THE FUTURE OF EUROPEAN AGRICULTURE – AN UPDATED OUTLOOK

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Abstract

This paper reports the results of a European agricultural outlook exercise that updates former studies in three ways, i.e. in terms of timeframes, spatial coverage and policy context. This updated European agricultural outlook constitutes a key component of the forthcoming ‘State of the Environment and Outlook report’ of the European Environment Agency (EEA). Both activity variables and environmental indicators are reported for a baseline projection and alternative scenarios. The main findings include the following: European harvested land is expected to continue to be primarily used for fodder activities and production of cereals (80% of total area); yields increase is projected to be the main source of production growth in Europe over the next 20 years; environmental pressures are expected to significantly increase in the New Member States, as a result primarily of considerable increases in fertilizers use.

Keywords:

Agricultural outlook, European agricultural policy, Environment

JEL classification: C61, Q18, Q21

1. Introduction

This paper reports the results of a European agricultural outlook exercise that updates former studies in three ways, i.e. (1) timeframes, as this outlook covers the next 20 years while agricultural projections usually cover only short and medium terms, (2) spatial coverage, as this is the first time to our knowledge that 8 of the New Member States of the EU are covered in a prospective study in a systematic and consistent way, and (3) policy context, as this outlook takes into account the Luxembourg Compromise on the MTR of the CAP. In addition, this outlook is based on an innovative methodology, which is shortly described here but more extensively addressed in dedicated papers. This updated European agricultural outlook constitutes a key component of the forthcoming ‘State of the Environment and Outlook report’ of the European Environment Agency (EEA). Both activity variables and environmental indicators are reported for a baseline projection and alternative scenarios.

The paper starts with a look at the methodological approach and analytical framework. The agricultural baseline projection is then reported, before reviewing the alternative scenarios.

2. The methodological approach and analytical framework

This European agricultural outlook is based on the CAPSIM model. The baseline projection takes into account the Luxembourg Agreement (i.e. the Mid-Term Review (MTR) of the Common Agriculture Policy (CAP)), in particular in terms of decoupling of payments and supports. The exchange rate used in the baseline projection has been fixed at 1.1 US$/Euro from 2001 onwards, in line with the latest European Commission’s assumptions (‘Prospects for agricultural markets 2004-2011 - Update for EU-25’, DG AGRI, July 2004).

The projection methodology basically combines two components: the standard structure of the agricultural sector model CAPSIM and certain amendments to systematically integrate external forecasts. Regarding CAPSIM this is a straightforward partial equilibrium modelling tool with

[1] The opinions expressed here do not necessarily reflect those of the European Environment Agency.

behavioural functions for activity levels, input demand, consumer demand and processing. It is designed for policy relevant analysis of the CAP and consequently covers the whole of agriculture of EU Member States in the concepts of the Economic Accounts (EAA) in a high level of disaggregation, both in the list of included items as well as in policy coverage. Complete coverage of the whole of agriculture permits to include the set of technical relationships in the context of trend forecasts, e.g. adding up of total areas or balancing of feed contents and animal requirements.

The overall projection tool (CAPSIM) is sourced by forecasts from different experts or modeling tools, and by trend forecasts using data from the "CoCo" database as ex post information. The purpose of these trend estimates is on the one hand to compare expert forecast with a purely technical prolongation of time series. On the other hand, they provide a fall back position in case no values from external projection are available. Instead of using rather naively independent trend forecasts for each time series, our trend estimates include consistency conditions such as closed area and market balances. The resulting estimator is hence a system estimator under constraints. Nonetheless it is to be acknowledged that the trend remain mechanical in that they try to respect technological relationships but remain ignorant about behavioural functions or policy developments.

Technological, structural and preference changes combine with changes in exogenous inputs to determine the future development of agriculture. It should be stated that ultimately almost any projection may be reduced to a particular type of trend projections, at least if the exogenous inputs, such as population, prices or household expenditure are also projected (usually by other research teams) as functions of time. In this sense trend projection may provide a firm ground on which to build projections and this is exactly their purpose in our work.

The intention of this paper is not to give a detailed description of the CAPSIM modelling underlying the European agricultural outlook, but to focus on the results. Therefore, we review the driving forces as well as the environmental indicators which are both of prime importance to this projection exercise, and leave the technical description of the model to dedicated methodological papers.

2.1 Demand and supply side driving forces

Driving forces of quantitative projections can basically be grouped into two categories:

- exogenous inputs into the model used and (e.g. yield increases over time)

- structural relationships within the modelling framework (e.g. identities, constraints).

The type of exogenous inputs depends on the design of the modelling framework: In partial equilibrium models such as CAPSIM, exogenous model inputs still play a decisive role in determining changes over time. Among the exogenous inputs, at least a measure of overall economic growth, population growth, technical change, and a policy framework are required, as all these categories are not endogenously determined in the modelling framework. General equilibrium models , on the other hand, yield overall economic growth as an endogenous model output, conditional on other model inputs and on the structure of the General equilibrium model. Because the structure of the model may succeed to represent some of those driving forces represented exogenously in other systems it is useful to consider the structure a driving force of its own. Moreover, dynamic general equilibrium models may be used to explain and to project endogenously factor accumulation (investment) and even endogenous technological progress as a result of human capital accumulation. In a similar vein, population growth is analysed endogenously in certain socio-economic frameworks and even policy is the subject of endogenous modelling in the area of political economic or political sciences.

The problem with more encompassing models is that they tend to be very complex, demanding and intransparent if they strive for the same level of detail as partial models. The latter is rarely the case, so that, for instance, general equilibrium models tend to be more aggregated and more abstract than partial equilibrium models. If the issues at hand, such as the environmental impact of agriculture over time, cannot appropriately dealt with at that high level of aggregation, it will be necessary to relegate some of the driving forces to the exogenous inputs rather than representing them endogenously. The modelling framework used in his study is a version of the modelling system CAPSIM which has been redesigned in view of the extraordinary long run horizon of this study. In the following, the representation of driving forces in CAPSIM is characterised. Principally, exogenous driving forces can be split into demand and supply side factors.

Population growth is evidently one of the most important exogenous inputs for most economic models, including CAPSIM. It is taken from the set of key assumptions compiled by the PRIMES modelling team, given in 10 year steps from 1990 to 2030. Because the ex post data differ from Eurostat population data which provide the bulk of the CAPSIM database, the projections have been expressed in index form (relative to 2000) and smoothed with a Hodrick-Prescott filter to give a continuous series of projections. The population growth according to this index is used in CAPSIM and in the trend projections. The same approach is used for (real) household expenditure.

Apart from population and expenditure growth, consumption is driven by price movements and other shifters (lifestyle, habits) interpreted as preference shifts over time. Price changes are partly endogenous, partly exogenous. Because the current version of CAPSIM is still a net trade model with an exogenous “Rest of the World” the most straightforward approach to market clearing is to assume either

- exogenous international market prices or

- exogenous net trade.

In the latter case prices are determined endogenously, in the former case net trade is endogenous. This rather simple framework is strictly applied only in standard simulations with given parameters. Assumptions on international prices and on EU net trade will be derived from the projections of international agencies.

The non agricultural (general) price index is an important special case which has to be specified in line with assumptions on the €/$ exchange rate. Medium run assumptions on these are also specified by DG Agri in the context of their “Prospects” publication. As any long run assumptions on the exchange rate are very difficult to make, a corresponding sensitivity analysis has been included in this study.

Finally we have to acknowledge that economic models are usually not capable to explain consumption development over time without variable parameters capturing taste shifts. The same approach is followed in the long run version of CAPSIM when the so called “commitment” parameters in the demand function of the linear expenditure system are considered functions of time.

One of the most important driving forces on the supply side in agriculture is technological change. Depending on the level of detail in modelling this may be represented partly in explicit form. CAPSIM distinguishes activity levels and yields such that crop yields, for example are an explicit modelling input. Other changes, such as long run shifts in manure and housing systems, can only be incorporated in the form of parameter shifts of the nutrient balance description but cannot be analysed as a separate activity in the framework of this study. Environmental indicators are heavily relying on the CAPRI methodology, see below.

Regarding structural change of the farm size distribution, part time farming and labour force changes, an explicit analysis is equally beyond the scope of our work as these are not explicit dimensions of CAPSIM. However structural change may be considered just a special type of technological change when viewed from an aggregate perspective. Because technological change is such an important driving force considerable efforts have been made to capture the bottom line of these shifts of behavioural functions on the supply and demand side with a sophisticated set of trend projections. These trend projections incorporate a great number of technological constraints (nutrient balances, land balance) as well as identities (production = area * yield) to compensate for detailed modelling of the individual contributions to overall technological change such as genetic improvements, capital accumulation, input quality and structural change.

A final driving force effective mainly on the supply side in the EU is the Common Agricultural Policy (CAP). It is sure to have great influence in medium run projections but in the long run it may be expected that policy is endogenously responding to pressure groups and objective constraints, partly imposed by trading partners in the WTO. The partly endogenous character of the CAP renders it a difficult task to specify reasonable assumptions on a “likely” future course of the CAP. Choices must be made on at least two issues:

- Will the reform process initiated in the MacSharry reforms and deepened in the recent MTR decisions continue in the next decades? A liberalised CAP could mean a decoupling of the last coupled forms of support and further cuts in domestic support and external protection.

- Will the second pillar of the CAP and environmental concerns gain in importance in the next decades? While second pillar policies cannot be modelled with CAPSIM a tighter budget for the first pillar can. Equally well it is necessary to make assumptions on the binding character of cross compliance which may even lead to a green “recoupling” of support to production.

We approach the problem of identifying driving forces in different ways: A survey of external sources (FAPRI, FAO, IFPRI, DG Agriculture) provides a collection of exogenous projections for cropping areas, production, consumption, and feed use. Moreover, we also carry out trend projections on our own. The result is a set of external projections to be integrated in CAPSIM. We consolidate these ‘competing’ sets of forecasts using an innovative methodology.

2.2 The environmental indicators

One of the goals of this outlook is to provide deeper insights into environmental consequences of ongoing and alternative developments. CAPSIM has been augmented with a simplified calculation of selected environmental indicators building on the base year specification in the CAPRI model which uses the same database. These indicators will be explained shortly. Without additional assumptions and informed reasoning it is impossible to draw conclusions for biodiversity, landscape characteristics and erosion, to mention the most important omissions. Furthermore our database does not permit to identify irrigated areas, organic farming, and environmental programs. Our main indicators are nutrient balances (N, P, K) and gaseous emissions (NH3, N20, CH4).

The nutrient balance starts with total *production by animals*, which is linked in the original CAPRI calculation to protein requirements, live weights and yields of animals at a lower level of disaggregation than in CAPSIM. For this study the CAPRI coefficients have been aggregated to the CAPSIM level. Because the main yield effect over time will be the increase in milk yields the yield dependency of manure production has been inferred from the comparison of the coefficients of the two CAPRI activities “high yield cows” and “low yield cows” in each EU Member State.

Only a part of total nutrient production is available for *organic supply to crop production* whereas the remainder is released to the atmosphere, to the ground water or accumulated in various soil layers. The share thus lost is determined by stable systems which are calculated in the CAPRI database at a level of detail which exceeds the possibilities within CAPSIM. For the projection we have calculated trend functions of the availability shares which reflect the ongoing changes in housing systems, but only in implicit form. In a “best practice” alternative scenario these availability factors have been increased to reflect improved management.

Losses of various forms are anticipated by farmers when they supplement the available organic supply with *mineral fertilizer purchases*. Total mineral fertilizer purchases have been split up into urea and other nitrogen fertilizers according to historical trends in their shares. In the past the *total fertilizer supply* has typically exceeded the *net exports in harvested material* by a certain amount. This *overfertilisation* characterises farmers behaviour and is equally projected by trends which are usually falling over time. It may be seen that farmers have reduced this overfertilisation which contributed to the improvement in the nutrient balance.

The part of organic nitrogen released as NH3 to the atmosphere is steered by another set of coefficients depending on stable systems and animal types. They are related to the manure coefficients for projection purposes such that a change in manure production automatically changes the forecasted emission of NH3. These animal related coefficients are equally changed in the best practice scenario.

NH3 losses related to mineral fertilizer use are determined as a share of total mineral fertilizer use which is again determined from the CAPRI database and reduced in the best practice scenario. The sum of NH3 losses from organic and mineral fertilizer gives the total *gaseous losses as NH3.*

Finally supply of nitrogen from *biological fixation and atmospheric deposition* is added and projected with coefficients held constant over time.

The balances for potassium and phosphate are calculated in a similar fashion with a few elements of the balance becoming irrelevant.

Methane is calculated with a set of aggregated CAPRI coefficients applied to the CAPSIM activities. Their yield dependency has been inferred from the differences of the CAPRI coefficients for high and low intensity cows similar to the treatment of manure output coefficients.

Emissions of N2O are linked in the CAPRI database to losses during application (with different coefficients for mineral and organic fertilizer), to losses in manure management (specific to management systems, regions, and animal types), to grazing farming systems and losses related to waste and crop residues. These different sources have been linked partly to activity coefficients, partly to mineral fertilizer use and partly to manure production to incorporate the effects of a changed composition of the total nutrient supply on N2O emissions.

It should be mentioned that all indicators have been calculated per ha of agricultural area used, that is net of fallow land or set aside.

3. The agricultural baseline projection

Particular attention is given to the agriculture activity variables in terms of cropping and livestock patterns over the 2025 horizon. This is indeed of prime importance for potential environmental impacts of fertilizers use, manure management and animal emissions on water and soil quality, biodiversity and climate change. The projections reported below cover 23 member states of the European Union (i.e. Cyprus and Malta are not included, due to limited data).

3.1 The crop sector

First of all, we consider the expected use of arable land (see Figure 1). The crop categories used in this section are defined as follows:

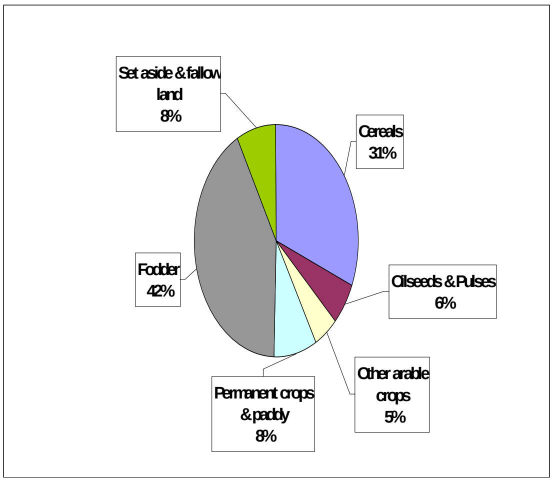
- Cereals: Soft wheat, Durum wheat, Rye and Meslin, Barley, Oats, Grain Maize, Other cereals
- Oilseeds & Pulses: Rape, Sunflower, Soya, Other oils, Pulses
- Other arable crops: Potatoes, Sugar Beet A, Sugar Beet B, Sugar Beet C, Textile and industrial crops, Vegetables
- Permanent crops & paddy: Fruits, Olives for oil, Wine, Paddy rice, Other crops
- Fodder: Fodder maize, Other fodder on arable, Grass and grazings
- Set aside & fallow land: Set-aside obligatory, Set-aside voluntary, Non food on set-aside, Fallow land

After an increase in the EU-15 in the second half of the 1990s (+5%), the total area grown with cereals in the (enlarged) EU is projected to stay fairly stable over the period to reach 52 millions ha by 2020; this would represent about 31% of the total arable land. The slight decrease of cereal areas over the 2020 horizon would primarily reflect the introduction of payments decoupling associated with the Mid-Term Review of the Common Agriculture Policy (CAP) and the overall reduction in the level of support. These developments reflect the projections for wheat production (soft and durum wheat), which is the prime cereal in the EU and is therefore expected to keep its predominance with about 23 millions ha in 2020. Most of the cereals would see their area decreased over the period (e.g. barley and oats; see also the latest projections from the European Fertilizer Manufacturers Association (EFMA), as reported in 'Forecast of food, farming and fertilizer use in the European Union 2004-2014'.)

Permanent crops and paddy areas are also expected to stay fairly stable by 2020 and would represent about 8% of agriculture land. On the contrary, oilseeds and pulses areas are expected to increase by about 12% by 2020 to represent 6% of the arable land. Finally, fodder and other arable crops areas are expected to experience a sharp decrease (about -9%), the former making 42% of total agriculture land by 2020. Set aside and fallow land is projected to represent 13 millions ha by 2020 (8% of total agriculture land), increasing by about 13% over 2001 levels. The reform of the CAP is expected indeed to affect in particular the areas dedicated to voluntary set-aside, which is projected to increase by about 23% from 2001 and 2020.

In sharp contrast with what is expected for the use of arable land, yields are generally expected to significantly increase over the period and lead to an overall increase of production levels. This is certainly the case for cereals where an expected 21% increase in yields offsets the effect of decreasing areas and lead to a projected 20% increase in production. Similar patterns are expected for fodder and other arable crops where production levels in 2020 resemble 2001 thanks to yields increase only. Oilseeds and pulses show the largest projected production increase (31%) due to yields increase of 17%. Finally, the only activity where a decrease in production is projected is permanent crops and paddy (-4%), as yields are expected to decrease.

However, expected yields patterns are very contrasted between the EU-15 and the New-10. For most of the activities reported above, the New-10 exhibit yields increase that are at least 50% greater than in the EU-15 (cereals: +29% vs. +18%; other arable crops: +26% vs. +8%; fodder: +16% vs. +10%). This is of prime importance as this dramatically affects the use of fertilizer and therefore the environmental pressures. Oilseeds and pulses is the only activity where the yields increase in the New-10 is lower than the one in the EU-15 (+4% vs. +20%). Nevertheless, in absolute terms, yields are far superior in the EU-15 than in the New-10 (cereals and other arable crops: +40%; oilseeds and pulses: +60%; permanent crops and paddy: +470%; fodder: +30%).



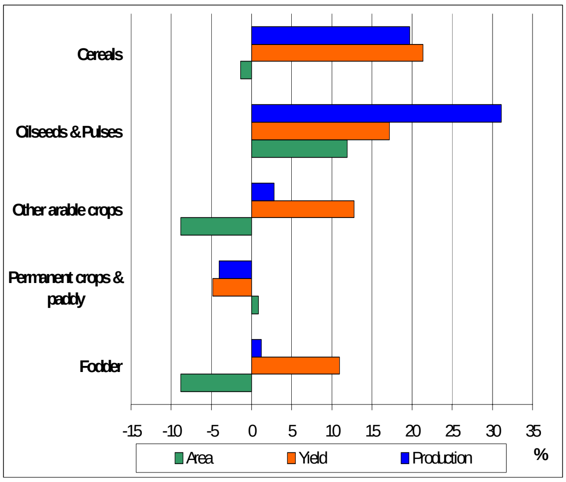


Figure 1. Use of arable land (2020) and sources of crop growth (2020/2001)

3.2 *The animal sector*

Changes in the beef sector depend on the one hand on the interplay of the assumed continuation of the milk quota regime with projected milk yield increases (+31% from 2001 to 2025 or to 7.500 kg in average per dairy cow), and on the other hand on the long term demand shift from beef to pig and poultry meat. The dairy cow herd is forecasted to drop by about 24 % from 2001 level to 19.1 Mio animals in 2025, accompanied by an increase in suckler cows of +21% to 14.9 Mio heads. Accordingly, calves availability is reduced and impacts on the forecasted beef cattle herd. Following decreases in fattened beef cattle and cow numbers, beef meat production is estimated to drop by about -1 Mio t from current 8.3 Mio t to 7.3 Mio t in 2025.

	1994	2001	2011	2015	2020	2025
Beef	7971	7432	6758	6666	6540	6445
Veal	890	847	821	816	811	809
Pork meat	20041	21099	21993	22075	21916	21652
Sheep and goat meat	1169	1090	1061	1063	1049	1024
Poultry meat	8975	10658	11530	12039	12579	13111

Table 1. Baseline projections for meat production

Rather prominent increases in pork meat production in the seventies and eighties have already cooled down in the last decade, and the EU production of 21 Mio t in 2001 is projected to increase only slightly to 21.6 Mio t, following modest increases in demand and keeping the EU net trade rather stable below 2 Mio t a year (see Figure 2).

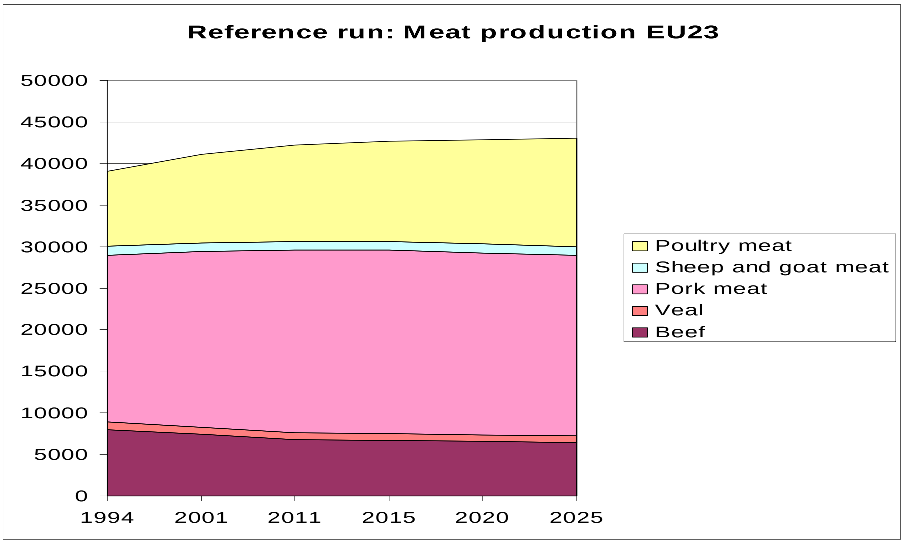


Figure 2. Baseline projections for meat production

In opposite to beef and pork, poultry meat demand and production continue in the projection their stronger increasing pattern, to reach 13 Mio t in 2025 starting from 10.6 Mio t in 2001, with net trade stable around 0.5 Mio t a year. In both cases, relative increases are stronger in the new Member States. Forecasted demand and production of sheep and goat meat remain a small and decreasing part of EU meat markets, dropping from the current 1.1 Mio t to 1 Mio t in 2025, with stable net imports of around 0.2 Mio t.

3.3 The environmental pressures

In terms of environmental pressures (see Figure 3), we focus on fertilizers use, nutrient surpluses and ammonia losses, and GHG emissions. With regard to fertilizers use, considerable increases are projected for mineral fertilizers consumptions in the New-10 over the next 20 years. The use of nitrogen (N) mineral fertilizers, which represents about 60% of total mineral fertilizer use in 2020, is expected to increase by about 35% over this period, while phosphate (P) and potassium (K) would increase in the meantime by about 52% and 41%. This sharply contrasts with the EU-15 situation where the use of mineral fertilizers is expected to stay fairly stable by 2020. This reflects primarily the differences in crops developments and yields increase between the EU-15 and the New-10 (as higher yields mean more fertilizers; Yields are an indicator directly linked to environmental pressures and impacts. However, since higher yields could also imply decreasing the total harvested area, the final net effect of yield changes on the environment has to be worked out alongside area developments) . To some extent, it also reflects the future developments of good farming practices in terms of fertilizers use in Europe, as the overfertilisation in the EU-15 (16% in 2001) is expected to decrease by 5% while in the New-10 (7% in 2001) it would increase by 30%. As far as organic supply to crops is concerned, its use is expected to slightly decrease over the period, both in the EU-15 and the New-10.

Calculations for expected nutrient balances/surpluses are also shown on Figure 3 (Calculation for nutrient surpluses takes into account the various stages in of the nutrients cycle, i.e. production by animals, organic supply to crop production, mineral fertiliser purchases, bio fixation and atmospheric origin, ammonia losses, net exports in harvested material and relative overfertilisation). The projections are once again very contrasted depending on whether we consider the EU-15 or the New-10. Due to the expected dramatic increase in the use of mineral fertilizers in the New-10, nutrients surpluses are expected to increase by 63% for nitrogen (N), 84% for phosphate (P) and 27% for potassium (K). In the meantime, surpluses are expected to decrease in the EU-15 (12% for N, 25% for P and 16% for K) due to a stable use of mineral and organic fertilizers. Ammonia losses are not expected to change over the period, due to efficiency improvements offsetting the increase in herd sizes.

With regard to GHGs, nitrous oxide emissions significantly increase in the New-10 (+15%), in line with the related fertilizer projections. On the other methane emissions are expected to decrease by 5% and 7% in the EU-15 and New-10 respectively, as cattle herd sizes decrease.

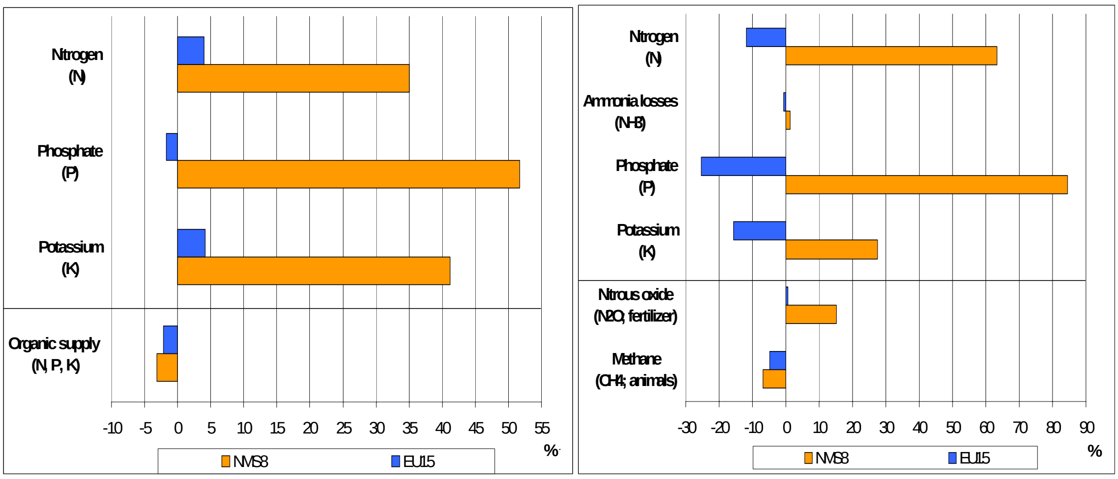


Figure 3. Environmental pressures: use of fertilizers, nutrients surpluses and GHG emissions (2020/2001)

4. The alternative scenarios

Below are reported the results of various alternative scenarios to the baseline projection described above. These address the issues of exchange rate, liberalization of the animal product markets and best practices for fertilizers handling.

4.1 A stronger Euro

The exchange rate in the reference run is fixed at 0.9 €/US$ from 2011 onwards, based on the last (July 2004) DG-AGRI outlook, thus the Euro is weaker as under current market conditions. The first counterfactual scenario analyses possible effects of a stronger Euro of 0.75 €/US$, close to levels observed during the year 2004. A stronger Euro decreases both export and import prices for agricultural goods in the EU, whereas prices for inputs not produced by agriculture itself (fertilizer, energy etc.) are assumed to stay unchanged at reference run levels. The same holds for a few special products assumed to be protected against exchange rate fluctuations (wine, olive oil). The overall effect is hence that of lower terms of trade for agricultural goods, where differences between agricultural commodities depending firstly on the size of import tariffs, which are assumed to work as specific ones and thus dampen the price transmission between world and EU markets, and secondly, on the existence and level of administrative prices. Because land prices are adjusting downwards but remain above the "trigger level" for large scale land abandonment, partly due to per ha farm premiums from the last CAP reform package, there is only a mild impact on total area use.

The overall effect of the stronger Euro on cropping pattern and herd sizes is rather small. For cereals, the major arable cash crops, world market prices in the reference run in 2011 are close to administrative prices, so that price decreases resulting from a stronger Euro would not be transmitted into EU market.

For most other crops, price drops are in the range of 15%, so that the relative competitiveness of cereals increases which let cereal areas expand slightly by +0.5% in 2011, whereas the share of oilseed and pulses drops by about 1.5%. Fallow land would somewhat increase (+0.3%), changes in other crops are mixed, but mostly small, and depend on the existing of Common Market Organizations which stabilize prices.

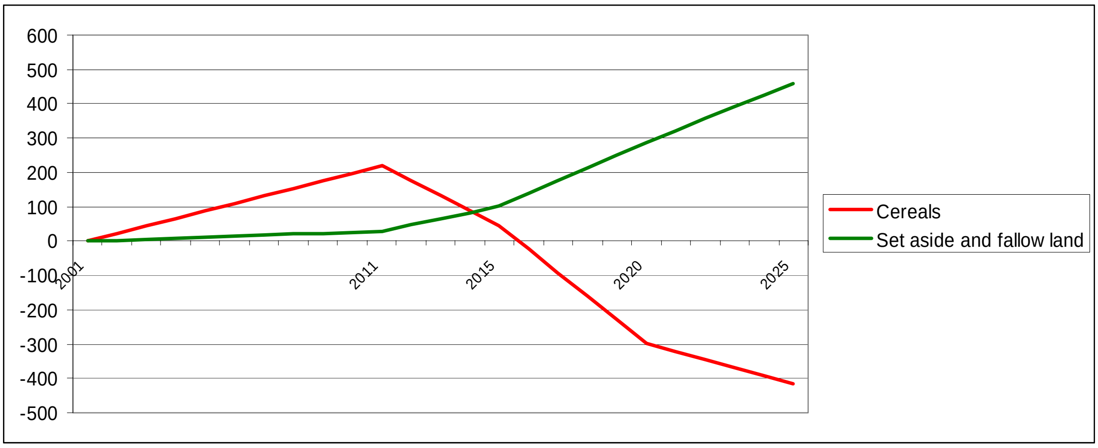


Figure 4. Differences in area use for cereals and set aside / fallow land in the low exchange rate scenario compared to the reference run in EU 23

Effects are different in 2025 as the continuation of the projected world market price increases for cereals would render the administrative prices irrelevant even under the stronger Euro. Consequently, on top of many other crops without administrative price scheme where price are reduced both in 2011 and 2025, changes in border prices for cereals would in 2025 be transmitted into EU market as well and thus provoke a drop in cereal prices by about 17%. Consequently, both areas under cereals (0.8%) and oilseeds/pulses (-0.5%) would drop compared to the reference run, and fallow land would increase by (+6%).

The effect on the animal sector depends again on the existence of price stabilizing policy interventions. In the beef sector, the intervention price for beef is the relevant price both in 2011 and 2025 in the reference run, any changes in border prices would hence not impact on internal markets. Together with the stabilizing effect of the milk quota regime, the relative competitiveness of beef cattle thus increases compared to other animal products with price drops, an effect amplified by lower feed prices and increased competitiveness of fodder production on arable land.

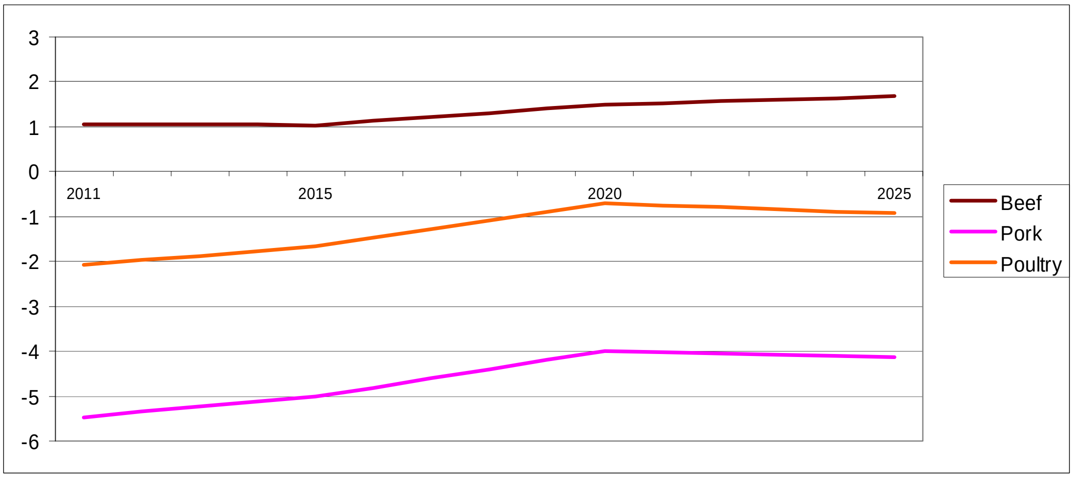


Figure 5. Percentage difference in the low exchange rate scenario compared to the reference run for beef, pork and poultry production in EU 23

Beef supply is simulated to increase by about +1.5% both in 2011 and 2025 compared to the reference run. In opposite to beef, pig markets are closer linked to EU border prices, EU market prices are assumed to fall with a stronger Euro by about 15% compared to the reference run, and pig meat supply drops by about 5.5% in 2011 and about 4% in 2025. Price (10%) and supply (2%, 1%) changes in poultry markets are somewhat smaller. As for beef, the supply reactions depend not only on decreased output prices, but on lower feed costs as well with prices for cereals, oil cakes etc. dropping. Consequently, the relative changes against the reference run are somewhat stronger in 2011 compared to 2025, as the intervention system for cereals keeps cereal prices constant and thus prevents stronger feed price reductions in 2011.

The latter effect explains why the decrease in Nitrogen supply is more pronounced in 2011 (0.7%) as in 2025 (0.1%). In 2011, organic N output (1.3%) and Ammonia losses (1.3%) decrease somewhat compared to the reference run, with rather stable cropping patterns, mineral fertilizer Nitrogen is thus increased (+0.5%) to replace the lower availability of organic Nitrogen. As the share of crop available Nitrogen in anorganic Nitrogen is higher compared to organic one, switching from organic to anorganic Nitrogen application reduces losses and thus improves the Nitrogen balance. The picture in 2025 is somewhat different: the reduction in organic Nitrogen is smaller (0.5%) as herd sizes of pig and poultry are higher compared to 2011, and crop needs are reduced as well, so that mineral fertilizer Nitrogen application drop as well (0.5%), explaining the rather small effect on the balance (0.2%). For Phosphate, results are very similar: a somewhat stronger reduction in the medium term (-1%) compared to 2025 (0.2%).

Regarding agricultural gases output, ammonia is reduced by 1.5% in 2011 and 0.9% in 2025 compared to the reference run, whereas Methane output stays stable in 2011 and even increases in 2025 (+0.5%). The latter is due to the fact that beef supply is expanded.

Overall, even if changes for specific products may be relevant, changes in the exchange rate have little impact on the broad picture. Consequently, the exchange rate assumption in the reference run is of minor importance for the results, at least for environmental indicators where many product specific effects cancel out each other. Evidently this would not hold for monetary variables such as agricultural income.

4.2 Liberalisation of animal product markets

To a larger extent, negative externalities of agricultural production are linked to emissions from animal production as methane output or ammonium losses and nitrate leaching linked to organic Nitrogen stemming from animals. The current CAP, assumed to be continued in the reference run, increases prices for animal products both by border protection and market interventions beyond the level which would prevail in the absence of Common Market Organizations for these commodities. The scenario discussed in the following tries to determine the impact of that aspect of the CAP in the reference run for the year 2025 on selected environmental indicators, and thus shows the possible outcome of the end point of continued liberalization in the context of WTO negotiations for animal products markets.

In the scenario, the quota regime for milk is abolished in the year 2025 accompanied with a gradual drop of administrative prices for butter and skimmed milk powder and tariffs for dairy products, starting after 2011. Equally, market interventions for beef meat are eliminated, and tariffs for the different meats and eggs are removed. Consequently, EU market prices are assumed to be identical with border prices in the year 2025. It is assumed that the milk regime leads to rents both at farm and dairy level, the later assumed to account for 10% of current differences between market prices for dairy products, and the fat and protein value linked to the price of raw milk. Quota rents for milk cows in the base year are a stylised aggregate of various studies.

Reducing administrative prices for dairy and removing tariffs provokes adjustments both at farm and dairy level: the lower prices for dairy products decrease demand for raw milk by the dairies, which will results in lower milk prices. The reduction in milk prices will decrease quota rents, and once these are zero, dairy cow herds (-10%) adjust till marginal production costs are equal to the reduced milk price (-33%). Equally, the lower prices of beef meat (-30%) compared to the reference run will reduce beef production (-4%). At the same time, market prices for pig (13%) and poultry (28%) meat will line up with world markets, and herds adjust (5% for pigs and –11% for poultry). The reduced herds lower the demand for fodder, and allow a reduction of fodder area (2%), which in turn leads to an expansion of other crops (cereals: +1%).

In terms of environmental indicators the liberalization matters but with a 4% improvement of the nitrogen surplus the impact turns out smaller than might be expected by many observers. Only moderate improvements are also the main result for the other environmental indicators.

4.3 Best practice scenario for fertilizer handling

The third scenario checks for the sensitivity of the results regarding the assumed management practices when handling fertilizer, changing three sets of parameters: ammonia losses linked to organic nitrogen output from animals, crop available N, P and K from organic fertilizer application and the overall efficiency of farms when balancing crop nutrient needs and fertilizer applications. The ammonia losses for each animal type and country in the reference run are kept stable at base year levels relative to manure production per animal. They depend among other on the share of the time animals spend grazing or in the stable, the type of storage system used and the application technique. Losses during the time animals are in the stable relate to the animal and housing type, and are between 10 and 20% in the reference run. Generally, it is assumed that the majority of farmers uses uncovered storage facilities, so that between 3 and 6 % of the nitrogen entering storage is lost. Emissions under the application techniques of manure in the reference run are set to 20% of the nitrogen remaining after storage. The crop availability of the remaining N, and the P and K in manure applied is a regional specific factors determined by balancing crop needs and known pure nutrient availability ex post.

In the “best practice scenario”, these assumptions are changed as follows: the crop availability from organic application is increased to 80% of the Nitrogen not lost as ammonia, and 95% for P and K. Ammonia losses in stables are cut by half or to 8%, whatever the smaller, storage losses down to factors between 0.06% to 0.12% depending on the animal type which would require full covered storage facilities and improved manure handling in the stable, especially more frequent sampling into storage. Better application techniques as injections are assumed to reduce ammonia losses during application to 5%. No changes are assumed regarding the grazing practice and the related ammonia losses. Depending on the animal and country, compared to the reference run, ammonia losses stay stable – in cases where animals are grazing the year round, as in many cases for sheep and goat – or are cut down by up to 70%. Losses of P, K are cut down by about -80% to -95%, where the picture for Nitrogen is more mixed, with a reduction by about 50% for most countries.

The improved management practice reduces the "over fertilization" factors giving the ratio of total supply to exports with harvested material. Here it has been assumed that the best practice farming would imply an "over-fertilisation" of 5%. In all countries with higher over-fertilisation the factor has been reduced accordingly in 2025. Given that such improvements would be achievable only gradually through a slow spread of better farming practices, it is assumed that this development would begin in the base period (2001).

Given in the new Member States nutrients have been supplied at very low levels these historical data have not been used as a basis for the over-fertilisation factors. Rather we have assumed that they would return to more normal farming practices as observed in EU 15 (with an over-fertilisation factor of 1.1, which has been reduced to 1.05 in the best practice scenario). The results on environmental indicators are strongly influenced by these assumptions as shown in the following tables on the nitrogen balances.

Region : EU 15 Product : Nitrogen		2001	2011	2015	2020	2025
Production by animals	Reference run	68.3	68.28	69.01	69.64	70.28
kg/ha	Best practice	68.3	68.28	69.01	69.64	70.28
Organic supply to crop production	Reference run	23.26	23.18	23.39	23.55	23.71
kg/ha	Best practice	23.26	33.27	37.69	43.14	48.69
Mineral fertiliser purchases	Reference run	68.68	71.5	72.66	74.29	75.88
kg/ha	Best practice	68.68	60.22	56.46	51.94	47.82
Total fertiliser supply to crops	Reference run	91.94	94.67	96.05	97.84	99.59
kg/ha	Best practice	91.94	93.49	94.14	95.08	96.51
Bio fixation + atmospheric origin	Reference run	15.99	16.13	16.18	16.24	16.29
kg/ha	Best practice	15.99	16.13	16.18	16.24	16.29
Gaseous losses as NH3	Reference run	21.34	21.54	21.79	22.03	22.26
kg/ha	Best practice	21.34	15.61	13.46	10.74	8.05
Net exports in harvested material	Reference run	81.5	87.31	89.41	92.17	94.98
kg/ha	Best practice	81.5	87.31	89.41	92.17	94.98
Nutrient surplus	Reference run	50.13	47.04	46.65	45.98	45.21
kg/ha	Best practice	50.13	41.71	38.77	34.91	31.36

Region : EU 08 Product : Nitrogen		2001	2011	2015	2020	2025
Production by animals	Reference run	40.97	40.73	40.82	40.8	40.75
kg/ha	Best practice	40.97	40.73	40.82	40.8	40.75
Organic supply to crop production	Reference run	11.31	10.95	10.87	10.73	10.58
kg/ha	Best practice	11.31	16.5	18.66	21.32	23.96
Mineral fertiliser purchases	Reference run	46.91	60.58	62.29	64.54	66.81
kg/ha	Best practice	46.91	55.03	53.06	50.62	48.1
Total fertiliser supply to crops	Reference run	58.21	71.53	73.15	75.27	77.39
kg/ha	Best practice	58.21	71.53	71.72	71.94	72.06
Bio fixation + atmospheric origin	Reference run	1.4	1.34	1.32	1.29	1.25
kg/ha	Best practice	1.4	1.34	1.32	1.29	1.25
Gaseous losses as NH3	Reference run	12.71	13.02	13.09	13.12	13.15
kg/ha	Best practice	12.71	9.55	8.2	6.5	4.8
Net exports in harvested material	Reference run	60.57	63.8	65.14	66.88	68.62
kg/ha	Best practice	60.57	63.8	65.14	66.88	68.62
Nutrient surplus	Reference run	16	25.83	26.2	26.62	27.04
kg/ha	Best practice	16	23.75	21.85	19.33	16.67

Table 2. Nitrogen balances in the "best practice" scenario compared to the reference run in EU 15 and 8 New Member States

Improved farming practices may be seen to have far stronger benefits for the environment than additional liberalisation of the livestock sector which benefits the environment, but only in an indirect way. As explained above the situation in the 8 New Member States may be expected to deteriorate in the next years given that mineral fertilizer purchases are likely to grow considerably. “Best practice” improvements, possibly fostered by environmental policies could help a lot to counteract this danger. The final tables show that these improvements partly apply to other environmental indicator variables as well.

Region : European Union Item : Environmental indicator per ha (kg/ha)		2001	2011	2015	2020	2025
Nitrogen	Reference run	42.64	42.4	42.14	41.66	41.12
	Best practice	42.64	37.77	35.04	31.44	28.05
Potassium	Reference run	31.44	29.54	29.12	28.52	28.01
	Best practice	31.44	19.92	16.27	12.26	8.81
Phosphate	Reference run	15.89	14.44	14.02	13.42	12.8
	Best practice	15.89	9.4	7.05	4.04	1.03
Ammonium	Reference run	19.45	19.68	19.87	20.04	20.21
	Best practice	19.45	14.28	12.3	9.8	7.32
Methane	Reference run	48.82	47.52	47.78	48	48.31
	Best practice	48.82	47.52	47.78	48	48.31
Nitrous oxide	Reference run	2.98	3.07	3.11	3.16	3.21
	Best practice	2.98	2.88	2.83	2.77	2.72

Table 2. Nitrogen balances in the “best practice” scenario compared to the reference run in EU 15 and 8 New Member States

An important caveat on our best practice scenario should be kept in mind: The improvements in management practice are simply assumed to happen, without considering their cost. It will either reduce agricultural income if these improvements are enforced by tighter environmental regulation or there will be additional support from public budgets. However it has been show that these changes would also have sizeable returns in terms of improved environmental quality.

5. Concluding remarks

A series of key messages can be drawn from the European agricultural outlook reported above.

First of all, harvested land is expected to continue to be primarily used for fodder activities and production of cereals; yields increase is expected to be the main source of agricultural production growth across Europe over the next 20 years.

Secondly, fertilizer use in the New Member States is expected to soar, increasing the agriculture-related environmental pressures considerably – By 2020, the use of nitrogen fertilizer is projected to increase by 35%, whereas phosphate and potassium use is expected to increase by up to 50% (meanwhile fertilizer use in EU-15 is expected to remain stable). This reflects that yield increase is expected to be the main source of agricultural production growth in the New Member States. To some extent, it also reflects the future developments of farming practices in terms of fertilizers use in Europe, as the over-fertilisation in the New Member States would increase by 30% while it decreases by 5% in the EU-15.

Thirdly, the potential for best practices in the agriculture sector is estimated to be substantial in terms of environmental benefits, e.g. for manure management.

Therefore, from a policy-making perspective, a key question / issue remains: which additional European policies could boost the adoption of environmental-friendly technologies and best practices, and lead to breakthroughs with major environmental benefits?

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