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SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK
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 Indonesia by 2050

Indonesia

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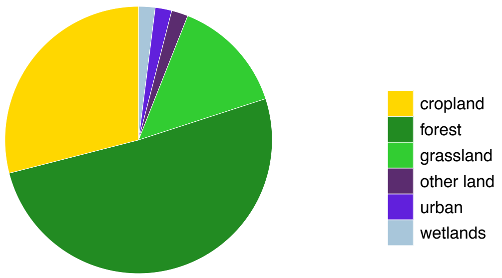
Land and food systems at a glance

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

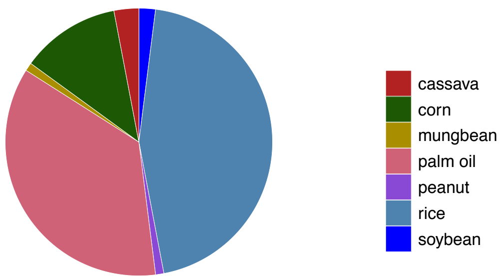
Land & Biodiversity

Fig. 1 | Area by land cover class in 2015



Source: Kementerian Lingkungan Hidup dan Kehutanan (2018)

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



Source: Kementerian Pertanian (2016)

Annual deforestation in 2015:
1 Mha

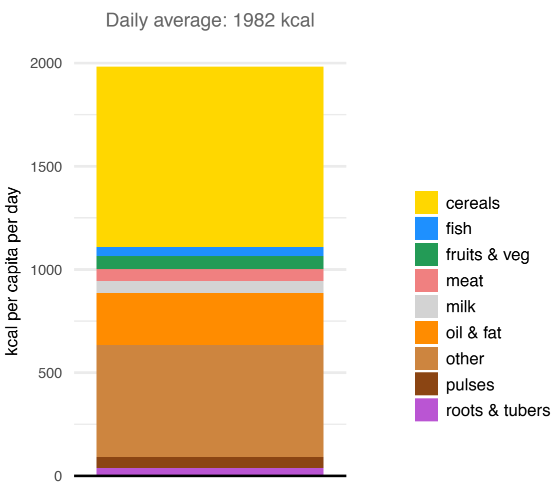
Source: Kementerian Lingkungan Hidup dan Kehutanan (2018)

Endangered species:
921 species in 2018

Source: Kementrian Lingkungan Hidup dan Kehutanan (2018)

Food & Nutrition

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



Source: Badan Pusat Statistik and Astuti (2015)

Share of undernourished in 2016:
8%

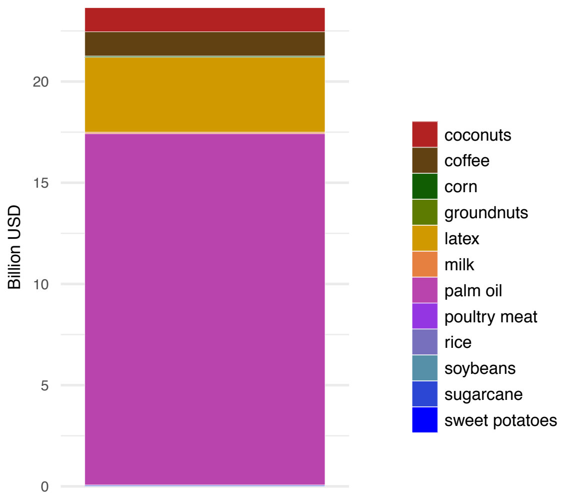
Source: FAOSTAT (2019)

Share of obesity in 2018:
23.1% of adults

Source: Harbuwono et al. (2018)

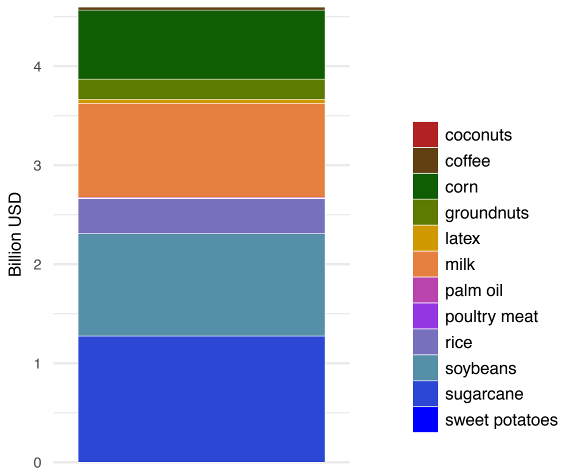
Trade

Fig. 4 | Main agricultural exports by value in 2015



Source: Kementerian Pertanian (2016)

Fig. 5 | Main agricultural imports by value in 2015



Source: Kementerian Pertanian (2016)

Surplus in agricultural trade balance in 2015: USD 13.55 bln

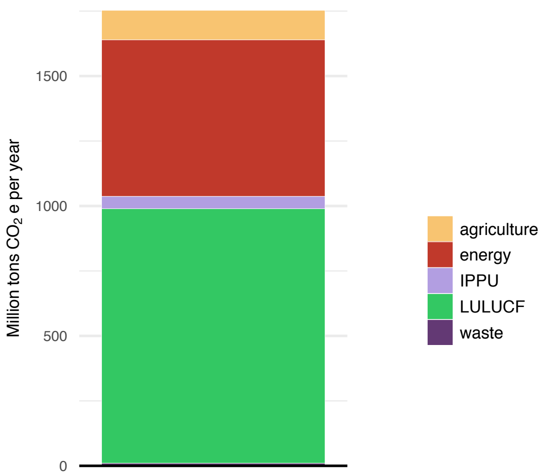
Source: Kementerian Pertanian (2016)

#1 palm oil, #2 rubber, and #7 coffee exporter in 2017

Source: OEC MIT, (2019)

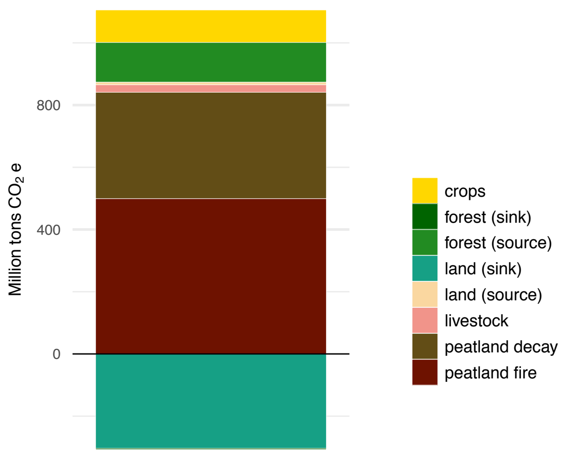
GHG Emissions

Fig. 6 | GHG emissions by sector in 2015



Source: Kementerian Pertanian (2016)

Fig. 7 | GHG emissions from agriculture and land use change in 2014



Source: MoEF, Republic of Indonesia (2017)

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.

GDP GROWTH & POPULATION

	GDP per capita (large change)	Population (large change)
Scenario definition	GDP per capita is expected to increase from USD 3,827 in 2015 to USD 14,617 in 2050 (SSP1 scenario selected).	The population is expected to increase by 15% between 2015 and 2050 from 65.4 mln to 75.4 mln (UN Medium growth scenario selected).
Scenario justification	Based on Bappenas (2005; 2019) and Kementrian PPN/Bappenas (2019b).	Based on the Indonesian Central Bureau of Statistics' projections, in 2045 the Indonesian population will be 324 mln, which roughly matches our selected scenarios at 342 mln (Kementrian PPN/Bappenas, 2019a).

TRADE

	Imports (small change)	Exports (large change)
Scenario definition	The share of total consumption which is imported: - decreases from 2% in 2010 to 0% in 2050 for rice, - increases from 10% in 2010 to 19% in 2050 for corn, and - increases from 60% in 2010 to 100% in 2050 for milk. The share of domestic consumption which is imported remains at 2010 levels for the other commodities.	The exported quantity increases: - from 17.5 Mt in 2010 to 52.5 Mt in 2050 for Palm Oil (CPO or FFB), - from 2.3 Mt in 2010 to 7 Mt in 2050 for rubber, - from 0.5 Mt in 2010 to 1.5 Mt in 2050 for cocoa, The exported quantity remains constant at 2010 levels for all the other products.
Scenario justification	Increasing exports is also a main objective of the national development plan (Kementerian Pertanian, 2016).	Based on Arifin et al. (2018).

Scenario signs no change small change large change

LAND

	Land conversion	Afforestation (large change)
Scenario definition	We assume that there will be no constraint on the expansion of agricultural land beyond existing protected areas and under the total land boundary.	We assume total afforested/reforested areas will reach 2 Mha by 2050.
Scenario justification	2018, Indonesia regulates the suspension/moratorium of new permit or licenses in some types of forest area and peatland (President of the Republic of Indonesia, 2018).	Based on existing Bonn Challenge commitments of around 2 Mha, which come from private sector reforestation, and historical reforestation rate trends. In 2015, our National Restoration Targets in Bonn Challenge numbered around 30 Mha, but this number is yet to be considered in our scenario (President of the Republic of Indonesia, 2011; Ministry of Environment and Forestry, 2012).

BIODIVERSITY

	Protected areas (no change)
Scenario definition	Protected areas remain constant at 22 Mha over 2000-2050.
Scenario justification	Based on The State of Indonesia's Forest 2018 (Kementerian Lingkungan Hidup dan Kehutanan, 2018), Ministry of Environment and Forestry, Republic of Indonesia.

Scenario signs no change small change large change

FOOD

	Diet (large change)	Food waste (large change)
Scenario definition	Between 2015 and 2050, average daily calorie consumption per capita increases from 2,440 kcal to 2,960 kcal. Between 2015 and 2050, per capita kilocalorie consumption: - increases by 77% for fish, - increases by 9% for sugar, - increases by 9% for poultry meat, - increases by 51% for fruits and vegetables, - increases by 68% for other, which includes nuts, - decreases by 4% for oil and fat, and - decreases by 7% for red meat.11 For all other food groups, there is no large shift in consumption.	Between 2015 and 2050, the share of final household consumption which is wasted decreases from 10% to 5%.
Scenario justification	Based on Arifin et al. (2018).	Based on Arifin et al. (2018).

PRODUCTIVITY

	Crop productivity (large change)	Livestock productivity (small change)	Pasture stocking rate (no change)
Scenario definition	Between 2015 and 2050, crop productivity increases: - from 3.4 t/ha to 5 t/ha for rice, - from 4.6 t/ha to 16.3 t/ha for corn, - from 1.4 t/ha to 1.9 t/ha for soy, - from 61.8 t/ha to 87.8 t/ha for sugarcane, and - from 17.1 t/ha to 23.9 t/ha for oil palm fruit.	Between 2015 and 2050, the productivity per head increases: - from 29.1 kg/head to 30.2 kg/head for beef, - from 0.125 kg/head to 0.224 kg/head for chicken, and - from 2.3 t/head to 2.4 t/head for cow milk.	The average livestock stocking density remains constant at 1.9 TLU/ha of pasture between 2015 and 2050.
Scenario justification	According to the *6 Sasaran Strategis Kementerian Pertanian 2015 -2019*, Indonesia will aim to reach rice, corn, and soy self sufficiency and increase sugarcane and meat productivity. According to the Palm Oil Association Company and the Indonesian Government, by the end of 2030 palm oil production is expected to reach about 60 Mt CPO and 160 Mt by 2050 CPO (Kementrian PPN/Bappenas, 2014; Kementerian Pertanian, 2015).	Based on 6 Sasaran Strategis Kementerian Pertanian 2015 -2019, according to which Indonesia will aim to increase meat productivity (Kementerian Pertanian, 2015).	Based on 6 Sasaran Strategis Kementerian Pertanian 2015 -2019, the 4th aim of which is to better allocate resources on agriculture, bioindustry, and bioenergy (Kementerian Pertanian, 2015), however data is scarce on current and potential stocking rates in pastureland in Indonesia.

Scenario signs no change small change large change

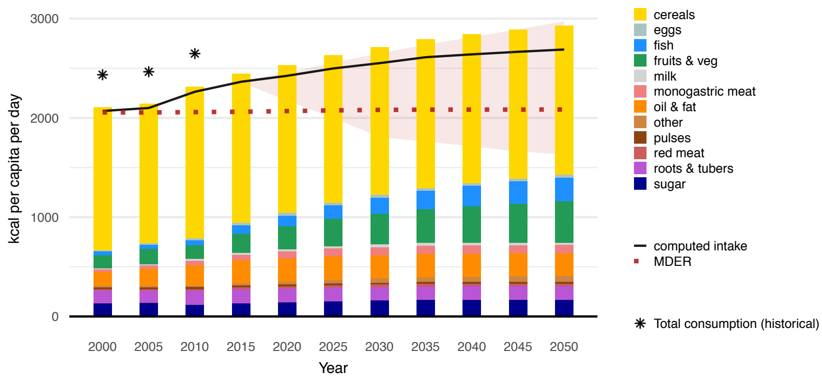
Results against the FABLE targets

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.



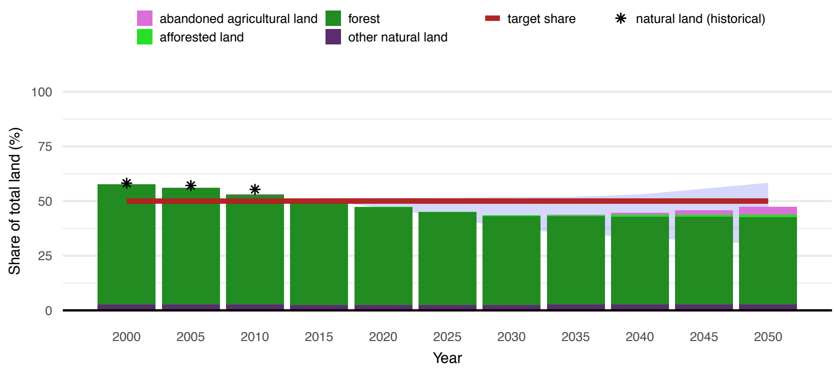
Historical data source: FAOSTAT (2019)

Our results show that average daily energy intake per capita increases between 2000 – 2015, from 2,089 kcal/cap/day and 2,367 kcal/cap/day. Over the last decade, food intake came mainly from cereals such as rice and maize. Calorie intake reaches 2,611 kcal/cap/day over the period 2031-2035 and 2,689 kcal/cap/day over the period 2046-2050. In terms of recommended diet, our results show stable consumption of cereals and higher consumption of fruits and vegetables, fish and sugar. The computed average calorie intake is 30 % higher than the Minimum Dietary Energy Requirement (MDER) at the national level in 2050.

Our results suggest that meeting national food security objectives in terms of reducing under-nourishment is attainable.

Biodiversity

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



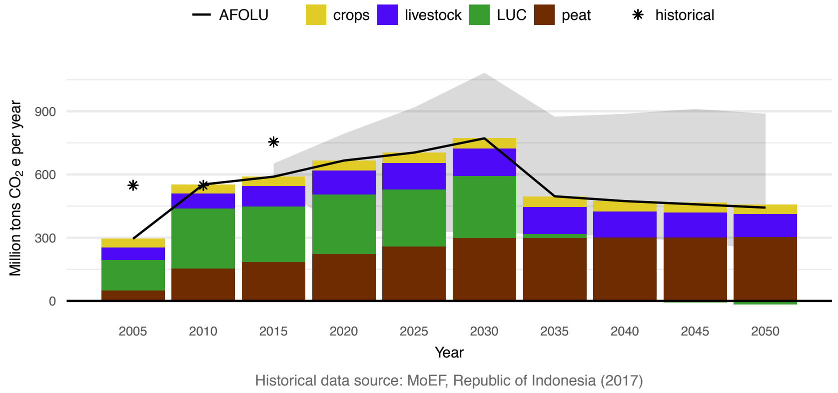
Historical data source: Kementerian Lingkungan Hidup dan Kehutanan (2018)

Our results show that the Share of Land which could support Biodiversity (SLB) decreased between 2000-2015 from 57% to 51%. The lowest SLB is computed for the period 2030 at 43% of total land. This is mostly driven by deforestation due to cropland expansion. SLB reaches 47% over the last period of simulation 2046-2050. The difference is explained by lower deforestation, afforestation, and abandonment of some cropland area where we assume some natural regrowth in vegetation.

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

GHG emissions

Fig. 10 | Computed GHG emissions from land and agriculture over 2000-2050



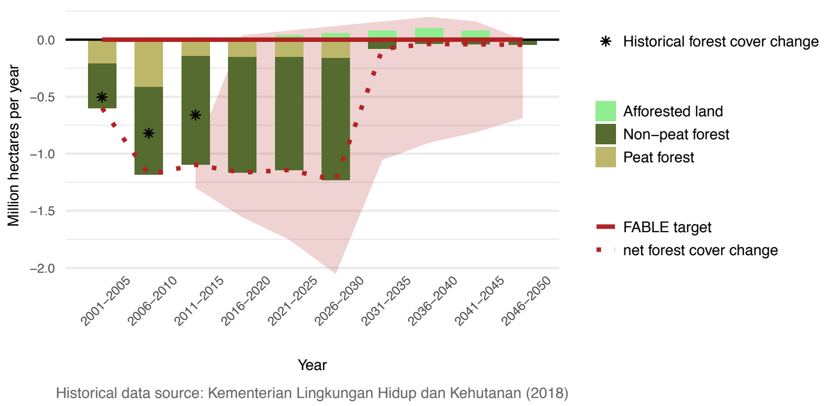
Note: AFOLU (Agriculture, Forestry and Other Land Use) is the sum of computed GHG emissions from crops, livestock and Land Use Change (LUC), emissions and sequestration from forestry are not included. Historical emissions include crops, livestock, peat decomposition, and land use change.

Our results show annual GHG emissions between 295 Mt CO_2e and 583 Mt CO_2e over 2000-2015. These are lower than Indonesia's 2nd Biennial Update Report (Republic of Indonesia, 2018), which estimates 423 Mt CO2e to 856 Mt CO2e from the AFOLU sectors over the same period and an increasing trend. Peak AFOLU GHG emissions are computed for the period 2026-2030 at 772 Mt CO_2e per year. AFOLU GHG emissions reach 443 Mt CO_2e over the period 2046-2050: 155 Mt CO_2e from agriculture, 303 from peatland decomposition and -15 from land use change. Positive net emissions from LULUCF by 2050 are mainly explained by peatland decomposition after drainage.

Compared to the global target of reducing emissions from agriculture, our results show only a slight reduction between 2035 and 2050 and do not meet the target of reaching zero or negative GHG emissions from LULUCF by 2050.

Forests

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



Our results show that annual deforestation ranged between 0.6 Mha and 1.1 Mha from 2005-2015 and tended to decrease over time. This is higher than the net deforestation estimates from the Ministry of Environment and Forestry which show 0.82 Mha in 2006-2010 to 0.66 Mha in 2011-2016.

The deforestation peak is computed for 2030 at 1.2 Mha/year and declines thereafter. This is mostly driven by the expansion of the area under rice, oil palm, cocoa, coconut, and vegetable cultivation. Afforestation is computed from 2015-2050 and leads to a zero or slightly positive net forest cover change over 2035-2045.

Compared to the global target of having zero or positive net forest change after 2030, our results almost reach the target with a net afforestation over 2030-2045 and a slightly negative forest change in 2050 (-45 kha/year).

Other relevant results for national objectives

Table 1 | Other Results

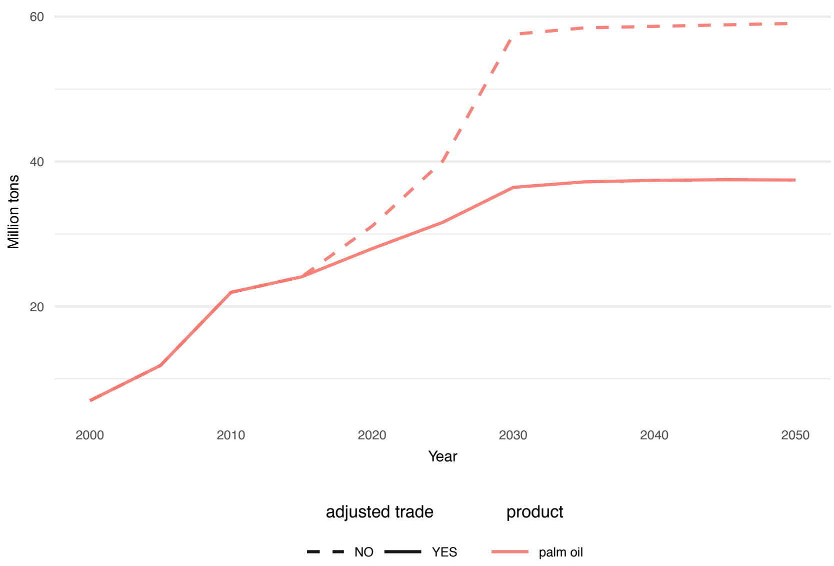
Variable	Unit	2000	2005	2010	2015	2020	2030	2040	2050
Palm oil									
Production (historical)	Mt	7.0	11.9	22.0					
Production (calculated)	Mt	7.0	11.9	21.9	24.1	31.1	57.6	58.7	59.1
Exports (calculated)	Mt	4.7	11.2	17.5	19.2	26.0	51.9	52.5	52.5

Source of historical data: FAOSTAT

Palm Oil production is projected to continue increasing until 2050. However, production begins to stabilize from 2030 onwards, reaching a level of 59 Mt in 2050. Historically, Indonesian exports amounted to approximately 32 Mt in 2015 (Kementerian Pertanian, 2016), which is higher than the calculated export quantities of 17.5 Mt. The projected exported quantities increase almost threefold until 2030, reaching 51.9 Mt compared to the calculated value for 2015. From 2035 to 2050, the exported quantities remain stable at 52.5 Mt.

Impacts of trade adjustment to ensure global trade balance

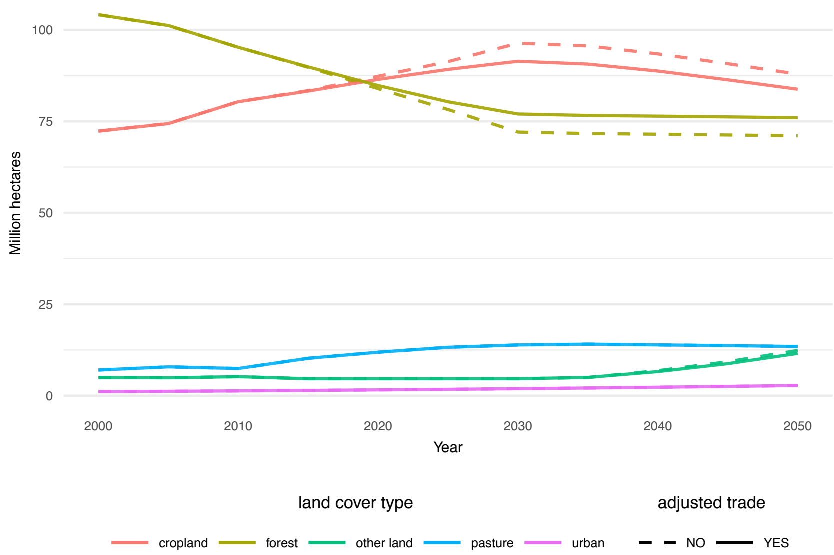
Fig. 12 | Impact of global trade harmonization on main exported/imported commodities over 2000-2050



Changes between the results with and without trade adjustment appear first in 2020 and become more pronounced from 2030 onwards, peaking in 2050 with a 41% reduction in palm oil exports compared to the results without trade adjustment. Historically, Indonesia's oil palm export amounted to 28 Mt in 2015, therefore our results tend to underestimate past growth in palm oil exports.

No change is observed between the results for imported commodities with and without trade adjustments.

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



The trade adjustment affects results concerning cropland and forested area starting in 2020. The cropland area declines by 4.7% and forest area increases by 7% by 2050 compared to no trade adjustment. This mostly results from the adjustment in palm oil exports after trade adjustment.

Discussion and next steps

In the context of the FABLE Scenathon, the Indonesian team has applied a set of assumptions to support pathways that help realize collective goals. The assumptions and some of the associated challenges and limitations of these initial results are discussed below.

Reflecting Indonesia's strong economic ambitions, per capita GDP increases by 19% in 2050, following the SSP1 scenario for GDP and the UN constant fertility scenario for population growth. The sustainable pathway scenario targets 2 Mha for ecosystem restoration by 2050. A moderate increase of crop and livestock productivity is set toward 2050 to maintain stable import volumes for all products with the exception corn and milk which increase and rice which decreases. The exported quantities of the main exported commodities strongly increase throughout the period. Food waste is set to decrease while the per capita consumption of cereals increases which leads to an increase in total calorie consumption per capita.

One of the main challenges faced in the process of refining the FABLE Calculator was setting limitations on certain values that can be achieved in a given time step. For example, in our scenario, we selected high productivity for corn. This resulted in the yield increasing from 4.6 to 16.3 tons per hectare. These numbers are currently unrealistic compared to the literature on maximum corn yields, which show a maximum of around 10 tons per hectare. There are also opportunities to refine the results concerning greenhouse gas emissions. These include, for example, capturing the various sources for peat emissions from the AFOLU sector in greater detail e.g. peat decomposition dynamics and the representation of peat fires.

Some of the strategic national policies should be better reflected in the Calculator. The Calculator places a strong emphasis on food production to meet a certain level of demand with limited consideration of land availability. In Indonesia, many farmers still practice slash and burn (shifting cultivation) in forest area that is characterized by low cropping intensity and low productivity compared to permanent agriculture. Increasing crop productivity and cropping intensity are the main targets for the agricultural sector to reduce demand for land. TORA (Tanah Objek Reforma Agraria) and Social Forestry (SF) are among the national policies which are designed to provide legal access to communities for owning and managing forest area. Under the TORA program, a community is provided legal certainty over land ownership within the forest area. With the legal ownership over the land, farmers will have access to government subsidies, credit, and extension services for supporting their farming activity on the land. Under the SF program, a community can be granted permits to manage the forest area for agroforestry or timber plantations (Community Timber Plantation-HTR, Community Forestry and Village Forest). The government has allocated approximately 4.9 million hectares and 12 million hectares of forest area for TORA and SF, respectively. These programs will contribute to the increase of crop production.

Our reforestation numbers come from the Indonesian private sector pledges made to the Bonn Challenge in 2015 and the historical reforestation rate trends in Indonesia. However, according to the Indonesian National Restoration plan, afforestation/reforestation should reach around 30 Mha (International Union for Conservation of Nature, 2015), mainly focusing on conservation areas. In the Indonesian context, reforestation means reforesting non-forested land in forest areas, while afforestation aims to reforest non-forested land in non-forest areas (APL).

In addition, the biodiversity aspects in the Indonesian FABLE Calculator also need more work in the future. In particular, the Calculator should be aligned with the different conservation statuses in Indonesia and our classification systems on protected areas, which are good methods for achieving unbiased results. Protected forest in Indonesia is classified into two functions: conservation forest (i.e. Nature Conservation Area) and protection forest (Hutan Lindung). In the draft Medium-Term Development Plan for Forestry, the conservation forest will be about 22.1 Mha and Protection Forest about 29.6 Mha (KLHK, 2018).

Finally, the one map policy is still in progress and will likely affect data availability and resolve some data inconsistencies among ministries. Collaboration among ministries working on low-carbon development needs to be improved and policies relating to future land demands across sectors need to be synchronized. Bringing together institutions and governmental and non-governmental organizations will help stakeholders understand the pathways needed for Indonesia to achieve sustainable food and land-use systems and guide their implementation.

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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