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Faculty of Natural and Agricultural Sciences

Fakulteit Natuur- en Landbouwetenskappe
Lefapha la Disaense tša Tlhago le Temo

Pathways for sustainable food and land use systems pathways with the FABLE Calculator

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Topics

- Quick intro AEERD & CEEPA
- FABLE Consortium
- FABLE Calculator

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Agricultural Economics, Extension and Rural Development
&
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Extraordinary professors and researchers from other institutions including CIRAD

Department of Agricultural Economics, Extension and Rural Development

Two undergraduate programmes:

⇢ BSc Agric (Agricultural Economics and Agribusiness Management) & BCom (Agribusiness Management)

Three Honours Programmes:

⇢ BAgric Hons (Extension); BAgric Hons (Rural Development); BCom Hons (Agricultural Economics)

Seven Master's Programmes

⇢ MAgric (Extension); MAgric (Rural Development); MScAgric (Agricultural Economics); MScAgric (Agricultural Extension); MCom (Agricultural Economics); MPhil (Agricultural Economics); MSc (Environmental Economics)

⇢ Collaborative Masters in Agricultural and Applied Economics for the past 15 years, training over 1600 students from Africa and hosting visiting lecturers from across Africa

Three PhD Programmes

⇢ PhD (Agricultural Economics); PhD (Extension); PhD (Rural Development)

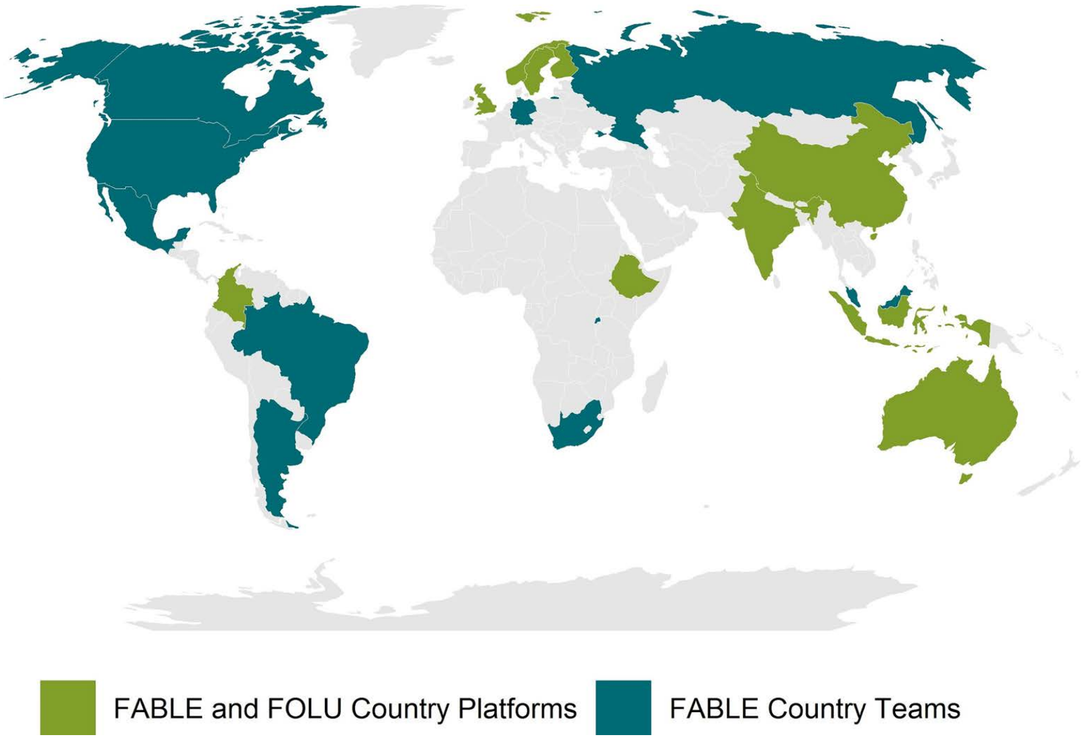
Research Streams

- ⇢Agribusiness Management & Risk Analysis
- ⇢Environmental Economics (CEEPA)
- ⇢Agricultural Extension
- ⇢Rural Development
- ⇢Food Security
- ⇢Sustainable development

FABLE Scenathon and Calculator

What is FABLE?

- Collaborative initiative launched in 2017
- Aims to understand how countries can transition toward sustainable land-use and food systems
- Brings together over 200 science and policy experts from 88 national institutes currently spanning 22 countries
- Country teams develop bottom–up, mid-century, national pathways that aim to address local development priorities, collectively achieve global sustainability objectives, and balance international trade in commodities.



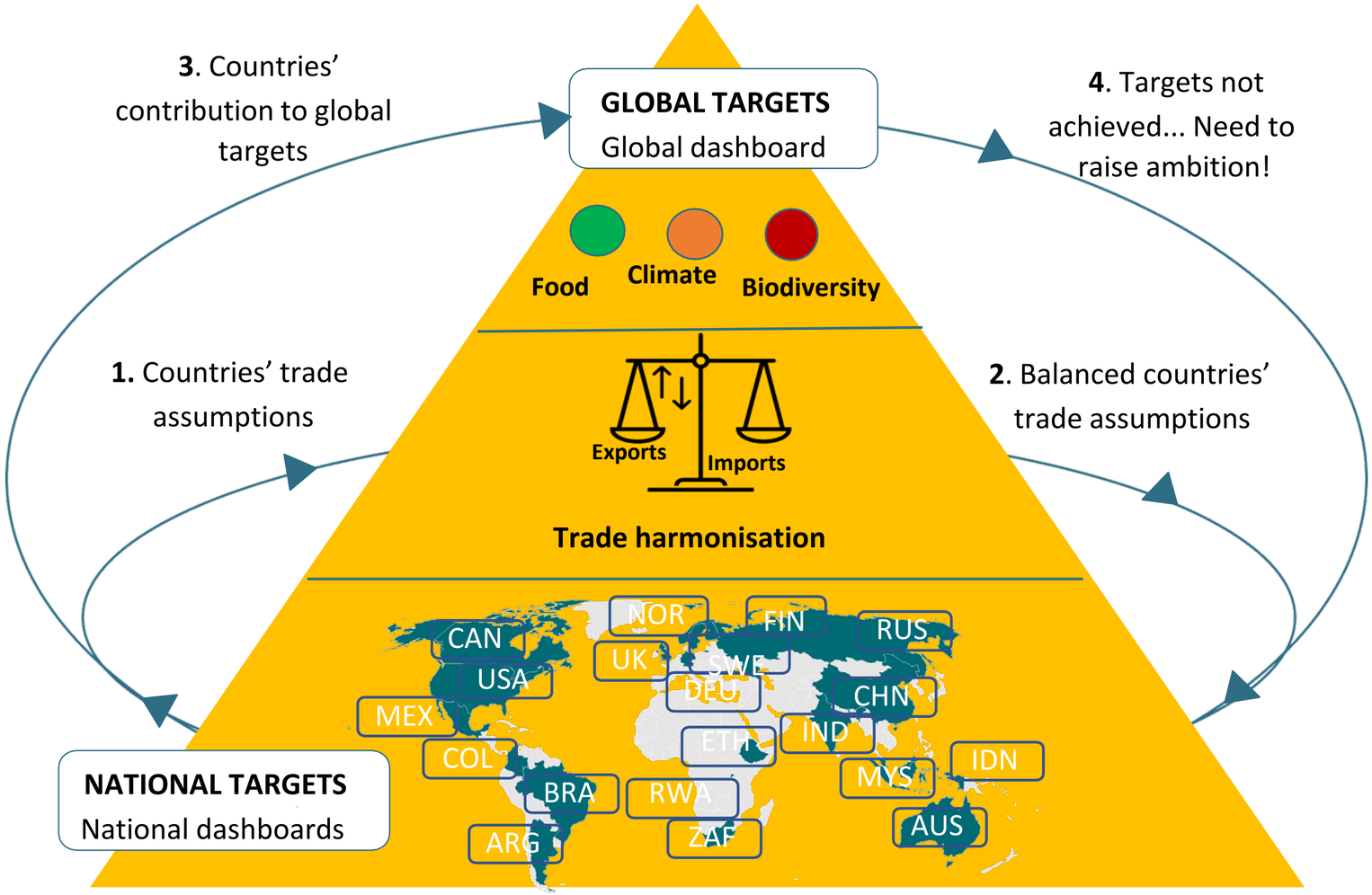
The FABLE methodology

FABLE tools

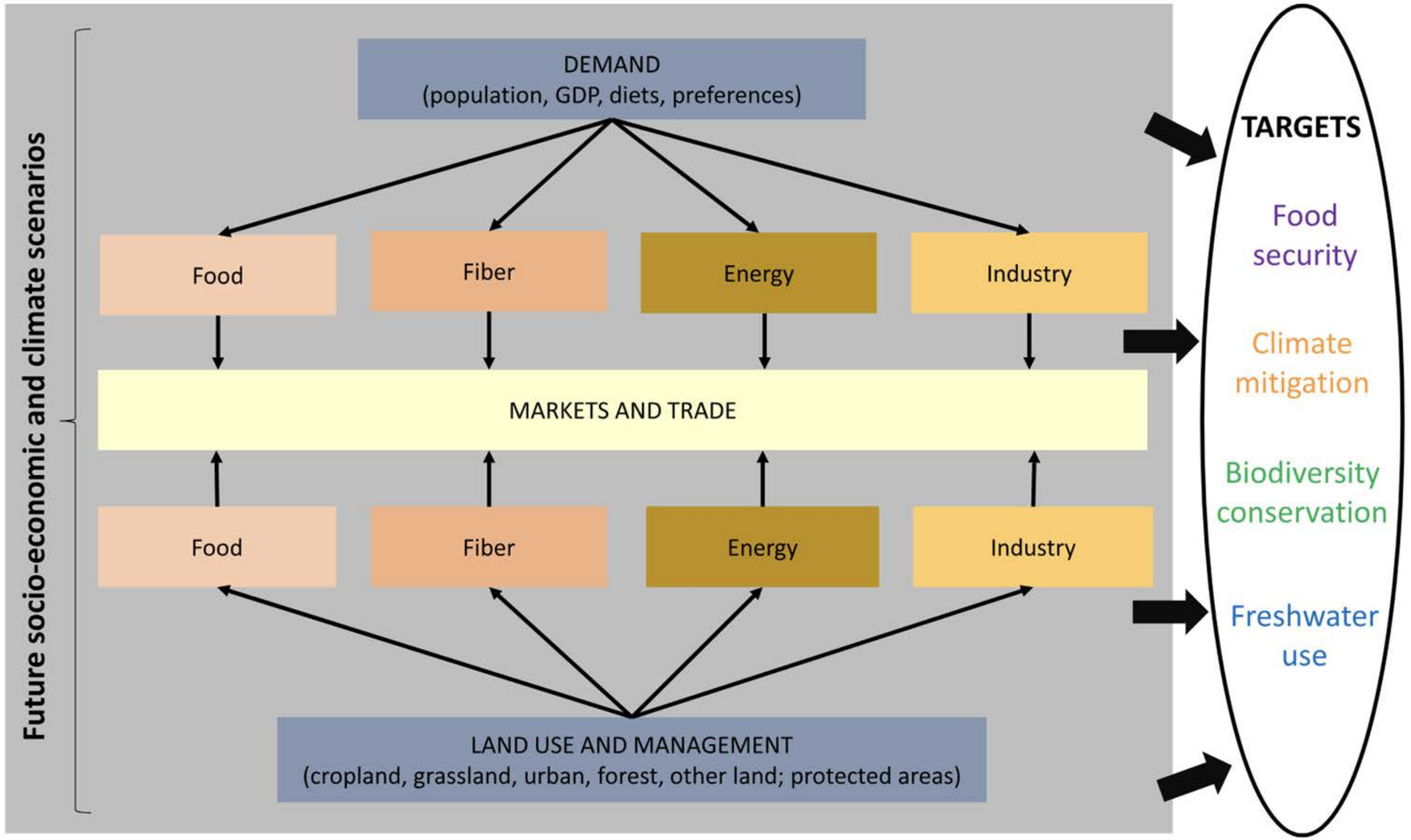
Scenathon web platform and Linker tool

National and regional **FABLE Calculators**

What is a Scenathon?



FABLE Calculator overview



Jones *et al* 2023

The FABLE Calculator

Created in 2018 to allow all FABLE country teams to rapidly develop the first generation of pathways towards sustainable land-use and food systems

⇢ It includes **˜80 products**: crops, livestock products, vegetable oils, and sugar.

⇢ It covers each **five-year time step over 2000-2050**.

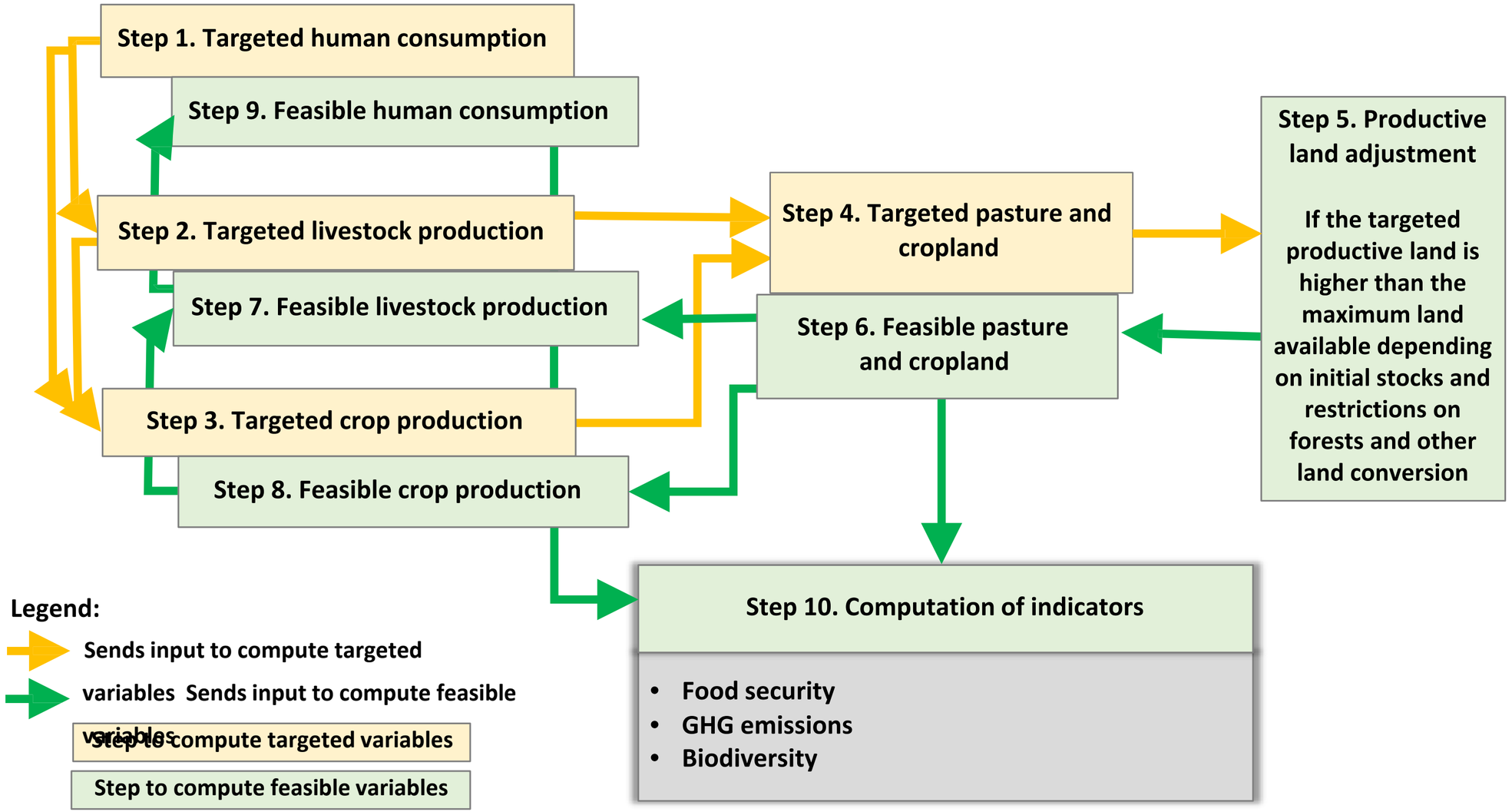
⇢ Projections of **future demand drive production and future land use**.

⇢ **Limited land availability** can reduce the consumption level compared to the initial target

⇢ **Market equilibrium** (quantity not value) constraint

Objective: To project the evolution of several indicators that can help assess the sustainability of the food and land systems under different assumptions

How does the FABLE Calculator work?



FABLE at the country level

- agree on a set of national long-term targets, broadly consistent with the objectives of the Paris Agreement, the Global Biodiversity Framework, and the Sustainable Development Goals;

- develop pathways to explore the evolution of national land-use and food systems by mid-century following the current trends versus more sustainable future;

- the determination of the pathway at the national level is key to ensure representation of local priorities, cultures, and contexts, and to inform national policies.

- adjust FABLE calculator to ensure balanced trade flows. throughout the process, country teams engage local stakeholders and experts to review assumptions, seek advice, and build a shared vision

Products

>80 agricultural products represented i.e. for each of these products, the model will predict the future **food**, **feed**, and **other non-food consumption**, future **losses and waste**, future **imports** and **exports**, future **production**, future **land-use**, future **water use**, etc.

Crops:

- cereals
- beverage and spices
- fruits and vegetables
- nuts
- oilseeds
- pulses

Processed crops:

- vegetable oil
- oil cakes
- sugar

Livestock products:

- milk and dairy
- beef
- pork
- eggs

Global targets

Theme	Target
Biodiversity Conservation	⇢ A minimum share of earth's terrestrial land supports biodiversity conservation. No net loss by 2030 ⇢ A minimum share of Earth's terrestrial land is within protected areas. At least 30% of global terrestrial area by 2030 ⇢ Zero net deforestation. Forest gain should at least compensate for the forest loss at the global level by 2030
Food Security	⇢ Zero hunger. Average daily energy intake per capita higher than the minimum requirement in all countries by 2030 ⇢ Low dietary disease risk. Diet composition to achieve premature diet-related mortality below 5%
Climate Mitigation	⇢ GHG emissions from crops and livestock compatible with keeping the rise in average global temperatures to below 1.5 °C, which we interpret as below 4 GtCO2e yr−1 by 2050 (3.9 Gt for non-CO2 emissions and 0.1 Gt for CO2 emissions) ⇢ GHG emissions and removals from Land-Use, Land-Use-Change, and Forestry (LULUCF) compatible with keeping the rise in average global temperatures to below 1.5 °C. Negative global GHG emissions from LULUCF by 2050
Freshwater Use	⇢ Water use in agriculture within the limits of internally renewable water resources, taking account of other human water uses and environmental water flows. Blue water use for irrigation < 2453 km3 yr−1 (global estimates in the range of 670–4044 km3 yr−1) given future possible range (61–90%) in other competing water uses

Example of Target definition

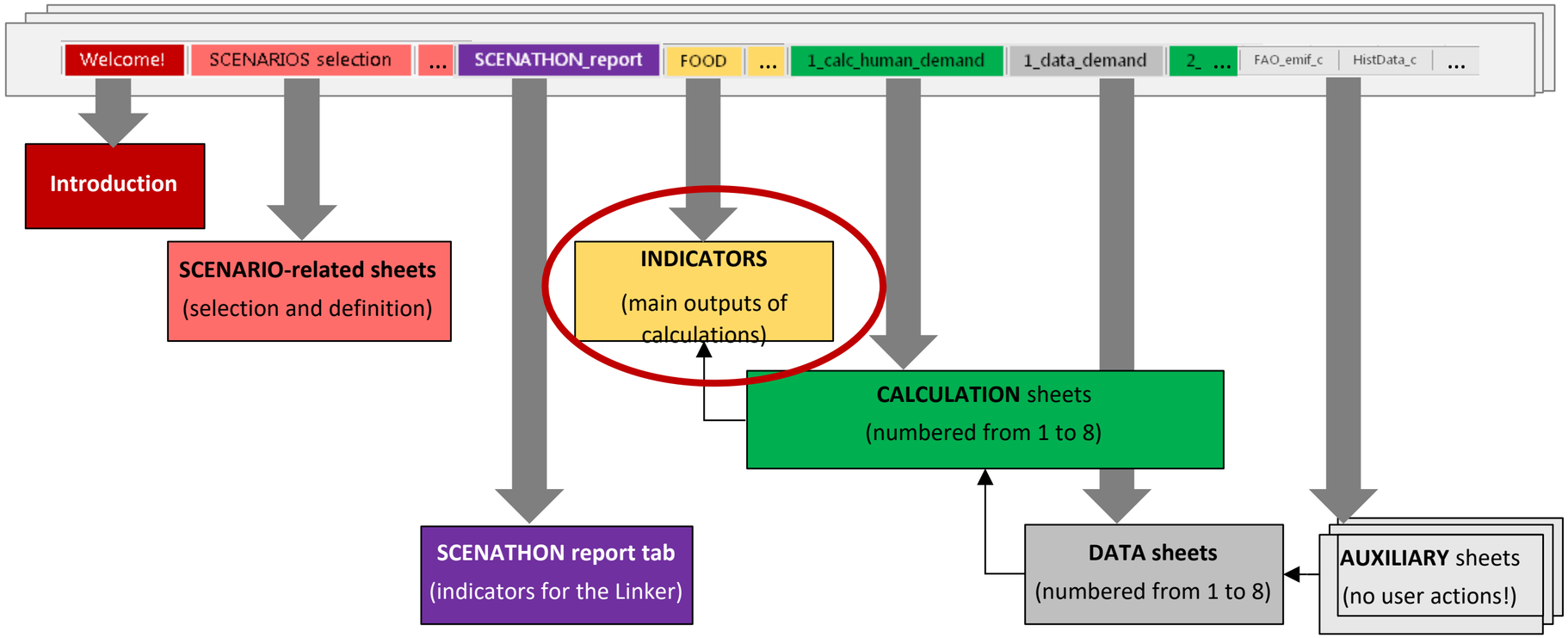
- In 2030 and 2050, the average daily kcal intake per capita in each region is:
  - ≥10% MDER
  - < 30% MDER
- By 2030 onwards globally, net forest cover change is:
  - ≥ 0
- By 2050 AFOLU emissions are:
  - ≤0

Example of Constraints

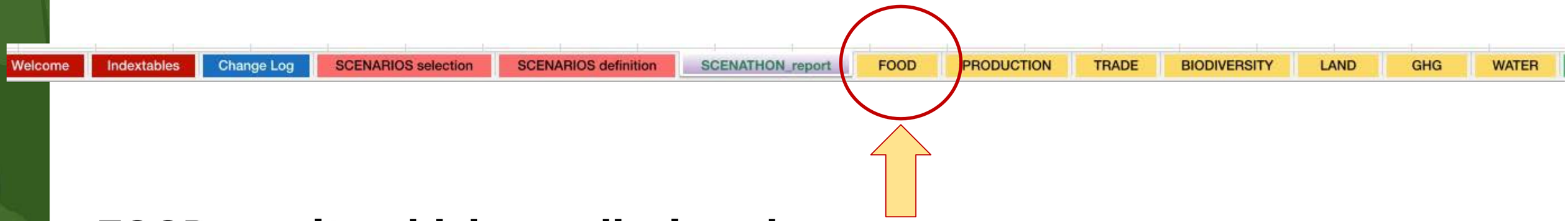
By 2050, climate mitigation efforts have been too little and too delayed - climate change impacts from Representative Concentration Pathway 6.0

FABLE Calculator

Excel based model



Results on food consumption

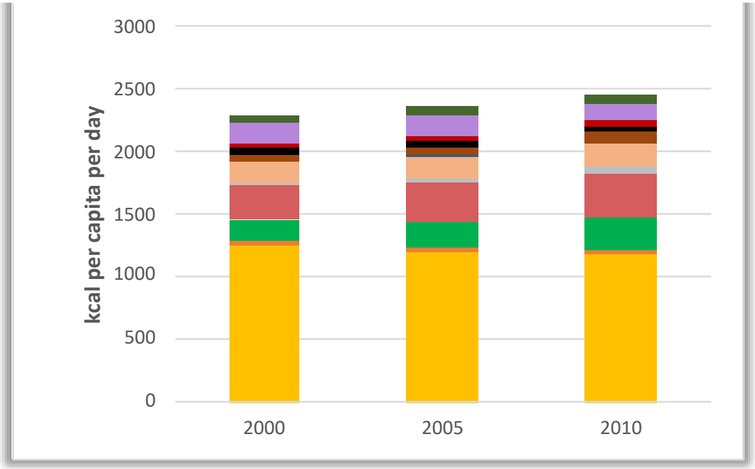


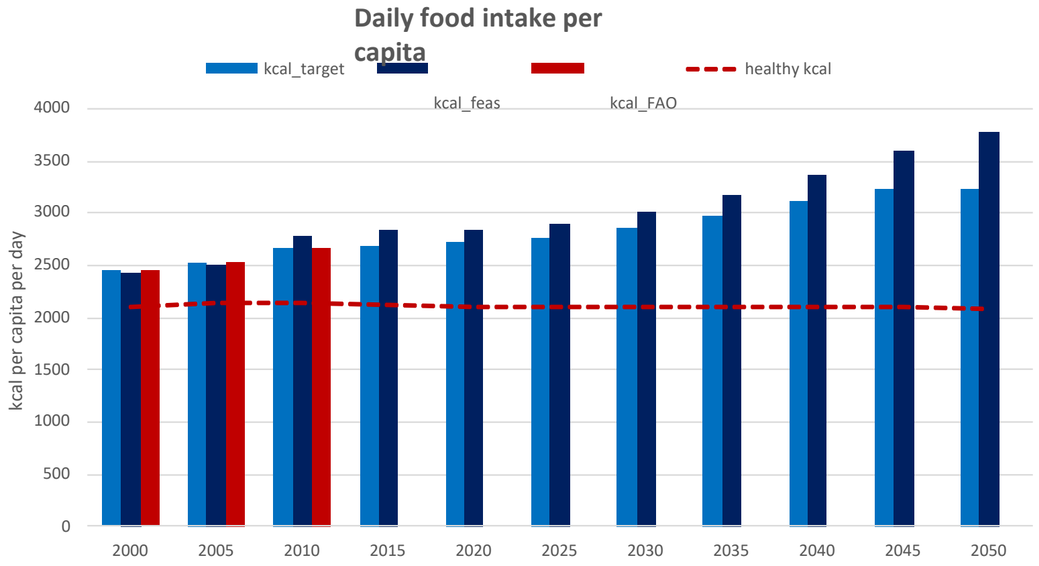
FOOD results which are displayed:

- Total average calorie consumption per capita per day
  - ⇢ Historical
  - ⇢ Targeted
  - ⇢ Feasible
  - ⇢ MDER – Minimum Daily Energy Requirement
- Total average protein and fat calorie consumption
- Average calorie consumption per food group

FOOD results

COUNTRY A

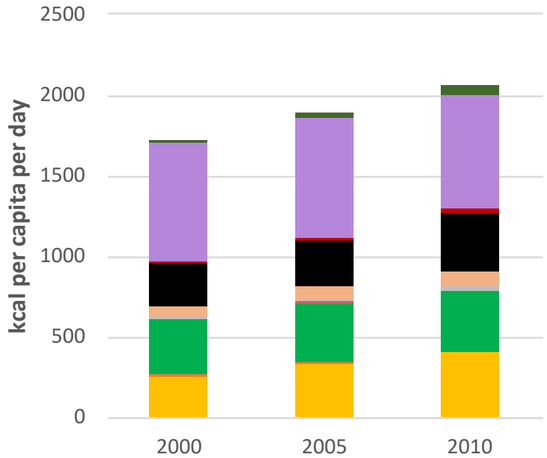


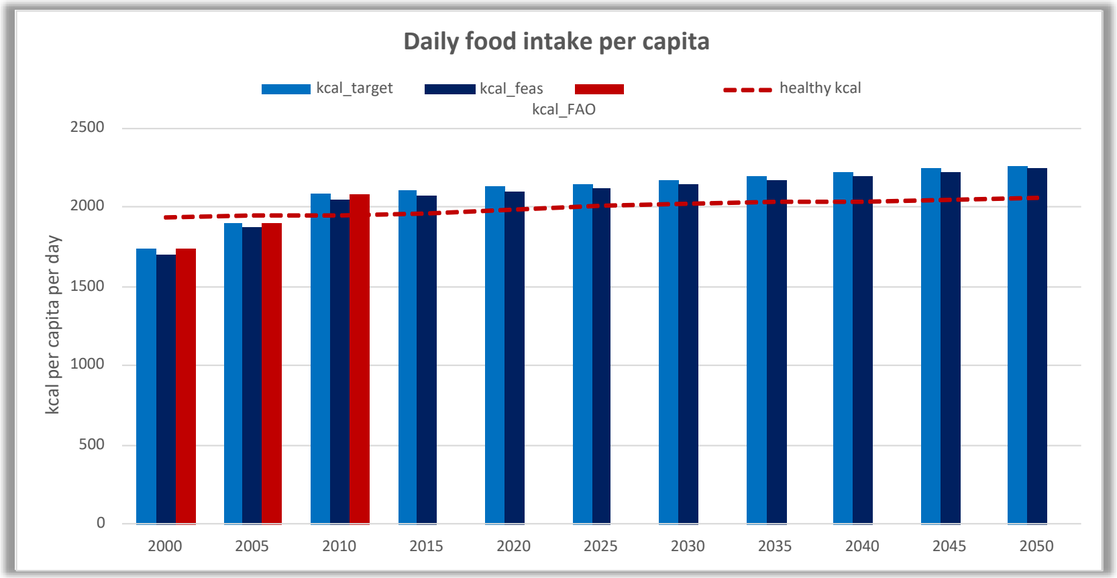


cereals
Fruits and vegetables
milk
other
pul
ses
roots & tubers
fish
monogastr ic meat
oil and fat
eggs
red meat
sugar

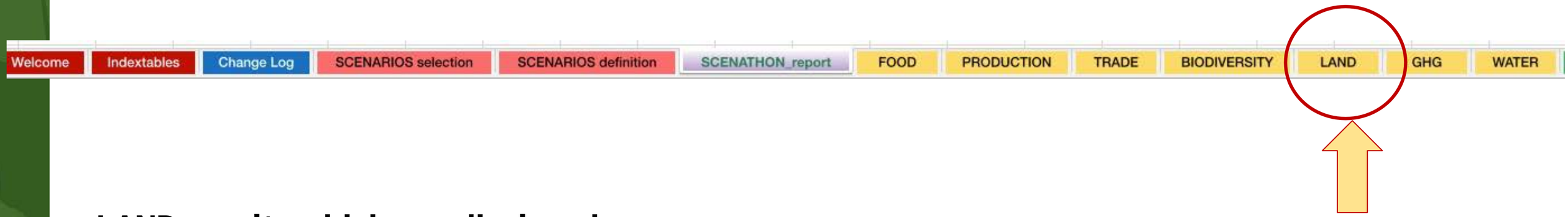
COUNTRY B

Historical consumption patterns





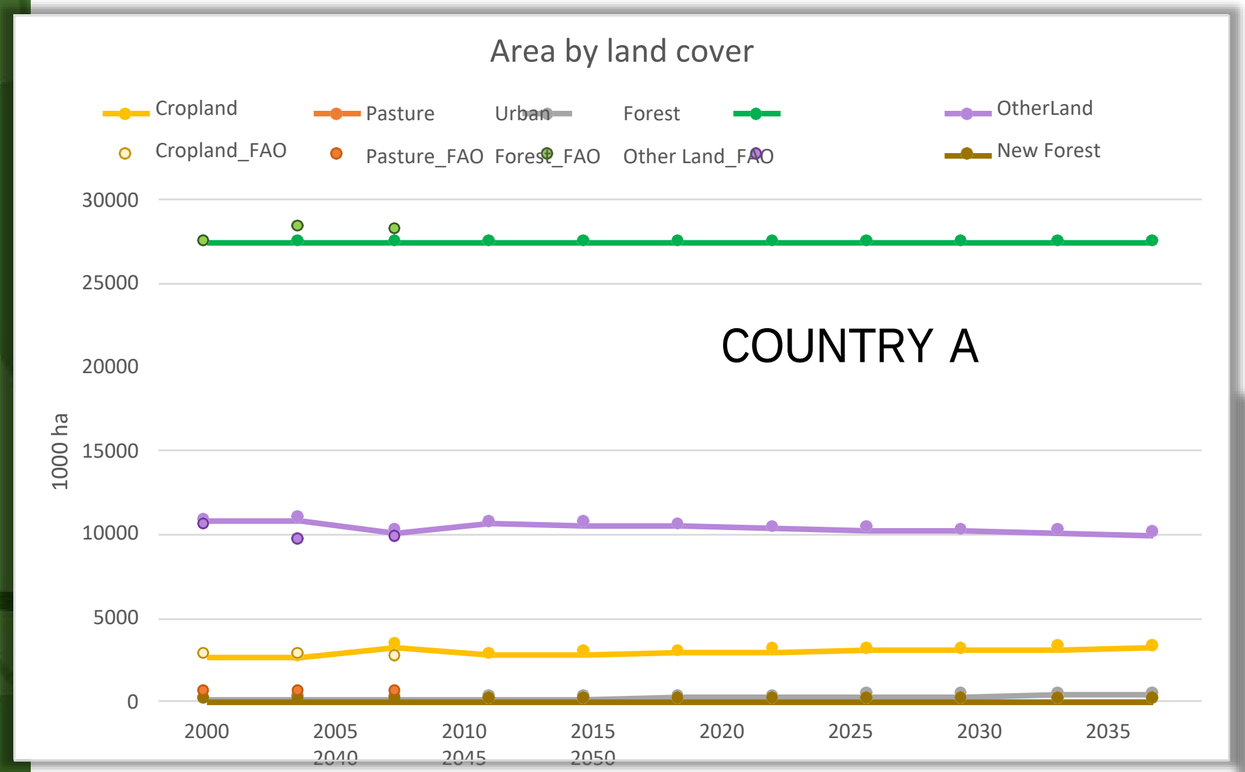
Results on land

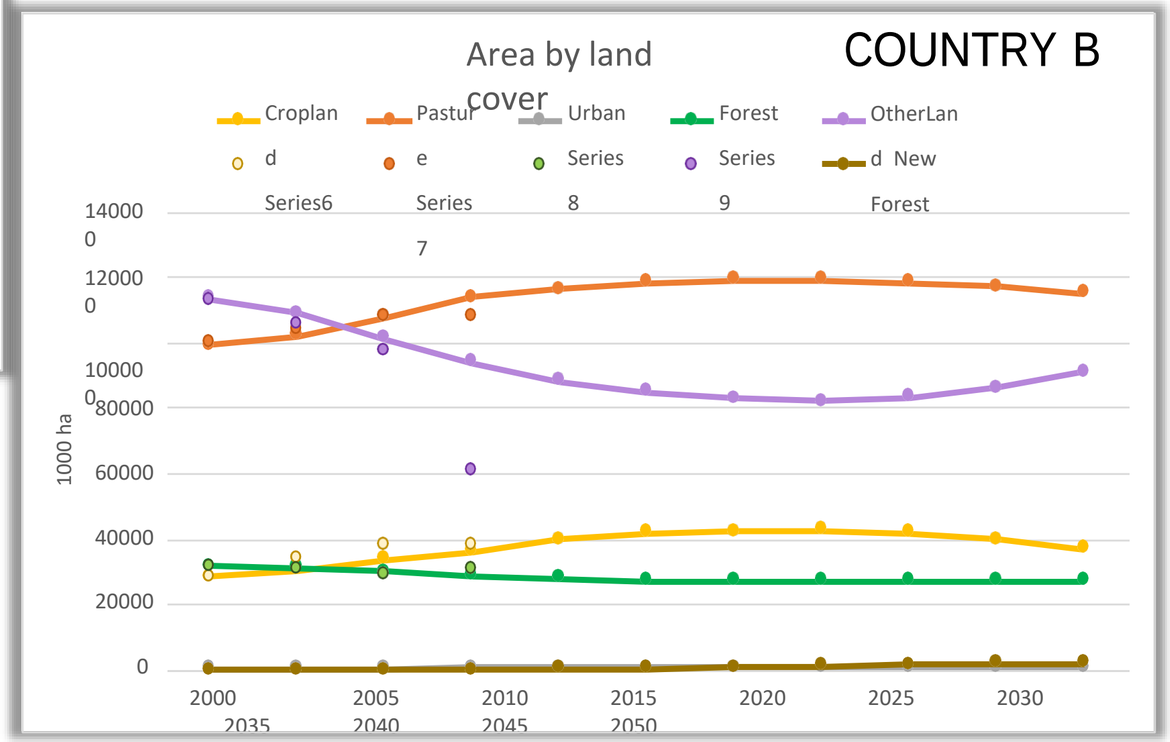


LAND results which are displayed:

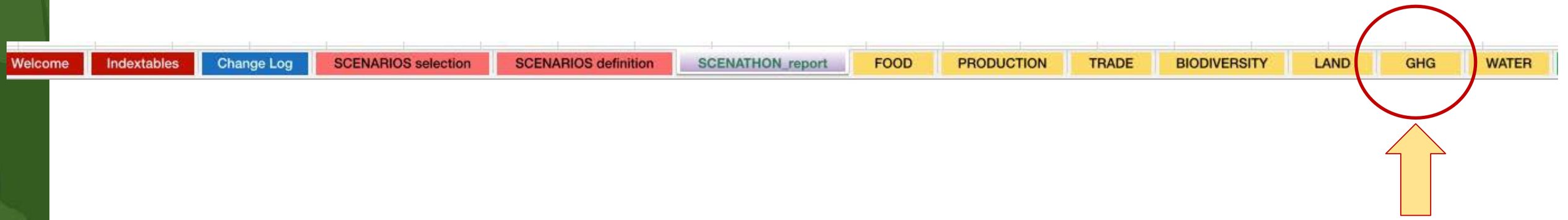
- Area by land cover per year
  - ⇢ computed area
  - ⇢ historical area according to FAO
- Forest area change per 5 yr timestep
  - ⇢ Forest
  - ⇢ Young forest (=New forest)
  - ⇢ Net
  - ⇢ Historical
- Land use change per land cover type per 5 yr timestep
- Production quantity and harvested area

Land results





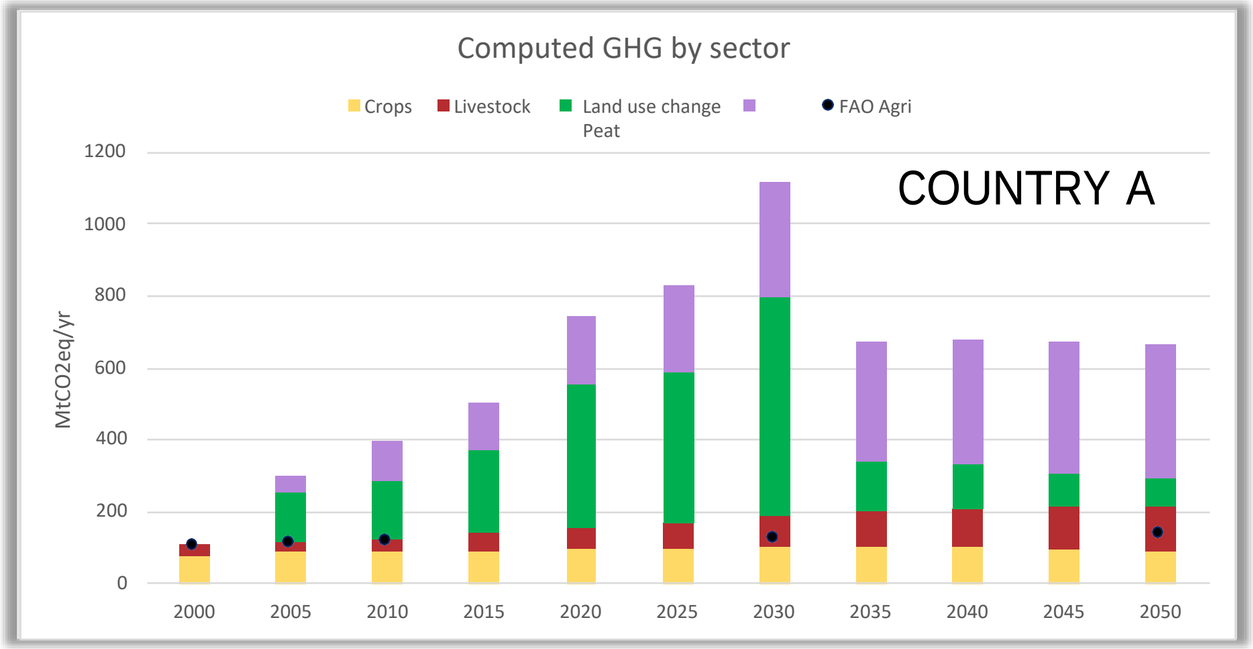
Results on GHG emissions

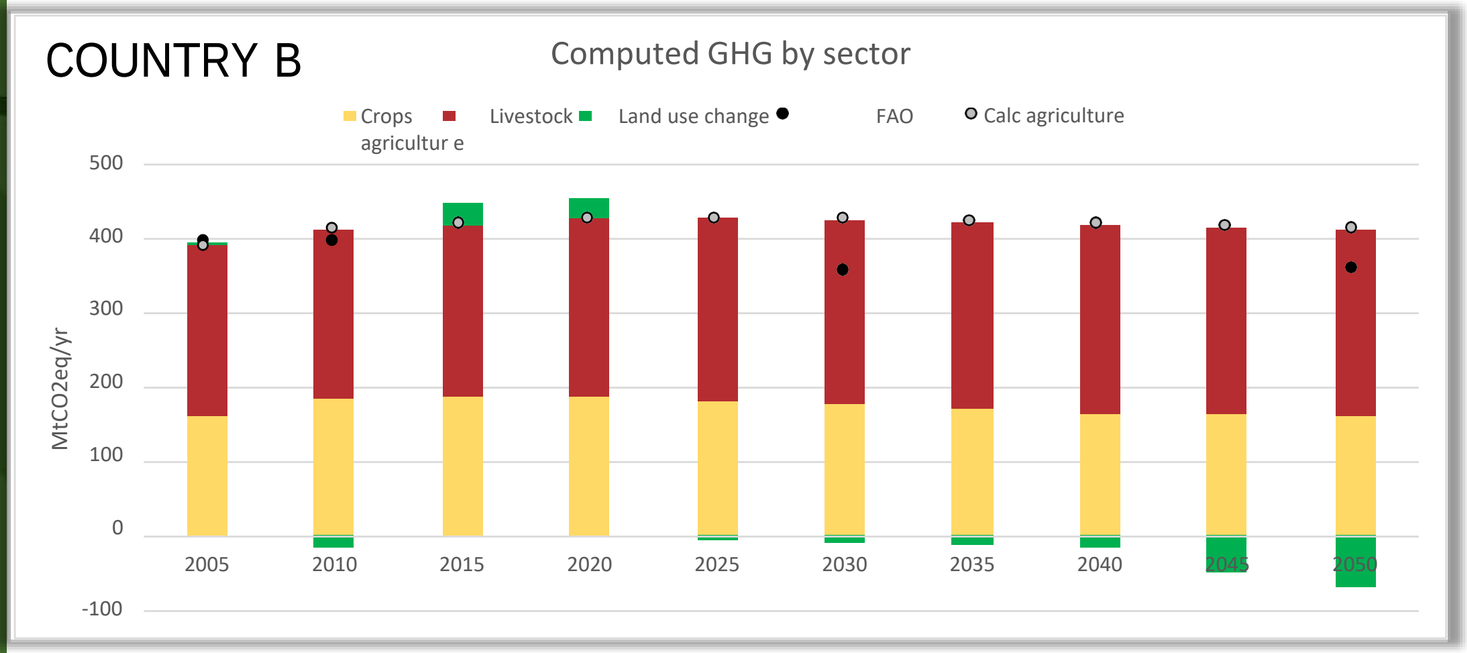


GHG results which are displayed

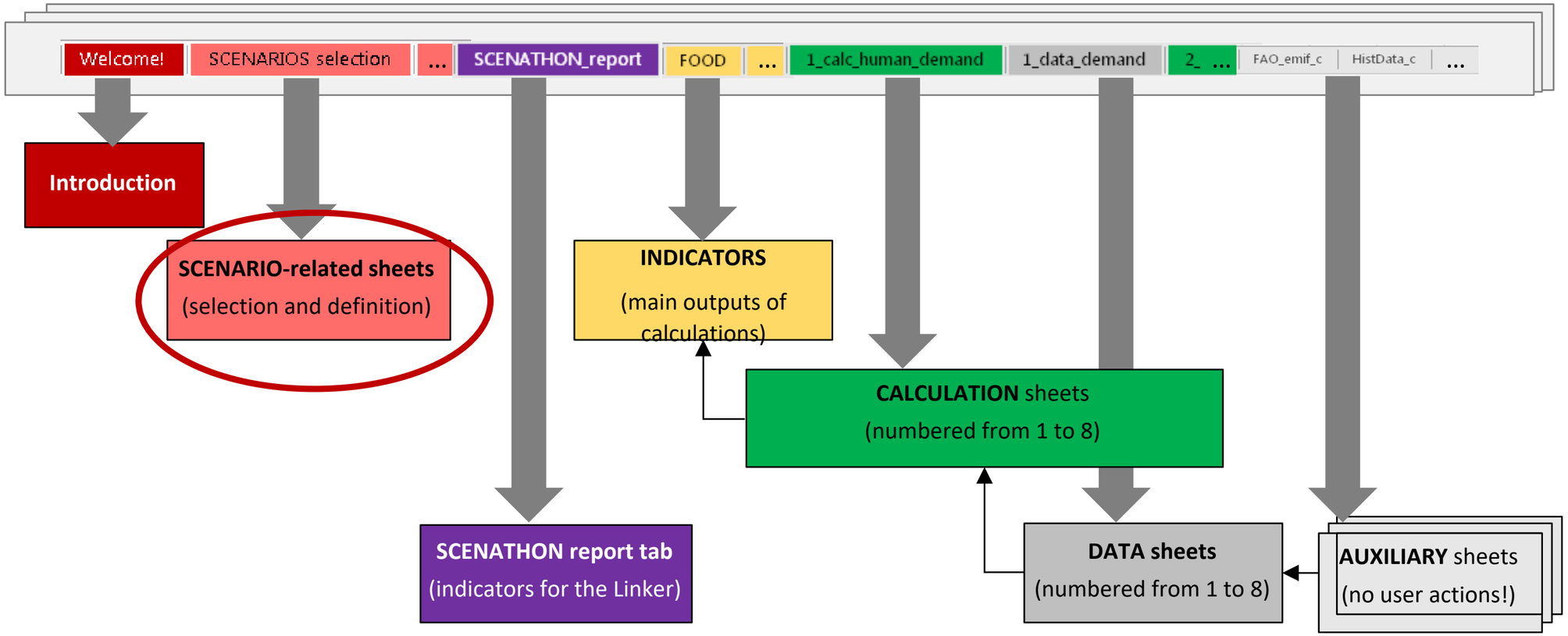
- Evolution of GHG emissions
  - ⇢ Computed GHG from Livestock
  - ⇢ Computed GHG from Crops
  - ⇢ Computed GHG from land use change
  - ⇢ Net computed GHG
  - ⇢ Historical and projected in 2030 and 2050 according to FAO (Livestock + Crops)

GHG


Computed GHG by sector
Crops
Livestock
Land use change
Peat
FAO Agri
COUNTRY A
MtCO2eq/yr
1200
1000
800
600
400
200
0
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050


COUNTRY B
Computed GHG by sector
Crops
agricultur e
Livestock
Land use change
FAO
Calc agriculture
MtCO2eq/yr
500
400
300
200
100
0
-100
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050

Defining scenarios



Defining scenarios: pre-defined

By default, there are 16 parameters that can be changed through scenarios

- Population:
  - SSPs, UN projections
- Constraints on agricultural expansion:
  - free expansion of agricultural land
  - no deforestation
  - no expansion of agricultural land

TABLE: Scen_foodloss

S.4.	
Selection	FoodLossScen
x	Current
	[illegible]
	Reduced
	MyFoodLossScen

TABLE: Scen_foodloss

S.4.	
Selection	FoodLossScen
	Current
	Increased
x	Reduced
	MyFoodLossScen

Define your own scenario

TABLE: Scen_foodloss

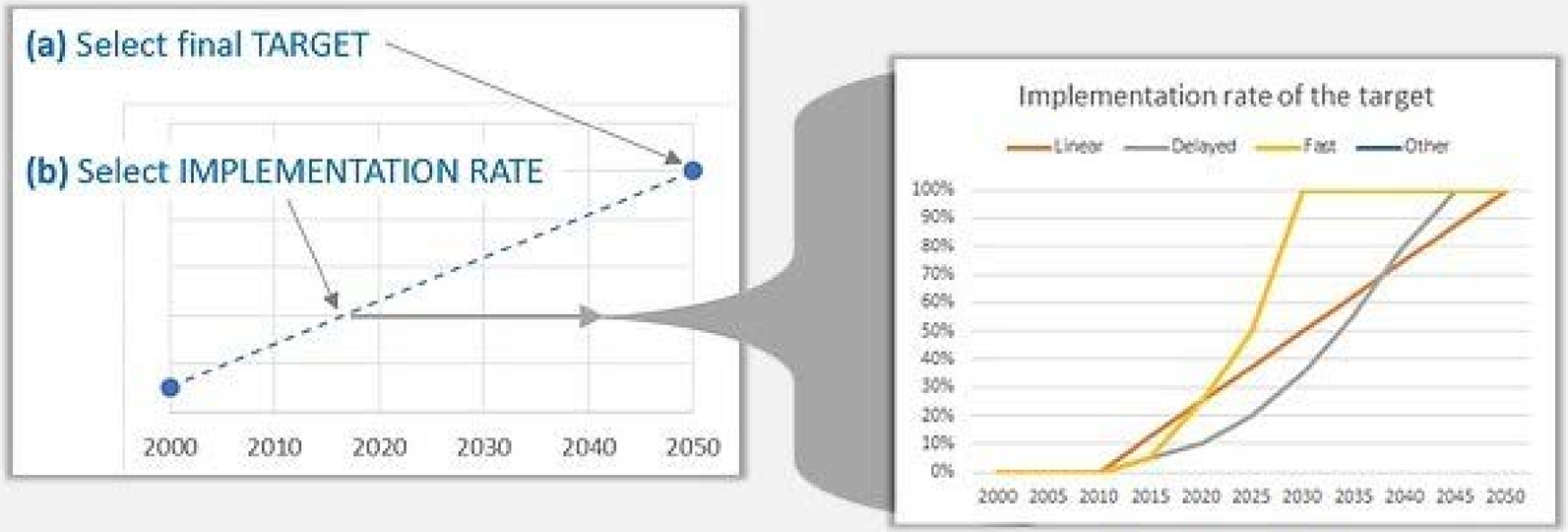
S.4.	Share of food supply which is wasted		
Selection	**FoodLossScen**	**Description**	**Value**
	Current	Same share as in 2010	
	Increased	Increased share compared to 2010	
	Reduced	reduced share compared to 2010	
x	MyFoodLossScen	Describe your scenario here	if you want to define your own reduction % of the share of food consumption wjich is wasted fill green cells in this table

Food loss share in 2050

Food loss share scenario	Commodity group	Scenario	Implemntation rate scenario	Food loss in 2050
				% conso
FoodLossScen	**Prod_group**	**Scen_group**	**ImplTiming**	**RelChange2050**
Current	CEREALS	CurrentCEREALS	Linear	0%
Current	FISH	CurrentFISH	Linear	0%
Current	FRUVEG	CurrentFRUVEG	Linear	0%
Current	PORK	CurrentPORK	Linear	0%
Current	MILK	CurrentMILK	Linear	0%
Current	OLSOIL	CurrentOLSOIL	Linear	0%
Current	EGGS	CurrentEGGS	Linear	0%
Current	PULSES	CurrentPULSES	Linear	0%
Current	REDMEAT	CurrentREDMEAT	Linear	0%
Current	ROOTS	CurrentROOTS	Linear	0%
Current	SUGAR	CurrentSUGAR	Linear	0%
Current	POULTRY	CurrentPOULTRY	Linear	0%
Current	NUTS	CurrentNUTS	Linear	0%
Current	ANIMFAT	CurrentANIMFAT	Linear	0%
Current	BEVSPICES	CurrentBEVSPICES	Linear	0%
Current	OTHER	CurrentOTHER	Linear	0%
Current	ALCOHOL	CurrentALCOHOL	Linear	0%
Increased	CEREALS	IncreasedCEREALS	Linear	10%
Increased	FISH	IncreasedFISH	Linear	10%
Increased	FRUVEG	IncreasedFRUVEG	Linear	10%
Increased	PORK	IncreasedPORK	Linear	10%
Increased	MILK	IncreasedMILK	Linear	10%
Increased	OLSOIL	IncreasedOLSOIL	Linear	10%
Increased	EGGS	IncreasedEGGS	Linear	10%
Increased	PULSES	IncreasedPULSES	Linear	10%
Increased	REDMEAT	IncreasedREDMEAT	Linear	10%
Increased	ROOTS	IncreasedROOTS	Linear	10%
Increased	SUGAR	IncreasedSUGAR	Linear	10%
Increased	POULTRY	IncreasedPOULTRY	Linear	10%
Increased	NUTS	IncreasedNUTS	Linear	10%
Increased	ANIMFAT	IncreasedANIMFAT	Linear	10%
Increased	BEVSPICES	IncreasedBEVSPICES	Linear	10%
Increased	OTHER	IncreasedOTHER	Linear	10%
Reduced	CEREALS	ReducedCEREALS	Linear	-10%
Reduced	FISH	ReducedFISH	Linear	-10%
Reduced	FRUVEG	ReducedFRUVEG	Linear	-10%
Reduced	PORK	ReducedPORK	Linear	-10%
Reduced	MILK	ReducedMILK	Linear	-10%
Reduced	OLSOIL	ReducedOLSOIL	Linear	-10%
Reduced	EGGS	ReducedEGGS	Linear	-10%
Reduced	PULSES	ReducedPULSES	Linear	-10%
Reduced	REDMEAT	ReducedREDMEAT	Linear	-10%
Reduced	ROOTS	ReducedROOTS	Linear	-10%
Reduced	SUGAR	ReducedSUGAR	Linear	-10%
Reduced	POULTRY	ReducedPOULTRY	Linear	-10%
Reduced	NUTS	ReducedNUTS	Linear	-10%
Reduced	ANIMFAT	ReducedANIMFAT	Linear	-10%
Reduced	BEVSPICES	ReducedBEVSPICES	Linear	-10%
Reduced	OTHER	ReducedOTHER	Linear	-10%
MyFoodLoosScen	CEREALS	MyFoodLoosScenCEREALS	Linear	
MyFoodLoosScen	FISH	MyFoodLoosScenFISH	Linear	
MyFoodLoosScen	FRUVEG	MyFoodLoosScenFRUVEG	Linear	
MyFoodLoosScen	PORK	MyFoodLoosScenPORK	Linear	
MyFoodLoosScen	MILK	MyFoodLoosScenMILK	Linear	
MyFoodLoosScen	OLSOIL	MyFoodLoosScenOLSOIL	Linear	
MyFoodLoosScen	EGGS	MyFoodLoosScenEGGS	Linear	
MyFoodLoosScen	PULSES	MyFoodLoosScenPULSES	Linear	
MyFoodLoosScen	REDMEAT	MyFoodLoosScenREDMEAT	Linear	
MyFoodLoosScen	ROOTS	MyFoodLoosScenROOTS	Linear	
MyFoodLoosScen	SUGAR	MyFoodLoosScenSUGAR	Linear	
MyFoodLoosScen	POULTRY	MyFoodLoosScenPOULTRY	Linear	
MyFoodLoosScen	NUTS	MyFoodLoosScenNUTS	Linear	
MyFoodLoosScen	ANIMFAT	MyFoodLoosScenANIMFAT	Linear	
MyFoodLoosScen	BEVSPICES	MyFoodLoosScenBEVSPICES	Linear	
MyFoodLoosScen	OTHER	MyFoodLoosScenOTHER	Linear	

Implementation rate

EXAMPLE: some scenarios require a 2-step selection (selection of the target and of the implementation rate for the considered time range).



Afforestation scenario

TABLE: AfforTarget

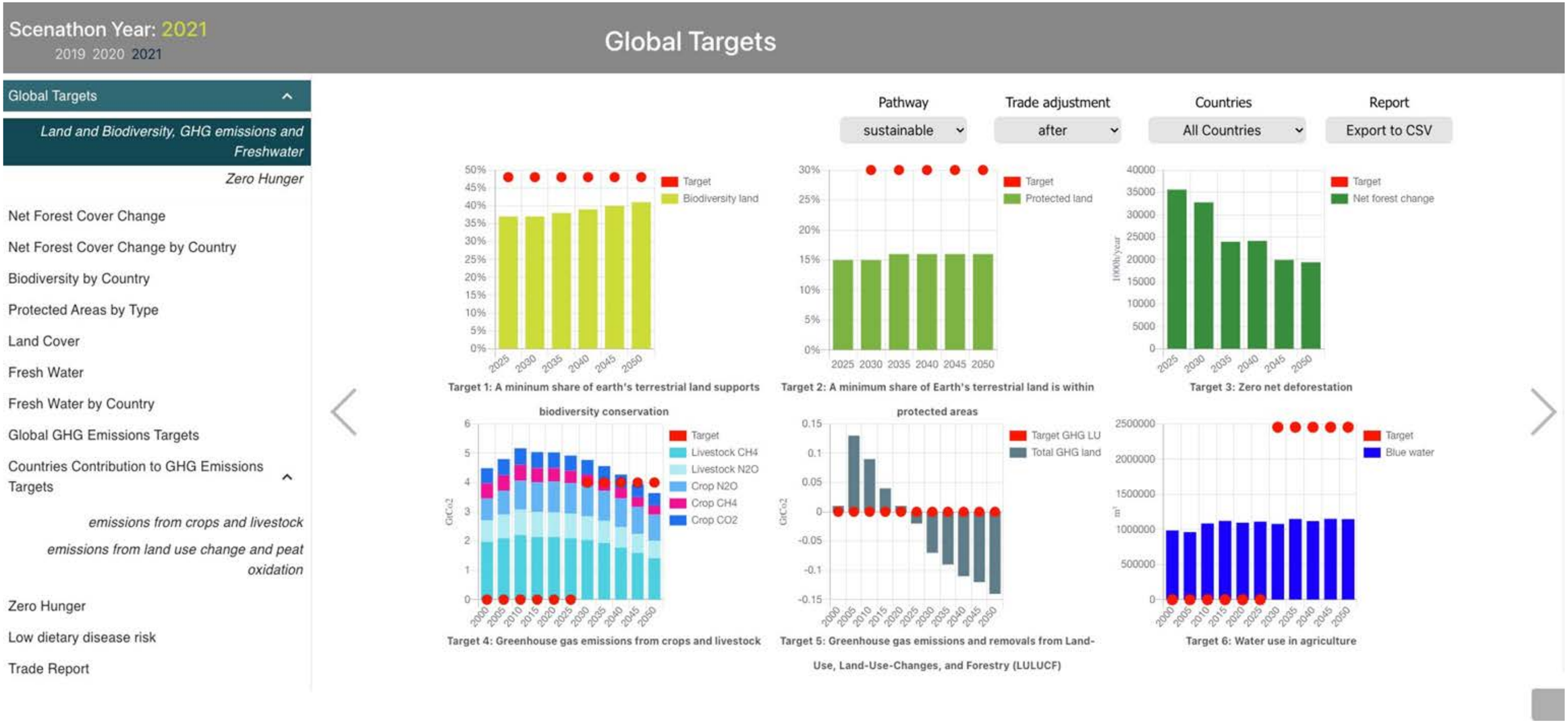
DIRECT		DIRECT	DIRECT	DATA-4	DATA-4	DATA-4	CALC	CALC	CALC
S.10.a									
Alternative targets for afforestation/reforestation by land cover type by 2050									
Afforestation/Reforestation scenario		Timing of the afforestation /reforestation target	Total cumulated afforested /reforested area since 2000 per period	Cropland in 2000	Pasture in 2000	Other land in 2000	Share of cropland among cropland, pasture and other land	Share of pasture among cropland, pasture and other land	Share of other land among cropland, pasture and other land
			1000 ha	1000 ha	1000 ha	1000 ha	%	%	%
AFFORScen	**Year**	**ImplTiming**	**AfforLand**	**Cropland**	**Pasture**	**OtherLand**	**ShCropland**	**ShPasture**	**ShOtherLand**
NoAffor	2050	AfforTiming	0	236821	999599	1258936	9%	40%	50%
BonnChallenge	2050	AfforTiming	0	236821	999599	1258936	9%	40%	50%
NoAffor	2000	AfforTiming	0	236821	999599	1258936	9%	40%	50%
BonnChallenge	2000	AfforTiming	0	236821	999599	1258936	9%	40%	50%
NoAffor	2005	AfforTiming	0	236821	999599	1258936	9%	40%	50%
BonnChallenge	2005	AfforTiming	0	236821	999599	1258936	9%	40%	50%
NoAffor	2010	AfforTiming	0	236821	999599	1258936	9%	40%	50%
BonnChallenge	2010	AfforTiming	0	236821	999599	1258936	9%	40%	50%
NoAffor	2015	AfforTiming	0	236821	999599	1258936	9%	40%	50%
BonnChallenge	2015	AfforTiming	0	236821	999599	1258936	9%	40%	50%

What will be the total afforested area in 2050?

In which land cover type the afforestation will occur?

Scenathon dashboard

scenathon.org



Results from the South Africa calculator

Pathways to Sustainable Land-Use and Food Systems in South Africa

Objective: To explore how sustainable food and land-use systems can contribute to raising climate ambition, biodiversity protection, and achieving food security in South Africa

Process

Developed two alternative pathways based on the literature (COVID-19 era): Current Trends (CT) and Sustainable Pathways (SP)

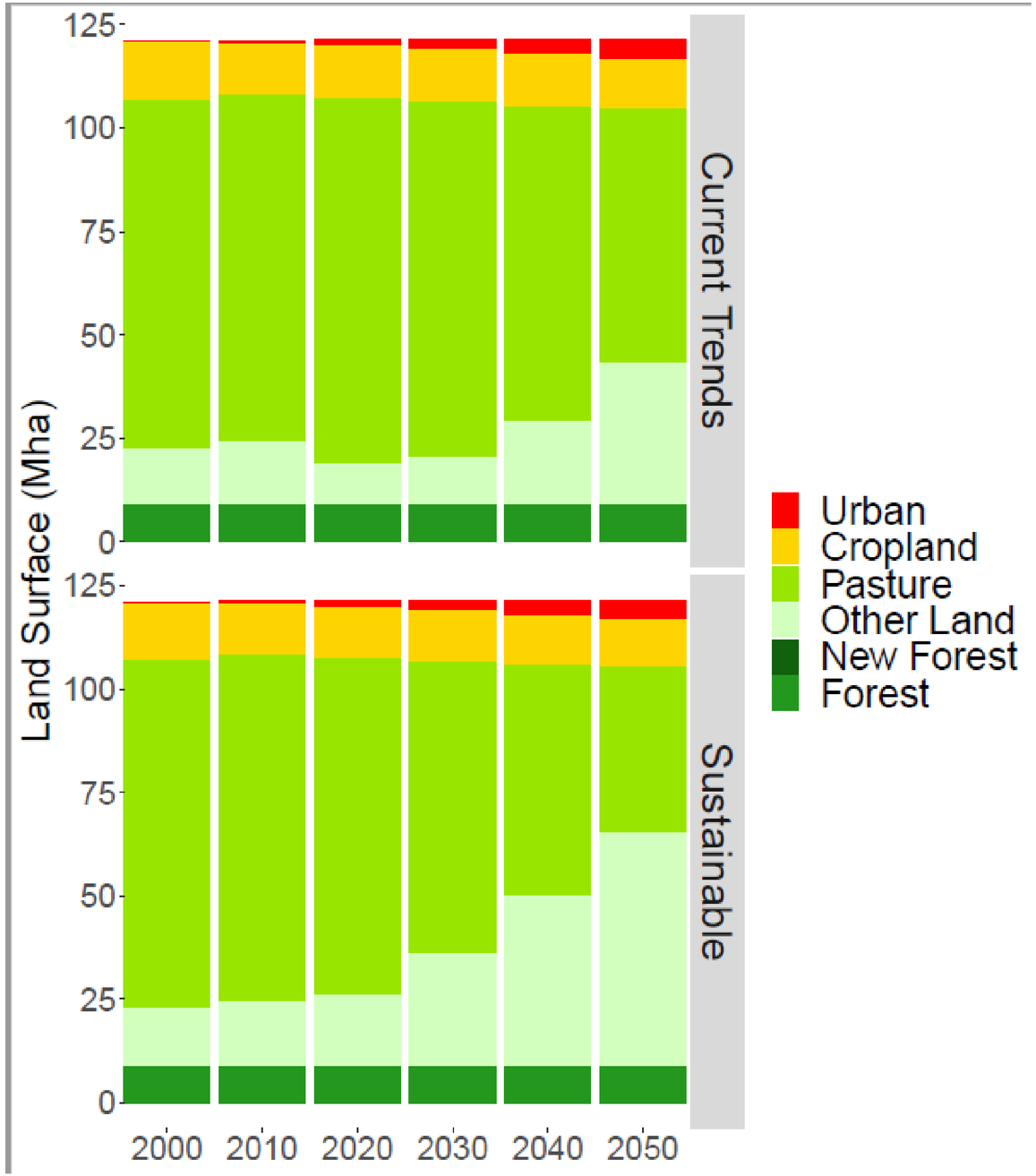
⇢The two are distinguished by how policies are implemented: to continue business as usual (CT), or aim for sustainable outcomes (SP)

⇢The pathways are derived from policy targets (e.g. biodiversity policy), projections about productivity, production growth, etc

⇢The pathways **examine trade-offs** between food security (calories), greenhouse gas emissions and biodiversity

Outcomes for biodiversity

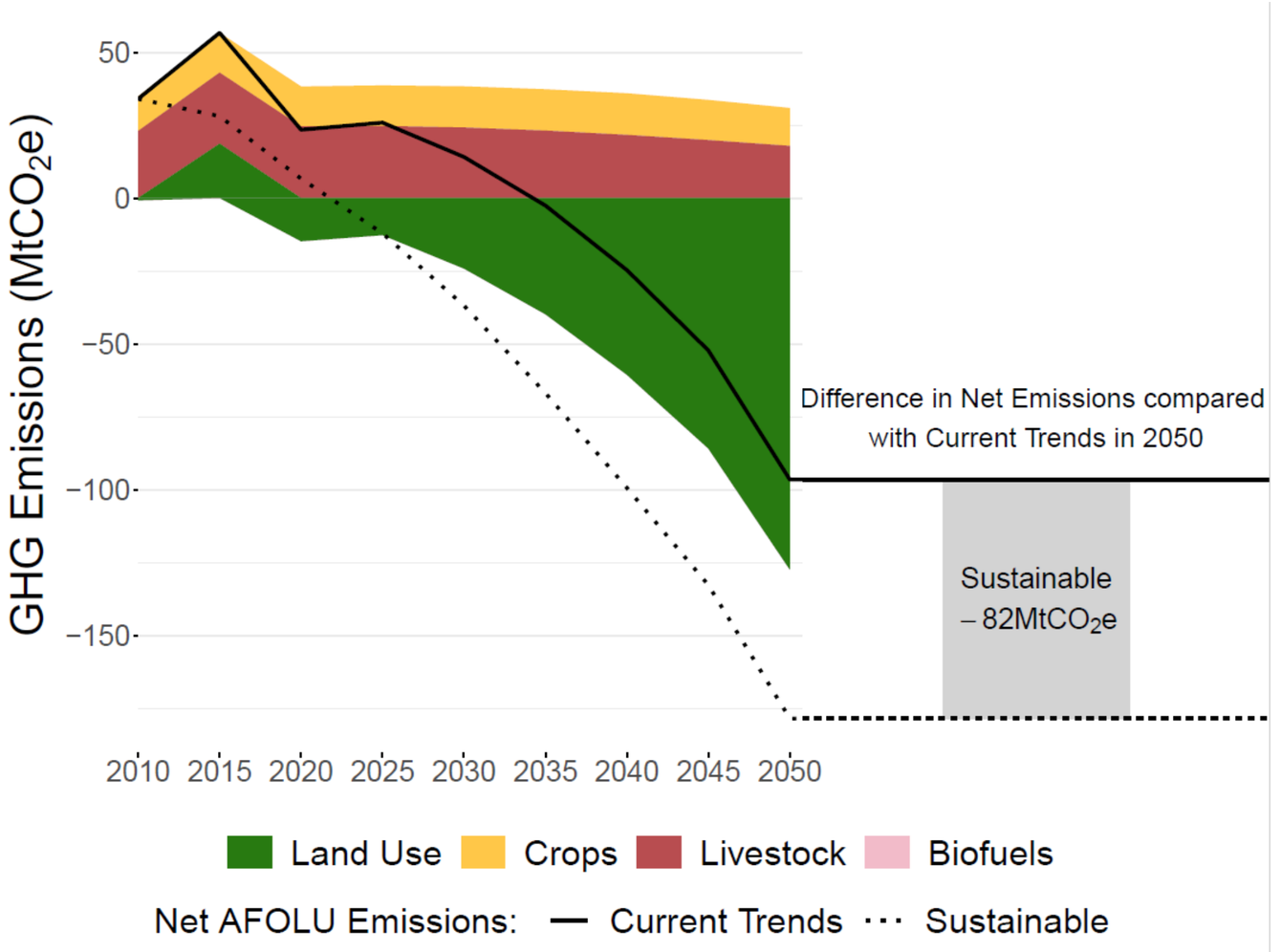
- ⇢Land use change between the Current Trend and Sustainable Pathways shows a decline in pasture areas overtime because of dietary shifts
- ⇢These are replaced by “areas where natural areas predominate”
- ⇢Assumption on dietary changes – reasonable?



Selomane & Reyers 2020

Outcomes for greenhouse gas emissions

- ⇢Projected AFOLU emissions and removals between 2010 and 2050 by main sources and sinks
- ⇢Most gains are made from land getting out of production and becoming a carbon sink
- ⇢How likely is production to change?

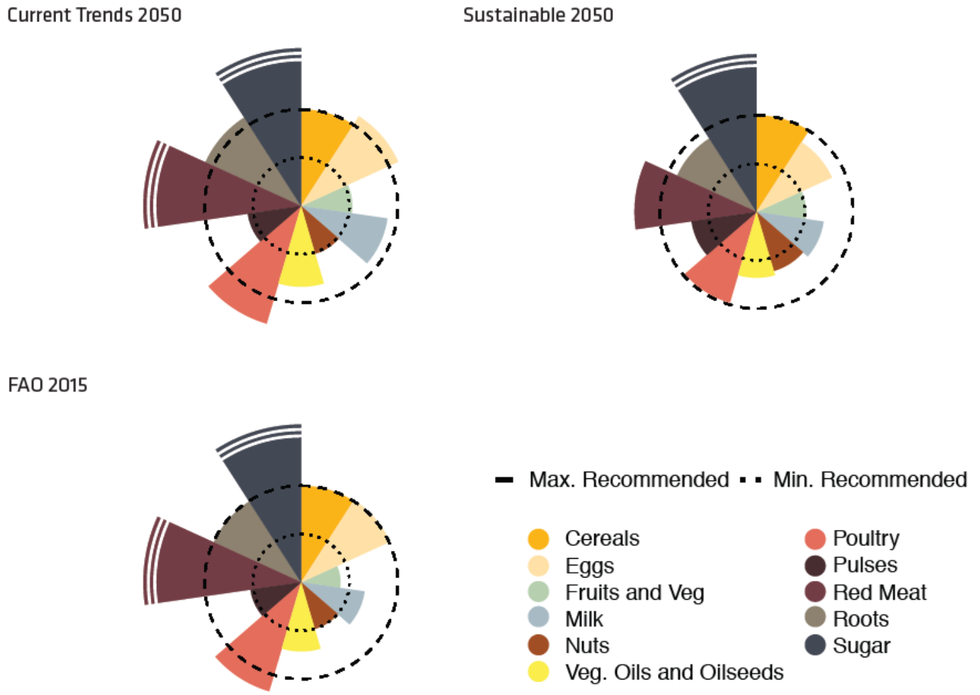


Selomane & Reyers 2020

Outcomes for food security

Driven primarily by reduction in red meat and poultry consumption

Food security outcomes at a macro level, and not actual household level security – inadequate given national FS versus household FS

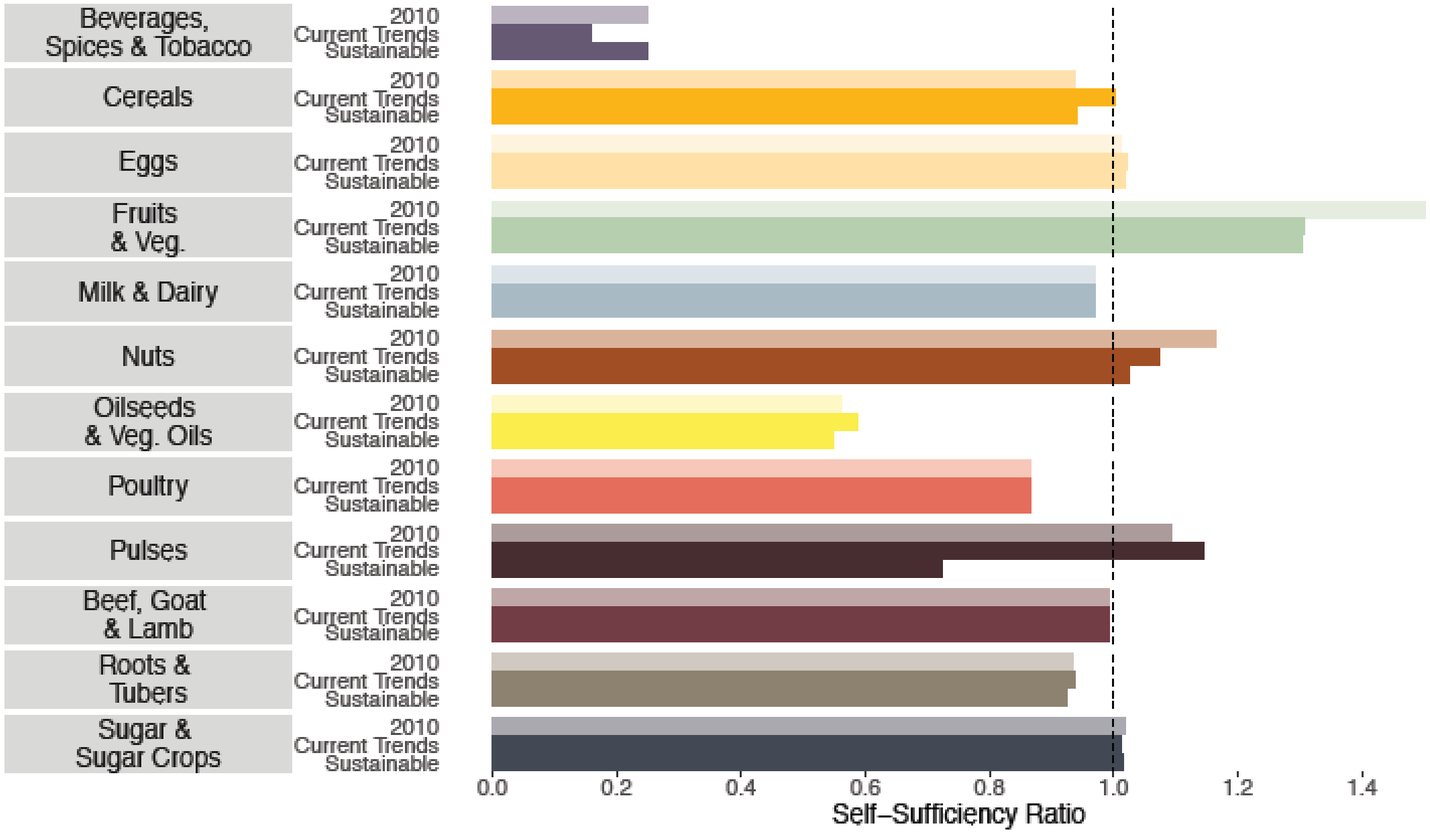


	2010	2030		2050	
	Historical Diet (FAO)	Current Trends	Sustainable	Current Trends	Sustainable
Kilocalories (MDER)	2,958 (1,827)	3,009 (1,845)	2,812 (2,073)	3,060 (1,852)	2,665 (2,079)
Fats (g) (recommended range)	79 (66-99)	91 (68-100)	78 (62-94)	106 (68-102)	78 (59-88)
Proteins (g) (recommended range)	81 (74-259)	82 (75-263)	78 (70-246)	87 (76-268)	77 (66-233)

Selomane & Reyers 2020

Resilience of the food system: Self sufficiency

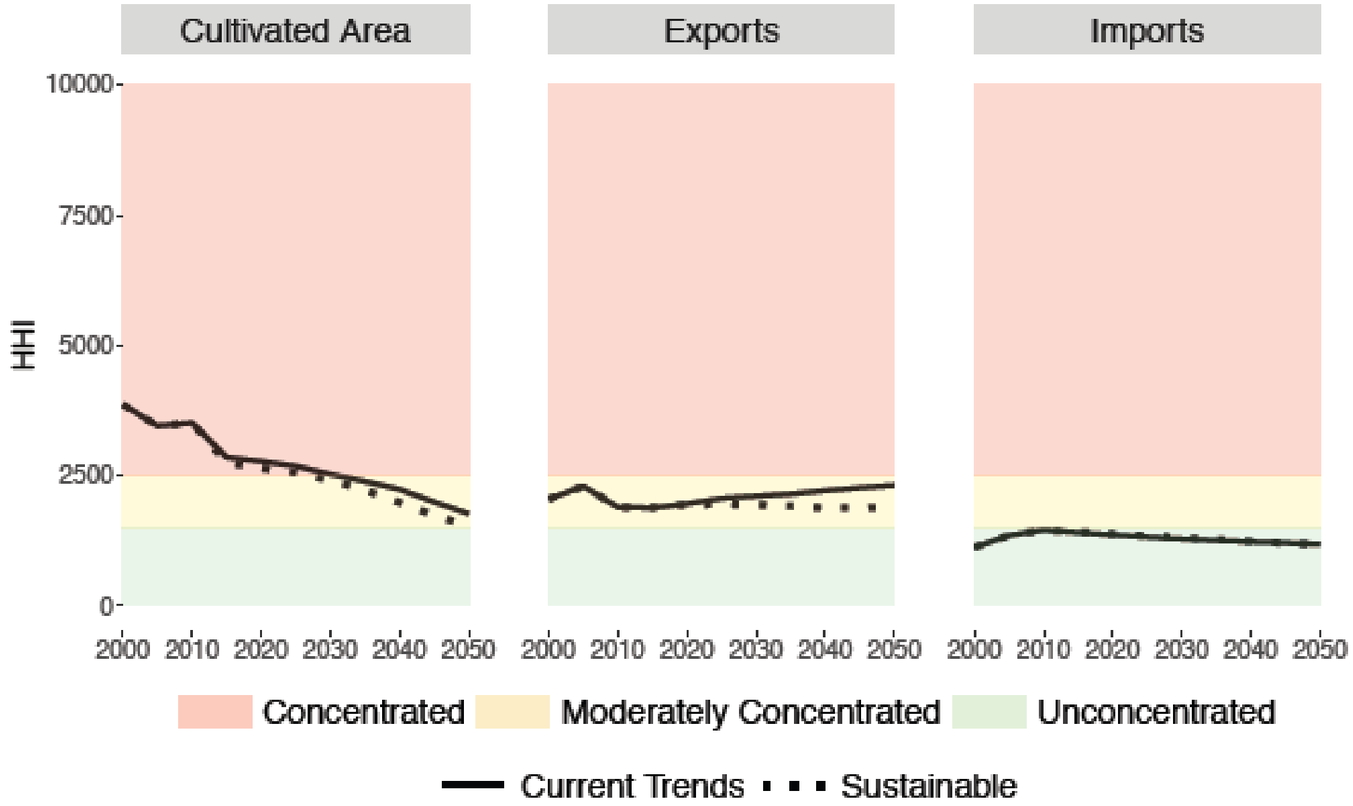
- Fragile food systems driven by vulnerabilities in international supply chains and national production system
- Resilience given by **self-sufficiency** and **diversity of production** and trade.
- SA is self sufficient in key food groups but not poultry



Selomane & Reyers 2020

Resilience of the food system: diversity of production & trade

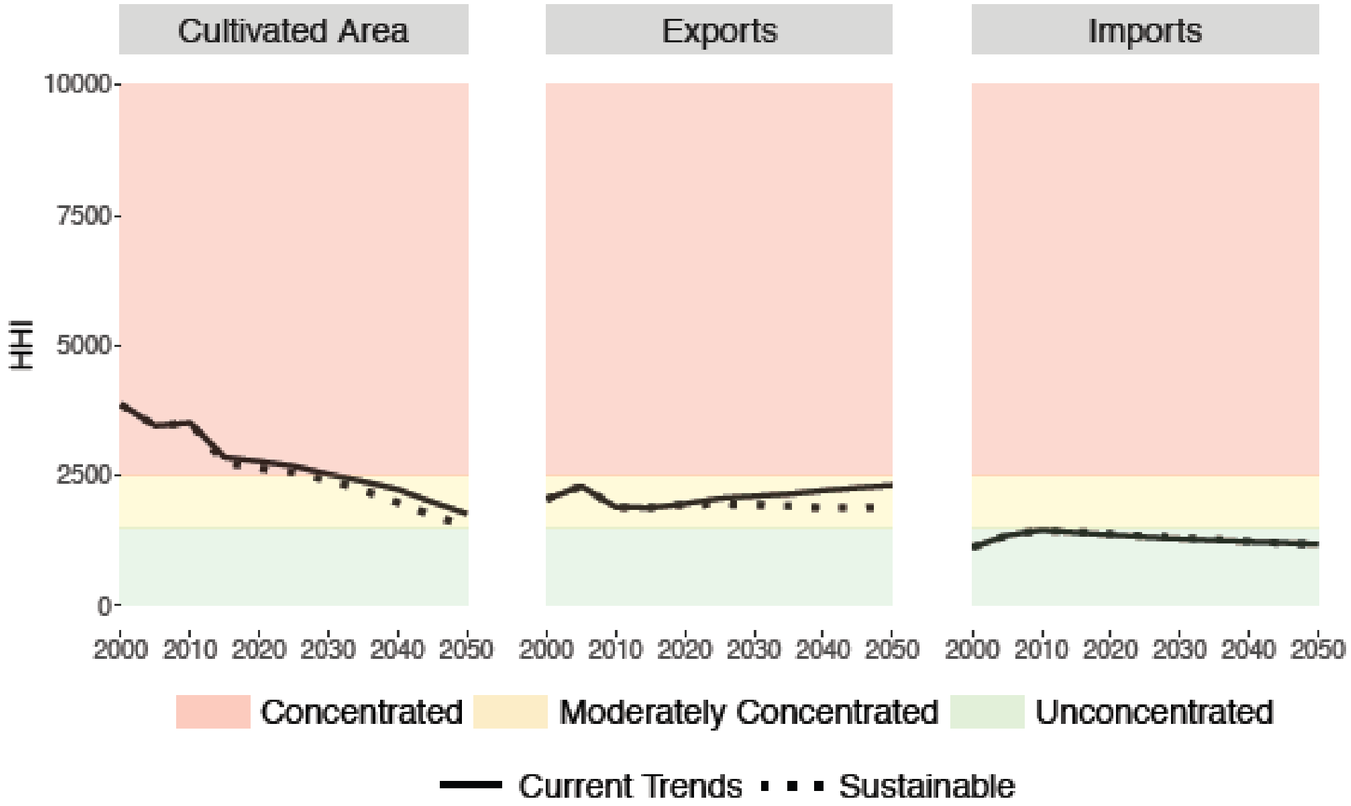
- ⇢ Assess how vulnerable countries' food systems are to international supply and demand shocks such as COVID-19.
- ⇢ We estimate the diversity of countries' trade and diversity in production using the Herfindahl-Hirschman Index (HHI).
- ⇢ Higher concentrations suggest that countries are more vulnerable to shocks affecting individual commodities.
- ⇢ Cultivated areas are getting more diversified
- ⇢ Trade is relatively unchanged but remain moderately concentrated



Selomane & Reyers 2020

Resilience of the food system: diversity of production & trade

- Diversity measured using The Herfindahl-Hirschman Index (HHI)
- The index measures the degree of market competition using the number of firms and the market shares of each firm in a given market
- Cultivated area is currently dominated by a few crops but this changes overtime
- Moderate levels of diversity for exports and high levels of diversity for imports



Selomane & Reyers 2020

Conclusion

- ⇢ The key differences between the Current Trends and Sustainable Pathways were driven by assumed dietary changes
- ⇢ Currently South Africa does not have “sustainable diets” or “healthy diets” but has the Food-based dietary guidelines from 2013
- ⇢ The dietary assumption came from the EAT Lancet diet (Willet *et al* 2019)
- ⇢ What would a sustainable healthy diet look like in South Africa?

Way forward

- ⇢The key conclusions in the FABLE project relied heavily on dietary shifts
- ⇢Shifting diets is a difficult process – and cannot merely be assumed
- ⇢What are the behavioural patterns influencing dietary choices?
- ⇢A new EU Horizon project aimed:
  - ⇢ at mainstreaming integrated assessment models
  - ⇢ improving the scenarios and assumptions in the FABLE calculator
  - ⇢ embedding behavioural choices of actors in the food system
  - ⇢ pilot among youth groups (A – B testing using an app)
- ⇢Focus on agri-food sector on other sectors

<u>Open questions</u>

- ⇢Other sectors' impacts on agri-food sector?
  - ⇢ Impacts of climate change on maize production and suitability
  - ⇢ Biodiversity loss and nature related risks for food
  - ⇢ Behavioural dynamics around diets and food waste
  - ⇢ Dietary trajectories and visions
- ⇢Missing data
  - ⇢ Soil moisture data to help model climate impacts on production
  - ⇢ Specific crop water use models
  - ⇢ Accounting for micro level dynamics for food security (inequality issue in SA)

Merci!

Main achievements of FABLE

- Decentralization of the modeling increases the likelihood to impact policies, and increase the realism of global pathways
- The FABLE Calculator is an open and transparent tool that can be easily deployed in more countries and combined with other tools
- Results are accessible on the scenathon.org website
- Projections of future international trade rely on the individual assumptions of researchers based in many countries
- Co-development of tools with Consortium members depending on individuals' expertise => everybody benefits
- In some countries, good collaboration with decision-makers has already been established
- Global results in the range of existing literature

Learn more

fableconsortium.or

g scenathon.org

abstract-landscapes.com/fable-calculator

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