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A GLOBAL INITIATIVE FOR THE UNITED NATIONS

The Food and Land Use Coalition

2019 Report of the FABLE Consortium

Pathways to Sustainable Land-Use and Food Systems

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2019 Report of the FABLE Consortium

Pathways to Sustainable Land-Use and Food Systems in the European Union by 2050

European Union

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Land and food systems at a glance

A description of all units can be found at the end of this chapter

Land & Biodiversity

Fig. 1 | Area by land cover class in 2015

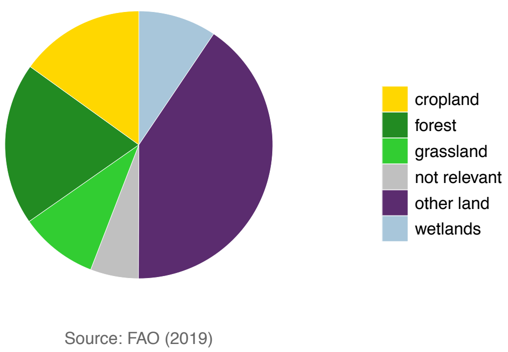
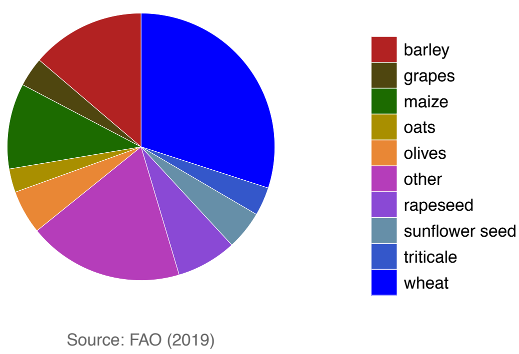


Fig. 2 | Share of harvested area by crop in 2015



Afforestation in 2015:
370 kha

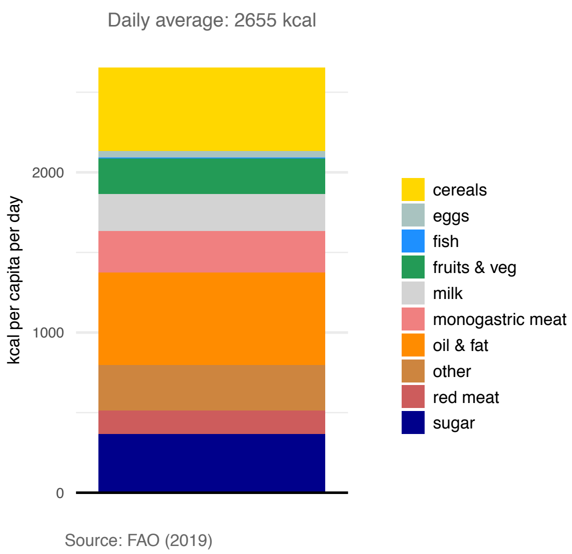
Source: FAOSTAT (2019)

Endangered species: 1677

Source: IUCN Red List (2019)

Food & Nutrition

Fig. 3 | Daily average intake per capita at the national level in 2015



Share of undernourished in 2015: < 2.5%

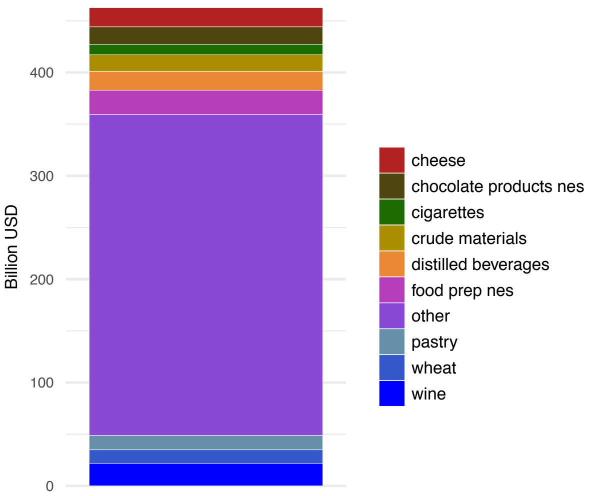
Source: FAOSTAT (2019)

Share of obese in 2015: 24.9%

Source: FAOSTAT (2019)

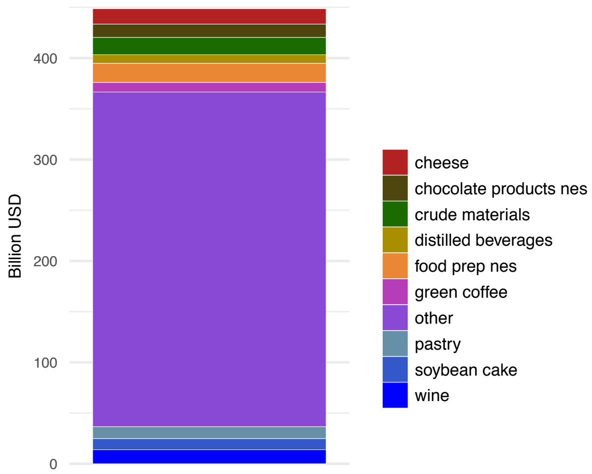
Trade

Fig. 4 | Main agricultural exports by value in 2015



Source: FAO (2019)

Fig. 5 | Main agricultural imports by value in 2015



Source: FAO (2019)

Surplus in agricultural trade balance in 2015: USD 14.10 mln

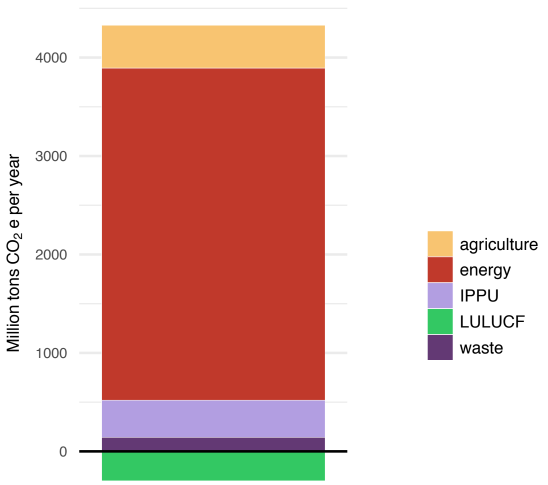
Source: FAOSTAT (2019)

In 2015, the EU was the first exporter of wheat, wheat flour, milk, and pork meat.

Source: FAOSTAT (2019)

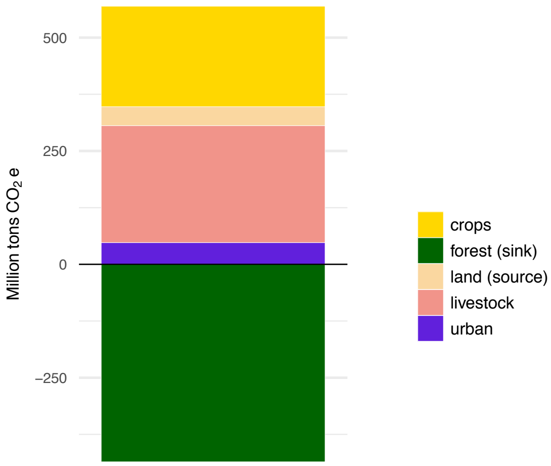
GHG Emissions

Fig. 6 | GHG emissions by sector in 2015



Source: EEA (2019)

Fig. 7 | GHG emissions from agriculture and land use change in 2015



Source: EEA (2019)

Main assumptions underlying the pathway towards sustainable land-use and food systems

For a detailed explanation of the underlying methodology of the FABLE Calculator, trade adjustment, and envelope analysis, please refer to sections 3.2: Data and tools for pathways towards sustainable land-use and food systems, and 3.3: Developing national pathways consistent with global objectives.

The assumptions and results presented in the rest of the document come from the FABLE Calculator for the Rest of European Union (ROEU), which includes 25 European Union member countries. Sweden, Finland, and the UK are not included, as they are members of the FABLE Consortium and participated individually in the Scenathon using the FABLE Calculator adapted to their respective national contexts.

GDP GROWTH & POPULATION

	GDP per capita	Population
Scenario definition	GDP per capita is expected to increase by 60% from USD 34,000 in 2015 to USD 54,000 in 2050.	The population is expected to increase marginally by 0.13% between 2015 and 2050 from 426 mln to 427 mln.
Scenario justification	The evolution of GDP follows the EU Reference Scenario 2016 (Capros et al., 2016).	The evolution of the population follows the EU Reference Scenario 2016 (Capros et al., 2016).

TRADE

	Imports	Exports
Scenario definition	The share of total consumption which is imported remains constant at 2010 levels for: - soyabean at 90%, - palm oil at 100%, and - for banana at 93%. It decreases from 92% to 50% for groundnuts.	The exported quantity increases: - from 21 Mt in 2015 to 38 Mt in 2050 for wheat, and - from 19 Mt in 2015 to 33 Mt in 2050 for milk. For the other products, exports remain constant at 2010 levels.

LAND

	Land conversion	Afforestation
Scenario definition	We assume free expansion of productive land within the total land boundary.	We assume 11 Mha of new forest by 2050.

Scenario signs no change small change large change

BIODIVERSITY

Scenario definition

Protected areas
The protected areas remain constant for the entire period 2000-2050.

FOOD

	Diet	Food waste
Scenario definition	Between 2015 and 2050, the daily per capita calorie consumption increases from 2,526 kcal to 2,708 kcal. Per capita consumption: - increases by 23% for fruits and vegetables, - increases by 23% for other, including nuts, - increases by 7% for eggs, and - increases by 7% for sugar.	Between 2015 and 2050, the share of final household consumption which is wasted decreases from 10 to 5% for all food groups.
Scenario justification	The diet projections follow the "Middle of the Road" assumption of the shared socio-economic pathways (SSP2), which are based on projections from FAO.	

PRODUCTIVITY

	Crop productivity	Livestock productivity	Pasture stocking rate
Scenario definition	Between 2015 and 2050, crop productivity increases: - from 5 t/ha to 6.4 t/ha for wheat, - from 4.3 t/ha to 4.8 t/ha for barley, and - from 7.3 t/ha to 12.7 t/ha for corn.	Between 2015 and 2050, the productivity per head increases: - from 5.4 t/TLU to 6 t/TLU for cow milk, - from 150 kg/TLU to 233 kg/TLU for pork meat, and - from 98 kg/TLU to 110 kg/TLU for beef.	The average livestock stocking density remains constant at 1.1 TLU/ha pastureland between 2015 and 2050.

Scenario signs no change small change large change

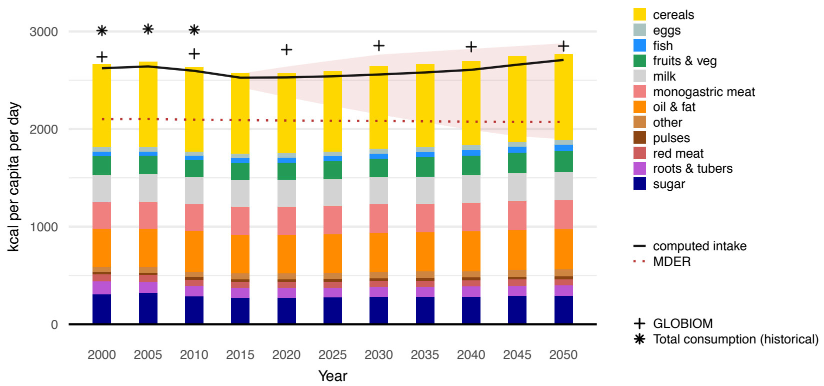
Results against the FABLE targets

The results for FABLE targets as well as "other results" are based on calculations before global trade harmonization.

Food security

Fig. 8 | Computed daily average intake per capita over 2000-2050

Note: The Minimum Daily Energy Requirement (MDER) is computed based on the projected age and sex structure of the population and the minimum energy requirements by age and sex for a moderate activity level. Animal fat, offal, honey, and alcohol are not taken into account in the computed intake.



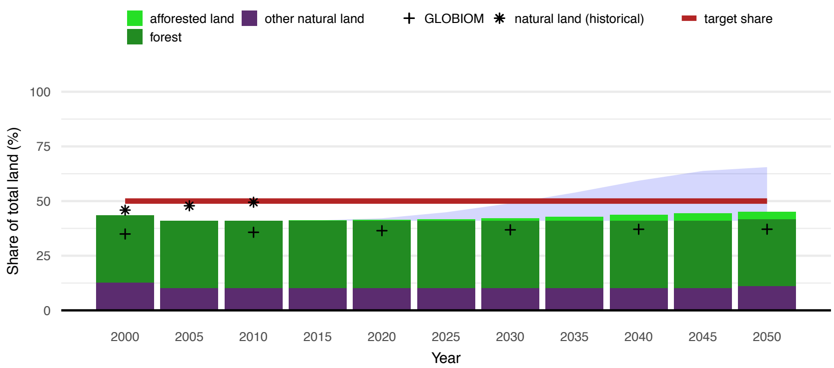
Historical data source: FAO (2019)

The computed average daily energy intake per capita decreases from 2005 to 2040 from 2,641 kcal/cap/day to 2,606 kcal/cap/day. An increase in caloric intake is computed at the end of the period, i.e. 2,659 kcal/capita/day in 2045 and 2,708 kcal/capita/day in 2050. In comparison with the results of GLOBIOM, the FABLE Calculator results have lower values over the entire period; the average difference is around 208 kcal/capita/day. We do not assume significant dietary shifts. Cereals remain the first source of kilocalories for the ROEU region throughout the entire period.

The computed average calorie intake is 24% higher than the Minimum Dietary Energy Requirement (MDER), on average. Our results generally suggest that meeting national food security objectives in the region remains attainable.

Biodiversity

Fig. 9 | Computed share of the total land which could support biodiversity over 2000-2050



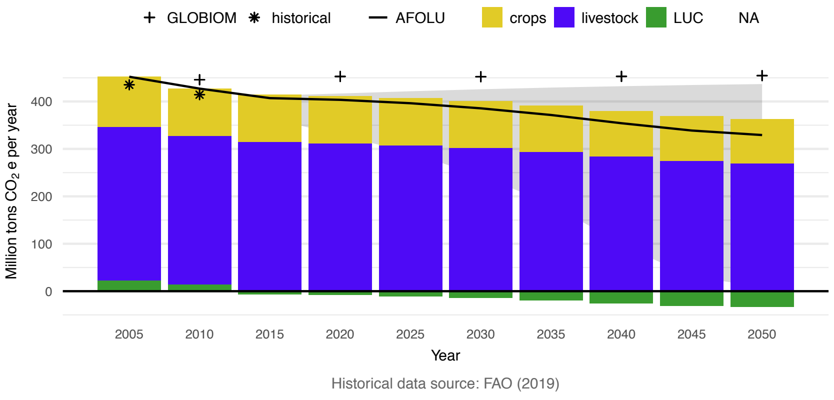
Historical data source: FAO (2019)

Our results show that the Share of Land which can support Biodiversity (SLB) increases between 2000-2015 from 44% to 45%. This number is somewhat lower than the estimates based on FAO land-cover statistics, which calculate a SLB of 49% by 2010. The lowest SLB is computed for the years 2005-2020 at 41% of total land. In comparison to the results of the FABLE Calculator, simulations with GLOBIOM result in a smaller proportion of land for biodiversity conservation. The SLB calculated with GLOBIOM ranges from 35% to 37%. Both the FABLE Calculator and GLOBIOM show relatively stable SLB throughout the period.

Compared to the global target of having at least 50% SLB by 2050, our results are slightly below the target for the region.

GHG emissions

Fig. 10 | Computed GHG emissions from land and agriculture



Note: AFOLU (Agriculture, Forestry and Other Land Use) is the sum of computed GHG emissions from crops, livestock, and Land Use Change (LUC), emissions and sequestration from forestry are not included. Historical emissions include crops and livestock. Carbon sequestration in forests is not included.

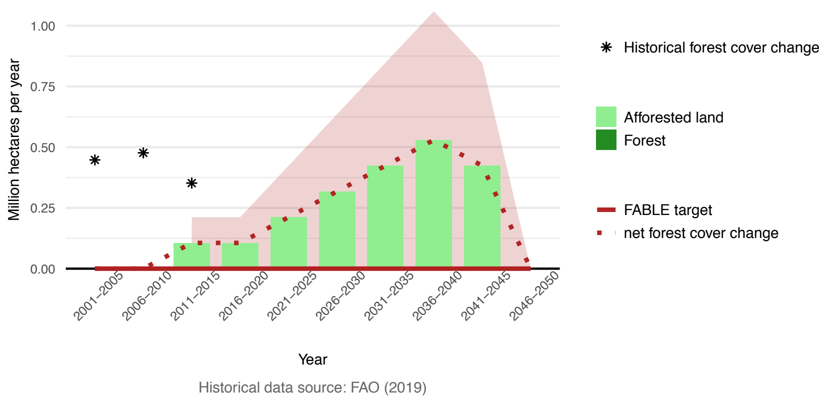
Our results show annual GHG emissions between 452 and 407 Mt CO_2e over 2005-2015, which continue to decrease over time. The calculated results are higher than FAO estimates of 435 Mt CO_2e for the year 2005, even though a decreasing trend is observed. A comparison of the results of the FABLE Calculator with those of GLOBIOM (crops and livestock) show that the latter tend to be higher, with 446 Mt CO2e in 2010 and 453 Mt CO_2e in 2020.

Calculated AFOLU GHG emissions are mostly driven by GHG emissions from livestock. AFOLU GHG emissions amount to 339-329 Mt CO_2e over the period 2046-2050. Negative-net emissions from land-use change by 2050 are mainly explained by zero deforestation throughout the period combined with minor afforestation.

Compared to the global target of reducing emissions from agriculture and reaching zero or negative GHG emissions from LULUCF by 2050, our results are on the target for the region.

Forests

Fig. 11 | Computed forest cover change over 2000-2050



Our results show zero annual deforestation for the entire period and afforestation starting over 2006-2012-2015. According to the FAO, afforestation occurred over 2000-2010 and at a higher level: 0.5 Mha/year.

The afforestation projections in the ROEU Calculator are based on the 1.5 °C scenario in IIASA's Global Biosphere Management Model (GLOBIOM). GLOBIOM projects a continued increase in forest area throughout the EU28, in line with historical trends and driven by increasing biomass demand for energy use (European Commission, 2018).

Our results are in line with the global target of having zero or positive net forest change after 2030.

Other relevant results for national objectives

Table 1 | Other Results

Variable	Unit	2000	2005	2010	2015	2020	2030	2040	2050
Milk									
Production (historical)	Mt	135.8	134.7	134.1					
Production (calculated)	Mt	135.2	132.7	127.6	129.7	131.6	135.9	139.9	148.2
Wheat									
Production (historical)	Mt	113.8	118.1	119.9					
Production (calculated)	Mt	112.6	111.4	121.1	122.0	124.6	130.4	136.8	146.6
Area by land cover									
Cropland (historical)	Mha	117.8	112.5	109.4					
Cropland (Calculator)	Mha	117.8	113.8	113.1	112.8	112.4	110.8	107.7	104.8
Cropland (GLOBIOM)	Mha	120.2		116.9		114.7	113.5	117.6	119.7
Pasture (historical)	Mha	60.1	58.6	56.4					
Pasture (Calculator)	Mha	61.2	70.4	69.1	68.9	68.7	67.8	66.0	65.6
Pasture (GLOBIOM)	Mha	76.5		75.0		73.1	71.8	66.0	63.1
Forest (historical)	Mha	100.9	103.0	105.5					
Forest (Calculator)	Mha	100.9	100.9	100.9	100.9	100.9	100.9	100.9	100.9
Forest (GLOBIOM)	Mha	95.1		93.9		93.1	92.4	91.9	91.3
Afforested land (Calculator)	Mha	0.0	0.0	0.0	0.5	1.1	3.7	8.5	10.6
Afforested land (GLOBIOM)	Mha	4.9		8.3		11.5	13.5	14.9	15.5
Otherland (historical)	Mha	49.7	54.1	57.0					
OtherLand (Calculator)	Mha	42.0	33.8	33.8	33.8	33.8	33.8	33.8	35.1
OtherLand (GLOBIOM)	Mha	17.3		17.6		17.7	17.7	17.7	17.7
Urban (Calculator)	Mha	6.5	9.6	11.5	11.5	11.5	11.5	11.5	11.5
Urban (GLOBIOM)	Mha	21.6		23.8		25.4	26.5	27.4	28.2

Source historical data: FAOSTAT

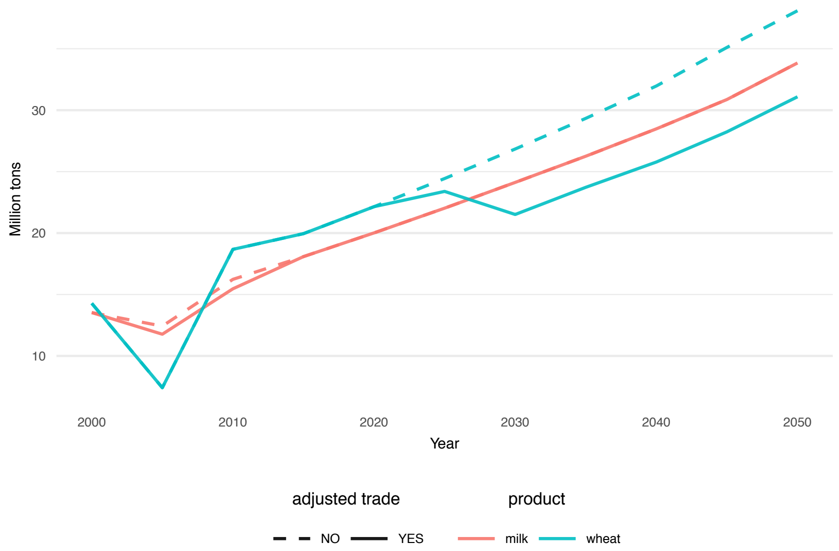
Milk production remains relatively stable over the period, given the scenario assumptions made. A minor decrease in milk production is observed from 2000 to 2015, followed by a slight but continuous increase thereafter. The calculated and projected production quantities range from 127 Mt in 2010 to 148 Mt in 2050.

Historical FAO data is slightly above the calculated production quantities for wheat. The production quantity of wheat in the ROEU region increases throughout most of the period, with values ranging from 111 Mt in 2005 to 147 Mt in 2050.

The cropland, other land and pastureland categories show a slight decrease for most of the period. The other categories show a slight increase in terms of their extension: urban land increases up to 2010 and then remains relatively stable, while afforested land increases at the end of the period. The other land category is higher than reported by the FAO mostly due to urban area, which is taken out of other land in the Calculator. In comparison to the FABLE Calculator results, GLOBIOM results project an increase in cropland after 2030 which is driven by dedicated energy crops, a decrease for forestland throughout the entire period mainly related to the expansion of settlements and a more pronounced decrease in pasture related to higher afforestation, particularly after 2030.

Impacts of trade adjustment to ensure global trade balance

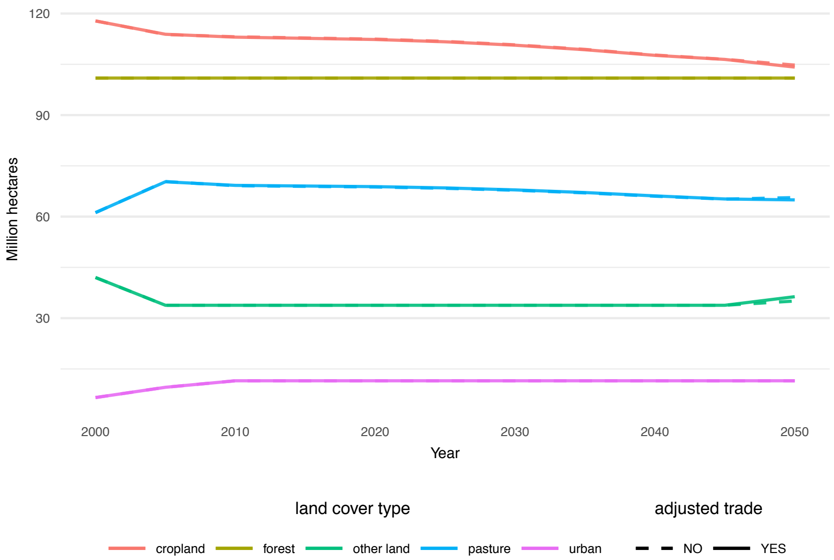
Fig. 12 | Impact of global trade harmonization on main exported/imported commodities over 2000-2050



The change for milk with trade adjustment is minor, differences are only observed for the years 2005 and 2010. For the rest of the period, the exports remain the same.

In contrast to milk, wheat exports from the ROEU region are impacted by the trade adjustment, particularly after 2030. In 2030 the difference is 5.3 Mt, which grows to 7 Mt by 2050.

Fig. 13 | Impact of global trade harmonization on land use over 2000-2050



The graph shows the three land-cover indicators that are affected by the trade adjustment: cropland, pasture and other land. As can be seen, however, the impact of the trade adjustment (dashed lines) is minor, with a respective average change of 120, -3, and -116 thousand hectares. For the other land-cover indicators, there is no impact of trade adjustment.

Discussion and next steps

The EU has established a long-term strategy to achieve zero net greenhouse gas emissions by 2050 (European Commission, 2018). The production of sufficient food, feed, and fibers will remain key for the European economy but at the same time, the agriculture and forestry sectors are also expected to contribute to the mid-century carbon neutrality objective. Biomass demand is expected to increase to produce heat, biofuels, biogas, building materials, and sustainable bio-based products such as biochemicals. Increased biomass supply is expected to come from diverse sources in order to ensure the sustainability of the production and the stabilization or enhancement of the carbon sink in existing forests. Reduction of non-CO2 emissions from agriculture will be mainly achieved through innovation e.g. precision farming to optimize the field application of fertilizer and other chemicals, improvement of cattle productivity, and treatment of manure in aerobic digesters. The EU strategy also relies on increasing carbon sequestration on agricultural land through better farming practices including agroforestry techniques, zero-tillage, and the use of cover crops. Finally, afforestation and restoration of degraded ecosystems could contribute to several objectives: CO2 sequestration, biodiversity, soils and water conservation, and biomass production.

We have partly used this long-term strategy from the EU to parametrize the Rest of the European Union (ROEU) FABLE Calculator. In our sustainable pathway scenario, afforestation/reforestation is expected to reach 11 Mha by 2050, crop and livestock productivity is expected to further increase, and the share of the final food consumption at the household level which is wasted is cut by half, allowing for growth in exports of milk and wheat, a stable self-sufficiency ratio for the other products, and a reduction of cropland and pasture area over time. However, some important components of the EU strategy are not yet included.

The FABLE Calculator does not represent bioenergy production, a topic that is central to the projection of EU climate policy up to 2050. The EU has set a target to ensure that 10% of transport fuel in each member state comes from renewable sources, such as biofuels, by 2020 (European Parliament, 2009). These renewable sources should respect some sustainability criteria i.e. bioenergy feedstock should not be grown on areas with high carbon stock or high biodiversity value (Frank et al., 2013). These sustainability criteria also apply to renewable energy produced outside the European Union with limits on high indirect land use change (iLUC) risk biofuels, bioliquids, and biomass fuels (European Parliament, 2018; Valin et al., 2016). Biodiesel is the most widely used biofuel in Europe and it is mostly produced from rapeseed oil. This growing demand for biofuels is not taken into account in the Calculator, which could lead to an underestimation of the cropland area: in our results we project a reduction in cropland area in ROEU but in GLOBIOM-EU the cropland area is projected to increase after 2030. It can also lead to an underestimation of imports for feedstock used for biofuel production.

The Fable calculator currently does not represent timber production from the forestry sector. About 60% of the forest area in the EU is privately owned by small family holdings or large estates owned by companies (European Union, 2011). The forestry sector plays a key role in the EU strategy as biomass demand is expected to increase. Di Fulvio et al (2019) carry out a spatially explicit analysis of the impacts of different biomass demand levels on biodiversity, combining life cycle analysis of various biomass products with GLOBIOM´s overview of the global economy on the AFOLU sectors. They show that the expansion of perennial cultivation for bioenergy might have negative impacts on biodiversity both in the EU and outside the EU through leakage.

Our results do not take into account CO_2 sinks due to carbon sequestration in existing forest ecosystems. The forest CO_2 sink offsets more than half the emissions from agriculture in the EU: emissions from agriculture were 440 Mt CO_2e, while the LULUCF CO_2 sink sequestered, and hence removed, around 249 Mt CO_2 from the atmosphere in 2017 (EEA, 2019). The challenge for the region, therefore, is how to maintain or enhance this carbon sink i.e. through forest restoration or afforestation while increasing biodiversity, guaranteeing food and nutrient security, and promoting other land use activities to reduce emissions in view of the policies that are being set on the table today, such as biomass use.

Despite its current limitations, the added value of a tool such as the FABLE Calculator is that it allows multiple stakeholders to sketch out a range of pathway solutions, highlight tradeoffs, and explore which shared pathway best satisfies national objectives and global targets, such as climate change mitigation, forest and biodiversity conservation.

Units

% – percentage
bln – billion

cap – per capita

CO_2 – carbon dioxide

CO_2e – greenhouse gas expressed in carbon dioxide equivalent in terms of their global warming potentials

GHG – greenhouse gas

Gt – gigatons

ha – hectare

kcal – kilocalories

kg – kilogram

kha – thousand hectares

km^2 – square kilometer

kt – thousand tons

Mha – million hectares

mln – million

Mt – million tons

t – ton

TLU –Tropical Livestock Unit is a standard unit of measurement equivalent to 250 kg, the weight of a standard cow

t/ha – ton per hectare, measured as the production divided by the planted area by crop by year

t/TLU, kg/TLU, t/head, kg/head- ton per TLU, kilogram per TLU, ton per head, kilogram per head, measured as the production per year divided by the total herd number per animal type per year, including both productive and non-productive animals

tln – trillion

USD – United States Dollar

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