Scenarios for the Austrian agricultural sector until 2025 considering climate change mitigation

Szenarien für die österreichische Landwirtschaft bis 2025 unter Berücksichtigung von Maßnahmen zur Vermeidung von Treibhausgasen

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Summary

This paper presents scenarios on the development of the Austrian agricultural sector in 2025 under current policy reforms. We apply a bottom-up land use model that captures structure, management, and relevant policies. It maximises agricultural producer surplus given exogenous variables, among them projections on future prices, land availability and technological restrictions. The results allow conclusions on climate change mitigation. They indicate increasing livestock production and substantial effects from losses of agricultural land.
Keywords: agricultural sector modelling, climate change, mitigation, Austria, Common Agricultural Policy

Zusammenfassung

Diese Arbeit präsentiert Szenarienergebnisse zur Entwicklung des österreichischen Agrarsektors bis 2025 unter den derzeitigen politischen Rahmenbedingungen. Es wird ein Landnutzungsoptimierungsmodell verwendet, um auf der Basis von exogenen Annahmen über Preisentwicklungen, Verfügbarkeit von Land und technologischen Restriktionen Auswirkungen auf Agrareinkommen, Landnutzung und Agrar-Umweltindikatoren zu ermitteln. Die Ergebnisse lassen Schlussfolgerungen für Klimaschutzmaßnahmen des Agrarsektors zu. Sie zeigen eine zunehmende Tierproduktion und substanzielle Effekte durch den Verlust von Agrarland.
Schlagworte: Agrarsektor, Modellierung, Österreich, Klimawandel, Vermeidungsmaßnahmen, Gemeinsame Agrarpolitik

Erschienen im *Jahrbuch der Österreichischen Gesellschaft für Agrarökonomie*, Band 25: 3-12, Jahr 2016. On-line verfügbar: http://oega.boku.ac.at.

1. Introduction

In its effort to meet the international obligations on emission reductions of greenhouse gases, Austria implemented the Climate Protection Act (KSG, BGBL. I Nr. 106/2011) in 2011. One of its novelties are emission targets for sectors outside the European Emission Trading System, among them the agricultural sector. The target value for the agricultural sector was 7.1 mio t CO_2 equivalents (eq) for the period 2008 to 2012. The actual emissions exceeded this value by 0.2. to 0.4 mio t CO_2eq. The share of agricultural emissions was 9.4% in 2012. Concrete emission reduction objectives for the future are defined for 2020 for agriculture including emissions from fossil fuels. The target is set to 8.48 mio t CO_2eq (BGBl. I Nr. 94/2013) compared to 2012 emissions of 8.38 mio t (BMLFUW, 2014a). In order to reach the 2020 targets the Austrian Climate Protection Act developed a framework for establishing sector specific measures. It combines traditional environmental policy instruments like standards or regulations and economic instruments. Concerning agriculture, the Agri-Environmental Program (ÖPUL) as part of the Program of Rural Development (PRD) was put into force in December 2014 and will be effective until 2020. The measures of both, the Austrian Climate Protection Act and the ÖPUL are likely to establish a new trajectory for the agricultural sector.

This analysis aims on applying a quantitative agricultural model on a policy and sensitivity scenario to analyse possible developments of the Austrian agricultural sector until 2025 and selected environmental impacts. Thereby, it focuses on climate change mitigation measures, although effects on mitigation (e.g. changes in CO_2eq) are not quantified.

The article is structured as follows: Likely sector developments are outlined next. Then, the model for the analysis is introduced before major assumptions are stated together with brief scenario descriptions. Finally, a discussion of the model results and major findings are presented.

2. Policy framework and market conditions

The model used for the quantitative assessment (see Chapter 3) reacts to external changes of key parameters, including resource availability, policy variables and market prices. Assumptions about the agricultural policy framework, future prices and constraints need to be made to derive scenario results which are then compared to an observed baseline situation. That refers to 2010-2012 and is designed to reflect market conditions during this period and the common agricultural policy (CAP) instruments in place at that time (CAP 2003 reform, Health Check 2008, and PRD 2007-2013). For the projection until 2025 the assumption was made that the PRD 2014-2020 will prevail and that the CAP reform of 2013 will be extended:

- there is a simplified cross-compliance, i.e. a bundle of environmental legislation to be met in order to receive direct payments of 691 mio € in 2019 and thereafter;
- 30% of direct payments are reserved, from 2015 onwards, for a new policy instrument in Pillar 1. Greening shall maintain permanent grassland, ecological focus areas and crop diversity;
- young farmers will qualify for special support – this will make investments in new production facilities more likely;
- part of Pillar 1 budgets will be granted as "coupled support"; in Austria 2% of direct payments will be channelled to Alpine farming to make livestock production more profitable in alpine regions;
- the transition from farm-specific historical to regionally uniform premiums will imply that cattle and milk production regions are likely to benefit (KIRNER and WENDTNER, 2012; KIRNER, 2011);
- at least 30% of the PRD budget must be reserved for voluntary measures on environmental and climate protection. The climate relevant measures in the PRD are (see KAUPE, s.a.; BMLFUW, 2014b):
    - increase pasture and alpine grazing (information, knowledge transfer, advisory services, ÖPUL);
    - adaptations in pork feeding management (knowledge transfer, advisory services, investment aid);
    - coverage of slurry tanks (investment aid), slurry fermentation (diversification aid, investment aid, renewable energy support, elementary services support) and drag hose slurry spreading (investment aid, ÖPUL);
    - organic farming, reduction of mineral fertilizer use (ÖPUL);
    - sustainable nitrate management, winter cover crops, permanent soil cover, minimum tillage, strip tillage and mulch seeding (ÖPUL);
    - fuel efficient driving of tractors and electric engines for irrigation facilities (investments in elementary services support).

Apart from measures that are explicitly focused on greenhouse gas mitigation, other policies are relevant as well. The Nitrates Directive limits the use of organic and inorganic fertilizers and defines minimum storage capacities for manure. Because N_2O has a high global warming potential, a reduction of fertilizer use creates a co-benefit. The new ÖPUL started in 2014 whereas other measures of the PRD have been implemented from 2015 onwards. Results on the first ÖPUL year show that the basic structure of the programme and the allocation of funds did not change fundamentally compared to the previous period.

3. Methods and scenario assumptions

The Positive Agricultural and Forestry Sector Model Austria (PASMA) is a bottom-up land use optimization model (e.g. SCHMID and SINABELL, 2005; SCHÖNHART et al., 2014). PASMA depicts the political, natural, and structural complexity of Austrian farming in a very detailed manner. The model structure ensures a broad representation of production and income possibilities that are essential in comprehensive policy analyses. Data from the Integrated Administration and Control System (IACS), Economic Agricultural Account (EAA), Agricultural Structural Census (ASC), Farm Accountancy Data Network (FADN), the Standard Gross Margin Catalogue, and the Standard Farm Labour Estimates provide necessary information on resource and production endowments for 35 NUTS-3 regions in Austria. The model considers conventional and organic production systems (crop and livestock), all relevant ÖPUL management measures, and the support programme for farms in less-favoured areas (LFA). PASMA maximises gross margins and is calibrated to historic crop, forestry, and livestock activities by using Positive Mathematical Programming (PMP; e.g. HOWITT, 1995). Other model features such as convex combinations of crop and feed mixes, expansion, reduction and conversion of livestock production, a transport matrix, and imports of feed and livestock are included to allow reasonable responses in production under various policy scenarios. By changing exogenous parameters (e.g. prices of outputs and inputs, premiums), constraints (e.g. available land), and technical coefficients (e.g. milk yield of cows) the model shows how agriculture is likely to adjust given that producer surplus is maximised. Dairy quotas are represented by lower producer prices for milk production above

quota thresholds. The abandonment of the quota system in 2015 is modelled by ending price discrimination for excess milk in PASMA.
The following assumptions (see table 1) were made to describe a situation *with existing measures* (WEM), i.e. measures that are already implemented or planned to mitigate climate change in Austria until 2025 (see also SINABELL et al., 2015):

- sector specific measures implemented according to the Austrian Climate Protection Act, in particular in the context of the ÖPUL;
- implementation of the CAP health check reform 2008 (mainly abolition of milk quota in 2015);
- implementation of the CAP 2013 reform (in particular abolition of sugar quota and suckler cow premium);
- regional premium scheme instead of individual historic payments
- land is maintained in good agricultural and ecological condition – "cross compliance" and requirements for “greening” (in particular crop rotation requirement) are met;
- the PRD is maintained in a slightly modified way with different premiums (in particular for less favoured areas and organic farms);
- loss of agricultural land is going to follow the long term trend;
- increase of milk yield per cow by 15% (2020) and 22.5% (2025) relative to reference period (6,418 kg).

All price projections are specific for the Austrian market situation and – apart from milk price projections – are based on OECD-FAO (2014; for details see SINABELL et al., 2015). Concerning the milk price development, lower prices for Austria are assumed due to likely milk production increases. Lower prices may prevail over a longer period until a new equilibrium is established (see SCHMID et al. 2011 for more elaborations on this expectation). The assumption on future milk prices is crucial because Austria has a comparative advantage in milk production and model results are very sensitive to changes of relative prices. Increasing milk yields increase feed demand in PASMA but all other variable costs are assumed to be unaffected. Feed demand is either supplied by regional production or imports. Changes in production result from increasing productivity over time and eventually increasing intensity. Climate change effects are not considered in this study due to the rather short period until 2025 but can be considerable (e.g. KIRCHNER et al., 2016; SCHÖNHART et al., 2014).

Tab. 1: Overview of scenarios assumptions

	REF	WEM		WEMsens
	2010/12	2020	2025	2020
market prices				
OECD/FAO 2014		yes	yes	yes
milk price forecast; € cent/kg	32	28	30	30
energy costs specific forecast		yes	yes	yes
CAP Pillar 1				
milk quota	yes	no	no	no
coupled livestock premia	yes	no	no	no
regional direct payments	no	yes	yes	yes
greening (CAP reform 2013)	no	yes	yes	yes
CAP Pillar 2 payments p.a or per ha				
Total volume mio €	1,034	1,090	1,090	1,090
ÖPUL volume mio €	527	472	472	472
organic farming scheme mio €	89	112	112	112
other premia mio €	438	330	330	330
organic premium grassland €/ha	110-240	70-225	70-225	70-225
organic premium cropland €/ha	110-285	230-450	230-450	230-450
org. prem. permanent crops €/ha	< 600	< 700	< 700	< 700
ban of agri-chemicals €/ha	50	60	60	60
UBAG/UBB arable land €/ha	85	15-45	15-45	15-45
UBAG/UBB grassland €/ha	50-100	15-45	15-45	15-45
index farmland hectares	100	98.4	97.7	100
index milk yield per cow	100	115	122.5	100
climate act measures 2013/2014	no	yes	yes	yes

Abbreviations: REF = reference scenario, WEM = with existing measures; WEM-sens = sensitivity scenario of WEM
Source: OWN CONSTRUCTION

Resource constraints are among the most important exogenous parameters of PASMA. For WEM until 2025 the availability of agricultural land was adapted in order to take into account the observed current average annual loss of 8,000 ha of agricultural land. In order to assess the effect of particular assumptions a sensitivity scenario (WEMsens) is considered. It varies the milk price and the assumptions on farm land loss and milk yields.

4. Scenario results

The results of WEM and WEMsens are presented in Table 2. Due to the assumed loss of land, arable land and grassland decline until 2025. Maize and silage maize become more profitable. Due to moderate yield growth assumptions, the harvested in 2025 is expected to surpass observed levels. Slightly lower expected prices for sugar in the future and the restricted land will imply a lower harvest of sugar beets.

Tab. 2: Results for the reference period and scenarios

		REF	WEM		WEMsens
		2010/12	2020	2025	2025
arable land	1,000 ha	1,370	1,307	1,245	1,255
perman. grassland[1)]	1,000 ha	1,028	957	927	941
temp. grassland[2)]	1,000 ha	59	57	54	54
cover crops	1,000 ha	318	305	291	286
crop harvest					
wheat	1000 t	1,537	1,500	1,500	1,500
rye	1000 t	197	200	200	200
barley	1000 t	871	800	800	800
oats	1000 t	105	100	100	100
maize corn	1000 t	2,204	2,200	2,300	2,300
potato	1000 t	716	700	700	700
sugar beet	1000 t	2,971	3,000	2,900	2,900
silomaize	1000 t	3,826	3,800	4,000	4,000
rape	1000 t	163	200	200	200
sunflower	1000 t	70	100	100	100
soja bean	1000 t	59	100	100	100
dairy	1,000 head	529	531	547	530
non-dairy	1,000 head	1,479	1,418	1,346	1,349
suckler cows	1,000 head	268	253,400	240	244
swine	1,000 head	3,162	3,203	3,399	3,427
fattening pigs	1,000 head	2,093	2,129	2,255	2,274
breeding	1,000 head	303	299	322	323
chicken	m head	13,136	12.695	10.718	11.221
layers	m head	6,793	6,555	5,804	5,996
broilers	m head	6,343	6,140	4,913	5,224
other poulty (total)	1,000 head	699	740	704	734
nutrient sales	1,000 t	108	100	90	93

1) permanent grassland excluding alpine grassland; 2) temporary situated on cropland; m head: million head

Source: OWN RESULTS

A significant change is modelled in dairy production. Due to its comparative advantage, the abolition of the dairy quota in 2015 and the abolition of the suckler cow premium, the number of dairy cows will likely increase at the cost of suckler cows. The results also indicate an increase in pork production due to the price forecasts of OECD-FAO (2014), which indicate comparable favorable market conditions not only for milk but also for meat. The scenario results of lower sales of fertilizer are explained by the fact that land is shrinking and upper limits on per hectare doses from the Nitrates Directive and the ÖPUL restrict the use. With respect to production intensity, the sales of mineral nutrients likely decline due to shifts from agriculture to other land uses, increasing production of manure from livestock and high participation rates in ÖPUL. Results of WEMsens are more similar to the REF than WEM results due to the higher milk prices compared to WEM and the assumption of zero land losses. Nevertheless, land utilized by agriculture is lower in WEMsens than REF due to a decreasing profitability in some sectors. The results for WEMsens indicate that important drivers of model results are milk prices, milk yields per cow and assumptions on loss of farm land.

5. Discussion and conclusions

The presented scenarios explore possible developments for Austrian agriculture in the coming decade. WEM and WEMsens more or less describe variants of a business as usual situation. The analysis highlights three major developments of future of land use and production: the ongoing loss of agricultural land, the abolition of the milk quota regime and relatively favorable market conditions for milk and meat producers based on OECD-FAO (2014). The shift of direct payments from cropland to grassland dominated regions of Austria is important as well. It will support milk producers in areas with unfavorable conditions to cover fixed costs throughout the coming decade. Such an outcome hinges on the assumption that a newly reformed CAP will continue today's programs in a similar way. The focus of the PRD towards climate protection reduces greenhouse gas emissions of national production but global effects of land use extensification in Austria are not covered by this study.

The applied methodology appears well suited to provide medium-term scenarios. This view is justified because the model takes both agricultural policies as well as price effects into account and provides consistent results on land use and livestock production in Austria. This is an advantage compared to expert-based scenario methods without model support.

When interpreting results, important assumptions need to be remembered though. For example, while the calibration to observed production levels and processes leads to a perfect representation of the reference situation, results on major structural shifts such as the abolition of the dairy quota system may be biased. PASMA does not yet take investment costs into account, which is particularly important for long term investments such as in livestock production. PASMA provides aggregated results at regional level, which underestimates farm level constraints such as on manure management. Besides model uncertainties, uncertainties from input data and scenario assumptions, such as on future farm prices and policies are substantial. Consequently, the strength of PASMA is rather in its capability to compare alternative price and policy scenarios.

Acknowledgements

The definition of mitigation measures is based on input by the Federal Environmental Agency which also supported the quantitative work. Feed-back from stakeholders during the scenario development process is gratefully acknowledged. This publication was supported by the project ADAPT-CATMILK of the Austrian Climate and Energy Fund (contract no. KR13AC6K11112) and by the BMLFUW Project 101114 - FACCE Knowledge Hub MACSUR 2.

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