International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

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

Published by International Institute for Applied Systems Analysis (IIASA) and the Sustainable Development Solutions Network (SDSN) 2019

The full report is available at www.foodandlandusecoalition.org/fableconsortium.
For questions please write to info.fable@unsdsn.org

Disclaimer
The 2019 FABLE report was written by a group of independent experts acting in their personal capacities. Any views expressed in this report do not necessarily reflect the views of any government or organization, agency, or programme of the United Nations.

Recommended citation: Jha C., Ghosh R., Chaturvedi V. and Anand M. (2019), "Pathway to sustainable Land-Use and Food Systems in India by 2050" In: FABLE 2019, *Pathways to Sustainable Land-Use and Food Systems,* 2019 Report of the FABLE Consortium, Laxenburg and Paris: International Institute for Applied Systems Analysis (IIASA) and Sustainable Development Solutions Network (SDSN), pp. 206-219.

Recommended Creative Commons (CC) License:
CC-BY-NC-ND 4.0 (Attribution-NonCommercial-NoDerivatives 4.0 International).

Design, layout and production by Phoenix Design Aid A/S, a CO2 neutral company accredited in the fields of quality (ISO 9001), environment (ISO 14001) and CSR (DS 49001) and approved provider of FSC™ certified products. Printed on environmentally friendly paper without chlorine and with vegetable-based inks. The printed matter is recyclable.

2019 Report of the FABLE Consortium

Pathways to Sustainable Land-Use and Food Systems in India by 2050

India

Chandan Kumar Jha[1*], Ranjan Ghosh[1], Vaibhav Chaturvedi[2], Manish Anand[3]

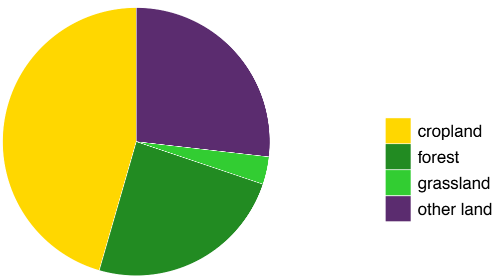
[1] Indian Institute of Management Ahmedabad (IIMA), Ahmedabad, India. [2] Council on Energy, Environment and Water (CEEW), New Delhi, India. [3] The Energy and Resources Institute (TERI), New Delhi, India.
*Corresponding author: chandankj@iima.ac.in

Land and food systems at a glance

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

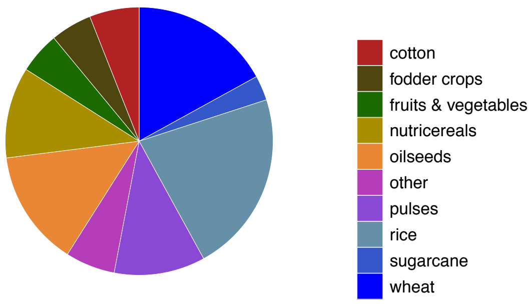
Land & Biodiversity

Fig. 1 | Area by land cover class in 2015



Source: Directorate of Economics & Statistics (2015)

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



Source: Directorate of Economics & Statistics (2015)

708,273 km² of forest area, of which 340,000 km² is degraded forestland

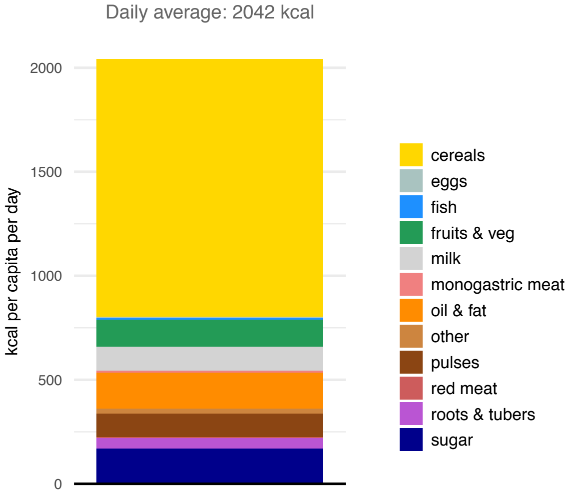
(TERI, 2018)

Endangered species: 172 species of plants

(IUCN Red List, 2019)

Food & Nutrition

Fig. 3 | Daily average intake per capita at the national level in 2011-2012



Source: NSS Report No. 558 (2011–12)

Share of undernourished in 2018: 14.8%

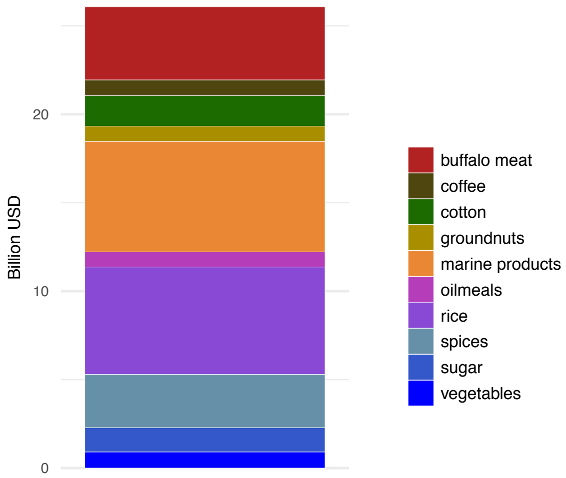
(FAO, IFAD, UNICEF, WFP and WHO, 2018)

Share of obese in 2016: 4.15%

(World Obesity Federation, 2017)

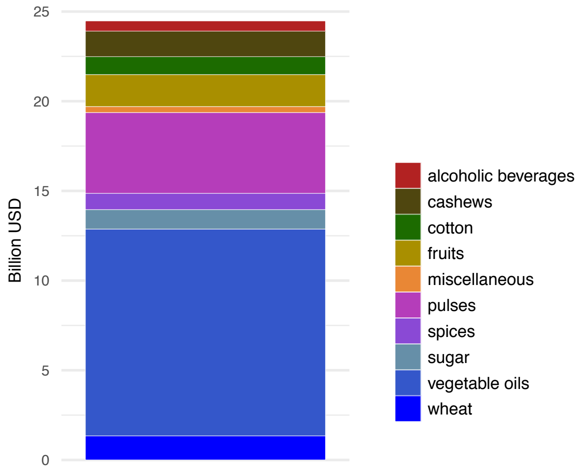
Trade

Fig. 4 | Main agricultural exports by value in 2017



Source: Ministry of Commerce & Industry (2018)

Fig. 5 | Main agricultural imports by value in 2017



Source: Ministry of Commerce & Industry (2018)

Surplus in agricultural trade balance in 2017: INR 619.25 bln

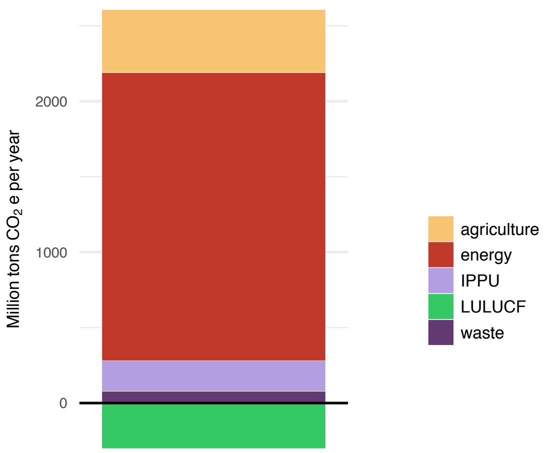
(Directorate of Economics and Statistics, 2018)

9th/7th most important exporter/ importer in the world in 2018

(World Trade Organisation, 2018)

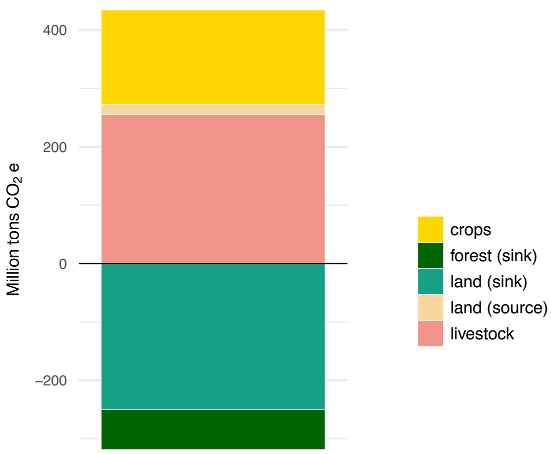
GHG Emissions

Fig. 6 | GHG emissions by sector in 2014



Source: Ministry of Environment, Forest & Climate Change (2018)

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



Source: Ministry of Environment, Forest & Climate Change (2018)

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	Population
Scenario definition	GDP per capita is expected to increase by 436% from USD 1,757 in 2015 to USD 7,712 in 2050 (SSP1 scenario selected).	The population is expected to increase by 31.57 % between 2015 and 2050 from 1.31 bln to 1.83 bln (UN constant fertility rate scenario selected).
Scenario justification	This strong growth in GDP per capita in India is also forecasted by other studies (Leimbach et al., 2017; PWC, 2017).	This is based on UN projections. Currently, India's population is 1.31 bln and it is expected to reach approximately 1.4 bln by 2022. The projection suggests that India's population will continue to grow for several decades up to 1.5 bln in 2030 and 1.8 bln in 2050 (United Nations, Department of Economic and Social Affairs, Population Division, 2015).

TRADE

	Imports	Exports
Scenario definition	The share of total consumption which is imported increases: - from 32% in 2015 to 63% in 2050 for soy oil. The share of total consumption which is imported remains constant at 2010 levels for the other commodities.	The exported quantity : - increases from 2.31 Mt in 2015 to 4.51 Mt in 2050 for rice, - increases from 2.6 Mt in 2015 to 4.7 Mt in 2050 for corn, - increases from 0.3 Mt in 2015 to 0.6 Mt in 2050 for milk, and - remains constant at 2010 levels for other products.
Scenario justification	India's agricultural imports, which accounted for 4.47% of India's total imports in 2014-15, registering a growth of nearly 17.8% between 2012 and 2015 (NCAER, 2015).	The pathway is based on the recent agricultural export policy of the Indian Government (Department of Commerce, 2018). The policy focuses on export-oriented production and better farm management to double farmers' income by 2022. It also aims to double agricultural exports from current USD 30 bln to USD 60 bln by 2022, and reach USD 100 bln in the next few years thereafter, relying on a stable trade policy regime. There is also an objective of diversifying our export basket, destinations, and boost high-value and value-added agricultural exports with a focus on perishables.

Scenario signs no change small change large change

LAND

	Land conversion	Afforestation
Scenario definition	We assume no expansion of agricultural land beyond 2015 agricultural area levels.	We assume total afforested/reforested area to reach 2.1 Mha 2050.
Scenario justification	Based on the Agricultural Statistics of India (2018), there has been very negligible change in agricultural land expansion since 2010. This can be explained by the fact that India is committed to its afforestation targets, and that cropping intensity has increased thus allowing for the necessary feeding of the growing population.	Based on India's Bonn Challenge Commitment (2014) and INDC (Government of India, 2015) which state that India's forest cover has increased, "from 23.4% in 2005 to 24% of the geographical area in 2013". The forest and tree cover of India is 24.39% of total land area or 80.20 Mha according to India's 2017 State of Forest Report (Forest Survey of India, 2017), India has pledged to restore 13 Mha of degraded and deforested land by 2020, and an additional 8 Mha by 2030.

BIODIVERSITY

	Protected areas
Scenario definition	The protected areas remain constant between 2015 to 2050.
Scenario justification	In India, the total area for conservation which is under protection ranges between 15 Mha in 2000 to 16.5 Mha in 2019 and has remained stable over the last 5 years. This area includes natural parks, wildlife sanctuary, community reserves, and conservation reserves (ENVIS Centre on Wildlife and Protected Areas, 2019).

OTHER

	Cropping Intensity
Scenario definition	We assume that the average crop harvesting intensity will increase from 1.1 in 2010 to 1.3 in 2030 and will remain constant at 2030 level for the rest of the period.
Scenario justification	The national statistics on land use show that cropping intensity is increasing in India (Department of Agriculture Cooperation and Farmers Welfare, 2018).

Scenario signs no change small change large change

	FOOD	
	Diet	**Food waste**
Scenario definition	Between 2015 and 2050, the average daily calorie consumption per capita increases from 2,116 kcal to 2,453 kcal. Per capita consumption: - decreases by 16% for cereals, - increases by 26% for milk, and - increases by 74% for the other food products.	Between 2015 and 2050, the share of household consumption which is wasted decreases from 10% to 5%.
Scenario justification	Studies suggest that as income will continue to rise, diets are projected to both diversify nutritionally and increase total energy intake, particularly from meat and dairy products (Ranganathan et al., 2016; Aleksandrowicz et al., 2019; Alexandratos and Bruinsma, 2012; NCAER, 2015; Indian Council of Agricultural Research, 2015).	Our assumption is based on several efforts made by the government and NGOs to reduce food waste in India by promoting awareness among large portions of the population over food wastage (Invest India, 2019).

	PRODUCTIVITY		
	Crop productivity	**Livestock productivity**	**Pasture stocking rate**
Scenario definition	Between 2015 and 2050, crop productivity increases: - from 2.2 t/ha to 3.7 t/ha for rice, - from 2.6 t/ha to 6.6 t/ha for corn, - from 0.05 t/ha to 0.44 t/ha for peas, and - from 70 t/ha to 75 t/ha for sugarcane.	Between 2015 and 2050, the productivity increases: - from 0.2 kg/head to 0.4 kg/head for chicken meat, - from 173 kg/TLU to 178 kg/head for pig meat, and - from 2.6 t/TLU to 4 t/TLU for cattle milk.	The average livestock stocking density remains constant at 12.38 TLU/ha of pastureland between 2015 and 2050.
Scenario justification	NCAER (2015) suggests that due to technological innovation and diffusion through institutional arrangements, growth in yield will be high in the coming decades. In addition, several subsidies will reduce the cost of technologies and increase economies of scale. The study suggests that the area expansion for several cereal crops including wheat is going to be weak and production, and growth will mostly be driven by yield increase.	Based on NCAER (2015), the increase in income levels, population, and urban space, as well as the increased use of feed will expand the production of livestock products in coming decades. Despite a major dependency on cereals, rising protein consumption will necessitate increasing livestock and dairy production. To meet the domestic demand, the Government of India is focusing on livestock intensification systems to improve yield (Planning Commission, 2012).	Initiatives were taken to improve livestock feeding systems because by 2025, India is likely to experience a fodder deficit of about 65% for green fodder and 25% for dry fodder (Indian Council of Agricultural Research, 2015; Planning Commission, 2012).

Scenario signs no change small change large change

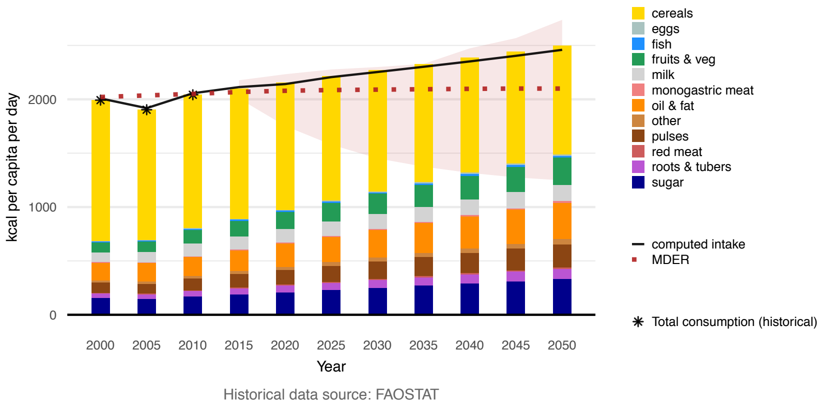
Results against the FABLE targets

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

Food security

Fig. 8 | Computed daily kilocalorie 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.

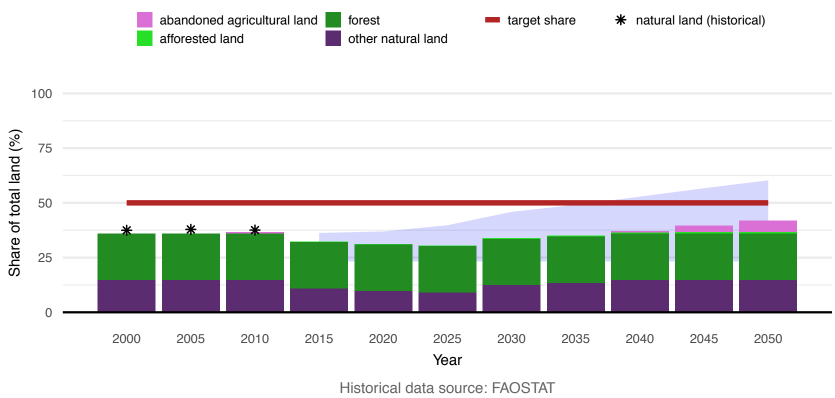


Our results show average daily energy intake per capita increases from 2000 kcal/cap/day in 2000 to 2260 kcal/cap/day in 2030 to 2,450 kcal/cap/day in 2050. This is 10% lower than the 68th round of India's National Sample Survey Office for the year 2012 due to some products not being taken into account into our calculations. Over the last decade, more than half of the food intake came from cereals (National Sample Survey Office, 2014).

In terms of recommended diet, our results show higher consumption of animal-based products and lower consumption of cereals. The computed average calorie intake is higher than the average minimum calorie requirement (MDER) at the national level from 2020 onwards.

Biodiversity

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

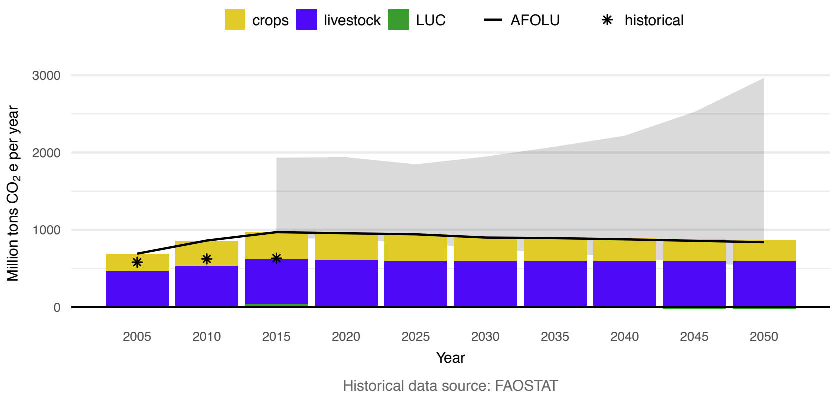


Our results show that the Share of the Land which could support Biodiversity conservation (SLB) remained stable between 2000-2015 at 36%. The lowest SLB is computed for the period 2020-2025 at 23% of total land. This is mostly driven by conversion of other natural land to cropland. SLB reaches its maximum value over the last period of simulation at 31%. This is mostly driven by abandonment of agricultural land and by a lower extent to afforestation.

Compared to the FABLE global target of having at least 50% SLB by 2050, our results are below the target, but our results are consistent with India's commitments under the Convention on Biological Diversity . For which India has recently submitted its sixth national report (Government of India, 2018). According to this report, "India has exceeded the terrestrial component of 17% of Aichi target 11, and 20% of corresponding National Biodiversity Targets relating to areas under biodiversity management".

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 and livestock.

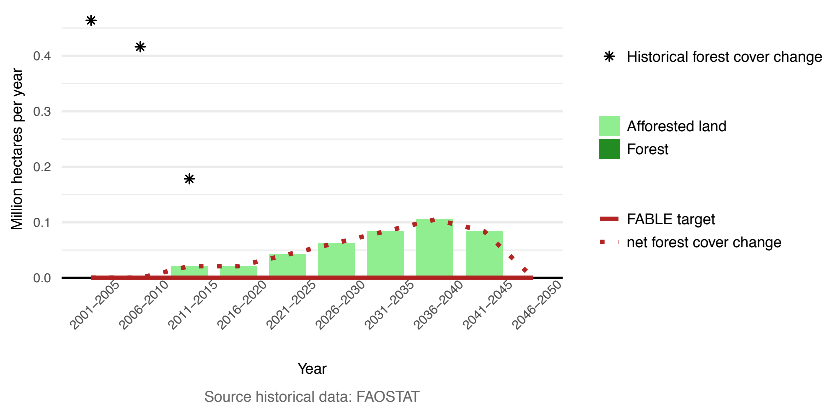
Our results show annual AFOLU GHG emissions between 642 and 969 Mt CO_2e/year over 2000-2015 which increase over time. This is 28% than FAO statistics in 2015 (FAOSTAT, 2019). For GHG emissions from agriculture only, our results are more than two times higher than reported emissions from the GHG platform India (GHG Platform India, 2017) and 36% higher than FAO. This is mostly due to an underestimation of Nitrous Oxide emissions from livestock on the GHG platform and from an overestimation of overall emissions from the livestock sector in our Calculator.

Peak AFOLU GHG emissions are computed for 2015 at 969 Mt CO_2e/year. This is mostly driven by GHG emissions from livestock. AFOLU GHG emissions reach 839 Mt CO2e over the period 2046-2050: 868 Mt from agriculture and -30 Mt from LULUCF. Negative net emissions from LULUCF by 2050 are mainly explained by agricultural land abandonment and afforestation.

Our results meet the FABLE target of having zero or negative emissions from land use change but emissions from the agricultural sector remain high over the whole period.

Forests

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



We do not project any deforestation over the whole period and afforestation varying between 21 kha/year and 105 kha/year between 2015-2045 with a peak over 2035-2040. According to FAO, the forest cover has increased by more than 400 kha/year over 2000-2010 and 170 kha/year over 2011-2015. Our results do not reflect well this past afforestation.

Compared to the FABLE global target of having zero or positive net forest change after 2030, our results meet the target. Our results also meet our national Bonn Challenge target by 2030.

Other relevant results for national objectives

Table 1 | Other Results

Variable	Unit	2000	2005	2010	2015	2020	2030	2040	2050
Crop Productivity									
Corn	t/ha	1.8	1.9	2.5	2.6	2.8	3.3	4.4	6.6
Peas	t/ha	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.4
Rice	t/ha	1.9	2.1	2.2	2.3	2.4	2.6	3.0	3.7
Sorghum	t/ha	0.8	0.8	0.9	0.9	0.9	1.0	1.1	1.3
Nuts	t/ha	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.4
Groundnut	t/ha	1.0	1.2	1.4	1.5	1.5	1.9	2.5	3.9
Pulses Other	t/ha	6.9	6.4	7.9	8.0	8.2	9.0	10.2	12.1
Sugarcane	t/ha	70.9	64.8	70.0	70.2	70.5	71.4	72.8	74.8
Land Cover Change									
Cropland (historical)	Mha	170.1	169.7	169.2					
Cropland (calculated)	Mha	170.1	169.7	167.1	173.9	173.8	159.8	150.3	136.4
Pasture (historical)	Mha	10.8	10.5	10.3					
Pasture (calculated)	Mha	15.2	15.3	15.4	17.0	17.0	17.0	17.0	16.9
Forest (historical)	Mha	65.4	67.7	68.4					
Forest (calculated)	Mha	65.4	65.4	65.4	65.4	65.4	65.4	65.4	65.4
Afforested land (calculated)	Mha	0.0	0.0	0.0	0.1	0.2	0.7	1.7	2.1
Other land (historical)	Mha	51.0	49.5	49.3					
Other land (calculated)	Mha	45.7	45.4	46.8	36.2	32.8	44.0	52.6	66.1
Urban (calculated)	Mha	0.9	1.6	2.7	4.7	8.1	10.4	10.4	10.4

Source of historical data: FAOSTAT

Results shows that crop yield is going to increase in comparison to historical period. The New Biofuel Policy of India relies on achieving the ethanol blending target from surplus crop production. To achieve this target India needs a more intensified production system.

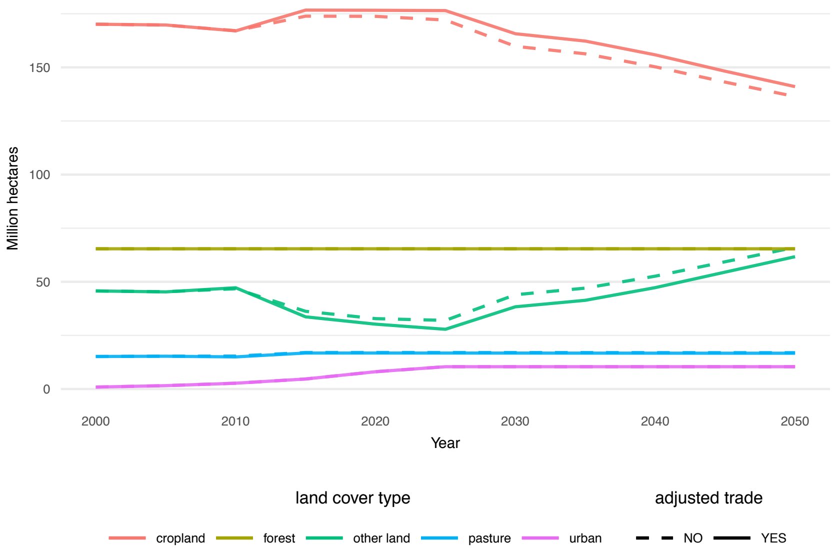
Our result shows a reduction of cropland area by 2050 while at the same time we have observed a deterioration of agricultural trade balance i.e., from a trade surplus at the beginning to a trade deficit by 2050. The increase of crop productivity allows increasing crop production even if the cropland area remains over 2015-2025 and even decreases after 2025.

Impacts of trade adjustment to ensure global trade balance

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

Trade adjustment leads to a decline:
- in rice exports,
- in beef exports,
- in apple imports, and
- in sunflower imports.

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



Trade adjustment leads to a higher cropland area and lower other land area because the agricultural production has to increase to offset the reduction in imported quantities for several commodities.

Discussion and next steps

The sustainable pathway developed using this useful analytical tool, the FABLE Calculator, aims to achieve a sustainable food and land use future for India. The intention behind this pathway and results analysis is to enable policymakers and civil society to understand the present conditions and the future trends of sustainable indicators to support the setting of national targets and monitor their progress. The selected pathway is also developed to achieve several international commitments for climate mitigation and forest conservation such as the Paris Agreement, the Convention on Biological Diversity, the Sustainable Development Goals, and the Bonn Challenge. The results from the pathway show a seven-fold increase in GDP per capita during the period 2015 to 2050 which significantly impacts dietary change for the same period. The results show that the demand for livestock products increases over the same period which also results in a high increase in GHG emissions from the livestock sector. The increase in population between 2015 and 2050 leads to a growing demand for food and creates pressure on natural resources. However, we assume that there will be no expansion in the crop land area, but this is offset by significant crop productivity and crop harvesting intensity resulting in an overall increase in crop production. To conclude, the analysis presents interesting trade-offs in the course of India's development. The results show gains in India across many dimensions in the long term, while emphasizing that some key concerns remain. The forest cover increases, and so does the land that can support biodiversity. The energy intake in terms of calorific requirements increases significantly with time as people become richer. The country continues to gain in terms of production in agriculture, but overall carbon dioxide emissions from the agricultural sector remain high and are difficult to significantly reduce by 2050.

The FABLE Calculator covers many aspects of pathways for sustainable land use and food system, but it currently faces limitations. For example, it does not include different agricultural production systems and management which are geographically diversified in India. In addition, the soil nutrient management system needs to be included in the Calculator to support better results. Moreover, we have not disentangled the different drivers of future crop productivity. In terms of water and irrigation systems, the Calculator does not yet integrate this important factor in its analysis, and this should be included as a way to strengthen the development of sustainable pathways to achieve the SDGs. Finally, to provide more micro-level assessments of future pathways the Calculator would need to include country specific policy-based scenarios to unveil the integrated impact of a particular policy. Overall, the Calculator is a valuable tool to address a range of issues and trade-offs. The present analysis focuses on shedding the light on some important issues for the country, but also on additional issues that could be analyzed in the future.

- The present analysis does not delve deep into the challenge posed by the use of biofuels. Enhancing the use of biofuels for addressing climate change is bound to have an impact on land-use systems.
- International trade in agriculture has important implications for farmers' livelihoods as well as the domestic agricultural economy. It would be interesting to look into this aspect.
- India is a water-scarce country. Cropping patterns and agriculture are, in general, to a large extent driven by water availability. It would be useful to delve deeper into the issue of water and its relationship with agriculture and land-use.

- Climate change will impact the productivity of crops across regions in India and will affect trade-offs between agriculture and land-use. This aspect is going to be critical and should be an important dimension to be explored in the future.
- The representation of alternative yield improving technologies and irrigation systems is not included in the current analysis. To improve the real potential for productivity the Calculator would need to include this factor.

One of the main challenges of transforming the economy is to understand the incentives of different groups, and to assess the winners and losers in the transition towards a sustainable future. Our aim is to achieve a transition that is able to address multiple sustainable development objectives, ranging from enhanced nutrition and better agricultural practices, while ensuring low carbon dioxide emissions as well as allowing for a climate resilient economy. There will be interest groups and stakeholders that will be impacted by changes across all these different objectives. Therefore, it will be critical to understand their trade-offs, and devise ways to compensate the losers and incentivize the winners. The FABLE analysis can provide crucial evidence to better understand trade-offs and synergies while helping to translate these insights into on-the-ground transformation.

Integrated analysis is a critical step in this direction. FABLE seeks to integrate different, and often conflicting, objectives and dimensions within a unified framework. This is the strength and value added, and it complements many other sector-specific analyses undertaken in India. Through such integrated analysis, along with inputs from key stakeholders, we aim to inform policy and address the multiple development challenges faced by India's policy makers.

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

References

Aleksandrowicz, L., Green, R., Joy, E. J. M., Harris, F., Hillier, J., Vetter, S. H., ... Haines, A. (2019). Environmental impacts of dietary shifts in India: A modelling study using nationally representative data. *Environment International*, 126, 207–215. https://doi.org/10.1016/j.envint.2019.02.004

Alexandratos, N., & Bruinsma, J. (2012). *World Agriculture Towards 2030/2050: The 2012 revision* [ESA Working Paper 12-3]. Retrieved from FAO website: http://www.fao.org/3/a-ap106e.pdf

Bonn Challenge. (2014). Bonn Challenge India. Retrieved July 12, 2019, from Bonn Challenge website: http://www.bonnchallenge.org/content/india

Department of Agriculture Cooperation and Farmers Welfare. (2018). *Annual Report 2017-18*. Retrieved from Department of Agriculture Cooperation and Farmers Welfare website: http://agricoop.nic.in/annual-report

Department of Commerce. (2018). *Agricultural Export Policy*. Retrieved from Department of Commerce, Ministry of Commerce and Industry website: https://commerce.gov.in/writereaddata/uploadedfile/MOC_636802088572767848_AGRI_EXPORT_POLICY.pdf

Directorate of Economics and Statistics. (2018). *Pocket Book of Agricultural Statistics 2017* [Data set]. Retrieved from http://agricoop.nic.in/recentinitiatives/pocket-book-agricultural-statistics-2017

ENVIS Centre on Wildlife and Protected Areas. (2019). *Protected Areas of India 2000- 2019* [Data set]. Retrieved from http://www.wiienvis.nic.in/Database/Protected_Area_854.aspx

FAO, IFAD, UNICEF, WFP and WHO. (2018). *The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition.* Retrieved from http://www.fao.org/3/i9553en/i9553en.pdf

FAOSTAT. (2019). *FAOSTAT database.* [Data set]. Retrieved from http://www.fao.org/faostat/en/#data

Forest Survey of India. (2017). State of Forest Report 2017 [Data set]. *Ministry of Environment, Forest and Climate Change.* Retrieved from http://fsi.nic.in/forest-report-2017

GHG Platform India. (2017). *Trend Analysis of GHG Emissions in India.* Retrieved from Vasudha Foundation website: http://www.ghgplatform-india.org/

Government of India. (2015). *India's Intended Nationally Determined Contribution: Working Towards Climate Justice.* Retrieved from Government of India website: https://www4.unfccc.int/sites/submissions/indc/Submission%20Pages/submissions.aspx

Government of India. (2018). *India's Sixth National Report to the convention on Biological Diversity.* Retrieved from Ministry of Environment, Forest and Climate Change website: https://www.cbd.int/nr6/

Indian Council of Agricultural Research. (2015). *Vision 2050.* Retrieved from Indian Council of Agricultural Research website: http://www.iari.res.in/download/vision/vision-2050.pdf

Invest India. (2019). Make In India. Retrieved May 30, 2019, from http://www.makeinindia.com/six-schemes-adopted-that-would-reduce-waste-benefit-farmers

IUCN Red List. (2019). *Threatened species in each country (totals by taxonomic group)* [Data set]. Retrieved from http://www.iucnredlist.org/about/summary-statistics#Tables_5_6

Leimbach, M., Kriegler, E., Roming, N., & Schwanitz, J. (2017). Future growth patterns of world regions = A GDP scenario approach. *Global Environmental Change*, 42, 215–225. https://doi.org/10.1016/j.gloenvcha.2015.02.005

Ministry of Commerce & Industry. (2018). *Foreign Trade Statistics of India* [Data set]. Retrieved from https://dgft.gov.in/more/data-statistics

Ministry of Environment, Forest & Climate Change. (2018). *India: Second Biennial Update Report to the United Nations Framework Convention on Climate Change*. Retrieved from Ministry of Environment, Forest & Climate Change. website: https://unfccc.int/sites/default/files/resource/INDIA%20 SECOND%20BUR%20High%20Res.pdf

Ministry of Statistics and Programme Implementation. (2018). *Agriculture- Statistical Year Book of India* [Data set]. Retrieved from http://www.mospi.gov.in/statistical-year-book-india/2018/177

NCAER. (2015). *Agricultural Outlook and Situation Analysis Reports-Fourth Semi-annual Medium-term Agricultural Outlook Report*. Retrieved from National Council for Applied Economic Research website: http://agrioutlookindia.ncaer.org/Agri_Outlook_Report_September_2015.pdf

NSS (National Sample Survey Office). (2014). *Report no. 558: Household Consumption of Various Goods and Services in India 2011-12*. Retrieved from National Sample Survey Office website: http://mospi.nic.in/sites/default/files/publication_reports/Report_no558_rou68_30june14.pdf

Planning Commission. (2012). *Report of the working group on animal husbandry & diary, 12th five-year plan (2012-2017)*. Retrieved from Planning Commission website: http://planningcommission.gov.in/aboutus/committee/wrkgrp12/agri/AHD_REPORT_Final_rev.pdf

PWC. (2017). *The long view: how will the global economic order change by 2050.* Retrieved from PricewaterhouseCoopers website: https://www. pwc. com/gx/en/world-2050/assets/pwc-the-world-in-2050-full-report-feb-2017. pdf

Ranganathan, J., Vennard, D., Waite, R., Dumas, P., Lipinski, B., Searchinger, T., & GLOBAGRI-WRR, M. A. (2016). Shifting diets for a sustainable food future. *World Resources Institute.* Retrieved from https://www.wri.org/publication/shifting-diets

TERI (The Energy and Resources Institute). (2018). *Economics of Desertification, Land Degradation and Drought in India.* Vol I: Macroeconomic assessment of the costs of land degradation in India. (p. 168). Retrieved from TERI website: https://www.teriin.org/sites/default/files/2018-04/Vol%20I%20-%20 Macroeconomic%20assessment%20of%20the%20costs%20of%20land%20degradation%20in%20 India_0.pdf

United Nations, Department of Economic and Social Affairs, Population Division. (2015). *World Population Prospects: The 2015 Revision, Key Findings and Advance Tables* [Working Paper No. ESA/P/WP.241]. Retrieved from United Nations website: https://population.un.org/wpp/

Wildlife Institute of India. (2019). *National Wildlife Database* [Data set]. Retrieved from http://www.wiienvis.nic.in/Database/Protected_Area_854.aspx

World Obesity Federation. (2017). Obesity prevalence worldwide – Adults. [Data set]. *World Obesity Federation.* Retrieved from https://www.worldobesity.org/resources

World Trade Organisation. (2018). *World trade statistical review* [Data set]. Retrieved from https://www.wto.org/english/res_e/statis_e/wts2018_e/wts18_toc_e.htm