

Prospects for Cereal Yields in Switzerland: Climate Change, Socioeconomic Conditions and Technological Development as Drivers of Future Crop Yields

Robert Finger, ETH Zürich, Institute for Environmental Decisions, Agri-Food and Agri-Environmental Economics Group. Contact: rofinger@ethz.ch

Motivation

The development of crop yields is a frequently used “indicator” to assess impacts of climate change on agriculture because crops are directly affected by changes in environmental and climate conditions. Recent studies (e.g. Ewert et al. 2005) suggest that the impact of climate change on crop yields must not be analyzed without taking adaptation, changes in socioeconomic conditions and technological development into account. In this study we show the potential effects of changes in these determinants on Swiss cereal yields.

Background

Both biophysical (Torriani et al. 2007) and economic (Finger and Schmid 2007) modeling approaches are recently used to assess impacts of climate change on Swiss cereal yields. It shows that climate change will, in particular due to the CO₂ fertilization effect, lead to higher Swiss cereal yields in the next decades. Moreover, these model results suggest that it is indispensable to take adaptation into account in order to avoid overestimation of (negative) climate change impacts.

If, and to what extent, adaptation measures are taken furthermore depends on the development of market conditions. Therefore, the expected crop price decline in Switzerland (due to market liberalization) will affect adaptation – such as the adoption of irrigation farming – and is thus important for the impact of climate change on cereal yields. Model results show that the expected price decline might have larger impacts on cereal yields than climate change (Finger and Schmid 2007).

Besides changes in climatic and market conditions, a third pillar of crop yield development has to be considered: technological development. Swiss cereal yields more than doubled in the last fifty years due to technological development: e.g. improvements in crop varieties, adaptation to environmental conditions, mechanization, and use of fertilizers and pesticides (Finger 2007). Because further development is expected to come from similar sources, technological development will be an important determinant of future cereal yields.

Methodology

In order to assess the future development of Swiss cereal yields and yield variability, the three pillars, i.e. climate change, socioeconomic conditions and technological development, have to be analyzed together. Winter wheat and corn yields are used as reference crops in our study. Following Ewert et al. (2005), single effects are combined based on scenario assumptions. Climate (change) scenarios for 2030 and 2050 are considered in our analysis (Finger and Schmid 2007). Moreover, scenarios for future development of socioeconomic conditions are adapted from Ewert et al. (2005) and properly adjusted to the Swiss case.

In the recent IPCC report, Alcamo et al. (2007) show, for the European agriculture at large, that climate change is expected to lead to small increases in crop productivity. However, they conclude that technological development might far outweigh these climate induced effects.

Results

Results derived for Switzerland are consistent with the results for the European agriculture at large (Alcamo et al. 2007). Climate change is expected to increase Swiss crop yields to a small extent. Winter wheat yields, for instance, are expected to increase by 6-7% due to climate change by 2050 (Finger and Schmid 2007). However, crop yield development in Switzerland might be even more affected by nonclimate issues than in other countries. Firstly, the expected relative decline of output prices due to market liberalization is much higher than for other European countries and thus will have a much higher impact on crop farming systems. Secondly, agricultural policy in Switzerland is different than, for example, in the European Union. Policy measures towards environmental friendly crop production were introduced earlier (and are more demanding) than in the European Union. Because of such policy measures, Swiss cereal yields already show a trend of saturation that is not observed in many other European countries yet (Finger 2007). Thus, policy induced effects on cereal yields in Switzerland already do, and will in future, outweigh climatic effects. Furthermore, agricultural policy might play a decisive role for adaptation to climate change and thus for crop yield development. Input (e.g. nitrogen) restrictions, for instance, might hamper intensification of cereal production and thus optimal adaptation. In contrast, governmental support to adaptation measures (e.g. irrigation systems) can enable sufficient adaptation to climate change.

In conclusion, we find effects of both socioeconomic and technological development to be more important for the development of Swiss cereal yields than effects induced by climate change. Moreover, we point out the importance of agricultural policy for the future development of cereal yields.

References

- Alcamo, J., J.M. Moreno, B. Nováky, M. Bindi, R. Corobov, R.J.N. Devoy, C. Giannakopoulos, E. Martin, J.E. Olesen, A. Shvidenko (2007): Europe. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 541-580.
- Ewert, F., M.D.A. Rounsevell, I. Reginster, M.J. Metzger, and R. Leemans (2005): Future scenarios of European agricultural land use - I. Estimating changes in crop productivity. *Agriculture, Ecosystems & Environment*, Vol. 107, Nos. 2-3, pp. 101-116.
- Finger, R. (2007): Evidence of slowing yield growth – the example of Swiss cereal yields. MPRA Paper No. 4972, University Library of Munich, Germany. http://mpra.ub.unimuenchen.de/4972/01/MPRA_paper_4972.pdf
- Finger, R. and S. Schmid (2007): Modeling Agricultural Production Risk and the Adaptation to Climate Change. Paper presented at the 101st EAAE Seminar "Management of Climate Risks in Agriculture", July 05-06, 2007, Berlin, Germany.
- Torriani, D., P. Calanca, S. Schmid, M. Beniston, and J. Fuhrer (2007): Potential effects of changes in mean climate and climate variability on the yield of winter and spring crops grown in Switzerland. *Climate Research* 34, 59-69