Nutrient import at the farm level within an urban-regional context of Eastern Austria

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***Abstract* – The objective of this study is to compare the nutrient import of farms in eastern Austria in the context of scenarios towards changed, more sustainable, urban food consumption patterns. We use a farm model to calculate changes in farm management – especially changed shares of organic farming in the region – and determine the impacts of these changes on plant nutrient import. The results show that organic farming has a low reliance on external nitrogen and is thus more resilient to price shocks than conventional farming. However, a complete conversion to organic farming of farms in a region would lead to critically low soil nitrogen levels.**

INTRODUCTION

Farmers' behaviour plays a crucial role in the distribution of crops grown and livestock kept of a region. If societal demand for sustainable food changes, farmers face the decision to adapt their farm activities to ensure an efficient allocation of scarce resources under the given circumstances and to enable a flexible response to unforeseen changes (Darnhofer 2014). To assess resource use of farms and changes in the regional food system under changing farming conditions, farmers responses play an important role. The objective of this study is to assess plant nutrient imports at the farm level on the basis of different scenarios in which the demand of consumers in Vienna changes in the context of the metropolitan region of Vienna. Plant nutrient imports are particularly relevant to agriculture in light of the fertilizer price shock due to the 2022 Russian invasion of Ukraine.

METHOD

This study investigated the farms in the metropolitan region of Vienna, i.e. the region 100 km around Vienna demarcated at the municipal level within Austria, see Figure 1. This region is diverse enough to include a broad range of farm practices, e.g. arable farming and grazing livestock.

We investigated scenarios towards more sustainable food consumption patterns of the Viennese population. To develop the scenarios, three general and commonly suggested factors that can improve the environmental quality of the food system were varied. These factors relate to the food consumption patterns of the Viennese population and concern: 1) Primarily regional food consumption, 2) exclusively organic food consumption, and 3) two thirds less meat consumption.

More precisely, we considered the following scenarios: Regional (Reg), Regional Meat (RegMeat), Regional Organic (RegOrg), and Organic Only (OrgOnly). So, these scenarios use either one or two of the described factors.

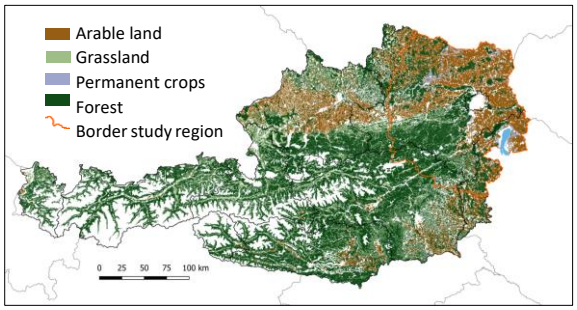

Figure 3. Location of the study region (see orange border). Source: Own drawing, based on data from Copernicus Land Monitoring Service (2020) and Statistik Austria (2020).

The factor of "primarily regional food consumption" establishes a connection between agricultural production in the study region and food consumption in Vienna.

We used farm level data with respect to crop and livestock production from the database of the Integrated Administration and Control System (BMNT 2015) to generate the relevant farm types present in the study region. After farm types were generated (with rule-based classification, inter alia cluster analysis), they were included in a farm model to calculate the Baseline, i.e. the agricultural structure of the year 2015.

This farm model uses linear programming and maximizes total gross margin of the farm in calculating the baseline, i.e. allocates scarce resources among activities in order to obtain the outputs that maximize their utility (Blanco, 2016). The model ensures compliance with the first and second pillar of the common agricultural policy. Technical coefficients and nutrient balances (nutrient offtake and supply) have been included from the Federal Institute of Agricultural Economics and the Bavarian State Institute of Agriculture.

The outlined scenarios were calculated by switches of farms from one farm type to another underpinned by data from a survey in the region, conducted in 2019. This was done without involving linear programming. Based on survey data, we assigned each farm of the same farm type preferential weights to apply a change in production orientation (operational focus with respect to crop and livestock production patterns) and production mode (conventional or organic mode of production) in response to the outlined scenarios in order to reflect empirically validated switching patterns among the defined farm

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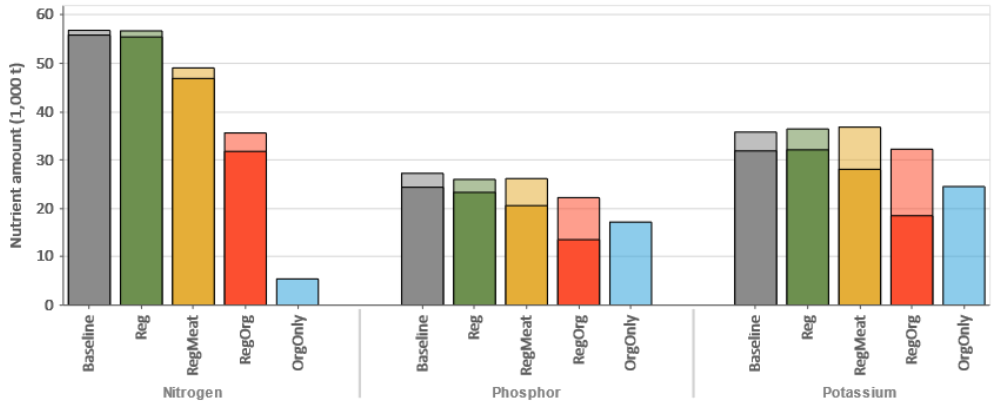

Figure 4. Plant nutrient import at the farm level in the investigated scenarios. Opaque – conventional farms; transparent – organic farms.

types of the study region. Finally, the resulting data were aggregated to the level of the study region.

Results

The share of organic utilized agricultural area was in the baseline 16% and increased in the scenarios (except in Reg). RegMeat, RegOrg, and OrgOnly exhibited a share of organic utilized agricultural area of 31%, 52%, and 100%, respectively. This increase is attributable to farmers' adaptation behaviour in the scenarios and resulted in changed nutrient imports as shown in Figure 2. Especially in scenario OrgOnly with exclusively organic farming, the nitrogen import decreased by approximately 88%. This is especially due to the largely closed nutrient flows in organic farming with prohibited synthetic nitrogen use. At the same time, the area of legumes (nitrogen-fixing crops) increased by over 3 times in RegOrg and OrgOnly. These results show that organic farming decreased the reliance on external inputs and thus, is more resilient to price shocks than conventional farming. Changes in nutrient imports between the scenarios outlined were more pronounced for nitrogen than for phosphor and potassium.

Discussion and conclusions

The nitrogen imports presented show that nitrogen import can be reduced, which is also vital to reduce nutrient leaching, greenhouse gas emissions and energy input. Reducing nitrogen import is especially relevant in the context of the farm to fork strategy of the European Union (reduce fertilizer application by 20% by 2030) and a carbon tax on fertilizers because organic farms are usually more energy efficient than conventional farms (Reganold and Wachter 2016). Yet, lower yields in organic farming are associated with lower quantity of produced agricultural goods. However, this can be partially mitigated by changing food consumption patterns (Lauk et al. 2022).

An important aspect to reduce nitrogen import is a more closed nutrient cycle with livestock farming. As organic farms are dependent on manure supply within the farming system, changes in the production orientation towards farm types without livestock are limited without considering nitrogen balances (especially with an increasing share of organic farming). Such an extreme scenario of exclusively organic farming (OrgOnly) might lead to critically low nitrogen levels in organic agriculture (Muller et al. 2017) and would, therefore, need to be accompanied by more flexible approaches for the supply of nitrogen to improve food supply.

Acknowledgements

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