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ÖSTERREICHISCHES INSTITUT FÜR WIRTSCHAFTSFORSCHUNG

Austrian Agriculture 2010-2030

Consequences of Measures to Mitigate Greenhouse Gases

Franz Sinabell (WIFO),
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Research assistance: Dietmar Weinberger (WIFO)

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AUSTRIAN INSTITUTE OF ECONOMIC RESEARCH

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Austrian Institute of Economic Research, University of Natural Resources and Applied Life Sciences, Vienna

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Abstract

The report presents forecasts on the production of the Austrian agricultural sector until the year 2030 taking into account policy measures to mitigate greenhouse gas emission. A detailed partial equilibrium model of Austrian agriculture is used to carry out the quantitative analysis. Production changes are driven by externally given prices and politically determined restrictions on land and input use. Price trends are based on projections of OECD and FAO from mid-2010. The results show a slight increase in cattle production which is due to the abandonment of the milk quota regime, to be expected in 2015. Following historical trends, a reduction of agricultural land is assumed to prevail over the next decades.

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Contents

Figures and Tables

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1 Introduction

Austria has to meet several obligations in the context of climate strategies and in accordance with EU regulations and international treaties. Apart from an annual report on air pollution inventories, forecasts on greenhouse gas emissions have to be provided. These forecasts provide a basis for the evaluation of past measures and potential needs for future measures to meet emission targets.

The development of the Austrian agricultural sector for the period 2010 to 2030 and its production and environmental impacts are the core focus of this analysis. The report is structured as follows: Likely sector developments are outlined next, followed by a short summary of the international situation on agricultural markets. Then, the model for the analysis is introduced before major assumptions are stated together with brief scenario descriptions. Finally, a short discussion of the model results and the major findings of the sensitivity scenario are presented. In the Appendix the detailed results of the scenarios are presented.

2 Framework of the analysis

The development of the agricultural sector is mainly analysed from impacts of the demand for farm commodities and public services, and of technological progresses. The commodity markets are increasingly characterized by a reduction of trade impediments. Global demand for food and technological progresses are the main driving force of sector developments. The transmission of demand and supply takes place via prices which are assumed to be set on global markets. Given the small size of Austria within EU-25, an assumption can be made that any supply or demand shift does not affect equilibrium prices.

In the past, many agricultural commodity prices were either set directly by policy makers or reflected heavy policy intervention. In some markets (e.g. milk and sugar) this is even true today. However, a reduction of farm commodity prices, initiated in 1992 in the EU (1995 adopted in Austria, as well) with a further bold step during the Agenda 2000 reform in 1999 and a further corroboration during the 2003 reform of the Common Agricultural Policy (CAP). Domestic prices of many important markets (grains and meat) have been near world market equilibrium during 2000 to 2006 and since 2007 agents on EU markets have been exposed to the high price volatility that had been confined to world markets in the past. Currently there are no signs that farm policy will intervene in markets as heavily as it did in past decades.

Nevertheless EU farm policy is concerned about price volatility and several EU member states have implemented schemes to help farmers to confine the consequences of volatile markets.

The demand for agricultural commodities has surged in recent years due to two major developments:

- several states - including the EU - have implemented very ambitious targets for biofuels which require feedstocks that are produced on agricultural land;
- economic growth at a global scale has been relatively high during recent years (apart from the dip in 2008 and 2009) and large populations can afford more and better food.

Apart from demand for farm commodities, there is a significant demand for public goods which are provided by agriculture. This demand is no longer increasing - compared to the situation around 2005 - but it is still relevant for most production decisions in Austria. There are aspects that fall in two classes:

- the active provision of goods and services for which private markets do not exist (like open landscape, bio-diversity), and
- the reduction of production intensities and emissions below the legally binding level of standards (e.g. support for organic farming, plantation of winter cover crops).

To the extent that discretionary policy interventions in farm commodity markets were reduced over the last decade, programmes to stimulate the support of public goods which addressed the farm sector, have proliferated.

The framework of the analysis is given by three major assumptions

- The development on farm commodity prices is mainly driven by the demand for farm commodities and technological progresses. In affluent societies with low population growth, the overall volume of food consumption will be relatively constant. Therefore, changing demand trends affect mainly the composition of food components (e.g. substitution of red meat by white meat). The demand from domestic market is only one determinant in agricultural markets. Due to a world wide growing population with better incomes the demand for food will be increasing at a faster pace. Given that EU markets are globally integrated this development will have an impact on EU agriculture.
- Society will be willing to pay for non-commodity outputs of the agricultural sector in future, however, the large increase observed in recent years will come to a halt.
- Technical progress will further shift agricultural supply curves to the right, however, likely at a lesser scale than previously observed due to environmental programmes.

These assumptions are made operational in an agricultural sector model for Austria which was developed to evaluate farm policy changes. Given the partial character of the model, further assumptions must be made concerning the actual price levels. These are taken from publication focussing on market trends at EU-level.

3 Modelling the Austrian Agricultural Sector

In this chapter, we present an approach that strives to meet these challenges of forecasting agricultural production in a very detailed manner. The Positive Agricultural Sector Model Austria (PASMA) is employed to estimate the impact of the 2003 CAP reform on selected agricultural and environmental indicators to measure rural/agricultural development. PASMA depicts the political, natural, and structural complexity of Austrian farming in a very detailed manner (Figure 1).

The structure ensures a broad representation of production and income possibilities that are essential in comprehensive policy analyses, i.e., development analysis. 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 40 regional and structural (i.e., alpine farming zones) production units in Austria.

Consequently, PASMA is capable to estimate production, labour, income, and environmental responses for each single unit. Most production activities are consistent with EAA, IACS and ASC activities to allow comparable and systematic policy analyses with official, standardised data and statistics.

The model considers conventional and organic production systems (crop and livestock), all other relevant management measures from the Austrian agri-environmental programme ÖPUL, and the support programme for farms in less-favoured areas (LFA). Thus the two most important components of the programme for rural development are covered on a measure by measure basis. Future model development will focus on farm investment aid and additional diversification measures. Apart from major components of the programme for rural development the complete set of CAP policy instruments is accounted for, as well. Both, the set of instruments before and after the 2003 reform are modelled explicitly.

The model maximises sectoral farm welfare and is calibrated to historic crop, forestry, livestock, and farm tourism activities by using the method of Positive Mathematical Programming (PMP). Howitt (1995) has initially published PMP and since then it has been modified and applied in several models e.g., Lee and Howitt (1996), Paris and Arafini (1995), Heckelei and Britz (1999), Cypris (2000), Röhm (2001), Röhm and Dabbert (2003). This method assumes a profit-maximizing equilibrium (e.g., marginal revenue equals marginal cost) in the base-run and derives coefficients of a non-linear objective function on the basis of observed levels of production activities.

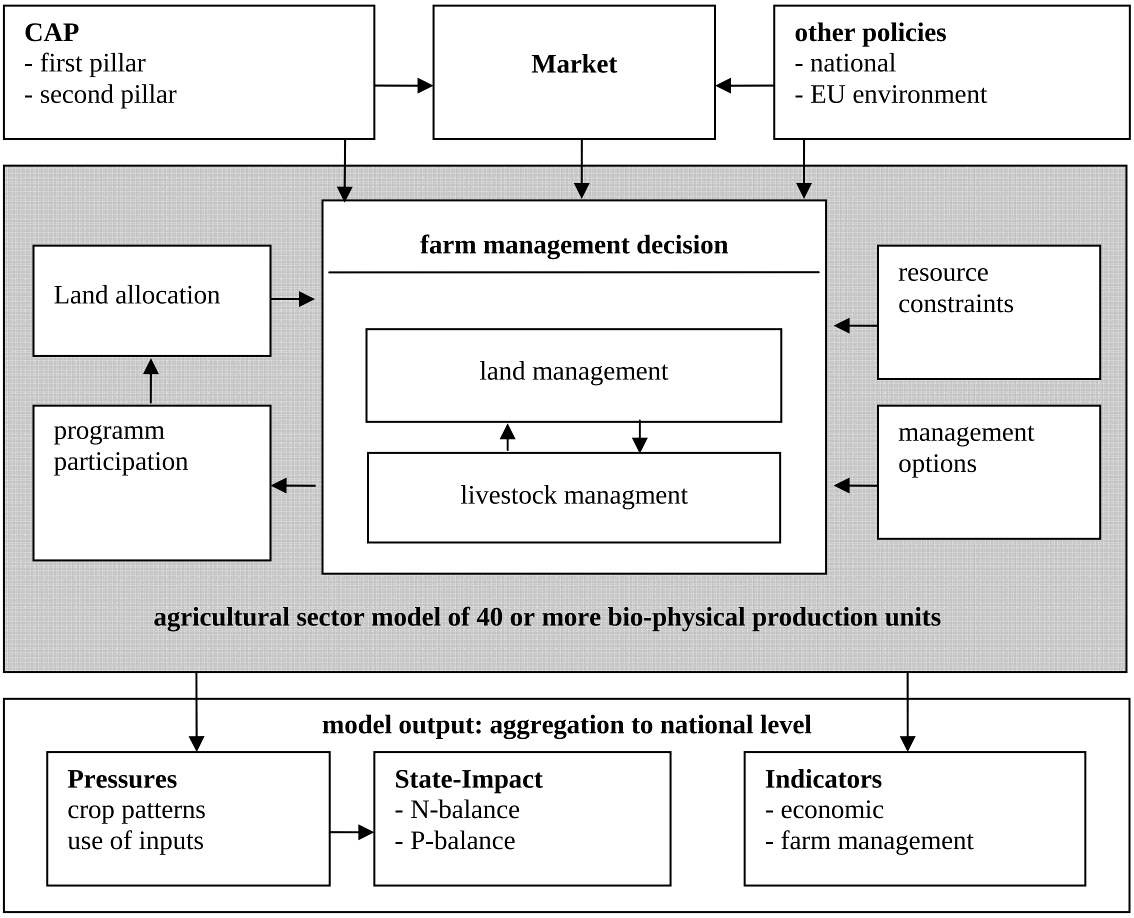

Figure 1: Structure of the agricultural sector model PASMA

Source: own construction.

Two major conditions need to be fulfilled: (i) the marginal gross margins of each activity are identical in the base-run, and (ii) the average PMP gross margin is identical to the average LP gross margin of each activity in the base-run. These conditions imply that the PMP and LP objective function values are identical in the base-run. Another important assumption needs to be made by assigning the marginal gross margin effect to either marginal cost, marginal revenue or fractional to both. In PASMA, the marginal gross margin effect is completely assigned to the marginal cost and consequently coefficients of linear marginal cost curves are derived.

In PASMA, linear approximation techniques are utilized to mimic the non-linear PMP approach (Schmid and Sinabell, 2005). Thus large-scale models can be solved in reasonable time. In combination with an aggregation procedure, i.e., building convex combinations of historical crop and feed mixes (Dantzig and Wolfe, 1961; McCarl, 1982; Önal and McCarl, 1989, 1991), the model is robust in its use and results.

PASMA is a set of three almost identical Linear Programming models. The purpose of the first one is to assign all farm activity levels i.e., crop, forestry, livestock, and farm tourism, and remaining cost shares from feed and manure balances. For instance, the area of meadows is recorded in various data sources listed above. However, information on which activities are actually carried out and to what extent are not available (e.g., grazing, hay, silage, or green fodder production activities). In the model, these activities and remaining cost shares (i.e., fertilizer and feed) are accordingly assigned using historical livestock records and detailed feed and fertilizer balances (phase 1). Phase 2 is the second LP in which the perturbations coefficients (Howitt, 1995) are incorporated to compute the calibration coefficients of a linear marginal cost curve primarily following the approach of Röhm and Dabbert (2003). The third LP (phase 3) is the actual policy model. Calibration coefficients are built in using linear approximation techniques that allow calibration of crop, forestry, livestock, and farm tourism activities to observed and estimated shares. 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 capacities under various policy scenarios. Product prices and other model assumptions are referenced in Sinabell et al., 2011.

4 Farm policy environment

4.1 The CAP Reform in 2003

In 1992, farm commodity prices that had been kept at high levels via government intervention were reduced significantly with a view to controlling excess production. In order to restrict to a minimum the resultant effects on farm incomes, premiums were introduced which were linked to the amount of land used for production and the number of livestock raised. Direct production incentives of higher prices were reduced, but it is still necessary to produce some crop such as wheat in order to get a crop premium. Additional premiums are granted when specified animals are slaughtered (bulls, oxen, calves, cows, heifers) or reared on the farm (suckler cows and heifers) and an extensification premium is granted when the number of livestock per hectare of land is below a specified limit.

In mid 2002, the European Commission published a mid-term review of the Agenda 2000 reform. The European Commission planned to decouple these premiums from production and to grant a transfer for the farm instead (dubbed "single farm payment"). This subsidy would be paid even if a farmer chose to produce nothing, as long as "land is maintained in good agronomic condition". The transfers which would be subject to decoupling (dubbed "crop premiums" or "livestock premiums" or "CAP premiums") are equivalent to more than half of the EU funds spent on agriculture

A final compromise on the proposals of the reform was reached on 26th June 2003. The key element is the introduction of a single farm payment (Greek Presidency, 2003; Fischler, 2003). This payment will replace premiums formerly linked to output or land.

When the reform proposals were drafted, it was anticipated that decoupled premiums have considerable impact on production incentives. Farmers will not need to plant certain crops or raise bulls in order to obtain financial support. In future, production decisions are expected to be based on market signals (i.e., prices) and consequently resource allocations are likely to improve.

The policy change has become effective on 1st January 2005. Payment entitlements are calculated on the basis of direct payments received in the reference period 2000-2002, they are transferable with or without land and between farmers within a region or a country. They can be only received if accompanied by eligible hectares and agricultural land is maintained in good ecological conditions.

Member States may choose to introduce the single farm payment in full or they may opt to keep some premiums attached to output or factor usage or to retain up to 10 % of direct payments for measures that have a positive environmental effect or improve the quality and marketing of agricultural products. In addition, they may implement the single farm payment at regional level. This implies a redistribution of money between farm enterprises (this option is chosen by Germany) and may lead to redistributions between regions.

Farm operators (but not the owners of land if they have rented it) are entitled to premiums based on historic payment entitlements (average of 2000 to 2002). These entitlements are weighted by premiums and will be adjusted during the reform period. The total of premiums per farm is divided by the sum of the relevant crop and forage area, thus obtaining the average farm premium per hectare. Premiums per hectare will therefore vary among farms.

All farmers receiving direct payments must set aside part of their land (small farms and organic farms are exempt) and will be subject to compulsory cross-compliance. Recipients of farm payments must abide by a list of 18 statutory European standards in the field of environment, food safety, and animal health and welfare (cross compliance). Direct payments to larger farms (above a threshold of € 5,000) will be reduced by 3 % in 2005, 4 % in 2006 and 5 % from 2007 to 2013 (modulation). Channelling expenditure away from market policies will make more than € 1.2 billions available for rural development.

For cereals (apart from rye), the intervention price remains the same with some modifications. Other crop regulations were simplified, but some production related premiums (notably those for durum wheat, protein crops, and energy crops) have been introduced by the reform. A reformed milk quota system will be maintained until the 2014-15 marketing year (see Sinabell and Schmid, 2008). Regulated prices of butter and skimmed milk powder will be cut asymmetrically in four stages. The quota will be moderately expanded in 2006 and a decoupled milk quota premium will add up to the single farm payment.

Many support schemes are not part of the decoupling process (e.g., subsidies for agro-environmental programmes and payments for farms in less favoured areas). Member states co-finance farm subsidies in addition to EU funds.

4.2 The CAP Reform in 2008

As decided in the 2003 reform a "health check" was carried out 5 years later. The objective was to make adjustments to guarantee that the intended objectives of the reform will be met.

On 20 November 2008 the EU agriculture ministers reached a political agreement on the Health Check of the Common Agricultural Policy. Among a range of measures, the following agreements are of major importance for agricultural market today (EC, 2011):

- Phasing out milk quotas: As milk quotas will expire by April 2015 a 'soft landing' is ensured by increasing quotas by one percent every year between 2009/10 and 2013/14. For Italy, the 5 percent increase will be introduced immediately in 2009/10. In 2009/10 and 2010/11, farmers who exceed their milk quotas by more than 6 percent will have to pay a levy 50 percent higher than the normal penalty.
- Decoupling of support: The CAP reform "decoupled" direct aid to farmers i.e. payments were no longer linked to the production of a specific product. However, some Member States chose to maintain some "coupled" – i.e. production-linked - payments. These remaining coupled payments will now be decoupled and moved into the Single Payment Scheme (SPS), with the exception of suckler cow, goat and sheep premia, where Member States may maintain current levels of coupled support.
- Assistance to sectors with special problems (so-called 'Article 68' measures): Up to 2008, Member States could retain by sector 10 percent of their national budget ceilings for direct payments for use for environmental measures or improving the quality and marketing of products in that sector. This possibility will become more flexible.
- Using currently unspent money: Member States applying the Single Payment Scheme are allowed either to use currently unused money from their national envelope for Article 68 measures (which finance measures to control income volatility in some EU member states) or to transfer it into the Rural Development Fund.
- Shifting money from direct aid to Rural Development: All farmers receiving more than €5,000 in direct aid had their payments reduced by 5 percent and the money is transferred into the Rural Development budget. This rate was increased to 10 percent by 2012.
- Abolition of set-aside: The requirement for arable farmers to leave 10 percent of their land fallow was abolished.
- Cross Compliance: Aid to farmers is linked to the respect of environmental, animal welfare and food quality standards. Farmers who do not respect the rules face cuts in

their support. This so-called Cross Compliance was simplified, by withdrawing standards that were not relevant or linked to farmer responsibility. New requirements were added to retain the environmental benefits of set-aside and improve water management.

- Intervention mechanisms: Intervention was abolished for pig meat and set at zero for barley and sorghum. For wheat, intervention purchases will be possible during the intervention period at the price of €101.31/tonne up to 3 million tonnes. Beyond that, it will be done by tender. For butter and skimmed milk powder, limits will be 30,000 tonnes and 109,000 tonnes respectively, beyond which intervention will be by tender.
- The energy crop premium was abolished.

4.3 The programme for rural development

After the Agenda 2000 reform in 1999, the programme for rural development (dubbed "second pillar of the CAP") was introduced in the EU. A volume of 91 bn Euros from EU funds has been allocated for the programme period 2007-2013 (EK, 2009). This amount was topped by contributions of Member States. The programme for rural development is of eminent importance for the Austrian agricultural sector, because transfers from this source outweigh transfers from the "first pillar of the CAP", e.g. instruments that have been commodity related.

The current programme period will end in 2013 and a new programme will start in 2014 if there will be a political agreement. The current programme for rural development was implemented in 2007. Main elements of the programme are:

* a genuine EU strategy for rural development will serve as the basis for the national strategies and programmes;
* less detailed rules and eligibility conditions will leave more freedom to the Member States on how they wish to implement their programmes;
* a strengthened bottom-up approach will better tune rural development programmes to local needs.

The policy has three major objectives:

Axis 1: Improving competitiveness of farming and forestry: The restructuring strategy would be built on measures relating to human and physical capital and to quality aspects.

Axis 2: Environment and land management: Agri-environmental measures are a compulsory component. A general condition for the measures under axis 2 at the level of the beneficiary is respect of the EU and national mandatory requirements for agriculture and forestry. One item listed in this axes with great importance for Austria natural handicap payments to farmers in mountain areas.

Axis 3: Wider rural development. The preferred implementation method is through local development strategies targeting sub-regional entities, either developed in close collaboration between national, regional and local authorities or designed and implemented through a bottom up approach using the LEADER approach.

The implementation of the programme in Austria has been recently evaluated (Sinabell et al., 2011) and the results corroborate the view that this programme has major effects on the production of the agricultural sector.

5 Market and economic environment

5.1 International food markets

European farm commodity markets are interlinked with international food markets in many ways. Given the imbalances between supply and demand in many markets, the EU is a major exporter, in particular of cereals, milk and white meat. The policy efforts to bring domestic market prices closer to equilibrium prices (see above) brings about that the gap between domestic prices world market prices is narrowing. Domestic supply – apart from heavily regulated products like milk – therefore is increasingly determined by the fluctuation of world market prices. Global demand for food and technological progresses (e.g., the adoption GMO crops in major producing countries,, organic food production) will be major driving forces of agricultural production during the next decade to come.

Over the medium-term, world agricultural markets are projected to be essentially supported by rising food demand driven by an improved macro-economic environment, higher population, urbanisation and changes in dietary patterns (OECD-FAO, 2010). Widespread economic growth and an expanding livestock sector are projected to combine to set the stage for a strengthening of world demand and maintaining a low stock-to-use ratio.

Cereals trade would also expand, particularly in developing economies, driven by rising income, diet diversification and higher demand for livestock products and feeds, allowing for a gradual, albeit moderate, price increase over the medium term. The medium-term prospects for the oilseed sector are expected characterised by increasing demand due to expanding growth of the biofuel market.

Meat markets are projected to be characterised by an expansion in production, consumption and trade with world meat prices showing moderate strength. Prospects for rising meat demand would mainly emerge from a favourable macro-economic environment of sustained income growth, notably in Asia and Latin America. World meat trade would increase and prices remain firm over the medium term as growing consumption is mostly expected to take place in countries that are net importers with limited possibilities to proportionally and competitively increase domestic supply (in quantity and quality).

The medium-term outlook for the dairy sector is expected to remain dominated by a strong expansion in global demand for dairy products. The latter would reflect not only income growth in many regions of the world, but also changes in consumer preferences towards dairy products.

At the time of writing this report, the times are lower prices for farm commodities in Europe seem to be gone. Given that the value marginal product of inputs (among them land) is determined by both, technology and output prices, higher commodity prices mean that more intensive farming systems will become more profitable.

5.2 National energy policies

Austrian energy policy is committed to substitute non-renewable energy sources by renewable ones. Raw materials produced by agriculture are a major alternative source. Two major legal sources are of interest in this context: the Austrian law for the provision of green electricity (Ökostromgesetz) and the European bio-fuel directive (EU, 2003) which has been recently repealed by the EU Directive on Renewable Energy (Directive 2009/28/EC).

Both measures are channelled to the agricultural via the price system: the regulations to boost bioenergy crop production work like a subsidy on farm commodities. Because Austrian sources of feedstock are not favoured over imported ones, the relevant production incentives in Austria are dominated by the price signals from regional and global markets.

Due to the mechanism of the bioenergy policies currently in place the best approach to model them is to take prices which are relevant for markets in the EU as a reference and to analyse their effects on local production.

5.3 Baseline economic assumptions

Several assumptions must be made to run the model outlined above. These are basically input prices which are derived from other sources (OECD-FAO, 2010). Price projections are based on assumption about the development of key indicators like population and GDP growth, and GDP deflator taken from OECD-FAO (2010) and estimates on world oil prices are based on WIFO (2011) and are consistent with Umweltbundesamt (2011).

Table 1: Assumptions on macro-economic variables in the European Union, 2010 – 2019

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
real GDP	%	1,0	1,8	2,3	2,2	2,2	2,2	2,2	1,7	1,7	1,7
price deflator	%	0,5	0,6	1,5	2,0	2,0	2,0	2,0	2,0	2,0	2,0
Population	%	0,3	0,2	0,2	0,2	0,2	0,2	0,1	0,1	0,1	0,1
GDP deflator	%	0,5	0,6	1,5	2,0	2,0	2,0	2,0	2,0	2,0	2,0
world oil price	USD/barrel	80,0	82,7	85,7	88,8	92,1	95,4	98,9	102,5	106,2	110,1

Source: OECD-FAO, 2010; oil prices WIFO, 2011

Several sources are available which can be used as basis of price forecasts. In this study, prices are derived from OECD-FAO outlooks on agricultural markets (see OECD-FAO, 2010). A comparison of this OECD-forecasts (Table 2) with projections of the Commission of the EU (European Commission, 2010) shows that international bodies have very similar assumptions about future development of key economic indicators. Due to the type of model, assumptions on the Austria economic environment (GDP growth, population dynamics, etc.)

are not necessary. Other driving forces (prices, technology, constraints) are referenced in the following sections.

The simulations are calculated for a number of years for which the most important policy changes will be the abolition of the milk quota in 2015. Many other changes, like the abolition of set-aside, the decoupling of direct payments, reforms for the sugar sector have taken place in recent years and the farm sector has already adjusted to these changes.

For the period from 2019 to 2030 constant prices were assumed, however, technological progress was assumed to go on. Technically, results for the years between these dates, linear approximation techniques were used to obtain the specific results. Special attention was attributed to the requirement of additionally.

Exogenous economic assumptions for Austria (like GDP or population size) are not explicitly necessary for the model used for this analysis because the partial equilibrium model of the agricultural sector is mainly depending on prices of outputs and inputs. Input prices were chosen to be consistent with recent forecasts for the Austrian energy sector (WIFO, 2011). Since production is driven by resource availability, prices and technological development, and since Austrian agriculture is an integrated part of the common market, European demand patterns carry over and determine the results.

5.4 Specific assumptions on farm commodities

The assumptions underlying future policy variables and future prices of farm commodities are referenced in the appendix. The forecast period in this study is going until 2030. For the period beyond 2019 OECD-FAO forecasts are not available. Therefore, the assumption is made that beyond this year, prices follow the trend. The assumptions on prices are referenced in Table 2 and Table 3.

Other assumption, in particular technical progress in plant and animal production are based on Sinabell and Schmid (2005). Deviating from this source, estimates of future milk yields per dairy cows (Table 1) are reduced according to the estimates discussed in an expert panel in January 2011.

5.5 Baseline data

The baseline data are describing the Austrian agricultural sector in 2008. This data set was established for a study on the evaluation of the program of rural development (Sinabell, et al. 2011).

The major sources of baseline data are various Statistik-Austria statistics on the agricultural sector, published in the monthly "Statistische Nachrichten", data from integrated administration and control system (IACS), administrative sources and data derived from the annual farm income report ("Grüner Bericht", BMLFUW, 2010 and 2008).

Table 2: Observed and expected nominal farm prices in Austria (€ per ton or 100 l)

	organic prices[1)]	ø2007/2009	ø2012/2013	2020	2030
Wheat	1.60	140,18	103,85	125,52	143,84
coarse wheat	0.75	113,94	89,83	104,21	116,37
Durum	1.60	197,89	136,98	173,32	204,03
Rye	1.50	111,99	72,77	94,61	116,33
coarse rye	0.60	98,36	63,36	82,85	102,23
winter barley	0.75	67,95	81,88	80,72	64,76
summer barley	0.75	67,95	81,88	80,72	64,76
Oats	0.60	131,93	94,75	114,61	136,27
Triticale	0.70	117,14	101,68	110,96	118,68
Spelt	2.20	247,36	171,23	216,65	255,04
Maize	0.80	105,80	100,96	107,22	105,45
Beans	0.75	218,52	199,19	209,72	220,72
Peas	0.75	159,49	143,06	152,01	161,36
soy-beans	0.75	276,41	251,97	265,28	279,19
sunflower	0.75	272,90	212,75	244,37	280,03
sugar-beet	0.00	25,68	25,92	25,81	25,64
starch potatoes	0.00	41,03	39,47	41,49	40,92
rape-seed	0.75	274,69	228,26	252,73	280,18
Fruits	1.50	427,37	332,90	378,61	439,56
Wine	1.50	364,53	329,98	346,70	368,99

Source: own assumptions based on OECD, 2004.

Note: [1)] Price mark-up of organic products relative to conventional ones.

Table 3: Observed and expected nominal farm prices in Austria and milk yields

	organic prices[1)]	unit	ø2007/2009	ø2012/2013	2020	2030
milk-A-quota	0.091	t	0,31	0,27	0,27	0,32
milk-D-quota	0.091	t	0,34	0,29	0,30	0,36
milk home consumption	0.091	t	0,17	0,14	0,14	0,17
milk yield per cow		t/cow	6.08	6.4	7.2	8.2
Veal	0.25	kg SW[2)]	4,15	4,31	4,31	4,11
heifer for breeding	0.15	head	1139,51	1230,24	1232,13	1116,36
heifer for suckler cow	0.15	head	775,86	854,52	856,16	755,78
beef of heifer	0.15	kg SW	2,14	2,24	2,24	2,11
Mutton	1.15	kg SW	4,17	4,15	4,16	4,17
beef (oxen)	1.15	kg SW	2,45	2,56	2,57	2,43
sheep cheese	0.15	head	0,42	0,44	0,44	0,41
Pork	0.3	kg SW	1,62	1,45	1,52	1,65
Beef	0.0	kg SW	2,55	2,64	2,65	2,52
Turkey	0.1	kg SW	1,22	1,13	1,17	1,23
fallow deer	1.5	kg SW	0,92	0,86	0,89	0,93
Wool	0.0	kg	0,55	0,55	0,55	0,55
Boar	0.0	head	3,30	3,28	3,29	3,30
goat meat	0.0	kg SW	1,57	1,56	1,56	1,57
goat cheese	0.15	head	47,01	41,24	43,68	47,85
male calves	0.15	head	351,66	360,77	360,96	349,33
male calves for beef	0.4	kg SW	405,10	415,60	415,82	402,42
female calves	0.25	head	252,38	264,60	264,85	249,26
female calves for beef	0.25	kg SW	365,02	382,69	383,06	360,52
Eggs	0.25	unit	0,11	0,12	0,12	0,11
Chicken	0.25	kg SW	0,87	0,84	0,85	0,88
young sow	0.8	head	305,36	279,07	290,21	309,14
young chicken	1.5	head	3,31	3,03	3,15	3,36
Cow	0.3	kg SW	1,53	1,66	1,66	1,50
Sow	1.5	kg SW	1,17	1,00	1,07	1,19
sheep meat	0.15	kg SW	0,36	0,51	0,43	0,34

Source: own assumptions based on OECD, 2004.
Note: [1)] Price mark-up of organic products relative to conventional ones. [2)] kg SW is kg carcasse

5.6 Other assumptions

The **storage of manure** has an essential influence on the level of emission from livestock. Structural information on storage facilities on Austrian farms was made available by the Austrian farm survey from 1999. These data were used to estimate the actual requirements of storage facilities depending on the type of livestock.

Multiple regression analysis was used to make theses estimates. Two linear multiple regression models were used to explain the capacity of both, slurry and solid manure storage capacity (see Sinabell and Schmid 2005).

Future **milk yields** per cow are based on assumptions which are made explicit in Table 1. The milk yield per cow of is taken from BMLFUW. The future development of milk yields is based on estimates of an exponential trend of data from 2002 to 2009 from the same source. The estimates were limited to this period because a statistics revision in 2001 brought about a large yield increase per cow. Thus future milk yields per cow are estimated relatively conservatively. Milk output at sector level is evaluated as the sum of regional milk yields times the number of dairy cows in each region minus 3 % losses. The average milk production at sector level is the consequence of three processes:

- the productivity gains per cow in each region,
- the regional shift of the cow population and
- the relation of non-organic cows to organic cows (with 5% lower yields).

The usage of **mineral fertilizers** is calculated in two ways: the consumption of urea is not derived from the model but given exogenously based on a linear trend of past observations. The level of input of all other nutrients is determined by the model based on nutrient balances (crop demand + observed surplus = mineral inputs + manure inputs + accumulation in soil). These balances are calculated for each structural unit therefore the aggregation error can be kept at a minimum (Sinabell and Schmid, 2005). The forecasts of mineral fertilizer are therefore reflecting the consequences of land use changes (e.g. more legumes when organic farming is expanding) and changes of the livestock-herd (e.g. less manure when less bulls are produced). Technical progress in crop production eventually has the consequence that less fertilizer is needed to produce the same amount of output.

6 Scenarios

In this section, the scenarios which are investigated in this study are outlined. We compare three sets of policy scenarios

- business as usual
- business as usual plus measures

Each of these scenarios is evaluated in sensitivity simulations in order to identify the consequences, different assumptions on the program of rural development have on key indicators of the agricultural sector. In all scenarios the assumption is made that the acreage of agricultural land is declining at the pace observed in the past following a linear trend.

Business as usual

The following policy measures are implemented:

- implementation of the CAP health check reform 2008 (mainly abolition of milk quota);
- special attention is given to the Austrian variant of implementation (maintenance of the premiums for suckler cows – including heifers);

- due to uncertainties concerning the flow of funds from "modulation" we make the assumption that Austrian farms who might be beneficiaries get the same amount as other farms loose through this measure;
- land is maintained in good agricultural and ecological condition ("cross compliance";
- the programme for rural development is maintained in an unmodified way
- introduction of a regional decoupled farm premium (instead of the historical premium model).

Business as usual plus measures

- slightly more efficient usage of mineral fertilizer (efficiency of N from manure increases by 12,5%)
- a further stimulation of organic farming by granting higher subsidies at the cost of an agri-environmental measure with lower environmental benefits (technically funds of the UBAG-meaures of the Austrian agri-environmental programme is shifted to organic farming)
- the production of 10.000 hectares of energy crops
- the abolition of the premium for suckler cows

Sensitivity analyses

- the abolition of the program of rural development in Austria for the two main scenarios

7 Results and discussion of the model sensitivity

7.1 Overview of the scenario results "business as usual"

The results of the scenario analyses are provided in the tables in the appendix. The results partly deviate from previous analyses of the Austrian farm sector after the 2003 CAP-reform (Sinabell and Schmid, 2003; Schmid and Sinabell, 2004 and 2005) but are consistent with more recent analyses (see e.g. Sinabell et al., 2011):

- the number of **cattle** is likely to increase which is a result that would change a declining trend over decades; the reason is that milk production is likely to expand after the abolition of the milk quota (2015) and this would involve an increase of the dairy herd;
- the number of **suckler cows** is less affected, because premiums per head will be coupled to production, even after the reform in Austria; a given share of heifers qualifies for such premiums as well, therefore the number of suckler cows and heifers is relatively constant;

- farmers will get coupled premiums either for suckler cows but other premiums for cattle will be abandoned, given the rising number of dairy cows, the number of **heifers** is assumed to increase in a proportional manner;
- the consequence of slightly increasing prices for **pork and poultry** and increasing feeding cost is that output of neither of these products will be expanded – this result is a consequence of the modelling approach which prevents an expansion of an activity if the relation of product prices and production costs is deteriorating; this result is consistent with prior observations (Sinabell and Schmid, 2005);
- the acreage of **arable land** will be reduced mainly due to the secular trend of competition for land from urbanisation and traffic infrastructure;
- **crop production** will decline due to the limited area; the increase of output prices is not sufficient to compensate rising input costs and therefore a significant expansion of output is not an economical option;
- the acreage **grassland** will be reduced considerably; the category declining at the fastest rate is extensive grassland – given the low productivity and the given increasing energy costs this type of landuse will become less competitive;
- the production of **manure** will shrink according to the development of the number of heads of livestock units, therefore there is ample excess storage capacity at regional scales compared to 2003 (with the EU nitrate action programme implemented);
- **organic farming** will not significantly expand because of the assumption that premiums of the agri-environmental programme will stay in place and prices of organic products are higher while opportunity cost will be lower after the implementation of the reform;

Discussion of the results:

- The model results indicate that the declining trend of the numbers of cows will come to an end and that the number of dairy cows will stabilize at a higher level. There is considerable evidence that milk production will increase after the abolition of the milk quota in 2015. However, there is some uncertainty if this increase necessarily involves that the number of cows increases because milk currently used for feeding calves could be used for dairy after the quota regime. The expected prices of milk are high enough to make milk production the most competitive livestock activity in Austria.
- The decline of non-cattle livestock production is mainly due to the fact that higher feed costs are not compensated by productivity gains. The relative prices therefore indicate that meat production in general will be limited by higher feed costs.
- Forecasts of the CAPRI model indicate that the cattle herd of Austria will decline further. Obviously the result is driven by the assumption that milk production will not expand as high as assumed in this study and / or that the milk yield per cow will be higher. Given that the Austrian milk yield per cow is relatively low it could be

plausible that more efficient milk producers increase the milk yield faster than assumed in our scenarios. The CAPRI model - on the other hand - expects even lower milk yields per cow than assumed in this study.

- The model analysis builds on assumptions on given prices for outputs and inputs. The output prices are derived from OECD-FAO (2010) while the input prices are consistent with WIFO (2011). Compared to OECD-FAO (2010) the input prices used in this analysis are slightly higher and therefore production in Austria is less competitive than in a situation with lower energy costs. The decline of crop production is partly explained by this constellation.

7.2 Results of the scenario "with measures"

The major driving forces of the sector development are the prices on farm commodity markets, technological progress, and policy variables. In the scenario "**with measures**" more land is used for the production of energy crops (short rotation poplars), organic farming will be more attractive (because the support of the agri-environmental program is higher); and nutrients from livestock will be used more efficiently.

The major results of this scenario compared to the baseline scenario are:

- The number of cattle is slightly decreasing while the number of dairy cows is practically the same. The most plausible reason is that a slight expansion of organic farming lowers the output and that the expansion of bioenergy crops limits the production of fodder and therefore makes livestock production less competitive.
- The number of suckler cows is lower than in the baseline scenario. The reason is that the assumption was made that the premium for suckler cows will be abolished. According to our results suckler cow production will prevail in several regions even under such detrimental conditions. This is explained by the fact that sufficiently low cost grassland is available and that investments in more productive activities in these regions are likely not economical.
- More land will be used for crop production and given the better production situation for organic farming, the acreage planted with legumes is relatively higher.
- The acreage of bioenergy short rotation poplar is 10,000 hectares given to the policy assumption that policies to boost bioenergy production will be in place.
- The output of crops (mainly cereals and corn) is increasing. The reason is that in the policy scenario the assumption was made that the agri-environmental measure "UBAG" is abolished and the premiums are shifted to organic farming. The consequence is that organic farming is slightly more attractive but on the remaining acreage production is more intensive and thus compensating the decreasing effect of organic farming.

- A puzzling result is that mineral fertilizer production is increasing in a situation where organic farming is expanding and the efficiency of fertilizers from manure is increasing. The two reasons for such a result are the intensification effect due to the abolition of UBAG (see above), the expansion of cereal production and corn production (crops which are mainly produced with mineral fertilizer).

Discussion of the results:

- The measures analysed in this scenario are obviously not chosen in such a way to minimize the greenhouse gas footprint of agriculture. There are two counteracting effects: more organic farming and a lower number of suckler cows will limit greenhouse gas emissions, while the expansion of crop production likely overcompensates this effect. We have also to acknowledge the result that bioenergy production is input intensive if high outputs are expected.
- The results show the policy dilemma that bioenergy policies induce more intensive production methods and that agri-environmental measures that are implemented to compensate for that are relatively costly.

7.3 General trends shown in the scenarios

All scenarios have one major trends in common: According to our scenarios the **output of milk and beef** will increase. This is a consequence of the abolition of the quota on milk. The efficiency gains due to higher milk yields per cow are not high enough to stabilize the cow herd at levels observed in 2010. On the contrary, milk prices are expected to be high enough to induce a higher number of cows. A consequence is that more calves are born and more bulls are fattened. The results are of course sensitive to the assumptions of relative prices. If bull production in neighbour countries becomes more competitive it is likely that more calves are exported. This would limit the production possibilities for bull fattening in Austria. However, currently there are no hints that this would be the case.

The similarity of results does not come at a surprise. In all scenarios, the EU farm policy reform of 2008 is implemented and the analysed variations are only small modifications compared to a continuation of the situation before 2010. We would expect to see trends showing in markedly different directions if we compare e.g. the base run scenario with a scenario of Austrian farm policy before 1995. We would also expect significantly different results if we would abandon the programme of rural development which is extremely important for the maintenance of production in marginal areas. Results for such a scenario are presented in the next chapter.

7.4 Model behaviour and sensitivity of the results

A comparison between the development of the cattle population and the number of poultry makes it evident that the type of model used in this analysis is pre-determining the results. The reason why poultry production declines is due to the underlying assumption that production cost are mainly determined by feeding cost and that feed concentrates are purchased on the market at given prices. When input prices and output prices change similarly, outputs can stay relatively constant. At the given prices, input costs are increasing at a higher rate than output prices and the wedge cannot fully be compensated by productivity gain. The situation is different in the case of cattle production. In this case the abandonment on a legally defined limit on production boosts output. This can only happen because there are sufficient resources for such an expansion (grassland that can be used by ruminants).

Table 4: Percentage change of abolition of the programme of rural development relative to the business as usual scenario (BAU) and scenario with measures (WM)

indicator	year	BAU	WM
		percentage change	
LU cattle conventional	2010	0.3	0.2
	2015	1.2	1.1
	2020	1.9	1.6
	2030	0.2	0.1
LU cattle organic	2010	-7.3	-5.3
	2015	-13.7	-11.2
	2020	-19	-16
	2030	-20.2	-18.1
mineral fertilizer	2010	-11.7	-10.4
	2015	-15.1	-13.8
	2020	-17.9	-16.1
	2030	-18.9	-15.9

Source: own results

In the sensitivity scenarios (see Table 4) the assumption was made that the program of rural development will be abolished. The results obtained are in line with those recently published by Sinabell et al. 2011 who analysed the same scenario for the year 2013:

- mountain farming will decline and relatively more land will be afforested
- production will become more intensive because incentives for low input farming are no longer available
- output will decline generally because there are no longer incentives to maintain production in disadvantaged regions
- organic farming will be a profitable production branch – however at a lower scale
- production will concentrate on regions with advantageous condition

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9 Appendix: Model results

Results scenario business as usual

	Population size [heads] Cattle					
	TOTAL Cattle		Dairy		Suckling Cows	
Year	Conv.	Org.	Conv.	Org.	Conv.	Org.
2008	1 644 439	352 770	445 123	85 107	185 711	80 741
2010	1 658 811	354 463	447 226	85 509	181 830	79 053
2015	1 671 865	353 104	456 475	84 744	179 451	80 116
2020	1 684 920	351 746	465 724	83 979	177 072	81 179
2025	1 677 472	352 759	462 082	84 759	180 029	81 020
2030	1 670 025	353 771	458 440	85 538	182 986	80 862

	Population size [heads] Cattle			
	Young Cattle < 1 yr		Breeding Heifers 1–2 yr	
Year	Conv.	Org.	Conv.	Org.
2008	537 371	99 098	169 524	31 263
2010	535 330	98 722	230 796	42 562
2015	547 605	98 986	202 942	36 942
2020	559 880	99 250	175 089	31 322
2025	554 338	99 553	174 383	31 321
2030	548 797	99 855	173 678	31 319

	Population size [heads] Cattle			
	Fattening Heifers, Bulls, Oxen 1–2 yr		Other Cattle > 2 yr	
Year	Conv.	Org.	Conv.	Org.
2008	194 575	35 882	112 135	20 679
2010	143 773	26 514	119 856	22 103
2015	169 515	31 316	115 877	21 000
2020	195 256	36 119	111 899	19 897
2025	194 829	36 024	111 811	20 083
2030	194 401	35 928	111 723	20 268

	Population size [heads]					
Year	TOTAL Swine	Young & Fattening Pigs > 20 kg	Breeding Sows > 50 kg	Piglets < 20 kg	Sheep	Goats
2008	3 064 231	2 023 536	297 830	742 865	333 181	62 490
2010	2 964 685	1 932 458	289 186	743 041	310 492	58 973
2015	2 944 776	1 914 242	287 457	743 076	305 954	58 270
2020	2 924 866	1 896 026	285 728	743 112	301 416	57 566
2025	2 857 332	1 842 469	279 993	734 871	297 661	57 732
2030	2 789 799	1 788 911	274 257	726 630	293 906	57 898

Year	Population size [heads]				
	TOTAL Poultry	Chicken	Other Poultry	Horses	Other
2008	13 027 145	12 354 358	672 787	87 072	41 190
2010	12 551 420	11 881 720	669 700	86 401	40 974
2015	12 456 275	11 787 193	669 083	86 267	40 931
2020	12 361 130	11 692 665	668 465	86 133	40 888
2025	12 028 123	11 361 819	666 304	85 664	40 342
2030	11 695 116	11 030 972	664 143	85 194	39 797

Annual milk yield (kg)					
2008	2010	2015	2020	2025	2030
6 059	6 258	6 820	7 209	7 685	8 161

Total usage of mineral fertilizers (t N)					
2008	2010	2015	2020	2025	2030
118 850	104 095	101 143	98 192	89 675	81 157

Urea (t N)					
2008	2010	2015	2020	2025	2030
10 534	9 226	8 965	8 703	7 948	7 193

Sewage sludge (t N)					
2008	2010	2015	2020	2025	2030
1 531	1 341	1 303	1 265	1 155	1 045

N left for spreading (kg N)					
2008	2010	2015	2020	2025	2030
132 571	131 876	131 737	131 599	129 843	128 087

Year	Areas [ha]			
	peas	soja beans	horse/field beans	clover hey, lucerne, ...
2008	22 306	18 419	3 695	98 966
2010	13 562	34 378	4 154	105 500
2015	14 604	32 091	3 346	91 241
2020	13 321	34 369	3 288	89 953
2025	12 949	35 065	3 120	86 371
2030	12 576	35 760	2 953	82 790

	Areas [ha]			
Year	corn	cropland	grassland	grassland (extensive)
2008	832 653	1 369 021	1 791 883	722 225
2010	802 152	1 360 000	1 731 000	722 225
2015	788 485	1 293 079	1 475 016	551 438
2020	781 123	1 280 422	1 422 205	522 974
2025	756 986	1 243 330	1 267 548	436 294
2030	732 848	1 206 238	1 112 891	349 614

	Harvest [1 000 t]					
Year	corn (total)	maize (corn)	silo-green maize	sugar beet	rape	sunflower
2008	5 714	2 449	3 949	3 091	175	80
2010	4 776	1 956	3 557	3 138	171	67
2015	5 229	2 268	3 855	3 167	176	72
2020	5 243	2 285	3 866	3 181	176	72
2025	5 207	2 308	3 791	3 175	179	71
2030	5 171	2 331	3 717	3 169	181	70

	Harvest [1 000 t]			
Year	peas	soja beans	horse/field beans	clover hey, lucerne, ...
2008	45	54	8	650
2010	31	95	11	682
2015	32	91	8	590
2020	30	100	8	597
2025	30	104	8	587
2030	30	108	7	573

Results scenario with measures

	Population size [heads] Cattle					
	TOTAL Cattle		Dairy		Suckling Cows	
Year	Conv.	Org.	Conv.	Org.	Conv.	Org.
2008	1 644 439	352 770	445 123	85 107	185 711	80 741
2010	1 658 811	354 463	447 226	85 509	181 830	79 053
2015	1 666 205	341 178	457 002	82 056	176 618	77 396
2020	1 673 599	327 892	466 777	78 603	171 406	75 738
2025	1 670 255	335 867	462 612	81 023	176 478	77 080
2030	1 666 910	343 843	458 447	83 442	181 549	78 423

	Population size [heads] Cattle			
	Young Cattle < 1 yr		Breeding Heifers 1–2 yr	
Year	Conv.	Org.	Conv.	Org.
2008	537 371	99 098	169 524	31 263
2010	535 330	98 722	230 796	42 562
2015	545 308	94 722	202 849	35 700
2020	555 286	90 722	174 902	28 837
2025	551 486	93 434	174 084	29 615
2030	547 687	96 146	173 265	30 393

	Population size [heads] Cattle			
	Fattening Heifers, Bulls, Oxen 1–2 yr		Other Cattle > 2 yr	
Year	Conv.	Org.	Conv.	Org.
2008	194 575	35 882	112 135	20 679
2010	143 773	26 514	119 856	22 103
2015	168 683	30 537	115 746	20 768
2020	193 593	34 560	111 635	19 433
2025	193 794	34 979	111 802	19 736
2030	193 994	35 399	111 968	20 040

	Population size [heads]					
Year	TOTAL Swine	Young & Fattening Pigs > 20 kg	Breeding Sows > 50 kg	Piglets < 20 kg	Sheep	Goats
2008	3 064 231	2 023 536	297 830	742 865	333 181	62 490
2010	2 964 685	1 932 458	289 186	743 041	310 492	58 973
2015	2 927 671	1 904 465	286 187	737 019	304 566	57 409
2020	2 904 911	1 884 620	284 247	736 044	299 797	56 562
2025	2 850 421	1 835 074	280 144	735 203	296 097	56 212
2030	2 795 931	1 785 528	276 042	734 361	292 397	55 861

	Population size [heads]				
Year	TOTAL Poultry	Chicken	Other Poultry	Horses	Other
2008	13 027 145	12 354 358	672 787	87 072	41 190
2010	12 551 420	11 881 720	669 700	86 401	40 974
2015	12 443 220	11 772 909	670 311	86 038	40 387
2020	12 345 900	11 676 001	669 898	85 866	40 253
2025	12 005 277	11 336 823	668 454	85 262	39 718
2030	11 664 654	10 997 644	667 010	84 659	39 183

Annual milk yield (kg)					
2008	2010	2015	2020	2025	2030
6 059	6 258	6 820	7 209	7 685	8 161

Total usage of mineral fertilizers (t N)					
2008	2010	2015	2020	2025	2030
118 850	104 095	104 764	103 680	94 523	85 366

Urea (t N)					
2008	2010	2015	2020	2025	2030
10 534	9 226	9 285	9 189	8 378	7 566

Sewage sludge (t N)					
2008	2010	2015	2020	2025	2030
1 531	1 341	1 350	1 336	1 218	1 100

N left for spreading (kg N)					
2008	2010	2015	2020	2025	2030
132 571	131 876	129 985	129 554	127 833	126 111

	Areas [ha]			
Year	peas	soja beans	horse/field beans	clover hey, lucerne, ...
2008	22 306	18 419	3 695	98 966
2010	13 562	34 378	4 154	105 500
2015	14 747	32 536	3 478	93 475
2020	13 487	34 889	3 442	92 559
2025	13 228	35 515	3 293	89 171
2030	12 970	36 140	3 144	85 782

	Areas [ha]			
Year	corn	cropland	grassland	grassland (extensive)
2008	832 653	1 369 021	1 791 883	722 225
2010	802 152	1 360 000	1 731 000	722 225
2015	796 770	1 310 510	1 760 916	726 598
2020	790 790	1 300 758	1 755 754	727 327
2025	767 568	1 265 431	1 590 621	627 951
2030	744 347	1 230 104	1 425 488	528 574

	Harvest [1 000 t]					
Year	corn (total)	maize (corn)	silo-green maize	sugar beet	rape	sunflower
2008	5 714	2 449	3 949	3 091	175	80
2010	4 776	1 956	3 557	3 138	171	67
2015	5 285	2 299	3 846	3 186	177	72
2020	5 309	2 321	3 856	3 203	178	72
2025	5 279	2 346	3 792	3 197	180	71
2030	5 250	2 371	3 728	3 191	182	70

	Harvest [1 000 t]			
Year	peas	soja beans	horse/field beans	clover hey, lucerne, ...
2008	45	54	8	650
2010	31	95	11	682
2015	33	92	8	605
2020	31	101	8	614
2025	31	106	8	606
2030	31	110	8	594