# Key Insights from the Climate Scenario Tool

November 2022 Update

wbcsd

# Purpose and overview

## Purpose

This document guides users of the Climate Scenario Tool by providing additional insights on drivers and trends across commodities.
We offer an overview of the **production and price outputs** for **selected regions and commodities**, where trends may not be easily discerned.

**Prices** are indexed, with 2020 = 100

**Production** is shown in megatons dry matter / year

This is a living document and will be updated with global insights and additional environmental variables through February 2023.
This document is based on modeling and supporting analysis by Vivid Economics, among other sources.

## Overview:

1. **Introduction**:
   - Scenario narratives and drivers
   - Key input assumptions and outputs

2. **Key Trends**:
   - Overview of key trends for each commodity group followed by some regional insights:
     - Cereals
     - Oil Crops
     - Sugar Crops
     - Animal Products
     - Forest Products

# **The Climate Scenario Tool** is driven by five scenarios that feature varying sources of transition risks, opportunities, and temperature targets

| Scenario | Scenario description |
|---|---|
|  **>3°C Historic Trends Scenario** | >3˚C **Historic Trends** represents a scenario in which climate **action remains stable at current levels** creating limited transition risks, but the world fails to limit global warming to manageable levels, resulting in substantial future physical risks. This scenario has low levels of transition risk. |
|  **<2°C Forecast Policy Scenario (IPR)** | Under <2˚C **Forecast Policy Scenario (IPR),** Climate action starts abruptly and late, around 2030, resulting in limited transition risk in early years. After 2030, transition risks ramp up significantly due to the sudden implementation of greenhouse gas (GHG) prices, area protection regulation, and a scale-up of bioenergy with carbon capture and storage (BECCS) capacity. This scenario has varying levels of transition risk over time. |
|  **<2°C Coordinated Policy Scenario** | <2˚C **Coordinated Policy Scenario** is a scenario where **timely policy and regulation** work to curb emissions in an orderly fashion, decreasing the physical risk of climate change but increasing the transition risk. This scenario has moderate levels of transition risk. |
|  **1.5°C Societal Transformation Scenario** | 1.5°C **Societal Transformation Scenario** represents **strong, coordinated and prompt global policy action**, as well as **market responses** (e.g. diet shifts and lower food waste) that result in widespread carbon pricing and land protection to enable decarbonization and limited physical impacts of climate change. This scenario has high levels of transition risk. |
|  **1.5°C Innovation Scenario** | Under 1.5˚C **Innovation Scenario,** large **demands** from the energy system for **BECCS, coupled with greater-than-historic yield growth** in agriculture and government support for R&D, enables early decarbonization and limited physical impacts of climate change. This scenario has high levels of transition risk, but may be muted by technological progress. |

# The Climate Scenario Tool reports business variables across 23 commodities and 18 regions between 2020-2050

## Coverage

### Types

**Regions**
18 regions incl. 6 large individual countries

**Timeframe**
Reported between 2020 – 2050, in 5-years intervals. Model runs up to 2100 to define carbon budget.

### Scenario Drivers

**Fixed across scenarios**
GDP, population, and trade

**Varying across scenarios**
GHG prices, bioenergy production, area protection, diet shifts, food waste, timber demand pathways, innovation

## Outputs

### Commodities

- Crops
- Animal Products
- Forest Products

### Business variables

**Market sizing**
Production and prices, market size, production share

**Land use**
Yield growth, land use change

### Environmental variables

Emissions, deforestation, and forest carbon stocks

## Crops

- Corn, rice and temperate cereals (e.g., wheat)
- Soy and other oilseeds
- Oil palm
- Sugar crops
- Fruits and vegetables
- Potatoes, tropical roots (e.g., cassava)
- Pulses, tree nuts and groundnuts (e.g., peanuts)
- Cotton

## Animal Products

- Poultry
- Eggs
- Dairy
- Beef, sheep, and goat
- Pork

## Forest Products

- Timber
- Pulpwood

# Contents

# Commodities overview

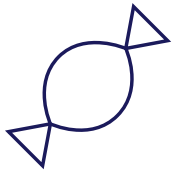
**This section summarizes how the key drivers drive changes in production and prices across five commodity groups:**

**Cereals**

Including temperate cereals like wheat and tropical cereals, such as maize.

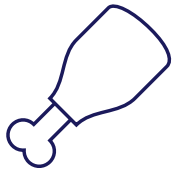
**Oil crops**

Including tropical oil crops, such as oil palm and soybean, and temperate oil crops, such as rapeseed.



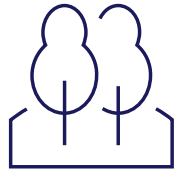
**Sugar crops**

Including sugar cane (tropical) and sugar beet (temperate).



**Animal products**

Including poultry, pork, beef, sheep, and goat.



**Forest products**

Including timber and pulpwood.

# Contents

# Cereals

Cereals

Negative effect | Positive effect | Prices | Production

## Key Drivers

### Food waste reductions

- By 2050, food waste will be reduced by 50% under the 1.5°C Societal Transformation Scenario, leading to a substantial decrease in demand, particularly in developed economies.

Reduces land competition

Reduces food demand

### GHG prices

- GHG pricing will increase the cost of producing cereals, particularly in scenarios/regions with high carbon prices.

Increases agricultural production costs

### Bioenergy

- Bioenergy crops production will shift from first to second generation crops by 2050, limiting the demand for cereals like maize for fuel use.

Reduces demand for maize and other first gen bioenergy corps

### Yield growth

- In the 1.5°C Innovation Scenario, average crop yields could increase by up to 69% globally by 2050. Yield growth will reduce land competition and prices for cereals, particularly in developed economies.

Reduces land competition

## Key Trends

### Prices

- Cereal prices under transition scenarios increase above Historic Trends in the first decade as **climate policies** increase pressure on the land use system.

### Production

- For **temperate** commodities, production decreases due to significant **food waste** reductions. For **tropical** commodities, production increases due to **less land constraints and lower climate action in tropical regions**

# Maize production

Cereals

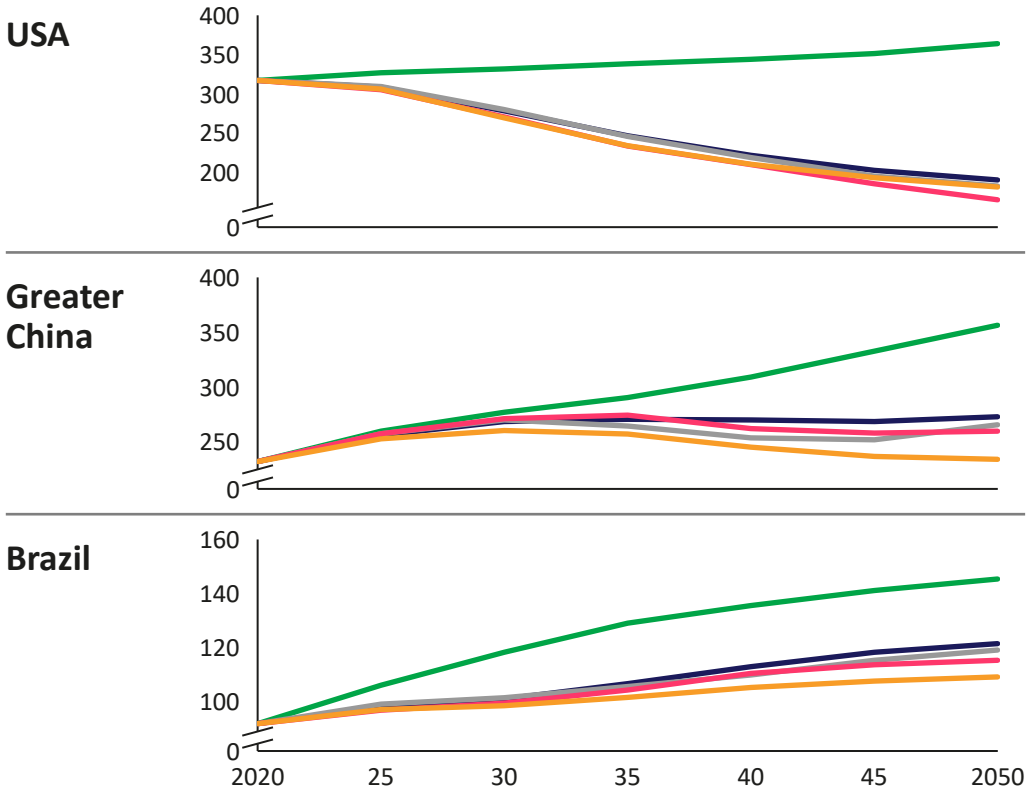
Maize is mostly used to produce food and fuel

>3°C Historic Trends | <2°C Forecast Policy (IPR) | 1.5°C Societal Transformation | <2°C Coordinated | 1.5°C Innovation

Protected areas | Food waste reductions | GHG Prices | Input efficiency | Bioenergy pathway | Diet shifts | Yield-enhancing tech

## Maize in selected markets, Production (Mt DM yr.)

Maize is mostly used for feed production, particularly ruminants and poultry in China and Brazil.




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | Growth in livestock production increases demand across all regions. In Brazil, a large share of total maize production in 2020 is exported. |
| **<2°C Forecast Policy (IPR)** | |
| **<2°C Coordinated** | **USA and Greater China:** A medium diet shift and decrease in food waste jointly decrease production. The shift kicks in after 2025 for China as the population starts declining.<br>**Brazil:** Land protection and high deforestation costs push Brazil to reduce its maize exports, halving production growth. Across all three scenarios, Brazil becomes a net importer between 2030 and 2040. Additionally, the medium diet shift (or high diet shift in the 1.5°C Societal Transformation scenario) and food waste reduction decreases overall demand for feed production from maize. |
| **1.5°C Innovation** | |
| **1.5°C Societal Transformation** | |

# Maize price

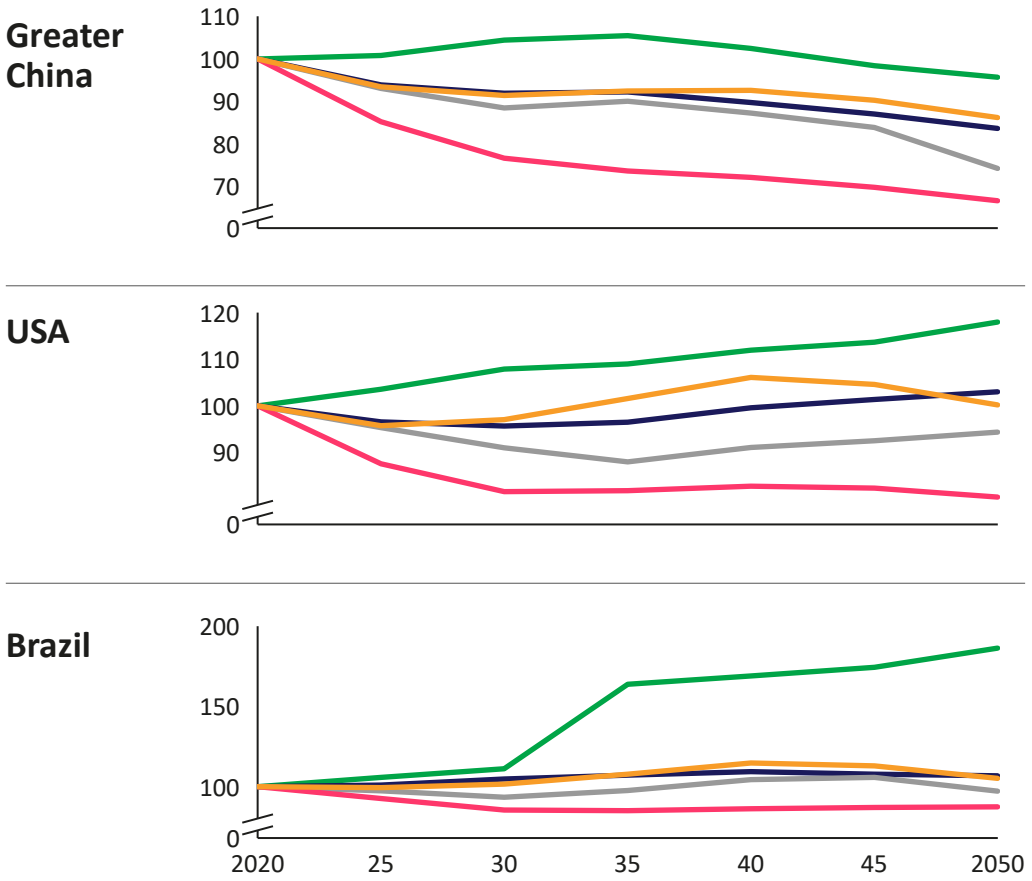
Cereals

Maize is mostly used to produce food and fuel

>3°C Historic Trends | <2°C Forecast Policy (IPR) | 1.5°C Societal Transformation
<2°C Coordinated | 1.5°C Innovation

Protected areas | Food waste reductions | GHG Prices | Input efficiency
Bioenergy pathway | Diet shifts | Yield-enhancing tech

## Price of Maize in selected markets, Indexed Prices (2020=100)




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **USA & Brazil:** Growth in livestock production increases feed demand and thus increases prices.<br>**Greater China:** Population decline starting in 2025 decreases maize demand, thereby decreasing the price |
| **<2°C Forecast Policy (IPR)** | **USA:** Maize exports peak in 2035 and then slowly decline through 2050, due to a reduction in feed demand and demand for first generation bioenergy.<br>**Greater China:** Moderate increases in innovation and yield-enhancing tech, combined with moderate decreases in meat demand decrease prices<br>**Brazil:** Moderate increases in innovation and yield-enhancing tech, combined with land protection policies and moderate decreases in meat demand, fluctuate maize price around its 2020 value. Brazil becomes a net importer of maize by 2050. |
| **<2°C Coordinated** | **USA:** Maize exports peak in 2035 and then slowly decline through 2050, due to a reduction in feed demand and demand for first generation bioenergy.<br>**Greater China:** Moderate increases in innovation and yield-enhancing tech, combined with moderate decreases in meat demand decrease prices<br>**Brazil:** Land protection reduces maize production, increasing costs despite increases in innovation and yield-enhancing tech. Brazil becomes a net importer of maize by 2050 |
| **1.5°C Innovation** | **USA:** Maize exports peak in 2035 and then slowly decline through 2050, due to a reduction in feed demand and demand for first generation bioenergy.<br>**Brazil:** Large increases in innovation and yield-enhancing tech, combined with a moderate decrease in meat demand and 1st generation biofuels decrease prices slightly. Brazil becomes a net importer of maize by 2050 due to land protection measures.<br>**Greater China:** Large increases in innovation and yield-enhancing tech, combined with a moderate decrease in meat demand decrease prices |
| **1.5°C Societal Transformation** | **USA & Brazil:** Moderate increases in innovation and yield-enhancing tech, combined with a high decrease in meat demand and 1st generation biofuels decrease prices. Brazil becomes a net importer of maize by 2050<br>**Greater China:** Moderate increases in innovation and yield-enhancing tech, combined with a high decrease in meat demand decrease prices, prices are also increased due to the high GHG price |

# Rice production

Cereals

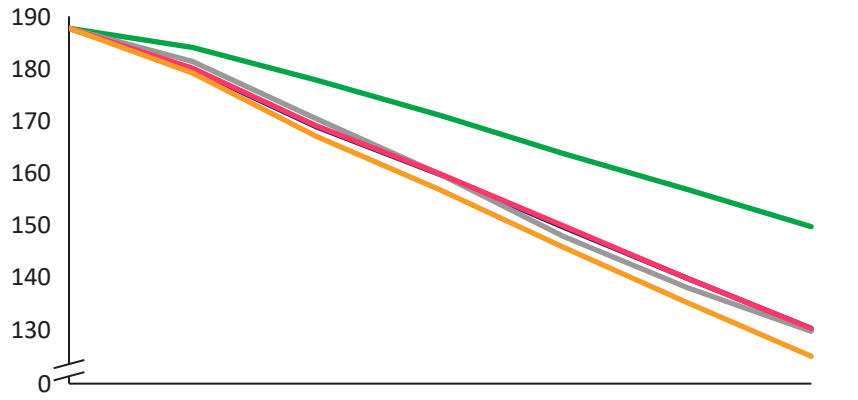
Rice is mostly used to produce food

>3°C Historic Trends | <2°C Forecast Policy (IPR) | 1.5°C Societal Transformation | <2°C Coordinated | 1.5°C Innovation

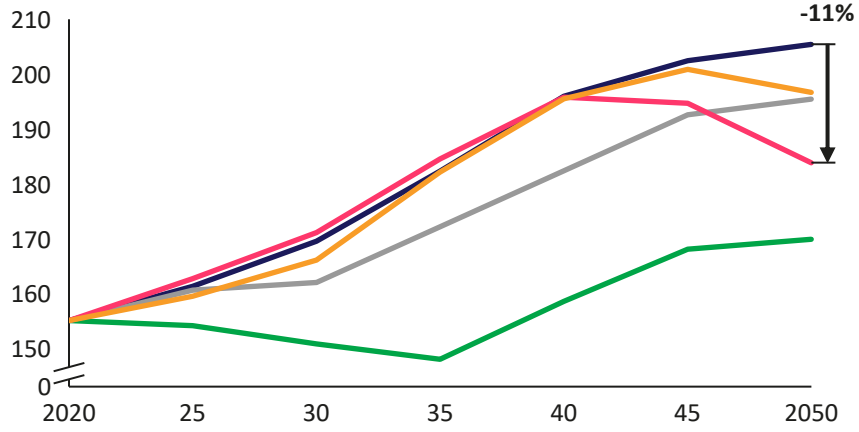
Protected areas | Food waste reductions | GHG Prices | Input efficiency | Bioenergy pathway | Diet shifts | Yield-enhancing tech

## Rice in selected markets, Production (Mt DM yr.)

**Greater China**




**India**




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **Greater China:** Production remains stable until 2025 and then declines following demographic trends. **India:** As demand for rice grows with population, India increases its imports from Southeast Asia. |
| **<2°C Forecast Policy (IPR)** | **Greater China:** Production declines linearly as population declines and food waste is reduced.<br>**India:** As demand for rice grows with population, production increases to meet demand. India cannot meet the entire additional demand with imports because neighboring economies in Southeast Asia face increasing land constraints due to climate policy and regulation. Hence, domestic production increases above Historic Trends across all transition scenarios.<br>In the **Forecast Policy** scenario, domestic demand is lower because climate policies are delayed and less stringent in developing economies in Southeast Asia, allowing India to meet rice demand with a larger share of imports. |
| **<2°C Coordinated** | |
| **1.5°C Innovation** | **Greater China:** Production declines linearly as population declines and food waste is reduced. **India:** Rice production increases until 2040 to accommodate the increase in demand. Close to 2050, high yield growth in neighbouring regions makes it simpler to import rice rather than producing it domestically, reducing production around the end of the century. |
| **1.5°C Societal Transformation** | **Greater China:** Production declines linearly as population declines and food waste is reduced. **India:** like in the 2° scenarios, as demand for rice grows with population, production increases to meet demand. India cannot meet the additional demand with imports because neighboring economies in Southeast Asia face increasing land constraints due to climate policy and regulation. Hence, domestic production increases above Historic Trends across all transition scenarios.<br>In the Societal Transformation scenario, rice production drops drop after 2045 following the effects of the additional food waste reduction on demand. |

# Rice price

Cereals

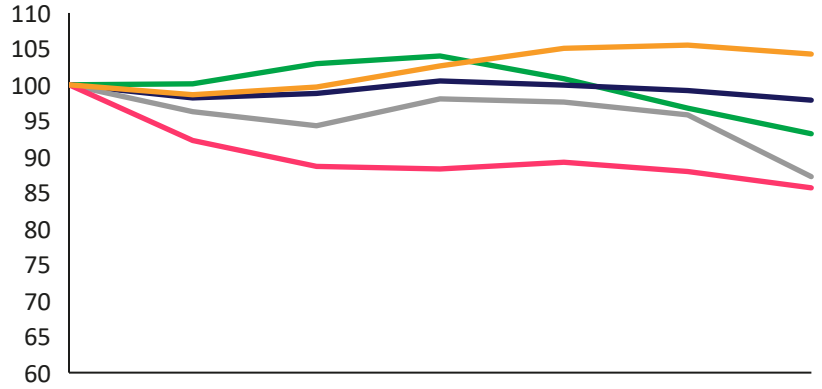
Rice is mostly used to produce food

>3°C Historic Trends | <2°C Forecast Policy (IPR) | 1.5°C Societal Transformation | <2°C Coordinated | 1.5°C Innovation

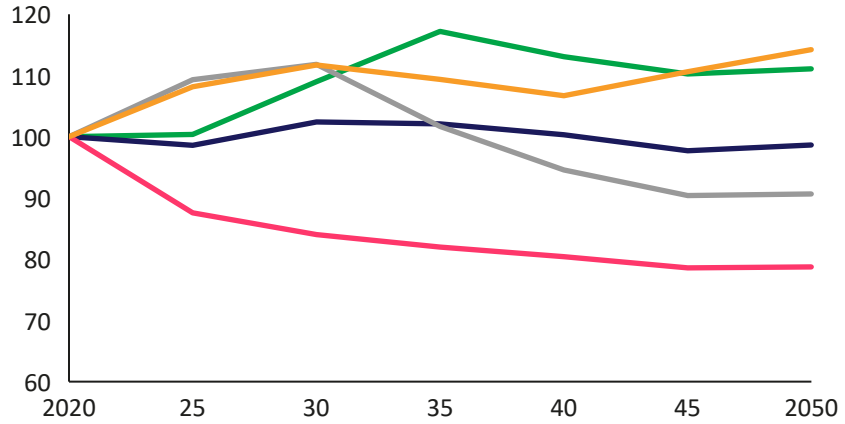
Protected areas | Food waste reductions | GHG Prices | Input efficiency | Bioenergy pathway | Diet shifts | Yield-enhancing tech

## Rice in selected markets, Indexed Prices (2020=100)

**Greater China**




**India**




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **Greater China:** Population decline starting in 2025 decreases rice demand, thereby decreasing the price<br>**India:** Prices increase as population and income growth increase demand for all commodities, increasing land competition |
| **<2°C Forecast Policy (IPR)** | Moderate increases in input efficiency and yield-enhancing technology decrease prices.<br>In India, under the Forecast Policy scenario prices are further reduced by the use of cheap external imports to meet rice demand. |
| **<2°C Coordinated** | |
| **1.5°C Innovation** | High increases in input efficiency and yield-enhancing technology decrease prices, despite a high GHG price. |
| **1.5°C Societal Transformation** | High GHG prices, area protection and a shift away from animal products increase the price of rice, despite moderate gains to input efficiency and yield-enhancing tech. |

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# Oil Crops

Oil crops

Negative effect | Positive effect | Prices | Production

## Key Drivers

### Diet shifts

- Shifts in diets away from animal proteins will: **a.** increase the use of vegetable oils to produce alternatives, **b.** reduce the use of oil crops for feed production.

Increases demand for vegetable oils

Reduces feed demand

### GHG prices

- GHG pricing will increase the cost of producing oil crops, particularly in scenarios/regions with high carbon prices. In tropical regions carbon prices drive land competition.

Increase agricultural production costs and land competition

### Bioenergy

- Bioenergy crops production will shift from first to second generation crops by 2050, limiting the demand for oil crops like soybean for fuel use.

Reduces demand for soybean and other first gen bioenergy corps

### Yield growth

- In the 1.5ºC Innovation Scenario, average crop yields could increase by up to 69% globally by 2050. Yield growth will reduce land competition and prices for oils produced using temperate oil crops, increasing their comparative advantage.

Reduces land competition; increased comparative advantage of temperate oil crops under 1.5oC Innovation

## Key Trends

### Prices

- Oil crop prices under transition scenarios increase above Historic Trends in the first decade as **climate policies** increase pressure on the land use system. For commodities such as soybean, **diet shifts and substitutes** for vegetable oils lead to price fluctuations.

### Production

- Tropical oil crop production benefits from comparative production advantages; land is also **less constrained** in these regions.

# Sunflower production

Oil crops

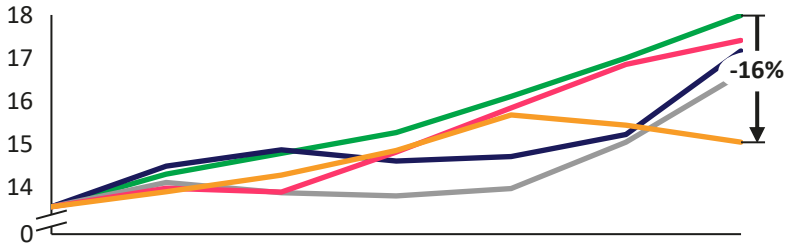
Sunflower can be used to produce edible vegetable oil as well as fuel

>3°C Historic Trends
<2°C Forecast Policy (IPR)
1.5°C Societal Transformation
<2°C Coordinated
1.5°C Innovation

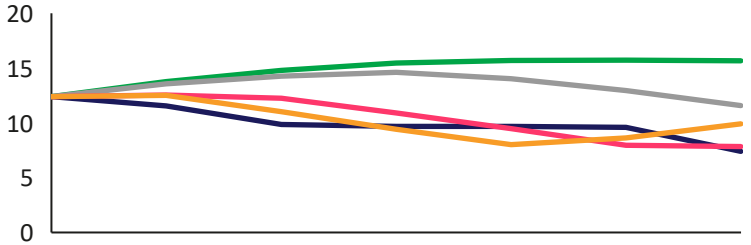
Protected areas
Food waste reductions
GHG Prices
Input efficiency
Bioenergy pathway
Diet shifts
Yield-enhancing tech

## Sunflower in selected markets, Production (Mt DM yr.)

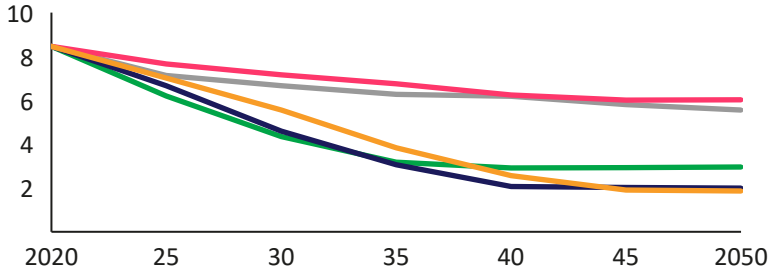
### Former Soviet Union (Excl. Russia)




### Russia




### EU & UK




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | Generally, production increases with demand (population and income). **EU & UK:** Production declines following a reduction in demand for vegetable oils from sunflower in favor of other tropical oil crops. |
| **<2°C Forecast Policy (IPR)** | **Former Soviet Union excluding Russia:** Imports for sunflower remain high until the effect of climate policies in neighboring regions increases prices, making domestic production competitive with imports. **Russia:** Across all transition scenarios production declines following an increase in land competition in Russia, increasing agricultural production costs. The exception is the **<2°C Forecast Policy** scenario where lower levels of area protection and slower policy uptake keep domestic production competitive in the first decade. **EU & UK: Coordinated -** Production declines following a reduction in demand for vegetable oils from sunflower in favor of other tropical oil crops. **<2°C Forecast Policy -** lower levels of land protection in Europe increase available space for agricultural production and reduce the need to meet demand for vegetable oils with imports. |
| **<2°C Coordinated** | |
| **1.5°C Innovation** | **Former Soviet Union:** As yields grow, demand is progressively met with domestic production increases with demand (population and income). **EU & UK:** Greater yield improvements in Europe increase available space for agricultural production and reduce the need for imports to meet vegetable oil demand |
| **1.5°C Societal Transformation** | **Former Soviet Union:** As land competition increases due to a ramp-up to in area protection, the region starts importing sunflower from neighboring countries after 2040. **EU & UK:** Production declines following a reduction in demand for vegetable oils from sunflower in favor of other tropical oil crops. |

# Sunflower price

Oil crops

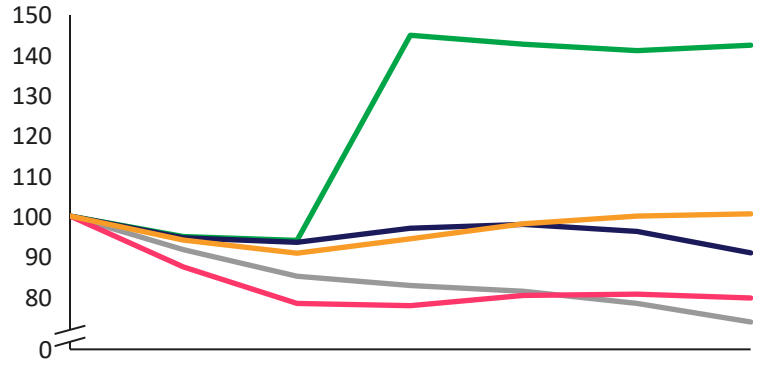
Sunflower can be used to produce edible vegetable oil as well as fuel

>3°C Historic Trends | <2°C Forecast Policy (IPR) | 1.5°C Societal Transformation | <2°C Coordinated | 1.5°C Innovation

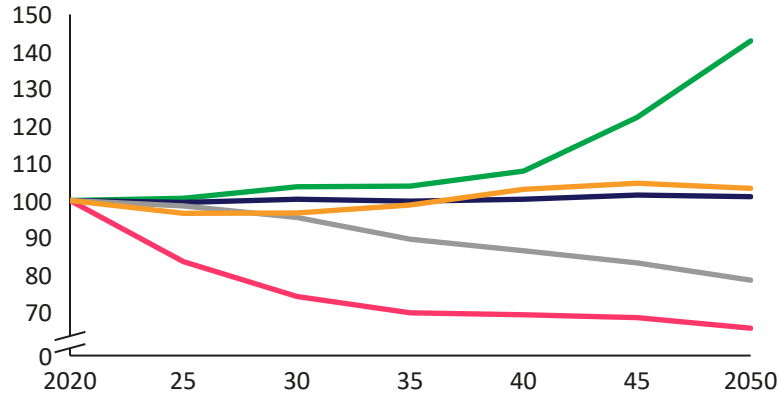
Protected areas | Food waste reductions | GHG Prices | Input efficiency | Bioenergy pathway | Diet shifts | Yield-enhancing tech

## Sunflower in selected markets, Indexed Prices (2020=100)

**Former Soviet Union (Excl. Russia)**




**EU and UK**




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **Former Soviet Union:** Prices rise due to an increase in land competition .<br>**EU & UK:** Prices remain constant through 2040 and then increase due to a decrease in production following historic trends. |
| **<2°C Forecast Policy (IPR)** | **Former Soviet Union:** Moderate increases in technological innovation coupled with low GHG prices decrease prices<br>**EU & UK:** Moderate increases in technological innovation and stagnating demand decrease prices |
| **<2°C Coordinated** | **Former Soviet Union and EU & UK:** Moderate increases in technological innovation, coupled with a medium diet shift and food waste reductions offset the moderate increase in environmental policy and regulation, keeping price close to 2020 levels |
| **1.5°C Innovation** | **Former Soviet Union and EU & UK:** High increases in innovation decrease prices through 2050, despite high GHG prices |
| **1.5°C Societal Transformation** | **Former Soviet Union and EU & UK:** Moderate increases in technological innovation, coupled with a strong diet shift and food waste reductions, decrease land competition, keeping prices stable at 2020 levels |

# Soybean production

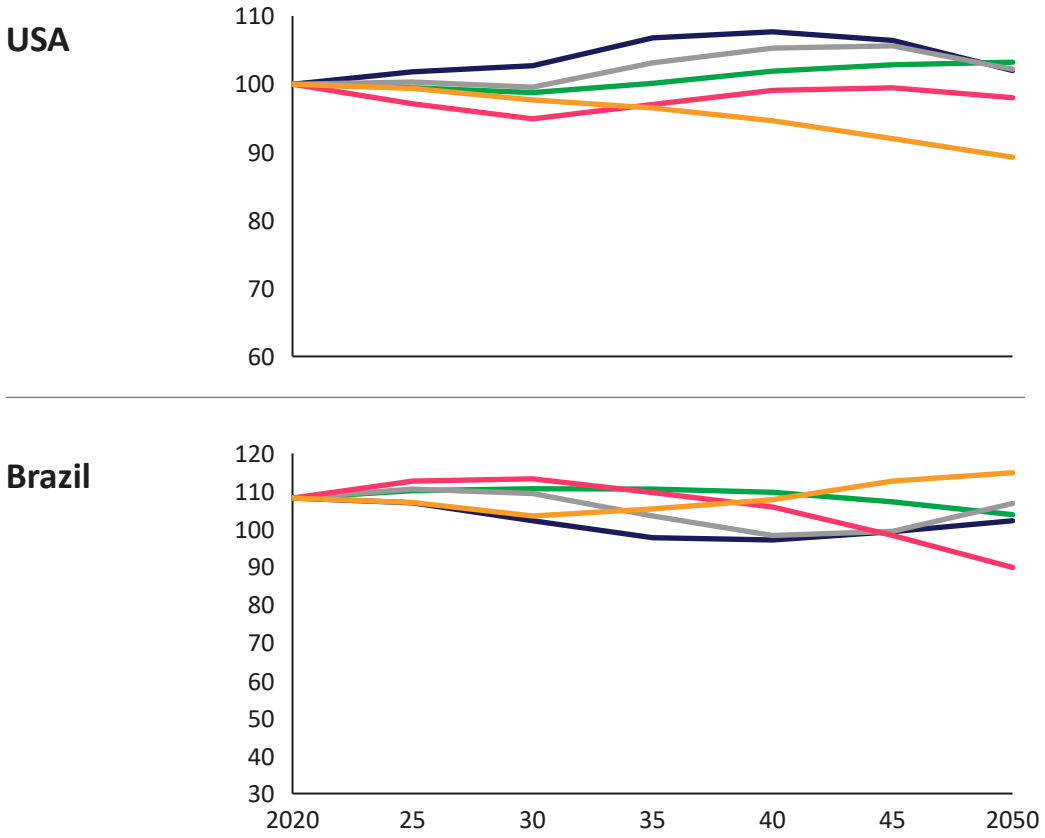
Oil crops

Soybean can be used to produce animal feed, food (alt proteins), and biofuel

>3°C Historic Trends
<2°C Forecast Policy (IPR)
1.5°C Societal Transformation
<2°C Coordinated
1.5°C Innovation

Protected areas
Food waste reductions
GHG Prices
Input efficiency
Bioenergy pathway
Diet shifts
Yield-enhancing tech

## Soybean in selected markets, Production (Mt DM yr.)




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **USA:** Production remains similar to today due to soybeans' versatile use as feed and food.<br>**Brazil:** Production increases due to increases in feed demand for meat production |
| **<2°C Forecast Policy (IPR)** | **USA & Brazil:** Production remains similar to today due to an increase in soy demand for vegetable oils and alt. proteins coupled with a decrease in soy demand for animal feed |
| **<2°C Coordinated** | **Brazil:** Production slightly declines from today's levels due to a decrease in soy demand for animal feed, but is mitigated by an increase in soy production for vegetable oils and alt. proteins<br>**USA:** Production slightly increases from today due to an increase in soy production for vegetable oils and alt. proteins |
| **1.5°C Innovation** | **Brazil:** Production falls due to a shift towards 2nd generation bioenergy production and a slight decline in demand for animal feed<br>**USA:** Production remains constant as an increase in biofuel production and alt. proteins balances a decrease in animal feed production |
| **1.5°C Societal Transformation** | Production decreases due to a large decline in animal feed demand and a shift towards 2nd generation bioenergy production |

# Soybean price

Oil crops

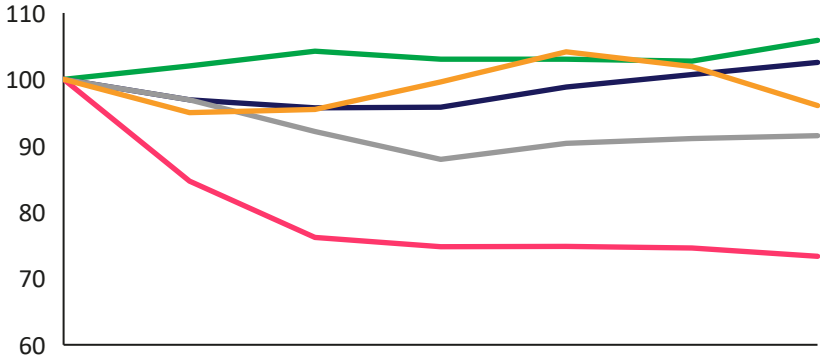
Soybean can be used to produce food (alt proteins) as well as fuel

>3°C Historic Trends | <2°C Forecast Policy (IPR) | 1.5°C Societal Transformation
<2°C Coordinated | 1.5°C Innovation

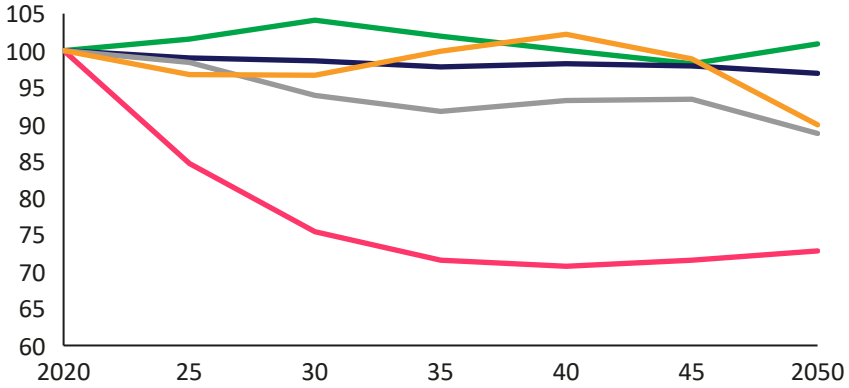
Protected areas | Food waste reductions | GHG Prices | Input efficiency
Bioenergy pathway | Diet shifts | Yield-enhancing tech

## Soybean in selected markets, Indexed Prices (2020=100)

**USA**




**Brazil**




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **USA & Brazil:** Prices remain similar to 2020 values and follow historic trends |
| **<2°C Forecast Policy (IPR)** | **USA & Brazil:** Moderate increases in input efficiency and yield-enhancing technology decrease prices, GHG prices are put into effect around 2030 and stabilize prices.<br>Prices are lower in the **<2°C Forecast Policy** scenario because countries are not as ambitious in terms of area protection. |
| **<2°C Coordinated** | |
| **1.5°C Innovation** | **USA & Brazil:** High increases in input efficiency and yield-enhancing technology decrease prices, despite a high GHG price. |
| **1.5°C Societal Transformation** | **USA & Brazil:** Moderate increases in input efficiency and yield-enhancing technology reduces pressures on the land use system, but high GHG prices raise and strict area protection regulation increase costs for the agricultural sector. These opposing forces cause price fluctuation between 2020-2050. |

# Oil palm production

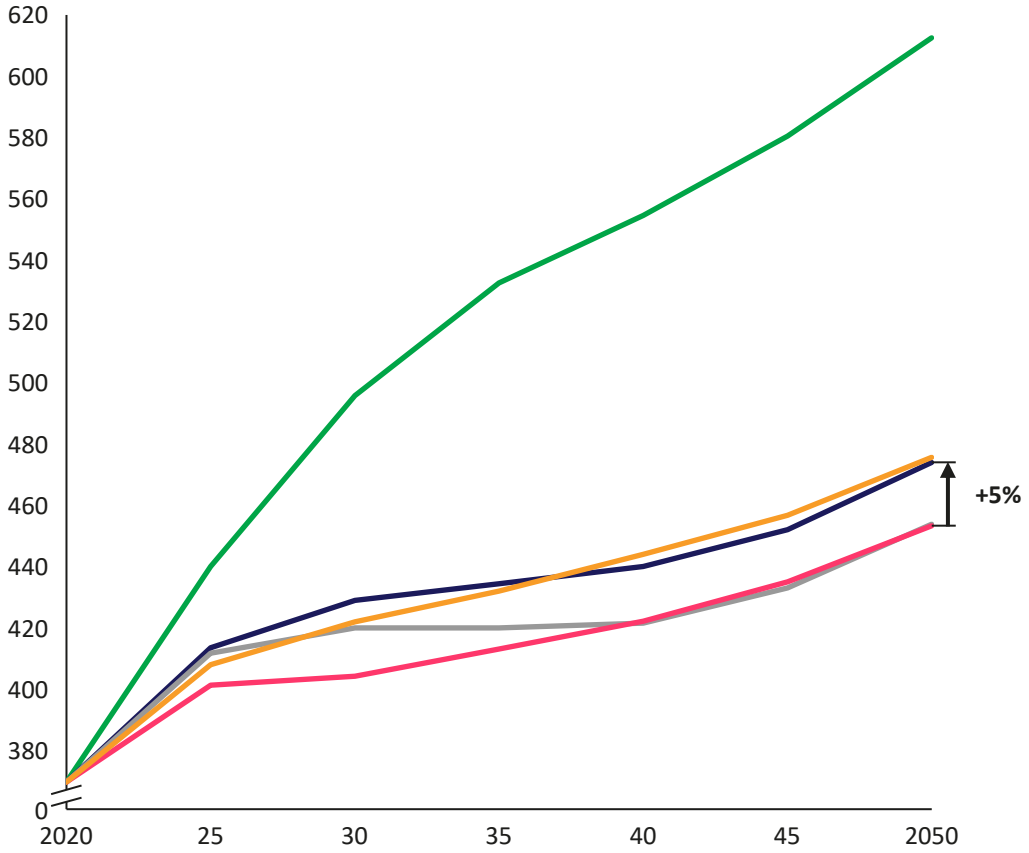
Oil crops

Oil palm is used to produce palm oil, an edible vegetable oil often used in plant-based products as a substitute for animal fat

- >3°C Historic Trends
- <2°C Forecast Policy (IPR)
- 1.5°C Societal Transformation
- <2°C Coordinated
- 1.5°C Innovation

- Protected areas
- Food waste reductions
- GHG Prices
- Input efficiency
- Bioenergy pathway
- Diet shifts
- Yield-enhancing tech

## Oil palm in Southeast Asia, Production (Mt DM yr.)




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | Demand for vegetable oils for food and fuel production keeps growing with population. |
| **<2°C Forecast Policy (IPR)** | Food waste reduction reduces palm oil demand.<br>A shift in demand away from livestock products increases demand for plant-based products. |
| **<2°C Coordinated** | Due to differences in protected areas, in the <2°C Coordinated Scenario, the EU and UK substitute oil palm for rapeseed in vegetable oil production, causing a slightly higher demand for oil palm from Southeast Asia under the <2°C Coordinated Scenario relative to the <2°C Forecast Policy (IPR) Scenario. |
| **1.5°C Innovation** | Food waste reduction decreases palm oil demand. High carbon prices reduce production incentives for palm oil around tropical rainforests. High investments in yield-enhancing technologies result in yield improvements in high-income countries like in Europe. The increase in production from the additional yield increases the use of local oil crops (e.g. rapeseed) to produce vegetable oils and reduces the demand for tropical oil crops. |
| **1.5°C Societal Transformation** | Demand from plant-based products keeps palm oil demand high, until it is eventually offset by lower food waste. |

# Oil palm price

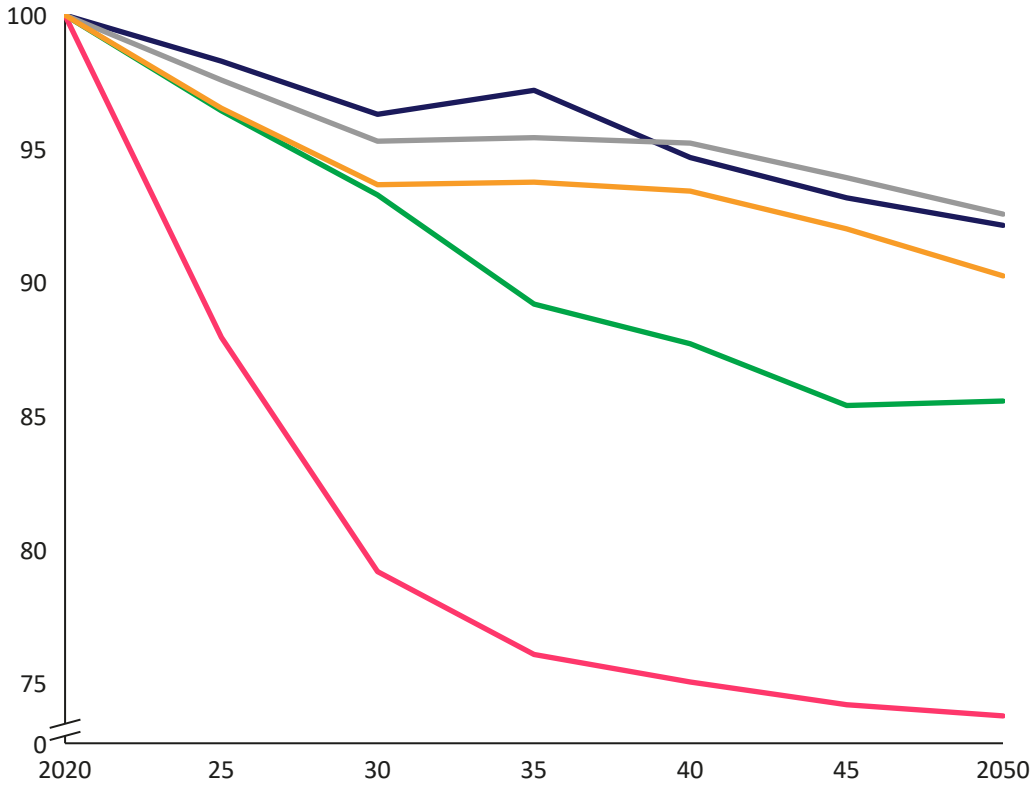
Oil crops

Oil palm is used to produce palm oil, an edible vegetable oil often used in plant-based products as a substitute for animal fat

>3°C Historic Trends
<2°C Forecast Policy (IPR)
1.5°C Societal Transformation
<2°C Coordinated
1.5°C Innovation

Protected areas
Food waste reductions
GHG Prices
Input efficiency
Bioenergy pathway
Diet shifts
Yield-enhancing tech

**Oil palm in Southeast Asia**, Indexed Prices (2020=100)




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | Increases in yield and input efficiency decrease price at historic rates |
| **<2°C Forecast Policy (IPR)** | Moderate increases in yield and input efficiency decrease prices through 2030. In 2030, the implementation of a GHG price stabilizes prices through 2040, before agricultural innovation grows to a point where it reduces the price again through 2050 |
| **<2°C Coordinated** | Moderate increases in yield and input efficiency decrease prices through 2030. However, prices spike from 2030-2035 due to the ramp up of GHG prices, before continuing to decline through 2050 |
| **1.5°C Innovation** | High increases in input efficiency and yield-enhancing technology decrease prices overall despite a high increase in GHG prices |
| **1.5°C Societal Transformation** | High GHG prices increase of oil palm, but moderate gains to input efficiency and yield-enhancing tech ultimately decrease the price overall |

# Contents

# Sugar Crops



Negative effect | Positive effect | Prices | Production

## Key Drivers

### Diet shifts

- Shifts in diets away from animal proteins will reduce the use of sugarcane for feed production.

Reduces demand for conventional proteins

### Food waste reductions

- By 2050, food waste will be reduced by 50% under the 1.5ºC Societal Transformation Scenario, leading to a substantial decrease in demand, particularly in developed economies.

Reduces land competition

Reduces food demand

### Yield growth

- In the 1.5ºC Innovation Scenario, average crop yields could increase by up to 69% globally by 2050. Yield growth will reduce land competition and prices for sugar crops.

Reduces land competition; increases comparative advantage of temperate oil crops under 1.5ºC Innovation

## Key Trends

### Prices

- Prices for sugar crops are **20%-60%** higher under Historic Trends than the transition scenarios as demand grows by about **50%** between 2020 and 2050

### Production

- Sugar crop production increases with income and population, but remains **11%-18%** below Historic Trends in all transition scenarios

# Sugar cane production

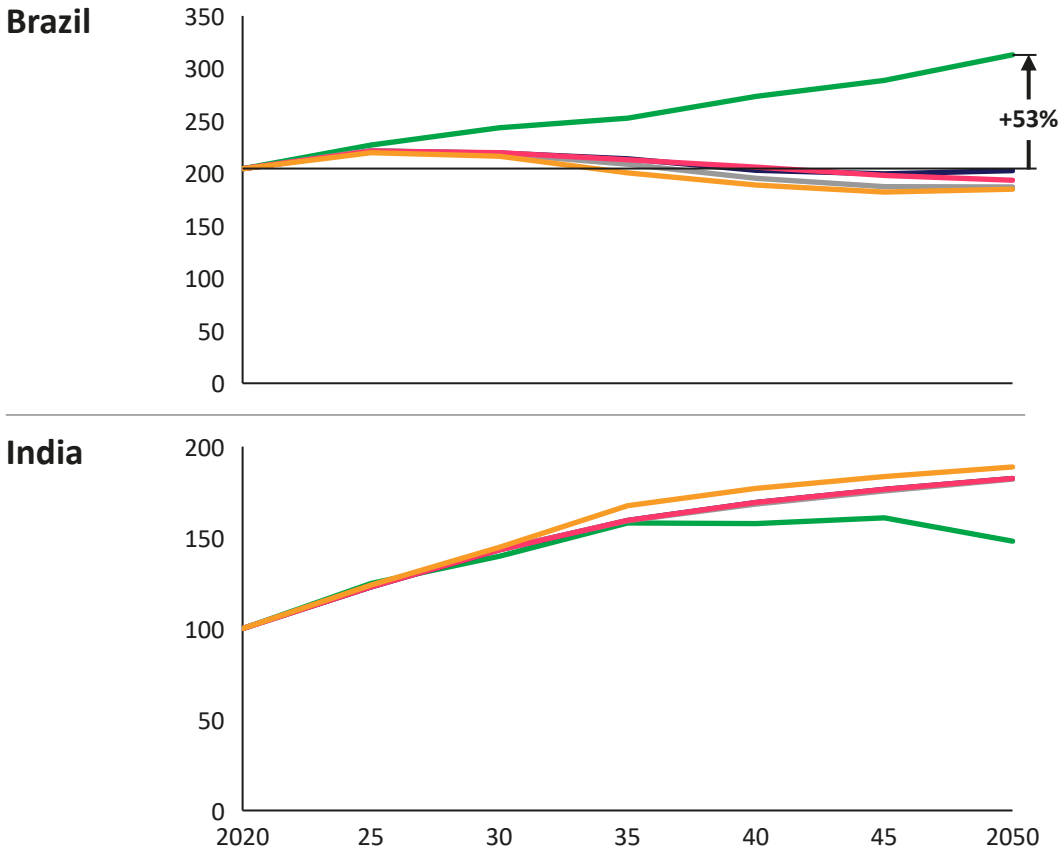
Sugar crops

Sugar cane can be used to produce sugar and biofuels

>3°C Historic Trends | <2°C Forecast Policy (IPR) | 1.5°C Societal Transformation
<2°C Coordinated | 1.5°C Innovation

Protected areas | Food waste reductions | GHG Prices | Input efficiency
Bioenergy pathway | Diet shifts | Yield-enhancing tech

## Sugar Cane in select markets, Production (Mt DM yr.)




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **Brazil:** Sugar cane production follows demand and grows with population and income.<br>**India:** Although sugar cane demand grows with population and income, production declines as the country becomes a net-importer. |
| **<2°C Forecast Policy (IPR)** | **Brazil:** Production decreases due to a shift towards alternative proteins and a decline in feed demand.<br>**India:** Under all action scenarios, tropical regions face additional land constraints due to area protection and climate policies and regulation. This leads to an increase in land and production costs for most agricultural commodities, increasing the comparative advantage of Indian sugar cane relative to Historic Trends. Consequently, India becomes a net exporter and production increases. |
| **<2°C Coordinated** | |
| **1.5°C Innovation** | |
| **1.5°C Societal Transformation** | |

# Sugar cane price

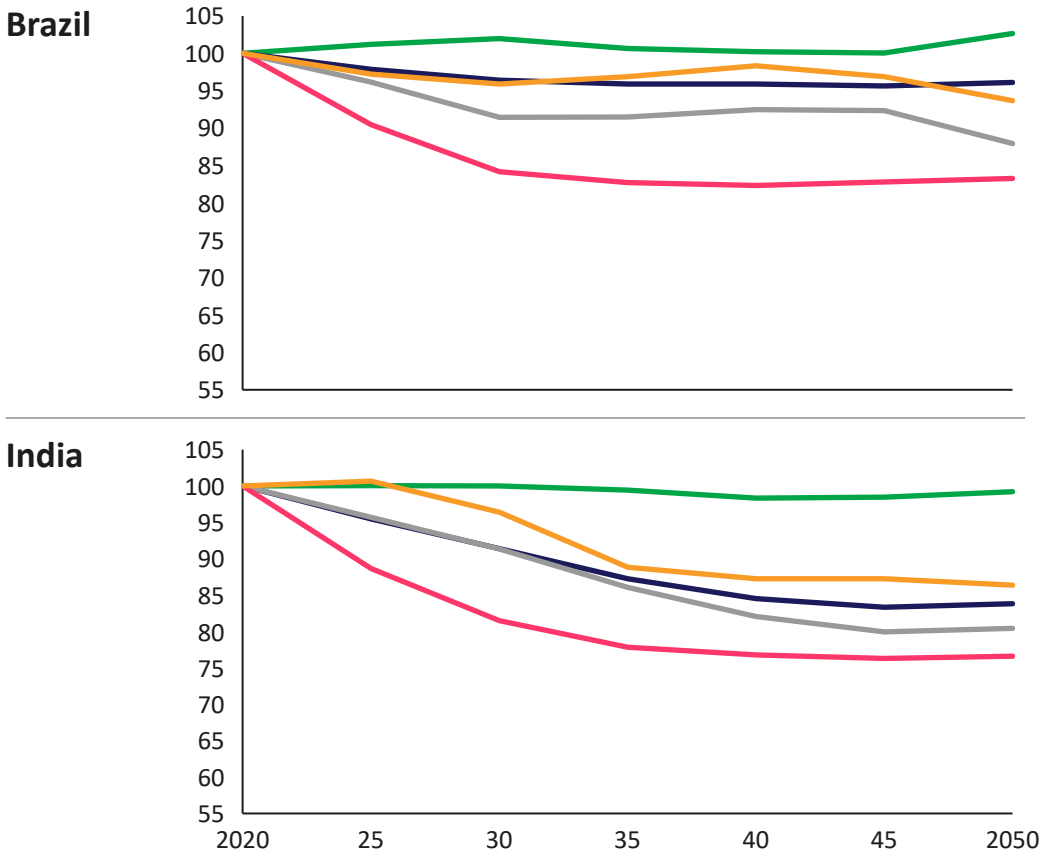
Sugar crops

Sugar cane can be used to produce sugar as well as fuel

>3°C Historic Trends | <2°C Forecast Policy (IPR) | 1.5°C Societal Transformation
<2°C Coordinated | 1.5°C Innovation

Protected areas | Food waste reductions | GHG Prices | Input efficiency
Bioenergy pathway | Diet shifts | Yield-enhancing tech

## Sugar Cane in selected markets, Indexed Prices (2020=100)




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **Brazil and India:** Sugar cane production follows historic trends |
| **<2°C Forecast Policy (IPR)** | **Brazil & India:** Moderate increases in input efficiency and yield-enhancing technology decrease prices, a low GHG price is implemented around 2030 |
| **<2°C Coordinated** | **Brazil & India:** Moderate increases in input efficiency and yield-enhancing technology decrease prices, despite a moderate GHG price |
| **1.5°C Innovation** | **Brazil & India:** High increases in input efficiency and yield-enhancing technology decrease prices, despite high GHG prices |
| **1.5°C Societal Transformation** | **Brazil & India:** Moderate increases in input efficiency and yield-enhancing technology decrease prices, despite high GHG prices |

# Contents

# Animal Products



Negative effect | Positive effect | Prices | Production

## Key Drivers

### Area protection

- By 2050, up to 50% of global land area could be protected, limiting the availability of land for agricultural and forestry production.

Increases land competition

### Carbon pricing

- Carbon prices could range from US$100–153 / ton $CO_2e$ by 2050, increasing the prices of emission-intensive proteins.

Increases animal product production costs

### Diet shifts

- Shifts in diets away from animal proteins will cause a decrease in production of conventional proteins. Poultry emerges as a substitute

Emissions intensive products see demand fall while low emissions products see demand soar

Reduces feed demand

## Key Trends

### Prices

- Population and income growth drive demand for animal products but price trends vary substantially by commodity and scenario. Differences are driven by a combination of **diet shifts, GHG prices, and area protection.**

### Production

- Production of **emissions-intensive beef** declines across all transition scenarios. Production of **less-emissions-intensive poultry** increases as it acts as a substitute.

# Beef, sheep and goat production

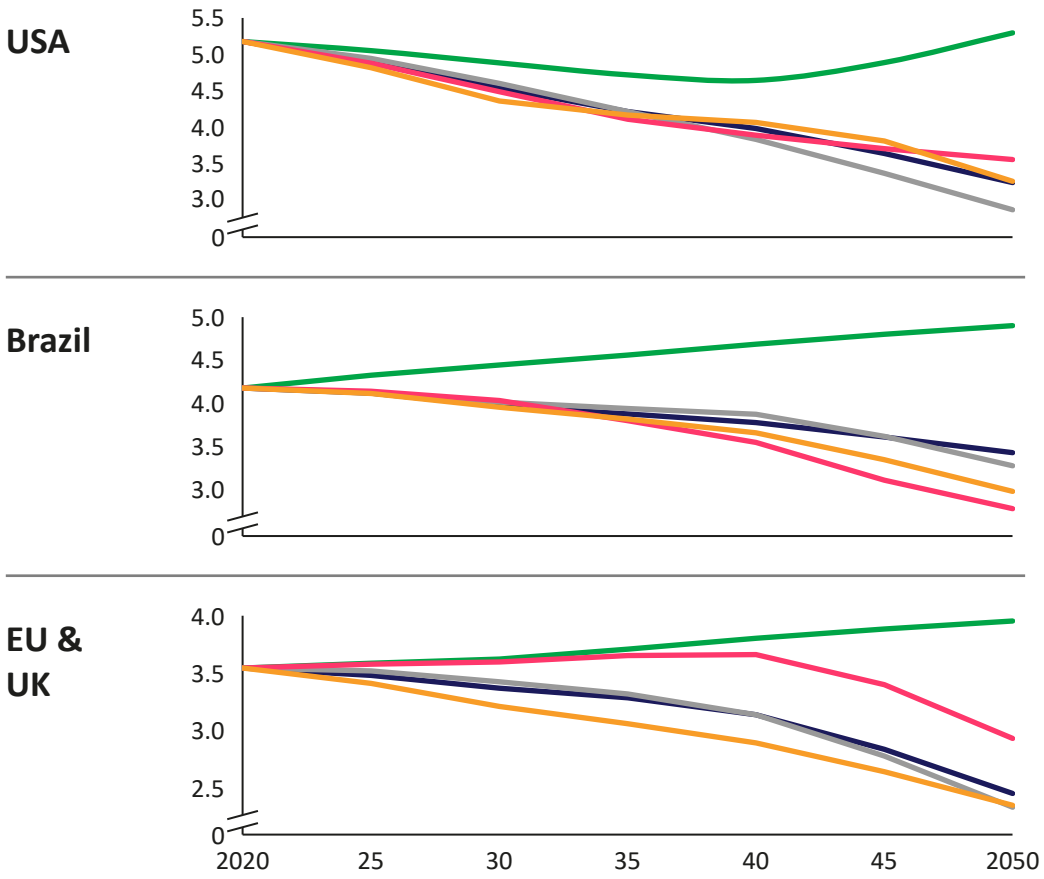
Animal Products

Beef, sheep and goat is a significant source of protein in many regions

>3°C Historic Trends | <2°C Forecast Policy (IPR) | 1.5°C Societal Transformation
<2°C Coordinated | 1.5°C Innovation

Protected areas | Food waste reductions | GHG Prices | Input efficiency
Bioenergy pathway | Diet shifts | Yield-enhancing tech

## Beef, sheep and goat in selected markets, Production (Mt DM yr.)




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | Growth in ruminant meat production follows historic trends and exports increase from these regions to emerging and developing economies as their meat demand increases. |
| **<2°C Forecast Policy (IPR)**<br>**<2°C Coordinated** | **USA, Brazil and EU & UK:** A medium diet shift reduces production. In the US, a net exporter, the difference in production between IPR and the Coordinated scenario is more evident. This is because under IPR the US is subject to more climate policy and regulation relative to its neighbors, leading to increased land competition and agricultural production costs. These conditions reduce the region's competitive advantage, resulting in a decline in exports and production larger than under the Coordinated scenario. |
| **1.5°C Innovation** | **USA and Brazil:** A medium diet shift decreases \production. Brazil loses some of its exports as yield growth in developed economies increases their competitive advantage.<br>**EU & UK:** Production continues at historic rates through 2040, as yield-enhancing technologies reduce land competition in Europe, increasing the region's competitive advantage and exports. After 2040, the medium diet shift offsets the increase in exports leading to a reduction in production. |
| **1.5°C Societal Transformation** | **USA, EU & UK:** A high diet shift decreases ruminant meat production<br>**Brazil:** Brazil hosts some of the most carbon-dense and biodiverse forests globally. Regulation to halt deforestation and incentives for land restoration increase the production costs of most meat commodities, reducing their production. A high diet shift decreases production even more. |

# Beef, sheep and goat price

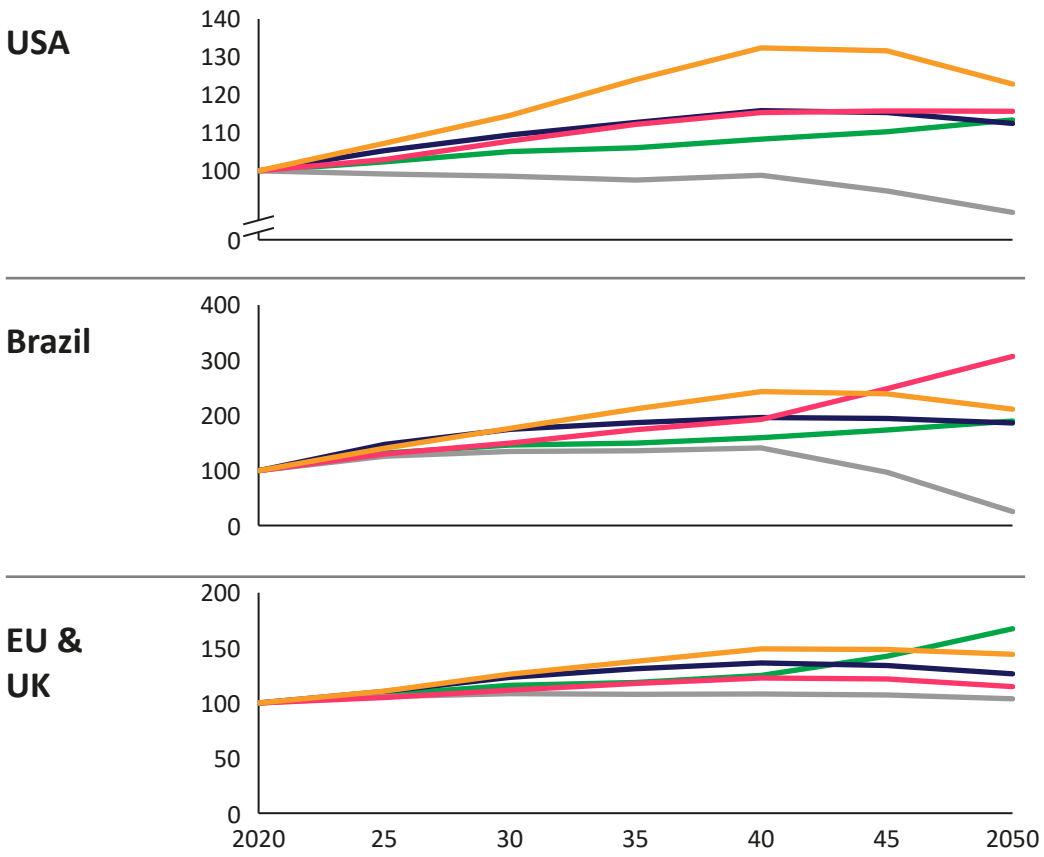
Animal Products

Beef, sheep and goat meat is a significant source of protein in many regions

- >3°C Historic Trends
- <2°C Forecast Policy (IPR)
- 1.5°C Societal Transformation
- <2°C Coordinated
- 1.5°C Innovation

- Protected areas
- Food waste reductions
- GHG Prices
- Input efficiency
- Bioenergy pathway
- Diet shifts
- Yield-enhancing tech

## Beef, Sheep and Goat in selected markets, Indexed Prices (2020=100)




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **USA & Brazil and EU & UK:** Growth in livestock demand increases prices |
| **<2°C Forecast Policy (IPR)** | **USA:** A moderate decrease in demand for meat decreases prices overall through 2050, despite higher production costs due to high GHG prices and land protection policies<br>**Brazil:** Moderate GHG prices, combined with increased land protection policies, slightly increase prices through 2040. However, a significant drop in demand for beef, sheep and goat occurs from 2040-2050, decreasing prices.<br>**EU & UK:** Price increases caused by GHG prices and land protection policies are counterbalanced by a slight decrease in prices due to a decrease in demand for ruminant meat. Overall, prices slightly increase through 2050 |
| **<2°C Coordinated** | **USA, Brazil and EU & UK:** Moderate GHG prices, combined with increased land protection policies, increase the price of ruminant meat |
| **1.5°C Innovation** | **USA and EU & UK:** High GHG prices, combined with increased land protection policies, slightly increase the price of meat<br>**Brazil:** High GHG prices significantly increase the price of meat |
| **1.5°C Societal Transformation** | **USA, Brazil, and EU & UK:** High GHG prices, combined with increased land protection policies, significantly increase the price of meat. |

# Pork production

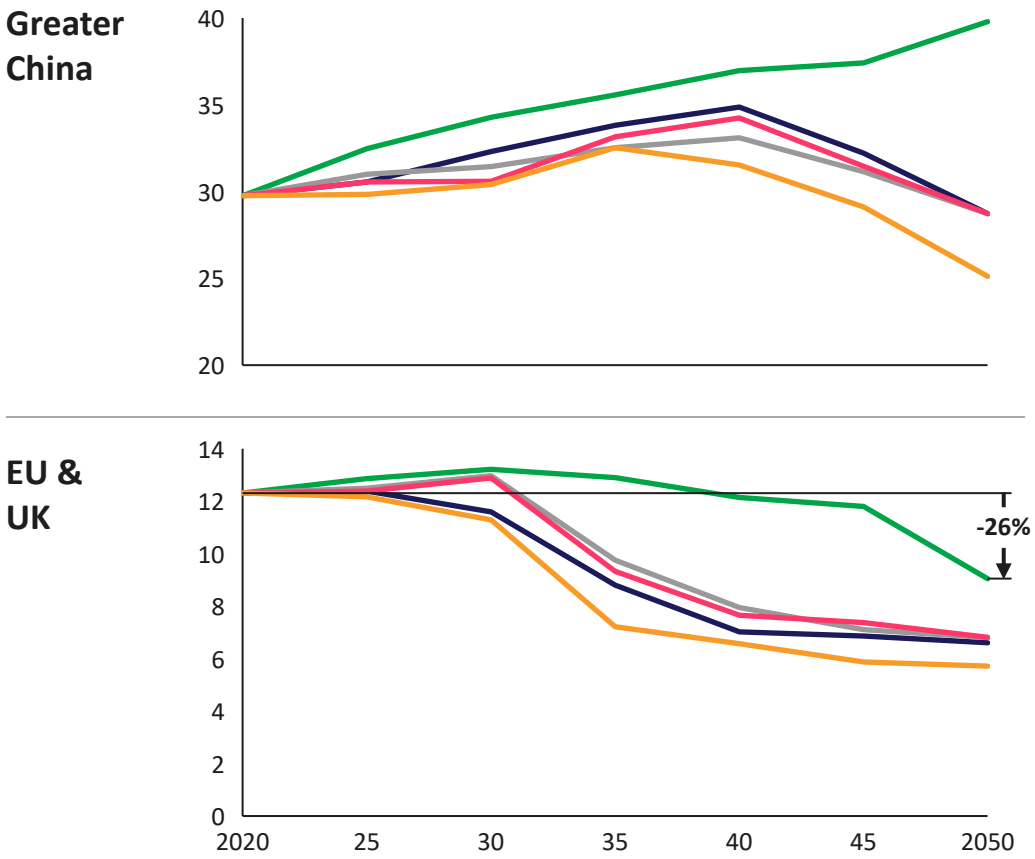
Animal Products

Pork is an important source of protein in many regions, particularly in China and the EU

>3°C Historic Trends | <2°C Forecast Policy (IPR) | 1.5°C Societal Transformation
<2°C Coordinated | 1.5°C Innovation

Protected areas | Food waste reductions | GHG Prices | Input efficiency
Bioenergy pathway | Diet shifts | Yield-enhancing tech

## Pork in selected markets, Production (Mt DM yr.)




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **Greater China:** Growth in production follows historic trends.<br>**EU & UK:** Growth in pork production remains stable around 2020 levels until 2045, when land constraints in Europe increase the price of pork and reduce its exports. |
| **<2°C Forecast Policy (IPR)** | **Greater China:** Growth in production continues at a slower rate through 2040 and then falls due to moderate diet shifts.<br>**EU & UK:** Production follows historic trends through 2030 and then falls due to a moderate diet shift |
| **<2°C Coordinated** | **Greater China:** Growth in production continues at a slower rate through 2040 and then falls due to moderate diet shifts<br>**EU & UK:** Production falls due to a moderate diet shift |
| **1.5°C Innovation** | **Greater China:** Growth in production continues at a slower rate through 2040 and then falls due to moderate diet shifts<br>**EU & UK:** Production follows historic trends through 2030 and then falls due to a moderate diet shift |
| **1.5°C Societal Transformation** | **Greater China:** Growth in production continues at a slower rate through 2035 and then falls due to high diet shifts<br>**EU & UK:** Production falls due to a high diet shifts |

# Pork price

Animal Products

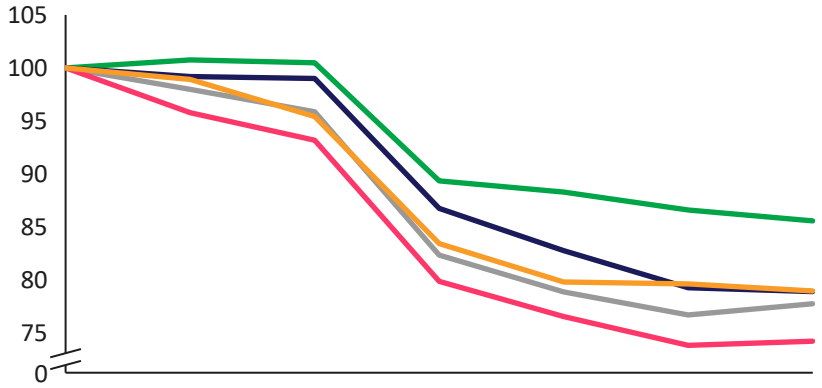
Pork is an important source of protein in many regions, particularly China and the EU

>3°C Historic Trends
<2°C Forecast Policy (IPR)
1.5°C Societal Transformation
<2°C Coordinated
1.5°C Innovation

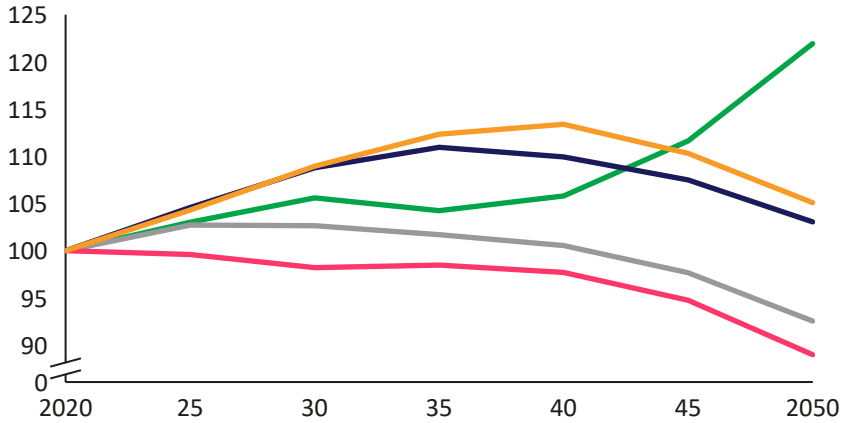
Protected areas
Food waste reductions
GHG Prices
Input efficiency
Bioenergy pathway
Diet shifts
Yield-enhancing tech

## Pork in selected markets, Indexed Prices (2020=100)

**Greater China**




**EU & UK**




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **EU & UK:** Growth in livestock demand increases prices<br>**Greater China:** Livestock demand decreases with a decrease in population, decreasing prices |
| **<2°C Forecast Policy (IPR)** | **EU & UK and Greater China:** A moderate increase in GHG prices raises pork prices, but a moderate decrease in demand for pork meat decreases prices overall |
| **<2°C Coordinated** | **Greater China:** A moderate increase in GHG prices raises prices, but a moderate decrease in demand for pork meat decreases prices overall<br>**EU & UK:** Moderate increases in agricultural innovation combined with a decrease in demand for pork meat decreases prices, but a moderate GHG price increases prices slightly overall |
| **1.5°C Innovation** | **EU & UK and Greater China:** High GHG prices, combined with increased land protection policies, decrease prices |
| **1.5°C Societal Transformation** | **EU & UK:** High GHG prices increase prices despite a high decrease in demand for pork.<br>**Greater China**: High decrease in demand and lower GHG prices results in decreased prices |

# Poultry meat production

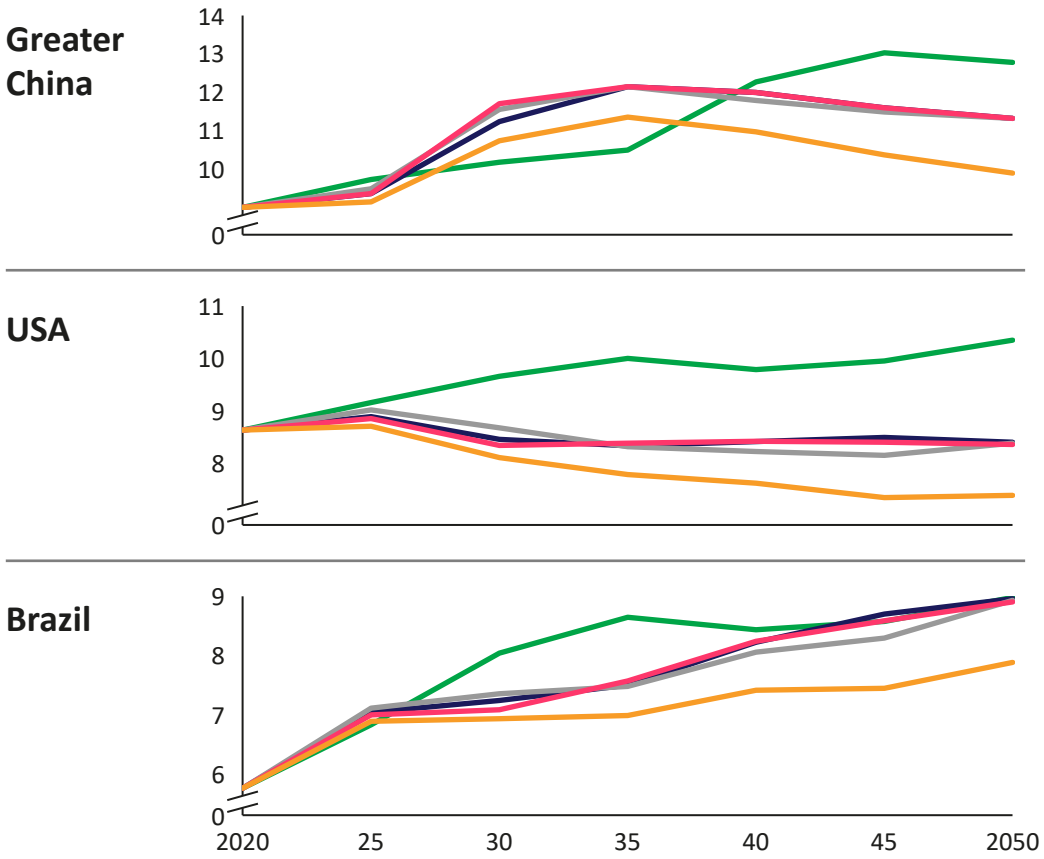
Animal Products

Poultry meat is a significant source of protein in many regions

>3°C Historic Trends | <2°C Forecast Policy (IPR) | 1.5°C Societal Transformation
<2°C Coordinated | 1.5°C Innovation

Protected areas | Food waste reductions | GHG Prices | Input efficiency
Bioenergy pathway | Diet shifts | Yield-enhancing tech

## Poultry Meat in selected markets, Production (Mt DM yr.)




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **Greater China:** The region switches from being a net-importer to a net exporter around 2035, leading to a substantial growth in production. Although domestic demand for poultry peaks in 2045 with population, exports remain stable, mitigating the effect on production which remains stable through 2050.<br>**USA:** Poultry production follows historic trends. After 2040, the growth in demand from neighboring emerging economies increases US exports and production.<br>**Brazil:** Production growth slows down after 2035 as both demand and exports stabilize. |
| **<2°C Forecast Policy (IPR)**<br>**<2°C Coordinated**<br>**1.5°C Innovation** | **Greater China:** Production of poultry meat grows between 2020 and 2030 as poultry is an interim substitute to emission-intensive meat products. After 2030, the growth in uptake of meat alternatives stabilizes annual demand and production levels<br>**USA:** Production declines due to moderate diet shifts<br>**Brazil:** Production of poultry meat grows as poultry is an interim substitute to emission-intensive meat products |
| **1.5°C Societal Transformation** | **Greater China:** Production of poultry meat grows between 2020 and 2030 as poultry is an interim substitute to emission-intensive meat products. After 2030, the growth in uptake of meat alternatives stabilizes annual demand and production levels<br>**USA:** Production declines due to moderate diet shifts<br>**Brazil:** Production of poultry meat grows as poultry is an interim substitute to emission-intensive meat products |

# Poultry meat price

Animal Products

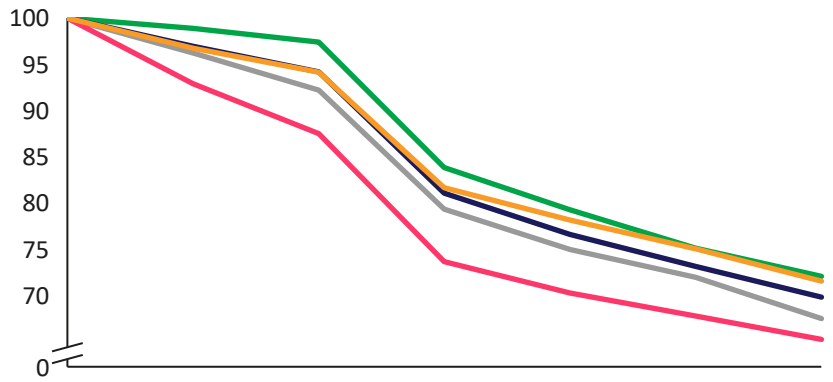
Poultry meat is a significant source of protein in many regions

- >3°C Historic Trends
- <2°C IPR Forecast Policy
- 1.5°C Societal Transformation
- <2°C Coordinated
- 1.5°C Innovation

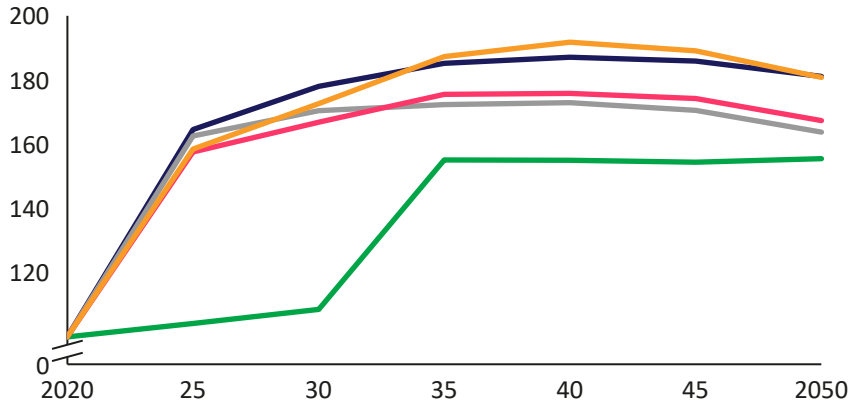
- Protected areas
- Food waste reductions
- GHG Prices
- Input efficiency
- Bioenergy pathway
- Diet shifts
- Yield-enhancing tech

## Poultry Meat in selected markets, Indexed Prices (2020=100)

**Greater China**




**USA**




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends** | **Greater China:** Livestock demand decreases with a decrease in population, which lowers prices<br>**USA:** To increase production, agricultural land expands without much investment in productivity and efficiency. After 2030, the pressure on the land use system pushes prices up. |
| **<2°C Forecast Policy (IPR)** | **Greater China:** Livestock demand decreases with a decrease in population combined with diet shifts and an increase in agricultural innovation, decreasing prices<br>**USA:** Growth in poultry demand as consumers switch from beef due to a medium diet shift combined with GHG prices implemented after 2030 increases prices |
| **<2°C Coordinated** | **Greater China:** Livestock demand decreases with a decrease in population combined with diet shifts and an increase in agricultural innovation, decreasing prices<br>**USA:** Growth in poultry demand as consumers switch from beef due to a medium diet shift combined with moderate GHG prices increases prices |
| **1.5°C Innovation** | **Greater China:** Livestock demand decreases with a decrease in population combined with diet shifts and an increase in agricultural innovation, decreasing prices despite high GHG prices<br>**USA:** Growth in poultry demand as consumers switch from beef due to a medium diet shift combined with high GHG prices increases prices, but is offset by large gains in agricultural innovation |
| **1.5°C Societal Transformation** | **Greater China:** Livestock demand decreases with a decrease in population combined with diet shifts and an increase in agricultural innovation, decreasing prices<br>**USA:** Growth in poultry demand as consumers switch from beef due to a high diet shift combined with high GHG prices increases prices |

# Contents

# Forest Products



Negative effect | Positive effect | Prices | Production

## Key Drivers

### Area protection

- By 2050, up to 50% of global land area could be protected, limiting the availability of land for agricultural and forestry production.

Increases land competition

### Carbon pricing

- Carbon prices could range from US$100–153 / ton $CO_2e$ by 2050, creating both costs and new revenue streams. Sustainable practices will determine who wins (or loses)

Increases the value of intact forest and creates new revenue streams

### Bioenergy

- Bioenergy production could reach over 100 EJ by 2050 to accommodate the growth in BECCS and biofuels, limiting land availability and creating additional competition among uses for forest products

Increases land competition

### Yield growth

- In the 1.5°C Innovation Scenario, average crop yields could increase by up to 69% globally by 2050 , dampening the impact of increased land competition between food, fuel, and forest products.

Reduces land competition increasing capacity for forest expansion.

## Key Trends

### Production

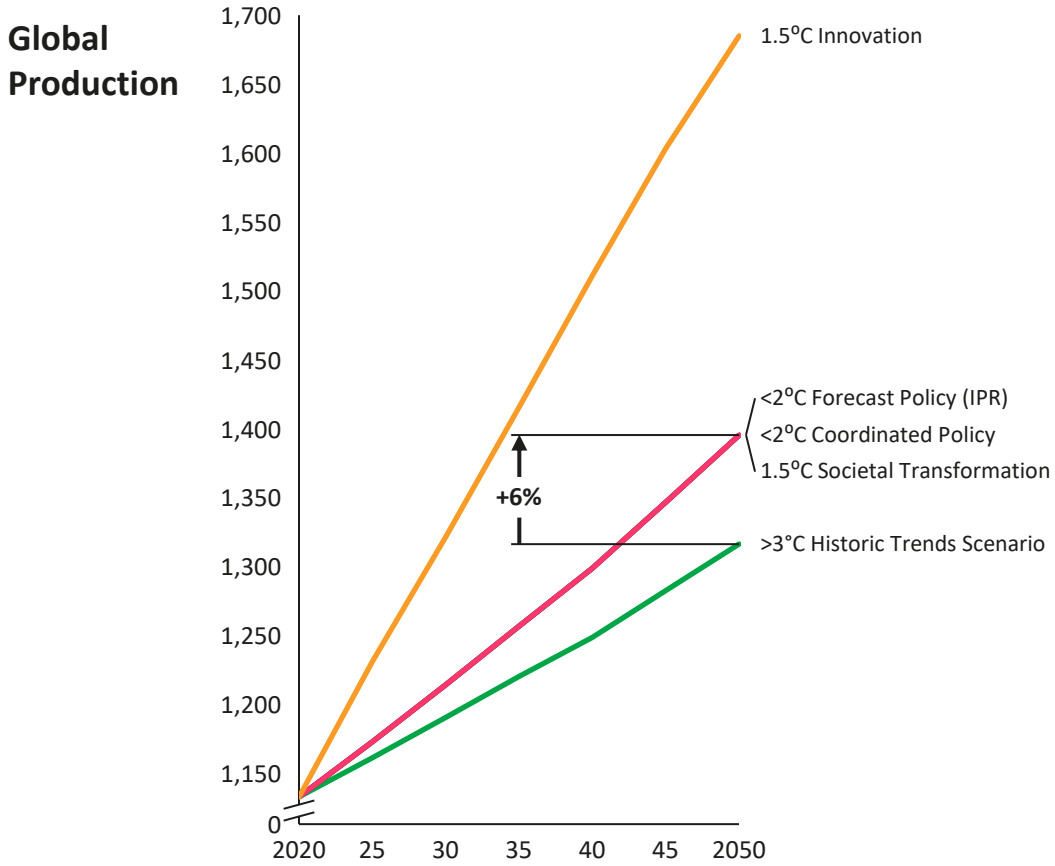
- Increased **GHG prices** under transition scenarios can incentivize additional demand for timber products in construction. **Productivity growth** under the 1.5°C Innovation scenario increases land availability and timber production capacity.

# Timber production grows with population, income, and demand for lumber from the buildings sector

Forest Products

**Timber, Global,** Production (Mt DM yr.)

The Innovation scenario has the highest trajectory in 2050




## Scenario-specific values and rationale

| Scenarios | Rationale |
|---|---|
| **>3°C Historic Trends Scenario** | Timber demand keeps growing at historical rates (+16% between 2020 and 2050), as climate action is not enough to incentivize a substantial shift to timber in the construction sector. |
| **<2° Scenarios** | Climate action pushes demand for lumber in new builds above Historic Trends, with 10% of new builds being constructed using timber. Area protection and climate targets increase land competition in the land use sector and reduce capacity for timber production. GHG prices increase the value of intact forest and create additional competition across uses for forestry products. |
| **1.5°C Societal Transformation** | Although the high carbon prices could incentivize additional demand for timber products in construction, the ambitious targets for area protection (50% globally by 2050) limit land availability for plantation and timber supply. Timber demand increases by 23% between 2020 and 2050. |
| **1.5°C Innovation** | The high carbon prices incentivize additional demand for timber products in construction as half of all new builds use timber as a construction material. High productivity growth increases land availability and timber production capacity. Demand grows by 50% between 2020 and 2050. |