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The Implications of Agricultural Trade and Market Developments for Food Security

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Abstract

THE IMPLICATIONS OF AGRICULTURAL TRADE AND MARKET DEVELOPMENTS FOR FOOD SECURITY

Gregoire Tallard, Peter Liapis and Graham Pilgrim
OECD

Reducing hunger and undernourishment is a global priority and the Sustainable Development Goals (SDGs) have the ambitious target of eradicating hunger entirely by 2030. Using the *OECD-FAO Agricultural Outlook* to 2024, this paper provides projections on the availability of calories at the national level, for the number of persons undernourished, and for the proportion of undernourishment (PoU) that are consistent with the market projections of the *Outlook's* baseline. It also considers the impact on undernourishment of four alternative scenarios: faster income growth relative to the baseline in developing countries; stronger growth in agricultural productivity; a combination of a faster income growth with a stronger productivity growth; and finally a more equitable access to available food supplies. Under the baseline, the global PoU is projected to fall from 11% to 8% over ten years, with Latin America as a whole dipping under the 5% threshold at which the FAO considers hunger to be effectively eradicated. The PoU falls from 12% to 8% in Asia and the Pacific and from 23% to 19% in Sub-Saharan Africa. The global total of undernourished people declines from 788 million to 636 million. The number of undernourished individuals fall the most in Asia. Higher income growth or more productive agriculture removes more people from the ranks of the undernourished, but in most cases, more equitable access to food leads to the biggest reductions. The analysis confirms that it is not lack of available food that is the fundamental problem, but rather effective access to that food. Trade plays an increasing role in ensuring national food availability for many countries.

Keywords: Prevalence of undernourishment, sustainable development goals millennium, development goals, projections, developing world, hunger, food security, scenarios.

JEL Classification: I31, O13, Q10, Q18

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Executive Summary

Reducing hunger and undernourishment is a global priority. The Millennium Development Goals (MDGs) included a target of halving between 1990 and 2015 the proportion of people who are undernourished. According to FAO estimates, this target was almost met at the global level, but progress was uneven across countries and there remained nearly 800 million undernourished when the MDGs expired in 2015. The new Sustainable Development Goals (SDGs), which replace the MDGs, have the ambitious target of eradicating hunger entirely by 2030.

This paper provides projections for undernourishment to 2024 consistent with the baseline of the 2015 *OECD-FAO Agricultural Outlook*. It assesses which countries are on trend to meet the SDG objective of eliminating hunger, as captured by the FAO's undernourishment indicator. The analysis considers the impact on these projected numbers of four alternative scenarios; faster income growth relative to the baseline in developing countries; stronger growth in agricultural productivity; a combination of the two; and finally more equitable access to available food supplies.

The *OECD-FAO Agricultural Outlook* contains projections for production, consumption and trade of the major agricultural commodities, and implicitly for the availability of calories at the national level for the 32 developing countries explicitly covered by the Aglink Cosimo model (OECD (2015a)). The FAO's undernourishment indicator measures the probability that an individual from a reference population consume less than the minimum calorie requirement for an active and healthy life. The Prevalence of Undernourishment (PoU) converts national calorie availability into estimates of undernourishment on the basis of an estimated distribution of peoples' access to available calories. This paper takes the Outlook estimates for calorie availability and – in the base case – keeps the distribution of access to those calories unchanged. On that basis it is possible to provide projections for undernourishment.

Under a "status quo" scenario in which policies remain unchanged and agricultural productivity growth continues on trend, the global PoU is projected to fall from 11% to 8% over ten years, with Latin America as a whole dipping under the 5% threshold at which the FAO considers hunger to be effectively eradicated. The PoU falls from 12% to 8% in Asia and the Pacific, with Indonesia and Thailand dipping under the 5% threshold, and from 23% to 19% in Sub-Saharan Africa. The global total of undernourished people declines from 788 million to 636 million.

By 2024 global consumption of calories from crop and livestock products will be 14% and 15% higher than in 2015 respectively. Developing countries account for 96% of the additional consumption of crop products and 88% of livestock products. Adjusting for population growth, per capita consumption levels for crops and livestock will rise by 4% and 5% respectively.

Faster income growth in developing countries of 1% cumulatively over the next ten years (raising the average annual growth rate by around a quarter) implies that per capita incomes end up 10% higher in 2024 and reduces the PoU in developing countries by a further 0.5%, with slightly larger effects in Africa than in Asia. Raising agricultural productivity growth in developing countries by 1% cumulatively over ten years (implying a gain of more than 50% across crop products relative to the baseline), would lower the PoU in developing countries by an additional 0.8% and enable the people's Republic of China (hereafter "China"), Nigeria and Peru to effectively eradicate hunger. Here, however, the average effects would be larger in Asia than in Africa. A combination of both effects would be essentially additive, with Bangladesh joining the group of countries free from hunger.

The biggest impacts on undernourishment come through a scenario which improved access to available calories through a more equal distribution of incomes and hence expenditures across national populations. Already, the world produces 50% more calories than needed to meet everyone's minimum calorie requirement. A 10% reduction in the coefficient of variation in 2024 lowers the overall PoU by 2.1 percentage points and allows all the countries in the income and productivity scenarios, plus India and Viet Nam, to eliminate undernourishment.

A combination of income growth, agricultural productivity gains, and reduced income inequality will keep most Asian countries on track to achieve the SDG of eliminating hunger. However, the PoU for Sub-Saharan Africa as a whole remains stubbornly high under all scenarios, and by 2024 the region will account for more than one third of the global total of undernourished. For the poorest African countries, much deeper transformations will be needed that raise the incomes of the poorest households and with it their access to food – whether that food is sourced domestically or from imports. The question of how to realise those gains, and the role of domestic agricultural production, is a broader development question beyond the remit of this paper.

Calorie availability can be provided by domestic production or by imports, and trade will play an important role in moving supplies from surplus to deficit countries. In most countries, the majority of additional consumption will be sourced from domestic markets. Overall there is a modest increase in the share of consumption imported for crop products, but larger increases are observed in some countries, including Bangladesh, China, Ethiopia, India, Mozambique and Viet Nam. The importance of trade to national food availability will be reinforced if overall income growth is the dominant source of increased calorie availability, and reduced if the main driver is domestic agricultural productivity growth.

1. Introduction

This paper analyses the linkages between food security, trade and markets using the OECD-FAO Aglink-Cosimo model. Specifically, it charts out the projected evolution of undernourishment, using FAOs methodology over ten years under the baseline of the 2015 *OECD-FAO Agricultural Outlook*. It then assesses the implications for undernourishment in developing countries of general income growth, productivity improvements and more equal access to food at the national level. The corresponding implications for agricultural trade and markets are also described.

Increasing food security and reducing hunger and undernourishment is a global priority. Hunger reduction targets were established by the 1996 World Food Summit (WFS) and the 2001 Millennium Development Goals Target 1c (MDG 1c). The WFS aimed to halve the number of undernourished between 1990 and 2015, whereas the MDG 1c aimed to halve the proportion. The 2015 *State of Food Insecurity in the World* (SOFI) report, published jointly by FAO, IFAD and WFP, provides estimates on the progress made on both targets[1]. The WFS target required the Number of Undernourished (NoU) to decline from 991 to 495 million by 2015 however the estimated NoU for 2014-16 is 780 million, which falls short of the target but nevertheless implies a sizeable reduction in the rate of undernourishment, given that the world's population increased by 1.9 billion (primarily within developing countries). The MDG 1c goal required the proportion of undernourished, as measured by the Prevalence of Undernourished (PoU)[2] indicator, to decline by half from 23.3%. The PoU indicator, estimated at 12.9% in 2014-16, nearly meets the target. At a global level, given the progress made by developed countries, the PoU indicator is sufficiently close to the MDG 1c target that the FAO considers that the target has been achieved.

The Sustainable Development Goals (SDGs) have been adopted as a successor to the MDGs, which expired at the end of 2015. SDG 2.1 aims to eradicate hunger by 2030 and ensure access of all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round. Discussions are ongoing about the indicators which will be used to measure hunger, but the FAO's undernourishment indicator will remain a key reference.

The structure of the paper is as follows: Section 2 provides an overview of the FAO method and its application in this analysis. Section 3 describes the projected changes in the level of undernourishment globally and in major countries and regions, and describes the market outcomes that generate the results. Section 4 examines alternative scenarios around the baseline and their effects on food insecurity, markets and trade. Section 5 presents the main conclusions.

2. Use of the FAO's undernourishment indicator

The FAO's Prevalence of Undernourishment (PoU) indicator is among a group of widely cited measure of food security. The FAO methodology benefitted from several refinements (FAO (2014a)) but has several limitations which are acknowledged in the SOFI report (FAO, IFAD and WFP (2015)). The estimation starts from the observation of food availability at the national level (via FAO's food balance data converted to calorie equivalent), which is translated to the individual level on the basis of an estimated intra-national distribution of access to food (via the distribution of expenditure). An individual's access to food is characterised by a distribution function which is based on household surveys. Those surveys, which are conducted every five to ten years, are used to derive the inequality in

1. The assessment of progress towards these targets took 1990-92 as the base period. Both WFS MDG hunger targets are to be reached by the end of 2015. To maintain consistency, progress has been assessed with reference to a three year average centred on 2015 that is 2014-16. As observations are only available for the 24 year period the 50% change is adjusted to correspond to a 48% reduction of the PoU with respect to 1990-92

2. The PoU indicates the Prevalence of Undernourishment at the national level expressed as the share of the population which does not meet the daily calorie requirement to live a healthy and active life.

food consumption parameters. This consists of a coefficient of variation parameter (CV), which accounts for inequality in food consumption, and a skewness parameter (SK), which accounts for asymmetry in the distribution. Due to the limited numbers of available National Household Surveys, in the years between surveys, the assumption is that the distribution of food access is constant while alternative methods are used to calculate the relevant parameters for countries without National Household Surveys. The quantity of calories to which each individual in the population is considered to have access is contrasted with a minimum dietary energy requirement[3] (MDER), estimated for the average person in a given population. People falling below this threshold are considered to be undernourished. Although calculated annually, the FAO reports the PoU in rolling three year averages in order to smooth out annual variations.

Undernourishment,[4] as captured by the FAO indicator, provides a broad gauge across countries of a major problem: people not consuming enough calories. It can also be projected forward using the *OECD-FAO Agricultural Outlook*, which implicitly describes the evolution of calorie availability across 53 regions and countries. However, it is only a partial gauge of food security in the widest sense, which, according to the FAO's definition exists when "all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". This definition suggests that people will only be food secure when sufficient food is available, everyone has access to it, its "utilisation" leads to satisfactory nutritional outcomes, and there is stability across those three dimensions over time. The FAO measure captures elements of availability and access. The level of national availability reflects the level of domestic demand – which can be met either by domestic production or by imports. The functions for domestic demand and import demand therefore reflect the ability to buy, i.e. "access" to food.

The principal advantage of the FAO's undernourishment index is that it is computed with relatively few observation requirements once the CV and SK parameters are estimated. The only annually released data used is food availability at the national level, which is obtained from the "food balance sheets" produced by the FAO. This is calculated on the basis of information provided by governments on their domestic food production, imports and exports as well as on changes in storage and amounts of food aid received. Food availability or supply is adjusted for food waste at the retail level which, once converted to calories, generates the average per capita Dietary Energy Consumption (DEC)[5]. This enables the FAO to publish estimates for the PoU annually for over 100 countries.

The calculations of the PoU indicator for this paper follows the same methodology and uses the same publicly available data that FAO used to calculate the PoU as reported in *The State of Food* Insecurity *in the World* (FAO, IFAD, WFP, 2015). The evolution of the PoU is then projected to 2024 using results from the OECD-FAO Aglink-Cosimo model. The FAO methodology used to calculate the PoU is incorporated in the Aglink-Cosimo modelling framework in such a way as to reproduce the historical results of the FAO (see Annex 1 for a full explanation).

3. In a specified age/sex category, MDER is the minimum amount of dietary energy per person that is considered adequate to meet the energy needs at a minimum acceptable body mass index (BMI) of an individual engaged in low physical activity. If referring to an entire population, the MDER is the weighted average of the minimum energy requirements of the different age/sex groups. As it depends on a population's age and sex distribution, MDER varies by country and over time. It is expressed as kilocalories per person per day.

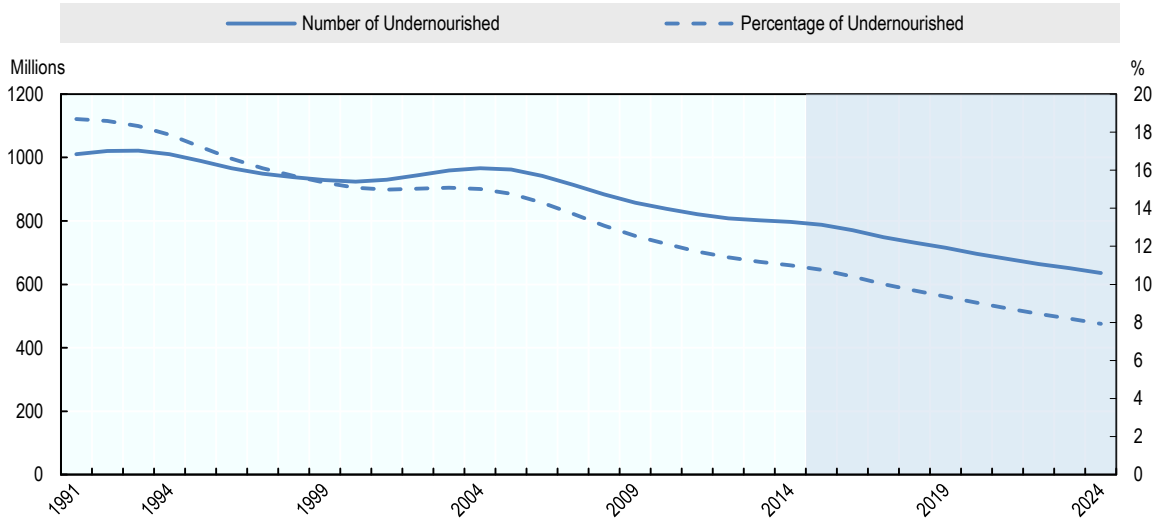
4. The terms hunger and undernourishment are used interchangeably in this paper. The term food security refers to a wider concept.

5. The dietary energy consumption per person (DEC) is the amount of food, in Kcal per day, for each individual in the total population.

3. Undernourishment under baseline market projections

The *OECD-FAO Agricultural Outlook* (OECD-FAO, 2015) presents a set of quantitative medium-term projections to 2024 and covers the projected developments in world and national prices, production, consumption, trade and stocks for the major agricultural commodities. The model covers 53 regions and countries of which 32 are developing countries. The assumptions for income growth are based on the *OECD Economic Outlook* (October 2014) and the IMF's *World Economic Outlook* (November 2014), while population projections are taken from the UN's World Population Prospects: The 2012 Revision of the medium fertility variant projection. The *Agricultural Outlook* projections can be used to derive future estimates for food availability across countries. It assumes that the distribution of access to total calorie availability remains unchanged, and project the evolution of the PoU (Figure 1), number of undernourished NoU (Figure 1 and 2) and the Depth of Undernourishment (DoU), or degree of food deficit [6], globally and across countries and regions over the next ten years.

Figure 1. Global evolution in undernourishment



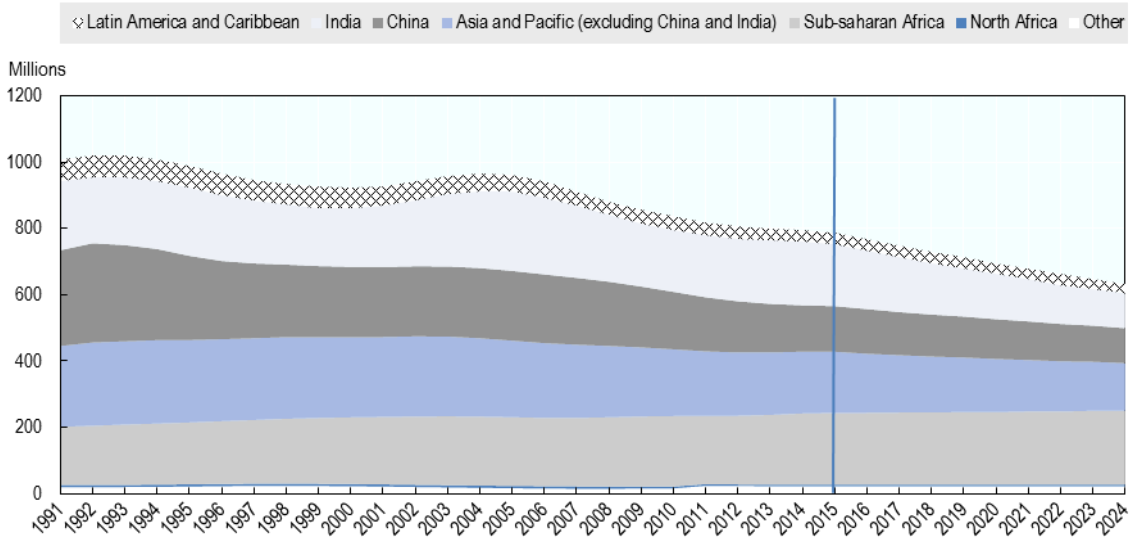
Under the "status quo" scenario as reported in the *Agricultural Outlook* to 2024, the agricultural sector will supply an additional 2.8 trillion (tln) kcal/day, with 83% coming from crops. Higher income as projected in the baseline will enable additional consumers to access that food so that by 2024, the number of undernourished individuals is projected to fall by almost 153 million relative to 2015 (Annex Table B.1). However, the total number of undernourished people, at 636 million, remains above the initial target set by the World Food Summit. Even with a rising population, the additional calories generated by agriculture and fisheries are sufficient to enable more people to consume above the MDER so that the share of people undernourished in 2024 drops to 8% of world's population (Figure 1). These additional calories also reduce the DoU faced by the typical undernourished individual. Worldwide, the food deficit metric improves over the coming ten years: not only does the number of undernourished individuals fall in absolute and relative terms, but the remaining undernourished individuals consume more calories, lowering the number of calories needed to reach the 5% global undernourishment target. The trend illustrated in Figure 1 suggests that agricultural markets should continue to contribute to

6. The depth of undernourishment, or degree of food deficit, is used to indicate how many additional calories per person per day would be needed to assure that only 5% of the population is undernourished, everything else being constant. The 5% threshold is adopted by the FAO to signal that a country is "statistically" close to eradicating hunger, everything else being constant

improved food security, but greater food availability alone will not be sufficient to meet the SDG2 of eradicating hunger by 2030.

The evolution of historical and projected numbers of undernourished in developing countries is illustrated in Figure 2. The Asia and Pacific region, the region where most of the world's population and food insecure people reside, is also the region with the largest gains in terms of eliminating the undernourishment. Over the baseline, the number of undernourished individuals drops by 156 million people from 510 million in 2015 to 354 million in 2024 and, as a result, the PoU falls from 12% to 8% in Asia and the Pacific, with Indonesia and Thailand dipping under the 5% threshold. Compared to 2015, the larger population along with the economic growth and higher incomes assumed in the baseline imply that the demand for calories in the Asia and Pacific region in 2024 expands by an additional 1.7 tln kcal/day. The vast majority of these calories, 82%, come from consuming crop products with livestock products providing the rest. Animals also require calories and demand approximately an additional 1.1 tln kcal/day. Thus, 57% of calories from crops are used directly for human consumption while 43% of the calories are largely used in the livestock sector generating 0.3 tln kcal/day of livestock products for human consumption. Not all of the calories are produced in the region and trade does currently play an important role filling shortfalls from local production. On the crop side 19% of the additional demand is supplied by net imports[7] while 7% of the livestock calories are imported.

Figure 2. Evolution of the Number of undernourished in selected regions



In absolute terms, the largest decline in the number of people from the ranks of food insecure occurs in the two most populous countries, China and India, where the numbers of undernourished fall by 32 and 83 million respectively between 2015 and 2024. In both cases, the incidence of undernourishment in 2024 falls to nearly 7% of the population. This substantial drop in India's undernourishment is attributed to the large increase in calorie availability, of which 86% come from food crops highlighting the vegetarian prevalence in the Indian diet. As is the case for many countries in the Asia and Pacific region, trade plays a vital role in India's food security as not all of the crop-based calories consumed are locally produced. In India's case, 25% of the additional calories consumed in 2024 are imported, while India is a net exporter of animal calories. The food security situation of the remaining undernourished also improves over the ten years to 2024. The typical undernourished individual needs an additional 95 Kcal per day for India to reach the 5% target compared to 270 Kcal per person per day in 2015.

7. Crop trade includes calories for human consumption and feed for animals.

Diets in China are more varied. Food crops generate 67% of the additional calories, while 33% of the additional calories originate from the livestock sector. In 2024, to raise its livestock production China uses about half of its crop calories, originating from both domestic and imported sources. Imports provide one-third of China's additional caloric consumption. The additional number of calories that will enable China to attain the 5% undernourished target falls to 83 Kcal per person per day from 172 Kcal per person per day in 2015.

The food security situation for people in the Latin America and Caribbean region also improves over the course of the next ten years as the number of undernourished drops below 35 million in 2024. Undernourishment is projected to improve across the vast majority of countries and the region as a whole is projected to eradicate hunger by 2024. Not only does the food security situation of the people improve, the region also supplies calories to the rest of the world.

Sub-Sahara Africa (SSA) is the region with the highest incidence of undernourishment. The PoU in the region drops from 23% in 2015 to 19% in 2024, however population growth implies that the number of undernourished people still increases by more than six million during the next ten years from 217 million to 223 million. Crop-based products generate the vast majority (94%) of the additional total 618 bln Kcal consumed per day and although livestock products provide a small share of calories for human consumption, they take up about 22% of the total calories provided by crops. In the current baseline, imports play a substantial role in the food security of people living in SSA, providing a quarter of the additional daily calories consumed from crops and 28% from animals.

The baseline represents market outcomes based on assumptions about the evolution of key macroeconomic and agricultural variables but history shows that alternative evolutions are also possible. Partial stochastic analysis was utilised to map out alternative market outcomes. The result indicate that future shocks in yields and macroeconomic variables are unlikely to result in a significant change to the downward trend in both the global prevalence of undernourishment or the number of people undernourished (Annex C).

4. Sensitivity analysis

Four alternative scenarios around the baseline were performed to measure their impacts on food insecurity and more precisely on the PoU and the number of undernourished. First, the impact of higher incomes were examined by assuming that the income growth rate for each developing country in every region from 2015 to 2024 is cumulatively 1% higher annually than the baseline resulting in 10% higher incomes in 2024 relative to the baseline. Second, the effect of higher agricultural productivity was examined by assuming that the productivity (yields) of each product in each developing country is cumulatively 1% greater annually than in the baseline, resulting in 10% higher productivity in 2024 relative to the baseline. Thirdly, the combined effects of both scenarios are presented. In each of the three scenarios examined, everything else is assumed constant including the distribution of access to food. The fourth scenario assumes an improvement in the distribution of access to food through a cumulative 1% reduction annually in the coefficient of variation so that in 2024, the coefficient of variation is 10% below the 2015 level in the developing world.

Scenario1: Impacts of income growth on undernourishment

As expected, higher incomes expand food demand leading to somewhat higher prices than under the baseline, which leads to higher food production as producers respond to price increases. With higher incomes, worldwide consumption in 2024 from crop based products is about 141 bln kcal/day 0.7% greater than the baseline, while calories from consuming livestock products is 60 bln kcal/day 1.7% greater[8] (Annex II Table 4 and 5). Producers in developing countries meet some of the new demand, while there are increased imports mostly from developed countries. Consumers in developed countries,

8 Unless stated otherwise, comparisons discussed below refer to the changes between the specific scenario and the baseline in 2024.

facing higher prices without the stimulus of additional incomes, reduce their consumption somewhat. Producers on the other hand react to the elevated prices and expand production thus mitigating the upward pressure on prices.

Consumers worldwide adjust their diets in response to changing relative prices and incomes. Consumption of livestock based calories in developing countries increases relatively more, raising their share of the additional calories consumed in 2024 from 16% to 29%. In contrast, the reduction in caloric consumption in developed countries is mostly from crops, representing 91% of the total reduction. The income scenario increases the number of consumers worldwide which have access to additional calories pushing 32.3 million people away from the undernourished category in 2024. This lowers the PoU by 0.4 percentage points relative to the baseline, to 7.5% of the world's population (Annex Table B.2).

The Asia and Pacific region gains the most from the income scenario with a 21.5 million reduction in the number of undernourished persons, representing two-thirds of the world's total decline of undernourished. Higher incomes in the region lead to additional caloric consumption of nearly 1% from crop based products and 2.3% of animal based products (Annex Tables B.4 and B.5) highlighting the fact that consumers are somewhat modifying their diet towards animal proteins. Of the total additional calories consumed in 2024, 32% are from animal products. Across the region, feed demand expands and, in calorie equivalent, is 1.9% greater than under the baseline. Higher local production and higher imports supply the additional calories demanded. The region's imports of crop and animal based calories are respectively 2.4% and 11.8% higher (Annex Tables B.4 and B.5). Although local production continues to provide the vast majority of calories demanded the share from imports expands. In the case of crop based products, local production provides 79% of the additional calories (for human and animal consumption), while locally produced livestock provide 83% of the animal-based calories consumed.

India and China record the largest decline in the number of undernourished with 9.9 and 5 million people respectively. In India, higher incomes result in additional crop and animal based calories consumed that are respectively 1.6% and 2.3% higher than the baseline in 2024. Of the additional crop based calories consumed, more than three quarters are imported. Additional consumption of livestock-based calories on the other hand, is mostly locally produced reducing India's net exports. The additional consumption enabled by the higher income scenario lead to a reduction in the average number of additional calories per person per day required to attain the 5% target. For India, higher income expands consumption so that by 2024, 70 kcal/person/day more, are needed for the average person to reach the 5% target instead of the 95 kcal/person/day needed in the baseline.

In China, higher incomes lead to more calories consumed from both crop and animal based products (0.4% and 2.6% respectively) with a preference for livestock products which represent 62% of the additional calories consumed. Chinese producers are not able to supply the additional calories demanded by Chinese consumers, turning to world markets to fill the gaps. Imports of crop based calories in 2024 are 2.8% higher while imports of animal-based calories are almost 46% above baseline levels. The net effect is that 18% of the additional livestock calories consumed are imported while imports supply 37% of the additional crop based calories (for human and animal consumption). China's food security situation with higher incomes exhibits a similar pattern to India's. Higher consumption reduces the number of additional calories per person per day to attain the 5% undernourished target to 69 kcal/person/day, 14 kcal/person/day less than under the baseline. Under this scenario, hunger in Bangladesh is almost eradicated as the PoU reaches 5.6% by the additional caloric consumption (Annex Table B.2) which is respectively, 1.1% and 2.4% higher than the baseline for crop based and animal-based products (Annex Table B.4 and B.5).

With agricultural markets evolving as projected in the baseline, the Latin American and Caribbean region achieves the 5% threshold by 2024. The additional consumption associated with higher incomes solidifies these gains with an additional 1.5 million residents no longer being considered undernourished. In 2024, higher incomes lead to caloric consumption from crop based and livestock products that are respectively 1.1% and 2% higher than the baseline (Annex Table B.4 and B.5). As in

other parts of the developing world, most of the additional calories (69%) are crop based. Even with higher consumption, the region also remains an important supplier to the rest of the world of both crop and livestock derived calories. In this scenario, exports of crop based calories are 2.3% greater than the baseline while larger livestock consumption result is somewhat diminished net exports (Annex Table B.4 and B.5).

Consumers in Sub-Saharan Africa benefit from higher incomes as 9.1 million people (28% of the global decrease) will no longer be undernourished in 2024. Compared to other regions, the improvement in the PoU in this scenario is the largest in the SSA falling 0.8%, to 18% in 2024. Consumption of crop based calories is 1.3% higher and from animal-based calories 3.4% higher than the baseline as consumers shift their consumption patterns (Annex Tables B.4 and B.5). Nonetheless, perhaps reflecting the region's relatively low incomes, most of the additional calories consumed (86%) are from crops. This reliance on crops for the additional calories consumed is higher than in any other region. And, more of the additional consumption is from local sources. For the region as a whole in 2024, crop imports (for food and feed), in calorie equivalent are 0.1% below the baseline lowering the region's net import position. In contrast, the calorie equivalent of livestock imports is 3.8% greater as higher incomes enables consumers to shift some of their consumption to livestock products that cannot be supplied locally.

Scenario 2: Impacts of productivity growth on undernourishment

Higher productivity in developing countries across all commodities and years is projected to increase output, reduce prices and stimulate consumption. This scenario assumes that higher agricultural sector productivity (in the form of higher yields) translates into higher output as opposed to producing the same output more efficiently. With higher productivity, an additional 438 bln crop based kcal/day and 142 bln animal-based kcal/day (respectively 2.3% and 4% higher than the baseline) are produced worldwide. Under this scenario, all of the additional production is provided by the developing world. In contrast to the income scenario, producers in developed countries, seeing lower prices without the additional boost from higher productivity, lower their output while consumers increase consumption somewhat. The net effect is to alleviate somewhat the downward pressure on prices.

The results suggest that the impact on food security worldwide is similar but somewhat higher than the income scenario, although specific impacts differ across countries. Similar to the income scenario the productivity scenario increases the number of consumers worldwide having access to additional calories, lowering the numbers undernourished. Compared to the baseline, by 2024, there are 53.6 million fewer undernourished people lowering the PoU by 0.7 of a percentage point to 7.3% of the world population (Annex Table B.1). Higher production and the resulting change in relative prices cause a shift in people's diets. Worldwide, 76% of the additional calories consumed in 2024 are from crops compared to 70% in the income scenario. In the developing world where the productivity effects are implemented directly, the effect is similar but less drastic. Calories from crops represent 76% of the additional calories consumed, two percentage points more than the income scenario. Improving productivity seems more effective in lowering food insecurity than improving income growth. Somewhat lower prices compared to the income scenario, lead to slightly more than 2% more calories (from all sources) consumed. Worldwide, 21 million more individuals escape undernourishment, compared to the income scenario.

For the people living in Asia and Pacific, higher productivity compared to the baseline, and the resulting lower prices lead to a 2.8% increase in calories consumed from crop products and 6.5% increase in calories consumed from animal products in 2024. Although the shift to animal-based calorie consumption seems relatively large, it is from a relatively small base. Diets in this region remain heavily crop based with 71% of the additional calories consumed coming from crops. As expected, with higher productivity, most of the additional consumption is sourced locally. The region remains a net importer of both crop and animal calories, but imports are respectively 17% and 37% below the baseline (Annex Tables B.4 and B.5). As the region of the world with the most food insecure people, the additional calories available due to higher productivity improve the food security situation of the people in the

Asia and Pacific region the most. The number of undernourished people falls by 47 million, accounting for the majority (87%) of the worldwide total decline.

China, with a decline of nearly 36 million food insecure persons, accounts for 76% of the region's reduction of undernourished and two6third of the world's total. The PoU also improves the most in China with a 2.4 percentage point reduction. Caloric consumption from crops is 7% above the baseline while consumption of animal-based calories is 10% higher. But, even with higher productivity, China's dependence on world crop markets increases with imports rising almost 13% above the baseline. In the livestock sector, production expands sufficiently to transform China into a net exporter (Annex Tables B.4 and B.5). With this performance, China reaches the 5% undernourished target by 2024. Interestingly, whereas in the income scenario only 38% of the additional calories were crop based, in the productivity scenario the share is 71%. In the higher incomes scenario, many Chinese consumers were able to buy more calories while also shifting to a more expensive animal-based diet. However, it seems that fewer lower income consumers were able to increase consumption sufficiently to eliminate hunger keeping China above the 5% PoU threshold. While it appears that lower prices from higher productivity enables lower income consumers to purchase more calories from less expensive crop based sources improving their food security and meeting the undernourishment target.

The food security situation in India also improves, with 3.1 million fewer individuals undernourished representing the second largest drop in the headcount. In India, unlike China, additional consumption of animal-based calories is the driver as only 25% of the additional calories consumed are from crops. Furthermore, in this scenario, India's net export position in livestock trade increases while net crop imports are lower (Annex Tables B.4 and B.5). Finally, Bangladesh almost reaches the 5% undernourished target reducing the gap to 5 kcal/person/day caloric consumption almost exclusively from crop based calories sourced locally.

As the Latin America and Caribbean region reaches the 5% undernourishment threshold in the baseline, the higher productivity scenario, as with the income scenario, only marginally improves the situation. The PoU declines 0.3 percentage points and the number of undernourished are 2.3 million less than in the baseline. Caloric consumption is respectively 2.4% (crop based) and 2.7% (animal based) above the baseline and the region continues to supply surplus calories to world markets. Crop productivity does not keep up with demand, however, as additional consumption of crop-based calories reduces the regions net exports relative to the baseline. On the other hand, productivity in the livestock sector not only enables additional local consumption, it also leads to more exports raising the region's net export position more than 25% above the baseline (Annex Tables B.4 and B.5). The development highlight of the Latin American and Caribbean region is that Peru reaches the 5% undernourished target by 2024.

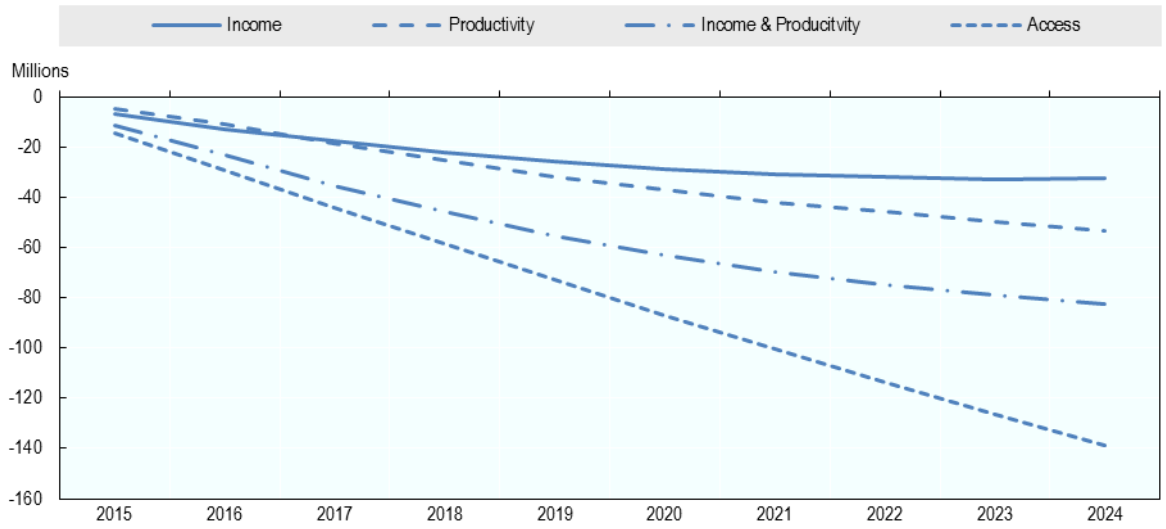
Higher productivity improves the food security situation of the people living in the Sub-Saharan African region marginally. Although production of crop and livestock derived calories are respectively 2.4% and 1.8% above the baseline, consumption is only 0.9% and 0.4% higher. It appears that lower prices have a relatively small effect on food consumption. In this scenario most of the additional consumption is locally based. Consequently the region's imports of crop and livestock based calories are below their baseline level (4% and 7% respectively Annex Tables B.4 and B.5). The PoU for the region is 0.4 percentage points lower than in the baseline. Even with the assumed higher productivity, 18.4% of the region's population remains undernourished in 2024. Nonetheless, the additional calories from higher productivity results in 4.5 million fewer undernourished people in 2024. For consumers in this region, higher incomes rather than a more productive agriculture results in greater consumption and improved food security outcomes. In this scenario, Nigeria joints the ranks of the food secure as less than 5% of its population consumes below the MDER.

Scenario 3: Combined impacts of income and productivity growth on undernourishment

The combined effects of a 10% increase in income and productivity accentuate the impacts of each single scenario in an additive way (Figure 3). Consumption of crop based and animal based calories in developing countries is respectively 3.2% and 7.8% higher than the baseline, which is more

or less the sum of the changes resulting from each scenario (Annex Tables B.4 and B.5). Compared to the baseline, 82.7 million individuals worldwide are liberated from undernourishment, dropping the global PoU by 1.0 percentage points to 6.9% by 2024. Most of the decrease in the undernourished occurs in Asia (65.5 million), with China (39.3 million) and India (11.8 million) leading the way, together these two countries are responsible for 62% of the worldwide decline in the number of undernourished. The other major beneficiaries with reduced numbers of undernourished are Pakistan, Ethiopia, Bangladesh, Indonesia, Philippines and Viet Nam.

Figure 3. Change in the number of undernourished



The results reflect the different pathways by which the two scenarios spur additional food consumption. Higher incomes directly increase consumption in developing countries by shifting out the demand curve. The magnitude depends on the income elasticity of demand which is product and country specific. Additional consumption is somewhat mitigated by higher prices resulting from more demand and that are necessary to bring forth the required supply. Higher productivity through an increase in yields on the other hand directly increases supply in developing countries. In this case, prices fall and consumption increases. Again, the magnitude is product and country specific. In SSA in particular, increases in incomes have a bigger direct impact than improvements in productivity, indicating that income demand elasticities are greater than supply elasticities (OECD, 2015a).

When income and productivity increase, both the demand and the supply curves shift and, for normal goods, consumption is larger than under either of the individual scenarios while the resulting price is bound between the higher price of the income scenario and the lower price of the productivity scenario. In developed countries, consumers and producers react to changing world prices created by the assumed changes in developing countries. In this case, the resulting lower prices of the productivity scenario dominate the higher prices of the income scenario for producers who provide less of both crop and animal calories. The combination of both scenarios increased consumption sufficiently to bring Bangladesh, to attain the 5% threshold joining China, Nigeria and Peru where this had already occurred in the productivity scenario.

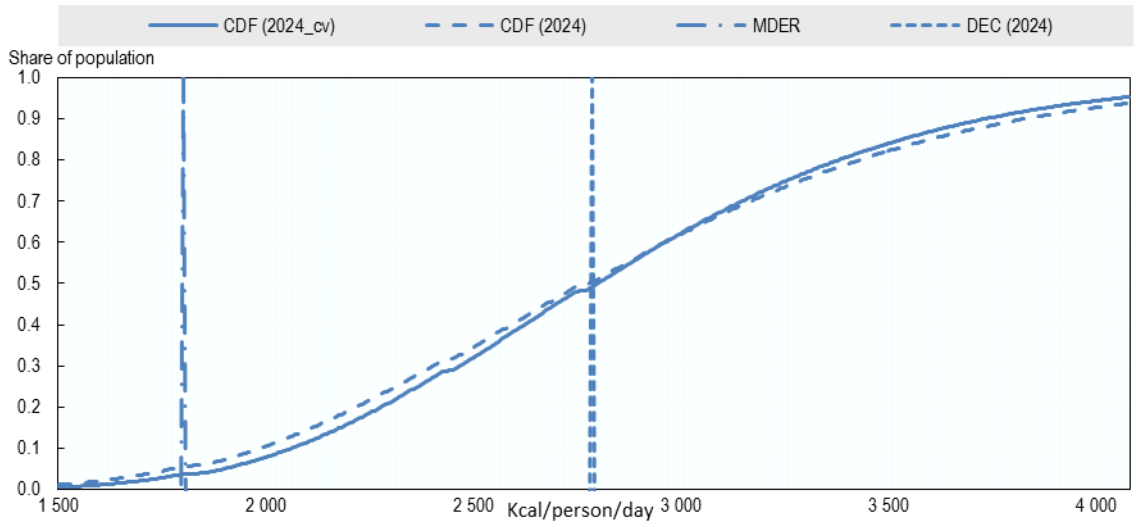
The results described above illustrate that if the world economy evolves as projected in the baseline, agricultural markets will make progress on but will not meet the SDG2 goal of eradicating hunger. A combination of further income and productivity growth would lead to the threshold closer of being met at the global level, but not for all countries.

Scenario 4: Impacts of changes in the distribution of food expenditures

What would be the implications for undernourishment if markets evolved as in the baseline but peoples' access to food became more equal? The implementation of this scenario is illustrated below for Bangladesh, following which the wider results for developing countries are presented. Essentially, access to food is improved through a gradual 1% cumulative annual reduction in the coefficient of variation (CV) so that in 2024, the CV in each developing country is 10% lower than in 2015.

Figure 4 shows, for illustrative purpose, the cumulative distribution function for calories consumption in Bangladesh in 2024. The horizontal axis registers the number of calories per person per day. The solid line in Figure 4 below shows the cumulative distribution of food access for Bangladesh in 2024 under the baseline. The skewness of the distribution is such that 55% of the population in 2015 consumed less than the average caloric consumption of 2 790 kcal/person/day. This distribution is based on a CV value of 0.26 as reported by the FAO with daily average caloric consumption of 2 790 kcal/person/day. The dotted line represents the cumulative distribution function assuming that access to food in 2024 is more equitable through a 10% reduction in the CV, everything else remaining the same. At the lower end of the distribution, the curve shifts out as more people have access to food and fewer people are consuming below the MDER threshold of 1 804 kcal/person/day. Even though total calories available have not changed, more equitable or easier access allows the share of the population consuming below the MDER level to drop from 6% to 4%, an improvement in food security that is even better than afforded by the combined 10% increase in income and productivity. Not only is undernourishment reduced, caloric consumption increases for everyone in the population consuming below the DEC. At the upper end of caloric consumption, more equitable food access means that fewer people are consuming excessively. For example 28% of the population consumes more than 3 100 kcal/person/day, compared to 29% with the original distribution.

Figure 4. Implications on food security of more equitable access to food: The case in Bangladesh



Note: (CDF) Cumulative Distribution of Food access, (MDER) Minimum Dietary Energy Requirement and (DEC) Dietary Energy Consumption.

This methodology was applied to the distribution functions for each developing country via a 10% reduction in each country's CV. The results suggest that the results of more equitable access to food are superior to any of the other scenarios across all countries and regions, other than in China (Annex Table B.1-B.3). But, even for China, more equitable access eradicates hunger in 2024. All of the countries that eradicate undernourishment with the income and/or productivity scenarios also do so with a 10% improvement in access to food. Additionally, India and Viet Nam, whose population remained food insecure in the other scenarios, join the ranks of countries without undernourishment. In the remaining countries where undernourishment persists, the total and share of the population that is undernourished are lower. Moreover, if trends as projected in the baseline continue to 2030 and access to food is 10% more equitable, agricultural markets would ensure sufficient calories to meet the SDG2 goal at the global level and for all regions except SSA. Those results suggest that while policies to increase food availability and to improve purchasing power can help reduce undernourishment, the fundamental issue is one of promoting more equitable access.

5. Conclusions

Hunger is a major problem and reducing hunger and undernourishment is a global priority. This paper provides ten-year projections for undernourishment consistent with the baseline of the 2015 *OECD-FAO Agricultural Outlook*.

The results suggest that the market outcomes projected in the baseline would reduce the number of hungry people and lower the PoU by almost three percentage points. On these trends, hunger will be effectively eradicated (with the Proportion of Undernourishment falling below 5%) in the Latin America and the Caribbean region as well as in Indonesia and in Thailand. As a whole, however, the developing world will not be on trend to meet the Sustainable Development Goal of eliminating hunger by 2030 except under one of the scenarios analysed in this paper.

The scenarios explored in this paper confirm that trade contributes to countries food security by moving production from surplus to deficit countries. Trade's role depends on each country's circumstance, although in many cases much of the additional consumption is sourced locally.

Higher incomes and improved productivity each have a beneficial effect on undernourishment. Globally, a given increase in productivity growth has a bigger impact than an equal percentage increase in overall incomes. In Sub-Saharan Africa, however, wider income growth has the greater effect. With the incomes rising by a further 1% each year cumulatively, no additional countries eliminate undernourishment. However, a 1% annual increase in agricultural productivity would enable Nigeria, Peru and China to join the ranks of countries where undernourishment is below the 5% threshold. The results from jointly raising incomes and productivity are essentially additive, enabling Bangladesh to join the ranks of countries where adequate nourishment is assured.

Improving the equality of people's access to food enables people in more countries to become food secure compared to any of the other scenarios described above. All of the countries that became food secure also do so if the access to food improves by 10% in ten years. Additionally, hunger in India and Viet Nam is eradicated.

The simulations confirm that it is not lack of available food that is the fundamental problem but rather effective access to that food. Furthermore, assuming the trends projected in the baseline continue to 2030 and that the distribution of access to food improves by 10%, the developing world as a whole will be on trend to reduce the rate of undernourishment to below 5%. Unfortunately, for some countries, especially in SSA, the depth of undernourishment is currently so severe that more drastic actions to raise access to food among the poorest will be needed.

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Annex A.

Methodology

The Annex briefly describes the methodology used to generate projections of the headcount and the incidence of undernourishment for this report. More details can be found in 2015 *The State of Food Insecurity in the World* and Refinements to the FAO methodology for estimating the prevalence of undernourishment indicator. The methodology presented for the Prevalence of Undernourishment (PoU) indicator in this paper follows the same methodology used to calculate the PoU within *The State of Food Insecurity in the World* report (FAO, 2012-15) and extends this by estimating the progress of this indicator to 2024 using results from the OECD-FAO Aglink-Cosimo model.

The SOFI report contains undernourishment estimates for countries which are not explicitly included in the Aglink-Cosimo model. Many of these countries are included in various regional aggregates. Regional results from the model are used to extrapolate food production and consumption, (in kcal/per/day equivalent) for each country within the region, thus generating projections of PoU for each country.

The methodology considers an average person from within the population, reflecting the average age, sex, stature and physical activity level. The distribution of daily food consumption during the year for this individual is estimated by a function f(x). The PoU is then computed by calculating the probability that this person will lie below the Minimum Dietary Energy Requirement (MDER). Thus the method assumes that:

$$PoU = \int_0^{MDER} f(x)\,dx$$

As f(x) reflects a typical level of daily energy consumption during the year, it will not reflect the possibility of an insufficient food consumption level that prevails for periods shorter than a year and is an acknowledged shortcoming of the metric. This can be of particular significance in poorer countries where availability of food for consumption may not be constant throughout the year.

The function f(x) reflects three parameters; (i) mean food consumption (DEC), (ii) variability (CV) and (iii) asymmetry (SK). The FAO considers three distributions to characterise f(x): the log-normal, the log-skew normal and skew-normal. Investigations by the FAO determined that the most suitable distributions for f(x), depends on the calculated variability (CV) and asymmetry (SK) which are data determined. For this project, the skew-normal distribution is not used because asymmetry conditions appropriate for its use were not encountered. The log-normal and skewed-log normal distributions are:

$$f(x) = \begin{cases} f_{LN}(x) & if\ SK \geq (CV^2 + 3)CV \\ f_{LSN}(x) & if\ 0.4 < SK < (CV^2 + 3)CV \end{cases}$$

Note: Cases where SK $\leq$ 0.4 are not present within the dataset and therefore not considered.

The FAO calculates the DEC from its Food Balance Sheets with an adjustment for retail level losses converted to calories per person per day. For the projection period, the baseline provides data on production, consumption (human and other uses), trade and stocks. These supply and utilisation data are akin to the information in the Food Balance Sheets. These are converted to calories using the same conversion factors used by the FAO. Exogenous assumptions on food sources not included in the baseline assure complete coverage of food availability for human consumption. As food waste is not explicit in the baseline, caloric availability from the baseline is calibrated to the DEC level to account for food waste at the farm and retail level. The calibration ratio between total calories produced per capita and DEC is held constant during the projection period. It is therefore assumed that there is no reduction in food losses either within the retail sector or at the farm level.

Historic MDER data is calculated from UN population data taking into account the country's age and sex distribution. For the projection period, the MDER is assumed to be constant because, although the model accounts for a growing population over this time frame, the age and sex distribution does not change by a significant proportion over 10 years.

The FAO calculates the CV and SK from National Household Survey (NHS) data when such data are available and reliable (Gero Carletto and al. (2015)). For the projections these two parameters are assumed constant at their 2014 levels. This assumption implies that, as average access to calories increases, the variability and asymmetry to food access within the population does not change. This entails that both, the calorie intake of the nourished and undernourished population, are simultaneously increasing while reducing the PoU. This assumption may bring comparability problem among countries as in reality the distribution may be changing over time.

The equations for the Log-Normal (LN) and Log-Skew Normal (LSN) distributions are as follows:

$$f_{LN}(x) = \frac{1}{x\,\sigma\sqrt{2\pi}} e^{\frac{-(\ln(x)-\mu)^2}{2\sigma^2}} \text{ where } \mu \in \mathbb{R},\ \sigma \in \mathbb{R}^+$$

$$f_{LSN}(x) = \frac{2}{\omega x}\phi\left(\frac{\log(x)-\xi}{\omega}\right)\Phi\left(\alpha\,\frac{\log(x)-\xi}{\omega}\right) \text{ where } \xi \in \mathbb{R}, \omega \in \mathbb{R}^+, \alpha \in \mathbb{R} \text{ and}$$

$$\phi(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}};\ \Phi(x) = \int_{-\infty}^{x} \phi(x)\,dx = \frac{1}{2}\left[1 + \operatorname{erf}\left(\frac{x}{\sqrt{2}}\right)\right]$$

For the Log Normal distribution the parameters are calculated as follows:

$$\sigma = \sqrt{\ln(CV^2 + 1)}$$

$$\mu = \ln(DEC) - \frac{\sigma^2}{2}$$

No closed form expressions are available for the Log skew normal distribution. Therefore the parameters are computed numerically using the moment generating functions for the distribution:

$$\mathbb{E}(X^n) = 2\,e^{n\xi + \frac{n^2}{2}\omega^2}\Phi\left(\frac{n\alpha\omega}{\sqrt{1+\alpha^2}}\right) \textit{ where } \begin{cases} \mathbb{E}(X) = DEC \\ \mathbb{E}(X^2) = (CV^2+1)DEC^2 \\ \mathbb{E}(X^3) = DEC^3(CV^3SK + 3CV^2 + 1) \end{cases}$$

To calculate the PoU 5 calorie intervals were considered and use the following to estimate the PoU:

$$PoU = \int_0^{MDER} f(x)\,dx \approx \sum_{i=0}^{500} \begin{cases} 0 & if\ x > MDER \\ (MDER - 5i)\,f(5i + 2.5) & if\ MDER - 5 \le x \le MDER \\ 5f(5i + 2.5) & if\ x < MDER - 5 \end{cases}$$

Note: As all MDER values are under 2500 (5*500) this ensures that the full curve is approximated, whilst reducing the calculation size.

Similarly, the depth of undernourishment (DoU) is calculated using the following:

$$0.05 = \int_0^{MDER-DoU} f(x)\,dx \approx \sum_{i=0}^{500} \begin{cases} 0 & if\ x > MDER - DoU \\ (MDER - DoU - 5i)\,f(5i + 2.5) & if\ MDER - DoU - 5 \le x \le MDER \\ 5f(5i + 2.5) & if\ x < MDER - DoU - 5 \end{cases}$$

Assuming equality in the above relationship results in some differences between the FAO data and the calculated values. The difference can be accounted for by the initial function being an estimate of the integral and rounding differences within the FAO figures. As a result the PoU presented in this report includes an adjustment factor to make the results align.

Aggregate figures are also calculated for regional levels. The regional NoU is calculated by summing each of the individual countries within the region with an adjustment factor. The regional PoU is calculated by dividing the regional NoU by the regional population with an adjustment factor. The adjustment factor in both cases accounts for differences that are not reported by the FAO as they are deemed statistically insignificant.

Annex B.

Tables

Table B.1. Number of undernourished by region ('000 000s)

Baseline and scenarios

	Baseline					Income		Productivity		Inc+Prod		Access	
	1990-92	2000-02	2010-12	2015	2024	2024	Difference	2024	Difference	2024	Difference	2024	Difference
WORLD	**1010.6**	**929.6**	**820.7**	**788.3**	**635.7**	**603.4**	**32.3**	**582.1**	**53.6**	**553.0**	**82.7**	**497.0**	**138.7**
DEVELOPING	**990.7**	**908.4**	**805.0**	**773.7**	**621.1**	**588.8**	**32.3**	**567.5**	**53.6**	**538.4**	**82.7**	**482.4**	**138.7**
AFRICA	**181.7**	**210.2**	**218.5**	**228.9**	**234.9**	**225.7**	**9.2**	**230.3**	**4.7**	**221.3**	**13.6**	**207.0**	**27.9**
NORTH AFRICA	ns	ns	ns	ns	ns	ns	0.1	ns	0.1	ns	0.2	ns	1.8
Algeria	2.1	2.7	ns	ns	ns	ns	0.1	ns	0.0	ns	0.1	ns	0.5
Egypt	ns	ns	ns	ns	ns	ns	0.1	ns	0.0	ns	0.1	ns	0.7
SUB-SAHARAN AFRICA	175.7	203.6	205.7	216.5	222.9	213.8	9.1	218.4	4.5	209.5	13.4	196.8	26.1
Ethiopia	37.3	37.3	32.1	32.1	32.0	29.6	2.5	31.8	0.2	29.5	2.5	28.1	3.9
Ghana	7.1	3.1	1.4	ns	ns	ns	0.1	ns	0.0	ns	0.1	ns	0.3
Mozambique	7.8	7.9	7.3	7.0	7.4	6.9	0.5	7.3	0.2	6.8	0.6	6.3	1.2
Nigeria	20.8	11.2	10.2	11.9	12.7	12.1	0.7	ns	1.3	ns	1.9	ns	4.4
United Republic of Tanzania	6.4	13.0	16.1	16.5	17.7	16.4	1.3	17.6	0.0	16.3	1.4	15.5	2.2
Zambia	2.7	4.7	6.9	7.5	8.7	8.5	0.2	8.6	0.1	8.5	0.3	8.2	0.5
South Africa	2.0	ns	ns	ns	ns	ns	0.0	ns	0.0	ns	0.1	ns	0.2
LATIN AMERICA and CARIBBEAN	**66.1**	**60.4**	**38.3**	**35.0**	**ns**	**ns**	**1.5**	**ns**	**2.3**	**ns**	**3.6**	**ns**	**8.5**
Argentina	ns	ns	ns	ns	ns	ns	0.0	ns	0.0	ns	0.0	ns	0.0
Brazil	22.6	19.9	ns	ns	ns	ns	0.2	ns	0.6	ns	0.8	ns	0.9
Chile	1.2	ns	ns	ns	ns	ns	0.0	ns	0.0	ns	0.0	ns	0.2
Colombia	5.0	3.9	5.3	4.7	4.1	3.9	0.1	4.0	0.1	3.9	0.1	2.8	1.3
Haiti	4.4	4.8	4.9	5.5	6.0	6.0	0.0	6.0	0.0	6.0	0.0	5.8	0.2
Mexico	6.0	ns	ns	ns	ns	ns	0.8	ns	0.7	ns	1.5	ns	2.0
Peru	7.0	5.4	3.2	2.4	1.8	1.8	0.0	ns	0.1	ns	0.2	ns	0.7
Paraguay	0.9	0.7	0.8	0.8	0.7	0.6	0.1	0.6	0.1	0.6	0.1	0.5	0.2
Uruguay	0.3	ns	ns	ns	ns	ns	0.0	ns	0.0	ns	0.0	ns	0.0
ASIA and PACIFIC	**742.9**	**637.8**	**548.2**	**509.8**	**354.0**	**332.5**	**21.5**	**307.4**	**46.6**	**288.5**	**65.5**	**251.8**	**102.2**
Bangladesh	36.0	27.7	26.5	25.1	10.8	9.9	0.9	9.6	1.2	ns	2.0	ns	3.6
China	289.0	211.2	163.2	137.8	105.4	100.3	5.0	ns	35.5	ns	39.3	ns	33.7
India	210.1	185.5	189.9	187.5	104.4	94.5	9.9	101.4	3.1	92.6	11.8	ns	34.9
Indonesia	35.9	38.3	26.9	18.4	ns	ns	0.3	ns	1.2	ns	1.5	ns	4.7
Iran, Islamic Republic of	2.9	3.8	4.7	ns	ns	ns	0.2	ns	0.1	ns	0.3	ns	1.1
Kazakhstan	ns	ns	ns	ns	ns	ns	0.0	ns	0.0	ns	0.0	ns	0.2
Korea	ns	ns	ns	ns	ns	ns	0.0	ns	0.1	ns	0.1	ns	0.2
Malaysia	1.0	ns	ns	ns	ns	ns	0.0	ns	0.1	ns	0.1	ns	0.2
Pakistan	28.7	34.4	38.3	42.0	35.5	31.5	4.0	34.1	1.4	30.2	5.3	28.4	7.1
Philippines	16.7	16.1	12.7	13.9	14.8	14.5	0.3	13.9	0.9	13.6	1.2	11.4	3.4
Saudi Arabia	ns	ns	ns	ns	ns	ns	0.0	ns	0.0	ns	0.0	ns	0.1
Thailand	19.8	11.6	6.0	4.9	ns	ns	0.1	ns	0.2	ns	0.3	ns	1.0
Turkey	ns	ns	ns	ns	ns	ns	0.0	ns	0.0	ns	0.0	ns	0.1
Viet Nam	32.1	20.7	12.2	10.5	7.5	7.1	0.4	6.8	0.7	6.4	1.1	ns	2.7

Note: 'ns' refers to countries with levels of undernourishment under 5%.

Table B.2. Percentage of undernourished by region

Baseline and scenarios

	Baseline					Income		Productivity		Inc+Prod		Access	
	1990-92	2000-02	2010-12	2015	2024	2024	Difference	2024	Difference	2024	Difference	2024	Difference
WORLD	**18.7%**	**15.0%**	**11.7%**	**10.8%**	**7.9%**	**7.5%**	**-0.4%**	**7.3%**	**-0.7%**	**6.9%**	**-1.0%**	**6.2%**	**-1.7%**
DEVELOPING	**23.3%**	**18.2%**	**14.0%**	**12.8%**	**9.3%**	**8.8%**	**-0.5%**	**8.5%**	**-0.8%**	**8.1%**	**-1.2%**	**7.2%**	**-2.1%**
AFRICA	**28.1%**	**25.4%**	**20.7%**	**19.6%**	**16.4%**	**15.8%**	**-0.6%**	**16.1%**	**-0.3%**	**15.5%**	**-1.0%**	**14.5%**	**-2.0%**
NORTH AFRICA	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	-0.1%	<5.0%	-0.1%	<5.0%	-0.1%	<5.0%	-0.9%
Algeria	7.8%	8.4%	<5.0%	<5.0%	<5.0%	<5.0%	-0.1%	<5.0%	-0.1%	<5.0%	-0.2%	<5.0%	-1.2%
Egypt	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	-0.1%	<5.0%	0.0%	<5.0%	-0.1%	<5.0%	-0.7%
SUB-SAHARAN AFRICA	34.9%	31.0%	24.1%	22.8%	18.8%	18.0%	-0.8%	18.4%	-0.4%	17.7%	-1.1%	16.6%	-2.2%
Ethiopia	74.9%	54.9%	35.9%	32.4%	26.3%	24.3%	-2.0%	26.1%	-0.1%	24.2%	-2.0%	23.0%	-3.2%
Ghana	47.3%	16.1%	5.6%	<5.0%	<5.0%	<5.0%	-0.3%	<5.0%	-0.1%	<5.0%	-0.4%	<5.0%	-0.9%
Mozambique	56.1%	42.0%	29.7%	25.7%	22.1%	20.6%	-1.4%	21.6%	-0.5%	20.2%	-1.9%	18.6%	-3.4%
Nigeria	21.2%	8.9%	6.2%	6.5%	5.5%	5.2%	-0.3%	<5.0%	-0.5%	<5.0%	-0.8%	<5.0%	-1.9%
United Republic of Tanzania	24.2%	37.2%	34.7%	31.5%	26.2%	24.2%	-2.0%	26.1%	-0.1%	24.2%	-2.0%	22.9%	-3.2%
Zambia	33.8%	45.2%	50.7%	48.3%	42.1%	41.2%	-0.9%	41.7%	-0.3%	40.8%	-1.2%	39.6%	-2.5%
South Africa	5.3%	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	-0.1%	<5.0%	-0.1%	<5.0%	-0.1%	<5.0%	-0.4%
LATIN AMERICA and CARIBBEAN	**14.6%**	**11.3%**	**6.4%**	**5.6%**	**<5.0%**	**<5.0%**	**-0.2%**	**<5.0%**	**-0.3%**	**<5.0%**	**-0.5%**	**<5.0%**	**-1.2%**
Argentina	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	0.0%	<5.0%	0.0%	<5.0%	0.0%	<5.0%	-0.1%
Brazil	14.9%	11.2%	<5.0%	<5.0%	<5.0%	<5.0%	-0.1%	<5.0%	-0.3%	<5.0%	-0.4%	<5.0%	-0.4%
Chile	8.9%	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	-0.1%	<5.0%	-0.1%	<5.0%	-0.2%	<5.0%	-0.9%
Colombia	14.7%	9.6%	11.3%	9.4%	7.4%	7.2%	-0.2%	7.3%	-0.2%	7.2%	-0.3%	5.1%	-2.3%
Haiti	60.3%	55.2%	49.0%	52.1%	50.8%	50.8%	0.0%	50.8%	0.0%	50.8%	0.0%	49.2%	-1.6%
Mexico	6.8%	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	-0.6%	<5.0%	-0.5%	<5.0%	-1.1%	<5.0%	-1.5%
Peru	31.5%	20.5%	10.8%	7.8%	5.3%	5.3%	-0.1%	<5.0%	-0.4%	<5.0%	-0.5%	<5.0%	-1.9%
Paraguay	20.5%	12.7%	12.1%	11.0%	8.4%	7.8%	-0.6%	7.6%	-0.8%	7.0%	-1.4%	5.8%	-2.5%
Uruguay	9.7%	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	-0.1%	<5.0%	-0.1%	<5.0%	-0.1%	<5.0%	-0.7%
ASIA and PACIFIC	**23.6%**	**17.5%**	**13.4%**	**12.0%**	**7.7%**	**7.2%**	**-0.5%**	**6.7%**	**-1.0%**	**6.3%**	**-1.4%**	**5.5%**	**-2.2%**
Bangladesh	32.8%	20.6%	17.3%	15.6%	6.1%	5.6%	-0.5%	5.4%	-0.7%	<5.0%	-1.2%	<5.0%	-2.1%
China	23.9%	16.0%	11.7%	9.6%	7.1%	6.8%	-0.3%	<5.0%	-2.4%	<5.0%	-2.7%	<5.0%	-2.3%
India	23.7%	17.5%	15.6%	14.6%	7.4%	6.7%	-0.7%	7.2%	-0.2%	6.6%	-0.8%	<5.0%	-2.5%
Indonesia	19.7%	18.1%	11.0%	7.2%	<5.0%	<5.0%	-0.1%	<5.0%	-0.4%	<5.0%	-0.5%	<5.0%	-1.7%
Iran, Islamic Republic of	5.1%	5.7%	6.2%	<5.0%	<5.0%	<5.0%	-0.2%	<5.0%	-0.1%	<5.0%	-0.3%	<5.0%	-1.2%
Kazakhstan	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	-0.1%	<5.0%	-0.1%	<5.0%	-0.2%	<5.0%	-0.9%
Korea	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	-0.1%	<5.0%	-0.1%	<5.0%	-0.2%	<5.0%	-0.4%
Malaysia	5.3%	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	0.0%	<5.0%	-0.1%	<5.0%	-0.2%	<5.0%	-0.6%
Pakistan	25.1%	23.4%	21.7%	22.3%	16.5%	14.6%	-1.9%	15.8%	-0.7%	14.0%	-2.5%	13.2%	-3.3%
Philippines	26.3%	20.3%	13.4%	13.6%	12.6%	12.4%	-0.2%	11.8%	-0.8%	11.6%	-1.0%	9.7%	-2.9%
Saudi Arabia	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	0.0%	<5.0%	0.0%	<5.0%	0.0%	<5.0%	-0.3%
Thailand	34.7%	18.4%	9.0%	7.3%	<5.0%	<5.0%	-0.1%	<5.0%	-0.3%	<5.0%	-0.4%	<5.0%	-1.5%
Turkey	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	<5.0%	0.0%	<5.0%	0.0%	<5.0%	0.0%	<5.0%	-0.1%
Viet Nam	45.6%	25.3%	13.6%	11.3%	7.5%	7.1%	-0.4%	6.8%	-0.7%	6.4%	-1.1%	<5.0%	-2.7%

Table B.3. Depth of undernourishment by region

Baseline and Scenarios

	Baseline					Income		Productivity		Inc+Prod		Access	
	1990-92	2000-02	2010-12	2015	2024	2024	Difference	2024	Difference	2024	Difference	2024	Difference
WORLD													
DEVELOPING													
AFRICA													
NORTH AFRICA													
Algeria	93	94	0	0	0	0	0	0	0	0	0	0	0
Egypt	0	0	0	0	0	0	0	0	0	0	0	0	0
SUB-SAHARAN AFRICA													
Ethiopia	846	672	531	504	438	411	-27	437	-2	415	-23	365	-74
Ghana	563	255	0	0	0	0	0	0	0	0	0	0	0
Mozambique	718	654	511	472	422	401	-21	416	-7	394	-28	338	-84
Nigeria	341	122	36	50	15	4	-11	0	-15	0	-15	0	-15
United Republic of Tanzania	391	565	584	562	499	473	-26	498	-1	472	-26	418	-81
Zambia	520	692	828	813	755	746	-9	751	-3	742	-12	678	-77
South Africa	11	0	0	0	0	0	0	0	0	0	0	0	0
LATIN AMERICA and CARIBBEAN													
Argentina	0	0	0	0	0	0	0	0	0	0	0	0	0
Brazil	295	205	0	0	0	0	0	0	0	0	0	0	0
Chile	81	0	0	0	0	0	0	0	0	0	0	0	0
Colombia	252	153	210	141	82	75	-7	77	-5	74	-9	0	-82
Haiti	814	1005	953	100[illegible]	989	989	0	989	0	989	0	912	-77
Mexico	64	0	0	0	0	0	0	0	0	0	0	0	0
Peru	447	338	148	94	10	7	-2	0	-10	0	-10	0	-10
Paraguay	333	215	179	139	78	61	-17	55	-23	38	-40	0	-78
Uruguay	79	0	0	0	0	0	0	0	0	0	0	0	0
ASIA and PACIFIC													
Bangladesh	576	320	287	254	31	11	-20	5	-27	0	-31	0	-31
China	473	341	227	172	83	69	-14	0	-83	0	-83	0	-83
India	387	345	288	270	95	70	-25	88	-8	65	-30	0	-95
Indonesia	343	338	147	77	0	0	0	0	0	0	0	0	0
Iran, Islamic Republic of	0	24	34	0	0	0	0	0	0	0	0	0	0
Kazakhstan	0	0	0	0	0	0	0	0	0	0	0	0	0
Korea	0	0	0	0	0	0	0	0	0	0	0	0	0
Malaysia	0	0	0	0	0	0	0	0	0	0	0	0	0
Pakistan	470	477	466	473	375	337	-38	362	-13	323	-51	261	-113
Philippines	447	356	246	259	238	232	-5	221	-17	215	-22	151	-86
Saudi Arabia	0	0	0	0	0	0	0	0	0	0	0	0	0
Thailand	531	339	101	87	0	0	0	0	0	0	0	0	0
Turkey	0	0	0	0	0	0	0	0	0	0	0	0	0
Viet Nam	730	387	262	201	86	69	-16	57	-28	41	-45	0	-86

Note: Depth of undernourishment is not calculated at the aggregate level. An aggregate DoU would combine countries which had both met their MDER and those which had not, giving a misleading impression of where efforts need to be focused.

Table B.4. Market impacts for crop-based products*

	Food consumption					Net Trade				
	Baseline (bln kcal/day)		In-come	Produc-tivity	Inc+Prod	Baseline (bln kcal/day)		In-come	Produc-tivity	Inc+Prod
	2015	2024	Difference from 2024 baseline (%)			2015	2024	Difference from 2024 baseline (%)		
WORLD	**16880.0**	**19202.0**	**0.7%**	**2.3%**	**3.0%**					
DEVELOPING	**13732.6**	**15971.0**	**0.9%**	**2.3%**	**3.2%**	**-1805.3**	**-2233.7**	**1.2%**	**-15.2%**	**-14.7%**
AFRICA	**2444.4**	**3101.7**	**1.1%**	**0.8%**	**1.9%**	**-878.3**	**-1140.3**	**0.1%**	**-1.8%**	**-1.9%**
NORTH AFRICA	571.3	650.2	0.3%	0.4%	0.7%	-488.3	-567.9	0.0%	0.4%	0.4%
Algeria	109.6	123.6	0.5%	0.3%	0.8%	-120.7	-131.4	0.0%	3.2%	3.2%
Egypt	307.9	355.3	0.4%	0.3%	0.7%	-222.6	-268.9	0.5%	-1.3%	-0.9%
SUB-SAHARAN AFRICA	1873.2	2451.5	1.3%	0.9%	2.2%	-390.0	-572.4	0.1%	-4.0%	-4.2%
Ethiopia	183.6	236.4	2.1%	0.0%	1.9%	-1.4	-7.4	51.8%	-208.5%	-159.5%
Ghana	90.7	111.9	2.0%	0.8%	2.8%	-15.6	-22.6	4.6%	-12.2%	-8.7%
Mozambique	69.7	89.4	1.7%	0.6%	2.3%	-12.4	-11.8	-3.4%	4.6%	1.2%
Nigeria	429.6	554.0	0.7%	1.5%	2.2%	-95.1	-129.8	0.2%	-4.4%	-4.6%
United Republic of Tanzania	94.4	127.9	2.6%	0.0%	2.6%	-13.7	-23.0	4.2%	0.7%	4.2%
Zambia	22.5	32.1	0.9%	0.4%	1.2%	9.3	8.9	10.1%	8.7%	20.5%
South Africa	136.1	153.0	0.4%	1.0%	1.4%	-27.5	-31.4	-9.7%	1.9%	-9.2%
LATIN AMERICA and CARIBBEAN	**1418.5**	**1586.3**	**1.1%**	**2.4%**	**3.4%**	**682.8**	**982.7**	**2.3%**	**-2.9%**	**0.0%**
Argentina	119.4	129.7	1.5%	0.5%	2.1%	426.0	533.4	3.7%	0.6%	6.1%
Brazil	462.9	524.3	1.3%	4.8%	6.2%	564.1	767.7	-1.6%	-2.4%	-4.7%
Chile	45.3	49.0	0.0%	0.9%	0.9%	-42.2	-43.6	-3.1%	8.9%	5.4%
Colombia	94.5	106.0	0.3%	0.2%	0.2%	-61.0	-65.7	-2.4%	-10.6%	-13.9%
Haiti	18.1	20.5	0.0%	0.0%	0.0%	-11.2	-12.8	0.0%	0.0%	0.0%
Mexico	317.3	348.8	1.9%	1.8%	3.8%	-213.6	-243.1	0.7%	8.2%	8.7%
Peru	80.7	91.9	0.0%	0.8%	0.9%	-49.6	-59.0	-2.0%	5.9%	3.5%
Paraguay	16.1	19.1	1.0%	1.4%	2.4%	113.7	133.8	3.5%	0.5%	3.9%
Uruguay	6.8	7.4	0.1%	0.8%	0.8%	34.5	44.0	3.3%	0.2%	3.6%
ASIA and PACIFIC	**9851.6**	**11262.6**	**0.9%**	**2.7%**	**3.6%**	**-1598.4**	**-2063.4**	**2.4%**	**-16.9%**	**-14.9%**
Bangladesh	398.4	502.4	1.1%	1.6%	2.8%	-96.6	-158.9	3.8%	-5.1%	-1.5%
China	3466.6	3688.3	0.4%	7.0%	7.5%	-1298.3	-1561.6	2.8%	13.0%	16.0%
India	2698.7	3283.3	1.6%	0.1%	1.6%	-207.2	-365.8	11.6%	-58.3%	-48.0%
Indonesia	753.7	872.6	0.3%	1.2%	1.6%	457.5	560.0	5.2%	37.6%	43.4%
Iran, Islamic Republic of	213.7	249.4	0.9%	0.6%	1.5%	-148.4	-180.2	0.7%	1.8%	2.5%
Kazakhstan	39.2	42.8	0.2%	0.5%	0.7%	47.0	53.9	5.3%	1.2%	6.4%
Korea	110.3	110.9	1.0%	1.9%	2.9%	-152.5	-169.7	1.7%	6.5%	8.1%
Malaysia	67.4	79.1	0.2%	1.1%	1.2%	345.4	371.0	4.0%	27.7%	32.0%
Pakistan	375.9	459.0	3.0%	0.2%	3.2%	-22.4	-34.9	33.3%	-84.3%	-50.9%
Philippines	218.5	253.6	0.2%	1.3%	1.5%	-37.9	-57.6	-0.5%	1.8%	1.4%
Saudi Arabia	67.0	81.5	0.0%	0.6%	0.6%	-166.3	-196.9	-0.5%	7.7%	7.1%
Thailand	176.7	191.6	0.3%	1.0%	1.3%	252.6	322.7	0.4%	14.4%	15.0%
Turkey	238.2	261.7	0.3%	0.2%	0.2%	-70.1	-73.5	-8.3%	4.2%	-5.6%
Viet Nam	233.1	257.3	0.5%	1.9%	2.5%	22.8	21.2	-20.9%	63.2%	42.2%

* Crop refers to wheat, coarse grains, rice, vegetable oil, roots and tubers, sugar, sweeteners.

Table B.5. Market impacts for animal-based products*

	Food Consumption					Net Trade				
	Baseline (bln kcal/day)		Income	Produc-tivity	Inc+ Prod	Baseline (bln kcal/day)		Income	Produc-tivity	Inc+ Prod
	2015	2024	Difference from 2024 baseline (%)			2015	2024	Difference from 2024 baseline (%)		
WORLD	**3096.2**	**3569.6**	**1.7%**	**4.0%**	**5.7%**					
DEVELOPING	**2163.0**	**2578.8**	**2.3%**	**5.4%**	**7.8%**	**-33.7**	**-65.4**	**14.9%**	**-57.7%**	**-46.2%**
AFRICA	**159.9**	**210.3**	**2.9%**	**0.4%**	**3.3%**	**-20.5**	**-35.7**	**4.1%**	**-10.7%**	**-6.6%**
NORTH AFRICA	50.2	60.7	1.8%	0.5%	2.3%	-7.0	-11.0	5.0%	-18.8%	-14.1%
Algeria	10.3	12.2	2.4%	1.5%	3.9%	-2.3	-2.8	4.3%	-6.3%	-2.5%
Egypt	25.0	30.2	2.0%	0.0%	2.1%	-4.1	-6.8	6.3%	-23.7%	-17.5%
SUB-SAHARAN AFRICA	109.7	149.5	3.4%	0.4%	3.7%	-13.5	-24.7	3.8%	-7.1%	-3.3%
Ethiopia	8.3	11.8	2.2%	2.9%	5.5%	0.2	0.3	-6.0%	14.4%	11.9%
Ghana	2.8	3.5	2.9%	0.0%	2.9%	-1.2	-1.6	3.3%	-4.0%	-0.7%
Mozambique	2.3	3.0	4.1%	1.1%	5.1%	-0.2	-0.4	7.7%	-7.9%	-2.7%
Nigeria	14.7	19.6	2.4%	0.9%	3.4%	-2.8	-3.8	0.5%	-0.7%	-0.2%
United Republic of Tanzania	5.1	7.5	3.8%	1.5%	5.1%	0.1	-0.1	83.1%	-109.5%	-68.1%
Zambia	1.4	2.0	3.6%	0.2%	3.6%	-0.1	-0.2	5.0%	-9.4%	-6.1%
South Africa	22.8	26.9	2.4%	0.4%	2.8%	-1.4	-3.0	5.0%	-29.0%	-24.4%
LATIN AMERICA and CARIBBEAN	**329.0**	**380.5**	**2.0%**	**2.7%**	**4.7%**	**29.7**	**36.6**	**-1.5%**	**25.5%**	**24.0%**
Argentina	37.2	42.5	1.7%	1.7%	3.5%	6.2	10.1	4.6%	6.4%	9.6%
Brazil	128.1	146.1	1.4%	4.6%	5.9%	28.3	34.9	2.8%	3.0%	5.9%
Chile	13.2	15.2	1.3%	0.0%	1.3%	4.2	3.9	0.3%	25.6%	25.0%
Colombia	21.6	26.0	1.3%	0.8%	2.0%	-0.7	-1.8	5.7%	-31.6%	-27.8%
Haiti	1.1	1.4	0.0%	0.0%	0.0%	-0.4	-0.6	0.0%	0.0%	0.0%
Mexico	58.1	67.4	4.6%	3.0%	7.7%	-9.6	-10.2	17.5%	-36.0%	-19.4%
Peru	12.4	15.6	0.9%	2.8%	3.7%	3.4	3.7	-0.3%	2.8%	2.7%
Paraguay	2.4	3.0	1.9%	1.9%	3.7%	1.1	1.3	0.7%	9.4%	10.3%
Uruguay	3.5	4.0	1.4%	0.2%	0.9%	3.3	3.4	0.0%	14.8%	15.5%
ASIA and PACIFIC	**1672.8**	**1986.7**	**2.3%**	**6.5%**	**8.9%**	**-42.4**	**-65.8**	**11.8%**	**-37.4%**	**-29.1%**
Bangladesh	14.1	17.8	2.4%	0.3%	2.6%	-0.2	-0.6	5.1%	-6.7%	-4.1%
China	942.8	1055.7	2.6%	10.0%	12.8%	-6.3	-10.8	45.8%	-106.2%	-77.9%
India	262.6	358.2	2.3%	3.8%	5.8%	10.3	10.7	-2.4%	10.2%	8.8%
Indonesia	44.1	53.3	1.3%	1.1%	2.4%	0.5	1.1	-4.3%	13.6%	10.3%
Iran, Islamic Republic of	22.9	26.8	2.9%	1.3%	4.1%	-1.2	-1.7	7.4%	-14.3%	-7.3%
Kazakhstan	12.0	13.2	1.0%	1.1%	2.1%	-1.1	-1.5	1.5%	-27.2%	-26.2%
Korea	25.1	27.9	3.0%	1.4%	4.4%	-7.8	-8.2	4.4%	-15.8%	-11.3%
Malaysia	15.2	18.5	0.9%	1.8%	2.6%	-1.4	-2.2	3.9%	-21.1%	-17.4%
Pakistan	82.4	107.0	2.4%	4.5%	7.0%	0.7	0.6	-29.4%	48.6%	32.1%
Philippines	33.6	40.1	1.9%	0.8%	2.7%	-1.9	-4.1	6.3%	-37.9%	-32.9%
Saudi Arabia	12.9	16.1	1.1%	0.1%	1.1%	-6.9	-9.2	1.8%	-8.1%	-6.4%
Thailand	21.8	24.2	1.6%	0.7%	2.3%	5.1	6.4	-0.8%	24.0%	22.9%
Turkey	32.5	38.5	1.1%	0.9%	2.0%	1.6	0.1	-147.6%	2170.8%	2004.9
Viet Nam	53.3	68.0	3.0%	1.4%	4.4%	-2.7	-5.8	9.8%	-16.9%	-8.4%

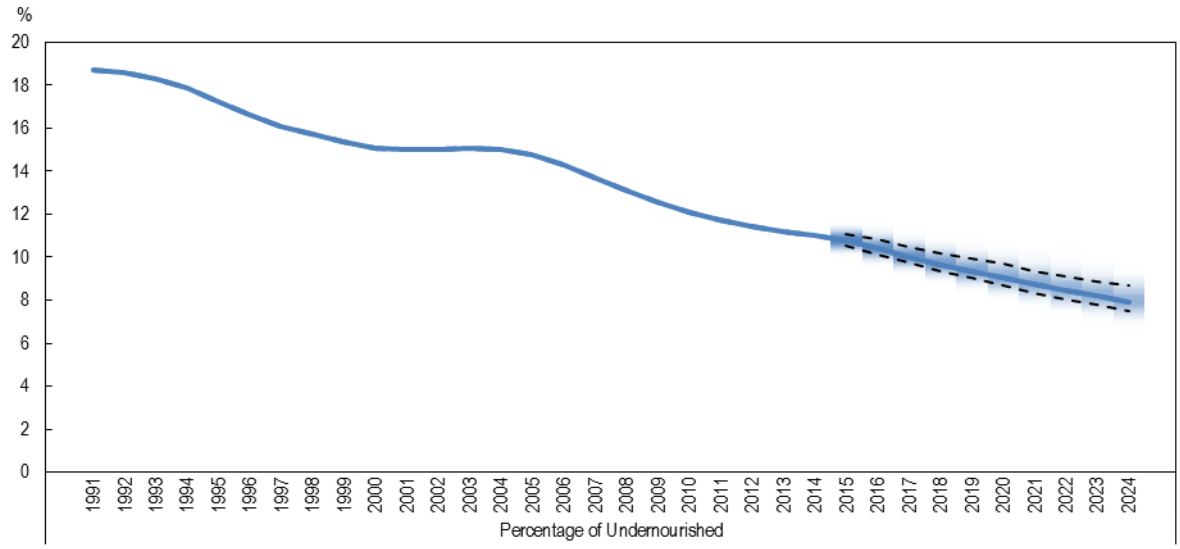
* Animal refers to bovine, pork, poultry, sheep, eggs, fresh dairy products, butter, cheese, casein, milk powders, fish.

Annex C.

Partial stochastic analysis

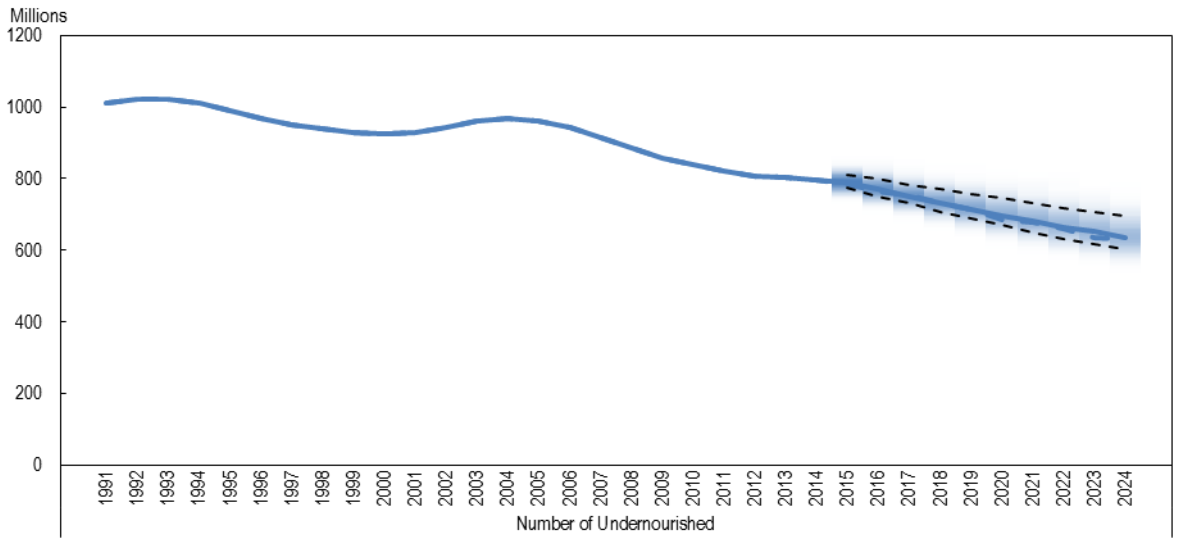
The baseline represents market outcomes based on assumptions about the evolution of key macroeconomic and agricultural variables but history shows that alternative evolutions are also possible. To capture some of this uncertainty, partial stochastic analysis[9] is utilised to map out alternative market outcomes and associated food security indicators – PoU and NoU – implied by historical variations and correlations in macroeconomic and yield variables. The results provide a range of likely outcomes (Figures C.1 and C.2).

Figure C.1. Variation in the Prevalence of Undernourishment (PoU) derived from stochastic analysis



9. More information on stochastic analysis can be found in the Methodology which can be accessed online on www.agri-outlook.org/.

Figure C.2. Variations in the number of people undernourished derived from stochastic analysis



In Figures C.1 and C2, the smooth line represents the baseline showing historical and projected values. The shaded area indicates the variability in the projections arising from uncertainties around the macroeconomic and yield variables. This shows how the probability that either the PoU or the NoU will attain a certain level in one specific year. The lower and upper dotted lines indicate the 10th and the 90th percentiles respectively. For instance in Figures C.1 and C.2 for the year 2024 the baseline projects that PoU will be 7.9% and the NoU will be 635.7 million people. The difference between the 10th and 90th percentiles for the PoU varies from 7.5% to 8.7% while the NoU varies from 601.6 million people to 694.7 million people meaning that given the historical variability, there is an 80% chance that the number undernourished will be either 59 million more or 34.1 million less than the baseline figure. These represent a change from the baseline of 9.3% or -5.3% which indicate a fairly tight distribution, pointing that future shocks in yields and macroeconomic variables comparable to those experienced in the past, including those of 2007-08, may not result in a significant change to the downward trend in both the global prevalence of undernourishment or the number of people undernourished.