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Literature Review of Methodologies to Generate Baselines for Agriculture and Land Use

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The FP7 project "Common Agricultural Policy Regional Impact – The Rural Development Dimension" (CAPRI-RD) aims at developing and applying an operational, Pan-European tool including all Candidate and Potential Candidate countries to analyse the regional impacts of all policy measures under CAP Pillar I and II across a wide range of economic, social and environmental indicators. The project is carried out by a consortium of 10 research organisations, led by Bonn University (UBO).

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Executive Summary

This Deliverable reviews the main methodologies used to generate baseline projections for world agricultural markets. The baseline represents the business-as-usual scenario considered likely to arise if current policies remain in place.

The focus will be on medium-term projections used as the reference scenario against which alternative policy interventions can be evaluated.

Abbreviations

AAFC	Agriculture and Agri-Food Canada
AGLINK	Worldwide Agribusiness Linkage Program
AGMEMOD	Agricultural Member State Modelling for the EU and Eastern European Countries
CAP	Common Agricultural Policy
CAPRI	Common Agricultural Policy Regional Impact Analysis
COSIMO	COmmodity SImulation MOdel
DG-AGRI	Directorate General for Agriculture and Rural Development
EAA	Economic Accounts for Agriculture
ESIM	European Simulation Model
FAO	Food and Agriculture Organization
FAPRI	Food and Agricultural Policy Research Institute
GDP	Gross Domestic Product
GTAP	Global Trade Analysis Project
IFPRI	International Food Policy Research Institute
IMAGE	
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
MIRAGE	
NUTS	Nomenclature of Units For Territorial Statistics
OECD	Organisation for Economic Co-operation and Development
PCE	Private consumption expenditure deflactor
UN	United Nations
USDA	United States Department of Agriculture
US	United States

1. Introduction

The exploration of likely future scenarios for agriculture can be very useful in public decision-making processes, particularly when used as a benchmark or business as usual scenario for assessment of the potential impacts of alternative policy options. The ex-ante assessment of agricultural policies needs to take into account the changes that would happen in absence of the new policy to be assessed: changes in the socioeconomic environment and effects of policies already in place. The baseline provides a reference scenario against which new policy interventions can be evaluated.

We could define an agricultural baseline as a consistent view on the likely evolution of global agricultural markets over some future time horizon and under a specific set of assumptions about exogenous drivers.

The baseline scenario should reflect as closely as possible the changes expected to occur in the world agriculture, considering that current policies remain in place. The main exogenous drivers influencing the evolution of agriculture will be population growth, technological change, and macroeconomic variables (GDP growth, inflation, crude oil price, exchange rate).

Using the baseline as a benchmark for assessment of alternative policy scenarios, the impacts of the policy change are measured as the difference in results between the policy scenario and the baseline scenario.

In this review, we will focus on baselines used in partial equilibrium analysis and, therefore, we are interested in medium-term projections of agricultural market developments. The baseline mirrors the evolution of key variables representing agricultural commodity markets (production, consumption, trade flows, market prices) from the base year to a point in the future (projection period).

Several national and international institutions develop projections for agricultural commodity markets. In general, these projections share some common features: they are based on historical data and a set of assumptions about exogenous and policy drivers (macroeconomic variables, technology, agricultural and trade policy); they use a composite of economic models and expert judgement to generate the projections; they project the main variables representing agricultural commodity markets from the baseyear until the time horizon (usually medium-term projections).

The considerable amount of time and resources that these institutions devote to the development of baselines are justified because:

- Baselines provide a reference or business as usual scenario for ex-ante assessment of alternative policy options
- Policy impact assessments are baseline-dependent. The impacts of policy shocks depend significantly on the baseline.
- Baselines provide a common point of reference for different modelling systems. Baseline projections are used to build the baseline scenario of different partial equilibrium models, allowing for comparison of results for alternative modelling systems addressing the same policy issue.

The aim of this deliverable is to review the methodologies used to generate agricultural baselines relevant for partial equilibrium analysis of agricultural and trade policies. Therefore, the focus will be on projections for agricultural markets developments, while using exogenous assumptions for the rest of the economy.

The definition of the baseline is a complex process and understanding the procedures used to generate projections is not simple. In this regard, two important issues need to be mentioned.

The first issue is about documentation of the baseline definition process. Extensive documentation exists on the results of baseline projections as well as on their applications to policy analysis. However, in this review we are mainly concerned with the methodological approaches used, for which detailed information is often missing. The procedure to develop baselines is often very complex, involving statistical analysis, quantitative modelling and expert judgement. Understanding which are the main drivers underlying the projections is crucial. Nevertheless, while the main assumptions are usually explained, there are little written documentation on the models and analytical tools used to derive the projections. Since baseline projections are quite non-transparent, we do not pretend here to make a comprehensive review; our aim is to identify the most relevant agricultural baselines and to analyse them based on the limited information available.

The second issue is about the type of models reviewed. Most partial equilibrium models involved in policy impact assessment use a baseline as a benchmark for analysing alternative policy scenarios. Nevertheless, not all partial equilibrium models are suited to generate baselines; while some of them are used both for baseline definition and scenario analysis, other models are calibrated to a given baseline before being applied in policy assessment.

The remainder of the paper is organised as follows. In Section 2, our focus will be on models used to develop baselines at the global level and we will present a review of the main worldwide agricultural outlooks. Section 3 deals with the baselines for specific countries or regions and, particularly, with the baselines with a focus on

European agriculture. The stochastic features in baseline definition are discussed in Section 4. In Section 5, we will compare the baseline definition process across partial equilibrium models. In Section 6, some ideas for further development of baseline methodologies will be discussed. Some concluding remarks are drawn in the last section.

2. Review of mid-term projections for global agricultural markets

2.1. Introduction

Global agricultural outlooks present a consistent view on the evolution of agricultural markets over the next 8-10 years. The projections generally are based on average weather and macroeconomic conditions and assume that current agricultural and trade policy will remain in force during the projection period.

Three institutions provide a global Agricultural Outlook every year: USDA, FAPRI and OECD-FAO. These detailed medium-term projections are used as a reference scenario from which to compare impacts of alternative domestic and international policies. Comparing the alternative scenarios to the baseline facilitates understanding how changes in policies and markets could impact the main output variables (agricultural commodity prices and market balances).

In this section, we compare the main medium-term agricultural projections with global coverage. Other institutions provide long-term global projections (IFPRI uses the IMPACT model to provide long-term scenarios), or country-specific projections focusing on a particular country or group of countries (Canada Market Analysis Group for Canada, DG-AGRi for the European Union).

Hereafter, we first describe the main agricultural outlooks and then compare them according to the spatial and product coverage, the methodology applied and the main outcome.

2.2. Main worldwide agricultural outlooks

2.2.1. USDA Agricultural Outlook

The Economic Research Service (ERS) of the United States Department of Agriculture (USDA) prepares a set of 10-year projections for U.S. and world agricultural commodity markets. The commodity coverage is focused on such products for which US government support programs exist (USDA, 2009).

The 10-year USDA baseline is developed using a composite of models and judgment-based analysis. The baseline is conducted through an interagency process involving five USDA agencies, coordinated by Interagency Committees. Short-term projections are used as a starting point. Output from these models provides essential guidance to the commodity, country, and policy analysts that contribute their expertise and judgment to the final projections.

The baseline is based on specific assumptions regarding macroeconomic conditions, policy, weather and international developments. A set of economic models is used as a starting point for generating the baseline projections:

- A domestic crop-area allocation model
- A number of U.S. commodity market models
- A US agricultural sector model, the Food and Agricultural Policy Simulator (FAPSIM), to analyze detailed technical and policy options. FAPSIM is an annual agricultural sector model, covering major US crop and livestock commodities.
- A global agricultural trade model, "Country-Commodity Linked Modeling System" that links 24 commodity markets in 39 countries/regions, to cover global agricultural markets.

Projections cover production, demand and trade for agricultural commodities, as well as aggregate indicators on the sector, such as farm income.

The process of constructing the baseline is not well documented. As a result, the driving forces behind USDA projections are relatively non-transparent.

2.2.2. FAPRI Projections for Agricultural Markets

The Food and Agricultural Policy Research Institute (FAPRI) is a research institute housed jointly at Iowa State University and the University of Missouri, Columbia. Each year, FAPRI prepares 10-year baseline projections for US and world agricultural markets. Results of the FAPRI baseline are published yearly in the FAPRI US and World Agricultural Outlook, which is intended to serve as the point of comparison for evaluating alternative policy scenarios (FAPRI 2009).

The FAPRI baseline is prepared using comprehensive data, a computer modelling system and an expert review process. The model FAPRI uses to develop the baseline contains over 3,000 equations representing supply and demand relationships in the United States and major countries around the world.

The FAPRI modelling framework consists of a set of partial equilibrium models, covering the US crops model, as well as the international cotton, dairy, livestock, oilseeds, rice, and sugar models. These models are non-spatial, multi-market models that represent several countries/regions and include a rest-of-the world aggregate. The models are independent, but they also have linkages between each other. As an example, the grains model interacts with the dairy and livestock models to provide information on feed demand in the countries, and also with oilseeds and rice models to supply information on the relative profitability and area harvested for the competing crops. Production is divided into yield and area equations, while consumption is divided into feed and non-feed demand. Agricultural and trade policies in each country are included in the model to the extent that they affect the supply and demand decisions of the economic agents. Examples of these include taxes on exports and imports, tariffs, tariff rate quotas, export subsidies, intervention prices, and set-aside rates. Macroeconomic variables such as Gross Domestic Product (GDP), population, and exchange rates are exogenous variables that drive the models' projections.

The FAPRI model typically evolves through time. While baseline assumptions and results are easily available, the written documentation on the model is very limited. This lack of transparency on the methodology as well as on the driving forces behind the trends is also common in other global agricultural outlooks.

2.2.3. OECD-FAO Outlook for World Agricultural Commodity Markets

The OECD-FAO annual Agricultural Outlook is prepared jointly by the Organisation for Economic Co-operation and Development (OECD) and the Food and Agriculture Organisation (FAO) of the United Nations (OECD-FAO 2009). The Agricultural Outlook presents a consistent view on the evolution of global agricultural markets over the next decade and provides a baseline for further analysis of alternative economic or policy assumptions. Markets for cereals, oilseeds, sugar, meats, dairy products and biofuels are covered. The outlook, including historical data and projections, is available through the OECD-FAO joint internet site www.agri-outlook.org.

The methodological approach involves a set of assumptions on exogenous and policy-related drivers, a collaborative expert system and a joint modelling system that facilitate the consistency of the projections (OECD 2007):

- The market assessments are based on a set of underlying assumptions regarding macroeconomic factors, agricultural and trade policies and production technologies. They also assume normal average weather conditions and longer term productivity trends.

- The Outlook brings together the commodity, policy and country expertise of OECD and FAO, providing an assessment of agricultural market prospects for production, consumption, trade, stocks and prices of the included commodities. This collaborative work aims at building consensus on how global agriculture may evolve in the coming decade and the key drivers of this evolution.
- A jointly developed modelling system, based on the OECD's Aglink and FAO's Cosimo models, facilitates consistency in the projections.

The AgLink project started with a pilot application of the model in conjunction with the OECD Agricultural Outlook for 1992. Since then, AgLink has played an important role in the yearly medium-term outlook activity of the OECD through the provision of a consistent analytical framework. In 2004 it was decided to extend the AgLink model to a larger number of developing countries and regions, and to jointly undertake the annual medium term outlook exercise in cooperation with the Food and Agriculture Organization of the United Nations (FAO). The new model component was called COSIMO (COmmodity SImulation MOdel). The general programming structure of COSIMO was taken over from AgLink while the behavioural parameters for the new country modules were taken from its predecessor at FAO, the World Food Model.

The use of a model jointly developed by the OECD and FAO Secretariats facilitates consistency in the baseline process. Nevertheless, the baseline process uses a lot of expert knowledge and does not rely on automatic procedures.

AgLink is a recursive-dynamic, partial equilibrium, supply-demand model of world agriculture, developed by the OECD Secretariat in close co-operation with member countries and certain Non Member Economies (NMEs) and covering annual supply, demand, net trade and prices for the main agricultural commodities (OECD, 2007).

In its current version, AgLink-COSIMO covers 39 agricultural primary and processed commodities and 52 countries and regions. Both models, AgLink and COSIMO, contain individual modules for each country or region.

The first step in the Outlook process is the adjustment of the country or region modules. For AgLink, OECD countries (and some non-OECD countries) provide information on future commodity market developments and on the evolution of their agricultural policies through a system of annual questionnaires. Then the individual country modules are calibrated on initial baseline projections and information provided in these questionnaires. For the rest of non-OECD countries, the COSIMO initial projections are a combination of views of the FAO market analysts and model-driven projections, as no questionnaires are distributed for those countries. External sources, such as the World Bank and the UN, are also used to complete the view of the main economic forces determining market developments. This part of the process is aimed at creating a first insight into possible market developments and at establishing the key macroeconomic and policy assumptions which condition the outlook.

In the next step, the modelling framework jointly developed by the OECD and FAO Secretariats is used to facilitate a consistent integration of this information and to derive an initial set of global market projections. The country modules are merged to form the entire AGLINK-COSIMO model. Supply and demand are represented by behavioural equations, with elasticities being either estimated, assumed or taken from other studies (Thompson, 2003). The model is solved simultaneously to generate a common baseline. The database is up-to-date, as the latest update from the actual market season will be used as base year (that means that the Outlook 2010 uses 2009 as base year).

Then follows a review process by which adjustments will be made where needed. The baseline is first reviewed by staff at both the OECD and the FAO, and subsequently by country experts in the OECD's Commodity Working Groups, before becoming a key component of the annual Agricultural Outlook activity.

2.3. Outlook comparison: methodological approach and projections

2.3.1. Baseline definition process

Projections on supply, demand and trade of agricultural products are highly demanding on data and market expertise. In this section we compare the methodological approaches used for the baseline definition as well as the resulting projections.

On the one hand, these outlooks share some common features: they are based on a set of assumptions about exogenous and policy-driven variables; the methodology for deriving the projections is a mix of model-based and expert-based analysis; they provide 10-year projections for a set of projection variables (agricultural prices and market balances) on a yearly basis.

On the other hand, each of those Outlooks uses different commodity and geographic aggregates and relies on different macro-economic assumptions and data sources.

An additional difficulty for comparing alternative baseline processes comes from the complexity of the processes themselves. Although all reviewed Outlooks use models to guarantee consistency of results, the final projections are not the output of a model run; expert knowledge represents the lion's part in the final baseline. As a result, even in the case where the models used are well documented, the process of defining the baseline remains quite non-transparent.

Since the baseline definition process evolves through time, the comparison will be based on the last Outlooks available at the moment of writing this report, that is, the 2009 Outlooks for the projection period 2009-1018. These projections are published at different periods of the year; USDA was released in February 2009 (USDA 2009), FAPRI in March 2009 (FAPRI 2009) and OECD-FAO in May 2009 (OECD-FAO 2009).

2.3.2. Regional and commodity aggregates

Each of the outlooks uses different commodity and regional aggregates. The complexity of the models depends on the number of commodities and their interactions as well as on the number of regions involved.

Regarding the regional dimension, all three reviewed Outlooks have a global coverage, involving more than 200 regions, which are usually aggregated to 20 to 60 trade blocks. As shown in Table 1, the most relevant trading regions are modelled individually in all the three Outlooks. The rest of the regions are aggregated in trade blocks, being OECD-FAO more disaggregated than USDA and FAPRI.

Table 1. Regional aggregates of the global agricultural outlooks

	Common countries/aggregates		**Specific countries/aggregates**
USDA (39 regions)	US **EU** Argentina	South Korea México New Zealand	Several country aggregates
FAPRI (26 regions)	Australia Brazil Canada	Russia India Turkey	Several country aggregates
OECD-FAO (58 regions)	China Japan	South Africa	Several country aggregates

As for commodity coverage, to represent production and demand in sufficient detail, a number of primary and secondary commodities have to be included. Interactions across commodities also need to be taken into account: product substitution for consumer, input and output relationships between raw and processed products, resource competition between crop and livestock activities.

As shown in Table 2, the list of common commodities is very limited. Still, some further comparison can be done on commodity groups (cereals, oilseeds, etc.). Of the three Outlooks, only USDA embodies crop land allocation and provides farm income indicators.

Table 2. Commodity aggregates of the global agricultural outlooks

	Common commodities	Specific commodities/aggregates
USDA (24 comm)	Wheat Rice	Corn Barley Sorghum Oats Other coarse grains Cotton Soybeans Soybeans meal Soybeans oil Horticultural crops
FAPRI (33 comm)	Sugar Milk Beef and veal	Corn Barley Sorghum Soybeans Rapeseed Sunflower Oil Rapeseed Oil Sunflower Meal Palm Oil Cotton Ethanol Biodiesel Cheese Butter Nonfat Dry Milk Whole milk Powder
OECD-FAO (39 comm)	Pork Poultry meat Egss	Coarse grains Oilseeds Oilseed meals Vegetable oils Butter Cheese Whole milk powder Skim milk powder Sheep meat Molasses Ethanol Biodiesel Dried Distiller's Grains

2.3.3. Macroeconomic variables

In the coming decade, the global agricultural sector will be shaped by many economic, policy, and technical developments. Besides current policies, the main drivers of the agricultural projections are macroeconomic variables, such as population and economic growth affecting demand growth, exchange rates impacting trade flows and oil prices influencing both supply and demand.

Agricultural outlooks considerably differ in their sources of data for exogenous variables (Table 3). The USDA baseline relies mainly on in-house data sources; the FAPRI baseline on data provided by IHS Global Insight; OECD-FAO mostly on data from in-house economic sources and international organisations. The assumptions about macroeconomic variables also differ because the outlook projections are made at different periods of the year and they reflect the latest information available at the time they were prepared.

Population growth is one of the main drivers of the demand side of the agricultural commodity markets projections. OECD-FAO uses population estimates from the 2006 Revision of the United Nations Population Prospects. The UN Population Prospects database is chosen because it represents a comprehensive source of reliable estimates which includes data for all countries and regional aggregates in the Outlook. For consistency reasons, the same source is used for both the historical population estimates and the projection data. For the projection period, the medium variant set of estimates was selected for use from the four alternative projection variants (low, medium, high and constant fertility). Both USDA and FAPRI use data coming from US statistical sources.

Table 3. Main data sources for macroeconomic variables

	USDA	FAPRI	OECD-FAO
Population growth	US Bureau of the Census and internal sources	US Bureau of the Census International Data Base	UN Population Prospects
GDP growth	In-house sources	IHS Global Insight	OECD and World Bank medium term economic projections
Exchange rate	In-house sources	In-house sources	In-house sources
Crude oil price	In-house sources	IHS Global Insight	Short-term projections for 2009-10 and OECD economic outlook

For the rest of macroeconomic variables used to generate the Outlook (GDP growth, producer prices index, consumer price index, exchange rate and crude oil price), the OECD-FAO Outlook uses historical data from the OECD Economic Outlook and projection data from the medium-term macroeconomic projections of the OECD Economics Department. For non-member economies, historical and projection data for these macroeconomic series are obtained from the World Bank Global Economic Prospects. Usually the oil price is based on information from the OECD Economic Outlook; in the 2009 Outlook, however, the short term oil price projections did not fully reflect the most recent market developments. Hence, for the first two years of the Outlook the oil price is from the US Energy Information Agency. For subsequent years, the oil price assumptions remain those of the OECD Economic Outlook.

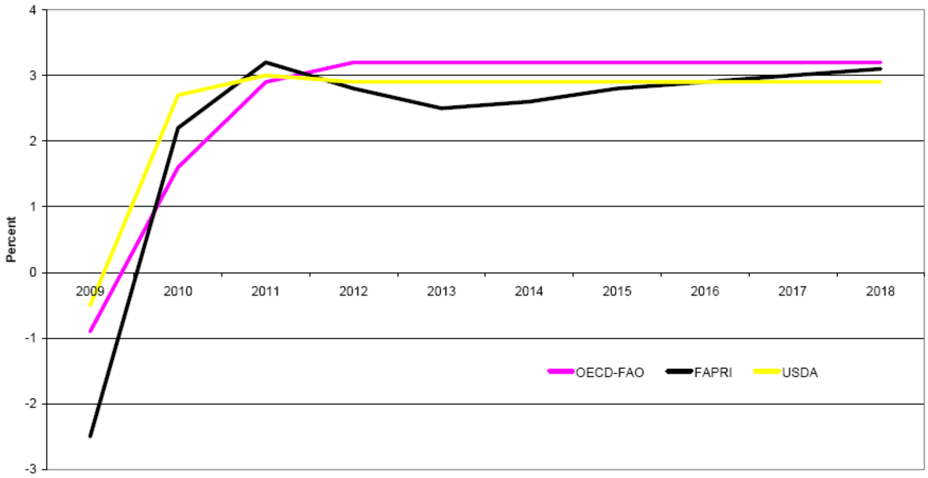
In the case of FAPRI, macroeconomic projections are taken from IHS global Insight. USDA uses mainly in-house sources for these projections.

Projections on macroeconomic variables depend on the assessment of the economic situation. Therefore, when the economic situation evolves very quickly, how it was the case in recent years (we moved from a high commodity prices situation in 2007/08 to an economic slowdown), alternative Outlooks may assume quite different paths for economic variables. For this reason, projections for macroeconomic variables in the 2009 Outlooks show more differences than in past ones. This is also pointed out in the comparative analysis of projections for agricultural commodity markets published by the Directorate General for Agriculture and Rural Development (European Commission 2009). Nevertheless, while the prospects are rather divergent in the first projection years, they tend to merge at the end of the projection period.

All baselines show similar trends in population growth. OECD-FAO assumes a slowly declining rate from aprox. 1.2% in 2009 to around 1.0 in 2018. FAPRI population growth rates go from 1.2% in 2009 to 1.1% in 2018.

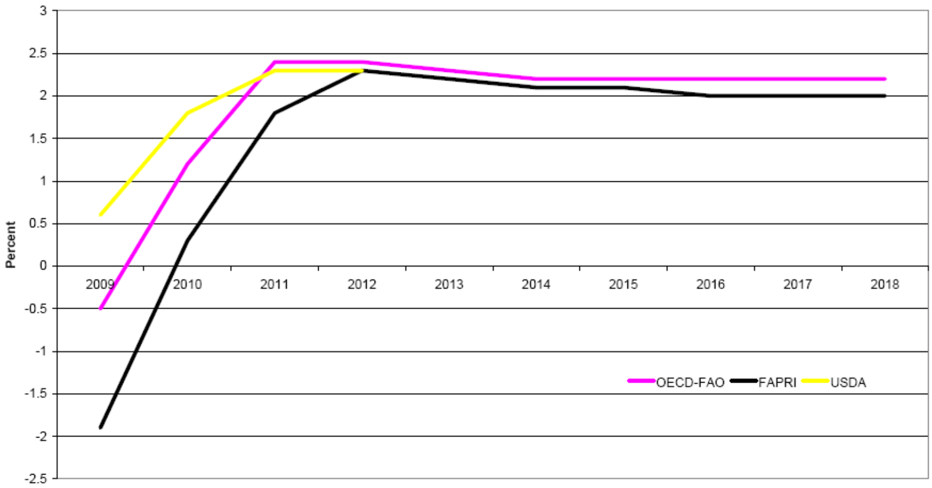
On the contrary, projections for GDP considerably differ across baselines in the first years of the projection period, though they show similar trends at the end of the projection period (see Figures 1 and 2).

Figure 1. Projections on GDP growth 2009-2018 (US)



Source: European Commission (2009)

Figure 2. Projections on GDP growth 2009-2018 (EU)



Source: European Commission (2009)

Energy prices have an increasing influence in agricultural markets through the emergence of the biofuels industry. All Outlooks assume a decrease in crude oil prices in 2009 followed by a price increase over the remainder of the projection period. Projected prices for the end-year 2018 are quite dissimilar; while USDA assumes an average price near 100 USD/barrel, FAPRI projection is around 80 USD/barrel and OECD-FAO projection is around 70 USD/barrel.

Exchange rate changes affect the trade competitiveness of countries and regions. OECD-FAO assumes relatively stable exchange rates, with the Euro-USD exchange rate around 0.7 over the projection period. FAPRI and USDA assume an appreciation of the US dollar at the beginning of the projection period followed by a moderate depreciation over the rest of the period.

2.3.4. Policy environment

Projections are established on the basis of existing agricultural and trade policies. The world policy environment includes the continuing implementation of reforms in agricultural, trade and energy policies.

All baselines incorporate the 2008 US Farm Bill (The Food, Conservation and Energy Act) and changes adopted in the framework of the "Health Check" of the Common Agricultural Policy.

Trade policies arising from the Uruguay Round Agreement on Agriculture are incorporated in the 2009 Outlooks. Commitments under the Uruguay Round are assumed fixed over the projection period. The 2009 Outlooks do not include any assumptions on policy changes arising from the Doha Round.

The global expansion in biofuels production is one of the major factors driving the projections. Increasing energy costs have provided an incentive for many governments to promote the use of renewable sources of energy. The increasing demand of biofuels is expected to have a significant impact on global agricultural markets. Assumptions about the evolution of the biofuels industry are incorporated in the 2009 Outlooks.

Major energy policies included in the baselines are the 2007 Energy Independence and Security Act (EISA) of the US, the 2003 Renewable Fuels Directive of the EU, biofuel policies such as the producer incentives in Canada, and biofuel mandates and regulations in Argentina, Brazil and Indonesia.

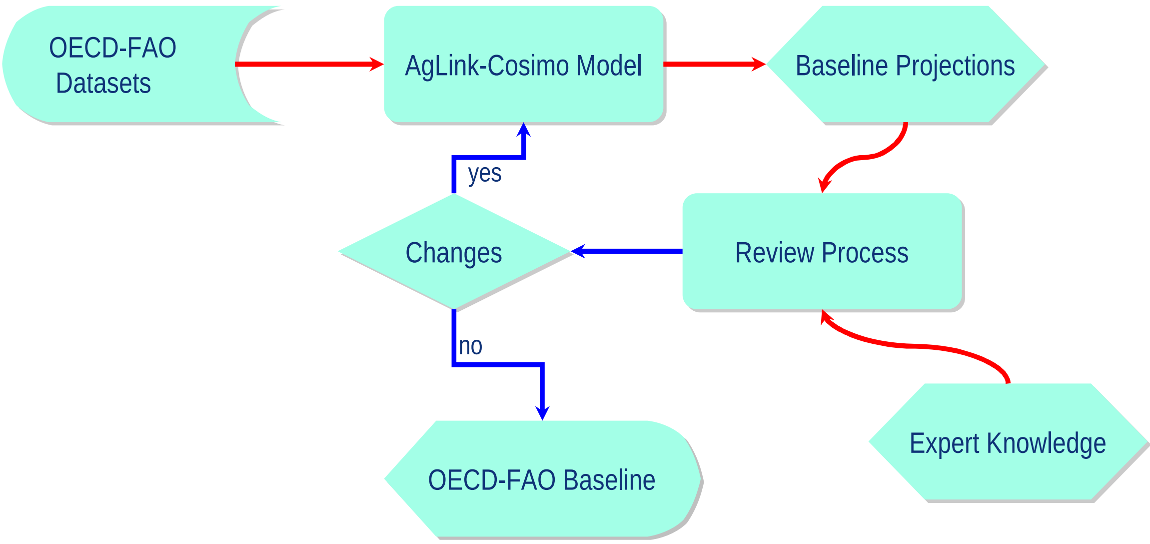
2.3.5. The baseline definition process

All three agricultural Outlooks provide 10-year projections for global agricultural commodity markets. The process of developing the baseline is repeated every year, using updated assumptions about exogenous drivers and the policy context.

The baseline definition process is quite similar across Outlooks. The projections are built based on a specific set of assumptions and using a composite of expert knowledge and economic modelling. Main differences across Outlooks come from the different weights of models and experts in the procedure, some baselines being more model-based while others are more expert-based.

The OCDE-FAO Outlook is prepared jointly by OECD and FAO. Figure 3 illustrates the baseline construction procedure. The baseline is development in close cooperation with national experts in OECD countries and FAO experts for non-OECD countries.

Figure 3. The OECD-FAO baseline process



The modelling system has also been developed jointly, based on AGLINK model from OECD and COSIMO model from FAO. The baseline process starts with a first calibration of individual country models using updated assumptions (national experts in OECD countries, FAO experts in non-OECD). Then a first run of the AGLINK-COSIMO model will generate a first set of projections, which will go through a review process implying a lot of expert judgement and model adjustments until a consensus is reached and a final set of projections is generated. One of the so-called advantages of this method is that a common view on the likely evolution of agricultural markets is built through the collaborative work of many national/regional experts.

The FAPRI Outlook is prepared by FAPRI modellers (and market analyst) through an iterative process in two “baseline weeks”. First, the set of international and US models for crops, livestock and biofuels are specified individually. Then, modellers meet together and share models outcome (mainly prices and net trade), make adjustment based on this new information and run their models again. The interaction among models goes on until all markets are in equilibrium.

The USDA baseline is prepared through an interagency process, 5 USDA Agencies being involved in the process, which is coordinated by the World Agricultural Outlook Board. Projections are based on expert judgment by commodity analysts and a set of economic models (mainly an agricultural sector model for US and a global agricultural trade model). Output from these models provides essential guidance to the commodity, country and policy analysts that contribute their expertise to the final projections. Detailed documentation on the baseline process is lacking.

All the baseline definition processes are quite non-transparent. Regarding the OECD-FAO baseline, detailed documentation exists but, since no systematic procedures are used, understanding the changes made to the model seems quite difficult. Also, it does not seem possible to keep track on the main drivers influencing the projections.

As for FAPRI and USDA, these projections are developed by US institutions and, therefore, focus mainly on the US agriculture. Even if the rest of the world is included, the level of detail is not comparable. This is one of the main shortcomings of these baselines when used for ex-ante assessment of agricultural policies beyond US.

Besides this focus on US, the FAPRI and USDA baseline processes are very opaque. In the case of FAPRI, models that can be quite different from each other are solved independently and through some model adjustments are meant to find market equilibrium. At the end, the process is mainly expert-driven. In the case of USDA, it is even harder to evaluate the process because it is very poorly documented.

2.3.6. Projections for agricultural commodity markets

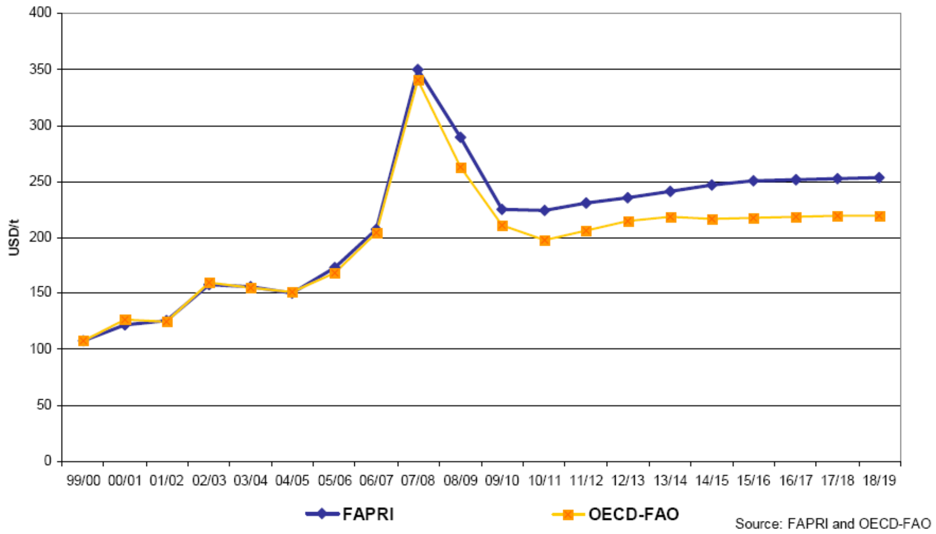
Output from the 2009 Outlooks mainly refers to prices and market balances for agricultural commodities worldwide.

We observe higher differences in projections from the 2009 Outlooks (baseline 2009-18) than in previous ones (European Commission 2009), which is not surprising given that differences in some macroeconomic assumptions are also higher due to the changing macroeconomic environment.

All outlooks note that the strong supply response to the high commodity prices in 2007/08, together with the economic downturn, will bring prices down again well below their 2007/08 peaks. However, prices are expected to remain well above pre-2007 levels. Both OECD-FAO and FAPRI project nominal prices for all sectors above the levels of the decade before the 2007-08 peaks. Agriculture is expected to cope better than other sectors with the economic crisis due to the relatively low income elasticity for food, at least in developed countries (European Commission 2009).

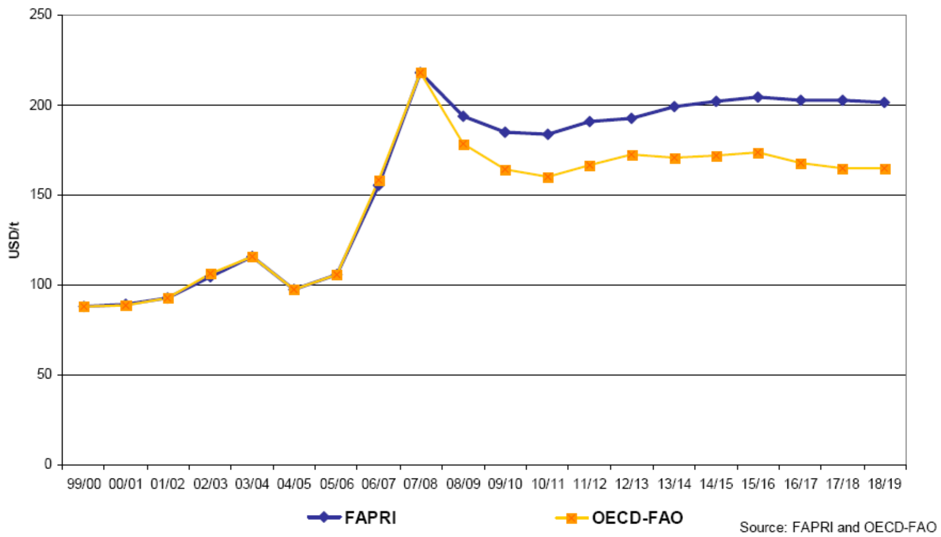
For cereals, demand is mostly driven by population growth in Asia, Africa and Middle Est. All outlooks project an upward trend for wheat production and a downward trend for wheat prices at the beginning of the projection period to stabilize throughout the rest of the projection period.

Figure 4. Wheat price projections



In the case of maize, both area and yields are expected to increase, and maize prices are expected to remain high.

Figure 5. Maize price projections



OECD-FAO, FAPRI and USDA projections for cereal prices go in the same direction. However, FAPRI projections are in general 10% to 15% higher (OECD-FAO assumes deeper and longer economic slowdown).

The growth in the oilseeds sector is tightly linked to increased demand for biodiesel feedstocks, population-driven increase in demand for vegetable oil, and feed demand for oilmeals. All outlooks project growth in production, consumption and trade of oilseeds and oilseeds oils.

Table 4 compares the projections from the 2009 Outlooks for the main agricultural commodities/commodity groups. The same projections for both US and EU agriculture are presented in Table 5.

Table 4. World projections 2009 (percentage change 2009-2018)

Product	Baseline	Production	Domestic use	Trade	World price
Wheat	USDA	8%	8%	18%	na
	FAPRI	6%	8%	19%	13%
	OECD-FAO	11%	11%	12%	4%
Maize	USDA	14%	10%	16%	na
	FAPRI	14%	12%	23%	9%
	OECD-FAO	na	na	na	1%
Rice	USDA	7%	8%	28%	na
	FAPRI	7%	4%	17%	24%
	OECD-FAO	8%	9%	16%	-1%
Oilseeds	USDA	34%	24%	34%	na
	FAPRI	21%	18%	28%	17%
	OECD-FAO	21%	22%	16%	19%
Sugar	USDA	na	na	na	na
	FAPRI	18%	14%	18%	15%
	OECD-FAO	19%	19%	20%	na
Cheese	USDA	na	na	na	na
	FAPRI	na	na	22%	24%
	OECD-FAO	18%	18%	26%	18%
Beef&veal	USDA	15%	17%	10%	na
	FAPRI	na	na	25%	15%
	OECD-FAO	13%	13%	29%	na

Table 5. EU and US projections 2009 (percentage change 2009-2018)

		European Union			United States		
Product	Baseline	Production	Domestic use	Net trade	Production	Domestic use	Net trade
Wheat	USDA	8%	7%	76%	5%	3%	6%
	FAPRI	4%	4%	53%	6%	2%	8%
	OECD-FAO	17%	13%	50%	4%	4%	4%
Maize	USDA	10%	9%	-86%	15%	17%	11%
	FAPRI	3%	4%	-17%	17%	10%	36%
	OECD-FAO	na	na	na	18%	na	na
Rice	USDA	-4%	6%	25%	12%	13%	13%
	FAPRI	4%	1%	14%	1%	12%	-8%
	OECD-FAO	-5%	10%	29%	10%	14%	10%
Oilseeds	USDA	10%	-11%	-14%	5%	7%	2%
	FAPRI	6%	-5%	-8%	12%	19%	-2%
	OECD-FAO	27%	17%	2%	8%	17%	-4%
Sugar	USDA	na	na	na	2%	6%	10%
	FAPRI	0%	-1%	7%	14%	12%	1%
	OECD-FAO	-3%	2%	45%	1%	7%	23%
Cheese	USDA	na	na	na	na	na	na
	FAPRI	12%	13%	-9%	14%	13%	-26%
	OECD-FAO	14%	15%	-8%	24%	24%	72%
Beef&veal	USDA	-6%	-6%	-13%	5%	2%	-100%
	FAPRI	-5%	-2%	61%	5%	5%	-37%
	OECD-FAO	-7%	-3%	204%	5%	4%	-17%

2.4. Evaluation of baseline projections

If the projections generated by any of the reviewed global outlooks are to be used as a reference scenario for further policy analysis, it is important to check the quality of the projections. Transparency and forecasting capacity are two important criteria to take into account.

The transparency of the baseline definition process is required if we are to evaluate the projections. Transparency is particularly relevant to understand what is driving the projections, which drivers are the crucial ones.

As we have seen in the previous sections, all global Outlooks use a mix of expert judgement and economic modelling. The emphasis given at each of these elements may differ but, in general, all the Outlooks use both expert knowledge and modelling very extensively. Moreover, the baseline definition process is quite non-transparent in all cases.

Differences are observed regarding documentation of the process. The USDA Outlook is very poorly document and then, nor the methodology nor the process to derive the projections are clear. More documentation can be found about the methodology used by FAPRI. Still, the process itself is clearly non-transparent. The OECD-FAO Outlook has the advantage of involving a worldwide group of national experts, implying both more transparency in the methods applied and more impartial review of the projections. Still, the way of adjusting the model to fit expert data remains opaque.

Regarding the forecasting capacity, in general we find that baseline projections fail to produce accurate forecasts for upcoming agricultural markets. Does this mean that these baselines are not good?

Several reasons may prevent baselines to provide forecasts:

- Failures in model specification
- Expert bias
- Constant macroeconomic and policy variables assumption

The last one is not really a failure. The baseline provides a consistent view of the future under a set of assumptions. Changes in macroeconomic variables and agricultural policies can not be fully anticipated. Therefore, the baseline cannot be viewed as a forecast of the future.

The problem is that it is not in general possible to separate these three reasons for failure. If baselines would provide forecasts, then comparison of projections against actual data will help to identify misspecification of the model and/or expert bias. But since the baseline provides a view of the future under a set of assumptions and not a forecast, how can we check quality?

It is quite clear that evaluation of the goodness of fit of a baseline is not an easy task. That being said, en said, even if baseline projections do not provide forecasts, evaluation of results and particularly evaluation of forecasting accuracy could provide insights into areas where the model's performance is inadequate, and could help identify sources of forecast errors.

Some sources of model misspecification are:

- Technology: inadequate projections of technological change

- Supply functions: Underestimation or overestimation of yields, inadequate specification of variable costs
- Demand functions: restrictive assumptions about income elasticity of demand
- Agricultural policies: misspecification of agricultural policies. US policy-makers have place high priority on economic efficiency and minimization of food costs. Other countries, however, have objective functions giving substantial weight to non-economic goals (food security, maintenance of viable rural communities), much more difficult to represent in economic models.

Some authors have compared projections to actual data series showing that there is still room for improvement of models. Wisner et al. (2002) examine the forecasting track record of the USDA and FAPRI baseline projections, offering reasons why the models have had major short-comings in tracking reality and warning about the risks of using baseline projections for purposes for which they were not designed. They show that both the USDA and FAPRI models have shown an upward bias in US export projections. These models have quite consistently generated projections of increasing grain exports in US, despite a long history in which actual exports trended downward.

3. Institutional baselines with a focus on specific countries/regions

3.1. Region-specific agricultural baselines

Once we have reviewed the global agricultural baselines, we will comment on baselines focusing at particular countries or regions. In general, these baselines do not provide agricultural projections at the world level but only for the region under study.

3.2. DG-AGRI baseline for the EU

The European Commission is engaged in outlook work since the beginning of the Common Agricultural Policy. Since the McSharry reform, this work has been intensified and it is published since 1998 at least once a year.

The Directorate General for Agriculture and Rural Development (DG-AGRI) is in charge of the baseline development. DG-AGRI makes available every year a medium-term outlook for EU agricultural markets and income, based on specific assumptions regarding macro-economic conditions, the agricultural and trade policy environment, the path of technological change and international market developments.

The last outlook for agricultural markets in the EU27 has been published in March 2009 and covers the period 2008-2015 (European Commission 2009). These projections for agricultural markets in the EU constitute an analytical tool for medium-term market and policy analysis.

Regarding the methodology used, little information is published. The projections are based on market statistics, model runs and market expert judgement. Furthermore, the medium-term projections are developed taking into account short-term commodity forecasts.

The DG-AGRI short-term commodity forecasts are based on statistical analysis on the basis of the latest information available on commodity markets and are developed through interdisciplinary Outlook Groups for cereals/oilseeds, meat and milk/dairy. They are carried out three times a year and consist of estimates of supply balance sheets (production, consumption, trade and stocks) for the current marketing year and projections for the following marketing year.

The medium-term agricultural outlook provides EU-wide projections of supply balance sheets (production, consumption, trade, stocks) and income for the next 7-8 years based on a set of economic models and taking into account short-term projections and expertise from market analysts.

The modelling framework has evolved through time. In the MTR Impact Analysis (2003), it is mentioned that a set of partial equilibrium models are used to obtain the DG-AGRI projections. While the assumptions are explained, the methodological procedure underlying the projections is not transparent.

According to Münch (2006), three models are used in the baseline process:

- AGLINK, for world level analysis, trade partners, trade negotiations, meat and milk markets…
- ESIM, for EU country level analysis, enlargement, crops, biofuels….
- CAPRI, for EU regional level analysis, rural development

In 2009, the medium-term projections are carried out using two recursive dynamic partial equilibrium models, ESIM and Aglink (Londero 2009). Income projections are mainly based on Economic Accounts for Agriculture and model output. Model output consists of supply balance sheets for main commodities and market prices. The outlooks provides detailed results for EU27, EU15 and EU12 aggregates for the main agricultural sectors (cereals, oilseeds, meat, eggs and dairy markets).

At the moment of finalising this report, the DG-AGRI baseline process is under review. Major changes are expected to be incorporated in the coming months, with the aim of improving the DG-AGRI baseline. This review process is partly motivated for recent economic and market developments that can have important implications for the future of EU agricultural markets, in particular the economic slowdown and the increased price volatility of agricultural commodities within the EU.

3.3. Medium Term Outlook for Canadian Agriculture

Agriculture and Agri-Food Canada (AAFC) develops a Medium Term Outlook for Canadian Agriculture. The outlook is an attempt to outline a plausible future of the international and domestic agri-food sectors (AAFC 2009).

The outlook is produced with two partial equilibrium models of agricultural markets: the AGLINK-COSIMO model is used to produce the international outlook and the AAFC Food and Agriculture Regional Model (FARM) is used for the national outlook.

Very little written documentation exists about the procedure to derive the projections.

4. Baselines of selected agro-economic models

4.1. Introduction

Some partial equilibrium models are used to develop medium-term projections for agricultural markets (AgLink and FAPRI) and, therefore, these models have already been reviewed in a previous section.

Other partial equilibrium models are comparative-static structural models and then not suited for agricultural markets projections (ESIM and CAPRI). These models usually use baseline projections generated by other models/institutions to build up their own baselines, which are an essential step before performing ex-ante assessment.

There are still other partial equilibrium models suited for developing baselines, but which do not undertake this process on a yearly basis (AGMEMOD). Hence, these baselines are not used as a reference point by other models.

In this section, we compare the process of defining a baseline scenario across partial equilibrium models. First, we will present the main features of the models not described in previous sections.

4.2. Selected partial equilibrium models

4.2.1. ESIM

ESIM, which stands for European Simulation Model, is a worldwide comparative static partial equilibrium net-trade model of the agricultural sector, depicting demand, supply and trade for major agricultural commodities. The original version was developed by the Economic Research Service of the US Department of Agriculture (USDA) and was programmed in SuperCalc by the. The version described here corresponds to the European version in GAMS, as described by Banse et al. (2005).

The main purpose of ESIM is to simulate the development of agricultural markets in the EU and accession candidates. As a worldwide model, it includes all countries, though in greatly varying degrees of disaggregation. All EU27 MS as well as Turkey and the US are modelled as individual countries, while all others countries are aggregated as a single unit “Rest of the World” (ROW).

The EU agricultural and trade policies are modelled in detail, including specific and ad-valorem tariffs, tariff rate quotas, intervention and threshold prices, export subsidies, product subsidies, direct payments for keeping land in agricultural use, production quotas and voluntary as well as obligatory set aside. Policies are only modelled for EU MS and candidate countries; for the USA and the ROW, production and consumption take place at world market prices.

ESIM has a very detailed depiction of the complex system of substitution of land among different products; this allowed for the simulation of the complex substitution effects between cereals/oilseeds and fodder crops resulting from the decoupling of direct payments under the 2003 reform (Balkhausen et al., 2008). Banse and Grete (2008) extend the ESIM model to account for production and use of biofuels.

All behavioural functions in ESIM are isoelastic. Supply at farm level is defined for 15 crops, 6 animal products, 11 processed products, biofuels and biofuel by-products, pasture and voluntary set aside. Human demand is defined for processed products and most of the farm products. The rest of the farm products do not go to human consumption because only enter the processing industry (e.g. rapeseed) or are only used in feed consumption (e.g. fodder or grass from permanent pasture). Trade is depicted as net trade.

The ESIM baseline is based on AgLink baseline and DG-Agri assumptions. The current ESIM baseyear period is a three-year average 2006-2008. Most base data is from DG-AGRI, although this data is complemented in many cases by data from other official sources. The current projection horizon is 2020.

Although world market prices are endogenous to ESIM, ESIM is not suited for world market price projections. This is because ROW agriculture is depicted at a very aggregate level (Banse et al. 2005). Nonetheless ESIM is well suited to depict the order of magnitude of world market effects of EU policy changes.

The ESIM baseline is defined at the MS level and is based on a set of exogenous assumptions (regarding the economic, technological and policy environment) and baseline projections from other models. Since ESIM do not generate agricultural projections, world market price projections are taken from large scale models that are designed explicitly to generate such projections like FAPRI or AGLINK.

To formulate the baseline, the exogenous assumptions are incorporated in ESIM through shifters:

- In the supply side, technological progress shifters in crop and animal production are based on a yield trend analysis; technical progress shifters in feed use and animal production as well as input cost and exchange rate projections are based on DG AGRI. Total agricultural area is assumed to be constant.
- In the demand side, income growth projections are based on DG AGRI; projection of population growth is based on growth rates.
- Agricultural and trade EU policies can also be shifted.

In the current baseline, the projections for world market prices come from the AgLink baseline. The ESIM model is calibrated to this set of world market prices by adjusting supply and demand shifters in the ROW. In order to increase the overall level of world market prices, for example, the income shifter in the ROW can be set higher. In order to calibrate world market prices for individual products the product specific technical progress parameters can be adjusted.

4.2.2. CAPRI

CAPRI is a partial equilibrium model for the agricultural sector developed for policy impact assessment of the Common Agricultural Policy and trade policies from global to regional scale with a focus on the European Union (Britz and Witzke, 2008).

CAPRI depicts agricultural commodity markets worldwide, whilst also providing a detailed representation of the diversity of EU agricultural and trade policy instruments. It is a comparative-static, spatial equilibrium model, solved by iterating supply and market modules:

- The supply module consists of a set of regional agricultural supply models, covering all EU regions (NUTS 2 level), Norway, Western Balkans and Turkey. The regional programming models capture in detail farming decisions for all the activities covered by the Economic Accounts for Agriculture (EAA) as well as the interactions between production activities and the environment. The mathematical programming approach allows a high degree of flexibility to model the diverse CAP measures. Major outputs of the supply module include crop and livestock activity levels, yields, input use, farm income, nutrient balances and GHG emissions.
- The market module is a global spatial multi-commodity model, where about 50 commodities (primary and secondary agricultural products) and 60 countries (grouped into 28 trade blocks) are modelled as a constrained equation system. The parameters of the behavioural equations for supply, feed demand, processing industry and final demand are taken from other studies and modelling systems, and calibrated to projected quantities and prices in the simulation year. Major outputs of the market module include bilateral trade flows, market balances and producer and consumer prices for the agricultural commodities and world country aggregates.

Table 6 shows the main CAPRI indicators at the global and EU level.

Table 6. Main indicators in CAPRI

At the regional level (EU NUTS 2 regions)	At the global level (trade blocks)
Activity levels (crops, livestock activities, feeding activities, processing activities)	Supply indicators (production)
Supply indicators (production, yields)	Demand indicators (food, feed, processing and biofuel demand)
Demand indicators (food, feed, processing and biofuel demand)	Trade indicators (bilateral trade flows)
Input indicators (input use, feed use)	Market prices
Income indicators (variable costs, revenues, farm income)	Welfare indicators (agricultural profit, tariff revenue, consumers well-being)
Environmental indicators (nitrogen and phosphate balances, ammonia emissions, GHG emissions)	

The comparative-static structural nature of CAPRI makes this model not suited for projections but for counterfactual analysis against an existing baseline or reference scenario. Consequently, the CAPRI baseline is based on agricultural market projections from other institutions as FAPRI, OECD-FAO and DG-AGRI. Hence, the CAPRI baseline describes the agricultural situation in a future year (simulation year) based on the situation in historical years and the likely developments expected to occur from the baseyear to the simulation year.

A distinctiveness of the CAPRI baseline is its regional resolution below the EU level, at the EU27 MS level and even at the level of NUTS 2 regions. Therefore, the CAPRI baseline reflects the likely developments in agricultural markets for an 8-10 year time horizon, from global to regional scale, under exogenous assumptions (population growth, technological change, GDP growth, inflation rate, exchange rate, crude oil price) and a status-quo policy setting.

The CAPRI baseline is updated in close-cooperation with DG-AGRI. An update of the CAPRI baseline is usually provided in a yearly basis, following the release of a new agricultural outlook by DG-AGRI.

The baseline definition process is a mix of trends, expert knowledge, parameters calibration and consistency check. The construction of the baseline follows several steps, making a distinction between regions represented in the supply module (for which the procedure is much more sophisticated) and those covered by the global market model:

- For all EU regions, trends are projected from the baseyear to the last projection year (simulation year). These trends are built upon historical time series, the output of the DG-AGRI baseline, expert knowledge available at the MS level, and the shifts in policies foreseen from the baseyear to the simulation year. A Bayesian estimation framework is used to guarantee a consistent set of projections (activity levels, yields, production, feed and processing demand, human consumption).
- The projection results at EU27 level are taken as given when calibrating the global trade model. First, we need to define developments in production, feed use, processing and human consumption for the different regions of the world not covered by the EU projection tool, as well as bilateral import and export flows from all trade block in the model. These developments are currently almost exclusively based on projections by the FAO and FAPRI (Adenäuer 2008). Then, the calibration of the market module is based on a highest posterior density estimator which tries to minimise the deviations of all variables in the market module from support values while satisfying all equations of the module.

Due to the regional resolution and the high number of activities, inputs and outputs covered by the CAPRI modelling system, the outcome of the baseline scenario comprises several Mio numbers. Checking results for plausibility remains a challenge.

One of the advantages of the CAPRI baseline definition process is the transparent integration of information coming from external projections (DG-Agri baseline).

One of the weak points of the approach is that a quality check of baseline results is not systematically done. The baseline would benefit from a post-model check by experts of the different markets and countries in order to make sure that the model outcome is plausible.

4.2.3. AGMEMOD

AGMEMOD is an econometric recursive-dynamic partial equilibrium model, covering the main primary and processed agricultural commodities in the EU at the MS level, and built for projection and simulation purposes.

Besides the animal product sectors, the current commodity coverage for grains consists of soft wheat, durum wheat, barley, maize, rye, triticale, oats, etc., and also of the oilseeds rapeseed, soy beans and sunflower. The model comprehends interactions between the agricultural and food sectors and countries, as well as the resulting feedback effects. AGMEMOD takes into account tariff quotas, restrictions of subsidised exports, production quota intervention prices, direct payments, decoupling of direct payments and set-aside obligations (AGMEMOD Partnership, 2007).

AGMEMOD is recursive-dynamic and aims to generate a baseline every 2 years under assumptions about macroeconomic variables, international agricultural market prices and agricultural and trade policy variables (AGMEMOD Partnership, 2007). The baseline projections cover a 10-year horizon, and are obtained through a set of MS models linked to an EU and world market model:

- Firstly, a national baseline is generated from template country models. The national baseline is reviewed through an internal validation process.
- Secondly, an aggregate model generates the AG-MEMOD baseline, which is reviewed through an external validation process.

The current base year is 2004 and the AGMEMOD modelling system provides projections up to 2015. Projections are generated for individual EU Member States and the EU at different aggregation levels (EU-10, EU-15, EU-25, EU-27), providing results on supply, demand, trade and prices for the main agricultural commodities (cereals, oilseeds, livestock products and dairy products).

4.3. Comparison of baselines across partial equilibrium models

4.3.1. Introduction

Once the main model baselines have been described, the main similarities and differences will be shortly discussed.

Since the AGMEMOD modelling system does not provide a yearly update of the projections, we will refrain from including it in this comparison. The review will then focus on the main modelling systems used for agricultural market projections (FAPRI and AGLINK) and the main modelling systems calibrated to institutional baselines with a focus on EU agriculture (CAPRI and ESIM).

Although the 2010 baselines are already available for some of the models (FAPRI and AGLINK), this is not the case for all the models under study. As a result, the comparison will be based on the 2009 baselines.

4.3.2. Main features and world differentiation

As it is evident, models used to derive baseline projections are dynamic models. As for the others, both CAPRI and ESIM are comparative static models and, therefore, only suited for counterfactual analysis.

All reviewed baselines are based on a similar set of underlying assumptions regarding macroeconomic factors, production technologies and agricultural and trade policies.

Table 7. Baseline comparison across PEMs - Main features

	FAPRI	AGLINK	CAPRI	ESIM
Model type	Recursive dynamic	Recursive dynamic	Comparative static	Comparative static
Baseline definition	Own baseline projections	Own baseline projections	Calibration to DG-AGRI baseline	Calibration to DG-AGRI baseline
Baseyear (last historical data year)	2009	2009	2004 (average 2003-05)	average 2006-07
Baseline (projection period)	2009-2018 (series)	2009-2020 (series)	2020 (point estimate)	2020 (point estimate)
Exogenous drivers	Population, macro variables, technical change	Population, macro variables, technical change	Population, macro variables, technical change	Population, macro variables, technical change

Though all models have world coverage, the degree of disaggregation is quite diverse. While AGLINK represents a high number of countries and regions, ESIM only covers, apart from the EU, Turkey, US and the RoW.

The EU27 is one of the trading blocks in all reviewed models. Three of the baselines further disaggregate the EU27 region: AGLINK differentiates between EU15 and EU12; ESIM also covers EU MS and CAPRI models not only MS but also NUTS 2 regions and even farm types within each region.

Table 8. Baseline comparison across PEMs - World and EU differentiation

	FAPRI	AGLINK	CAPRI	ESIM
Regional differentiation				
World disaggregation	26 countries regions, including the main trading blocks	58 countries regions, including the main trading blocks	28 countries regions, including the main trading blocks	Only EU, US, Turkey and RoW
EU disaggregation	Only EU27	Only EU27, EU15 and EU12	EU27 aggregates, MS and NUTS 2 regions	EU27 aggregates and MS
Trade representation	Only net-trade	Only net-trade	Bilateral trade	Only net-trade
Policy representation				
EU policies	Rough representation	Rough representation	Highly detailed	Detailed
US policies	Highly detailed	Rough representation	Rough representation	No
Trade blocks	Rough representation	Rough representation	Rough representation	No

There is one important difference in the way trade is represented, since only CAPRI models bilateral trade flows. The other three models use a net-trade approach.

All reviewed models try to capture the relevant agricultural and trade policies and, since recently, they also include a representation of the biofuel sector. Differences both in the way policies are represented and the regional coverage are however significant. AGLINK is developed by an international institution meaning that a similar template model is used for all OECD countries and a simplified approach is used for the rest of the regions. Consequently, the representation of policies is well balanced across model regions.

The other three models focus either on US or on EU agriculture. Still, major differences are observed. FAPRI represents US policies in high detail and EU policies only roughly, while CAPRI is very detailed for EU policies and not for US. The ESIM model focuses at the EU policies and does not take into account policies for the rest of the world.

Inside the EU, only CAPRI represents agricultural and trade policies in very detail.

4.3.3. The methodological approach

In all cases, the baseline methodology involves a mix of expert-based and model-based analysis. Nevertheless, recursive-dynamic models rely more on expert knowledge to derive their baselines, while comparative-static models rely more on economic modelling.

Table 9. Baseline comparison across PEMs - Methodology

	FAPRI	AGLINK	CAPRI	ESIM
General approach	Mix of expert and model based analysis	Mix of expert and model based analysis	Mix of expert and model based analysis	Mix of expert and model based analysis
Institutions involved	FAPRI (only US experts)	OECD-FAO (world coverage)	EU CAPRI consortium (only EU)	ESIM developers (only EU)
Projection data	Expert judgement	Expert judgement	External data sources (DG-AGRI, FAO, FAPRI)	External data sources (DG-AGRI, FAO, FAPRI)
Model calibration	Parameters calibration to fit expert data	Parameters calibration to fit expert data	Model calibration to fit DG-AGRI baseline	Model calibration to fit DG-AGRI baseline
Calibration procedure	Non-transparent process, expert-driven	Non-transparent process, expert-driven	Systematic process, model-driven	Non-transparent process, modeller-driven
Validation procedure	Melting-down process involving a lot of expert knowledge	Review process involving a lot of expert knowledge	No established validation procedure	No established validation procedure

The AGLINK baseline takes the national datasets as given and calibrates the behavioural functions of the country/region models to fit this datasets. When the country models are merged and world prices become endogenous, a first set of projections is generated; deviations from the projection data will be checked and the models will be adjusted in an iterative process until a consensus is reached. This process gives a lot of emphasis at expert judgement.

FAPRI also uses an iterative procedure to fit the models as much as possible to projection data agreed by a team of market analysts.

On the contrary, CAPRI puts more emphasis on model equations and micro theory. In the CAPRI baseline, the initial projection data is only used as prior information, since it does not fulfil model equations (Adenäuer 2008). Hence, it is not the model which is fitted to projection data but projection data is fitted to model equations.

Validation of baseline results is quite different depending on the model-based or expert-based nature of the projections. AGLINK and CAPRI represent both extremes. While the AGLINK baseline involves a worldwide network of experts to develop and review the baseline, the CAPRI baseline is generated mainly by automatic procedures. As Adenäuer (2008) points out, the strength of the baseline process of CAPRI is the weak point of AGLINK and vice versa. AGLINK could benefit from the incorporation of some systematic procedures to speed up the baseline process and make it more transparent. All the same, CAPRI could benefit from the setting up of a review process to discuss and validate baseline results with market analysts.

5. Stochastic features in baseline projections

5.1. Relevance of stochastic analysis

Most baseline projections are based on average estimates regarding economic, policy and technological conditions. Deterministic impact analysis of agricultural and trade policy options that is based on these baselines remains subject to important uncertainties and may provide incomplete or even misleading results.

Increasing concerns about the volatility of agricultural commodity markets as well as their impacts on food security and farm income highlight the importance of taking uncertainty into account when conducting policy impact assessment. Stochastic analysis can capture the relevant uncertainties influencing agricultural market developments, such as those attached to yields or variable costs.

Even though the volatility of agricultural markets has played a major role in recent years, there are very few stochastic applications of large scale agro-economic models.

Regarding the baseline definition, only FAPRI has developed a stochastic version with a focus on the US agricultural sector. Other institutions draw attention to the importance of developing stochastic baselines and, in some cases, have started performing sensitivity analysis.

5.2. The FAPRI stochastic baseline

Traditionally, FAPRI has used a deterministic model to generate annual 10-year baseline projections (FAPRI 2009) and analyse a wide range of domestic and trade policy questions. The deterministic model provides a single set of projections based on assumptions of average conditions.

As it became clear that a deterministic model was inadequate for addressing some of the questions posed by policy makers, since 2000 has supplemented this comprehensive deterministic baseline for U.S. and world agricultural markets with a stochastic baseline focused on U.S. agricultural markets. While the deterministic baseline describes a single possible outlook, the stochastic baseline looks at 500 alternative futures. These 500 alternative futures differ from one another in terms of their underlying assumptions about weather, demand conditions, and other exogenous factors (FAPRI 2006).

Westhoff et al. (2006) highlight that point estimates of agricultural and trade policy impacts often paint an incomplete picture. They argue that stochastic modelling can be particularly useful when policies have asymmetric effects or when there is intrinsic interest in the tails of distributions. U.S. agricultural policies provide many examples of asymmetries that increase the value of stochastic analysis.

For example, stochastic models are better suited to estimate government expenditures when policy instruments imply payments only when prices fall below trigger prices. The asymmetry of U.S. government farm programs has important implications when estimating taxpayer costs. Projections prepared in early 2005 by the Food and Agricultural Policy Research Institute (FAPRI) indicate that the deterministic estimate for U.S. government farm program expenditures is more than $3 billion per year lower than the mean of the stochastic estimates of the same baseline (FAPRI 2005). The deterministic and stochastic estimates differ primarily because of large differences in the estimated cost of the loan program, and not because of any significant difference in prices. The stochastic approach has been extensively used to analyse US farm programs (Westhoff et al. 2008, Meyer et al. 2010).

To keep the scale of the effort manageable, a simpler version of the FAPRI model is used to develop the stochastic baseline. The stochastic model focuses on US markets and is less detailed than its deterministic counterpart. Most of the equations in the stochastic baseline are the same equations FAPRI uses to develop the deterministic baseline. However, two major exceptions to this rule occur in the case of US trade with other countries and US crop supply equations:

- World markets represented by single reduced-form equations: rather than the detailed representation of world agricultural markets included in the FAPRI deterministic model, the stochastic model uses reduced-form equations to determine US export demand. These reduced-form equations are a function of current and lagged U.S. prices and are intended to mimic the price responsiveness of a global system.
- No regional differentiation for US crops: the region-specific supply equations of the deterministic US crops model are replaced with a set of national-level equations.

Even so, the stochastic model has approximately 1,000 equations representing US crop and livestock supply, demand, trade, and prices, as well as aggregate indicators such as government farm program costs, net farm income, agricultural land values, and consumer food price indices (FAPRI 2006).

FAPRI uses a Monte Carlo approach to approximate the empirical distribution of the stochastic variables through correlated random draws and solve the model for each of the draws. The following is a simplified description of the process used to develop the stochastic baseline (FAPRI, 2006):

1. The deterministic baseline is prepared.
2. All equations of the stochastic model are calibrated, so that given the specific assumptions of the deterministic baseline; the stochastic model generates the deterministic baseline projections for endogenous variables.
3. For selected exogenous variables, correlated empirical distributions are developed based on approximately 20 years of historic data. These variables include deviations from trend yields, deviations from trend non-agricultural production expenses, error terms from selected domestic demand equations, and deviations from trend error terms from the reduced-form export demand equations.
4. Based on the estimated distributions, 500 sets of 10-year correlated draws are created.
5. The stochastic model is solved for each of the 500 sets of exogenous variables, generating 500 alternative baseline projections.
6. Results are usually grouped and average and , appropriate changes are made in the model or in the way distributions are derived, and steps 3-5 are repeated as necessary until a reasonable set of stochastic baseline projections are obtained.

Both the model and the process to derive the stochastic baseline are constantly evolving. Major disadvantages of this approach are the high computational requirement and the difficulties to exploit model results.

Stochastic analysis is particularly important to model US farm programs. Because the crop loan and countercyclical payment programs can make very large payments when prices are low, but negative payments do not result when prices are high, there is an important asymmetry that can cause the mean of the stochastic baseline to differ significantly from the deterministic baseline for particular variables.

5.3. Sensitivity analysis with AgLink-Cosimo

In several occasions, OECD-FAO has conducted sensitivity analysis to assess variability of relevant variables. In the 2009 Outlook, OECD-FAO (2009) focus on the changing macroeconomic environment underlying the projections and points out that, because of the turmoil in the economic environment, the baseline projections must be interpreted with caution.

With macroeconomic conditions changing so quickly, the standard baseline projections for agricultural markets provided by the 2009 Outlook have been complemented with a scenario analysis of revised short–term GDP prospects and alternative GDP recovery paths. A sensitivity analysis of commodity markets to crude oil prices and a survey of the impact of the economic crisis on various actors in the agri-food chain also contribute to the assessment of the resiliency of the sector to the global economic crisis (OECD-FAO 2009).

To take into account the effects of the economic slowdown, a sensitivity analysis on lower GDP growth was conducted. This was based on alternative GDP growth estimates of the latest short term updates provided by the OECD and World Bank, complemented by relatively simple and transparent assumptions on longer term growth (recovery) developments.

The 2009 Outlook also examines the sensitivity of agricultural prices to crude oil prices. On the one hand, energy and agricultural prices have become much more interdependent with industrialised farming, more processing and increased transport, as well as the emergence of the biofuels industry (particularly for maize, oilseeds and sugar feedstocks). On the other hand, crude oil prices are highly volatile and some projections are well above those used in the Outlook.

6. Concluding remarks

Baseline projections for agricultural commodity markets are a highly demanding process. In general, the models used are very complex and the methods of integrating model results and market and policy expertise are quite opaque. Although extensive documentation exists regarding the alternative agricultural market projections, we cannot say the same about the procedures used to derive those projections.

The lack of homogeneity in data sources for exogenous variables implies differences in projections for these variables. This is one reason why different models/institutions yield different agricultural baselines. But larger differences are found in the processes used to develop the projections. In the case of global agricultural Outlooks, the lack of transparency in the baseline definition procedures makes very difficult any comparative analysis.

Keeping in mind that a comprehensive comparison has not been possible, we still can point out some advantages and drawbacks of the reviewed methodologies. For instance, an advantage of the OECD-FAO is the balanced global coverage, with similar country/region representation and a review process involving worldwide expertise. Nevertheless, this balanced approach also have some drawbacks: a lot of time and effort is required to build consensus in a common baseline; policy representation for each country/region cannot be very detailed (this aspect is particularly relevant for the EU); the modelling system have to be adjusted to fit expert judgement and then, cannot be very robust. This could explain why there are so few applications of AGLINK to agricultural impact assessment.

The major advantage of FAPRI is the stochastic baseline, which improves the impact assessment of US agricultural and trade policies. Extending the stochastic approach to the assessment of UE policies could be advantageous but it is important to bear in mind that the FAPRI stochastic baseline has been developed to answer specific policy questions in the US. Since the policy situation in the EU is quite different, the stochastic baseline suited for analysing EU agricultural policies could be quite different too.

Since baselines are usually designed as reference scenarios for policy impact assessment of alternative policy options, the accuracy in representing agricultural and trade policies becomes a key issue. One of the strengths of the CAPRI baseline is its flexibility to model agricultural and trade policies in the EU at a disaggregate level. This aspect is particularly important when modelling EU policies, which commonly involve a diversity of policy instruments defined at the MS level and even at the regional level.

Important tradeoffs exist, however, between regional disaggregation and stochastic analysis. Highly disaggregated models hardly can become stochastic. Stochastic models hardly can include the level of regional disaggregation requires to properly represent EU agricultural policies.

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Annexes

A. Other relevant agricultural projections

A.1. Introduction

Apart from the medium-term projections reviewed in this Deliverable, a number of long-run projections for agricultural developments exist. These long-run projections mainly focus on food security or environmental issues.

Furthermore, in this review, the focus was on partial equilibrium models of the agricultural sector. Baseline definition in CGE models, which considerably differs from the partial equilibrium projections, has not been analysed. Nevertheless, given the increasing interactions between agriculture and other sectors of the economy, more general equilibrium analysis of agricultural policies are found nowadays, usually combined with partial equilibrium analysis in order to complement it.

A.2. IFPRI scenarios for global food markets

The International Food Policy Research Institute (IFPRI) provides long-term global baseline projections of agricultural commodity markets and food security. In the beginning of the nineties, IPPRI developed the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) in order to provide a long-term vision about the world food situation and to examine alternative futures for global food supply, demand, trade, prices, and food security (Rosegrant et al. 2002).

IMPACT is a partial equilibrium agricultural sector model for assessing the global food situation in the medium and long term. IMPACT depicts a competitive world agricultural market for 40 crop and livestock commodities (including cereals, soybeans, cotton, roots and tubers, meats, milk, eggs, oils, sugar/sweeteners, fruits/vegetables, and fish) and it is specified as a set of 115 country/regional agricultural sub-models (Rosegrant et al. 2008). For each of these regions, supply, demand, and prices for agricultural commodities are determined:

- Production is driven by both economic and environmental factors and has both extensive (area) and intensive (yield) components.
- Domestic demand for a commodity is the sum of its demand for food, feed, and other uses. Food demand is a function of the price of the commodity, the prices of other competing commodities, per capita income, and total population. Per capita income and population increase annually according to country-specific population and income growth rates. Feed demand is a derived demand determined by the changes in livestock production, feed ratios, and own- and cross-price effects of feed crops. Demand for feedstock for biofuels production is derived from the implied demand that various alternatives for the

development of ethanol and biodiesel. The demand for other uses is estimated as a proportion of food and feed demand.

The country and regional sub-models are linked through trade. Commodity trade by country is the difference between domestic production and demand. This net-trade specification does not permit a separate identification of both importing and exporting countries of a particular commodity. World agricultural commodity prices are determined annually at levels that clear international markets.

IMPACT generates annual projections for cropping activities (area, yield, production, food and feed demand, prices and trade); and livestock activities (production, demand, prices, and trade). The current base year is 2000 (using a three-year average of 1999-2001) and the model incorporates FAOSTAT data (FAO various years) on commodity, income, and population; a system of supply and demand elasticities from literature reviews and expert estimates. Projections are made for the year 2020.

The most comprehensive set of results for IMPACT are published in the book Global Food Projections to 2020 (Rosegrant et al. 2001). Both the model and the projections are well documented.

A.3. Scenar 2020: Alternative futures for agriculture

The Scenar2020 project, which integrates a CGE model with the two partial equilibrium models CAPRI and ESIM, adopts a different process of baseline construction. The CGE adopted by this project is LEITAP, a global dynamic CGE model developed at LEI as a modified version of GTAP to treat explicitly agricultural policies.

The baseline built by Scenar2020 takes into account both population ad GDP growths but in addition other external exogenous drivers. Among other, the most important demand driven drivers are the consumer preferences. Moreover, other exogenous drivers are more focused on the supply side, i.e. global slow down of yield growth of cereals, continuous trends in cost saving technical progress and environmental issues (yield increase effect caused by increased CO2 concentrations, a temperature effect leading to a yield increase in most European regions and a water availability effect leading to a yield decrease in some European regions). On the world market, the study considers trends for agricultural markets, as reported in OECD and FAPRI outlooks.