Thünen-Baseline 2013-2023: Agri-economic projections for Germany

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Abstract

This article presents selected results of the Thünen-Baseline as well as the assumptions upon which these results are based. The Thünen-Baseline is established using and combining several models of the Thünen model network. It provides a reference scenario for the analysis of the impacts of alternative policies and developments. The projections are based on data and information available as of winter 2013/14. The baseline assumes a continuation of the current policy framework and the implementation of already decided policy changes. For the Thünen-Baseline 2013 to 2023, this implies the implementation of the EU-CAP reform decided in 2013 and its national implementation according to the decisions made at the German Ministers of Agriculture conference.

Overall, the Thünen-Baseline 2013 to 2023 draws a picture of a competitive agricultural sector in Germany, which adapts well to the changes of the latest policy reform and seizes the opportunities for expanding production, especially in the dairy sector. On the other hand, the projections also highlight that – under the assumptions made and with unchanged policy conditions – the problems that may accompany intensive livestock production will not simply dissolve. In contrast, in view of the projected high profitability of intensive pig and poultry production the related challenges could increase.

Keywords: *agricultural policy, impact assessment, modelling, Germany*

Zusammenfassung

Thünen-Baseline 2013-2023: Agrarökonomische Projektionen für Deutschland

Die Thünen-Baseline 2013 bis 2023 ist eine auf den deutschen Agrarsektor fokussierte modellgestützte Projektion der erwarteten Entwicklungen auf der Grundlage der im Winter 2013/14 vorliegenden Daten und Informationen. Sie stellt eine Referenzsituation für die Analyse von Auswirkungen alternativer Politiken und Entwicklungen dar. Die Thünen-Baseline geht von einer Beibehaltung der derzeitigen Agrarpolitik bzw. der Umsetzung bereits beschlossener Politikänderungen aus. Für die vorliegende Baseline bedeutet dies im Wesentlichen die Umsetzung der 2013 beschlossenen Reform der Europäischen Agrarpolitik und ihrer nationalen Umsetzung entsprechend des Beschlusses der deutschen Agrarministerkonferenz.

Insgesamt zeichnet die Thünen-Baseline 2013 bis 2023 das Bild einer wettbewerbsstarken Landwirtschaft in Deutschland, die sich gut an die Veränderungen der jüngsten Agrarreform anpasst und die Möglichkeiten zur Produktionsausdehnung, insbesondere im Milchbereich, wahrnimmt. Auf der anderen Seite zeigen die Projektionen, dass sich unter den getroffenen Annahmen und unveränderten politischen Rahmenbedingungen die Probleme, die sich aus der intensiven Tierproduktion ergeben können, nicht im Zeitablauf „von selbst" lösen, sondern im Gegenteil angesichts der projizierten Rentabilität der Veredlungsproduktion weiter an Bedeutung gewinnen könnten.

Schlüsselwörter: *Agrarpolitik, Politikfolgenabschätzung, Modellierung, Deutschland*

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1 Introduction

This article presents and discusses selected results of the Thünen-Baseline 2013 to 2023 as well as the assumptions upon which these results are based.[1] The projections are based on data and information available as of winter 2013/14. It is important to stress that the Thünen-Baseline is not a forecast about the future. Rather, the baseline describes expected developments should the current agricultural policy be continued in accordance with specific assumptions about the development of exogenous influences. The Thünen-Baseline thus serves as a reference scenario for analyses of the impacts of alternative policies and developments. It complements the more general and highly aggregated results of the baseline reports of the EU-Comission (2013) and the OECD-FAO (2013) by offering a detailed picture of the projected situation of German agriculture in 2023, taking into account national policies.

The assumptions for the development of the exogenous factors and the agricultural policy conditions selected for the baseline were chosen in close consultation with experts from the German Ministry of Food and Agriculture. Preliminary baseline results were discussed with representatives from the federal as well as Länder ministries. This approach enabled the integration of expert knowledge as well as the definition of a scenario that is widely accepted as a relevant basis for further policy impact analyses.

2 Methodology

The Thünen-Baseline is established using and combining several models of the Thünen model network. The Thünen model network connects farm, regional and sector partial and general equilibrium models for the joint application for policy impact assessments. With the help of the model network, the impacts of a wide range of trade, agricultural and environmental policies on various facets of the agricultural sector, e.g. markets, production, environment, income, can be analyzed at different levels (Figure 1). In the analysis, a coordinated, parallel and/or iterative implementation of the model takes place. This implementation allows for the alignment of important assumptions, the exchange of model results as a basis for other models of the network, and the reciprocal check of the model results. This approach aims at providing a consistent overall result. The databases and characteristics of models used for the establishment of the Thünen-Baseline 2013 to 2023 are briefly described below.

The MAGNET model (Modular Applied GeNeral Equilibrium Tool) is a multiregional, general equilibrium model covering global economic activity as well as single countries and regions (Woltjer et al., 2013). It provides a detailed representation of the interactions between agriculture, the input sector and the food industry as well as commercial economics and the service sector, and accounts for the intra- and interregional linkages between markets and actors. MAGNET is based on a simultaneous system of non-linear equations, which ensure an equilibrium in the model and the identity between expenses and income. Behavioural equations describe the economic activities of different actors (for example, consumers and producers). Product demand, product supply and factor demand functions are specified so that consumers and producers maximize their utility or profit. Linking supply and demand, the model endogenously determines prices and quantities that lead to balanced product and factor markets. Trade modelling differentiates products by origin based on the Armington assumption (Armington, 1969) and considers transport requirements, and describes trade structure in the form of a matrix of bilateral trade flows (see Hertel and Tsigas, 1997). The GTAP data base 8.2 used for this study includes 57 sectors and 129 regions for the base year 2007 (https://www.gtap.agecon.purdue.edu/databases/v8/v8_doco.asp).

AGMEMOD (http://www.agmemod.eu) is a partial, multinational, multiple-product model based on econometrically estimated parameters and a recursive-dynamic approach. It covers production, consumption, trade, inventories and prices for 20 agricultural and 17 processing sectors of the EU member states, accession candidates and other neighbouring countries. The German model provides a detailed representation of grains and oilseed, potatoes, cattle and calves, sheep, pigs, poultry and milk as well as their processed products (Salamon and von Ledebur, 2005). Coupled with each other and the appropriate world markets, the models create a combined EU Model for the individual EU Member States (van Leeuwen et al., 2011). In the present model, version 7, the world markets are endogenous, but calibrated to fit to the OECD price projections (OECD-FAO, 2013). The data base covers the years 1973 to 2012.

The regionalized agricultural and environmental information system RAUMIS (Henrichsmeyer et al., 1996) is employed to analyze medium and long-term agricultural and environmental policy impacts. The model consolidates various agricultural data sources with the national agricultural accounts as a framework of consistency. It comprises of more than 50 agricultural products, 40 inputs with exogenously determined prices, and reflects the German agricultural sector with its sector linkages. According to data availability, the spatial differentiation is based on administrative bodies, i.e., 326 regions (NUTS III level) treated as single „region farms." Production adjustments caused by changes in the general framework conditions such as agricultural policies are determined by using a comparative-static mathematical programming approach that maximizes a non-linear objective function for regional farm income. The model is calibrated to observed production decisions using a positive mathematical programming approach (Howitt, 1995; Cypris, 2000). Model base years are available in four-year intervals from 1979 to 2010.

Farm level aspects are covered by FARMIS, a process-analytical programming model for farm groups (Osterburg et al., 2001; Offermann et al., 2005; Deppermann et al., 2013) based on information from the farm accountancy data network (FADN). Production is differentiated for 27 crop and 15

1 The full report with detailed results is published in German as Offermann et al. (2014).

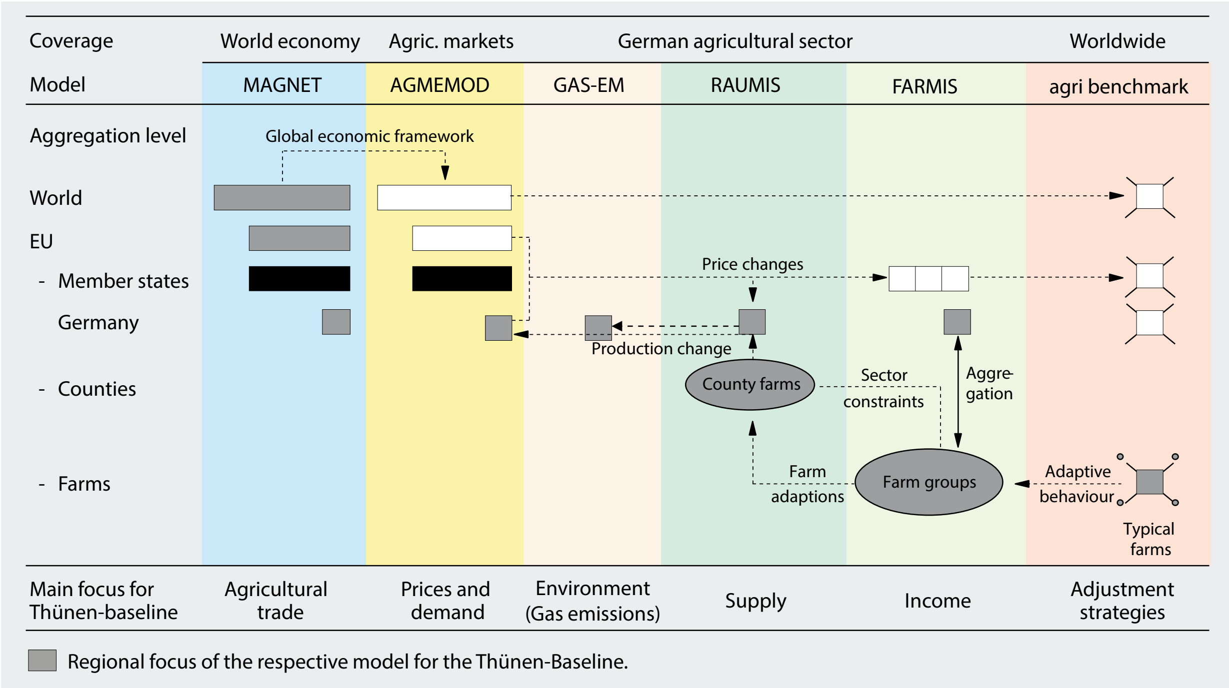


Figure 1
The use of models of the Thünen model network for the establishment of the Thünen-Baseline 2013 - 2023

livestock activities. The matrix restrictions cover the areas of feeding (energy and nutrient requirements, calibrated feed rations), intermediate use of young livestock, fertilizer use (organic and mineral), labour (seasonally differentiated), crop rotations and political instruments (e.g., set-aside and quotas). The model is calibrated to observed production decisions and elasticities using a positive mathematical programming approach. For this study, the model specification is based on data from the accounting years 2009/10, 2010/11 and 2011/12. The farm sample was stratified by region, type, system and size, resulting in 646 farm group models (of which 90 groups represent organic farming). Results are aggregated to the sector using farm group specific weighting factors. To account for structural change, econometrically estimated farm exit probabilities were applied to the aggregation factors for the projection. Within regions, farms compete for land on rental markets (Bertelsmeier, 2005).

TIPI-CAL und TYPICROP are accounting models applied within the framework of the global agri benchmark network (www.agribenchmark.org). They represent in detail production technology and physical interrelationships at farm level. As part of the model network, these models are mainly used to analyze the impacts of changes in policy, economic, and regulatory framework on selected farms, and to investigate the financial consequences of different alternative farm adjustments and development strategies. The database comprises typical farms, which are established based on a globally harmonized Standard Operating Procedure together with more than 40 partners in different countries. Data are collected annually, and the validation of results and specification of adjustment strategies is done in cooperation with farmers and advisors.

For the projection of greenhouse gas and ammonia emissions from agriculture in the baseline scenario, the Thünen model network is linked to the model GAS-EM. GAS-EM is a modular spreadsheet programme to estimate gaseous and particulate emissions from animal agriculture and crop production including professional horticulture. GAS-EM was first described in Dämmgen et al. (2002) and has been developed further continuously since then. The assessment of emissions within GAS-EM uses the definitions of agriculture according to the definitions of IPCC. All calculation procedures involved are based on the rules provided by the respective conventions and the current guidance documents. In addition, the German agricultural inventory uses differing methods in specific circumstances in order to improve the description of national emission conditions (Haenel et al, 2014). It is used to generate the official National Emission Inventory Reports for Germany. For this study, the projections of gaseous emissions in 2023 are based on the RAUMIS projections for land use and livestock numbers in the baseline scenario.

For the analysis of the impact of the new greening requirements (see section 3.2), the extent of existing landscape elements was established based on the ATKIS 'Basic Landscape Model' (ATKIS Basic DLM). The ATKIS describes the topographic features of the landscape in vector format. The features are assigned to a certain feature type and defined on the basis of their spatial position, their geometrical type, descriptive attributes and relations to other objects (relations) (AdV, 2008).

Spatial analysis of ATKIS adopts a method used to establish the 'Index of regional proportions of ecotones' (Enzian and Gutsche, 2004). Since 2002 this GIS-based register is established in German pesticide risk management. It adjusts pesticide risk mitigation measures for differences in landscape composition according to the amount of semi-natural habitats. The method involves a topological analysis of the landscape features and the land use/land cover (LULC) types represented by ATKIS. It allows the identification and quantification of transition areas between LULC types and landscape features. Transition areas are grouped into (1) transition areas with direct proximity of two LULC types (e.g. the zone between a crop field and grassland, crop field and settlement, crop field and forest) and (2) indirect proximity of two LULC types interrupted by streams, ditches, hedges, roads etc.

3 Assumptions

3.1 General economic framework

The Thünen-Baseline 2013 to 2023 builds on external projections for macroeconomic developments from 2013 to 2023, as compiled in secondary sources like the USDA (2011, 2012). The baseline scenario is characterized by an annual growth of the world economy of 3.3 %, and a more modest growth in Germany (1.75 % p. a.). World population growth is projected to increase by 1 % p. a., while the population in Germany is slightly declining (-0.2 % p. a.). The baseline scenario assumes that the Euro continuously gains in value compared to the US-Dollar, resulting in an exchange rate of 1.41 $/€ in 2023 (EU-Commission, 2013). As international trade mostly takes place in US-Dollar, this lowers world market prices from the point of countries of the Eurozone.

Inflation in Germany remains low at 1.7 % p. a. Agricultural land in Germany is assumed to continue to be lost at an annual rate of -0.1 %, accompanied by structural change at historic rates with a decline of farm numbers by -3.4 % each year. The assumptions for the development of input prices in Germany are generally based on historical trends from 2003 to 2012. For energy inputs, the oil price projections used in the OECD-FAO-outlook (2013) are applied, which imply continuously high price increases (+3.1 % p. a). Due to the high importance of energy costs for the production of nitrogen fertilizers, fertilizer prices were also linked to the price forecasts of oil.

World market price projections[2] for agricultural products from the OECD-FAO (2013) are used as a calibrated basis in the AGMEMOD model to establish price developments in the EU and Germany. For the projection period international prices for livestock products, expressed in Euro, rise further (+10 % to +30 %) compared to the already high price level in 2009 to 2011, whereas world market prices for crop products decrease slightly.

3.2 Policy framework

The baseline assumes a continuation of the current policy framework and the implementation of already decided policy changes. For the Thünen-Baseline 2013 to 2023, this implies the implementation of the EU-CAP reform decided in 2013 and its national implementation according to the decisions made at the German Ministers of Agriculture conference. The most important policy assumptions of the baseline can be summarised as follows:

- Trade policy framework: The baseline accounts for the EU accession of Croatia, and numerous bilateral trade agreements which will be implemented over the following years (e.g. with countries in South America and North Africa and the Balkan states).
- Price and quota policies: EU regulation No. 1308/2013 foresees a safety net with public intervention mechanisms for selected products. In addition, the EU commission has at its disposal a reserve fund for crisis prevention and management measures, to be able to react to general market disturbances. The Thünen-Baseline presumes that neither these measures nor export support for milk products are applied during the projection horizon due to the prevailing world market conditions. The baseline scenario takes into consideration the stepwise increase of the milk quota until 2013/14 and its abolishment in 2015. The sugar market reform is implemented based on the study by Gocht et al. (2012), and covers the end of the quota regime in 2017 while maintaining border protection. In view of the OECD-FAO projection of world market prices, an EU-internal sugar price of 390 €/t in 2023 results from these calculations.
- Direct payments of the first CAP pillar: The redistribution of funds between EU member states, the national redistribution of 4.5 % of the budget to the second pillar, and support for young farmers lead to a base payment of 175 €/ha and a greening payment of 85 €/ha. To support smaller farms, a top-up is granted of 50 €/ha for the first 30 ha and 30 €/ha for the next 16 ha.
- Greening: Eligibility for a part of the direct payments depends on the fulfillment of the so-called 'greening' requirements. These comprise protection of permanent grasslands, minimum crop diversity and provision of ecological focus areas (EFA). For the Thünen-Baseline it is assumed that the share of EFA remains fixed at 5 % of arable area throughout the projection period, and that all options for elements counting as ecological focus area are accepted in Germany.
- Support measures of the second CAP pillar: The cut of EU funds for second pillar measures in Germany is compensated by the national redistribution of funds from the first pillar. The baseline assumes that the distribution to individual measures remains unchanged compared to the previous finance period.
- Support for bioenergy: Electricity stemming from biogas is supported in Germany by the Renewable Energy Sources Act (EEG), which guarantees a certain price for electricity generated from renewable energy sources. It is expected that the amendment to the EEG in 2012 will slow down the expansion of biogas plants (Gömann et al., 2013), leading to a demand for 1.2 million ha of energy maize in 2023. Taking into account projections for fuel demand, it is assumed that the new policy framework will reduce demand for biofuels until 2015, with only a modest increase in the following years, whereas demand for ethanol from cereals remains constant.

2 All price developments refer to nominal prices.

4 Results

4.1 Changes in agricultural trade pattern

Macroeconomic developments as well as changes in the political framework (e.g. the implementation of bilateral trade agreements, the end of milk and sugar quota regimes, biofuel targets) influence trade flows in the baseline. Figure 2 provides an overview of the changes in world trade between 2010 and 2023. Total agricultural exports increase from 702 bn € in 2010 to 843 bn € in 2023. The share of EU-28 internal-trade as a percentage of world agricultural trade decreases from 30 % to 26 %. EU exports to non-EU countries increase slightly from 70 bn € to 76 bn €.

A regional disaggregation (Figure 3) shows that EU-exports increase to all regions with the exception of the Commonwealth of Independent States (CIS). Exports to CIS-countries are projected to stagnate as a consequence of expected population decline and the related impacts on demand. Imports from Central and South America, Asia and Africa increase markedly due to the implementation of trade agreements with the EU, which offer export opportunities for the respective countries. Imports from North America and Oceania do not change significantly.

4.2 Farm gate prices

In addition to world market prices and macroeconomic developments, the (politically influenced) demand for

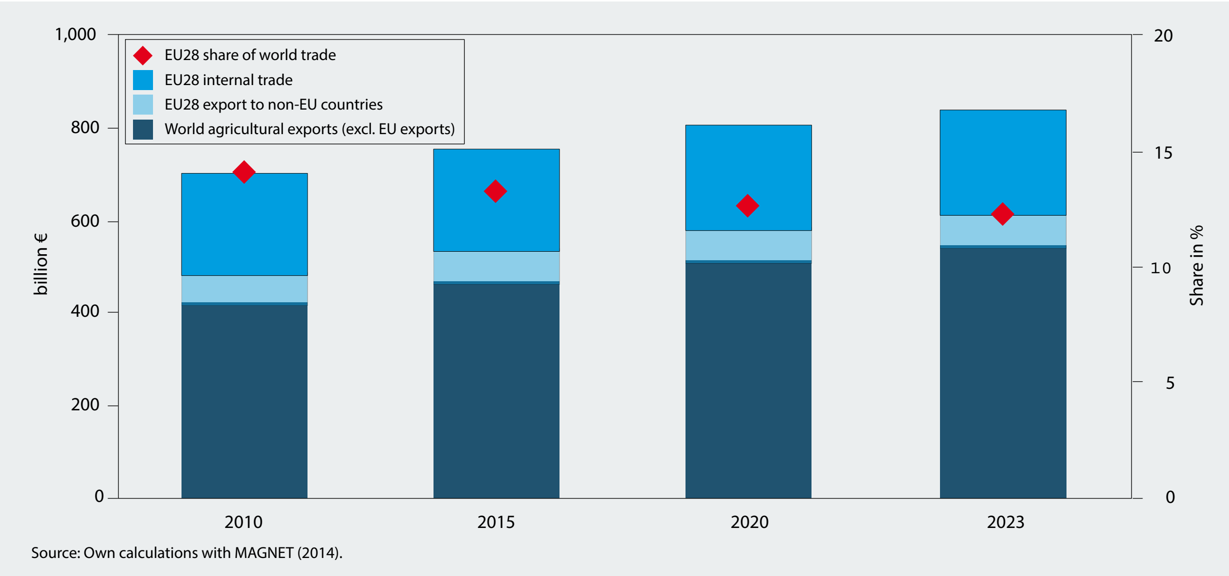


Figure 2:
Agricultural world trade and share of EU-28 (exports)

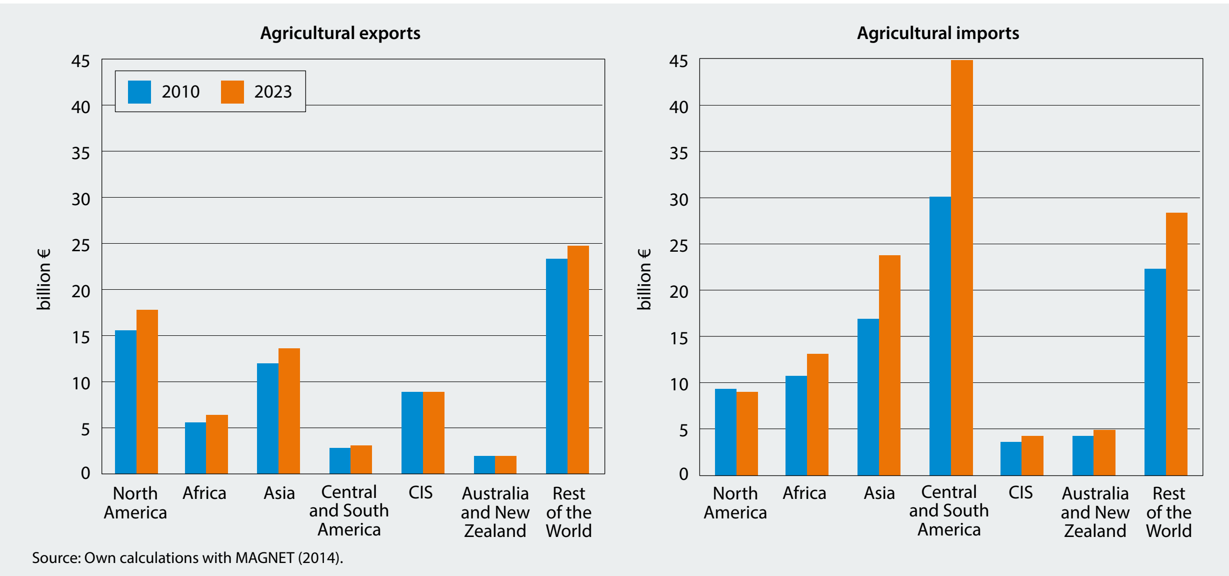


Figure 3:
Agricultural exports and imports of EU-28 in 2010 and 2023

biofuels and biogas is a further important determinant of prices for agricultural products in Germany.

Wheat prices are projected to decrease slightly during the beginning of the projection period (Figure 4), and then remain constant at around 200 €/t, thus being significantly higher than intervention prices. Feed cereal (e.g. maize, barley) prices stabilize at the comparatively high level of approximately 170 €/t. World market developments support prices for rapeseed in Germany. Therefore, despite the drop in domestic demand for rapeseed for biofuels, the decrease of the rapeseed price is moderate and prices remain rather constant at 370 €/t. This means that the rapeseed price is significantly lower than in the record year 2012, but 11 % higher than during the period 2009 to 2011.

Solid demand from the world market leads to an increase in nominal prices for livestock products of 10 to 30 % in 2023 compared to the period 2009 to 2011. In Germany, an increase in beef production as a consequence of higher dairy cow numbers following the end of the quota regime dampens the price development for beef. The broiler prices shown in Figure 4 represent wholesale prices. The prices on farm gate level are expected to rise less dynamically due to an assumed substantial increase in the trade margin that could already be observed in the past.

The developments in the dairy sector are strongly influenced by the end of the quota scheme. Despite currently quite strong world market prices, a decrease of prices until 2015/16 can be expected. The extent of this decrease can however not be projected with the equilibrium models used for this study. In the subsequent period until 2023, prices for milk products are projected to remain stable despite the anticipated production increase, due to a persistent demand from abroad. The farm gate price for milk stands at 33 €/100 kg milk with 3.7 % fat and 3.4 % protein (excluding VAT). Prices for cheese increase, not least due to rising production costs. Whole milk powder production is expanded following an increased demand from Asia, which towards the end of the projection period diminishes the price differentiation between whole and skimmed milk powder. The butter price in Germany follows world market trends and remains comparatively stable after 2015.

4.3 Agricultural production

Table 1 provides an overview of the development of land use and agricultural production in the Thünen-Baseline. Despite the projected increase of cereal prices by about 27 % in 2023 compared to the average of the period 2009 to 2011, cereal area decreases slightly (-7 %). This is due to the increase of energy maize to approximately 1.2 million ha, and the continuing loss of agricultural land. Within the cereal production, there is a marked shift to wheat growing, with a decrease of the area used for more extensively grown cereals like summer barley. This shift in cropping structure and the increase of yields over time lead to an increase of cereal production by approximately 50 million t by 2023, despite the smaller

Table 1

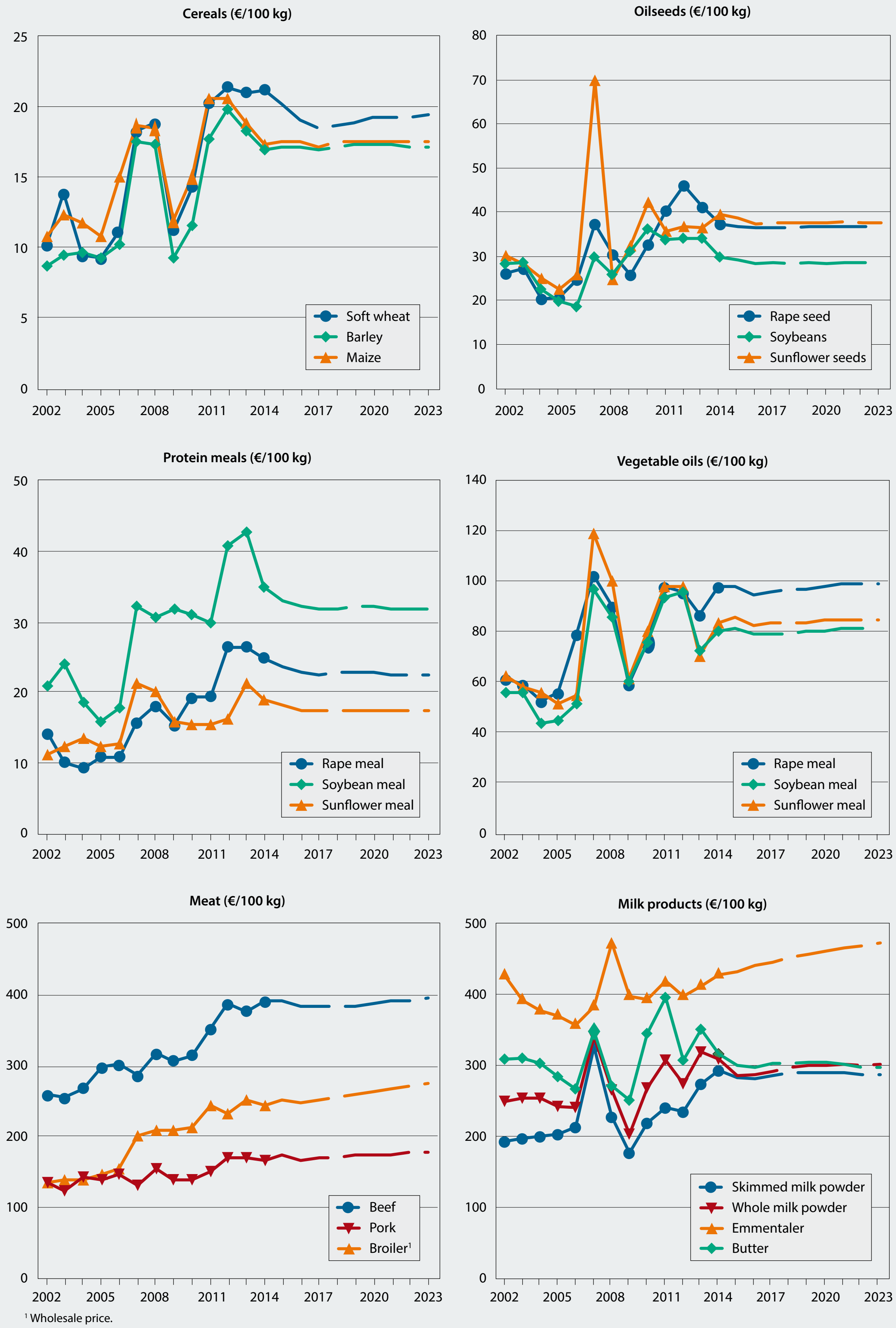
Development of production, land use and income in German agriculture

	Unit	1999	2007	2010	Baseline 2023	Baseline 2023 vs. 2009/11
		Absolute				in %
Land use						
Cereals	1,000 ha	6,840	6,830	6,662	6,184	-7
Wheat	1,000 ha	2,706	3,131	3,257	3,607	11
Barley	1,000 ha	2,196	1,948	1,706	1,378	-19
Rye	1,000 ha	851	664	667	452	-32
Oilseeds	1,000 ha	1,137	1,408	1,409	1,369	-3
Potatoes	1,000 ha	298	270	259	297	15
Pulses and root crops	1,000 ha	804	732	731	680	-7
Silage maize	1,000 ha	1,203	1,017	1,050	1,027	-2
Other arable fodder	1,000 ha	469	599	750	688	-8
Energy maize	1,000 ha	51	444	809	1,217	50
Set aside [1]	1,000 ha	720	593	244	601	146
Cattle	1,000 head	14,831	12,749	12,772	12,951	1
of which: Dairy cows	1,000 head	4,765	4,123	4,191	4,308	3
Milk production[2]	1,000 t	26,768	28,057	30,051	35,372	18
Beef and veal production	1,000 t	1,396	1,136	1,221	1,207	-1

[1] Incl. unused grasslands.

[2] Actual fat and protein content.

Source: Own calculations with RAUMIS (2014).



Source: Own calculations with AGMEMOD (2014).

Figure 4:
Development of farm gate prices in Germany

cropping area. Oilseed areas remain constant, while production increases by 4 %. Silage maize and other arable fodder area is slightly reduced, as fodder yield increases while cattle numbers remain more or less constant.

With the abolishment of the milk quota and rising milk prices, milk production increases to 34.5 million t by 2023. Compared to the period 2009 to 2011, this corresponds to a growth of milk output in Germany by 18 %. Breaking the historic trend, dairy cow numbers increase slightly. Total cattle numbers – and thus beef production – remain almost constant.

The observable trend of a regional concentration of dairy production accelerates following the end of the dairy quota system. On average, milk production increases by 300 kg/ha UAA from 2009/11 to 2023. According to the model results, an above-average expansion of dairy production will take place in the coastal regions and in the lower Rhine region, in some middle mountain areas, as well as in the Allgäu and pre Alpine regions (Map 1). These grassland and lower-yielding arable crop areas have generally shown a particularly competitive dairy production in the past, and already exhibit high dairy production densities. A withdrawal from dairy production can in particular be observed on arable locations, such as for example the Cologne-Aachen area, the Hildesheim plain and the northeast of Brandenburg. In addition, some grassland regions lose production shares. This affects, for example, the Black Forest as well as parts of Hesse, and thus grassland regions that have proven to be less competitive for dairy production in the past and in which dairy production has been declining. These regions are often found near urban centres which offer comparatively good off-farm job opportunities.

The share of milk production produced in farms with larger dairy herds further increases significantly. This trend is especially marked in the northern regions, where over 90 % of the milk is produced in farms with more than 60 cows in 2023. Many farms with smaller herds either exit milk production, or use the opportunities offered by the end of the milk quota scheme to enlarge their herds. In the southern regions, this leads to an increased importance of medium-sized farms, which in the baseline provide approximately 50 % of the regional production.

4.4 Income

The following analysis of income developments at the farm level focuses on the indicator 'farm net value added (FNVA) per agricultural working unit (AWU)'. FNVA measures the return to the factors land, labour and capital, and is put in relation to the amount of labour input to account for differences and changes in farm size. All income figures are adjusted for inflation and refer to 2010 prices.

Compared to the base period of 2009/10 to 2011/12 (Figure 5), the average FNVA/AWU increases by 13 %, and is thus markedly higher than average income over the last ten years. The decrease of farm gate prices in real terms and the reduction of direct payments are partly offset by multiple factors:

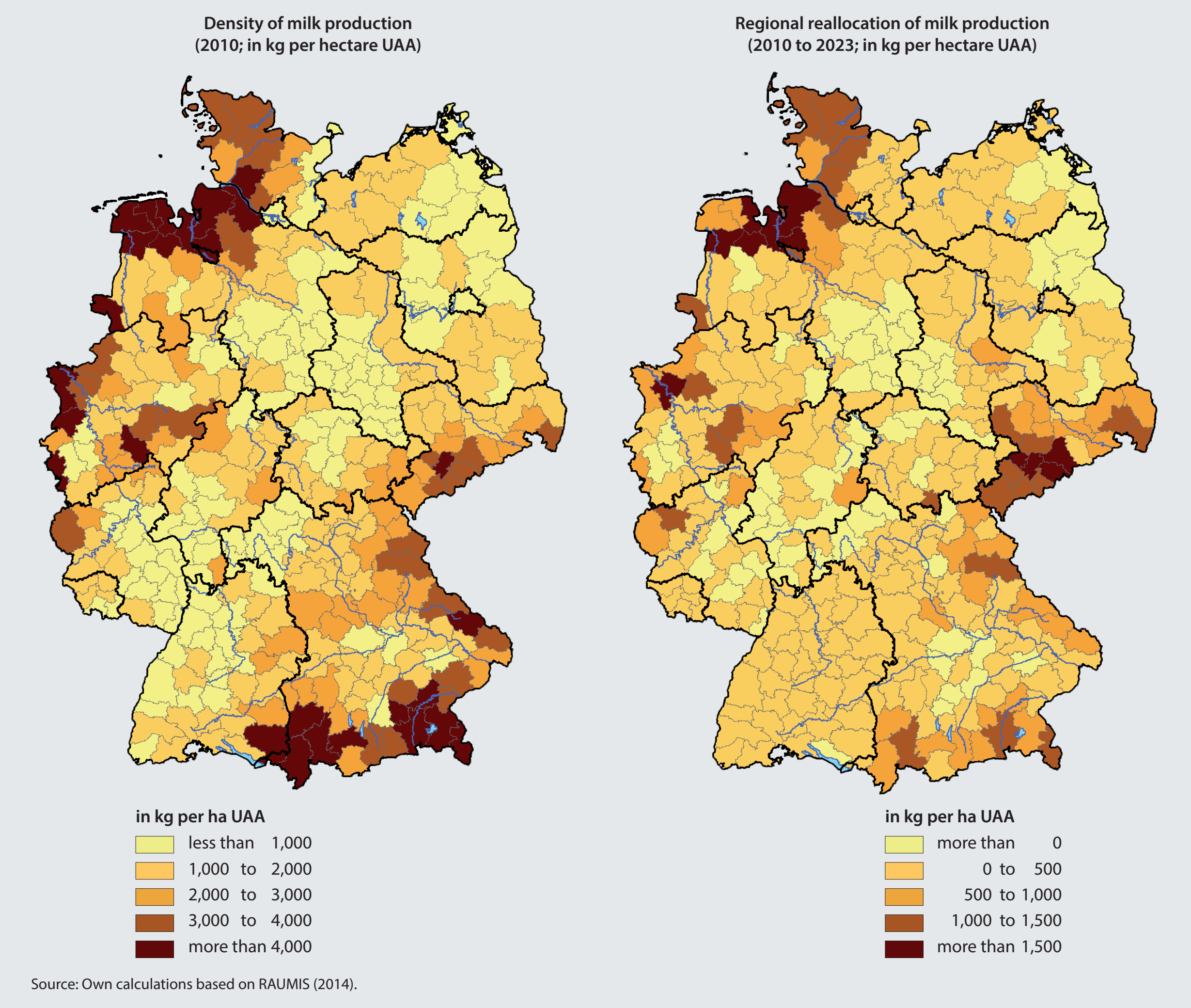
- the opportunities for an increase of milk production following the end of the quota scheme;
- the growing importance of income generation from producing energy maize for biogas generation;
- lower costs for protein feed;
- the continuing structural change, with high exit rates especially of small farms with below-average income potential and the resulting opportunity for growth for remaining farms;
- the reduced labour requirements as a consequence of technical change; and
- improvements in crop and dairy yields.

The large differences in the income of farms of different size observed in the base period persist. However, income developments differ by farm type (Figure 5), which can be mainly attributed to the different price developments for agricultural products (Section 4.2). In addition, the reduction of direct payments, the introduction of nationally uniform basic and greening payments and the redistributive payments for smaller farms lead to changes in support payments whose size and direction strongly depend on region (federal state) and individual farm characteristics (e.g., volume of direct payments in base period and land area).

On the one hand, arable farms are especially affected by the strong increase of fertilizer and energy prices and the decrease of prices for rape and sugar beet. On the other hand, they benefit from the still growing demand for energy maize. The average land area of arable farms increases markedly, due to the high exit rates of small arable farms with lower incomes. Overall, income of arable farms stabilizes at the comparatively high level of the base period. Dairy farms profit from the elimination of quota costs and a strong increase in the average milk production quantity. Despite an above-average reduction of direct payments, the income of dairy farms rises by 24 % and thus reaches a level comparable to that of arable farms. Due to the increase in prices for farm inputs, other grazing livestock farms cannot increase their income above the low level of the base period (–3 %) despite the positive developments of beef prices. Mixed and pig and poultry farms profit from rising pork and poultry prices in the Thünen-Baseline. In addition, pig and poultry farms are less affected by the reduction and reformation of direct payments than other farm types. While on average farms receive 50 €/ha less than in the base period, the payments in pig and poultry decrease by only 5 €/ha. Income increases by 11 % in mixed and 44 % in pig and poultry farms. However, higher regulatory requirements are currently under discussion, e.g. as part of the fertilizer directive, and could increase production costs for these farms in the future.

The increase of rental prices for grassland especially affects other grazing livestock farms due to the high share of grasslands in combination with an often high share of rented land. According to the model results, rents are projected to increase strongly especially in regions with intensive livestock farming.

The income of organically managed farms declines slightly in the baseline compared to the base year period as



Map 1:
Regional relevance and reallocation of milk production in Germany

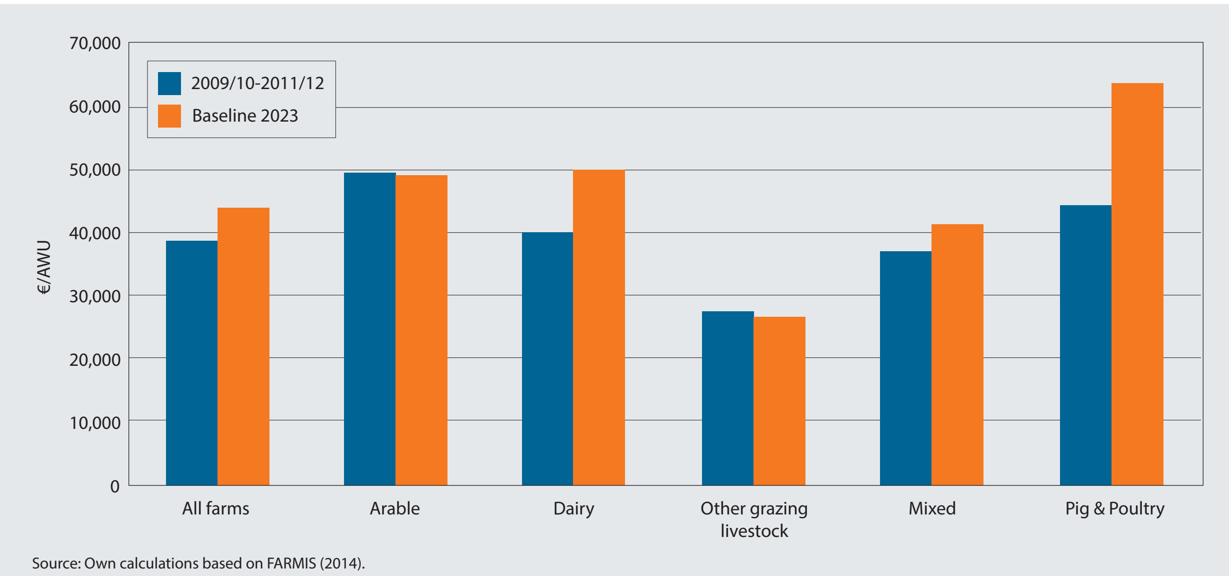


Figure 5:
The development of farm net value added per agricultural work unit by farm type (in real terms in prices of 2010)

shown in Figure 6. Yield and price increases and relative gains from the reform of direct payments are generally not sufficient to compensate rising input prices. Only organic arable farms increase their income (+9 %), which is mainly due to the growing size of the average farm in the wake of structural change. The FNVA/AWU decreases in organic dairy (-4 %), other grazing livestock (-14 %) and mixed farms (-11 %).

4.5 Environmental impacts

One of the key indicators for the environmental impacts of agriculture is the N-surplus, which the difference between all nutrient inputs and outputs on agricultural land. For the soil surface nitrogen balance, inputs include mineral and organic fertilizers, atmospheric deposition, and symbiotic and asymbiotic N-fixation, while output refers to the quantity of nitrogen in harvested crop production. A positive balance or surplus reflects inputs that are in excess of crop and forage needs. A modified calculation of the N-surplus is used to assess the potential impact of excess nitrogen on water, by subtracting nitrogen loss through the volatilization of ammonia to the atmosphere from livestock housing and stored manure.

Compared to the historic developments during the past decade, the trend of declining livestock numbers is not sustained in the baseline scenario, while the increase of biogas production leads to a rise in the quantity of nitrogen from fermentation residues, which has a lower utilization rate than mineral fertilizers. Inputs from organic fertilizers increase by 13 % in 2023 (Table 2), while inputs from mineral fertilizers stagnate due to higher fertilizer prices and increased nitrogen use efficiency . Overall, the sectoral nitrogen soil surface surplus remains almost constant at 70 kg/ha UAA.

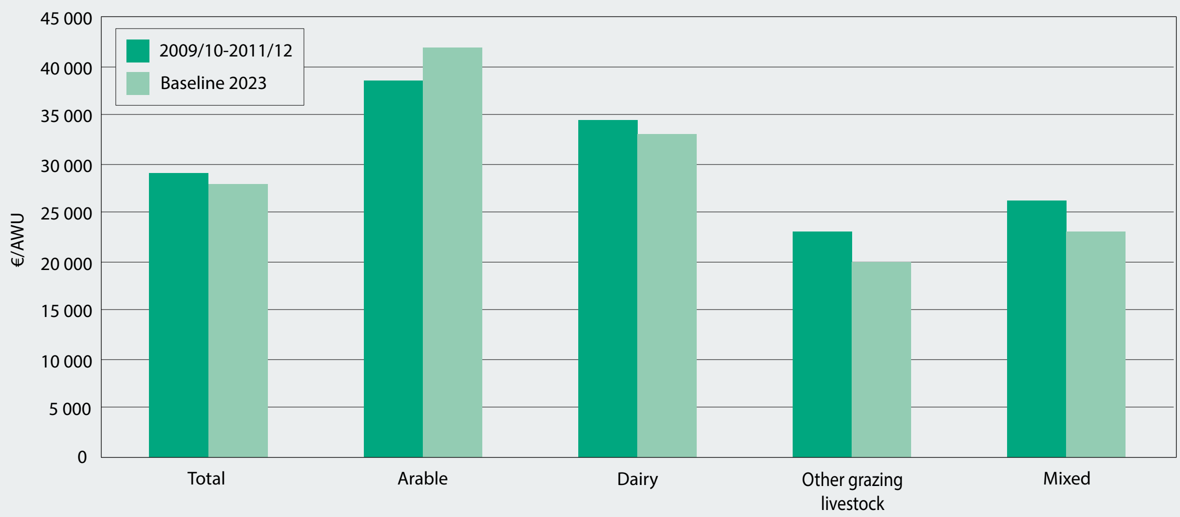
Regional nitrogen balances are to a large extent influenced by the amount of regionally produced manure and energy maize. Map 2 provides an overview of regional stocking rates and nitrogen from livestock excretions and fermentation residues from biogas production in 2023. Stocking rates vary greatly, with an average of 0.9 livestock units (LU) per ha, and values of more than 2 LU/ha in the northwest of Germany. High nitrogen inputs from organic fertilizers are projected especially for the northwestern part of Germany, and some regions in Schleswig-Holstein and Bavaria. While average nitrogen input from organic fertilizers are around 94 kg N/ha UAA, values exceeding 300 kg N/ha UAA are observed in some regions with intensive livestock production in Lower Saxony.

Ammonia is one of the most important airborne pollutants. Directive 2001/81/EC of the European Parliament and

Table 2
Development of the nitrogen balance

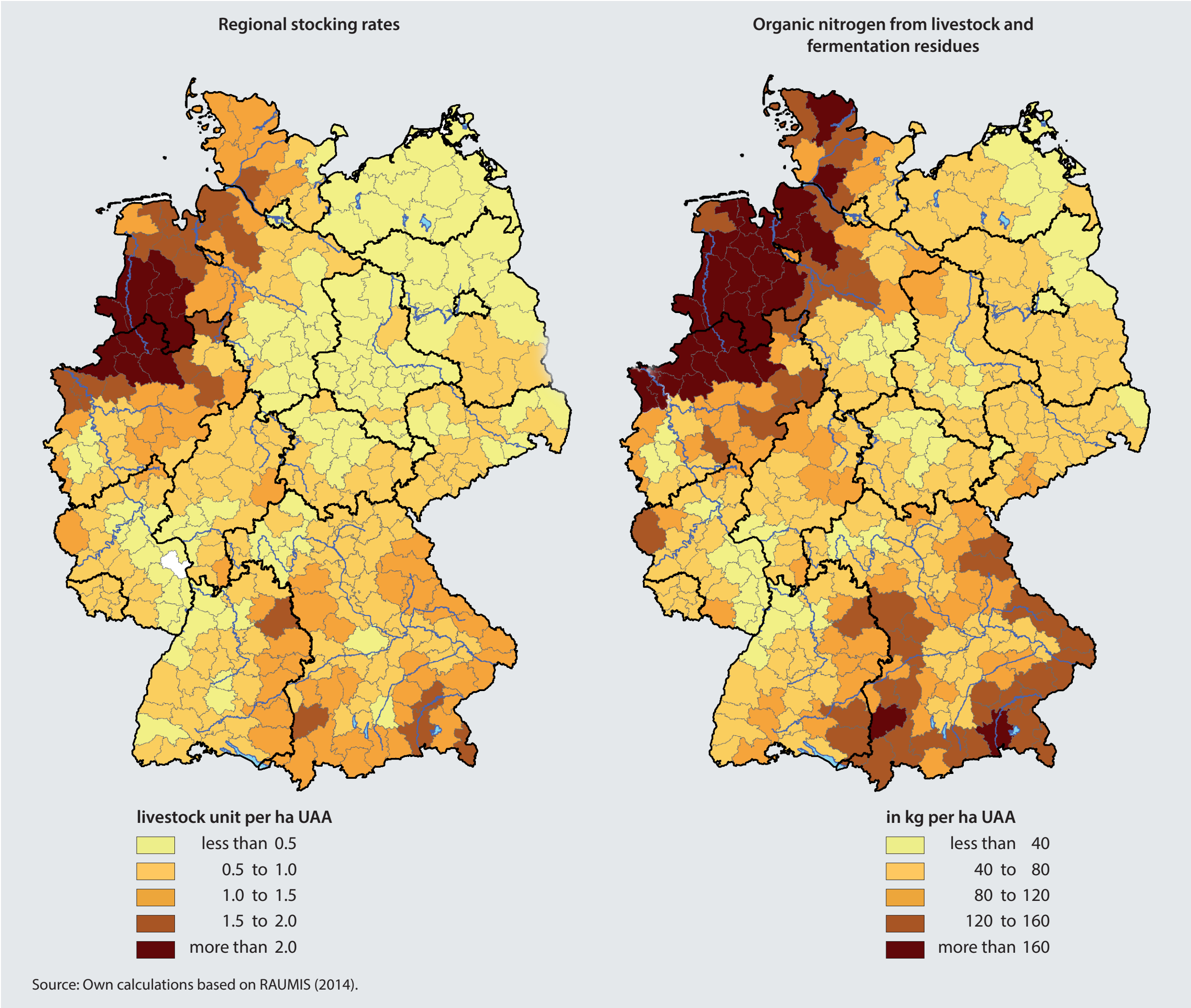
Elements of the nitrogen balance	2009/2011	2023	Change in % to 2009/11
	kg N/ha UAA		
Inputs			
Organic fertilizer	81	94	13
Mineral fertilizer	98	98	0
Symbiotic fixation Asymbiotic fixation Asymbiotic deposition	36	35	-1
Total inputs	215	229	6
Outputs/losses			
N in harvested yields Ammonia losses	-146	-159	8
Nitrogen balance (soil surface balance)			
Denitrification Leaching Accumulation in soils	69	70	2

Source: Own calculations based on Raumis (2014).



Source: Own calculations based on FARMIS (2014).

Figure 6:
The development of farm net value added per agricultural work unit in organic farms (in real terms in prices of 2010)



Map 2:
Regional stocking rates and organic nitrogen from livestock and fermentation residues (2023)

the Council on National Emission Ceilings for certain pollutants (NEC Directive) foresees a reduction of ammonia emissions in Germany to less than 550,000 t after 2010. The European Commission already suggested further reductions. Figure 7 provides an overview of the past and projected development of ammonia emissions in Germany. The reduction of livestock numbers in the eastern part of Germany in the early 1990s, the continuous decrease of cattle numbers and technical progress with respect to the management of organic fertilizers all have contributed to the decrease of ammonia emissions in the past. Total ammonia emissions fluctuated around the emission limit during the years 2010 to 2012. The emissions are projected to increase again above the limit until 2023 due to an increase in livestock numbers. Ammonia emissions from storage and spreading of fermentation residues from biogas production are not yet accounted for in the guidelines for emission calculations. These could add another 40,000 t of ammonia emissions per year. The projections thus highlight that additional measures for ammonia reductions will be necessary to ensure full compliance with legal emission limits.

Greenhouse gas emissions will slightly increase (+1 %) compared to 2005, due to a small rise in cattle numbers and an increase of nitrous oxide (N_2O) emissions as a consequence of a higher turnover of nitrogen in soils.

5 Relevance and impact of the „Greening" obligations

The exemption of very small farms from the greening obligations is relevant for only a marginal share of total arable and grassland (0.7 % and 1.6 % respectively), whereas the exemption of organic farms refers to 6 % of total agricultural area. Based on the cropping patterns of 2012, approximately 25,000 farms will need to adjust their land use by reducing the share of the dominant main crop(s) by 9 % (125,000 ha in total). In the majority of the concerned farms, farmers have to reduce the share of either maize or winter wheat.

In Germany, in total 550,000 ha are required to fulfill the obligations for EFA. Current fallow land already accounts for 100,000 ha; however its regional distribution is quite uneven

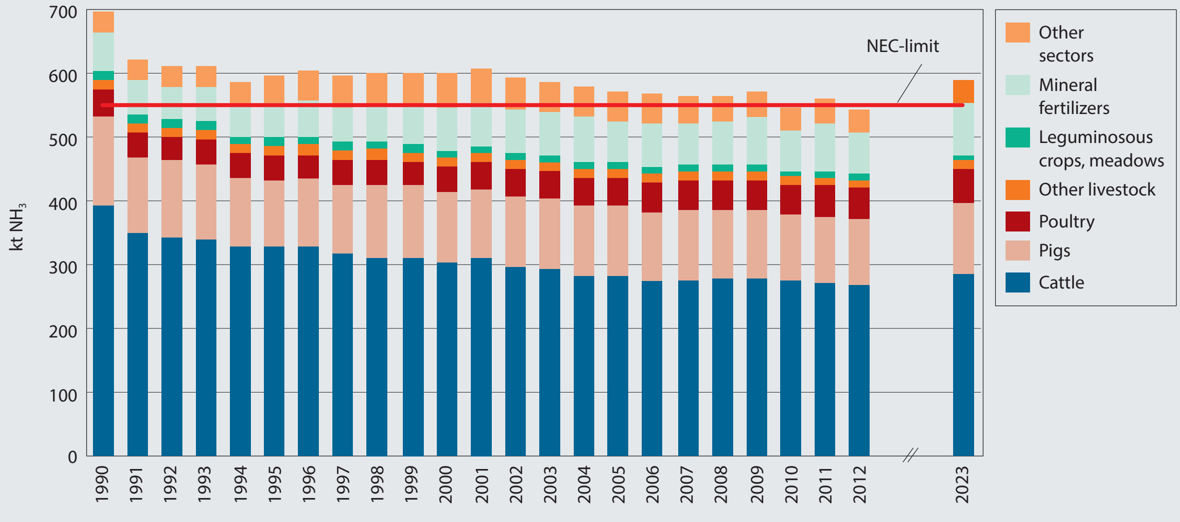
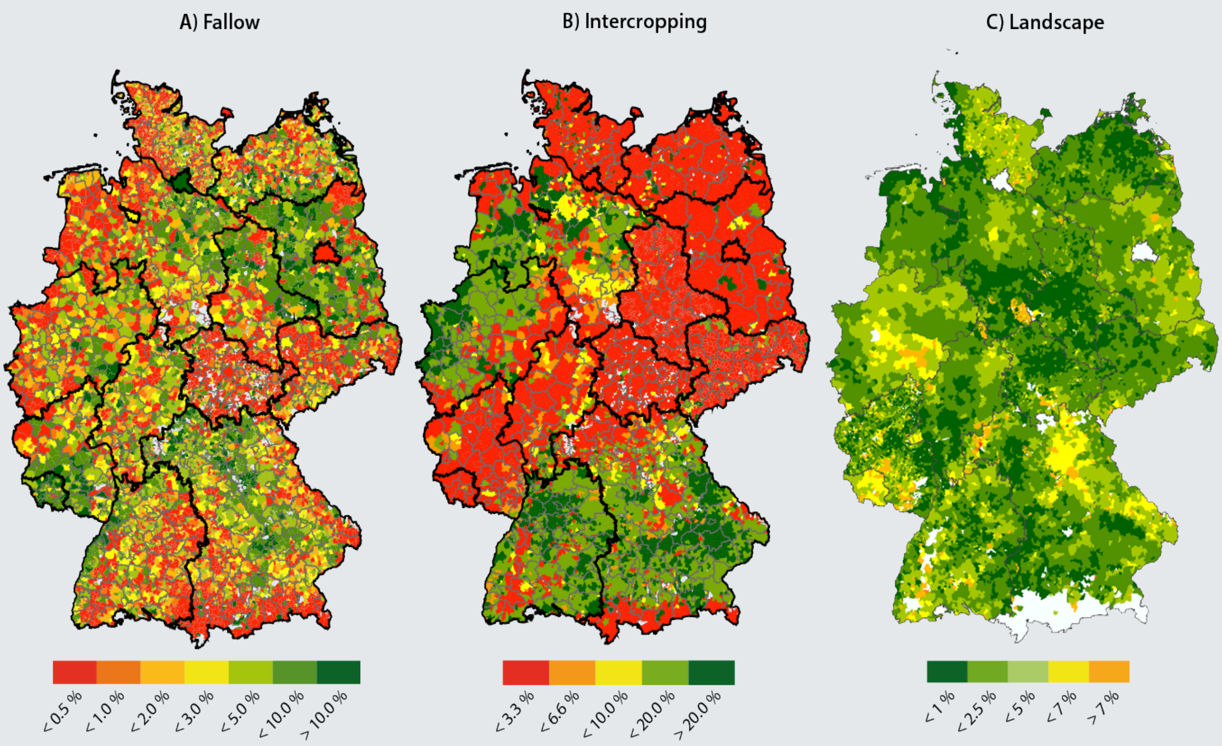


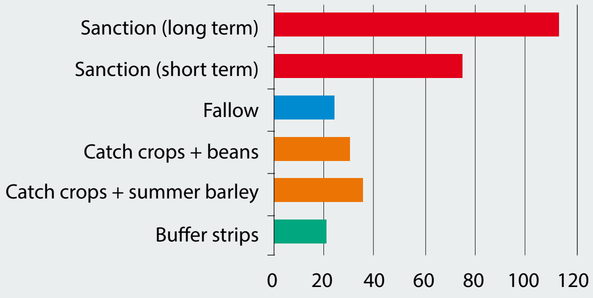
Figure 7:
Development of ammonia emissions in Germany



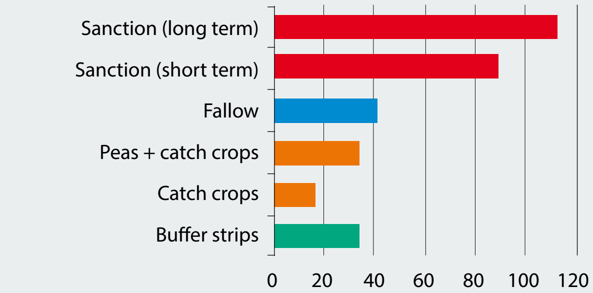
Map 3:
Regional shares of fallow land, intercropping / catch crops and landscape elements as percentage of arable area

(Map 3, A). Taking into account the eligibility of leguminous crops, current cropping levels could provide another 100,000 ha of EFA. Especially the eligibility of catch (or intertillage) crops can significantly reduce the impact of the EFA obligations. In 2010, catch crops were grown on 1.2 million ha (Statistisches Bundesamt, 2011), with high shares especially in northwestern and southern Germany (Map 3, B). Taking into account existing fallows as well as leguminous and catch crops, only 40,000 ha (<0.4 % of arable area) remain. Depending on the region, existing landscape elements cover 1.5 to 4.6 % of the arable area (Map 3, C). The data shows that even at smaller regional levels the existing

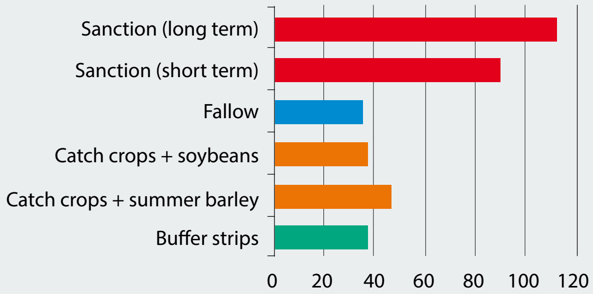
Adjustment costs of the **arable farm in Ostholstein** range from 21 to 36 €/ha UAA, and are thus considerably lower than sanctions (75 to 113 €/ha). The best option combines the inclusion of barley in the crop rotation and buffer strips to fulfill the EFA obligation. Fallow is also a competitive option, as it fulfills both crop diversity and EFA requirements. Catch crops however are an expensive option for this farm, as the necessary introduction of summer crops reduces whole farm gross margin.



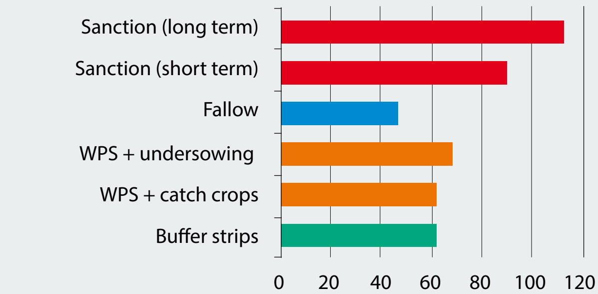
For the **arable farm in southern Lower Saxony**, cost are lowest (17 €/ha UAA) if catch crops are used to fulfill EFA obligations and barley is grown to extend crop rotations. The reason is that this farm already grows mustard before sugar beets, and only needs to replace mustard by a seed mixture. The alternative options are more than twice as costly (34 to 42 €/ha UAA). Not fulfilling the greening obligations would lead to losses of 90 to 113 €/ha.



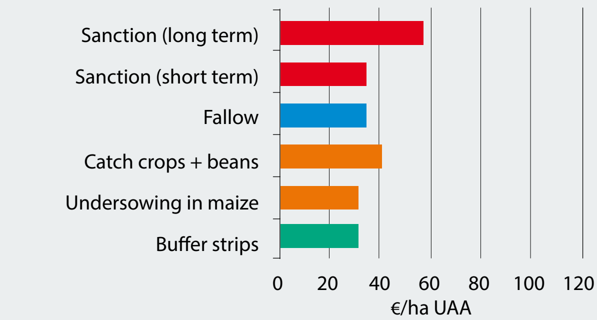
The best option for the **arable farm in Saxony-Anhalt** is to leave some land fallow. This strategy only causes costs of 36 €/ha UAA. The options of buffer strips as EFA and barley for extending the crop rotation, or the combination of catch crops and soybeans are, however, only marginally more expensive (38 €/ha). Thus, greening could promote cultivation of soybeans in some regions.



Adjustments costs of the **bull fattening farm in North Rhine-Westfalia** range from 47 to 69 €/ha UAA, while sanctions would lead to losses of more than 100 €/ha UAA in the long run. Based on the calculations the combination of fallow and purchase of fodder maize is the most competitive option. The reason is a) that maize purchase is comparatively cheap, and b) gross margin loss of wheat is comparatively small. However, as the availability of fodder maize is generally limited, in most cases one the alternative options will be realized.



The **dairy farm in Schleswig-Holstein** would face sanctions equal to 35 €/ha UAA in the short run if greening obligations are not fulfilled. As this is only slightly higher than the adjustment costs (32 to 41 €/ha UAA), it could be beneficial for the farm not to participate in (part of) the greening payments, especially if regional availability of maize is poor or maize prices are high. However, in the long run, sanctions would increase to 57 €/ha UAA. In this situation, growing ley grass and rye silage as well as catch crops on part of the maize area will become the best option.



Source: Own calculations based on TIPI-CAL and TYPICROP (2014).

Figure 8
Cost of adjustments to greening obligations in €/ha UAA

levels of eligible land use and landscape elements suffice to fulfill the EFA requirements of the greening obligations.

It is therefore expected that overall, the impact of the greening obligations will be limited. However, depending on the circumstances, the obligation may require a noticeable change of land use in individual farms. We investigate five constellations of intensive farms which are particularly affected by one or more of the greening obligations to illustrate the related impacts at farm level and to analyze the profitability of different potential adjustment strategies (Figure 8).

6 Reflection of results, assumptions and model restrictions

The results of a baseline projection depend on the assumptions on the development of exogenous factors and the assumptions on biophysical and economic causalities inherent in the model specifications. This chapter aims to reflect the results of the Thünen-Baseline against the outcome of similar projections of the EU-Commission (2013), to identify the key uncertainties in model assumptions and specifications and to discuss their implications for the results.

The projections of domestic price levels of the EU-Commission (2013) and the Thünen-Baseline are quite similar. For cereals, absolute prices in the target year are very close, though the gap to respective world market prices is higher in the EU-Commission projections. The price developments for oilseeds and protein meals are also very similar. For meat and milk, the Thünen-Baseline projections of prices in Germany are a bit lower than the prices projected by the EU-Commission for the EU market (Figure 9), which reflects differences in the development of regional market and supply conditions. Milk production is projected to increase strongly in Germany, which explains a lower national price. As a consequence of the slight increase in beef production and the sluggish development of respective demand in Germany, beef prices are projected to increase less than in the EU-Commission's outlook. Increasing competition from imported pigs for slaughtering restricts the increase of farm gate pork prices in Germany in the Thünen-Baseline.

The Thünen-Baseline relies on a number of assumptions concerning the development of factors and variables not explicitly covered in the models used. Some of the areas concerned are characterized by high uncertainties:

- While the basic elements of the reform of the EU-CAP 2014 to 2020 have been decided, the final design of many regulatory details as well as their national implementation were still under discussion at the time of this study. Especially the final implementation of greening requirements may differ from the assumptions made for this study, which could impact the results of the model projections. In addition, the still open decisions of other member states concerning the degree of remaining coupled payments could also affect agriculture in Germany. With respect to trade agreements, the impact of the currently negotiated free trade agreement with the United States on trade as well as on production is an important issue.
- Uncertainty also exists with respect to the development of the oil price, which affects the prices of agricultural inputs as well as, via the so-called „bushel-barrel-correlation," the level of world market prices for agricultural products.

All the models used for this study are based on a detailed depiction of policies and economic relationships and interdependencies in agricultural production. They have successfully been applied for many policy impact analyses (e.g., Gömann et al., 2008; Gocht et al, 2012), and are continuously developed further. Still, due to specific model characteristics and restricted data availability, it is inevitable that some policy instruments or new technical developments cannot be modelled, or only in a simplified way. The most important restrictions in this respect are:

- The static models are not explicitly taking into account short-term fluctuations, e.g., of world market prices. During the last years, especially world market prices of milk fluctuated markedly within a single year, often due to climate events in some export countries. These effects are not covered.
- The end of the milk quota scheme, which restricted milk quantities in the EU for 30 years, represents a structural break, whose impacts are difficult to project, especially during the first years. Higher price fluctuations may occur, in particular if climatic events or demand shifts occur during this period. These phenomena cannot be projected with the used model system, which is simulating equilibrium markets.
- Supply and demand of agricultural products for energy production is currently not comprehensively modelled. Thus, the area cropped with energy maize is determined by the current and the expected expansion of the number of biogas plants.
- New methodological guidelines for the calculation of gaseous emissions will lead to changes in the results for greenhouse gas emissions (obligatory implementation of new guidelines in 2015; IPCC, 2006) and ammonia emissions (new Guidebook, EEA, 2013) in the future.

7 Conclusions

Overall, the Thünen-Baseline 2013 to 2023 draws a picture of a competitive agricultural sector in Germany, which adapts well to the changes of the latest policy reform and seizes the opportunities for expanding production, especially in the dairy sector. On the other hand, the projections also highlight that the problems that may accompany intensive livestock production will not simply dissolve. In view of the projected high profitability of intensive pig and poultry production the related challenges could even increase.

The Thünen-Baseline 2013 to 2023 provides the basis for subsequent policy impact analysis. Potential future studies include the analysis of the impacts of adjustments to the CAP following the midterm review in 2017, as well as the investigation of a more fundamental reform after 2020.

Source: Own calculations and illustrations based on EU Commission (2013).

Figure 9
Comparison of price projections for meat and milk – Thünen-Baseline 2013–2023 vs. EU-Commission prospects (2013)

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