Food self-sufficiency in Austria: simulation results for 2030 and 2050

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***Abstract* - Agricultural production and food security, respectively, is likely to be influenced by climate change and other risk factors such as possible shortages of fossil fuels, protein feed or Phosphorus fertiliser. We analyse these possible influences on supply balances for food and feed products in Austria in 2030 and 2050 by means of simple simulation models. Depending on the model and respective scenario, the results indicate possible substantial changes in the acreage needed and in net trade positions.**

INTRODUCTION

Various studies have addressed the impact of climate change on agricultural production and food security (e.g., Wreford et al., 2010; OECD, 2013). Besides climate change, important risk factors influencing future food availability include the availability of necessary inputs such as fossil fuels, protein feedstuff and Phosphorus (P-) fertiliser.

In the following we present selected results of the project "Food Security", funded by the Austrian Climate and Energy Fund within the Austrian Climate and Research Programme (ACRP) and coordinated by the Austrian Agency for Health and Food Safety (AGES).[2] In line with the time frame of international studies (e.g., Alexandratos and Bruinsma, 2012), we address self-sufficiency in agricultural products in Austria in 2030 and 2050. By means of two simple simulation models, we analyse the impact of different scenario-specific assumptions on certain agricultural supply balance positions.

DATA AND SIMULATION MODELS

The data used for the simulation models are predominantly derived from the agricultural supply balances provided by Statistics Austria (for the period 2000-2010) and from projected supply balance positions (period 2011-2020). These projections were estimated within the project and are based on the OECD-FAO agricultural outlook for the EU-27. Additional data include population figures (including forecasts of Statistics Austria by 2050), feed balances and data on livestock and acreage provided by Statistics Austria and the Federal Ministry of Agriculture as well as supporting calculations, estimations and assumptions provided by the project partners.

In our supply balance database (2000-2020), we generally account for the positions production, domestic use and trade balance (as the residual, i.e., net imports or net exports including changes in stocks). Components of the position "production" are data on land use, livestock and crop and animal yields, respectively. Coefficients for crop-specific feed use by type of animal were derived from feed balances and livestock data. These coefficients are used to separate total domestic use into a "feed use" and a "non-feed use" position (including seed use, industrial use, human consumption, etc.). Components of the position "non-feed use" are population figures and the respective per capita consumption.

We establish two simple simulation models which differ in the exogeneity or endogeneity of certain variables. In both models, non-feed use is exogenously given. Model 1 simulates the impact of changes in consumption (feed and non-feed use) and in trade balances on production. Incorporating assumptions on yields in a second stage, the model identifies necessary changes in acreage and livestock. Model 2 simulates the impact of changes in consumption and in production (particularly, of yields) on trade balances and therefore identifies net trade positions.

The project team identified and assessed the most important risk factors influencing self-sufficiency rates (SSR) in Austria in 2030 and 2050 and their respective magnitudes: (i) in the models, crop yields are affected by the impact of climate change, by the availability of P-fertiliser, by technical progress, and by the intensity level of inputs (the latter two factors also affect animal yields); (ii) possible shortages of fossil fuels were used to determine the per capita bioenergy demand of certain crops; and (iii) we make assumptions on possible shortages of imports of protein feedstuff (in model 1 only). Different magnitudes of these risk factors are bundled in four different scenarios for 2030 and 2050: a "baseline scenario" assuming a continuation of current trends, an optimistic "best-case scenario", a "most-probable-case scenario" with quite moderate assumptions, and a rather pessimistic "worst-case scenario". The impact of climate change on crop yields (as provided by the project partners at BOKU-Met, based on the Global Agro-ecological Zones (GAEZ) modelling framework) is assumed to be equal in all scenarios. Increases in bioenergy de-

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mand are assumed to be low in the best-case, medium in the most-probable-case and highest in the worst-case scenario. Import restrictions of protein feedstuff are assumed to be medium in the most-probable and high in the worst-case scenario.

We meet uncertainties on the numerical level of certain exogenous supply balance components in 2030 and 2050 by Monte Carlo simulations. Assuming a triangle distribution (based on the period 2000-2020) and making 1,000 independent draws of random values for each variable and product, we generate a range of possible input data for trade balances and non-feed use per head (including scenario assumptions on imports of protein feed and bioenergy use), crop-specific acreages and livestock.

Results

Choosing projected data for 2015 as a reference point, Fig. 1 shows that the assumed crop yields per hectare in 2050 are lower only in the worst-case scenario; yields of protein crops, however, are lower in all scenarios. Figure 1 also shows that (i) at the national level, the underlying assumptions concerning climate change generally suggest positive impacts on crop yields, (ii) apart from the worst-case scenario, the largest positive changes are due to assumptions on technical progress, and (iii) in the worst-case scenario, large negative changes due to less P-fertilisation and lower intensity levels of (other) inputs generally outweigh any positive changes. Assumed changes of factors affecting yields in 2030 (not shown in Fig. 1) are slightly lower.

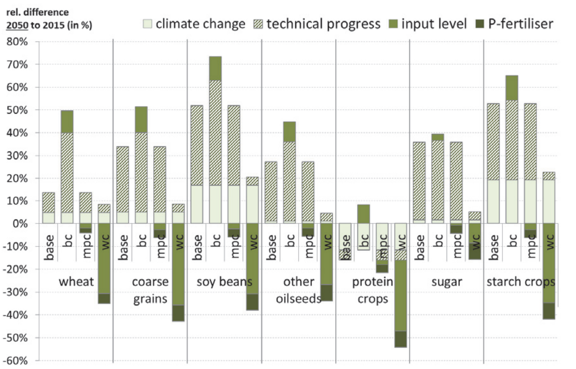

Figure 1. Impact of scenario-specific assumptions on crop yields (2050 rel. to 2015, in %). Base=baseline; bc=best case; mpc=most probable case; wc=worst case.

Figure 2 summarises the resulting SSRs of the simulations. In this figure, agricultural products are sorted by average SSRs in the period 2000-2010. In addition, Fig. 2 illustrates the respective minimum and maximum average SSR out of eight simulation results (i.e., four scenarios, two years in each case) for each model and product. The simulation results for model 1 show that changes in average SSRs (relative to 2015) are moderate. As model 1 identifies production needs, the incorporation of scenario-specific yields in a second stage allows deriving the necessary changes in livestock and acreage. Average changes in mean livestock numbers by type of animal range from -6% (best-case scenario, 2030) to +17% (worst-case scenario, 2050) in all cases except for sheep. Resulting changes in the average total acreage that is considered in the model are highest in 2050 and range from -29% (-297,000 hectares, best-case scenario) to a need of +109% (+1.1 mill. hectares, worst-case scenario).

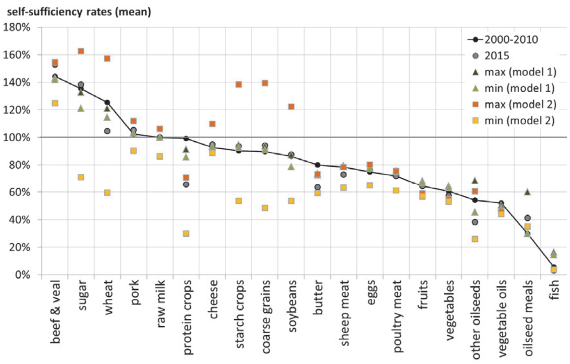

Figure 2. Self-sufficiency rates (maximum and minimum mean of four scenarios for both 2030 and 2050).

In model 2, SSRs are directly affected by changes in yields. Changes in average SSRs are quite substantial, thereby implying changes in net trade positions (see Fig. 2): in the worst case, products like sugar (-67%age points (pp) in 2050, relative to 2015), wheat (-45pp), pork (-15pp) and milk (-14pp) may become net imported products with SSRs below 100%; in the best case, products like cheese (+15pp in 2030), starch crops and coarse grains (+45pp each in 2050), and soybeans (+35pp in 2050) may become net exported products.

Conclusions

Our simulation results indicate possible substantial changes in the necessary acreage to meet production needs (in the worst case, the total considered acreage needs to double) and in net trade positions of agricultural products, respectively. The analysis of different scenarios aims at illustrating the range of possible outcomes. It is important to note that the simulation models do not forecast SSRs in 2030 and 2050. Rather, they show the possible ranges of SSRs using Monte Carlo simulations and based on a set of assumptions, by leaving aside economic considerations of agents and by taking certain variables as given. However, the results indicate the importance of further research and discussions on food security and food availability risks in the EU.

Acknowledgement

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