A Balanced Global Food Demand and Supply in 2050: How can we meet the challenge?

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Introduction

Poverty and hunger remain enormous problems in spite of a remarkable progress in the performance of the global food system over the last 50 years. Still among 1 billion people around the world are hungry and 1 billion people live on just $1.25 per day. This challenge of global food security and the risk of a rising global food wedge between human needs and global food production is in spite of technological advances expected to increase significantly towards 2050 – unless significant changes in present food demand trends food production pattern and productivity and overall productivity and capacity of the world food system do take place in the coming years. Will the world actually be able to meet the global food challenge in 2050?

The underlying and emerging trends and driving forces affecting global food security include the well-known factors of

- economic growth and urbanisation and the significant increases in food demand and diet shifts,
- demographic shifts in terms of population growth, aging, and rural labour shortages,
- increased market concentration and globalisation of processing, distribution and retailing,
- sweeping technological change ,
- degradation of natural resources and increasing water scarcity
- rising energy prices and climate change.

Crude calculations estimate that the global food demand will increase from 70-100 percent of current production leading to a significant and increasing global food wedge seriously challenging the global food security on our road to 2050 (e.g., according to Keating et al. (2014) a deficit of some $127x10^{15}$kcal).

This paper will by way of the tailor-made global economic model estimate the global food wedge in 2050 based upon a number of assumptions relating to the underlying trends and driving forces mentioned above. By way of a few illustrative examples, targeted prospected pathways to balance global food demand and supply in 2050 will be presented and discussed.

Literature Review

An important strand of articles published within the last 5-7 years focus on the measurement of global food security. FAO has improved its methodology to calculate the number of undernourishment (Wanner et al., 2014). Barrett (2010), de Haen et al. (2011) and Jones et al. (2013) reviewed the most common indicators of food security (i.e., the FAO indicator of undernourishment, household food consumption surveys and childhood anthropometrics) and concluded that measuring global food security still remains difficult. The authors criticize the FAO indicator of undernourishment as well as the underlying food balance sheet (FBS) data. De Haen et al. (2011) however, also conclude that there is currently no other option available to measure global food security, mainly because the more accurate regional or local approaches to measure food security do not have a global coverage and are difficult to aggregate. Several other indicators of global food security (e.g., the Global Hunger Index of IFRPI) are also based on the FBS data, but are enriched with additional data to capture e.g., the utilization aspect of food security.

Another part of the literature focuses on the measurement of global food security based on simulation models. Analyzing how trade barriers made the world more food insecure after the price peak in 2007/08 Rutten et al. (2013) and several other authors utilized a rise (fall) in the consumption of food to represent an improvement (deterioration) in food security. Valine et al. (2014) employed embodied crop calories in animal products (Pradhan et al., 2013) to compare different food demands in 2050. Thompson and Smith (2002) as well as Rosegrant et al. (2012) use the FBS data as basis to integrate information on calories and further nutrients into the Aglink and IMPACT model, respectively. Keating et al. (2014) approached the assessment of global food security from a different angle. The authors projected global food demand to 2050 utilizing an energy-equivalent basis as aggregated metrics. Comparing the calorie equivalent of global food demand and supply in 2050 they identified a "mega wedge" of additional food demand and three pathways (reducing consumption, improving production, avoiding losses) and subcategories (e.g., reducing overconsumption in human diets) as well as an optimal expert based solution.

Data and Methods

Our simulations are based on an extended GTAP framework utilizing Version 9 of the data base. We followed the approach of Taheripour et al. (2007) to include Agro-Ecological Zones (AEZ, GTAP Land Use and Land Cover 8.1 Data Base) as well as production and consumption of biofuels. We isolated the biofuel sectors in the GTAP data base with the help of Splitcom. The new feature of our GTAP model is a submodule that is based on the FBS data of the FAO and captures the calorie as well as the macro- and micronutrient equivalent of consumption, production, storage and waste of food.

Simulations and Results

Following Keating et al. (2014) we utilize our extended GTAP model and the production and consumption changes to estimate a baseline global food wedge in calorie equivalents in 2050. There are assets and drawbacks to all aggregated metrics. A price weighted production metrics might for example not be able to capture a shift to higher valued food consumption, whereas a calorie-based aggregation suffers from aggregation bias comparable to false competition in trade. We are also aware that the rough calorie measurement only covers the physical supply of food (availability) and the access to it, whereas the utilization and the stability of food supply are not taken into account. We therefore follow Thompson and Smith (2002) to implement food stability indicators as self-sufficiency and stocks-to-consumption ratios to capture additional aspects of the multidimensionality of food security. We also review other indicators of global food security to scrutinize their usefulness.

We run additional scenarios to mimic different pathways to balance global food demand and supply in 2050. Based on the World Population Prospects of the UN and the recommended value of per capita calorie intake, we calculate the energy-equivalent that is necessary to meet global food demand in 2050 as an upper bound. Targeting this upper bound by simultaneously swapping different exogenous variables (e.g., technical change parameter) we additionally implement a "no-hunger scenario". The approach is discussed. The paper is a first step to integrate different datasets and approaches in a common modelling framework and an effort to identify areas for future research efforts.

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