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Summary

Organic farming has expanded rapidly in Europe during the last decade. In view of the latest agricultural policy reform (Agenda 2000), the current political climate and a continuously growing demand for organic products, a further expansion of organic farming seems likely. In view of these prospects, the objective of this study is to provide a quantitative assessment of the impacts of a significant expansion of organic farming in the European Union on agricultural production, markets and the environment. In addition, the study analyses the possibilities for providing prognoses and policy assessments for organic farming within the chosen modelling approach.

As an introduction, the development of organic farming in the European Union is outlined, and important factors influencing its expansion are discussed. A literature review shows that over time financial motives have gained in importance in comparison to philosophical and environmental motives. Economic aspects therefore contribute considerably to the understanding of the significant differences in the regional and chronological development of organic farming in Europe. Existing studies which have analysed the impacts of widespread conversion to organic farming are confined to regional or national levels, and are often based on the extrapolation of comparative farm level calculations. No study exists which has analysed an expansion of organic farming in the European Union.

To allow an EU-wide modelling and quantitative analysis of an expansion of organic farming, the **modelling system CAPRI** was extended and adjusted. CAPRI is a comparative-static agricultural sector model covering both supply and demand for agricultural products, and is used for ex-post and medium-term ex-ante analyses of the Common Agricultural Policy. Agricultural supply is presented by 207 regional programming models. The main advantages of the CAPRI modelling system with respect to the objectives of this study are a relatively detailed regional differentiation, a high disaggregation of agricultural production, a consistent representation of the most important instruments of EU agricultural policy and the possibility of linking supply and market models. As the market module of CAPRI was not available at the time of the modelling, the market model GAPsi was used for this study.

The **data** needed for the modelling of organic farming is largely determined by the structure of the process analytical supply model used, and includes information on activity levels in the base year, process-specific input-output-coefficients as well as prices and support payments for organic farming. Most of the data used was collected in the EU research project „Organic farming and the CAP" (FAIR3-CT96-1794) with the help of national experts. Remaining data gaps were closed using consistency preserving estimation procedures. The implementation of organic farming in the model requires the specification of the special characteristics of this farming system, in particular the restrictions with respect to fertilisers, livestock rearing and feeding. For ex-ante analyses, input-output-coefficients are forecasted for the target year 2005. In this respect, the study discusses possible divergent trends of yields and prices in organic and conventional production. It becomes apparent that data availability and the high dynamic of organic market development currently do not allow any well-founded quantitative prognosis of the future demand for organic products. Different scenarios are therefore calculated to identify the influence of the development of demand on the results.

An endogenous determination of the expansion of organic farming within the existing model poses several methodological problems. Therefore, in a first step, the share of organically managed land is fixed exogenously, which allows the calculation of the direction and the level of the effects of an expansion of organic farming. The main **scenarios** analysed cover an EU-wide share of organic farming of 0, 10 and 20 % respectively of the total agricultural area. All scenarios refer to the year 2005, with agricultural policy implemented according to the Agenda 2000 agreement. New equilibrium prices were determined by iteratively linking the regional supply models and the market model GAPsi. The impact of an expansion of organic farming is analysed with respect to changes of production structure, quantities produced, development of conventional farm gate prices, gross value added, budgetary expenses and selected environmental indicators in the target year 2005. As a reference, a simulation run based on organic farming levels observed in 1997 is used.

An EU-wide expansion of organic farming to 10 % or 20 % of the total agricultural area has a significant effect on several policy-relevant indicators, but this impact is less than often projected on the basis on farm level comparative calculations. This is due to several different intra- and inter-sectoral feedback loops:

- The reduced supply of many agricultural products leads to an increase of conventional prices, which in turn provides an incentive to increase production.
- The design of the agricultural policy of the EU more or less fixes the production of some goods. The quota system for milk and sugar essentially means

that any potential reduction of production on individual farms is compensated for by the transfer of quotas to other farms.

- The reduced stocking rates and the higher shares of forage in feeding rations in organic farming systems lead to a lower demand for feed concentrates. The resulting decrease in the consumption of feed grains offsets part of the reduction of cereal production.
- The higher number of calves from milk production sustains sectoral beef production and thus counteracts the impacts of the reduced importance of beef fattening in organic farming systems.

Taking into account these stabilising effects, the following impacts of an expansion of organic farming to 10 % or 20 % of total agricultural area can be recorded:

Production structures change significantly due to the changed price ratios and the differences in organic and conventional farming systems. The cereal area increases slightly for higher shares of organic agriculture. While the shares of wheat and rye areas increase, the areas used for maize and barley decrease. One of the major changes is the significant reduction of the area of silage maize, with the freed land being used for other arable fodder crops. Former voluntary set-aside and fallow land is increasingly being used for production by conventional farms in response to the decreased availability of agricultural land and the higher prices for agricultural products. The number of dairy cows increases, as dairy yield in organic farming is lower, and the milk quota is still fully utilised.

Production of almost all products declines with increasing shares of organic farming, with quota products being the notable exception. Particularly large is the decrease of the production of barley and oilseeds (9 % and 6 % less respectively for the scenario „20 % organic farming“), whereas the impacts on pig and poultry production are small. Due to the reduction of livestock numbers and the greater importance of forage in feeding rations in organic farming, the use of cereals for feeding decreases with increasing shares of organic farming, and thus the sectoral net-decrease of cereal supply is significantly lower than the reduction of cereal production.

For several agricultural products, the model results imply a slight increase of farm gate prices due to the reduced supply. An exception are those cereals for which the price is determined by the intervention system even with Agenda 2000 reforms implemented. Calf prices fall, because the number of calves produced increases as a result of the higher number of dairy cows, while at the same time intra-sectoral demand for male calves decreases.

The quantitative analysis of several **environmental indicators** reveals a positive impact on nutrient balances, the use of plant protection products, and the emission of greenhouse gases. For the evaluation of local environmental effects, for example nitrate leaching, it needs to be taken in to account that the model results differ significantly between regions. The reduction in livestock numbers, a consequence of the conversion to organic farming for some farms, is one of the main environmental influence factors. In regions with high stocking rates, and often correspondingly high nutrient surpluses, the environmental contribution of an expansion of organic farming is therefore greater. In contrast, for global environmental problems like the greenhouse effect, the contribution is independent of the geographical distribution of the reductions. However, in this respect it is important to take into account that the decrease of agricultural production in the EU which results from the expansion of organic farming is partly compensated for by an increase of production in other parts of the world, and a corresponding increase in greenhouse gas emissions. A final evaluation can therefore only be made within the framework of a global model.

In a second step, the study analyses the possibilities for providing **prognoses and policy assessments** for organic farming within the chosen modelling approach. The allocation steering based on positive mathematical programming (PMP) proves to be overly inert with respect to the diffusion of innovations in its original implementation, and is therefore not suited for an endogenous determination of the expansion of organic farming for the scenarios analysed. The development of a modified version made it possible to overcome this restriction while preserving the advantages of the PMP-method with respect to the perfect reproduction of observed base year levels and the avoidance of over-specialised border solutions. The new formulation of the cost function assumes the non-linear term of the variable costs of organic farming to depend on the ratios of activity levels but to be largely independent of the total share of organic farming. The chosen functional form implies linear cost increases for increasing shares of organic farming for constant ratios of activity levels. The expansion of organic farming is restrained by the increase in income losses arising from higher reductions in conventional farming, and by cost changes induced by the LP restrictions. This approach is assessed to present a feasible solution for modelling new activities for which PMP terms cannot reliably be estimated. With this approach, the expansion of organic farming under different framework conditions is essentially dependent on the relative competitiveness of conventional farming.

Using the newly developed approach, the **impact of changing framework conditions** on the expansion of organic farming is analysed. In addition to the cur-

rently much-discussed increase of the support for organic farming and its financing by decreasing other agricultural support payments, the calculations also look at the consequences of a complete reduction of the price mark-ups available for organic products. For all of these scenarios, an expansion of organic farming to 20 % of the total agricultural area in the EU is achieved by raising support payments for organically managed land. The analysis therefore highlights the differences in results that occur from the different effects that changing conditions have in different regions and for different activities.

First, a uniform **increase in area payments** for organic farming is analysed, while assuming constant farm gate prices for organic products. The increase in support is chosen such that according to the model solution, 20 % of the total agricultural area in the EU is converted to organic management. The increase in organic area varies between member states. The relative increase is low in regions where support is already high in the base year, in regions where organic farming is already widespread in the reference scenario, and in regions with very intensive agricultural systems. The expenses for the support of organic farming increase significantly, raising doubts about the financing within the existing EU budget plans for the development of rural areas.

An increase of the available budget could be achieved by means of the so-called **modulation**. The Agenda 2000 offers the opportunity for member states to cut direct payments to agriculture and use the retained EU funds for certain measures for the development of rural areas. The reduction of the direct payments for arable area and animals affects all farms. Under the scheme analysed in this study, the effects on the relative competitiveness of organic and conventional farming systems are marginal, and an expansion of organic farming to 20 % of the total agricultural area is achieved using the same level of support payments as in the scenario without modulation. Significant differences exist, however, with respect to sectoral output quantities. Several activities suffer a loss in competitiveness as a consequence of the reduction of direct payments. The area used for cereals and oilseeds is reduced, and beef production is curbed. Fallow land as well as arable fodder area is expanding, and the share of forage in feeding rations is increasing. The adjustments of production structure can be observed for both farming systems, but are generally lower in organic farming. Here, substitutions between different activities are more difficult to realise due to the higher importance of intra-farm interconnections and the legal restrictions with respect to the use of external inputs.

An expansion of organic farming induced by higher support payments poses the danger that farm gate prices for organic products fall and that in turn the financial attractiveness of organic farming is diminished. An expansion of organic

farming to 20 % of the total agricultural area with a **complete reduction of the price mark-ups for organic products** can only be achieved with a significant **increase in the support payments** for organic management. The model calculations highlight the considerable changes in the regional expansion and the production structure which result from a uniform increase in support payments for organic farming in this scenario. The relative competitiveness of agricultural activities in organic farming changes. Compared to the scenario with constant organic prices, the production of organic products decreases due to the shift of production to more extensive areas. Organic pig and poultry production is drastically reduced, since the revenue loss for these activities cannot be compensated for by reduced feeding costs. The regional importance of organic farming is shifted significantly. In regions where revenues in organic farming are high in the reference situation, the uniform increase of the payments cannot always compensate for the reduced prices despite the adjustments of production. Higher support payments coupled with a reduction of the price mark-ups for organic products further shifts the attractiveness of organic farming in favour of extensive farms and regions.

The model results point to the significant influence the regional distribution of organic farming, and the distribution of converting farm types, has on the extent of potential impacts of a more widespread conversion. This highlights the scope for policy making to pursue policy objectives more efficiently by designing the support programs accordingly. To be able to provide extended recommendations with respect to more targeted support programs, future studies will need to also discuss the „optimal“ share of organic farming with respect to existing policy objectives. In view of the multitude of agricultural policy objectives, the complexity of interrelations, and often incomplete information, dealing with this question poses an ambitious project that can probably only be solved step-by-step.

For the questions examined in this study, the adaptation of the modelling system CAPRI has proved to provide a suitable instrument for analysis. The improved availability of data will in the future enable a more detailed modelling of organic farming. To facilitate a prognosis of the development of organic farming, the coordinated application of different models within the framework of a model group should be investigated.