Methodological Annex: Half-Earth protection scenario
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Contents

1.   Introduction

The half earth scenario was devised in Kok et al. (2020) and restricts the future possible expansion of agricultural land use so that globally, in total 50% of the land area is protected, giving priority to biodiversity rich areas. Intensive agriculture is not forcibly removed, but room for expansion is severely limited.

2.   Model implementation

The implementation of the half earth scenario in the MAGNET model is done by a so-called shifting of the asymptote (describing the maximum amount of agricultural land) to match the required protected area. The asymptote in the land supply function depicts the upper bound of the available land to be used in agriculture. The closer land supply approaches the asymptote, the sharper increase in land prices is required to convert additional land in use. In the half-earth scenario, the availability of future land expansion is reduced significantly, which corresponds to moving the asymptote to the left (in figure 1 the blue curve becomes red). As seen in the Figure 1, this will result in much sharper increase in land prices to higher land scarcity. This directly impacts the cost of all primary agriculture production and dependent sectors. Intensification is increased as investing more capital, labour and fertilizer can increase yields to reduce the land use pressure. Regions with higher possibility of expanding agricultural land (i.e. higher land availability) will be more impacted. An overview of the size of the land reduction shocks is reported in figure 2 below.
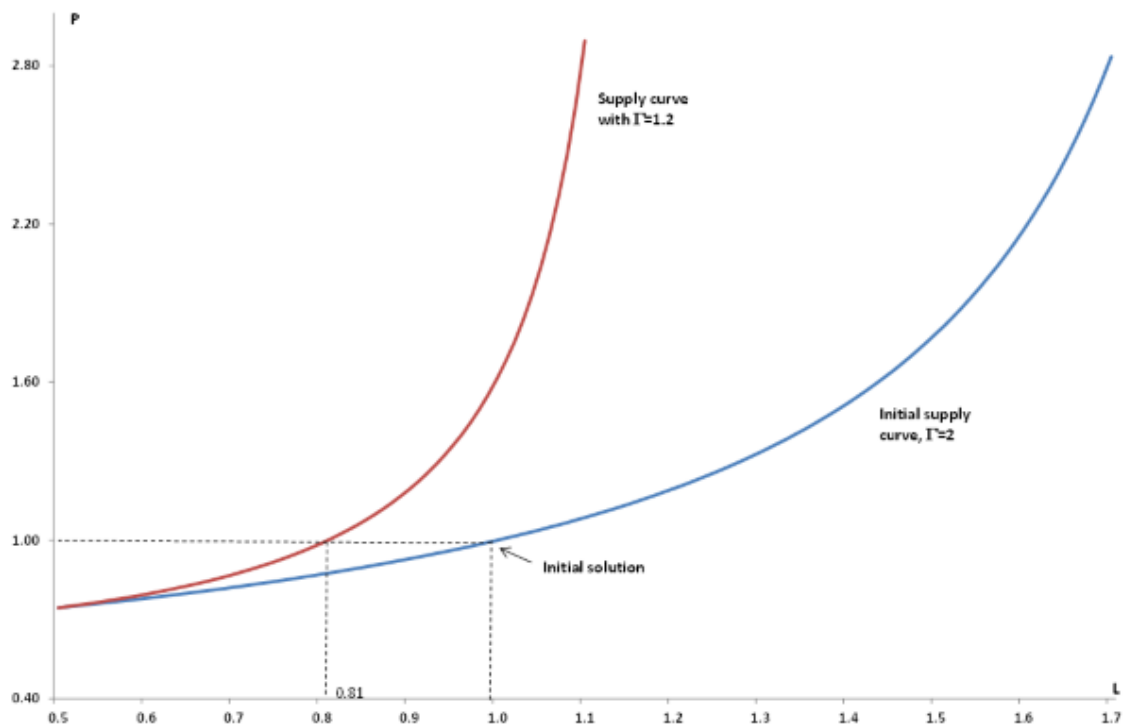
Figure 1. Land supply curve in the MAGNET model and implementation of the half earth scenario. The blue curve represents the land supply curve in the baseline scenario. The red curve represents the land supply curve in the half earth scenario.
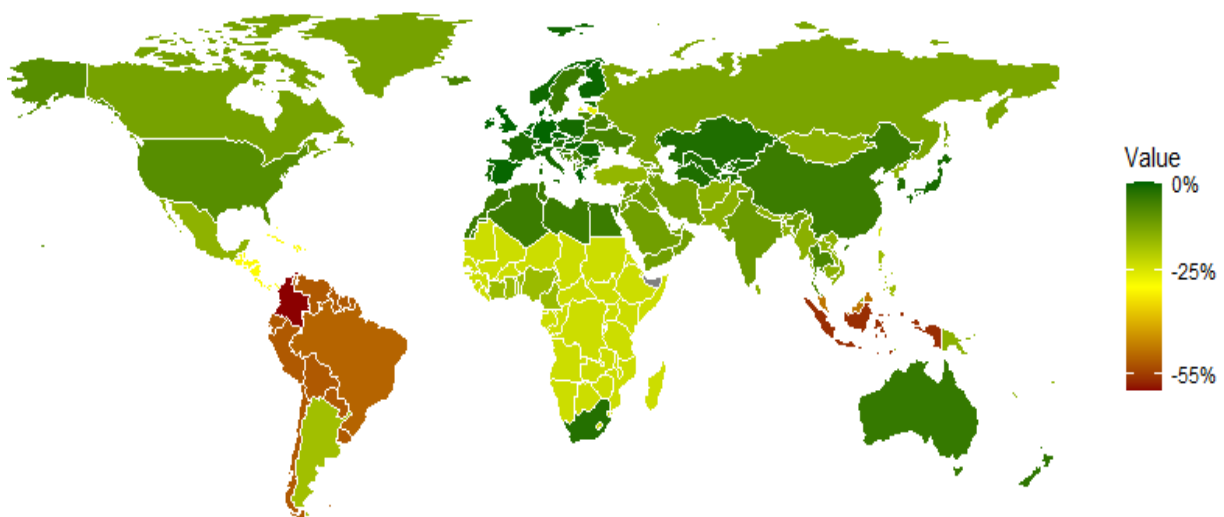

Figure 2. Magnitude of region-specific shocks in the half earth scenario. The magnitude of the reported shocks refers to the reduction (%) of land available for agriculture across different regions.

The "Half Earth" scenario leads to significant changes in land use and fertilizer application, as agricultural systems adapt to reduced land availability. On average, countries relying on extensive agriculture (land-intensive) are more negatively affected than countries relying on intensive agricultural systems (input-intensive), as the latter are relatively less exposed to the negative impacts associated with the reduction of land available for agricultural production. An overview of how the Half Earth scenario ripples through the whole economic system is illustrated in figure 3 below.
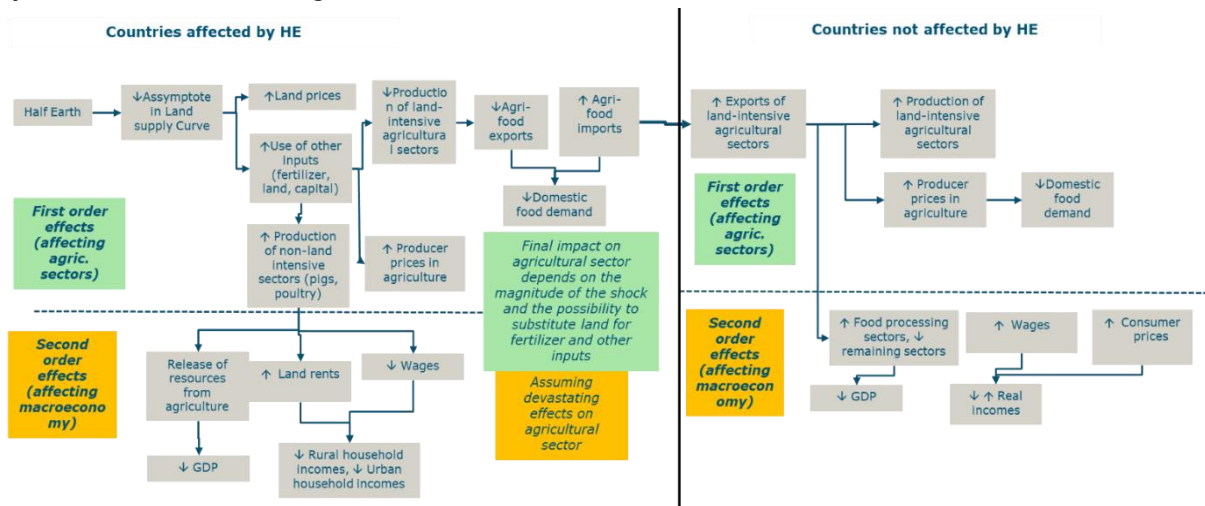

Figure 3. Flow-through effects in the Half Earth scenario compared to the SSP2 baseline scenario in 2050.

3.　Agricultural impacts

Global agricultural land use declines by -10.8% relative to the baseline outcomes, with the most significant impacts occurring in Africa (-17.1%) and Latin America (-19.1%). These regions, which currently rely on large areas of arable land, are more exposed to the reduction of productive land, experiencing a stronger decrease in agricultural production volumes (Table 1). In contrast, regions such as Europe, experience smaller declines in total land use (-1.6%), reflecting more intensive land management practices and higher productivity per unit of land (Table 1). The reduction of available farming land has direct negative impacts on land prices (Figure 4 and Table 1). Globally, land prices increase by an average 14.1%, with more severe effects observed in land-scarce regions and in regions producing larger volumes of agricultural products. In the EU, land prices increase by an average 10.5%, with stronger effects observed in the Netherlands (+23.5%), Denmark (+28.4%), Germany (+14.9%), and Italy (+15.2%) (Figure 2). In response to the declining availability of land and the increase in land prices, chemical fertilizers use globally rises by 13.9% (or 38.5 million tons) in 2050 (Table 1 and Figure 5). Stronger effects are observed in regions majorly affected by the land reduction such as Africa (average +36.5% or 19.9 million tons) and Latin America (average +23.5% or 8.6 million tons). In the EU, the use of chemical fertilizers increases by an average 8.3% (or 1.6 million tons), particularly in France (+10.4% or 0.4 million tons) and Germany (+10.6% or 0.3 million tons) (Figure 5).

Table 1. Impacts (%) of the Half Earth scenario on agricultural sectors with respect to the baseline in 2050.

|	Production volume	Producer prices	Consumption volume	Food expends capita	Export volume	Import volume	Land use	Fert. use	Capital use	Labor use	Land price	Real wages	Total endowment price	Total endowment use
AFR	-9.2	16.9	-1.7	6.6	-11.1	11.6	-17.1	36.3	-3.9	-3.5	14.0	-16.5	31.5	-5.0
ARG	-1.2	7.1	-0.4	1.1	-1.6	2.9	-12.8	4	-0.6	-0.9	30.5	-1.3	13.1	-2.0
AUS	2.0	4.0	-0.1	0.3	0.1	-0.9	-2.9	4.3	2.4	2.5	11.6	2.6	18.1	2.0
AUT	4.7	2.9	-0.2	0.2	3.0	0.3	-1.8	9.4	1.5	1.8	1.9	6.1	6.1	1.2
BEL	4.3	4.0	-0.2	0.6	2.3	-0.1	0.0	7.4	1.8	3.3	10.8	2.1	11.2	2.0
BGR	1.8	3.8	-0.3	0.6	0.7	1.2	-1.9	5.6	2.0	2.8	10.2	2.3	16.4	1.6
BRA	0.6	4.0	-0.3	1.0	2.2	-0.5	-19.1	21.2	1.3	0.9	33.3	1.1	15.6	-0.9
CAM	-16.2	13.1	-1.1	2.5	-19.6	3.4	-28.8	28	-12.3	-13.6	26.7	-18.0	8.1	-14.9
CAN	4.2	4.1	-0.1	0.5	2.2	-0.3	-8.6	8.1	2.3	3.3	23.2	4.8	16.8	2.6
CHE	1.8	2.8	-0.1	0.2	6.3	-0.2	-2.2	3.3	1.8	1.8	10.6	2.7	7.0	1.5
CHN	-0.8	3.9	-0.4	0.9	4.9	-0.7	-4.5	2	0.1	0.1	7.5	0.8	8.2	-0.3
COCOA	-10.8	34.2	-2.4	11.1	-10.9	24.2	-14.5	36.5	-3.5	-1.7	9.8	-22.4	53.6	-4.9
COL	-18.5	12.7	-1.1	0.7	-21.9	2.2	-34.0	-15.1	-11.5	-15.1	35.4	-16.2	6.1	-16.6
CZE	2.6	2.8	-0.2	0.4	1.4	0.5	-0.2	6.2	1.8	2.5	8.2	2.9	9.5	1.7
DEU	6.0	3.0	-0.2	0.3	5.1	0.0	0.1	10.6	2.4	3.2	14.9	7.2	9.0	2.6
DNK	6.5	2.9	-0.1	0.5	5.1	1.5	0.2	17.2	3.0	3.3	28.4	4.5	13.8	2.8
EAS	-1.9	5.6	-0.6	1.5	0.5	-0.6	-9.5	24.6	0.3	-0.1	14.0	-2.7	10.2	-0.9
ESP	5.2	4.0	-0.1	0.5	2.8	0.7	0.0	8.2	4.0	5.2	16.3	7.6	16.1	4.5
EST	1.8	3.6	-0.2	0.7	1.2	-1.8	-1.4	7.2	1.4	2.3	2.6	0.7	7.8	1.5
FIN	1.0	2.9	-0.1	0.2	1.3	-1.1	-0.5	2.8	0.9	1.0	4.3	2.0	3.8	0.9
FRA	6.1	3.2	-0.1	0.4	3.7	0.6	-1.5	10.4	3.1	3.1	15.7	5.1	11.2	2.8
GBR	1.8	2.5	-0.1	0.1	2.9	-0.7	0.1	4.7	1.5	1.1	9.1	2.6	4.4	1.3
GRC	3.0	3.1	-0.1	0.6	2.3	-0.3	0.0	8.8	4.9	4.4	10.5	5.2	18.9	3.9
HUN	2.2	3.2	-0.3	0.5	0.7	1.2	-0.6	6.7	2.2	2.3	9.8	2.3	11.0	1.8
IDN	-11.2	8.7	-0.5	2.5	-5.0	1.7	-19.8	16.4	-2.1	-2.4	38.7	-13.4	13.1	-4.6
IND	-5.8	9.2	-1.0	3.4	-7.3	6.7	-8.9	8.7	-2.3	-1.5	8.4	-9.6	14.2	-3.1
IRL	4.1	2.0	-0.1	0.0	4.3	0.8	0.1	3.4	1.1	4.0	10.2	4.4	5.5	1.5
ITA	5.3	3.3	-0.1	0.3	5.6	-0.5	-0.7	12.1	2.6	4.7	15.2	6.5	12.2	3.1
JPN	2.0	2.4	-0.1	0.1	10.4	-0.5	-1.1	7.4	1.4	2.0	8.8	4.0	5.1	1.5
KOR	1.2	3.3	-0.1	0.3	3.6	0.2	-1.9	3.7	1.1	1.5	7.1	1.8	7.9	0.9
LTU	9.8	3.5	-0.1	0.5	4.3	-0.4	-6.7	12.6	0.7	5.8	8.9	7.1	14.9	0.6
LVA	3.7	3.9	-0.3	0.2	3.1	1.0	-23.8	18.8	2.6	3.0	13.6	-1.3	7.2	0.3
ME	1.7	3.8	-0.4	1.0	5.3	-1.1	-11.4	31.4	2.4	2.2	17.9	2.8	10.8	1.8
MEX	-1.6	6.3	-0.5	0.7	1.2	1.0	-14.3	15.5	0.4	0.5	22.0	0.9	12.7	-0.6
MYS	-24.2	7.6	-0.2	0.8	-9.2	-0.4	-31.7	-18.2	-7.4	-11.8	28.3	-21.1	0.7	-12.9
NAF	-0.2	4.7	-0.5	1.1	4.9	0.3	-3.4	12.8	1.1	1.1	9.1	0.9	9.6	0.6
NLD	2.0	4.4	-0.2	0.6	2.0	-0.4	0.4	5.7	2.6	7.2	23.5	8.8	17.6	3.5
NOR	1.4	2.6	-0.1	0.3	0.3	-1.5	-0.7	2.7	1.5	2.2	8.5	3.7	4.5	1.4
NZL	0.1	3.6	-0.2	0.5	2.3	-0.1	-2.6	1.4	1.7	2.1	8.7	2.1	12.1	1.7
PHL	-7.3	10.1	-0.5	2.1	-1.7	2.9	-15.5	6.4	-3.0	-2.6	15.9	-11.1	6.7	-3.7
POL	2.5	3.4	-0.2	0.4	3.4	1.6	-1.0	6.1	1.1	1.2	3.7	5.0	6.5	1.0
PRT	7.6	3.5	-0.1	0.4	4.6	1.4	-0.4	15.1	3.1	6.7	14.4	7.1	14.6	4.0
RESTEU	3.7	3.0	-0.2	0.2	3.1	-0.1	-3.3	7.2	1.3	3.4	4.8	5.9	8.8	1.6
REUR	1.3	3.7	-0.3	1.0	0.1	2.4	-6.3	12.1	1.9	2.2	16.9	2.4	13.9	1.4
RLAM	-3.7	5.4	-0.4	0.9	-3.9	1.8	-17.6	26.8	-0.7	-1.4	22.5	-2.8	10.3	-2.9
ROU	5.4	3.6	-0.3	0.6	2.8	0.7	-0.6	13.8	1.7	1.6	7.1	3.6	9.6	1.1
RUS	2.6	3.4	-0.3	0.6	2.1	0.3	-8.5	12.6	2.1	2.4	16.5	3.0	10.4	1.6
STAN	-0.1	3.7	-0.4	1.2	3.7	0.0	-1.8	4.8	0.8	0.6	4.4	-0.3	8.2	0.6
SVK	3.6	2.9	-0.2	0.3	2.4	0.8	-0.8	8.4	1.9	3.4	8.8	3.8	10.4	2.0
SVN	3.4	3.4	-0.2	0.5	0.8	-0.8	-0.9	3.6	1.7	2.3	1.8	8.5	9.1	1.5
SWE	1.9	2.6	-0.1	0.2	1.3	0.1	-4.7	5.1	0.5	0.9	6.9	2.4	2.3	0.5
THA	3.6	5.4	-0.4	0.8	2.7	-1.3	3.9	7.6	1.2	0.4	8.2	7.9	10.3	0.7
TUR	-0.6	5.3	-0.3	1.0	1.2	-1.2	-9.7	4.4	1.0	0.4	12.8	5.1	8.3	0.5
TWN	-9.9	8.3	-0.2	1.2	-14.4	1.7	-22.5	-7.5	-1.9	-2.7	23.2	-8.5	15.6	-5.9
USA	-0.8	4.5	-0.1	0.3	-0.8	0.2	-7.4	2.2	0.2	0.1	13.1	-0.2	13.7	-0.3
ZAF	15.3	5.7	-0.5	0.9	12.8	1.4	-1.7	39.1	4.6	3.9	22.8	8.5	23.7	4.1
EU	5.4	3.4	-0.2	0.4	2.6	0.3	-1.6	8.9	2.1	3.2	10.5	4.4	10.8	2.0
WORLD	-8.7	5.3	-0.4	1.0	0.0	0.0	-10.8	13.4	0.6	1.0	14.1	0.4	11.7	-0.1

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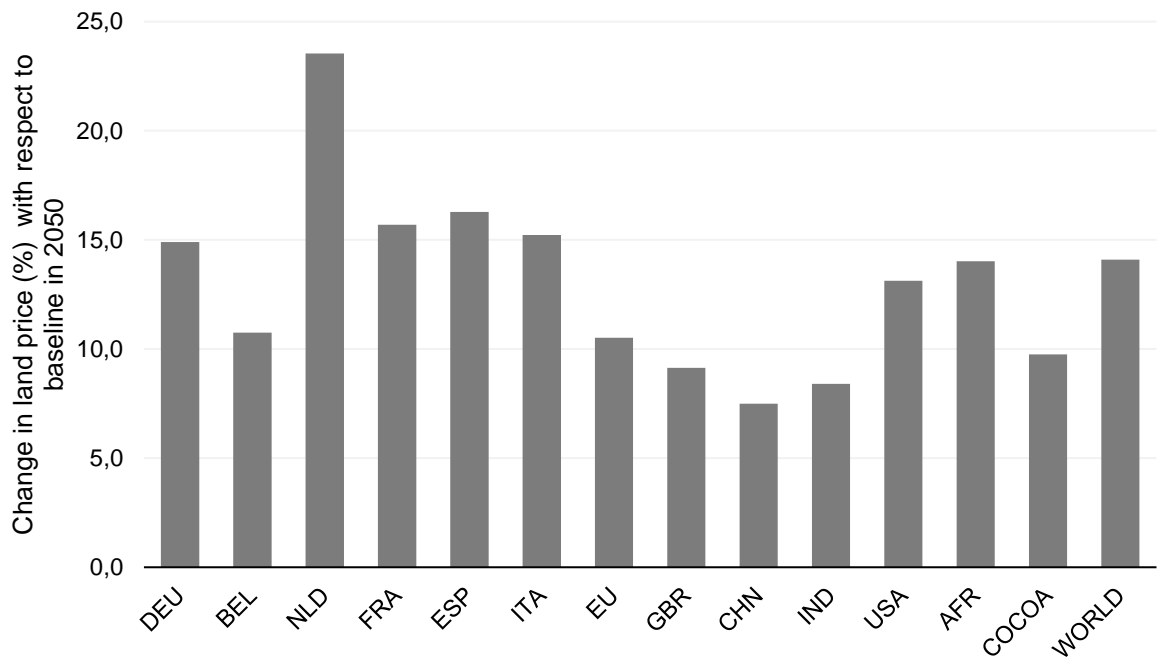
Figure 4. Change in land prices (%) in the Half Earth scenario with respect to baseline in 2050.
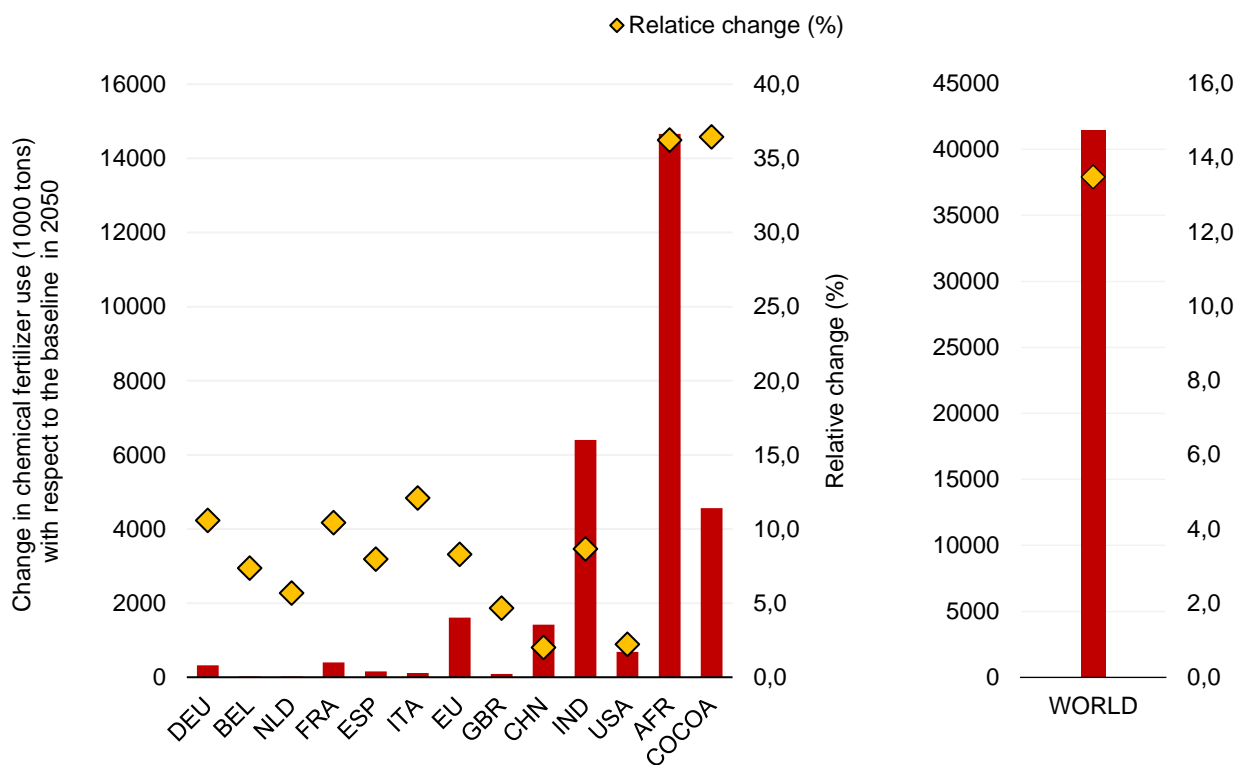

Figure 5. Change in chemical fertilizer use (1000 Tons and %) in the Half Earth scenario with respect to baseline in 2050.

The decline in agricultural land has direct consequences on agricultural production volumes, decreasing globally by 8.7% or 405 million tons compared to the baseline in 2050 (Table 1). Land-intensive regions see a relatively stronger decline in production being more exposed to fluctuations in land prices. Production volumes primarily decrease in Africa and Latin America (Table 1) while increasing in the EU (5.4% or 51.8 million tons - Figure 6) due to a lower exposure to reductions in land availability and a parallel rise in exports of agrifood products. At commodity level, production primarily decreases for oilseeds and sugar beet (-3.8% or 191.2 million tons) and horticultural commodities (-3.3% or 130 million tons), particularly in Africa, Latin America, and south and east Asia (Figure 7 and Table 2). Differently, production in EU primarily expands for cereals and horticulture, with major increases observed in France, Germany, Italy, and Spain (Figure 6).
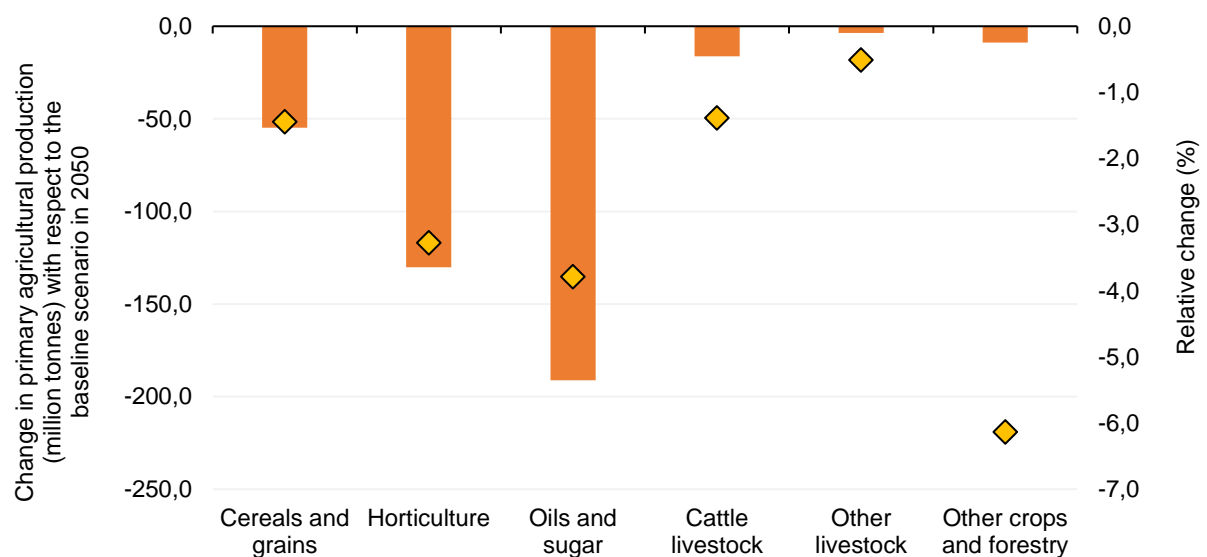

Figure 6. Change in agricultural production (Million Tons and %) in the Half Earth scenario with respect to baseline in 2050.
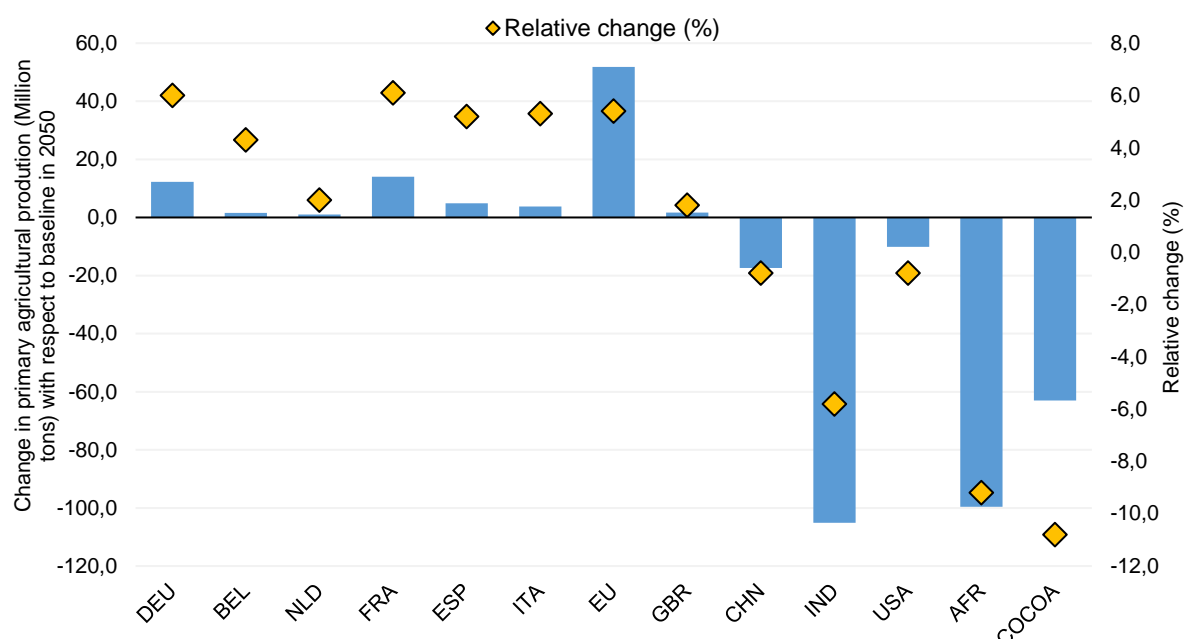
Figure 7. Change in production of agricultural products (Million Tons and %) in the Half Earth scenario with respect to baseline in 2050.

Table 2. Impacts (%) of the Half Earth scenario on the production of agricultural products with respect to the baseline in 2050.

	EU	EUR (non-EU)	NAMO	MENA	AFR	LAC	SEA	WORLD
Paddy rice	7.6	6.0	4.6	-1.1	-15.1	13.4	-2.4	-2.4
Wheat	6.4	1.6	-4.6	0.5	-14.2	-0.8	-2.7	-0.5
Grains	2.6	0.9	1.1	-2.2	-6.5	-2.2	-2.8	-1.4
Vegetables	4.1	0.7	-0.9	1.6	-9.1	-2.0	-1.8	-1.8
Fruits	7.6	3.2	0.4	1.4	-8.3	-3.0	-2.7	-3.3
Nuts	12.3	7.5	-2.5	4.1	-16.9	-0.1	-5.0	-5.0
Roots	5.3	0.6	4.3	0.5	-9.2	-1.3	-2.5	-4.9
Pulses	12.1	9.1	4.2	3.4	-10.8	-1.8	-4.6	-2.9
Oils	13.3	8.0	-0.5	5.7	-10.8	-1.1	-14.0	-6.3
Sugar beet/cane	6.2	2.7	1.8	0.3	-7.1	-0.5	-5.5	-2.5
Other agricultural products	8.2	1.1	-4.4	-0.5	-16.9	-9.6	-7.2	-6.6
Other crops	15.2	20.0	11.8	13.5	-19.3	-8.7	-0.1	-5.6
Other cattle	0.5	0.0	0.3	-0.3	-1.8	-2.5	-2.5	-1.6
Bovine Cattle	0.0	0.0	0.2	-0.7	-1.1	-1.8	-4.9	-1.8
Swine	-1.6	-0.7	0.9	-1.3	-1.2	-1.3	-1.3	-1.1
Poultry	-0.9	-0.8	0.5	-1.1	-0.9	-1.1	-0.2	-0.5
Dairy	-0.3	-0.3	-0.3	-0.6	-2.6	-1.5	-2.1	-1.3
Wool	-3.2	4.5	1.1	2.8	-2.2	-1.5	-3.2	-1.4
Forestry	0.0	-1.7	-1.4	-1.3	-2.2	-1.9	-0.7	-1.1
Fisheries	0.0	0.4	0.1	0.1	1.4	0.9	0.6	0.7
Aquaculture	-1.4	-0.6	-1.7	-1.6	-5.7	-1.5	-2.1	-2.0

Changes in global trade play a key role in shaping overall economic impacts. Global agricultural trade volumes remain stable, but regional trade patterns shift significantly. Africa experiences a -11,1% decline in export volumes, reflecting reduced production capacity, while Europe sees a 2,6% increase in exports volumes (1000 tons), driven by higher productivity and intensification of agricultural practices (Table 1 and Figure 8). In value terms, exports from the EU increase by 11.9%, reflecting the competitive advantage gained in global agricultural markets. Major increases in exports are observed in Italy (+5.6%), Germany (+5.1%) and France (+3.9%). Parallelly, regions majorly affected by land reductions see a stronger increase in food imports, particularly rising in across African countries (+16.5%) by 2050 (Figure 8).

Shifting production patterns have significant economic implications, particularly for regions heavily dependent on agriculture. Global agricultural producer prices increase by 5.3%, reflecting reduced supply and higher production costs (Table 1 and Figure 9). Africa experiences the largest price increases (+16.9%), exacerbating food security challenges in the region. In contrast, a more contained price increase is observed in higher income regions such as the EU (+3.4%), where the higher capability to adapt to land constraints through intensification, has moderate consequences on agricultural prices (Figure 9).
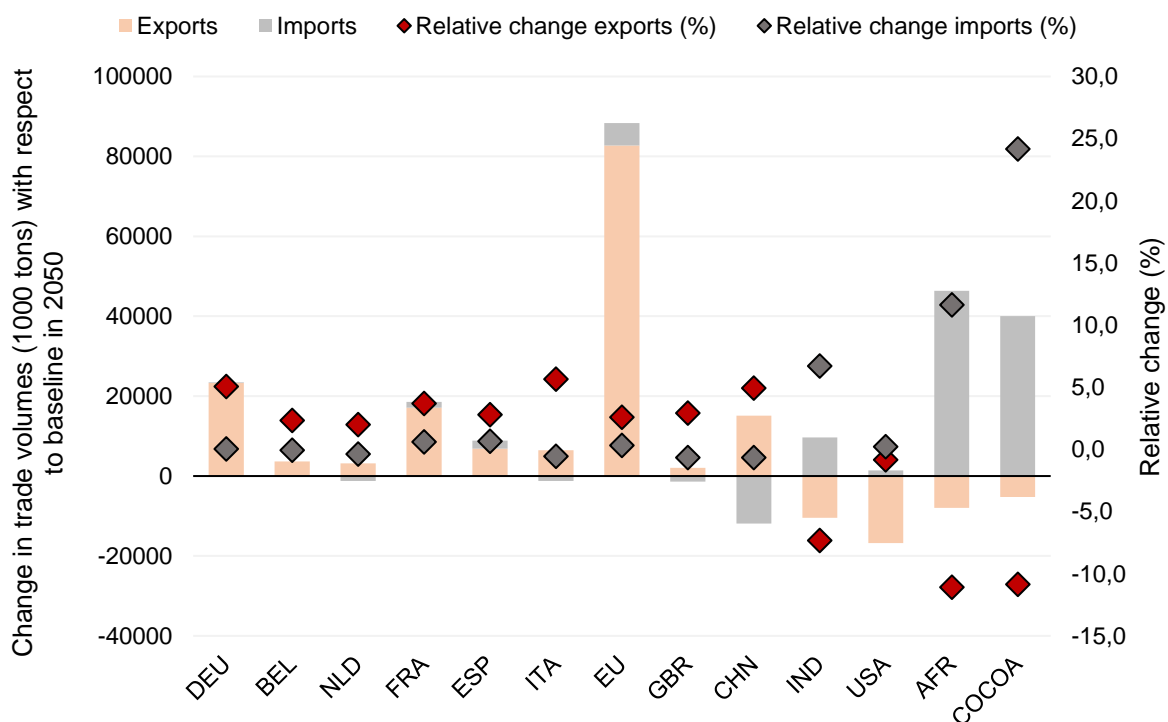

Figure 8. Change in agricultural trade (1000 tons and %) in the Half Earth scenario with respect to the baseline in 2050.
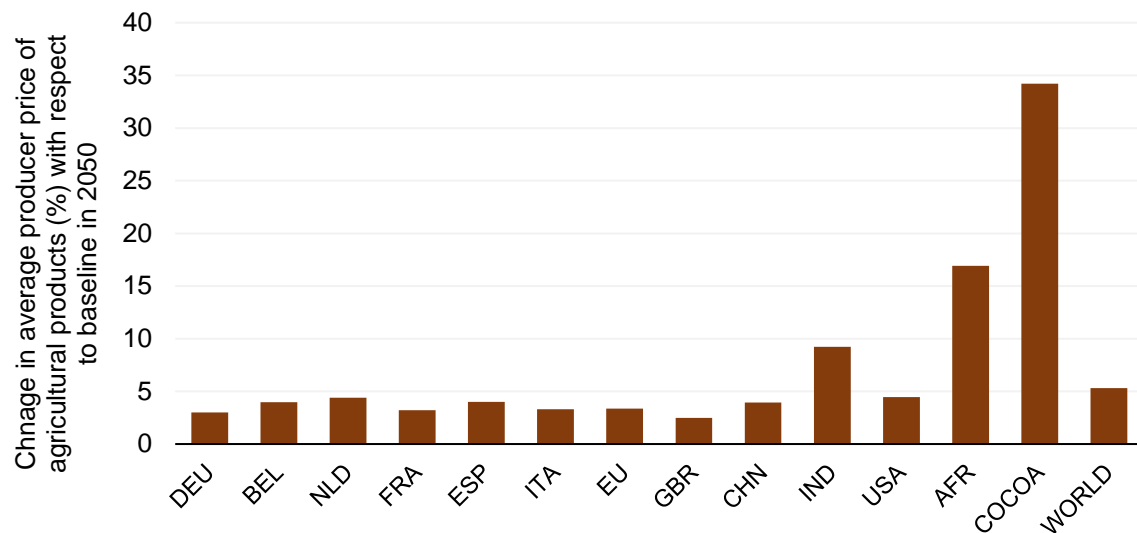
Figure 9. Change in average agricultural producer price (%) in the Half Earth scenario with respect to the baseline in 2050.

Changes of producer prices in agriculture reflect the higher production costs linked to the lower availability of land. On average, labor and capital use in agricultural sectors globally rise by 1.0% and 0.6%, respectively, although this average hides stronger declines in majorly affected regions such as Africa and Latin America, where agricultural sectors significantly shrink. Labor use in agriculture in African countries declines by an average 7.6%, followed by an average decline of capital use by 5.4% (Table 1). This leads to a decline in real wages in agricultural sectors which, despite averagely increasing worldwide (+0.4%), decline in African countries by 15.1% in 2050.

Positive effects on production endowments are observed in the EU where the average expansion of production stimulates labor and capital use by agricultural sectors (Table 1 and Figure 10). Average labor demand in the EU increases by 3.2%, followed by a higher use of capital (+2.1%). The increase in labor demand parallelly drives an increase in real wages in the EU agricultural sectors, increasing by 4.4% compared to the baseline in 2050 (Figure 10).
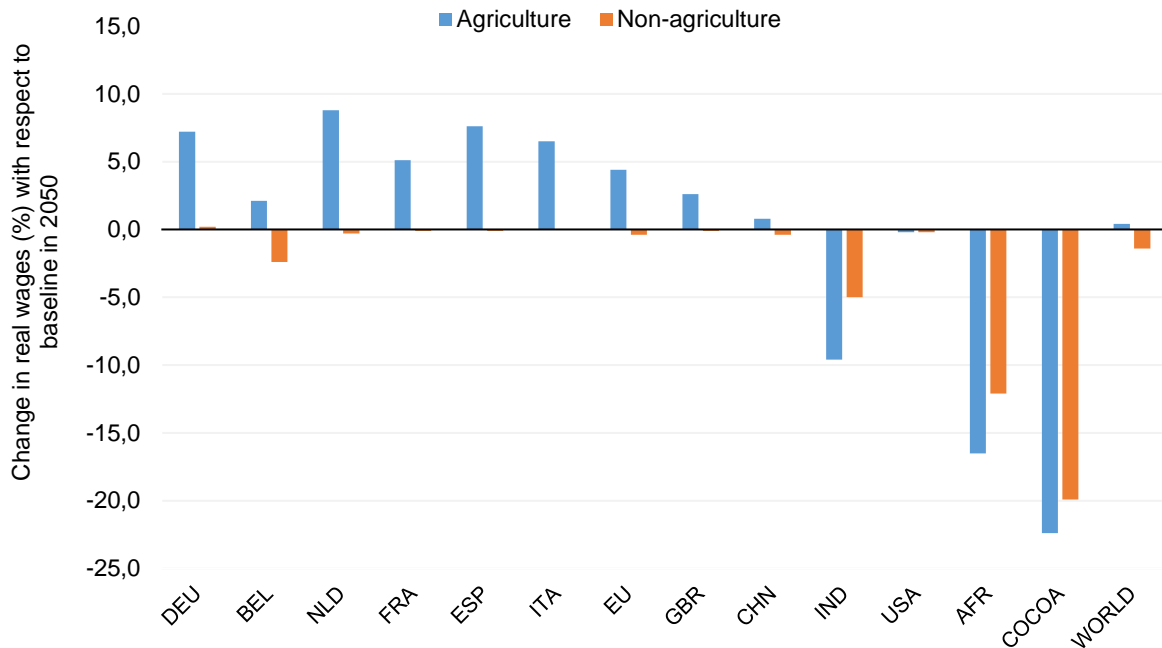
Figure 10. Change in real agricultural and non-agricultural wages (%) in the Half Earth scenario with respect to the baseline in 2050.

In response to the average appreciation of agricultural products, food consumption volumes globally decline by -0.4%, with more significant reductions observed in Africa (-1.7%) and Latin America (-0.4%). In the EU, while the decrease in consumption is more contained (average -0.2%), the share of food expenditures within total households' budget rises by 0.4%, remaining however below the average rise in food expenditures observed at the global level (+1.0%).

Finally, as global agricultural production declines, greenhouse gas (GHG) emissions from the agricultural sector decrease (-0.5% or -100 million tons CO2-eq.) compared to baseline in 2050 (Figure 11). Despite so, GHG emissions across EU countries moderately rise (+0.5% or 57 million tons CO2-eq.) driven by the rise in agricultural emissions (+3.8% or 20 million tons CO2-eq.), primarily increasing in France (+5.4% or 6 million tons CO2-eq.) and Germany (+5.5% or 4 million tons CO2-eq.)
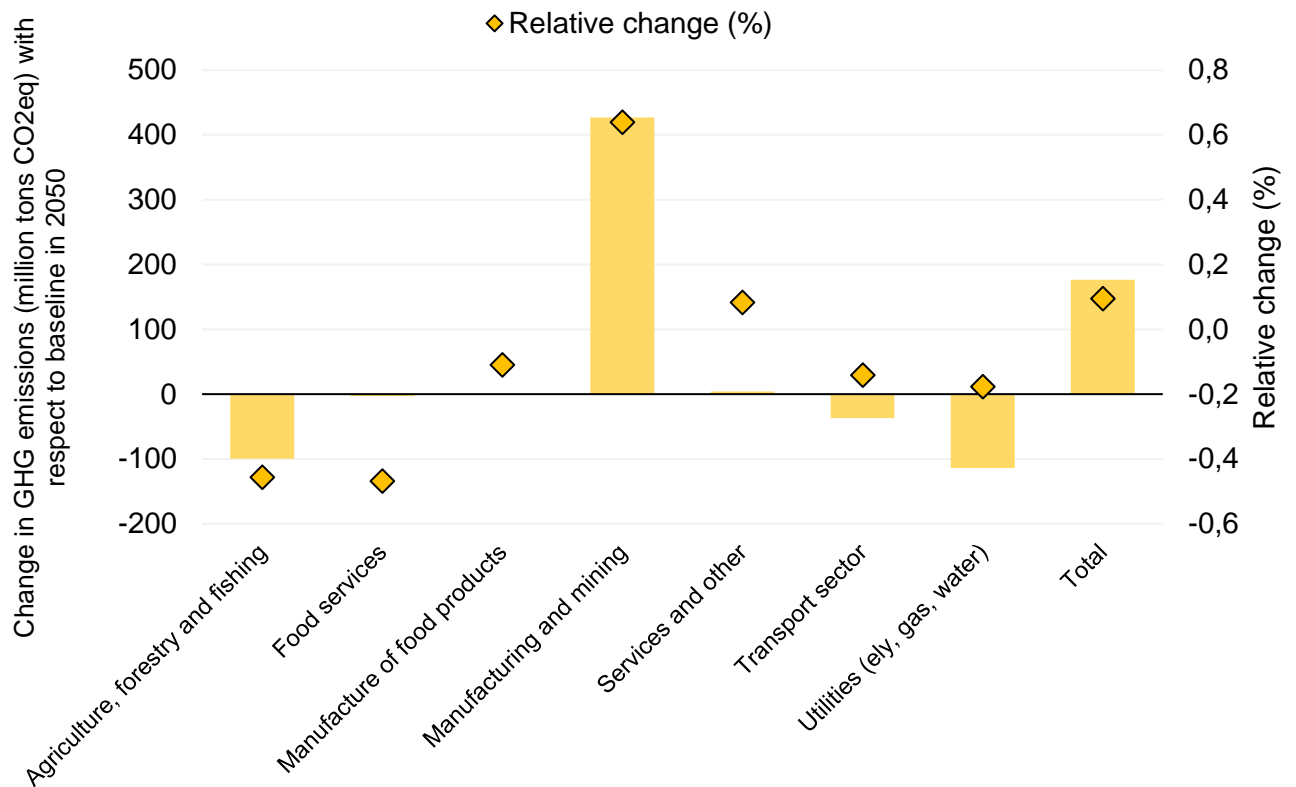
Figure 11. Change in greenhouse gas emissions (Million tons of CO2eq and %) across sectors with respect to the baseline scenario in 2050.
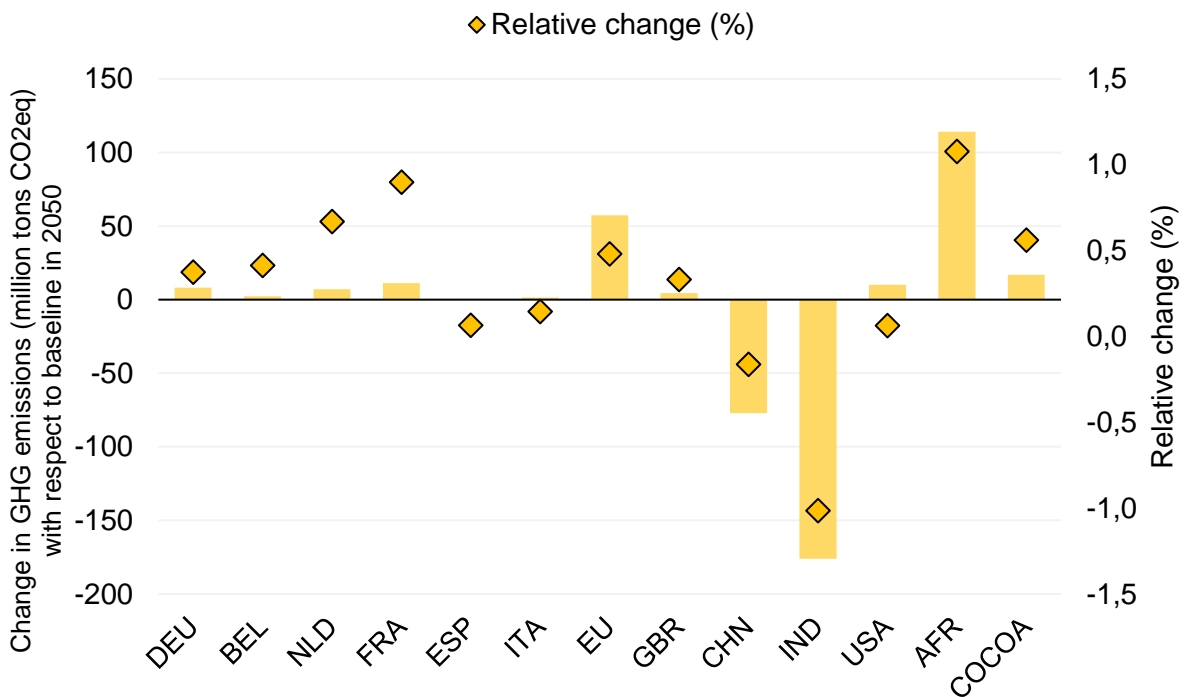

Figure 12. Change in greenhouse gas emissions (Million tons of CO2eq and %) across regions with respect to the baseline scenario in 2050.

4. Non-Agricultural impacts

4.1. Food processing and manufacturing and food services sectors

Following the impacts globally observed across agricultural sectors, food processing and manufacturing sectors, as well as food services, are negatively affected by the reduction in agricultural land in 2050 (Table 3). Production volumes of processed foods primarily decrease in regions facing a higher decline in agricultural production such as Africa and India (figure 13). European countries, on average less affected by the land reduction shock, gain a competitive advantage in the production on processed foods, expanding production volumes by 1.5% in 2050 (figure 13). This advantage translates in better terms of trade for EU countries which expands average exports of processed foods by 4.2% compared to baseline in 2050. Differently, imports of such products sharply rise across African countries (average +21.5%) and in some large agrifood producing countries such as India (+10.1%), Indonesia (+11.7%), and Colombia (+10.8%).

The average appreciation of primary agricultural products is subsequently reflected upon processed foods which globally appreciate by an average 5.0% in 2050 (figure 14 and Table 3). Sharper price increases are observed in India (+12.8%), China (+5.1%), and Africa (+10.1%), while effects on EU prices are slightly less severe (+2.7%). Across EU members, the higher domestic agrifood prices coupled with an increase in export demand result in stronger appreciations of processed foods in the Netherlands (+3.7%), Belgium (+4.5%), and Germany (+2.8%). While changes in production and price-effects on food services are relatively moderate, the appreciation of processed foods decreases global consumption of such products by -1.3% compared to the baseline in 2050. In the EU, the decrease in consumption of processed foods is more contained, with consumer demand declining by an average -0.8% in 2050.
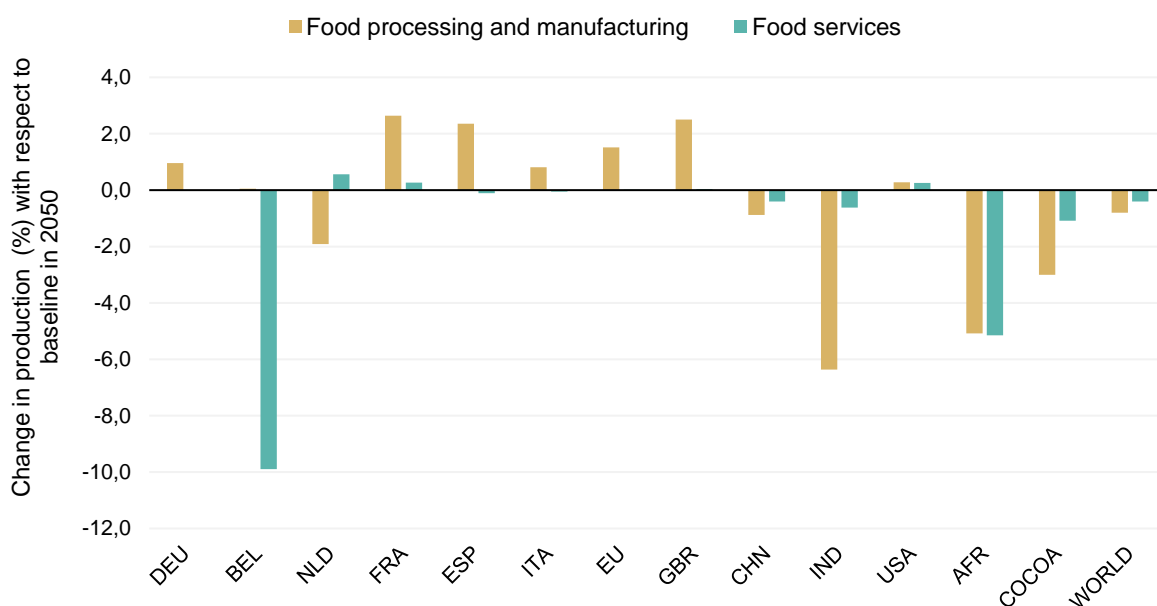

Figure 13. Change in production (%) of food processing and manufacturing and food services sectors with respect to baseline in 2050.
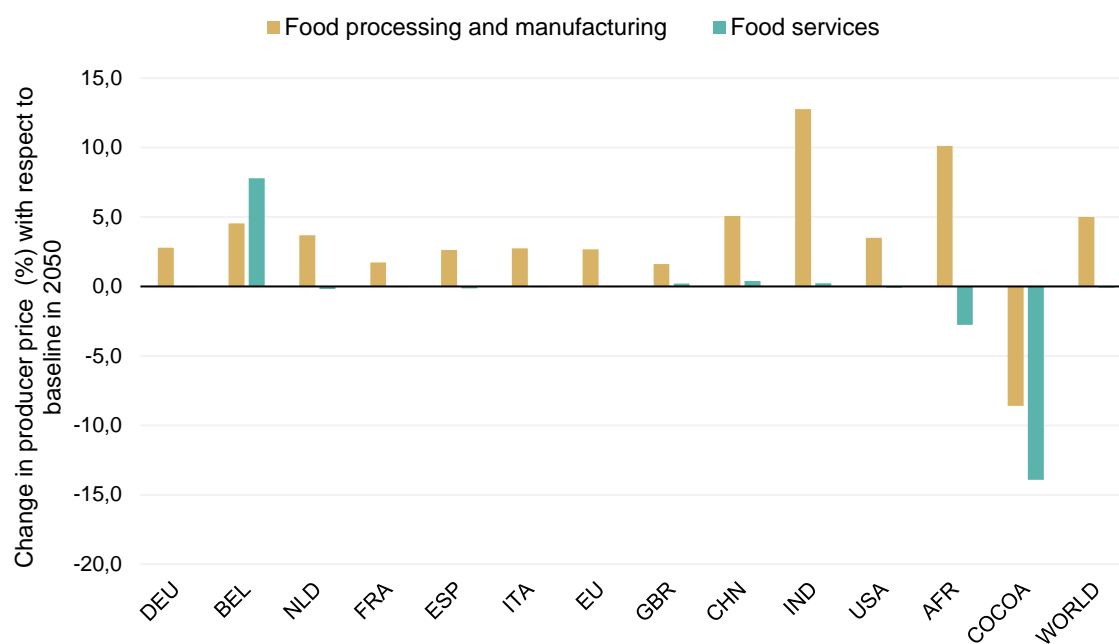
Figure 14. Change in producer price (%) of food processing and manufacturing and food services sectors with respect to baseline in 2050.

Table 3. Impacts (%) of the Half Earth scenario on food sectors with respect to the baseline in 2050.

	Production volume		Producer prices		Consumption volume		Export volume*	Import volume*
	Food processing & manufacturing	Food services	Food processing & manufacturing	Food services	Food processing & manufacturing	Food services		
AFR	-5.1	-5.1	10.1	-2.8	-2.5	-2.1	-12.4	19.9
ARG	3.6	-0.4	3.7	-0.6	-0.9	0.9	11.2	4.0
AUS	1.9	0.2	2.1	-0.1	-0.6	0.0	11.1	-1.3
AUT	0.9	0.1	2.3	0.2	-0.8	-0.5	3.2	0.0
BEL	0.0	-9.9	4.5	7.8	-1.2	-8.0	0.6	-0.2
BGR	3.8	0.0	2.0	-0.5	-0.6	1.2	8.0	-0.2
BRA	1.0	-0.3	2.8	-0.2	-0.7	0.1	8.2	-0.2
CAM	-11.5	-0.2	15.2	-1.1	-4.3	-0.6	-43.2	24.1
CAN	2.3	-0.3	3.0	0.1	-0.8	-0.1	8.1	0.0
CHE	1.8	-0.4	2.6	0.8	-0.8	-0.7	5.0	-0.8
CHN	-0.9	-0.4	5.1	0.4	-1.3	-0.6	3.8	-0.4
COCOA	-3.0	-1.1	-8.6	-13.9	-0.9	-2.8	-21.1	18.0
COL	-5.7	-0.3	11.5	-0.2	-2.6	-1.5	-33.6	10.8
CZE	1.2	0.0	2.9	0.4	-0.8	-0.3	2.5	-0.3
DEU	1.0	0.0	2.8	0.0	-0.9	-0.4	3.7	-1.1
DNK	4.2	0.2	2.0	0.0	-0.7	0.1	5.9	0.3
EAS	-1.8	0.4	8.0	-0.1	-1.9	-1.4	-0.4	1.4
ESP	2.4	-0.1	2.6	-0.1	-0.9	0.1	8.3	-1.7
EST	-0.9	0.6	2.8	-0.5	-1.0	-0.4	-0.8	0.7
FIN	1.7	0.1	1.5	0.1	-0.6	-0.3	8.3	-1.9
FRA	2.6	0.3	1.7	0.0	-0.7	-0.1	8.2	-1.8
GBR	2.5	0.0	1.6	0.1	-0.6	-0.2	8.1	-1.4
GRC	2.1	-0.2	2.6	-0.2	-0.9	0.2	10.5	-0.1
HUN	3.1	0.2	2.2	0.0	-0.6	0.3	5.5	-0.1
IDN	-6.2	-3.0	12.5	2.0	-2.0	-0.5	-21.4	11.7
IND	-6.4	-0.6	12.8	0.2	-2.4	-1.0	-22.1	10.1
IRL	7.5	0.2	1.7	0.1	-0.6	-0.2	9.0	3.1
ITA	0.8	-0.1	2.7	0.1	-0.9	-0.2	4.6	-0.1
JPN	0.8	-0.4	2.1	0.5	-0.6	-0.6	15.4	-2.6
KOR	0.8	-0.7	3.5	1.2	-0.8	-0.9	9.4	-0.9
LTU	-0.4	0.8	1.6	-0.7	-0.8	1.1	-0.2	0.2
LVA	5.6	0.2	3.5	0.5	-1.0	-4.4	7.6	0.4
ME	0.3	-0.5	3.8	0.4	-1.4	-0.6	19.9	-1.1
MEX	-1.4	0.1	4.7	-0.3	-1.2	0.1	-1.0	2.7
MYS	-16.5	-4.2	12.9	3.6	-1.5	-1.4	-23.1	1.9
NAF	0.0	0.7	4.2	-0.6	-0.9	-0.1	6.6	0.2
NLD	-1.9	0.6	3.7	-0.2	-1.2	0.7	-1.8	-0.2
NOR	3.6	0.4	1.0	0.2	-0.5	-0.4	11.0	-0.7
NZL	2.4	-0.1	1.4	-0.3	-0.6	0.6	3.2	-1.6
PHL	-4.3	-0.1	14.1	0.2	-2.7	-3.1	-22.2	3.9
POL	1.0	0.2	2.4	0.0	-0.8	-0.1	2.2	-0.5
PRT	4.6	0.2	3.5	0.1	-1.0	-0.2	14.0	0.1
RESTEU	2.7	0.5	1.8	0.2	-0.7	-0.3	7.2	-1.3
REUR	1.7	-0.2	3.7	-1.0	-0.6	1.1	5.5	1.9
RLAM	0.6	-0.2	3.0	0.0	-0.8	-0.1	4.8	-0.7
ROU	-0.7	0.3	3.1	-0.4	-1.0	0.1	2.2	0.8
RUS	0.9	0.0	3.1	0.2	-0.7	-0.1	11.2	-0.1
STAN	2.7	-1.0	2.6	0.1	-0.8	-0.2	10.6	1.6
SVK	2.8	0.6	1.9	0.0	-0.7	0.1	5.6	-0.7
SVN	0.2	0.0	3.1	0.1	-1.0	-0.7	2.2	-0.1
SWE	3.6	0.1	1.7	0.2	-0.6	-0.3	10.4	-1.1
THA	-0.6	-1.7	5.6	0.4	-1.1	-0.5	2.0	-0.9
TUR	-2.6	-1.0	5.4	-0.3	-1.7	-0.8	-3.0	4.0
TWN	-0.3	-0.3	6.1	0.4	-1.3	-0.7	3.7	0.4
USA	0.3	0.3	3.5	-0.1	-0.9	0.0	6.3	-1.0
ZAF	3.0	-0.8	3.5	0.0	-0.8	0.2	23.2	-1.0
EU	**1.5**	**0.0**	**2.7**	**0.1**	**-0.8**	**-0.2**	**4.2**	**-0.6**
WORLD	**-0.8**	**-0.4**	**5.0**	**-0.1**	**-1.3**	**-0.4**	**0.0**	**0.0**

*Trade estimates refer only to food processing and manufacturing sectors.

4.2.   Non-agricultural non-food sectors

On a global scale, non-agricultural non-food sectors see a minor decline in production (-0.1%), suggesting that the contraction of agricultural land does not translate into a substantial boost for other sectors. Producer prices of non-agrifood products averagely decrease by -0.8%, reflecting the average lower demand for non-agrifood products, decreasing due a relatively higher share of expenses allocated to the more expensive agrifood products across countries. (Tables 1 and 4). Global consumption of non-agrifood products decreases by an average -0.2%, with greater contractions observed in regions experiencing a sharper increase in agricultural prices. In the EU, consumption of non-agrifood products remains close to the baseline in 2050 as consumers are on average less affected by the relatively moderate appreciation of agrifood products. However, such average hides negative effects observed across specific EU members. Countries as the Netherlands, Italy, or Germany, face a rather sharper rise in the price of agrifood products, with consumers allocating a higher budget to such commodities and parallelly declining the consumption of non-agrifood commodities (Table 4).

Trade of non-agrifood commodities moderately changes, as adjustments of imports and exports to the shift in demand remain rather contained. Imports minorly increase across all regions, compensating for the rather moderate reduction in domestic production. Contrarily, export volumes averagely decrease in response to the contraction of domestic production. The EU sees a decline in export capacity (-0.2%), primarily driven by the adverse effects observed in southern European countries such as Greece, Italy, and Spain where production volumes of non-agrifood products decrease more pronouncedly.

Even if moderate, the decrease in production observed across non-agrifood sectors has a direct effect on the price and use of production endowments (Table 4). Globally, a lower demand for labour and capital leads to an average depreciation of production factors of -1.4%, with effects being less remarked in the EU as non-agrifood production declines relatively less. Capital use in non-agrifood sectors globally declines by -0.5%, reflecting reduced investment in affected industries. With this, real wages in such sectors parallelly experience a contraction at a global level (average -0.4%), primarily driven by stronger declines observed in lower-income regions (Figure 10 and Table 3). Effects in the EU remain rather contained, as average non-agricultural wages decrease by -0.4% in 2050.

Table 4. Impacts (%) of the Half Earth scenario on non-agricultural non-food sectors with respect to the baseline in 2050.

	Production volume	Producer prices	Consumption volume	Export volume	Import volume	Capital use	Labor use	Real wages	Total endowment price	Total endowment use
AFR	0.6	-7.7	-2.1	7.4	-2.4	0.2	0.9	-12.1	-12.1	0.4
ARG	-0.2	-1.4	0.8	-8.3	2.6	0.1	-0.1	-0.5	-0.6	0.1
AUS	0.0	-0.3	0.1	-0.5	0.9	0.1	-0.1	0.1	0.0	0.0
AUT	-0.2	-0.1	-0.3	-0.3	-0.1	-0.1	-0.3	0.5	0.4	-0.1
BEL	0.1	0.1	-2.1	0.6	0.1	0.0	0.3	-2.4	-2.4	0.1
BGR	0.1	-1.0	0.1	-1.4	0.6	0.1	0.1	-0.5	-0.5	0.1
BRA	-0.5	-0.5	1.1	-4.1	2.6	-0.1	-0.3	-0.3	-0.3	-0.2
CAM	1.3	-1.5	0.1	5.1	-1.3	0.5	2.4	-5.5	-5.3	0.9
CAN	-0.2	-0.3	-0.1	-1.3	0.3	0.0	-0.2	-0.1	-0.1	-0.1
CHE	0.0	-0.1	-0.3	0.0	0.3	0.0	-0.1	0.0	-0.1	0.0
CHN	-0.4	-0.4	-2.8	-0.7	0.1	0.0	-0.5	-0.4	-0.4	-0.1
COCOA	0.0	-14.3	-0.6	7.4	-6.9	0.0	-0.2	-19.9	-19.9	0.0
COL	0.4	-1.4	0.0	5.2	-3.3	0.1	0.3	-2.6	-2.6	0.2
CZE	0.0	-0.2	0.2	-0.2	-0.1	0.0	0.0	-0.2	-0.2	0.0
DEU	-0.3	-0.1	-1.1	-0.5	-0.1	-0.1	-0.4	0.2	0.1	-0.2
DNK	-0.2	-0.3	-0.4	-1.2	0.5	0.0	-0.2	-0.2	-0.2	-0.1
EAS	-0.1	-0.9	-0.1	0.9	0.2	-0.2	0.0	-2.7	-2.7	-0.2
ESP	-0.4	-0.5	0.0	-2.3	0.2	0.0	-0.3	-0.1	-0.1	-0.1
EST	-0.4	0.4	-0.3	-0.1	0.1	-0.1	-0.1	-2.0	-2.0	-0.1
FIN	-0.1	-0.1	0.4	-0.3	0.1	-0.1	-0.1	-0.1	-0.1	-0.1
FRA	-0.3	-0.3	0.4	-1.3	0.3	-0.1	-0.3	-0.1	-0.1	-0.1
GBR	0.0	0.0	-0.5	0.0	0.2	0.0	0.0	-0.1	-0.1	0.0
GRC	-0.8	-0.6	0.7	-3.4	0.7	-0.1	-0.3	-0.3	-0.3	-0.2
HUN	-0.2	-0.5	0.1	-0.8	-0.2	0.1	-0.1	-0.3	-0.3	0.1
IDN	1.4	-2.1	0.0	4.7	0.6	0.4	2.4	-4.6	-4.5	0.6
IND	0.6	-1.7	-0.2	3.9	0.2	0.3	0.8	-5.0	-4.9	0.4
IRL	-0.1	-0.2	-0.1	-0.1	0.7	-0.1	-0.4	-0.1	-0.1	-0.1
ITA	-0.2	-0.2	-2.9	-0.7	0.0	0.0	-0.3	0.0	0.0	-0.1
JPN	-0.1	-0.1	0.9	-0.2	0.1	0.0	-0.2	0.0	0.0	-0.1
KOR	0.1	0.0	0.0	0.0	0.0	0.0	0.1	-0.2	-0.2	0.1
LTU	-0.1	-0.8	0.1	-0.7	0.3	0.1	-0.1	-0.3	-0.3	0.1
LVA	-0.2	0.0	-0.3	0.7	-0.1	-0.1	0.1	-4.6	-4.6	-0.1
ME	-0.1	-0.3	0.9	0.0	0.1	-0.1	-0.2	-0.3	-0.3	-0.1
MEX	-0.1	-0.6	0.7	-0.8	-0.2	0.1	-0.2	-0.4	-0.4	0.0
MYS	1.6	-0.7	-0.3	2.7	1.1	0.3	2.0	-3.4	-3.2	0.7
NAF	-0.1	-0.6	-0.1	-0.1	-0.1	0.0	-0.2	-0.8	-0.8	-0.1
NLD	0.0	-0.7	-2.4	-0.9	0.6	0.2	-0.3	-0.3	-0.3	0.1
NOR	-0.1	-0.1	0.0	-0.3	0.3	-0.1	-0.1	0.1	0.1	-0.1
NZL	-0.1	-0.7	0.1	-3.3	1.5	0.2	-0.2	-0.3	-0.3	0.0
PHL	0.0	-1.1	0.1	3.5	0.1	-0.3	0.1	-5.1	-5.1	-0.3
POL	-0.2	-0.3	0.0	-0.7	-0.1	0.0	-0.2	0.3	0.3	0.0
PRT	-0.3	-0.3	0.8	-1.5	0.1	-0.1	-0.2	-0.3	-0.3	-0.1
RESTEU	-0.3	-0.3	0.1	-0.5	0.2	-0.1	-0.5	0.2	0.2	-0.1
REUR	-0.4	-1.0	-0.1	-3.0	0.9	0.1	-0.3	-0.8	-0.8	0.1
RLAM	0.1	-0.8	0.1	-0.4	0.4	0.2	0.1	-0.8	-0.8	0.1
ROU	-0.2	-0.6	-0.5	-0.9	-0.1	0.1	-0.4	-0.1	-0.2	0.0
RUS	-0.1	-0.2	0.2	-0.4	0.3	0.0	-0.2	0.0	0.0	0.0
STAN	-0.2	-0.8	0.3	-0.9	0.0	0.0	-0.2	-1.2	-1.2	0.0
SVK	-0.1	-0.2	0.2	-0.4	-0.2	0.0	-0.1	-0.2	-0.2	0.0
SVN	-0.3	-0.2	-0.2	-0.3	-0.3	-0.1	-0.3	0.6	0.6	-0.1
SWE	0.0	0.0	-0.1	-0.1	0.2	0.0	-0.1	-0.1	-0.1	0.0
THA	-0.4	-0.8	-0.2	-0.7	0.1	0.2	-0.3	0.8	0.7	0.1
TUR	-0.6	-0.4	0.0	-1.3	-0.4	-0.1	-0.7	-0.4	-0.5	-0.1
TWN	0.2	-0.2	-0.4	0.2	0.0	0.0	0.1	-0.5	-0.5	0.0
USA	0.0	-0.1	-0.2	-0.8	0.3	0.0	0.0	-0.2	-0.2	0.0
ZAF	-0.5	-0.6	0.1	-2.5	2.2	0.0	-0.6	0.5	0.4	-0.3
EU	**-0.2**	**-0.3**	**0.0**	**-0.6**	**0.2**	**0.0**	**-0.2**	**-0.4**	**-0.5**	**0.0**
WORLD	**-0.1**	**-0.8**	**-0.2**	**0**	**0**	**0.0**	**0.0**	**-1.4**	**-1.4**	**0.0**

5.   Economy-wide impacts

The contraction in agricultural land alters value-added contributions across industries, affecting GDP, and household incomes across countries (Table 5). The most severely affected sector is agriculture, forestry, and fishing, which faces a global contraction in its value-added of around 1.0% or 86 billion US dollars compared to baseline in 2050 (Figure 15). The EU stands out as an exception due to the relatively lower magnitude of the impact, which overall benefits EU agricultural markets. Total value-added from agriculture, forestry, and fishing in the EU increases by 3.6% (or 12 billion US dollars), primarily driven by France, Germany, Italy, Spain, and the Netherlands, which cumulatively account for an increase of 9 billion US dollars of value-added (Figure 15). The broader agrifood sector also experiences substantial disruptions with an average global decline of -0.7% or -96 billion US dollars compared to baseline in 2050. Contrarily, major benefits are observed in the EU where total value-added from the agrifood sector increases by 1.4% (or 19 billion US dollars) in 2050. Manufacturing sectors are on average less affected, with a total value-added decreasing by -0.1% or -25 billion US dollars in 2050. Such decline is additionally observed in the EU where, due to the reallocation of resources to the expanding agricultural sectors, the total value added from manufacturing sectors moderately declines by -0.1% or 3.8 billion US dollars in 2050. Finally, the services sector remains relatively stable, with most countries experiencing minor fluctuations.

The global GDP impact is rather modest (-0.4% or -650 billion US dollars), although certain regions experience sharper contractions (Figure 16 and Table 5). African countries bear on average the heaviest burdens (-4.6% or -256 billion US dollars), driven by their higher dependence on agriculture. Impacts on GDP are rather moderate in the EU, although the lower consumption volumes across sectors negatively affect GDP (-0.03% or -20 billion US dollars) in 2050. The Netherlands stands out as GDP sees a moderate increase of 0.3% (4 billion US dollars), primarily driven by the better terms of trade linked to the rising volume agrifood of exports.

Finally, despite agrifood prices see an average increase across countries, the overall consumer price index (CPI) moderately declines at global level by an average -0.3% with respect to the baseline in 2050 (Table 5). This is primarily due to adjustments in consumption patterns and price reductions in non-agricultural sectors, driving an overall decline in consumer prices.
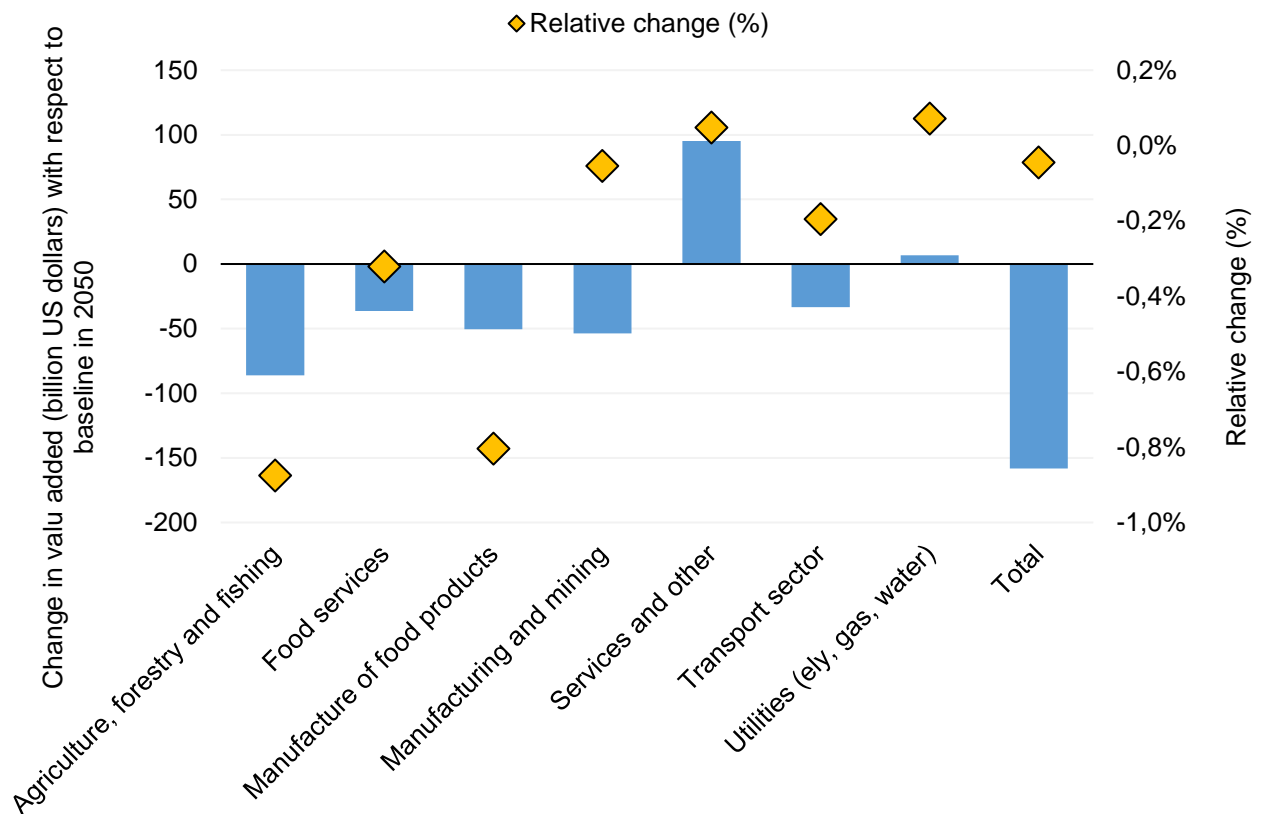
Figure 15. Change in sectoral value-added (billion US dollars and %) in the Half Earth scenario with respect to the baseline in 2050.
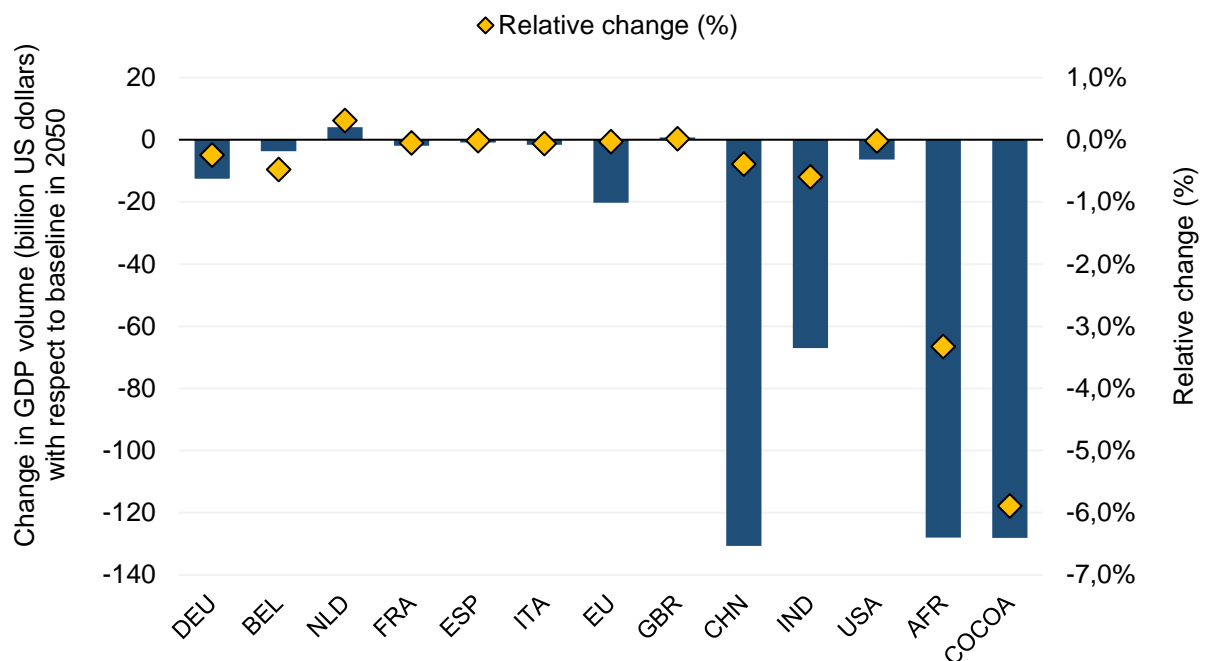

Figure 16. Change in the volume of gross domestic product (billion US dollars and %) across regions in the Half Earth scenario with respect to the baseline in 2050.

Table 5. Economic impacts (%) of the Half Earth scenario with respect to the baseline in 2050.

	Value added				GDP Volume	Household income	CPI index (total)
	AGRICULT, FORESTS AND FISHING	AGRIFOOD	MANUFACTURING	SERVICES_UTILITIES			
AFR	-2.6	-3.8	0.2	0.4	-3.3	0.9	-2.8
ARG	-2.6	0.1	-1.5	0.5	-0.1	0.7	-0.1
AUS	1.9	1.0	0.0	0.0	0.0	-0.3	0.0
AUT	1.6	0.6	0.1	-0.2	-0.2	-0.3	-0.1
BEL	3.6	-0.3	0.5	-0.1	-0.5	-0.9	0.2
BGR	1.8	1.6	0.2	0.1	0.3	0.5	-0.1
BRA	-1.4	-0.6	-1.1	-0.1	-0.3	0.2	-0.1
CAM	-13.2	-6.9	1.6	0.7	-0.8	0.0	-0.8
CAN	3.2	1.1	-0.2	0.0	-0.1	-0.1	0.0
CHE	2.0	0.9	0.2	-0.1	0.0	-0.3	0.0
CHN	-0.1	-0.2	-0.1	-0.1	-0.4	-0.4	-0.1
COCOA	-4.0	-2.8	1.1	-0.9	-5.9	2.8	-4.3
COL	-19.3	-7.6	0.7	0.0	-1.3	-1.7	-0.3
CZE	2.4	1.2	0.0	0.0	0.0	-0.2	-0.1
DEU	4.8	1.3	-0.2	-0.2	-0.2	-0.3	-0.1
DNK	3.6	2.6	-0.5	0.1	0.1	0.0	-0.1
EAS	-0.7	-0.5	-0.9	0.1	-0.7	-0.5	-0.6
ESP	5.8	1.4	-0.6	0.0	0.0	0.2	-0.1
EST	1.0	0.6	0.3	-0.3	-0.5	0.0	-0.6
FIN	1.8	1.3	0.0	-0.2	-0.1	-0.2	-0.1
FRA	3.5	1.9	-0.3	-0.1	0.0	-0.1	-0.1
GBR	2.4	0.8	0.3	-0.1	0.0	-0.3	0.0
GRC	4.1	1.8	-2.1	0.1	-0.1	0.1	0.0
HUN	2.1	1.7	-0.3	0.3	0.1	0.1	-0.1
IDN	-4.3	-4.4	0.4	0.8	-0.1	0.1	-0.7
IND	-2.3	-2.1	-0.5	0.8	-0.6	-0.2	-1.1
IRL	3.3	3.2	0.2	-0.6	-0.1	-0.2	-0.1
ITA	4.5	1.2	-0.2	0.0	-0.1	-0.2	-0.1
JPN	2.9	0.6	0.1	-0.1	-0.1	-0.3	0.0
KOR	1.0	0.0	0.1	0.0	0.0	-0.2	0.0
LTU	1.0	0.6	0.4	-0.1	0.2	0.5	-0.1
LVA	-4.2	-0.5	-0.4	0.1	-1.5	-1.6	0.0
ME	1.9	0.4	0.1	-0.2	-0.1	-0.3	-0.2
MEX	-0.5	-0.3	-0.1	0.1	-0.2	0.0	-0.2
MYS	-13.0	-10.6	1.2	0.3	-0.1	-0.4	-0.1
NAF	0.6	0.5	0.1	-0.1	-0.2	-0.2	-0.4
NLD	8.3	2.0	0.1	0.2	0.3	0.4	-0.1
NOR	1.6	1.9	0.0	-0.1	0.0	-0.3	0.0
NZL	1.6	1.5	-0.6	0.2	0.1	0.2	-0.1
PHL	-4.4	-3.0	-0.2	-0.3	-1.4	-1.0	-0.7
POL	1.5	1.0	0.1	-0.1	-0.1	-0.1	-0.1
PRT	4.8	1.7	-0.5	0.0	0.0	-0.1	-0.1
RESTEU	2.4	1.1	0.5	-0.3	-0.1	-0.1	-0.1
REUR	1.5	0.7	-0.5	0.3	-0.2	0.5	-0.3
RLAM	-3.3	-1.0	0.0	0.2	-0.2	-0.2	-0.1
ROU	1.3	0.4	-0.1	0.1	-0.2	0.0	-0.1
RUS	1.6	1.0	0.0	0.0	-0.1	-0.2	-0.1
STAN	0.6	0.7	-0.3	0.0	-0.3	0.0	-0.5
SVK	2.5	1.7	0.0	0.0	0.1	-0.1	-0.1
SVN	2.4	1.0	0.1	-0.3	-0.3	-0.3	-0.1
SWE	1.0	1.1	0.1	-0.1	0.0	-0.3	-0.1
THA	0.7	-0.7	0.2	0.0	-0.5	-0.1	-0.2
TUR	0.8	-0.5	0.5	-0.4	-0.7	0.0	-0.5
TWN	-10.5	-1.6	0.2	-0.1	-0.1	-0.2	0.0
USA	-0.6	0.1	0.0	0.0	0.0	-0.2	0.0
ZAF	6.7	4.3	-0.9	-0.2	-0.2	0.4	-0.1
EU	3.6	1.4	-0.1	-0.1	-0.1	-0.1	-0.1
WORLD	-1.0	-0.7	-0.1	0.0	-0.4	-0.1	-0.3

6. Discussion and Conclusion

The Half Earth scenario presents complex economic consequences across global markets, driven by the significant reduction in agricultural land. The contraction of agricultural land alters sectoral compositions, leading to a redistribution of economic activity. While agricultural producer prices increase globally due to supply constraints, non-agricultural sectors experience a relative decline in production and consumption as household expenditures shift toward higher food costs. This shift is most pronounced in lower-income and land-intensive regions, such as Africa and Latin America, where the reduction in land availability exerts considerable pressure on domestic production and trade balances.

The EU, in contrast, emerges as a relative beneficiary of these shifts due to its higher agricultural productivity and technological adaptability. The region experiences an expansion in agrifood production and exports, leading to an increase in agricultural value-added and improving trade performance. However, these benefits are not uniformly distributed across EU member states. Countries such as the Netherlands, Germany, and Italy see a more pronounced rise in agrifood prices, influencing household consumption patterns and leading to a modest contraction in manufacturing and non-agrifood consumption. Additionally, despite overall economic resilience, real wages in non-agricultural sectors slightly decline due to shifting labor demand, while food expenditures take a larger share of household budgets.

From a macroeconomic perspective, the global GDP impact remains relatively contained, but regional disparities highlight the asymmetric economic burdens. African nations face the sharpest GDP contractions due to their dependence on a land-intensive agriculture, while Europe and other industrialized regions manage to mitigate losses through the intensification of agricultural practices (higher inputs use) which partially compensate for the loss in agricultural land availability. Finally, despite rising food prices, the overall consumer price index (CPI) registers a moderate global decline, primarily due to offsetting reductions in non-agricultural prices. This effect is especially relevant in developed economies, where diversified economic structures help stabilize broader inflationary pressures.

The economic repercussions of the Half Earth scenario underscore the intricate linkages between land use, sectoral production, trade, and overall economic stability. While the reduction of agricultural land induces notable disruptions in agrifood markets, it also reshapes global agrifood trade, non-food sectors and, labor and capital markets. The global economy experiences a moderate contraction, with lower-income, agriculture-dependent regions bearing the heaviest costs, whereas technologically advanced and trade-oriented regions like the EU demonstrate relative resilience. For the EU, the shift in agricultural market dynamics offers both opportunities and challenges. The expansion of agricultural value-added and agrifood exports bolsters economic performance, yet it comes at the cost of higher food prices and adjustments in non-agrifood sectors. Within the EU, the benefits are unevenly distributed, with export-oriented agricultural economies such as the Netherlands, Germany, and Italy gaining a competitive advantage. Differently, certain Southern European countries face trade and production challenges especially in non-agrifood sectors, underlying the need for investments in technological advancements for enhancing the resilience of the economy in facing heavy environmental shocks.