

## ***Food and Nutrition Security in the FOODSECURE Scenarios***

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### Key message

**Even in a world characterized by inequality, global food security can improve up to 2050. However, on average, more equal worlds improve food and nutrition security over a wider range of FNS indicators.**

### Short summary

Since the high food price peaks of 2008 and 2011, there has been increased focus on the state of food and nutrition insecurity around the world. To address this concern, a number of systems have been introduced to monitor the state of food and nutrition security. These systems rely on indicators to examine ex-post trends in food and nutrition security (FNS) and monitor the current status of FNS at the country/regional level that have not been systematically applied in long-term ex-ante projections.

In this paper we have incorporated a set of commonly used food and nutrition security indicators in our Toolbox 2050 to examine developments in food and nutrition security in four stakeholder defined futures at global, regional and household level. The scenarios are differentiated by the degree of inequality on one axis and sustainability on the other, complementing the Socio-Economic Pathway (SSP) approach with a set of scenarios focused on FNS outcomes in future worlds.

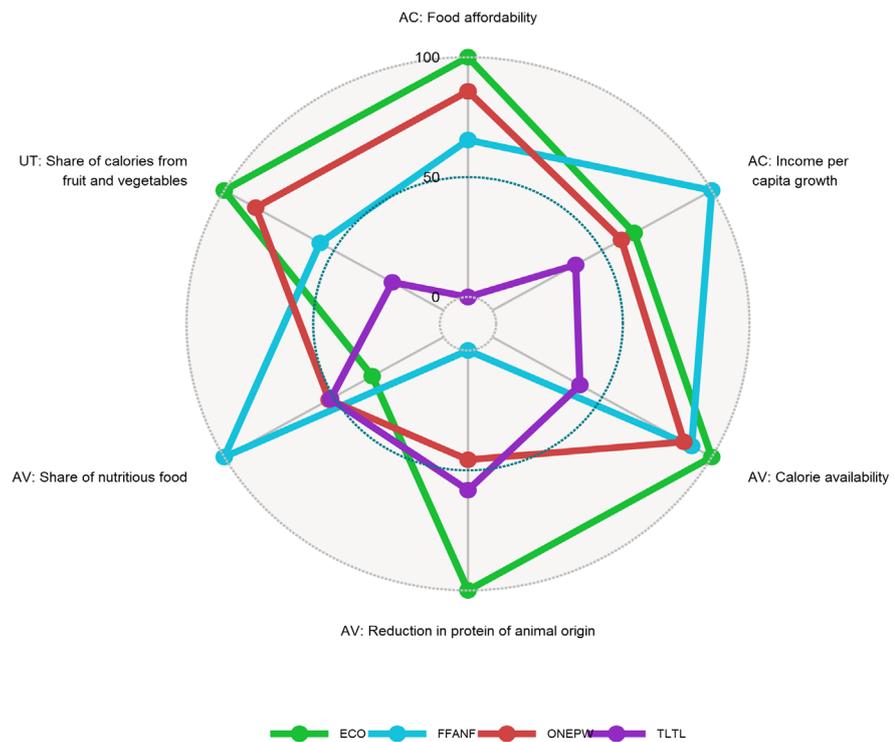
The global picture shows us how the food and nutrition security status of the average world citizen is likely to develop in each of the four worlds for a number of indicators (Figure 1). The global analysis is complemented with a regional analysis of between country inequality – showing whether certain regions are at risk of being left behind. The third level of analysis is at the household level, where we are concerned with within country inequality in terms of food and nutrition security and whether improvements for the average household ‘trickle down’ to the poorest in society. We examine within country inequality for five key countries: India, Ghana, Uganda, Indonesia and China.

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This brief reports on the key findings of FOODSECURE deliverable report D7.4 “[Food and Nutrition Security and Sustainability in Long-Term Projections: An Assessment of the FOODSECURE Scenarios](#)”.

Our analysis shows that global results belie a more detailed and nuanced picture at the regional and household level and therefore care should be taken in drawing conclusions on food and nutrition security at too high a level.



**Figure 1 Global food and nutrition security in 2050**

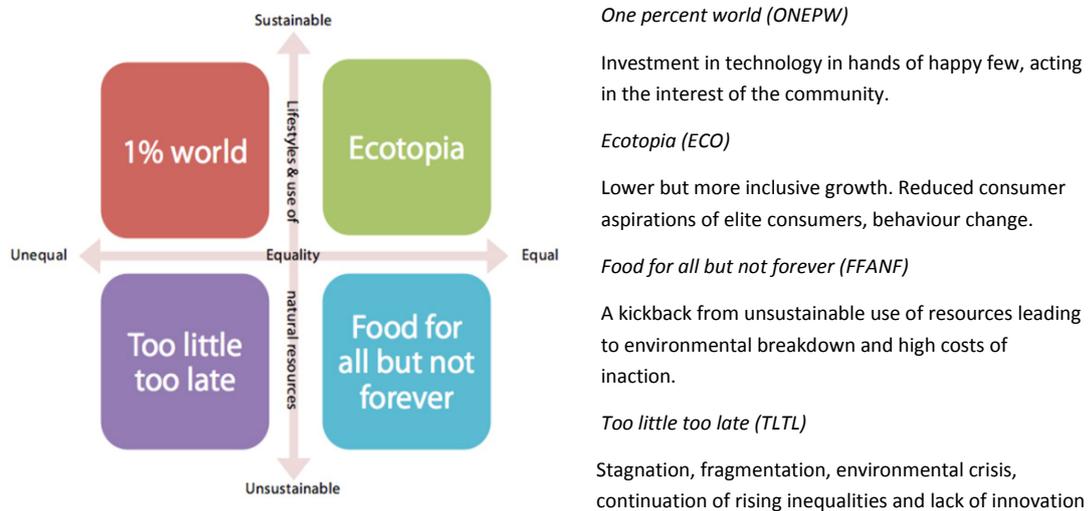
Note: Lines represent the average of MAGNET-IMAGE and GLOBIOM outcomes. Food security indicators are normalised (Shutes et al., 2017).

## Full summary

### Introduction

Developments in food and nutrition security up to 2050 are examined for the four FOODSECURE scenarios using a range of commonly used food and nutrition security indicators. The FOODSECURE scenarios were developed through a stakeholder participatory process which resulted in four future worlds differentiated by the degree of inequality on one axis and sustainability on the other (see Figure 2). A sustainable but unequal world is represented by 1% World, a sustainable and equal world in Ecotopia, an equal but unsustainable world in Food For All But Not Forever and an unsustainable and unequal world in Too Little Too Late (see Dijk et al. 2016 for full details). These food and nutrition security focused scenarios complement the climate focused Socio-Economic Pathway (SSP) scenarios.

The impact on food and nutrition security (FNS) is examined at multiple levels in the four scenarios: global, developing regions and households in selected countries using a suite of food and nutrition security indicators that have been included in the FOODSECURE modelling Toolbox 2050.



**Figure 2. Scenario storylines**

## Approach: Quantifying the four future worlds

A number of improvements have been made to the models in the Toolbox to enable the assessment of food and nutrition security outcomes (see Shutes (Ed.) 2015 and Kuiper & Shutes, 2014). The FNS indicators that have been added to the Toolbox are shown in Table 1. The indicators are largely based on the FAO indicators of food security (FAO, 2016) which allow for comparisons to be made between historical, current and future estimates of FNS indicators.

The stakeholder process produced a set of narratives and expected trends in population growth, GDP per capita, cereal yield, meat consumption and land use up to 2050. These trends, together with the information in the narratives, was used to quantify the FOODSECURE scenarios. Specifically, to assign scenario specific values to nine variables: GDP and capital growth, population and labour growth, crop productivity, livestock productivity, land use change regulation, trends in meat consumption and trade tariffs and subsidies. Together with common assumptions on fossil fuel prices, Common Agricultural Policy reform and biofuel mandates, these nine variables depict the differences between the FOODSECURE scenarios (see Annex to this brief, based on Table 4 of Shutes et al., 2017).

**Table 1 Food and nutrition security indicators in Toolbox 2050**

Scale	FNS Dimension	Metric
Global, regional and national	Availability	Calorie availability
	Availability	Share of nutritious food, defined as the share of calories not derived from cereals
	Availability	Reduction in share of protein of animal origin
	Accessibility	Income growth per capita
	Accessibility	Food affordability defined as reductions in the food price index
	Utilisation	Share of calories from fruit and vegetables
Household	Accessibility	Food consumption growth by household in constant value terms
	Accessibility	Share of nutritious food consumed by household, defined as the share of calories not derived from cereals
	Accessibility	Share of calories from fruit and vegetables consumed by household
	Accessibility	Share of protein from animal sources consumed by household

## Results

### Global level: improvements in global food and nutrition security in most scenarios

Overall, global food security is set to improve in most scenarios as shown in Figure 1. On average, calorie availability and income (GDP) per capita increase in all four scenarios, accompanied by a shift to more nutritious foods in all four worlds measured by a shift away from cereals in the diet. Food prices decrease in three out of four scenarios, TLTL being the exception. The other two indicators sketch a mixed picture. The supply of protein of animal origin, associated with a shift towards a diet with more meat is increasing in all worlds except for ECO due to assumed changes in diets. Although the consumption of more meat is less sustainable than other diets, it is likely to have a positive impact on food security in regions characterised by undernourishment, while the opposite is true for regions where obesity is a problem.

The ECO scenario is located on the outside for most indicators and characterised by an increase in affordable food, higher calorie availability, a reduction in protein from animal origin and the highest share of calories from fruit and vegetables and high income per capita growth. The latter is lower than FFANF but because the scenario assumes a more equal distribution of income, it has a positive impact on global food security. The low ranking on the share of nutritious food is due to increased cereal consumption to compensate for the reduction in calories from meat consumption.



Conversely, the TLTL scenario is located close to the centre of the diagram. Apart from share of nutritious food and reduction in protein of animal origin, it ranks lowest for all food security indicators. The FFANF and ONEPW scenarios are in between the ECO and TLTL scenarios. In the FFANF world, income per capita growth is the highest but because of the impact of climate change on yields, food prices started to rise again at the end of this scenario. The high level of animal product consumption, and other luxury food products made affordable through higher income lead to a much larger share of nutritious food in the diet. Income per capita growth is relatively low in the ONEPW scenario, mainly because of the very unequal wealth distribution at the global level. As a consequence of high crop yield growth caused by technological change, food becomes more affordable. However, apart from the one percent elite, the majority of the global population do not benefit from nutritious diets.

### Developing regions: greater improvements in Sub-Saharan Africa and South Asia in most scenarios

As with the global picture, most regional FNS indicators show an improvement across scenarios compared to the initial picture in 2010. There remains a large degree of variation between the four worlds with overall greater improvements in food and nutrition security in the ECO and FFANF scenarios and lower improvements in ONEPW and TLTL.

Food and nutrition security improves markedly in the relatively low income regions of Sub-Saharan Africa and South Asia in ECO, FFANF and ONEPW. Food availability increases, however the supply of protein from animal origin in both regions in 2050 remains low in absolute levels in comparison to the rich countries today, partly due to the lower importance of meat in the South Asian diet. Food accessibility also increases due to per capita income growth which is compounded by lower food prices in Sub-Saharan Africa, and offset by slightly higher food prices in South Asia. Food utilization improves in Sub-Saharan Africa but decreases in South Asia when consumption is shifted to other nutritious products. However, the latter result should be treated with caution as the models tend to disagree about the projections for fruit and vegetables consumption. In contrast to the other three scenarios, food and nutrition security is not or only very moderately improving in the TLTL world in these regions. Income per capita, calorie availability and diets improve only slightly, while at the same time access to food deteriorates due to steeply rising food prices.

Food and nutrition security in East Asia and Latin America and Caribbean, is relatively higher in 2010 in comparison to Sub-Saharan Africa. Food and nutrition security also improves up to 2050 in these regions in the ECO, ONEPW and FFANF scenarios but improvements are less dramatic than in the other two regions because of the higher base levels. Calorie availability increases to around 3,250 kcal per cap in both regions, which is comparable to the current level of Spain. Equally, the consumption of meat increases to around 45-50 grams/cap/day, which is close to many OECD countries. As basic needs are already fulfilled and relative income is high, consumers make the decision to have a more sustainable diet towards less



meat in the ECO scenario. Food prices slightly increase in East Asia and decrease in Latin America and Caribbean. This is, however, expected to have limited impact on food security as consumers spend a relatively low share of their (high) income per capita on food items.

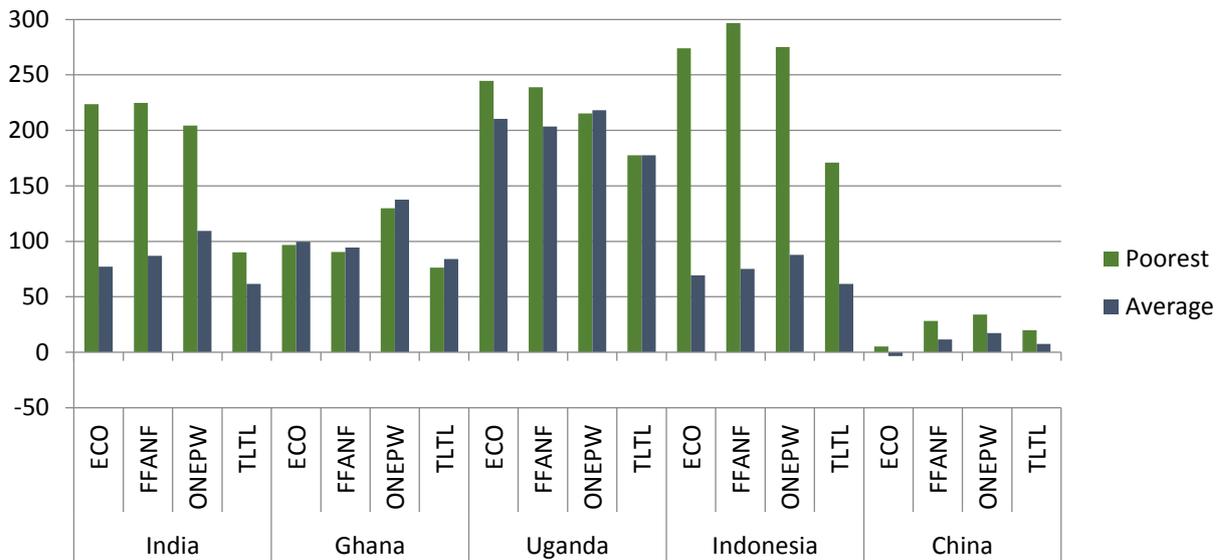
### Household level: more food of higher quality for the poor in India, China, Indonesia and Uganda in all worlds

The Toolbox 2050 allows us to examine within country inequality at household level for five key countries. We compare growth in real food consumption of the poor and average household in India, China, Indonesia, Uganda and Ghana to examine the likely impact on food and nutrition security of the poor in these countries (Figure 3).

Real food consumption grows faster for the poor than the average household in all regions except Ghana suggesting reduced inequality in all worlds in these countries. The greatest increases appear in either ECO or FFANF and the least in TLTL. The picture for Ghana is more bleak as the growth in food consumption of the poor lags behind average food consumption in all worlds due to the poor being locked in an agricultural sector that is shedding labour as it becomes more mechanised, leading to decreases in the unskilled agricultural wage.

The increases in food consumption translate into improvements in food quality for the poor in India, Indonesia and Ghana. The quality of the diet of the poor improves by more than the average in Ghana, even though the quantity of food in the diet increases by less. Diet quality improves in China in all worlds except ECO, where the reduction in meat consumption affects the overall consumption of nutritious food. The improvements in food quality are greatest in the ECO, FFANF and ONEPW scenarios and least in TLTL in India, Indonesia and Ghana. The shift away from meat in the diet in ECO in China means that the share of nutritious food is projected to fall in this scenario as consumers rely more on cereals for calories.

Despite showing some of the strongest pro-poor growth in food consumption between 2010-2050, the quality of the diet in Uganda decreases in all worlds. Therefore while food consumption is increasing, households are relying more on cereals and less on fruit and vegetables and meat. The fact that this effect is seen only in Uganda, points to population growth as the main driver of the reduction in diet quality as Uganda is projected to have the fastest growing population in the world over the coming years. The impact of these high population growth rates is reflected in the need to sustain the rapidly growing population with more but poorer quality foods.



**Figure 3 Percentage change in quantity of food consumed by household 2010-2050**

## Implications and recommendations

Our analysis displays the need for analysis that go beyond the global level. The regional analyses is a necessary complement, taking into account regional differences to assess possible between country inequalities, and showing whether certain regions are at risk of being left behind. In addition, the household analysis – which is concerned with within country inequality in terms of FNS and whether improvements for the average household ‘trickle down’ to the poorest in each society – is another useful addition to the global analysis, providing more in-depth detail about the effects of certain policies on the poorest and therefore most food insecure households.

## References

Dijk, Michiel van, Maryia Mandryk, Marc Gramberger, David Laborde, Lindsay Shutes, Elke Stehfest, Hugo Valin, and Katharina Zellmer. 2016. “Scenarios to explore global food security up to 2050: Development process, storylines and quantification of drivers.” FOODSECURE working paper 38. LEI Wageningen UR.

[http://www.foodsecure.eu/navigator?title=scenarios to explore global food security up tp 2050](http://www.foodsecure.eu/navigator?title=scenarios%20to%20explore%20global%20food%20security%20up%20to%202050)

FAO (2016). Food security indicators. <http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/>

Kuiper, Marijke and Lindsay Shutes (2014) Expanding the household coverage of global simulation models: An application to Ghana. FoodSecure Technical Paper no.3 <http://econpapers.repec.org/paper/fscfstech/3.htm>

Shutes, Lindsay (Ed.), Michiel van Dijk, Frans Godeschalk, John Helming, Marijke Kuiper, Maryia Mandryk, Hans van Meijl, George Philippidis, Martine Rutten, Elke



Stehfest, Andrzej Tabeau, Hugo Valin and Geert Woltjer. (2015) Toolbox 2050: Description of Linked Economic-Biophysical Modelling. FoodSecure Deliverable 7.2.

Shutes Lindsay , Hugo Valin, Elke Stehfest, Michiel van Dijk, Marijke Kuiper, Hans van Meijl, Andrzej Tabeau, Monika Verma , Diti Oudendag, Willem-Jan van Zeist and Petr Havlik (2017). *Food and Nutrition Security and Sustainability in Long-Term Projections: An Assessment of the FoodSecure Scenarios*. Paper developed as part of deliverable 7.4 of the FoodSecure project on 'Long-term supply, food and non-food demand drivers, contrasting scenarios and their impact on FNS'.

<http://www.foodsecure.eu/navigator?title=foodand%20nutrition%20security%20and%20sustainability%20in%20long-term%20projections>

## Annex - Scenario quantification

Assumption	Ecotopia	Food For All but Not Forever	One Percent World	Too Little Too Late
GDP <sup>a</sup> /capital growth <sup>2</sup>	High in LICs, MICs; medium in HICs with structural change in mid 2020s and mid 2030s	High with downwards structural change in mid 2040s	Low in LICs; medium in other regions	Low
Population <sup>a</sup> /labour growth	Low	High in HICs; Low in LICs, MICs & BRICS L	High	Low in HICs; medium in LICs, MICs & BRICS
Agricultural productivity <sup>b</sup> (crops)	Historical trend with downwards structural change after 2020s in all regions and upwards change after 2030s in LICs, MICs and BRICS	Decreasing below historical trend with downwards structural change in mid 2040s in HICs; Increasing above historical trend with downwards structural change in mid 2040s in HICs	Above historical trend with rapid increase in the 2030s	Increasing below historical trend and levelling off
Agricultural productivity <sup>a</sup> (livestock)	High: efficiency parameters achieve 50% convergence to the levels of the most efficient regions in a 'middle of the road' scenario (MAGNET-IMAGE)	High: efficiency parameters achieve 50% convergence to the levels of the most efficient regions in a 'middle of the road' scenario (MAGNET-IMAGE)	Low in LICs, medium or high in other regions (MAGNET-IMAGE)	Low: efficiency stagnates at current the regional levels (MAGNET-IMAGE)
Increases in livestock productivity common across scenarios (GLOBIOM)				
Land use change regulation <sup>a</sup>	Strong: protected areas are extended up to 2x Aichi target: a total 34% of terrestrial area (IMAGE). 100% of remaining forest protected by 2050 (GLOBIOM)	Low: protected areas at current level	Strong: protected areas are extended up to 2x Aichi target: a total 34% of terrestrial area (IMAGE). 90% of remaining forest protected by 2050 (GLOBIOM)	Low: protected areas at current level
Trends in meat consumption <sup>a</sup>	Low: consumption of animal products 30% lower than endogenous outcome in HICs and MICs	Medium: Endogenous dynamics	Medium: Endogenous dynamics	Medium: Endogenous dynamics
Trade tariffs and subsidies <sup>b</sup>	Doubling of tariffs with a minimum rate of 20% from 2020 onwards (MAGNET), no change (GLOBIOM)	Full liberalisation of trade from 2020 onwards (MAGNET), lower cost of trade expansion (GLOBIOM)	Full liberalisation of trade from 2020 onwards (MAGNET), lower cost of trade expansion (GLOBIOM)	Doubling of tariffs with a minimum rate of 20% from 2020 onwards (MAGNET), higher cost of trade expansion (GLOBIOM)
Fossil fuel prices <sup>c</sup>	IEA 6 Degrees Scenario: strong growth in oil, coal and gas prices albeit at a decreasing rate			

<sup>2</sup> In MAGNET, natural resources are assumed to grow at 25% of the GDP growth rate.



Common Agricultural Policy <sup>b</sup>	Abolition of milk and sugar quotas in 2015 and 2017 Reduction of first pillar budget by 2% per year in all periods
Biofuel mandates <sup>d</sup>	Current policies are continued and biofuels levels (GLOBIOM) and shares (MAGNET) kept constant after 2030

<sup>a</sup> Authors' calculations based on IIASA (2015)

<sup>b</sup> Authors' calculations from stakeholder provided trends (Dijk, van et al., 2016)

<sup>c</sup> Authors' calculations based on IEA (2015)

<sup>d</sup> Biofuel digest (2011); US Renewable Fuel Association Statistics (2016)