

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 Colombia by 2050



Colombia

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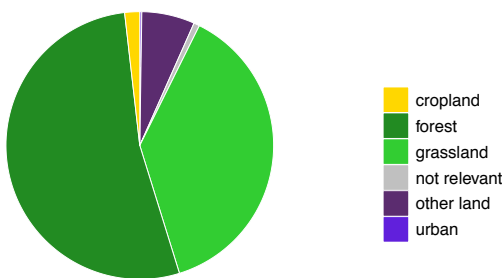
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Land and food systems at a glance

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

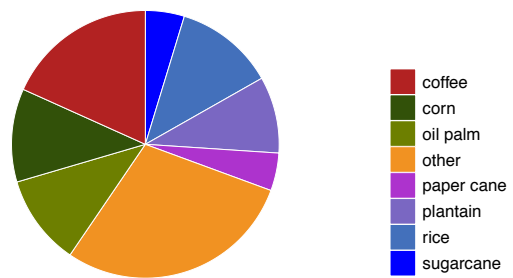
Land & Biodiversity

Fig. 1 | Area by land cover class in 2010-2012



Source: Ideam, Rodríguez & Peña (2013)

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



Source: Min. de Agricultura & Desarrollo (2016)

Annual deforestation in 2015:
124 kha = 0.21% of total forest area

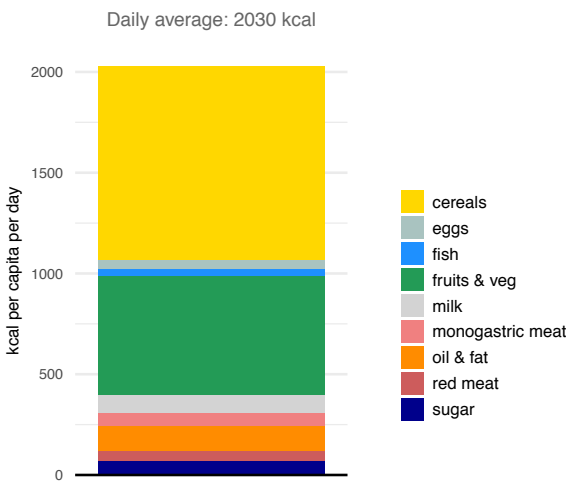
(González et al., 2018)

Endangered species: 1,203 species

(Ministerio de Ambiente y Desarrollo Sostenible., 2019)

Food & Nutrition

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



Source: Min. de la Protección, S., Inst. Nacional de, S., & Uni. de, A. (2011)

Share of undernourished in 2015:

Children age 0-4 years: 10.8%
Children age 5-12 years: 7%
Children age 13-17 years: 10%

(ICBF, 2015)

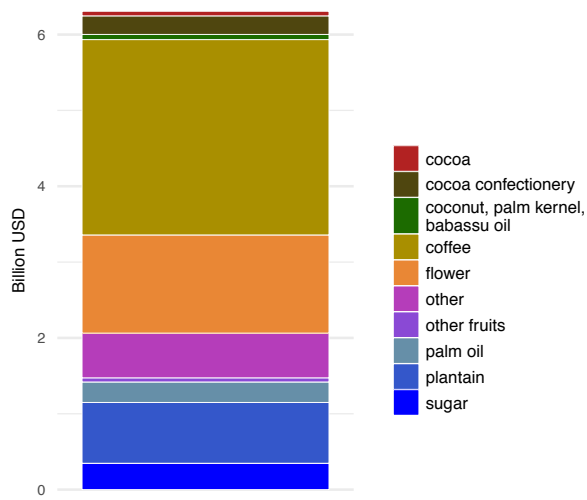
Share of overweight in 2015:

Children age 0-4 years: 6.3%
Children age 5-12 years: 24.4%
Children age 13-17 years: 17.9%
Adult age 18-64 years: 37.7%

(ICBF, 2015)

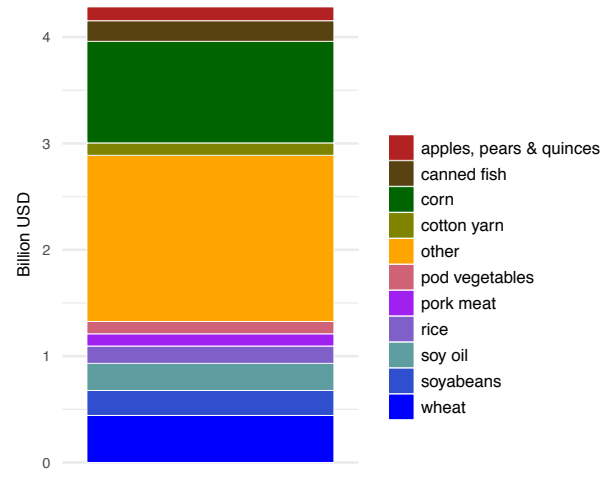
Trade

Fig. 4 | Main agricultural exports by value in 2015



Source: Dian (2018)

Fig. 5 | Main agricultural imports by value in 2015



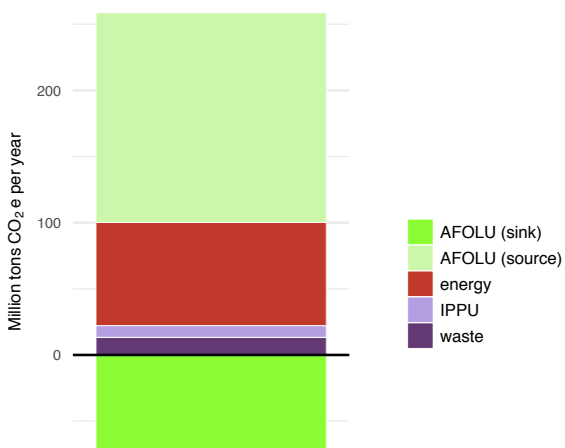
Source: Dian (2018)

Surplus in agricultural trade balance in 2015:
USD 2.6 bln
(DANE, 2019)

3rd most important coffee exporter in the world in 2015
(International Coffee Organization, 2019)

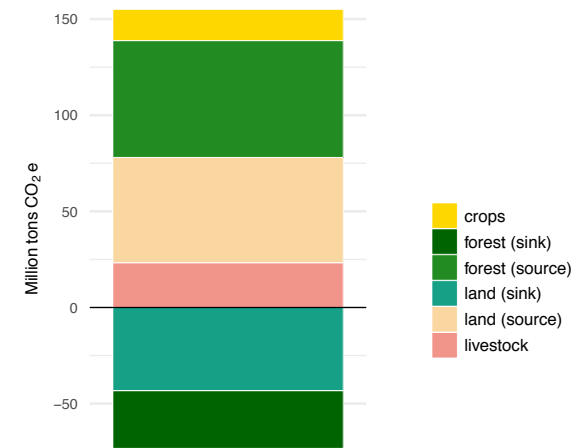
GHG Emissions

Fig. 6 | GHG emissions by sector in 2012



Source: Ideam, Pnud, Mads, Dnp, & Cancilleria (2017)




Fig. 7 | GHG emissions from agriculture and land use change in 2012






Source: Ideam, Pnud, Mads, Dnp, & Cancilleria (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 | |
|---|--|
|  | |
| Scenario definition | |
| GDP per capita  | Population  |
| GDP per capita is expected to increase by 416% from USD 4,750 in 2000 to USD 16,468 in 2050. | The population is expected to stay quite stable between 2015 and 2050, from 48.2 mln to 48.5 mln (UN low growth scenario was selected). |
| Scenario justification | |
| Assuming a scenario in which the GDP growth rate is above 4.2% and a population growth close to 1%, an increase in GDP per capita of this magnitude is possible under a very optimistic scenario. However, this choice of scenario contrasts with other scenarios based on historical trends that expect a 70% increasing in GDP per capita by 2050 (Guillemette and Turner, 2018). | Currently, the National Administrative Department of Statistics (DANE) - the governmental office in charge of population censuses in Colombia, is finalizing data processing for the most recent population census (DANE, 2018). As of November 2018, with a geographic coverage of 99.8%, Colombia's population is approximately 45.5 mln (DANE, 2018). This value falls short by around 3 mln with respect to the projected one by UNDESA (2017) for the year 2015 (48.2 mln). Additionally, it is around 5 mln less than the total expected for 2020. Considering the above, the low growth scenario was deemed appropriate (UNDESA, 2017; DANE, 2018). |

| TRADE | |
|---|--|
|  | |
| Scenario definition | |
| Imports  | Exports  |
| The share of total consumption, which is imported stays constant at 2010 levels for crop and livestock commodities. | The exported quantity increases: <ul style="list-style-type: none"> - from 1.7 Mt in 2015 to 2.4 Mt in 2050 for banana, - from 0.7 Mt in 2015 to 1.1 Mt in 2050 for sugar, and - from 0.2 Mt in 2015 to 1.6 Mt in 2050 for palm oil. The exported quantity remains constant at 2010 levels for the other commodities. |
| Scenario justification | |
| According to official statistics, Colombia imports a high volume of cereals to satisfy internal demand. Wheat, barley, and approximately 70% of corn have been imported during the last decades (DANE, 2019). It is highly probable that this trend continues in the future. Colombia is unable to produce most cereals at a competitive cost compared to production costs in other latitudes where soil and climatic conditions allow for a more efficient crop production. Hence, the country is, and will be in the near future, highly dependent on food imports. | According to FAO, world production for banana has been increasing at a rate of 3.5%/year during the last 30 years. In Colombia, production for the same period has been increasing at a rate of 4.3%/year. Most of the production in Colombia is intended for export; in 2018 Colombia sent bananas to 31 countries around the world. We can expect that this trend will continue in the years to come. The palm oil crop has been increasing in the last decade in Colombia, from 300 kha in 2007 to ca. 500 kha in 2017. During the same period exports and internal consumption have both increased substantially. Colombian coffee production and exports have been decreasing slightly over the last two decades (FAO, 2017). |

Scenario signs  no change  small change  large change



Scenario definition

Scenario justification

LAND

Land conversion

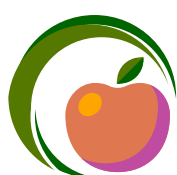
We assume that deforestation will be halted beyond 2030.

The changes expected on the deforestation patterns follow the response to current national policies. Colombia's Paris Agreement commitments bound the country to zero deforestation by 2020 (IDEAM et al., 2017; SIAC and Ministerio de Medio Ambiente y Desarrollo Sostenible, 2017).

Afforestation

We assume total afforested/reforested area to reach 2 Mha by 2050.

Colombia's Bonn Challenge commitment is to restore 1 Mha by 2020. Although, the program has had a slow start and many areas are planned to be restored by 2020, current afforestation (restoration) levels are far from the goal with ca 86 kha restored (Ospina et al., 2015; Bonn Challenge, 2014).



Scenario definition

Scenario justification

FOOD

Diet

Between 2015 and 2050, the average daily calorie consumption per capita decreases from 2,316 kcal to 2,267 kcal. Per capita consumption:

- increases by 7% for pig and poultry meat,
- decreases by 1.6% for milk,
- decreases by 4.7% for eggs,
- decreases by 5.4% for vegetable oil,
- increases by 1.4% for sugar, and
- remains constant for the other food groups.

The OECD (2019) expects an increase in meat consumption from 2017 to 2027:

- beef and veal: by 7%, from 11.47 kg/cap to 12.34 kg/cap,
- poultry: by 10.6% from 28.61 kg/cap to 32.01 kg/cap, and
- pork: from 7.09 kg/cap to 8.02 kg/cap.

Food waste

Between 2015 and 2050, the share of final household consumption which is wasted decreases from 10% to 5%.

There are no official statistics nor comprehensive studies on food waste associated to household consumption in Colombia. In 2016, the National Planning Department of Colombia published a study (based on 2007 data) estimating that 16% of food waste in the country occurs from the consumption side, chiefly from households (DNP, 2016). Although, the government of Colombia recognizes the importance of formulating national policies to deal with the problem of food waste, the process is at its very early stages, with no targets and specific policy instruments set in place to tackle the problem (FAO, 2016). Assuming strong commitment from the government and relevant stakeholders for developing comprehensive and ambitious policies on the issue, it would be expected that by 2050 the share of final household consumption should decrease to 5% for the year 2050.

Scenario signs  no change  small change  large change



BIODIVERSITY

Protected areas =

Scenario definition

The protected areas remain constant between 2015 and 2050.

Scenario justification

Protected areas have been recently expanded by 1.5 Mha as referred to in the National Bill 125 from 2015 "Expansion of protected areas in Colombia" (Parques Nacionales Naturales de Colombia, 2018).



PRODUCTIVITY

Crop productivity ↗

Between 2015 and 2050, crop productivity:

- increases from 18.9 t/ha to 21.2 t/ha for oil palm fruit,
- increases from 2.7 t/ha to 4.6 t/ha for corn,
- remains constant at 2.8 t/ha for rice, and
- remains constant at 0.7 t/ha for coffee.

Livestock productivity ↗

Between 2015 and 2050, the productivity per head increases:

- from 0.8 kg/head to 1.5 kg/head for poultry meat, and
- from 1.2 kg/head to 2.6 kg/head for eggs.

It remains constant from 2015 to 2050 for the other livestock products.

Pasture stocking rate =

The average livestock density remains constant at 0.5 TLU/ha of pastureland between 2015 and 2050.

Scenario definition

Scenario justification

Corn productivity is expected to increase in the future following historical trends from the last decade according to FAOSTAT (2019a) and national production reports (Ministerio de Agricultura y Desarrollo Sostenible, 2016). Rice productivity is expected to remain constant due to the historical trends and lack of technological development, according to FAO and national production reports (FAOSTAT, 2019; Ministerio de Agricultura y Desarrollo Sostenible, 2016).

We assume there will be an increase in poultry productivity reflecting the trend observed during the last decade interval. For the other livestock products, productivity remains constant, changing only in overall numbers but not in terms of their efficiency (FEDEGAN, 2019).

Livestock density has remained stable (between 0.55-0.6 TLU/ha) during the last 40 years (FEDEGAN, 2019). Additionally, Colombia's population is expected to remain relatively stable by 2050 as indicated above.

Scenario signs = no change → small change ↗ large change

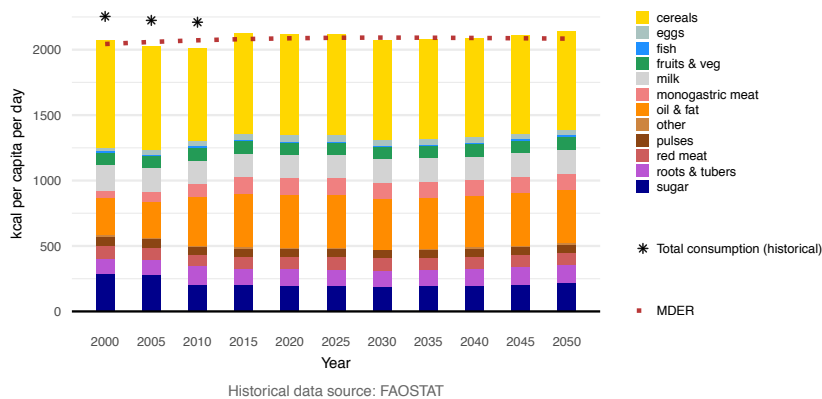
Results against the FABLE targets

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.

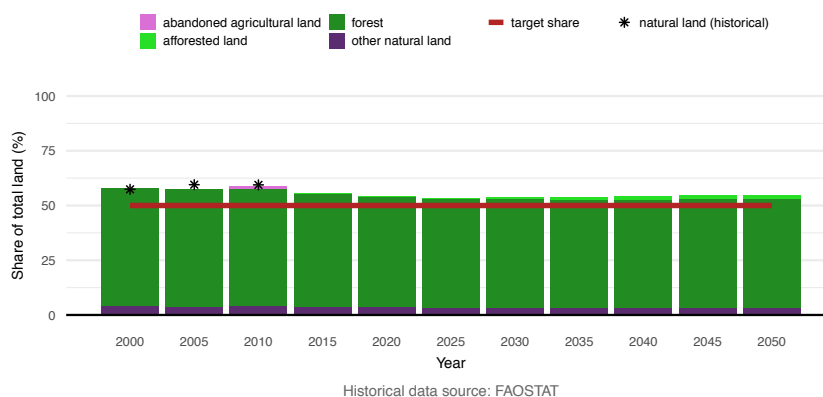


Our results show average daily energy intake per capita increases from 2,159 to 2,330 kcal/cap/day between 2000-2015. Calorie intake reaches 2,121 kcal/cap/day over the period 2031-2035 and 2,135 kcal/cap/day over the period 2046-2050. In terms of recommended diet, our results show quite stable diet over 2000-2050.

Our results show that the feasible average daily intake is at the limit of the minimum intake (MDER) which has been computed based on projections of the age and sex composition of the population, average activity level and recommendations. If we would add categories which are not yet included in the FABLE Calculator, the available energy intake would be 3% higher than the MDER in 2030 and 7% of the MDER in 2050.

Biodiversity

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

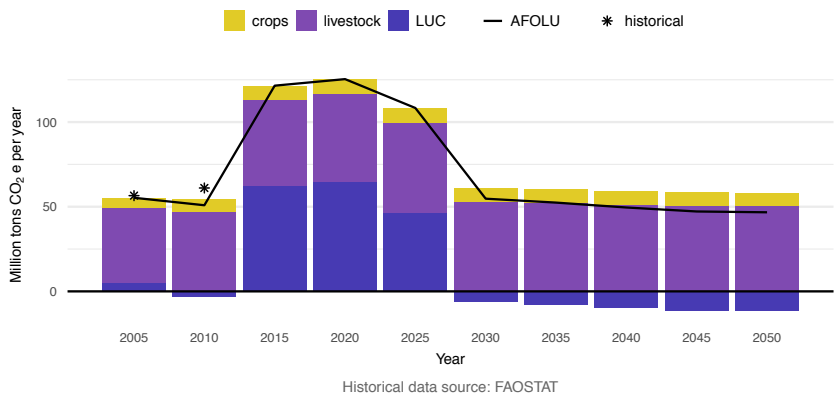


Our results show that the Share of Land which could support Biodiversity (SLB) remains relatively constant at 69% between 2000-2010 with a decrease towards 2015 following the deforestation rates for the same period (57%). After the lowest value is reached in 2025 at 55%, SLB slowly increases thanks to the afforestation efforts and reaches 56% over the last period of simulation, 2046-2050.

Compared to the global target of having at least 50% SLB by 2050, our results are above the target. Our results are consistent with national biodiversity conservation targets according to the national biodiversity monitoring program by the Humboldt Institute (Gomez et al., 2016).

GHG emissions

Fig. 10 | Computed GHG emissions from land and agriculture



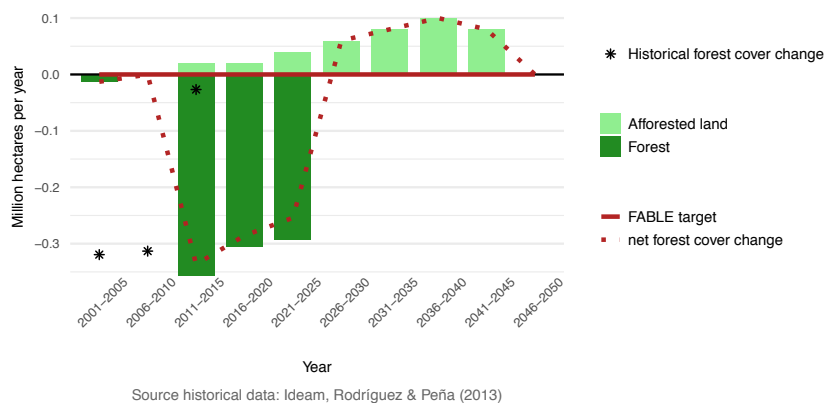
Note: AFOLU (Agriculture, Forestry and Other Land Use) is the sum of computed GHG emissions from crops, livestock and Land Use Change (LUC), emissions and sequestration from forestry are not included. Historical emissions include crops and livestock.

Our results show annual GHG emissions between 44 and 120 Mt CO₂e over 2000-2015 which increase over time. Although, the final values are similar to those observed in the national monitoring program, the trend is misleading. The observed emissions from AFOLU for the country remained relatively stable since 2000 with slight increases until 2012 (IDEAM et al., 2017). Peak AFOLU GHG emissions are computed for the period 2016-2020 at 125 Mt CO₂e/year. This is mostly driven by GHG emissions from deforestation. AFOLU GHG emissions reach 47 Mt CO₂e over the period 2046-2050: 58 from agriculture and -11 from LUC. Negative emissions from LUC by 2050 are mainly explained by the halt of deforestation after 2030 and some abandonment of agricultural land.

Compared to the global target of reaching zero or negative GHG emissions from LULUCF by 2050, our results are above the target. Colombia committed to reduce its emissions to its 2015 level by 2030 with an overall reduction of emissions of 66.5 Mt CO₂e. This can be achieved if the policies to control deforestation and the restoration program (i.e. Bonn Challenge) are fully implemented.

Forests

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



Our results show an annual deforestation of 357 kha/year between 2010-2015. This is above the national estimates reported by the National Forest Monitoring program for Colombia (González et al., 2018). This program reported an average of 350 Mha/year over 2001-2007. Colombia is committed to zero deforestation by 2030. Our deforestation results are mostly driven by pastures for cattle and to a lower extent, cropland expansion due to corn, soybean, and rice expansion. In reality, the expansion of coca also contributes to deforestation, but this crop is not included in the Calculator. Over 2026-2030, we compute that forest regrowth will offset 70% of the deforestation over the period. Since we have implemented a zero-deforestation policy after 2030, afforestation will be the dominant feature of forest dynamics after 2030.

Our results meet the national commitments with a 5 to 10-year delay. Colombia was committed to have zero deforestation by 2020 but the current trends are indicative of a lack of control on deforestation and the inability of the country to stop the social dynamics causing the deforestation hotspots.

Other relevant results for national objectives

Table 1 | Other Results

| Variable | Unit | 2000 | 2005 | 2010 | 2015 | 2020 | 2030 | 2040 | 2050 |
|---|------|------|------|------|------|------|------|------|------|
| Computed exported quantities of selected commodities | | | | | | | | | |
| Banana | Mt | 1.5 | 1.6 | 1.7 | 1.6 | 1.7 | 2.2 | 2.3 | 2.5 |
| Sugar Raw | Mt | 1.1 | 1.2 | 0.8 | 0.7 | 0.8 | 1.0 | 1.0 | 1.1 |
| Palm Oil | Mt | 0.1 | 0.2 | 0.2 | 0.3 | 0.5 | 1.4 | 1.5 | 1.6 |
| Coffee | Mt | 0.6 | 0.6 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |

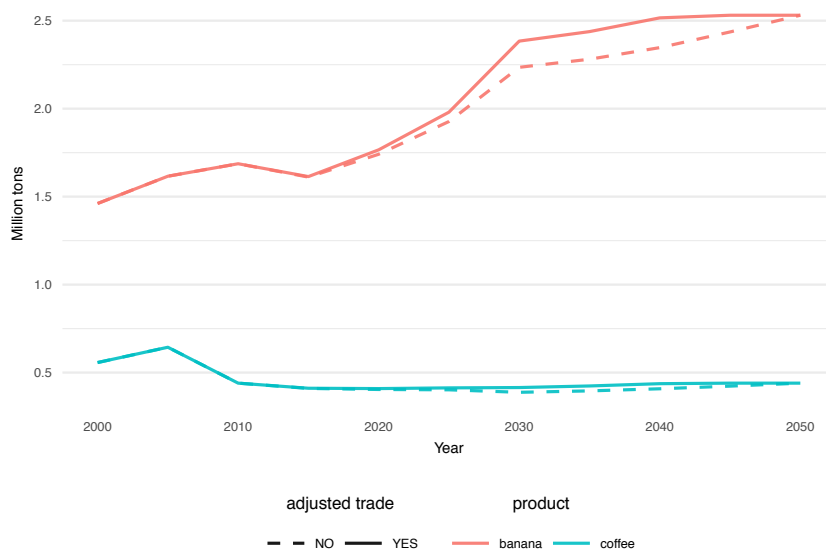
Historical wheat production has fluctuated about a mean quantity of around 15 Mt, which is matched well by the Calculator. Our results suggest that wheat production will increase overall given the scenario assumptions made. This is due to a balance between a reduction in cropland and an increase in yield over the model integration.

The Calculator matches historical beef production data well, as both FAOSTAT (2019) and the Office for National Statistics (2019) indicate a growth from around 700 kt to 900 kt between 2000 and 2015. Beef production decreases over the next 35 years, driven by the shift away from a meat-based to a plant-based diet. The reduction in production is not as severe as the change in pasture land cover would imply due to an increase in both livestock productivity and stocking density.

The Calculator generally matches the historical trends well. We see large changes away from productive land to “other land” and new forest. This is consistent with the high ambition scenario of the CCC Land Use Report (Committee on Climate Change, 2018).

Impacts of trade adjustment to ensure global trade balance

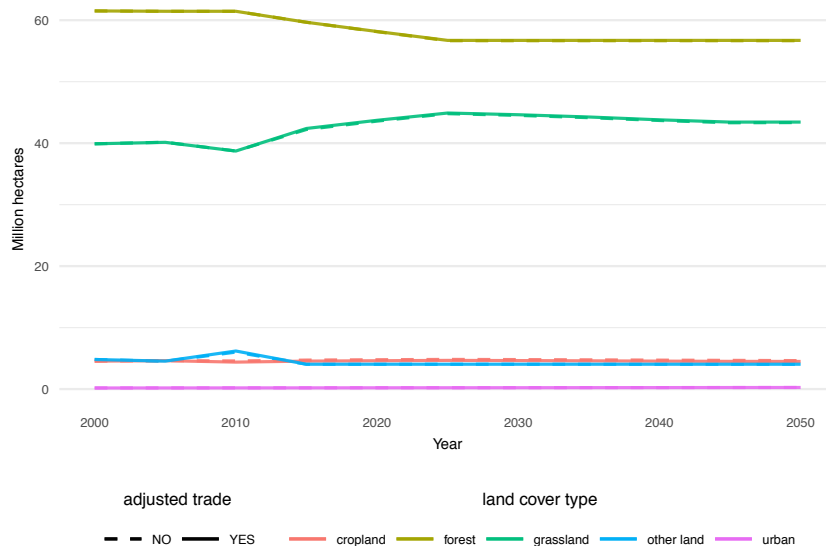
Fig. 12 | Impact of global trade harmonization on main exported/imported commodities over 2000-2050



The trade balance adjustment resulted in small reduction in exported quantities of banana and coffee.

Colombia imports most of its oil and oilseeds such as soy and sunflower oil, soybeans, and sunflower seeds. Another relevant group of imported food are cereals, mostly wheat, corn, and barley. After the trade balance there are no changes in the import quantities for these main products.

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



Trade adjustment does not have significant impacts on land use in Colombia.

Discussion and next steps

In the last decades, the main driver of deforestation in Colombia has been the growing of illicit crops and the low productivity of cattle (pastures) both operating under a strategy of land grabbing not intended for food production. This phenomenon is spatially complex and difficult to control, despite efforts by the Colombian and US governments. Furthermore, we consider that crop production should be planned according to water availability and existing infrastructure for water distribution. The current limitations of crop production at the national level are mostly due to the lack of efficient irrigation. The production costs of crops should include environmental costs such as non-point water pollution and/or land degradation.

In order to develop an accurate long-term pathway for Colombia, a small economy vulnerable to sudden changes in trends, inertia, and a climate-dependent crop production the representation of short-term variability in the FABLE Calculator should be improved.

From the land-use sector and GHG emissions perspectives, electricity generation is an important source of environmental change in Colombia. We consider that future developments of the FABLE Calculator would benefit from the inclusion of this economic dimension.

Colombia faces important food security challenges for the decades ahead as it imports a large proportion of the cereals and oil seeds necessary for human consumption and animal feed. The costs of national production in Colombia given the soil and climatic conditions are not competitive enough compared to the products available on the international trading market to allow for a sufficient national production. In addition, the Colombian food production will be affected by climate variability as most of the national production relies on seasonal rains with a very

limited use of irrigation making crops susceptible to droughts (i.e. coffee, sugar cane, oil palm, cacao, and rice).

The FABLE Calculator allows us to understand the challenges that the country faces to feed its own population. The evidence provided by the FABLE Calculator is allowing us to suggest that it is urgent to develop long term policies aimed at promoting food security based on a balanced diet and limiting the competition between land dedicated to food production and to forested areas. The policies should be based on quantitative science-based evidence and not only on short term political expectations. The FABLE Calculator can support the decision-making process led by policy makers by highlighting the impact of different agricultural expansion scenarios and technological development strategies on the rates of greenhouse gas emissions at the national level.

Units

% – percentage

bln – billion

cap – per capita

CO₂ – carbon dioxide

CO₂e – 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

km² – 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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Colombia

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