Impact of Global Change on agricultural land use in the Austrian Upper Danube catchment – first results of ACRE-Danube

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***Abstract* - ACRE-Danube is an Agro-eConomic model for agricultural pRoduction on rEgional level and was developed as a decision tool for politics with respect to questions of global change- and political scenarios for the upper Danube basin. In order to estimate the impacts of global change on the Austrian part of the Danube river basin, scenarios were calculated where global change as well as the CAP reform 2003 were considered. This paper introduces the first results of the scenario calculations.** [1]

Global Change and Agricultural Production

Agricultural production is influenced by climatic, biological, physical, socio-economic, political and technological environment. Thus, the potential impact of global change on agricultural landuse is highly uncertain and not easy to estimate. Impact studies on agricultural land use tend to focus either on the consequences of economic and political conditions or on climate change. Only few studies explicitly consider both – socio-economic and climate change factors. Using the optimisation model ACRE-Danube we calculated scenarios which considered political conditions as well as estimated impacts of global change. The political conditions were included in the form of selected measures of the CAP (Common Agricultural Policy) reform 2003. The climate change and technological advance factors were simulated as crop productivity factors for four scenarios of the ICCP (Intergovernmental Panel on Climate Change) scenario family.

The Optimisation Model ACRE-danube

ACRE-Danube is a comparative static partial-equilibrium model, which maximises the total gross margin on a regional level by calculating optimal production. The optimisation approach of the ACRE-Danube is based on the extension of Positive Mathematical Programming published by Röhm & Dabbert (2003).

Agricultural production in each of the model's sub regions at district-level (NUTS-level 3) is represented by a single farm. The simulated period is one year. Agricultural production includes 19 food and non food crops, as well as 12 production processes for livestock. The model consists of a process analytical approach, feeding of animals and fertilization of crops are optimized by using feed and manure produced model-endogenously. Trade between the districts is not possible.

ACRE-Danube is calibrated with statistical data for the reference year 1995. The complete model region of ACRE-Danube includes a total of 74 districts out of which 16 districts are located in Austria. Through variation of agricultural input parameters (e.g. crop yields and subsidies) economic, political and climate change scenarios can be simulated.

Global Change Scenarios

Agricultural Policy

The agricultural policy scenario of CAP reform 2003 was modelled in ACRE-Danube by assuming reformed payments according to BMLFUW (2003) and AMA (2005).

Single Farm Payments were derived for the Austrian districts on the basis of the calculated average of direct payments received for crops and livestock, as well as the reference amount of milk within the period from 2000 to 2002. *Coupled direct payments* are granted for protein and energy crops as well as for suckler cows. Selected elements of *Cross Compliance* (e.g. erosion prevention) are taken into account while *Modulation* is not considered. *Compensatory Allowances for Mountain or Less Favoured Areas* and *Agri-environmental Payments* are also implied in ACRE-Danube as well as changes of set-aside rates.

These agricultural policy conditions are currently considered up to the year 2013. However, due to lack of information we consider the agro-political conditions of the year 2013 for the calculated scenario year 2020.

Climate Change and Technological Advance

In order to simulate global change with respect to climate change and technological progress, crop yield data were modified. Basic yield data of ACRE-Danube were modified by yield change factors estimated by Ewert et al. (2005), who developed a coherent, internally consistent and plausible set of four crop productivity scenarios based on the IPCC SRES (Special Report on Emissions Scenarios) framework. The scenarios consider different effects of climate change and increasing CO_2 as well as

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technology development, in particular crop management and breeding. For the scenario calculations in ACRE-Danube, the total crop productivity modification factors were used, cf. Table 1.

Table 1. Factors of crop productivity relative to basis yield for different parameters and IPPC SRES scenarios in 2020 (Nakićenović et al., 2000).

Parameter	IPCC scenario			
	A1FI[a]	A2[b]	B1[c]	B2[d]
Climate	0.99	0.99	1.01	1.00
Co_2	1.04	1.04	1.03	1.04
Technology	1.37	1.37	1.30	1.20
Total	*1.41*	*1.40*	*1.34*	*1.25*

[a] Global economic and fossil fuel intensive world, [b] Regional economic world, [c] Global environmental world, [d] Regional environmental world. Source: Ewert et al. (2005)

RESULTS

Table 2 represents the development of acreages for selected crops in the years 2002 and 2020 for 4 ICCP SRES scenarios within 16 Austrian districts. The selected crops represent those with the largest share of acreages.

The comparison between the scenario of the year 2002 (Agenda 2000 with no changes of crop productivity) and the ICPP scenarios in the year 2020 (CAP reform scenario and assumed crop productivity modifications) illustrates that the area of silage maize decreases by 3 to 4 % while clover and set-aside increases by 2 to 3 % respectively by 7 %. The differences between the acreages in the IPCC scenarios is no higher than 1 % for silage maize and clover between scenario A1FI and the other scenarios. The increase of the obligatory set-aside area is mainly on account of other fodder cereals (e.g. winter barley).

Table 2. Development of fodder crops and set-aside in the Austrian Danube catchment area for the year 2002 and different IPPC SRES scenarios in 2020 based on Ewert et al. (2005) in percentage of total acreage of arable land.

	2002	2020			
		A1FI	A2	B1	B2
Silage maize	16	12	13	13	13
Clover	24	27	26	26	26
Set-aside	3	10	10	10	10

Source: own calculations

Regions with a high share of grassland (e.g. Bludenz) may increase their total gross margin (TGM), whereas regions with a high share of arable land undergo a decline in TGM (e.g. Braunau) compared with 2002.

Decreases in acreage of silage maize and increases in clover may be explained by substitution of silage maize by clover as fodder crop. The reason for this substitution is changes in subsidies. In 2002 clover did not receive a premium and silage maize received 332 EUR per hectare; thus, clover is increasing in profitability in comparison to silage maize and partially replace silage maize. The increase in set-aside area is caused by the increase of prescribed set-aside area in CAP reform to 10 % of arable land.

The changes in crop productivity variation may be considered less significant because the differences between the changes of crops between the IPCC scenarios are quite small even though the differences in crop productivity factors are relatively large. The difference between the crop productivity modification factor of scenario A1FI and B2 count 16 % while differences between the shares are only 2 to 3 %.

The increasing tendency of total gross margin for districts with high share of grassland is caused by the increase of payments received for the complete agricultural area by *Single Farm Payments*. In Agenda 2000 only payments for environmental programms were received for grassland.

CONCLUSIONS AND DISCUSSION

According to scenario calculations presented here, CAP reform and global change will result in a slight change in agricultural land use with respect to fodder crops.

The influence of technical advance and climate change is small. However, it should be taken into consideration that the assumed changes in crop productivity comprise only a short projection period and are represented by only one factor for all crops. Simulation of crop specific yield changes for longer periods may reveal a more significant land use change.

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