TRUSTEE

Towards **Ru**ral **S**ynergies and **T**rade-offs between **E**conomic Development and **E**cosystem Services

Baseline validation I

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Deliverable 7.1

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Project title	**Towards Rural Synergies and Trade-offs between Economic Development and Ecosystem Services**
Project number	235175 (ANR- 13-RURA-0001-01)
Deliverable	Baseline validation I (D7.1)
Description	The Baseline validation I (D7.1) deliverable includes an overview of the main agricultural modelling systems and their baseline generation processes, as well as a description of the CAPRI baseline.
Due date	Month 6 (February 2014) - Draft
Date of submission	Month 15 (November 2014) - Final version

RURAGRI ERA-NET

SEVENTH FRAMEWORK PROGRAMME

AGENCE NATIONALE DE LA RECHERCHE ANR

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The research leading to these results has received funding from the European Union by the European Commission within the Seventh Framework Programme in the frame of RURAGRI ERA-NET under Grant Agreement n° 235175 TRUSTEE (project n° ANR- 13-RURA-0001-01).

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EXECUTIVE SUMMARY

The objective of this deliverable is to review the methodologies used to generate and validate agricultural baselines relevant for partial equilibrium analysis of agricultural and trade policies, with a focus mainly on medium-term projections for agricultural market developments.

In order to analyse the main approaches used to generate agricultural baselines, we have performed a literature review of the main agricultural outlooks and their baseline construction process from global to regional scale. At worldwide level, USDA, FAPRI and OECD-FAO publish each year an agricultural outlook including 10-year projections for agrifood markets. At the European Union level, DG-AGRI provides 10-year prospects for agricultural markets and income on a yearly basis.

The analysis shows that the baseline definition process is quite similar across outlooks, but some differences can be observed due to the distinct weights of models and experts in the procedure, some baselines being more model-based while others are more expert-based.

Agricultural baselines are used 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. For instance, the medium-term baseline of the CAPRI model is calibrated to the DG-AGRI baseline.

Besides these medium-term projections, the IMPACT model provides a long-term vision about agricultural commodity markets and food security. In recent years, other models apart from IMPACT have been adapted to simulate long-term drivers of agricultural commodity markets and land use. Among these models we find the Global Biosphere Management Model (GLOBIOM), the Model of Agricultural Production and its Impact on the Environment (MAgPIE) and CAPRI.

Before using these agricultural baselines as a reference scenario for further policy analysis, a validation process should be undertaken to check the quality of the projections. In this sense, the principal aspects to be considered in the validation process are discussed in this document.

TABLE OF CONTENT

ABBREVIATIONS AND ACRONYMS

AGLINK	Worldwide Agribusiness Linkage Program
AMS	Agricultural Marketing Service
CAP	Common Agricultural Policy
CAPRI	Common Agricultural Policy Regional Impact Analysis
COSIMO	Commodity Simulation Model
DG AGRI	EC Directorate General for Agriculture and Rural Development
EAA	Economic Accounts for Agriculture
ERS-USDA	Economic Research Service - United States Department of Agriculture
ESIM	European Simulation Model
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse gas
FAO	Food and Agriculture Organization of the United Nations
FAPRI	Food and Agricultural Policy Research Institute
FAPSIM	Food and Agricultural Policy Simulator
FAS	Foreign Agricultural Service
FSA	Farm Service Agency
GLOBIOM	Global Biosphere Management Model
IFPRI	International Food Policy Research Institute
IIASA	International Institute for Applied Systems Analysis
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
ISU	Iowa State University
JRC-IPTS	EC Joint Research Centre - Institute for Prospective and Technological Studies
MAgPIE	Model of Agricultural Production and its Impact on the Environment
MCMR	Multi-commodity multi-regional models
MU	Missouri University
NASS	National Agricultural Statistics Service
OECD	Organisation for Economic Co-operation and Development
UN	United Nations
US	United States
USDA	United States Department of Agriculture
WAOB	World Agricultural Outlook Board
WASDE	World Agricultural Supply and Demand Estimates

1. INTRODUCTION

The exploration of likely future scenarios for agriculture is 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 this reference scenario against which new policy interventions can be evaluated.

An agricultural baseline is defined as a view on the evolution of global agricultural markets over some future time horizon and under a specific set of assumptions about exogenous drivers. Thus, the baseline mirrors the evolution of key variables representing agricultural commodity markets (production, consumption, trade flows and market prices) from the base year to a point in the future (projection period). The baseline scenario reflects 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 and exchange rate).

Several national and international institutions develop projections for agricultural commodity markets using a mix of economic models and expert judgment. USDA, FAPRI and OECD-FAO publish each year an agricultural outlook at global level that includes 10-year projections. With a focus in European Union, AGLINK-COSIMO offers projections at EU aggregate level and CAPRI from global to regional and farm-level scale. In order to use these agricultural outlooks as a reference scenario for further policy analysis, the quality of the projections must be validated. At this stage, transparency and forecasting capacity are two important criteria to take into account. Transparency is particularly relevant to understand what is driving the projection and forecasting capacity to provide insights into areas where the model's performance is inadequate helping to identify sources of forecast errors.

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

The document is divided into six parts: chapter 2 provides a description of the main worldwide agricultural outlooks and their baseline construction process. Chapter 3 outlines the EU prospects for agricultural outlook and the EU baseline process. An overview of CAPRI model and its baseline is included in chapter 4. A description of the most important long-term agricultural baselines is comprised in chapter 5. Main aspects for validation of agricultural baseline projections are shown in chapter 6. Concluding remarks are presented in chapter 7.

2. WORLDWIDE AGRICULTURAL OUTLOOKS

2.1. Introduction

In this section, which is partially based on Blanco (2010), we describe the main medium-term agricultural outlooks with global coverage. These are provided by three institutions every year: USDA, FAPRI and OECD-FAO. Each of these organisations delivers a global Agricultural Outlook with projections for global agricultural commodity markets every year.

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; and they provide 10-year projections for a set of projection variables, basically agricultural prices and market balances, on a yearly basis. However, each of these outlooks uses different commodity and geographic aggregates and relies on different macro-economic assumptions and data sources. The complexity of the models depends on the number of commodities and their interactions as well as on the number of regions involved.

Projections provided by these outlooks 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 agricultural commodity prices and market balances.

2.2. USDA agricultural outlook

The Economic Research Service (ERS) of the United States Department of Agriculture (USDA) prepares a set of 10-year projections for US 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[2] is developed using a composite of models and judgment-based analysis. The short-term projections provided by the World Agricultural Supply and Demand Estimates (WASDE) are used as a starting point. These projections take on board survey results from the National Agricultural Statistics Service (NASS), market news reports from the Agricultural Marketing Service (AMS), trade data from the Department of Commerce, satellite imagery from the Foreign Agricultural Service (FAS), recent weather information analysed by the World Agricultural Outlook Board (WAOB) meteorologists, program information and data from the Farm Service Agency (FSA), and other commodity-specific sources. Output from these models provides essential guidance to the commodity, country and policy analysts that contribute their expertise and judgment to the medium-term projections.

The 10-year supply, demand, and price projections are prepared by an interagency committee chaired by the WAOB. These projections are for major commodities and countries, and are based on specific assumptions including normal weather, the continuation of U.S. current policies, and a specific global and U.S. macroeconomic scenario.

[2] http://www.ers.usda.gov/topics/farm-economy/commodity-outlook/usda-outlook-process.aspx

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 US commodity market models.
- A US agricultural sector model, the Food and Agricultural Policy Simulator (FAPSIM), to analyse 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 Modelling System" that links 24 commodity markets in 39 countries/regions to cover global agricultural markets.

The projections process[3] that results in the annual report starts in the preceding summer. Macroeconomic assumptions covering gross domestic product, inflation, exchange rates and population are prepared in August and September. The global trade analysis and U.S. export projections are elaborated in October. The domestic analysis for program commodities, which incorporates the trade analysis results, is realized in November. Commodity projections for agricultural trade measures and farm income are made in December and January. The USDA's annual medium-term projections report is published in February each year.

The data in the database have been published in annual USDA medium-term projections since 2000. Each year's projections include 2 years of history and 10 years of projections. The most recent projections from February 2014 cover the period 2012/13 to 2023/24.

Projections cover production, demand and trade for agricultural commodities, as well as aggregate indicators on the sector, such as farm income. However, 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. Furthermore, the process of constructing the baseline is not fully documented and, as a result, the driving forces behind USDA projections are relatively non-transparent.

2.3. FAPRI projections for agricultural markets

2.3.1. The FAPRI agricultural outlook

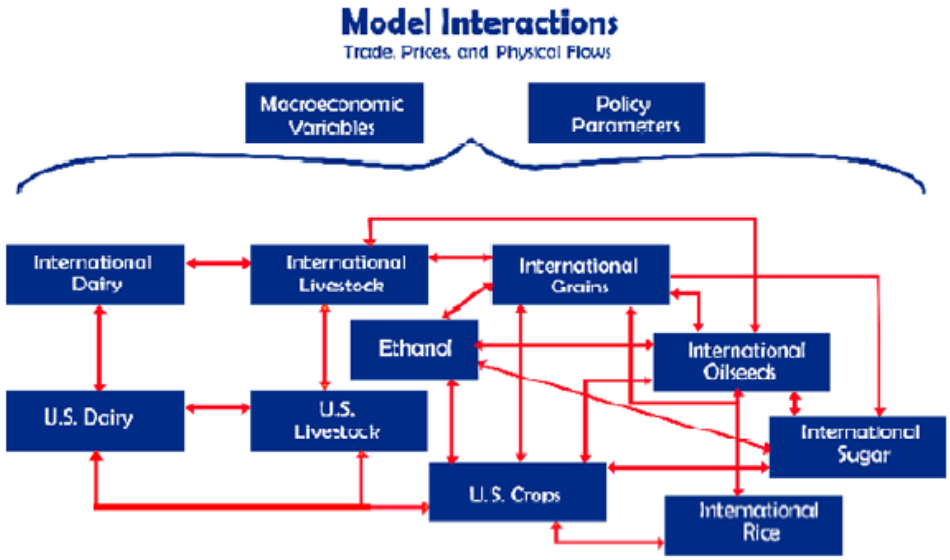
The Food and Agricultural Policy Research Institute (FAPRI) is a research institute housed jointly at Iowa State University and the University of Missouri (USA). Each year, FAPRI prepares 10-year baseline projections for US and world agricultural markets. Results of the FAPRI baseline are published yearly 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 used to develop the baseline contains over 3,000 equations representing supply and demand relationships in the United States and major countries around the world.

[3] http://www.ers.usda.gov/topics/farm-economy/agricultural-baseline-projections/usdas-long-term-projections-process.aspx#.U5cx-_l_tyw

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 dynamic, non-spatial, multi-market models that represent several countries/regions and include a rest-of-the world aggregate (26 regions aggregates and 33 commodity aggregates). 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.

Figure 1 : Model interactions in the FAPRI system



Source: Meyers *et al*. (2010).

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.

In addition to the FAPRI global model, the University of Missouri maintains FAPRI GOLD (grains, oilseeds, livestock and dairy) for the EU agricultural sector. This model is a dynamic, partial equilibrium model that generates country specific estimates of supply, utilisation, trade and market prices for UK, France, Germany, Ireland, Italy, rest of EU-15, Poland, Hungary, rest of NMS-10, Romania and Bulgaria, as well as estimates of supply and utilisation for the total EU (Moss, 2011).

2.3.2. The FAPRI baseline process

Although FAPRI mainly relies on the modelling system, individual analyst/modellers are critical to the process, and the quality of the analysis depends significantly on the skill and experience of these analysts and how well they interface with each other and with the modelling system (Meyers *et al*. 2010).

Even though the FAPRI model typically evolves through time, there are five main steps in the principles of the baseline process (Meyers *et al*. 2010):

- Updating models, data and assumptions, including the November WASDE and latest macroeconomic projections so that starting conditions for the analysis are as current as possible.

- Late November "meltdown" at Iowa State University when analysts spend a week together to produce the preliminary baseline.

- Early December peer review of this preliminary baseline in Washington, D.C., where other analyst from government and international agencies, agribusiness, and other universities provide feedback and critique of the analysis.

- Mid-January "meltdown" at Missouri University, where analysts spend a week to update the analysis and address comments from the review, as well as newly updated figures from WASDE and macroeconomic projections.

- Late February or early March completion of the baseline, briefing of U.S. Congress, USDA, and release to the media and public.

The FAPRI Outlook is prepared by FAPRI modellers and market analyst through an iterative process. The interaction among models goes on until all markets are in equilibrium. 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.

2.4. OECD-FAO outlook for world agricultural commodity markets

2.4.1. The OECD-FAO agricultural outlook

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 methodological approach involves a set of assumptions on exogenous and policy-related drivers, a collaborative expert system and a joint modelling system (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.

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). 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. 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. 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 (OECD-FAO, 2013).

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.

2.4.2. The AGLINK-COSIMO baseline process

The first step in the outlook process is the adjustment of the country or region modules. 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.

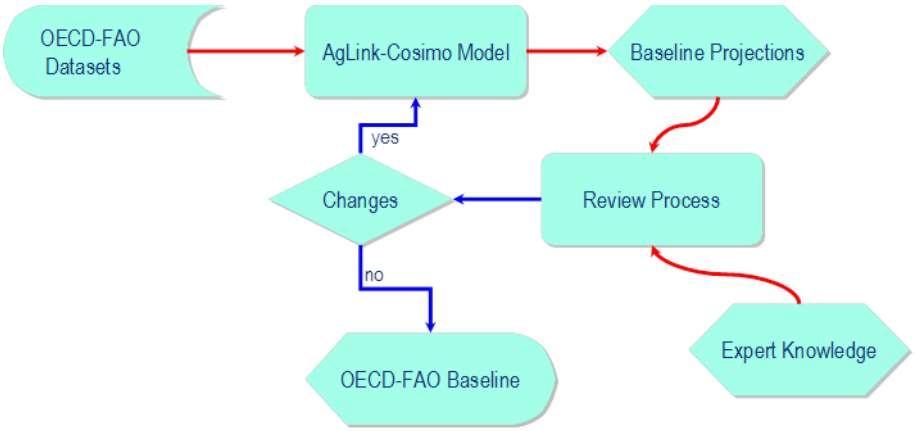
In the next step, the modelling framework jointly developed by the OECD and FAO Secretariats is used to facilitate a consistent integration of this information and to derive an initial set of global market projections. The country modules are merged to form the entire AGLINK-COSIMO model. Supply and demand are represented by behavioural equations, with elasticity being 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.

Figure 2 illustrates the baseline construction procedure. The baseline is developed in close cooperation with national experts in OECD countries and FAO experts for non-OECD countries.

Figure 2 : The OECD-FAO baseline process



Source: Blanco (2010).

Regarding the OECD-FAO baseline, one of the advantages of the construction process is that a common view on the likely evolution of agricultural markets is built through the collaborative work of many national/regional experts. Nevertheless, even if detailed documentation exists, 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.

3. INSTITUTIONAL BASELINES WITH A FOCUS ON EUROPE

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.

3.1. European Union agricultural outlook

3.1.1. The EU prospects for agricultural outlook

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 the European Commission every year constructs an outlook for the medium-term developments in the 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. These projections for agricultural markets in the EU constitute an analytical tool for medium-term market and policy analysis providing results for EU27, EU15 and EU12 aggregates for the main agricultural sectors (Blanco, 2010).

Since 2010, the baseline process has experienced significant modifications partly motivated by economic and market developments that could 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 (Blanco, 2010). The review[4] process includes an extended time horizon, beyond the usual 7 years, and product coverage (biofuels, detailed oilseed complex, sugar and whole milk powder), as well as the introduction of a specific part into the publication regarding scenarios on various uncertainties. Furthermore, the validation procedure has been extended to an external review of the baseline in a workshop held every October in Brussels, gathering high-level policy makers, modellers and market experts.

3.1.2. The EU baseline process

Regarding the methodology used for the EU baseline construction process, 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. While the assumptions are explained, the methodological procedure underlying the projections is not transparent. A recent innovation that has helped to enhance transparency is the publication of the background information on the baseline construction process (Nii-Naate, 2011) and the proceedings of the annual baseline validation workshop (Fellmann and Santini, 2014).

The process of the European Commission's baseline construction has three major stages:

1. The first stage consists in the construction of a first draft medium-term baseline to generate world market and EU prices, and EU commodity balance sheets, which are consistent with a global market-determined equilibrium (Fellmann and Helaine, 2012). Projection provides detailed results for the EU-27, EU-15 and EU-N12 aggregates for cereal, oilseed, sugar, rice, biofuel, meat and dairy markets (Nii-Naate, 2011).

   Regarding the process, first, a set of macroeconomic projections is introduced into the latest version of the AGLINK-COSIMO model, which was used for the OECD-FAO Agricultural Outlook to simulate agricultural commodity markets worldwide and in the EU-27, EU-15 and EU-12. Second, the EU module of AGLINK-COSIMO is adjusted according to the latest EU short-term outlook generated by DG AGRI, which involves statistical and qualitative judgments (Nii-Naate, 2011).

2. The second stage consists in a discussion of the first baseline results in a Baseline Review week and has three components:

   The first draft medium-term baseline is reviewed by market and modelling experts of DG AGRI and JRC-IPTS to generate a preliminary baseline, which is used as the starting point for the uncertainty assessment of the baseline and the calibration process of CAPRI and ESIM models (Nii-Naate, 2011).

   The CAPRI and ESIM models are calibrated to provide a baseline scenario for individual EU Member States and at more disaggregated (i.e. NUTS-2) levels that are missing from the AGLINK-COSIMO model (Nii-Naate, 2011). Another objective is to perform sensitivity and uncertainty analyses on the outlook.

   The baseline is verified in a workshop organised by the JRC-IPTS and DG AGRI gathering high-level policy makers, modelling and market experts from the EU, Switzerland, the

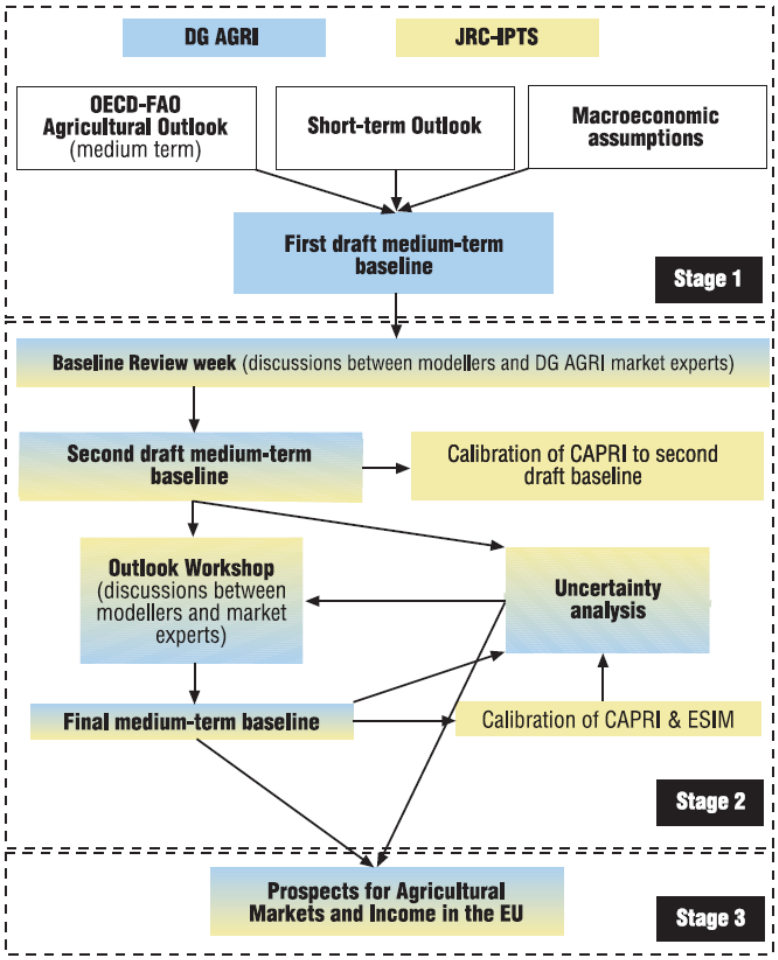
[4] http://ec.europa.eu/agriculture/markets-and-prices/medium-term-outlook/index_en.htm#about

United States, South Africa, and international organisations such as the FAO, the OECD and The World Bank (Fellmann and Santini, 2014). Adjustments to the baseline are made until modelling and product and commodity experts are satisfied with the baseline projections.

3. The third stage consists of publishing the final projections in the DG AGRI's Prospects for Agricultural Markets and Income in the EU in December each year.

A graphical approach of the baseline construction process is illustrated in Figure 3.

Figure 3 : Flowchart of the baseline construction process



Source: Nii-Naate (2011).

4. THE CAPRI BASELINE

4.1. Overview of the CAPRI model

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, 2012). It depicts agricultural commodity markets worldwide, whilst also providing a detailed representation of the diversity of EU agricultural and trade policy instruments.

CAPRI is a comparative-static and spatial equilibrium model that exploits wherever possible well-documented, official, harmonized data sources specially from EUROSTAT, FAOSTAT, OECD and extractions from de Farm Accounting Data Network (FADN) (Britz and Witzke, 2012). The model is 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. Other policies and trade blocks are roughly represented. 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, including primary and secondary agricultural products, and around 40 trade blocks (individual countries or country groups) 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.

After each iteration, the constant terms of the supply and feed demand functions are calibrated to the results of the regional aggregate programming models aggregated to Member State level. The supply module works with exogenous prices but solving the market module delivers new prices that are used in the next iteration of the supply module (Britz and Witzke, 2012).

Table 1 shows the main CAPRI indicators at the global and EU level.

Table 1 : 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)	

Source: Blanco (2010).

4.2. The CAPRI medium-term baseline

The CAPRI baseline describes the agricultural situation in a future year, the so-called 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 EU28 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 comparative-static structural nature of CAPRI makes this model not suited for generating its own 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:

- AGLINK-COSIMO provides baseline results at EU15, EU12 and EU27 aggregate level. Since the 2013 baseline, results are provided for EU15, EU13 and EU28.
- Other projections sources (e.g. FAPRI, FAO) are used to supplement AGLINK-COSIMO data for the non-EU countries.

Regarding regional projections as well as activities not covered by AGLINK-COSIMO model, CAPRI needs to supplement AGLINK-COSIMO with internal projections. AGLINK-COSIMO projection values are used to scale proportionally the CAPRI projections at lower aggregation level such that they are consistent with the AGLINK-COSIMO baseline (Himics et al., 2013).

The CAPRI baseline is updated in close-cooperation with DG-AGRI using a mix of trends and expert knowledge. 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 current projection horizon is 2020.

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 and 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.

In order to ensure reliability and plausibility of results, a validation process is needed. First step of the validation exercise is to check deviation of CAPRI results from the AGLINK-COSIMO results at the EU aggregate level (EU27, EU15, EU-N12). The second step is to examine results at MS level and blocks of other non-EU countries for prices, production level (areas, number of animals), supply/demand (production, domestic use), trade (export, import, net export) and policies. The evaluation of results for non-AGLINK-COSIMO activities is based on expert judgement or other sources, like the annual Commodity Market Development EU Outlook workshop organised by the DG AGRI and JRC-IPTS each year. Differences in baseline results might arise due to the higher spatial resolution and higher number of activities, inputs and outputs covered by the CAPRI modelling system compared to AGLINK-COSIMO (Himics et al., 2013).

The complexity of the CAPRI model, together with the fact that AGLINK-COSIMO baseline only provide results at EU aggregate level and that no other EU wide baseline at regional or farm-type level exists, do not allow checking all the disaggregated results. Hence, a detailed expert validation must focus on selected indicators for specific countries, sectors, activities and policy areas (Himics et al., 2013).

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.

4.3. Current baseline settings

The current CAPRI baseline has been calibrated to DG AGRI baseline 2013, published in December 2013. Consequently, assumptions taken into account for the CAPRI baseline construction are the same as those considered by DG AGRI.

The baseline assumes normal weather conditions, steady demand and yield trends. Furthermore, the set of assumptions includes the following policy and macroeconomic aspects (European Commission, 2013):

- Policy assumptions

DG AGRI outlook assumes status quo policy and reflects future policy changes that have been agreed upon. Hence, the baseline incorporates a full implementation of the CAP Health Check and also includes the following aspects of the CAP reform towards 2020:

- Milk quotas abolition by April 2015.
- Sugar and isoglucose quotas abolition after the 2016/17 marketing year.
- Intervention mechanisms: up to 3 million tonnes a year of common wheat, 50 000 tonnes of butter and 109 000 tonnes of skimmed milk powder can be bought in each year at

fixed intervention prices. Beyond these limits, intervention would be possible by tender, as it is with durum wheat, barley, maize, paddy rice and beef and veal.

- Calculation of the decoupled single farm payment for EU-15 and the EU-13 on the basis of the historical budget expenditure and the future budget envelopes. Payments will fall gradually in the EU-15 and increase in the EU-13.
- The level of coupled payments will remain constant throughout the outlook period.

The 'greening' measures, in particular the requirements on permanent grassland and ecological focus area, are also considered to the extent possible based on assumptions used in the Impact Assessment of CAP reform. Regarding crop diversification provisions, further work is underway to better estimate the aggregated impact on production.

Looking at international trade, all commitments under the Uruguay Round Agreement on Agriculture will be honoured in full. No assumptions are made about the Doha Development Round and the Bali Ministerial Declaration. The free-trade agreements with Columbia, Peru and Central America are taken on board, but bilateral and regional trade deals still in the pipeline are not.

- Macroeconomics environment

Over the projection period, world GDP growth is assumed to decline slightly from 3.9% to 3.6% considering lower growth levels than previous ones and the slowing down of the economic growth in certain emerging countries. Regarding EU GDP, zero growth is expected in 2013, followed by rises of 1.4 % in 2014 and between 1.8 % and 2.0 % for the remainder of the outlook period. The outlook assumes that the turmoil of the economic crisis which started in 2008 will dissipate after 2014, though with lower rate of growth than previously projected.

In relation to population, projections show a steady decrease in annual population growth from 0.2% to 0.1% in the medium term, with slightly higher growth in the EU-15 and a marginal drop in the EU-13.

Further to the economic crisis, annual inflation in the EU was still high in 2012 at 2.6%, for the outlook period, assumptions range between 1.6% and 2.0%. In general, inflation is expected to be higher in the EU-13 than in the EU-15.

The euro value of USD is expected to strengthen over the outlook period with an exchange rate of 1.36 USD/EUR in 2014 and 1.41 USD/EUR in 2023.

The Brent oil price is expected to drop in the first few years of the outlook period to 94 USD/barrel in 2015, and thereafter to strengthen to 116 USD/barrel in 2023.

5. LONG-TERM AGRICULTURAL BASELINES

In the beginning of the nineties, the International Food Policy Research Institute (IFPRI) 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. 2001).

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 44 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. 2012). This modelling system generates annual projections for cropping activities (area, yield, production, food and feed demand, prices and trade) and livestock activities (production, demand, prices, and trade) up to 2050.

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

Apart from IMPACT, over the last years other modelling systems have been adapted to elaborate long term-projections to deal with long-term drivers in the agricultural sector (climate change, natural resources scarcity, etc.). In order to link climate change and long-term socio-economic development, a set of projections called Shared Socio-Economic Pathways (SSPs) has been created by researchers from the International Institute for Applied Systems Analysis (IIASA) and elsewhere. SSPs provide alternative pathways for future socio-economic development taking into account economic, institutional, social and technological changes (for more detailed information see Kriegler *et al*., 2010). These SSPs are used by different modelling systems like the Global Biosphere Management Model (GLOBIOM), the Model of Agricultural Production and its Impact on the Environment (MAgPIE) and CAPRI.

GLOBIOM[5], developed by IIASA, is a global recursive dynamic model that integrates the agricultural, bioenergy and forestry sectors. This model simulates demand, supply, bilateral trade flows and prices for 18 crops, livestock production activities, forestry commodities, bioenergy and water, at 10-year-step intervals from 2000 up to 2050 (Havlik *et al*., 2011; Valin *et al.,* 2013).

MAgPIE is a global land use allocation model at a spatial resolution of three by three degrees, which is coupled to a Lund-Potsdam-Jena dynamic global vegetation model with managed Lands (LPJmL). MAgPIE considers regional economic conditions, potential crop yields and land and water constraints to generate specific land use patterns, yields and total costs of agricultural production for each grid cell. The model runs on a time step of 10 years from 1995 to 2055 in a recursive dynamic procedure (Lozte-Campen *et al*., 2008; Popp *et al*., 2010).

CAPRI is also able to construct long-term baselines based on a combination of sources: medium-term projections (up to 2020) from the Aglink-COSIMO reference scenario, long-term projections from the GLOBIOM model and biofuel related projections from the 13 PRIMES energy model, analysis of historical trends and where available also more specific expert information (Witzke *et al.*, 2014).

[5] http://www.globiom.org/

6. EVALUATION AND VALIDATION OF AGRICULTURAL BASELINE PROJECTIONS

Projections generated by any of the reviewed global outlooks can be used as a reference scenario for further policy analysis. To do this, a previous check of the quality of the projections is required to ensure plausibility of results. The main criteria to take into account in that validation process are transparency and forecasting capacity.

The transparency of the baseline definition process is particularly relevant to understand what is driving the projections and 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.

Even if 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 documented 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 but the process itself is still 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. Nevertheless, 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? Apart from weather and natural conditions, 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 cannot be fully anticipated. Therefore, the baseline cannot be viewed as a forecast of the future.

In general, it is not 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 failure are:

- Technology: inadequate projections of technological change. Technological parameters come from other studies and are usually estimated based on historical data. These parameters may not reflect the future structure of markets. Hence, assumed parameters are almost by definition likely to be incorrect.

- 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. Agricultural policy measures that place high priority on economic efficiency and minimization of food costs are easier to represent in agro-economic models than measures giving substantial weight to non-economic goals (food security, maintenance of viable rural communities). The key question is whether the model properly captures the effect of the policy on market outcomes.

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. Modellers are aware of that bias in past projections and have tried to make appropriate corrections, so it would not be safe to assume that more recent projections have the same bias.

7. CONCLUDING REMARKS

This deliverable provides a review of the methodologies used to generate and validate baselines for agricultural partial equilibrium models at global and regional scale, with a focus mainly on medium- term projections.

The analysis shows that 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.

To ensure plausibility of the results from projections generated by any of the reviewed modelling systems, a quality check of the projections is needed. Nevertheless, the validation processes is not well known since, in most of the cases, the process of constructing the baseline is little detailed.

LIST OF FIGURES

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TRUSTEE

Towards **Ru**ral **S**ynergies and **T**rade-offs between **E**conomic Development and **E**cosystem Services

The TRUSTEE project in a nutshell

Title	Towards Rural Synergies and Trade-offs between Economic Development and Ecosystem Services
Project coordinator	Cécile Détang-Dessendre, INRA UMR Cesaer (Dijon, France)
Grant Agreement	235175 RURAGRI (ANR- 13-RURA-0001-01)
Funding Scheme	RURAGRI ERA-NET, European Commission 7th Framework Programme
Total cost	2,6 M€
Duration	2013 – 2016 (36 months)
Short description	The trade-off/synergy dilemma between economic development and ecosystem services is one of the major issues of sustainable rural development. The main research objective of TRUSTEE is to disentangle the complex relationships between economic development and ecosystem services at different spatial scales using an interdisciplinary approach that involve scientists, experts, and stakeholders. The sub-objectives are: - Analyse the multi-scaled determinants of economic development and ecosystem services on a large European gradient of rural and rural/urban areas. - Increase our understanding of how to achieve mutual benefits for economic development in rural areas and ecosystem services. - Identify and assess the governance mechanisms and policy instruments that enhance sustainable rural vitality in very diverse contexts. - Produce synergies among international researchers of varied disciplines and between researchers and various stakeholders at different governance scales.
Consortium	16 partners from 8 European countries
Read more	http://www.trustee-project.eu/

RURAGRI ERA-NET

SEVENTH FRAMEWORK PROGRAMME

AGENCE NATIONALE DE LA RECHERCHE ANR