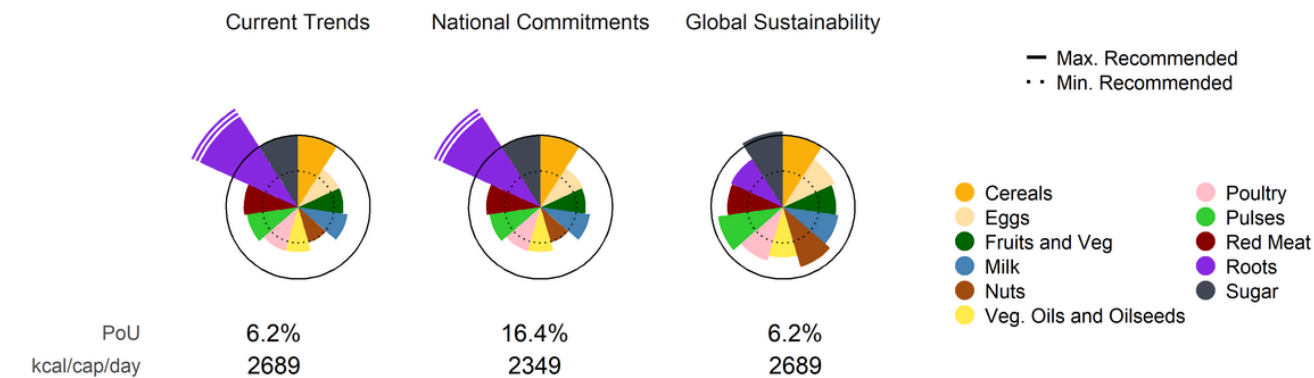


Figure 6. Evolution of land cover 2020-2050

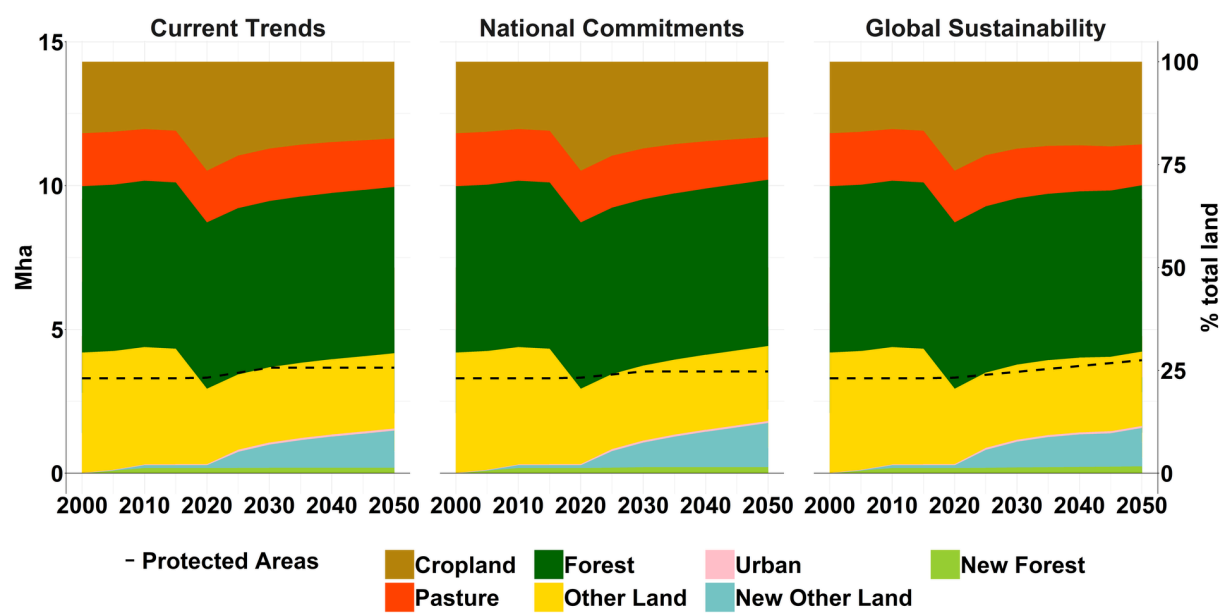


Figure 7. Evolution of the cropland composition 2000-2050

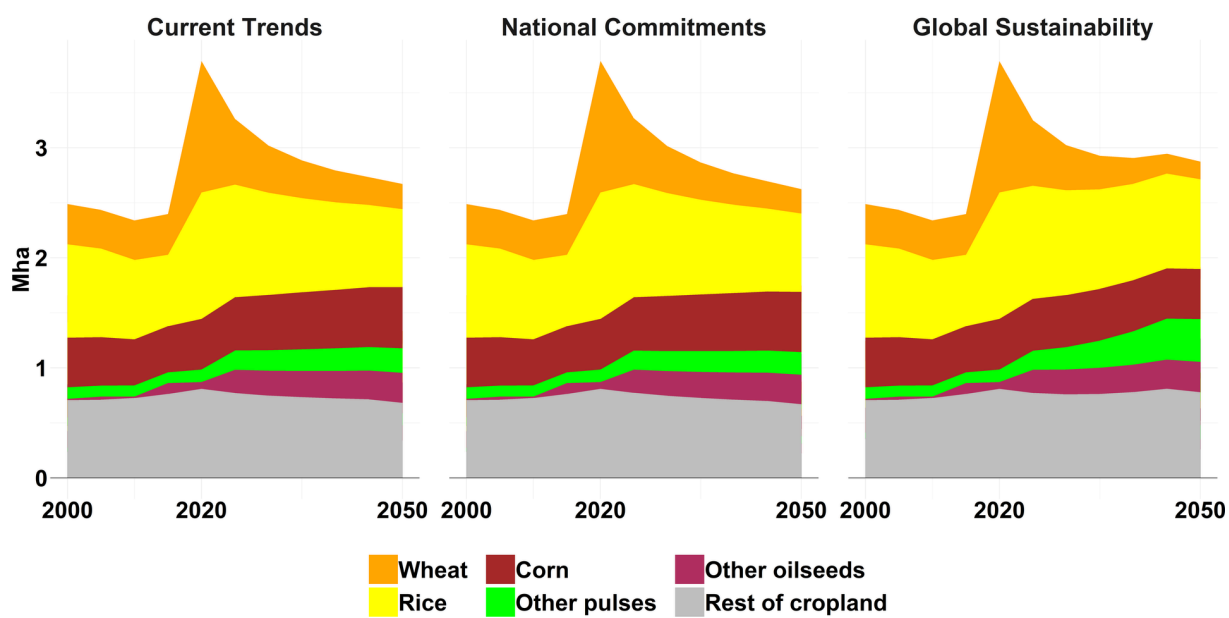


Figure 8. Projected AFOLU emissions and removals between 2020 and 2050 by main sources and sinks across pathways

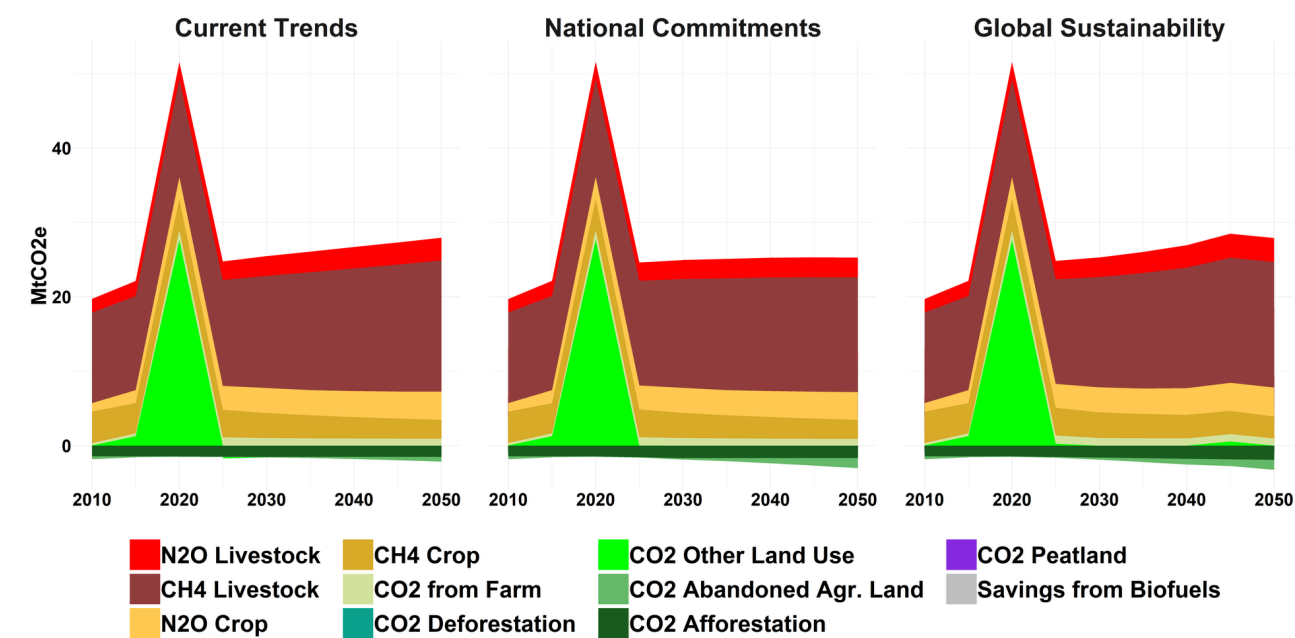


Figure 9. Share of cropland under agroecological practices

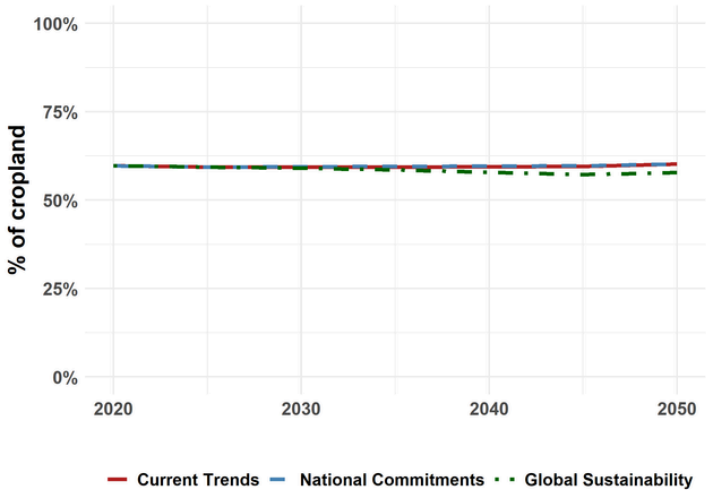
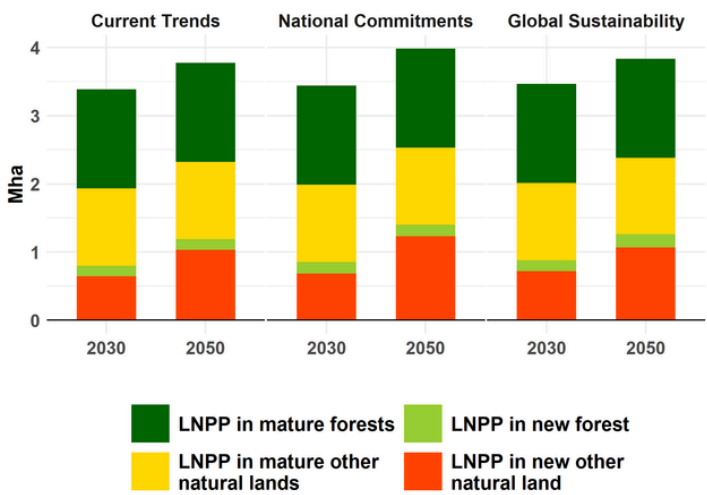


Figure 10. Total area of land where natural processes predominate (LNPP)



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

Figure 11. Nitrogen application

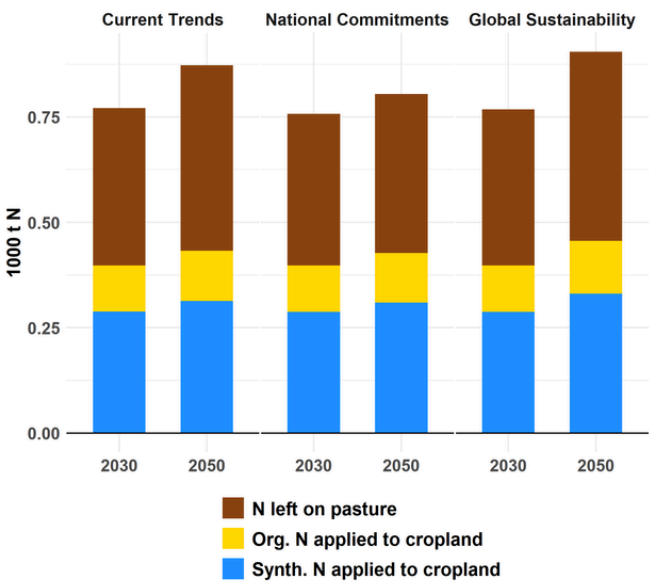
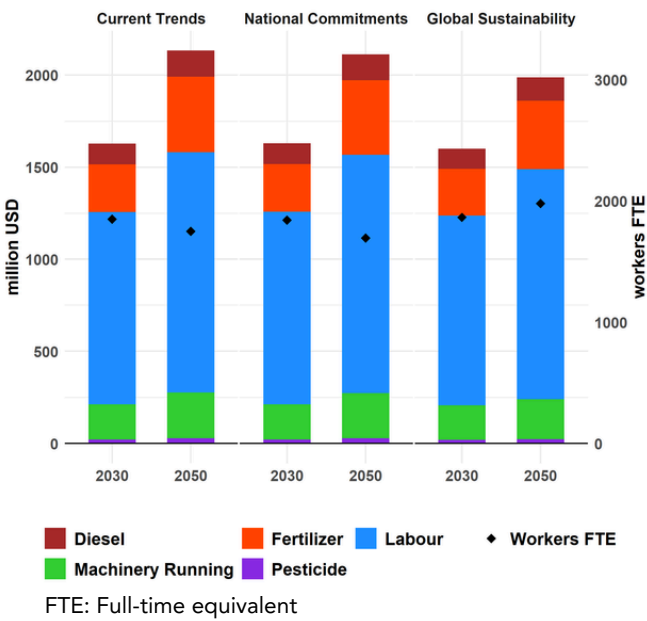


Figure 12. On-farm production costs



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

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY
1. Macroeconomics	1.1) GDP per capita	SSP2 , assuming a medium rate of convergence of economic growth (approximately 2.5% increase in GDP per capita), projects GDP per capita to 2282 USD/capita/year in 2050 [1018 USD/capita/year in 2020].	SSP1 , 3516 USD2000/cap /year in 2050. The Agriculture Development Strategy (ADS) forecasts 2242 USD/cap/year in 2030 (ADB-NEP, 2013).	SSP1 , 3516 USD2000/cap /year in 2050. This sustainability scenario anticipates a rapid convergence of economic growth.
	1.2) Population	UN high growth , projected rapid increase of 41.3 million in 2050 [29.3 million in 2020]	UN constant fertility , 33.3 million in 2030 and 38.7 million in 2050. This is the closest to the ADS forecast of 35.1 million in 2030.	UN constant fertility , 33.3 million in 2030 and 38.7 million in 2050.
	1.3) Inflation	Prices are assumed to change due to inflation based on the average annual Consumer Price Index (CPI) fluctuation from 2000 to 2020.	Prices are assumed to change due to inflation based on the average annual Consumer Price Index (CPI) fluctuation from 2000 to 2020.	Prices are assumed to change due to inflation based on the average annual Consumer Price Index (CPI) fluctuation from 2000 to 2020.
	1.4) Inequalities	-	-	-
2. Land	2.1) Constraints on agricultural expansion/deforestation	Free expansion of productive land under the total land boundary.	Free expansion of productive land under the total land boundary	Free expansion of productive land under the total land boundary
	2.2) Afforestation, and forest plantations targets	No afforestation scenario, with forestland remaining constant to 2020 levels (5973 k ha in 2050).	Low afforestation , with a new forest area of 20 k ha (5993 k ha in 2030 and 2050). The ADS anticipates a 30 k ha increase in forest area by 2030 compared to 2014. ADS is expected to cover 40% of terrestrial land by 2030 (ADB-NEP 2013).	Moderate growth , with 50 k ha more additional forestland than in 2014.
	2.3) Urban and settlements area	UN high growth in the urban population, with forecasts of 8.5 million in 2030 & 14.7 million in 2050 [6.2 million in 2020].	UN constant fertility , with an urban population of 8.4 million in 2030 and 13.8 million in 2050. The ADS assumed a 4% growth rate to the 2010 level.	UN constant fertility , with an urban population of 8.4 million in 2030 and 13.8 million in 2050.
	2.4) Protected areas	No Expansion , of the current 23% PA of the country's total area by 2030 [3327.8 k ha in 2020, 2030 and 2050].	PA Expansion to 25% of total area by 2030 [3707 k ha in 2030 and in 2050]. The national government has no specific	PA Expansion to 30% of total land area by 2030 [4441 k ha in 2030 and in 2050]. A new Aichi target of 30% of terrestrial land by 2030 is being

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY
			goals, but it is committed to expanding PAs (ADB-NEP, 2013).	discussed. We expected a moderate growth to achieve this aim by 2050.
3. Productivity and management	3.1) Crop productivity for the key crops	BAU scenario, with the productivity of major crops as: <ul style="list-style-type: none"> - <i>Paddy</i>: 4.1 t/ha in 2050 [3.8 t/ha in 2020], - <i>Maize</i>: 3.2 t/ha in 2050 [2.9 t/ha in 2020], - <i>Wheat</i>: 3.5 t/ha in 2050 [3.1 t/ha in 2020]. - <i>Millet</i>: 1.2 t/ha in 2050 [1.2 t/ha in 2020]. - <i>Barley</i>: 3.9 t/ha in 2050 [1.3 t/ha in 2020]. 	Low growth scenario, as ADS forecasts a 2% annual growth rate in cereal production until 2030, which corresponds to the following for the major crops: <ul style="list-style-type: none"> - <i>Paddy</i>: 4.2 t/ha in 2050, - <i>Maize</i>: 3.5 t/ha in 2050, - <i>Wheat</i>: 3.4 t/ha in 2050, - <i>Millet</i>: 1.2 t/ha in 2050, - <i>Barley</i>: 2.0 t/ha in 2050. 	High growth scenario, with substantial yield potentials as follows: <ul style="list-style-type: none"> - <i>Paddy</i>: 5.2 t/ha in 2050, - <i>Maize</i>: 3.9 t/ha in 2050, - <i>Wheat</i>: 5.0 t/ha in 2050, - <i>Millet</i>: 1.2 t/ha in 2050, - <i>Barley</i>: 5.3 t/ha in 2050.
	3.2) Cropland under agroecological practices	No change from 2010 in the adoption of agro-ecological practices, such as diversified farming (61.5%), conservation tillage (95%), embedded natural farming (25%) and organic farming (0.23%).	No change from 2010, in the adoption of agro-ecological practices.	No change from 2010 level, in the adoption of agro-ecological practices.
	3.3) Livestock productivity for the key livestock products	BAU Growth scenario with: <ul style="list-style-type: none"> - <i>Milk</i> 2.5 t/LU in 2050 [2.1 t/LU in 2020], - <i>Pork</i> 0.11 t/LU in 2050 [0.09 t/LU in 2020], - <i>Beef</i> 0.03 t/LU in 2050 [0.04 t/head in 2020], - <i>Chicken meat</i> 0.37 t/LU in 2050 [0.33 t/LU in 2010], - <i>Mutton</i> 0.05 t/LU in 2050 [0.05 t/LU in 2020], - <i>Eggs</i> 0.08 t/head in 2050 [0.08 t/head in 2020]. 	High Growth scenario with: <ul style="list-style-type: none"> - <i>Milk</i> 2.7 t/LU in 2050, - <i>Pork</i> 0.12 t/LU in 2050, - <i>Beef</i> 0.05 t/LU in 2050, - <i>Chicken meat</i> 0.41 t/LU in 2050, - <i>Mutton</i> 0.06 t/LU in 2050, - <i>Eggs</i> 1.04 t/LU in 2050. <p>According to ADB-NEP (2013), milk yield was 900 litres/lactation in 2010, and under the ADS plan, it is expected to increase to 2000 litres/lactation in 2030.</p>	High Growth scenario with: <ul style="list-style-type: none"> - <i>Milk</i> 2.7 t/LU in 2050, - <i>Pork</i> 0.12 t/LU in 2050, - <i>Beef</i> 0.05 t/LU in 2050, - <i>Chicken meat</i> 0.41 t/LU in 2050, - <i>Mutton</i> 0.06 t/LU in 2050, - <i>Eggs</i> 1.04 t/LU in 2050.

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY
	3.4) Pasture stocking rate	BAU growth scenario with 6.3 LU/ha cattle stocking density in 2050 [4.3 LU/ha in 2020].	BAU growth scenario with 6.3 LU/ha cattle stocking density in 2050.	High growth scenario with 7.0 LU/ha cattle stocking density in 2050.
	3.5) Forest management	-	-	-
4. Trade	4.1) Share of consumption which is imported for key imported products (%)	Stable imports at 2020 levels until 2050, with import shares in consumption such as: <ul style="list-style-type: none"> - Paddy: 23%, - Maize: 20%, - Wheat: 16%, - Millet: 6%, and - Barley: 35%. 	Reduce import shares in food consumption by half by 2050, if the levels in 2020 are more than 5%; otherwise, reduce them to zero, as: <ul style="list-style-type: none"> - Paddy: 12.5%, - Maize: 10%, - Wheat: 8%, - Millet: 3%, and - Barley: 17.5%. <p>The ADS plans to limit import to 4% per year (598 million dollars in 2010 and 1310 million dollars in 2030) and maintain 0-5% trade surplus in food grains (ADB-NEP, 2013).</p>	Reduce import shares in food consumption by half by 2050 from its level in 2020 as: <ul style="list-style-type: none"> - Paddy: 12%, - Maize: 10%, - Wheat: 8%, - Millet: 3%, and - Barley: 17.5%.
	4.2) Evolution of exports for key exported products (1000 tons)	Stable exports up to the maximum historical exports from 2000 to 2020, as follows: <ul style="list-style-type: none"> - Wheat 9.0 k ton in 2050, - Pulses 37.0 k ton in 2050, - Lentil 37.5 k ton in 2050, - Tea 14.0 k ton in 2050, - Spices 36.9 k ton in 2050. 	Increase exports by 1.3 times of the largest historical exports between 2000 and 2020 by 2050, as follows: <ul style="list-style-type: none"> - Wheat 11.7 k ton in 2050, - Pulses 49.2 k ton in 2050, - Lentil 48.8 k ton in 2050, - Tea 18.2 k ton in 2050, - Spices 47.9 k ton in 2050. <p>The ADS has set an annual growth rate of 11% for agricultural export value. Lentil, cardamom, wheat and tea have identified as prospective export commodities (ADB-NEP, 2013).</p>	Increase exports by 1.5 times the maximum historical exports from 2000 to 2020 by 2050, as: <ul style="list-style-type: none"> - Wheat 13.5 k ton in 2050, - Pulses 56.8 k ton in 2050, - Lentil 56.4 k ton in 2050, - Tea 21.0 k ton in 2050, - Spices 55.3k ton in 2050.

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY
5. Food	5.1) Average dietary composition	Current FAOSTAT diet for 2020(in kg/cap/yr): - Cereals: 242.7, - Roots: 91.4, - Sugar: 55.3, - Pulses: 14.5, - Nuts: 1.2, - Veg. oils: 10.4. - Fruits (Tropical): 17.8, - Fruits (Temperate): 33.5, - Vegetables 138.5, - Beverages: 0.4, - Spices: 5.4; - Alcohol: 5.4, - Beef and mutton: 10.9, - Pork 1.0, - Poultry: 2.3, - Fish: 31.6, - Eggs: 2.5, - Milk: 37.4, - Dairy products: 2.1, - Animal fat: 0.3, - Others: 2.7.	ICMR-WHO recommended diet¹ , increase dietary diversity, ensuring a minimum daily per capita consumption of 2144 kcal; more protein and micronutrients; increase animal protein from 13% to 30% by 2030 (in kg/cap/year): - Cereals: 192.6, - Roots: 31.9, - Sugar: 15.5, - Pulses: 14.8, - Nuts: 9.9, - Veg. oils: 12.0, - Fruits & vegetables: 84.0, - Beef, mutton, pork: 2.2, - Poultry: 4.5, - Fish: 4.3, - Eggs: 11.0, - Milk: 54.8, - Animal fat: 3.5. Source: Pokhrel (2020).	EAT-Lancet recommended diet , as(in kg/cap/year): - Cereals: 77.5, - Roots: 16.7, - Sugar: 10.5, - Pulses: 25.1, - Nuts: 16.7, - Veg. oils: 13.4, - Fruits & vegetables: 167.0, - Beef, mutton, pork: 4.7, - Poultry: 9.7, - Fish: 9.4, - Eggs: 4.3, - Milk: 83.5, - Animal fat: 3.9.
	5.2) Share of food consumption which is wasted at household level	Constant share of food consumption as in 2010: - Cereals 5%, - Roots: 14%, - Pulses: 3%, - Nuts: 3%, - Veg. oils: 3%. - Fruits & Vegetables 16%, - Beef and mutton: 11%, - Poultry: 11%, - Fish: 17%,	Reduced share in comparison to 2010, as: - Cereals 4%, - Roots: 12%, - Pulses: 3%, - Nuts: 3%, - Veg. oils: 3%. - Fruits & Vegetables 15%, - Beef and mutton: 10%, - Poultry: 10%, - Fish: 15%,	Reduced share in comparison to 2010, as: - Cereals 4%, - Roots: 12%, - Pulses: 3%, - Nuts: 3%, - Veg. oils: 3%. - Fruits & Vegetables 15%, - Beef and mutton: 10%, - Poultry: 10%, - Fish: 15%,

¹ ICMR-WHO recommended diet is calculated for Nepal based on the Indian Council of Medical Research (ICMR) and World Health Organization (WHO) recommendations. See Pokhrel (2020) for the details.

Scenarios and assumptions

		A) CURRENT TRENDS	B) NATIONAL COMMITMENTS	C) GLOBAL SUSTAINABILITY
		- Milk: 11%.	- Milk: 10%.	- Milk: 10%.
6. Biofuels	6.1) Targets on biofuel and/or other bioenergy use	No use of biofuels for the period 2010-2050.	No use of biofuels for the period 2010-2050.	No use of biofuels for the period 2010-2050.
	6.2) Targets on other non-food use	-	-	-
7. Water	7.1) Irrigated crop area	No assumption is made for an increase in irrigation areas.	The ADS plans to increase irrigated land to 1071 k ha by 2033 (ADB-NEP, 2013).	No assumption is made.

References:

- 1) ADB-NEP (2013) Final Report. Technical Assistance for the Preparation of the Agricultural Development Strategy, Asian Development Bank (ADB)-Nepal (NEP), June, Project Number: TA 7762 – NEP.
- 2) Pokhrel, S. 2020. Food availability and consumption in relation to developing strategies for sustained production and supply in Nepal.
<https://afu.edu.np/sites/default/files/Food%20availability%20and%20consumption%20in%20relation%20to%20developing%20strategies%20for%20sustained%20production%20and%20supply%20in%20Nepal.pdf>