D2.1: REPORT ON SELECTED DATA BASE COMPARISON

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1 Introduction

Regular database updates and improvements are easily occupying the major part of resources in modelling. This database work may benefit from SUPREMA due to enhanced possibilities of comparisons and potentially sharing or harmonisation of data. A first step towards harmonisation and comparison of data was to develop or organize mappings where useful. This Deliverable 2.1 links to Task 2.1 of the SUPREMA project, which starts with a stock-taking of previous mapping activities and approaches (e.g. AGRICISTRADE, AgMIP, AgClim50), which are described in Section 3. Section 4 identifies a comprehensive set of policy, environmental, economic and social areas that serve two purposes. First, they are critical for current model (scenario) applications as part of work to be conducted in WP3 on *Testing the SUPREMA model family.* Second, on top of the usual topics that were and are on the past and current agenda of policy makers, this set also cover topics that have been mentioned as important ones for future research by stakeholders in the WP1 workshop on *Challenges, needs and communication – topics for model improvements, applications and dissemination.* In general, the wide range of topics deal with policy, environmental, economic and social issues that target the broad spectrum of agricultural, horticultural, forestry, fishery and rural economies at various geographical scales (from local to global). Depending on upcoming policy questions now and in the future, either a stand-alone model or a combination of models is then supposed to be applied to give insight into the topic. An example involving AGMEMOD and MITERRA could be a comparison of key activity data at the EU member state level or a comparison of market-environmental data (section 4.3). While standard data update activities would not be part of SUPREMA, this Task 2.1 will help to identify useful opportunities for productive communication and data exchange (Section 4). Conclusions on model gaps are summarized in Section 5.

2 Data infrastructure of models

2.1 Variables

In principle, the data infrastructure of models is build up from two types of data, respectively for exogenous variables and for endogenous variables.

Exogenous variables
Especially model baseline results are driven by several underlying assumptions and exogenous variables (Figure 2.1), which are determined outside the model (Salputra et al, 2018).

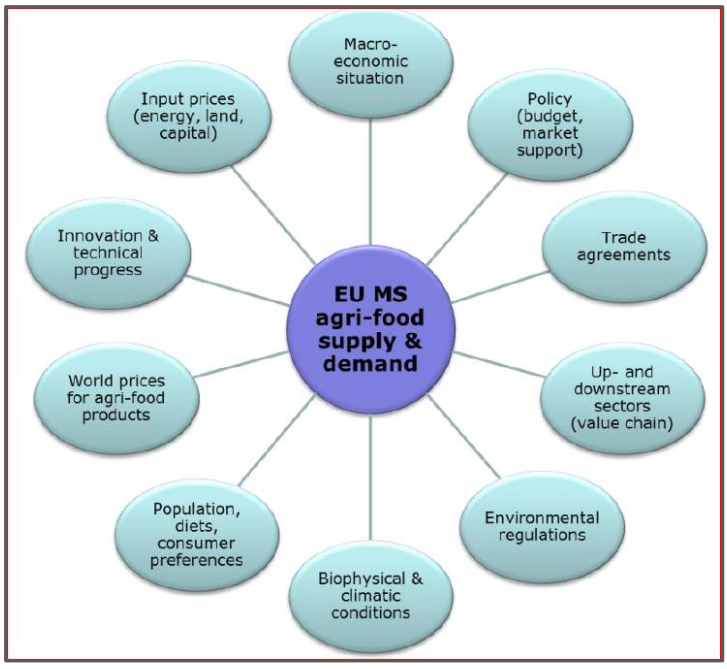

Figure 2.1 Factors influencing the EU agri-food market

The baseline assumes normal biophysical and climatic conditions, steady demand and yield trends, and no market disruption (provoked by, for example, the outbreak of animal diseases, food safety issues, extreme weather events). Consequently, all assumptions imply relatively smooth market developments, although in reality markets tend to be much more volatile. Therefore, the baseline must be considered as a possible pathway that the agri-food market is expected to follow given unchanged policies, a steady development of demand and technological progress, and a continuation of normal geopolitical, macroeconomic and weather conditions.

There are different type of exogenous variables, which are in general grouped as:

- Supply side drivers, like innovation and technical change, energy price.
- Demand side drivers, like population growth, economic development, consumer preferences.
- Resources, like livestock, land, water, fossils, labour.
- Policies:
    - agricultural market policies, like production quota, premiums and subsidies, intervention prices
    - environmental policies, like phosphate targets, CO_2 reduction targets (Effort Sharing Regulation proposal of EC, that covers non-ETS sectors like agriculture).
    - trade policies, like import tariffs, export subsidies, export bans.

Another type of driver in the models regards the use of elasticities taken from various sources, e.g. literature and other models. These will influence model calculations as well, and must be taken into account when it comes to a possible linkage of models.

To conclude, numbers on all type of exogenous drivers have to be identified and if necessary harmonized across models before a linkage between two or more of them can be managed.

Endogenous variables
Driven by the assumed exogenous variables, models provide calculated outcomes that are represented in endogenous variables. In case that a specific endogenous variables is projected in more than one model that are supposed to be linked or compared, e.g. agricultural production or land use, then these have to be harmonized in their initial values.

Dimensions of database
Data can be collected in a broad range and taken from various statistical sources. In order to harmonize data across different models, four dimensions of the databases can be mapped:

- *indicators* used on the one hand; and
- *sector* and *geographic levels* for which these indicators should provide values in the *projection period* on the other hand.

These dimensions, i.e. indicators, sectors, regions and time, will be looked at for each of the templates that are considered in Chapters 3 and 4 of this Deliverable 2.1.

2.2 SUPREMA model family

With sectoral policies becoming more and more interrelated, with cross-cutting sustainability objectives that address the interlinkages, policy coherence is becoming paramount. Agricultural policy is no exception to this trend and its objectives are also contingent on climate change, environment, energy, food security, trade or land use policies. Moreover, agricultural production is increasingly linked to a wide variety of upstream and downstream sectors due to the emerging bio-economy and circular economy.

Economic modelling has developed during the last decades to provide one of the strongest tools to evaluate agricultural, environmental and energy policies, leading to the existence of a large suite of established models for policy analysis. These models have tried to tackle the different challenges by expanding their coverage or

linking with global or biophysical models. Notwithstanding these efforts models are still far from being fit for purpose in this new policy environment. Moreover, the steps taken towards this new policy challenges have not been as coordinated as it would be desirable and sometimes lead to contradicting results which cannot be clearly explained. Therefore, SUPREMA intends to close the gaps between expectations of policy makers and the actual capacity of models to deliver relevant policy analysis, addressing societal challenges towards European agriculture (climate change and low carbon economy, circular economy, land use, SDGs). The SUPREMA model family includes a set of seven core models that are already extensively used in support of key European impact assessments in agriculture, trade, climate and bioenergy policies:

- CAPRI (Common Agricultural Policy Regionalised Impact Modelling System) is a regionalised partial equilibrium model representing the agricultural sector from global to regional scale with a focus on the EU (Member States, regions, farm types, grid, etc.).
- GLOBIOM (Global Biosphere Management Model) also is a partial equilibrium model, with more detail in terms of land use modelling and consistent representation of the agriculture and forestry sectors.
- MAGNET (Modular Applied GeNeral Equilibrium Tool) is a global computable general equilibrium (CGE) model, with a modular structure and a focus on the bioeconomy (incl. bioenergy, biomaterials, biobased chemicals).
- AGMEMOD (AGriculture MEmberstates MODelling) provides within the Agricultural Outlook of the European Commission results on market outcomes and price formation in absolute terms, and at Member State levels.
- AGLINK-COSIMO is a partial equilibrium model to simulate developments of annual market balances and prices for the main agricultural commodities produced, consumed and traded worldwide.
- MITERRA-EUROPE is a deterministic environmental assessment model of agriculture, at Member States and regional levels, developed for assessments of policy options, scenarios and measures.
- IFM-CAP (Individual Farm Model for Common Agricultural Policy) is a static positive mathematical programming farm-level simulation model, which builds on the EU-FADN data, complemented by other relevant EU-wide data sources such as the Eurostat, Farm Structure Survey (FSS) and CAPRI databases.

The Technology Readiness Level (TRL) of these models for current applications are 7 (i.e. system prototype demonstration in operational environment) or 8 (system complete and qualified), measured on a scale from 1 (basic principles observed) to 9 (actual system proven in operational environment). Figure 2.2 shows the SUPREMA models and their interrelations.

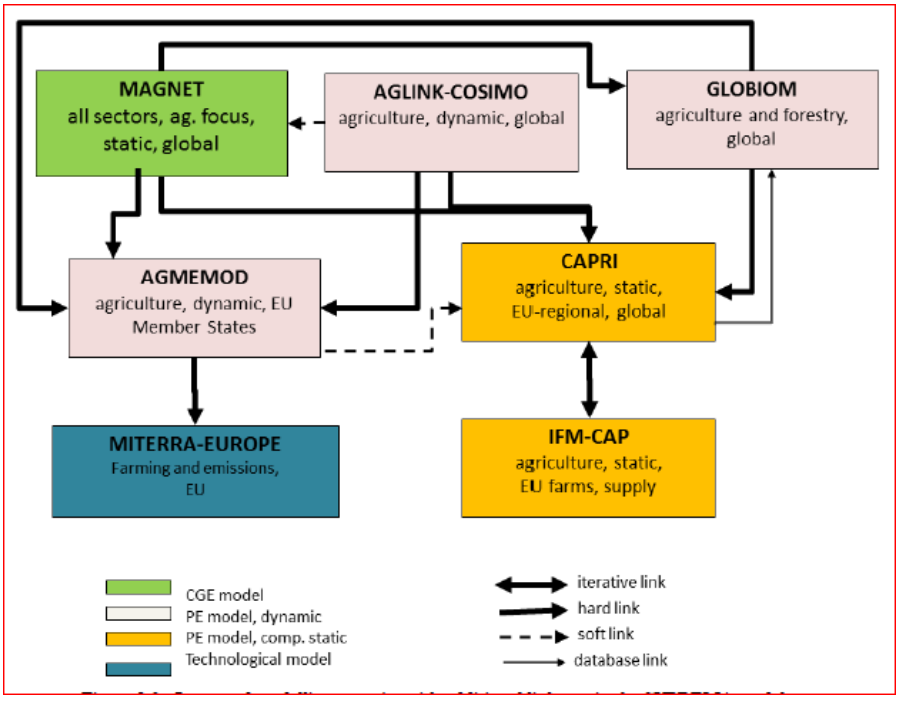

Figure 2.2 SUPREMA model family with linkages

The models are policy relevant and offer the perspective for improvements individually and especially as a linked system to cover a broad range of existing and newly emerging topics. The performance and capacity of current tools, individually and as a linked system, is being enhanced in a few focus areas for integrating new policy challenges (e.g. climate change, SDGs, supply chains). The capacity of the modelling network will be strengthened by an enhanced infrastructure for database improvements and model interaction, strengthening of existing and establishing new linkages among models, targeted technical improvements and consolidation activities (i.e. model testing and versioning).

Before enhanced actions can be made in this field, the first objective of task 2.1 is to stocktake previous activities on comparing databases and sharing of harmonized data in cases that (a set of) SUPREMA models are involved (see chapter 3). The second objective of task 2.1 is to make mappings of the extended SUPREMA database that will cover new emerging topics and policy challenges for the relevant SUPREMA models (see chapter 4).

As there are no extensions and improvements foreseen for IFM-CAP in the SUPREMA project, this model type is kept outside the analysis in this Deliverable 2.1.

3 Stock-taking of existing data mapping templates

All models of the SUPREMA platform have the aim to conduct policy analysis over a future period for a) a reference scenario; and b) alternative scenarios incorporating changes in assumptions on e.g. policy instruments, macroeconomic circumstance, speed of technological change, climate situation. It is known that model types (e.g. PE versus GE models) in general differ from each other in terms of used database, supply and demand behaviour captured, underlying solving mechanisms, starting year of analysis, and geographic and commodity coverage. Though such differences can sometimes result in contradictory findings, even when conducing a same scenario, research can benefit from the use of different models in form of:

- consistency checks of scenario outcomes and storylines;
- providing complementary information on indicators, and geographic and sector coverage;
- taking the strengths of each model, depending on the policy issue addressed.

There is no perfect economic-biophysical model available that can address all possible aspects and policy questions on its own. In general there are two approaches to overcome shortcomings in the current set of available models, namely:

- to build an extensive all comprising model from scratch, which includes all required aspects;
- to link already existing models and take advantage of their individual strengths and key features.

Considerable advantages of the second approach above the model building from scratch are the re-use of models, time saving development, increased coverage of aspects and interactions, improved projections, extensive inclusion of expert knowledge, and flexibility to answer a variety of research questions. The rationale behind is to keep the possibility to run a specific model in separate mode in case that is sufficient to answer a specific research question, while in other cases the linking of the models would provide better insights.

A first step towards harmonisation and comparison of data used by the SUPREMA family was to develop or organize mappings where useful. With this respect, SUPREMA intends to link to existing platforms enabling science-policy interaction in the domain of agriculture and food. Therefore task 2.1 includes a stock-taking of previous activities that have taken place in the AgMIP/AgClim50 project (section 3.1) and the AGRICISTRADE project (section 3.2).

3.1 AgMip and AgClim50 templates

3.1.1 Aim of project

For the data mapping work of task 2.1, at first a linkage with the AgMip platform is of importance. The Agricultural Model intercomparison and Improvement Project (AgMIP), wherein agricultural models are improved based on their intercomparison and evaluation using high-quality global and regional data and best scientific practices, and document improvements for use in integrated assessments. This AgMIP Impacts Explorer was created with support from the UK Department for International Development. More information on AgMIP findings, products, and activities is available at www.agmip.org.

In the light of the Paris Agreement on Climate Change at the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC), the EC-JRC initiated the project "Challenges of Global Agriculture in a Climate Change Context by 2050" (AgCLIM50) with the main aim to look at the range of potential economic impacts of climate change and mitigation options in the agricultural sector by 2050 (Pérez Domínguez and Fellmann et al, 2017; http://publications.jrc.ec.europa.eu/ repository/bitstream/ JRC106835/ jrc106835_agclim50_jrc_science_for_policy_report.pdf). Alternative scenarios have been applied to different models, harmonized with respect to basic model assumptions, to assess the impact of climate change on the agricultural sector by 2050 and the economic consequences of stringent global emission mitigation efforts to stabilize global warming at 2°C by the end of the century under different Shared Socioeconomic Pathways (SSPs). For this study the AgMip mapping template has been extended to the AgClim50 mapping template in order to harmonize the models used.

3.1.2 Models involved

The following five models have been used for the AgClim50 analysis (Box 3.1):

- CAPRI: Common Agricultural Policy Regionalised Impact Modelling System
- GLOBIOM: Global Biosphere Management Model
- IMAGE: Integrated Model to Assess the Global Environment
- MAGNET: Modular Applied GeNeral Equilibrium Tool
- MAgPIE: Model of Agricultural Production and its Impact on the Environment

The combination of integrated assessment (IMAGE), partial equilibrium (CAPRI, GLOBIOM, MAgPIE) and computable general equilibrium (MAGNET) models for this analysis ensured a good coverage of (a) biophysical features on land availability, quality, and spatial heterogeneity; and (b) cross-sectorial linkages through factor markets and substitution effects. Out of the five models, CAPRI, GLOBIOM and MAGNET belong to the SUPREMA model family and will be explained in Box 3.1, while features of IMAGE and MAgPIE are in Annex 1.

3.1.3 Mapping of models' databases

The AgClim50 project applied a soft linkage approach to combine a package of distinct model types for answering its specific set of research questions. In principle, different model types can be (partly) linked in case their underlying databases are either

- directly comparable for specific issues, e.g. commodities or regions; and/or
- indirectly comparable after data transformation, e.g. aggregation of specific commodities or regions.

The databases used in the three models considered have been compared and mapped in order to sort out similarities and complementarities with regard to topics that they can take into account. Model output on prices, production, demand, land use and yields have been looked at. Second, relevant aspects influencing these outputs that play a role in the models were compared and mapped as well, i.e. exogenous drivers like policy instruments, demographic development, economic development, climate change, consumer preferences and resource availability. This is an essential step in order to investigate and pinpoint appropriate levels for combining and providing complementary output on specific research questions.

Box 3.1 Suprema models used in AgClim50 project

CAPRI (see http://www.capri-model.org/ CAPRI) The Common Agricultural Policy Regionalised Impact (CAPRI) modelling system is an economic large-scale comparative-static agricultural sector model with a focus on the EU (at NUTS 2, Member State and aggregated EU-28 level), but covering global trade with agricultural products as well (Britz and Witzke 2014). It consists of two interacting modules: the supply module and the market module. The supply module consists of about 280 independent aggregate optimisation models, representing regional agricultural activities (28 crop and 13 animal activities) at Nuts 2 level within the EU-28. CAPRI is designed to capture the links between agricultural production activities in detail (e.g. food and feed supply and demand interactions or animal life cycle), and based on the production activities, inputs and outputs define agricultural GHG emission effects. It incorporates a detailed nutrient flow model per activity and region (which includes explicit feeding and fertilising activities, i.e. the balancing of nutrient needs and availability) and calculates yields per agricultural activity endogenously. Therefore, CAPRI can calculate endogenously GHG emission coefficients following the IPCC guidelines.

GLOBIOM (see www.iiasa.ac.at./GLOBIOM). The Global Biosphere Management Model (GLOBIOM) (Havlík et al. 2014) is a global recursive dynamic partial equilibrium model of the forest and agricultural sectors, where economic optimization is based on the spatial equilibrium modelling approach. The supply side of the model is based on a bottom-up approach (from land cover, land use, and management systems to production and markets). Agricultural and forest productivity is modelled at the level of grid cells of 5x5 to 30x30 arc-minutes, using biophysical models, such as EPIC (Williams 1995), while demand and international trade occur at the regional level (from 30 to 57 regions covering the world, depending on the model version and research question). Besides primary products, GLOBIOM has several final and by-products, for which the processing activities are defined. It computes market equilibrium for agricultural and forest products by allocating land use among production activities to maximize the sum of producer and consumer surplus, subject to resource, technological and policy constraints. Production levels are determined by the agricultural or forestry productivity in that area (dependent on suitability and management), market prices (reflecting the level of demand), and conditions and cost associated to conversion of land, to production expansion and, when relevant, to international market access. By including the bioenergy sector, forestry, cropland and grassland management, and livestock management, it allows for a full account of all agriculture and forestry GHG sources (including N2O, CH4, CO2).

MAGNET (http://www.magnet-model.org/). The Modular Applied GeNeral Equilibrium Tool (MAGNET) model is a multi-regional, multi-sectoral, applied general equilibrium model based on neo-classical microeconomic theory (Woltjer et al. 2014). It is an extended version of the standard GTAP model (Hertel 1997). Its core is an input–output model, which links industries in value added chains from primary goods, over continuously higher stages of intermediate processing, to the final assembly of goods and services for consumption. Primary production factors are employed within each economic region, and hence returns to land and capital are endogenously determined at equilibrium, i.e., the aggregate supply of each factor equals its demand. On the consumption side, the regional household is assumed to distribute income across savings and (government and private) consumption expenditures according to fixed budget shares. MAGNET uses a more general multilevel sector specific nested CES (constant elasticity of substitution) production function, allowing for substitution between primary production factors (land, labour, capital, natural resources) and intermediate production factors and for substitution between different intermediate input components (e.g. energy sources, and animal feed components). It includes an improved treatment of agricultural sectors (like various imperfectly substitutable types of land, the land use allocation structure, a land supply function, substitution between animal feed components), agricultural policy and biofuel policy (capital-energy substitution, fossil fuels-biofuels substitution). On the consumption side, a dynamic CDE expenditure function is implemented which allows for changes in income elasticities when purchasing power parity corrected real GDP per capita changes. Segmentation and imperfect mobility between agriculture and non-agriculture labour and capital are introduced in the modelling of factors markets. MAGNET is linked to IMAGE (Stehfest at al. 2014) to account for biophysical constraints and feedbacks.

Source: Pérez Domínguez and Fellmann et al, 2017

Four dimensions of the databases have been mapped in the AgClim50 project:

- *indicators* (*variables* in AgClim50 vocabulary) used on the one hand; and

- *sector* (*Items* in AgClim50 vocabulary) and *geographic* (*Regions* in AgClim50 vocabulary) *levels* for which these indicators should provide values in the *projection period* on the other hand.

The sector, geographic and temporal details of the three involved models are addressed in sections 3.1.3.1 to 3.1.3.3 respectively, while the indicators that make sectors and regions measurable are in section 3.1.3.4.

3.1.3.1 Sector level

MAGNET does include all products produced in the economy, but agricultural sector is highly aggregated. On the other hand, GLOBIOM and CAPRI only focus on certain agricultural products and their processed products. They have a higher disaggregation of agricultural products than MAGNET but even between these two models the products are not identical. Nevertheless, they have to be mapped to each other in order to exchange data between the models (Table 3.1). Products from CAPRI (column 1) and GLOBIOM (column 2) are mapped to the sectors presented in MAGNET (column 3).

Table 3.1 Mapping of sectors/items in AgClim50 project

CAPRI	GLOBIOM	MAGNET
Soft wheat	Wheat / soft wheat*	Wheat
Durum	Wheat/ durum wheat*	Wheat
Barley	Barley	Other Grains
Maize	Corn	Other Grains
Rice	Rice	Paddy Rice
Oats	Oat*	Other Grains
Rye	Rye*	Other Grains
-	-	Other Grains
-	Millet	Other Grains
-	Sorghum	Other Grains
other grains	-	Other Grains
Rapeseed	Rapeseed	Oilseeds
Sunflower	Sunflower	Oilseeds
Soya	Soybeans	Oilseeds
other oilseeds	-	Oilseeds
	Oil palm	Oilseeds
other crops	-	Other Crops
Olives	-	Vegetables and Fruits
protein crop	-	*not mapped*
Potatoes	Potatoes	Vegetables and Fruits
sugar beet	Sugar beet*	Sugar beet and cane
-	Sugarcane	Sugar beet and cane
raw tobacco	-	Vegetables and Fruits
cotton	Cotton	Other Crops
-	Dry beans	Vegetables and Fruits
-	Cassava	Vegetables and Fruits
-	Chick peas	Vegetables and Fruits
	Peas*	Vegetables and Fruits
-	Groundnut	Vegetables and Fruits
-	Sweet potatoes	Vegetables and Fruits
Tomatoes	-	Vegetables and Fruits

CAPRI	GLOBIOM	MAGNET
Oranges	-	Vegetables and Fruits
Apples	-	Vegetables and Fruits
Wine	-	Beverages and Tobacco
-	Corn silage*	Other Crops
-	Other green fodder*	Other Crops
-	Short rotation plantations	Other Crops
rape meal	-	Oil cake
sun meal	-	Oil cake
soya meal	-	Oil cake
rape oil	-	vegetable oil
sun oil	-	vegetable oil
soya oil	-	vegetable oil
Olive oil, extra virgin	-	vegetable oil
	Oil palm	vegetable oil
Ethanol	-	Ethanol
Wheat ethanol	Wheat ethanol	Ethanol
Corn ethanol	Corn ethanol	Ethanol
Sugar ethanol	Sugar beet ethanol	Ethanol
-	Sugar cane ethanol	Ethanol
Biodiesel	-	Biodiesel
rape bio diesel	Rape FAME	Biodiesel
soy bio diesel	Soya FAME	Biodiesel
sun bio diesel	Sunflower FAME	Biodiesel
-	2nd gen Ethanol	*not mapped*
-	Methanol	*not mapped*
sugar	-	Sugar
Cattle	-	Ruminants
Dairy cows	-	Ruminants
Suckler cows	-	Ruminants
Bovine animals (less than 1 year)	-	Ruminants
Cows	-	Ruminants
-	Bovines dairy (cows)	Ruminants
-	Bovines dairy (replacement heifers)	Ruminants
-	Bovines other	Ruminants
-	Small ruminants dairy (adult females)	Ruminants
-	Small ruminants dairy (replacement females)	Ruminants
-	Small ruminants other	Ruminants
Pigs	Pigs	Other Animal products
Sheep total	-	Ruminants
Cow's Milk	-	Milk
Other milk	-	Milk
-	Poultry – laying hens	Other Animal products
-	Poultry – broilers	Other Animal products
-	Poultry - mixed	Other Animal products
Eggs		Other Animal products

CAPRI	GLOBIOM	MAGNET
Mutton and Lamb		Ruminants Meat
Beef and veal		Ruminants Meat
Pig meat		Other Meat
Chicken Meat/ Broiler		Other Meat
Poultry meat		Other Meat
Other Poultry		Other Meat
Skim milk powder		Dairy Products
Whole milk powder		Dairy Products
Emmenthal cheese		Dairy Products
Butter		Dairy Products
Cream		Dairy Products
Other fresh dairy products		Dairy Products
Drinking milk		Dairy Products
Casein		Dairy Products
Other dairy products		Dairy Products
-	Sawn wood, Wood pulp	*not mapped*
-	Fuel wood	*not mapped*
-	Energy wood	*not mapped*
-	Other industrial round wood	*not mapped*
-	Heat	*not mapped*
-	Electricity	*not mapped*
-	Gas	*not mapped*

*for EU only

3.1.3.2 Geographic level

CAPRI covers the member states in the European Union, Norway and Western Balkan at the NUTS 2 level (250 regions). The database of MAGNET consists of 135 regions covering the whole world and its economy, while GLOBIOM covers 179 countries of the world. All models have a flexible regional aggregation option.

Table 3.2 Mapping of regions in AgClim50 project

CAPRI	GLOBIOM	MAGNET
Nuts2 regions		
Austria	Austria	Austria
Germany	Germany	Germany
Denmark	Denmark	Denmark
Spain	Spain	Spain
Finland	Finland	Finland
France	France	France
Ireland	Ireland	Ireland
Italy	Italy	Italy
Netherlands	Netherlands	Netherlands
Portugal	Portugal	Portugal
Sweden	Sweden	Sweden
United Kingdom	United Kingdom	United Kingdom
Belgium	Belgium (includes Luxembourg)	Belgium (includes Luxembourg)

CAPRI	GLOBIOM	MAGNET
Luxembourg Greece Malta Cyprus	Greece (includes Malta and Cyprus)	Greece (includes Malta and Cyprus)
Bulgaria	Bulgaria	Bulgaria
Czech Republic	Czech Republic	Czech Republic
Croatia	Croatia	Croatia
Hungary	Hungary	Hungary
Estonia	Estonia	Estonia
Lithuania	Lithuania	Lithuania
Latvia	Latvia	Latvia
Romania	Romania	Romania
Slovenia	Slovenia	Slovenia
Slovak Republic	Slovak Republic	Slovak Republic
Poland	Poland	Poland
Norway	Russia	Russian Federation
Western Balkan	Turkey	Turkey
	Ukraine	Ukraine
	Australia and New Zealand	Rest of former Soviet Union
	Pacific Islands	
	China	China
	India	India
	Japan	Japan
	South Korea	Korea
	Rest of Asia	Rest of Asia
	South East Asia	
	USA	USA and Canada
	South America	
	Central America	
	Africa	Africa

3.1.3.3 Time path

The base year in MAGNET in the AgCLim50 project is 2011 due to dependency on the actuality of the GTAP database Version 9. Currently, CAPRI uses 2015 as base year, while GLOBIOM starts its calculations in 2000.

3.1.3.4 Variables and indicators

In general, models make use of two types of variables, i.e. exogenous and endogenous variables.

Exogenous variables
O'Neill et al. (2014; 2017) developed five Shared Socioeconomic Pathways (SSPs) for determining the socioeconomic background for the climate change research. The SSPs contain narratives for developments of demographics (population), economy (e.g. GDP) and lifestyle, policies and institutions, technology, and environment and natural resources. The three models involved in the AgClim50 project based the development of their exogenous variables on following three SSPs:

- *SSP1 (Sustainability):* featuring relatively high levels of economic growth, education and technological growth; lower levels of demographic growth; convergence between developed and developing countries, sustainability concerns in consumer behaviour;

- *SSP2 (Middle of the Road):* representing business as usual development, and
- *SSP3 (Regional Rivalry/Fragmentation)*: featuring opposite tendencies to SSP1 – relatively slow economic growth, sustained population growth.

Tables 3.3 and 3.4 give the common and policy drivers that influence the output of respectively AGMEMOD, MAGNET and GLOBIOM.

Table 3.3 Common drivers influencing the output in models of AgClim50 project

Common drivers	CAPRI	MAGNET	GLOBIOM
GDP	In bn USD	in percentage change for all regions, based on USDA	in USD, for all represented countries, based on SSP2 scenario
Population	In heads	in percentage change for all regions, based on World bank	in heads, for all represented countries, based on SSP2 scenario
Technological change	for land using sectors based on econometric estimations	for land using sectors based on FAO, for other inputs per sector based on GDP and MAGNET internal distribution	for land using sectors based on econometric estimations
Trade policy	tariff rate quotas	trade protection data; tariff rates, ad valorem	tariff rate quotas
Climate Change mitigation	technical mitigation options in terms of production, and emission (CO2, CH4, N2O); soil organic carbon balance; water use	CO2 emissions included	technical mitigation options in terms of production, and emission (CO2, CH4, N2O); soil organic carbon balance; water use

Exogenous variables have been compared and adjusted across the models involved. If the exogenous variable is identical like GDP and population development in CAPRI and MAGNET, both models have to use the same value for the exogenous variable. In cases where the exogenous variable is comparable but slightly different such as the technology change in crop production in MAGNET and GLOBIOM, difference must be identified and - consequently - the parameters must be adjusted.

Endogenous variables

Driven by its set of exogenous variables, models provide outcomes that are expressed by endogenous variables. In order to achieve consistency, there is a need to harmonize endogenous variables that are projected in more than one model – e.g. agricultural production - in their initial values in terms of levels and start year. Table 3.4 depicts a list of indicators/variables and its metrics for which more than one model in the AgClim50 project generates an outcome.

Table 3.4 Common variables/indicators of models in AgClim50 project*

Variables	Unit	Variables	Unit
Prices and (farm) Income variables		**Market variables**	
Real producer price/input price	USD/t	Feed use dairy	1000 t
Real export price	USD/t	Feed use dairy	1000 t prt
Area and yield variables		Feed fish sector	1000 t
Area harvested	1000 ha	Feed fish sector	1000 t prt
Area harvested – rainfed	1000 ha	**Environmental variables**	
Area harvested – irrigated	1000 ha	Fertiliser N	1000 t
Land cover	1000 ha	Water for irrigation	km3
Crop yield	dm t/ha, fm t/ha	Total GHG emissions	MtCO2e
Crop yield – rainfed	dm t/ha, fm t/ha	Total CO2 emissions	MtCO2e
Crop yield – irrigated	dm t/ha, fm t/ha	Total CH4 emissions	MtCO2e
Exogenous crop yield	dm t/ha, fm t/ha	Total N2O emissions	MtCO2e
Climate change shifter on crop yield	%	**Technological innovation variables**	
Livestock yield (endogenous)	kg prt/ha	Technical mitigation options - Production	1000 t
Exogenous livestock yield trend	kg prt/ha	Technical mitigation options - Emissions	MtCO2e
Feed conversion efficiency (endogenous)	kg prt/kg prt	Technical mitigation options - CO2	MtCO2e
Feed conversion efficiency trend	kg prt/kg prt	Technical mitigation options - CH4	MtCO2e
Market variables		Technical mitigation options - N2O	MtCO2e
Food use	1000 t	**Macroeconomic variables**	
Feed use	1000 t	Total population	million
Feed use	1000 t prt	Total GDP (MER)	bn USD 2005 MER
Other use (seed /industrial use, losses)	1000 t	**Environmental policy variables**	
Imports	1000 t	Carbon tax level	USD/tCO2e
Exports	1000 t	**Consumer preference variables**	
Production	1000 t	p.c. calory availability	kcal/cap/d
Domestic use (total use=food + feed + other)	1000 t		
Net trade	1000 t		
Feed use ruminant meat	1000 t		
Feed use ruminant meat	1000 t prt		

**According to Excel data template received from AgClim50 project members (June 2018 version)*

3.2 AgriCisTrade template

3.2.1 Aim of project

The FP7 project *AGRICISTRADE* (*Exploring potential for agricultural and biomass trade with the EU)* had the aim to analyse the potential impact of trade agreements between the EU and the Commonwealth of Independent States' (CIS). Also it contributed to delivering insights on the potential developments of the food, feed and biomass sectors in Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Moldova, Russia and Ukraine (http://www.agricistrade.eu/). Based on its multidisciplinary expertise, the *AGRICISTRADE* consortium investigated agro-ecological, socio-economic and institutional bottlenecks to exploit the agricultural potentials in CIS and showed the implications of policy interventions for development perspectives of a number of selected supply chains. *AGRICISTRADE* improved existing biophysical and economic modelling tools through enhancing their empirical base and regional representation, and develops a framework for assessing agricultural production and demand potentials in CIS. Modelling tools were used to quantify and analyse the impact of market developments, technology and policy scenarios on CIS agricultural production, demand and trade, specifically addressing the implications of these scenarios for the agri-food sector in the EU.

3.2.2 Models involved

The AgriCisTrade project developed a toolbox that consists of three models out of the SUPREMA model family, namely AGMEMOD as a detailed economic model of the agricultural and food sector, MAGNET as a tool to analyse the general economic linkage of the agri-food system with the overall economy, and the global partial equilibrium model GLOBIOM for providing insight in the biophysical underpinnings of the medium- to long-term development of the production potential. All three models belong to the SUPREMA model platform and are therefore worthwhile to look at from the data mapping perspective. They capture:

- agricultural production and markets, but from different aspects with respect to agriculture, e.g. trade in MAGNET and soil properties in GLOBIOM; and
- detailed representation of specific sectors in AGMEMOD, but this aspect is underrepresented in the other models.

For a proper analysis of the future potential of agricultural markets in EU and CIS it was important to consider the broad variety of trade, soil qualities and sector detail in both regions. The comparative advantages of each of the three models in the AriCisTrade toolbox were explored as follows (Box 3.2):

- AGMEMOD's richness of agricultural products and processing activities.
- MAGNET's complexity of interaction between the agri-food sectors and the rest of the economy in the factor markets and in international trade with various countries.
- GLOBIOM's land use allocation within countries and its bio-physical data.

Box 3.2 Short description of models used in AgriCistTrade

AGMEMOD is able to depict agricultural production, demand and resulting prices in detail and includes all agricultural market policies, e.g. subsidies on production, production quotas, and decoupled payments. AGMEMOD projects reactions in agricultural production to changes in the market. It does however not include links between agriculture and the rest on economy.
GLOBIOM models besides agricultural and timber markets also land use based on bio-physical properties such as soil, slope, altitude, climate but also several management types which differ in low or high input use and irrigated or rain-fed production (Havlík *et al.*, 2011). GLOBIOM has a spatial resolution of 0.5° x 0.5° grid which can be aggregated to countries or regions. This detailed representation of land and agricultural production allows drawing conclusions on possible land expansion and yield potential but also identifying limits of them. Furthermore, GHG emissions from land using sectors and land use changes are included in the model. Compared with AGMEMOD, it covers biophysical relationships and climate issues, but agricultural policies are modelled in less detail.
MAGNET simulates bilateral trade including specific tariffs and hence is able to explicitly show effects of trade agreements between two countries or country groups. Furthermore, all economic sectors compete for endowments, e.g. if labour is used in the textile industry, it cannot be used in agriculture. Compared with AGMEMOD and GLOBIOM, it covers a full economy.
Source: D5.1 on Model Coupling in AgriCisTrade (2014)

The AgriCisTrade toolbox had the purpose to generate medium term projections up to 2030 on agricultural and biomass potential and trade under 1) a baseline and 2) various policy scenarios. It had to reflect the impact of supply and demand drivers on food, feed and energy use under several scenarios for EU and CIS. An operational system, named Mojito, was developed for a soft linkage of the models involved that ensured the analysis of production and demand potential as well as trade and land use issues (see Deliverable 5.1 of AgriCisTrade

project[1]). Note that the Mojito model linkage system can deal with other models than AGMEMOD, MAGNET and GLOBIOM as well, while it can also combine less or more models than the three mentioned.

3.2.3 Mapping of models' databases

The AgriCisTrade project applied a soft linkage approach to combine a package of distinct model types for answering its specific set of research questions. In principle, different model types can be (partly) linked in case their underlying databases are either

- directly comparable for specific issues, e.g. commodities or regions; and/or
- indirectly comparable after data transformation, e.g. aggregation of specific commodities or regions.

The databases used in the three model of the AgriCisTrade toolbox have been compared and mapped in order to sort out similarities and complementarities with regard to topics that they can take into account. First, (endogenous) model output on prices, production, demand, land use and yields were looked at. Second, relevant aspects influencing these outputs that play a role in the models were compared and mapped as well, which especially concern exogenous drivers like policy instruments, demographic development, economic development, climate change, consumer preferences and resource availability. This is an essential step in order to investigate and pinpoint appropriate levels for combining and providing complementary output on specific research questions.

Also, four dimensions of the databases have been mapped in AgrCisTrade:

- *indicators* used on the one hand; and
- *sector* and *geographic levels* for which these indicators should provide values in the *projection period* on the other hand.

The sector, geographic and temporal details of the three involved models are addressed in sections 3.2.3.1 to 3.2.3.3 respectively, while the indicators that make sectors and regions measurable are in section 3.2.3.4.

3.2.3.1 Sector level

MAGNET does include all products produced in the economy, but agricultural sector is highly aggregated. On the other hand, AGMEMOD and GLOBIOM only focus on certain agricultural products and their processed products. They have a higher disaggregation of agricultural products than MAGNET but even between these two models the products are not identical. Nevertheless, they have to be mapped to each other in order to exchange data between the models (Table 3.5). Products from AGMEMOD (column 1) and GLOBIOM (column 2) are mapped to the sectors presented in MAGNET (column 3). Moreover, the mapping between AGMEMOD and GLOBIOM gets more attention as they cover a set of agricultural products which is not fully identical. This hampers a full data exchange between both models as that is only possible for similar products. It also means that product aggregates, e.g. total grains in AGMEMOD or GLOBIOM, cannot be compared as long as these do not cover all grain categories. On the other hand, aggregates of selected grain categories – based on common presence - could be created in order to make data exchange data between both models possible.

[1] Martin Banse, Aida Gonzalez-Mellado, Petra Salamon, Verena Wolf, Foppe Bouma, Andrzej Tabeau, Petr Havlik (2014). Conceptual framework for quantitative analysis. Deliverable 5.1 of AgriCisTrade project.

Table 3.5 Mapping of sectors in AgriCisTrade project

AGMEMOD	GLOBIOM	MAGNET
Soft wheat	Wheat / soft wheat*	Wheat
Durum	Wheat/ durum wheat*	Wheat
Barley	Barley	Other Grains
Maize	Corn	Other Grains
Rice	Rice	Paddy Rice
Oats	Oat*	Other Grains
Rye	Rye*	Other Grains
Triticale	-	Other Grains
-	Millet	Other Grains
-	Sorghum	Other Grains
other grains	-	Other Grains
Rapeseed	Rapeseed	Oilseeds
Sunflower	Sunflower	Oilseeds
Soya	Soybeans	Oilseeds
other oilseeds	-	Oilseeds
	Oil palm	Oilseeds
other crops	-	Other Crops
Olives	-	Vegetables and Fruits
protein crop	-	*not mapped*
Potatoes	Potatoes	Vegetables and Fruits
sugar beet	Sugar beet*	Sugar beet and cane
-	Sugarcane	Sugar beet and cane
raw tobacco	-	Vegetables and Fruits
cotton	Cotton	Other Crops
-	Dry beans	Vegetables and Fruits
-	Cassava	Vegetables and Fruits
-	Chick peas	Vegetables and Fruits
	Peas*	Vegetables and Fruits
-	Groundnut	Vegetables and Fruits
-	Sweet potatoes	Vegetables and Fruits
Tomatoes	-	Vegetables and Fruits
Oranges	-	Vegetables and Fruits
Apples	-	Vegetables and Fruits
Wine	-	Beverages and Tobacco
-	Corn silage*	Other Crops
-	Other green fodder*	Other Crops
-	Short rotation plantations	Other Crops
rape meal	-	Oil cake
sun meal	-	Oil cake
soya meal	-	Oil cake
rape oil	-	vegetable oil
sun oil	-	vegetable oil
soya oil	-	vegetable oil

AGMEMOD	GLOBIOM	MAGNET
Olive oil, extra virgin	-	vegetable oil
	Oil palm	vegetable oil
Ethanol	-	Ethanol
	Wheat ethanol	Ethanol
	Corn ethanol	Ethanol
	Sugar beet ethanol	Ethanol
-	Sugar cane ethanol	Ethanol
Biodiesel	-	Biodiesel
rape bio diesel	Rape FAME	Biodiesel
soy bio diesel	Soya FAME	Biodiesel
sun bio diesel	Sunflower FAME	Biodiesel
-	2nd gen Ethanol	*not mapped*
-	Methanol	*not mapped*
sugar	-	Sugar
Cattle	-	Ruminants
Dairy cows	-	Ruminants
Suckler cows	-	Ruminants
Bovine animals (less than 1 year)	-	Ruminants
Cows	-	Ruminants
-	Bovines dairy (cows)	Ruminants
-	Bovines dairy (replacement heifers)	Ruminants
-	Bovines other	Ruminants
-	Small ruminants dairy (adult females)	Ruminants
-	Small ruminants dairy (replacement females)	Ruminants
-	Small ruminants other	Ruminants
Pigs	Pigs	Other Animal products
Sheep total	-	Ruminants
Cow's Milk	-	Milk
Other milk	-	Milk
-	Poultry – laying hens	Other Animal products
-	Poultry – broilers	Other Animal products
-	Poultry – mixed	Other Animal products
Eggs		Other Animal products
Mutton and Lamb		Ruminants Meat
Beef and veal		Ruminants Meat
Pig meat		Other Meat
Chicken Meat/ Broiler		Other Meat
Poultry meat		Other Meat
Other Poultry		Other Meat
Skim milk powder		Dairy Products
Whole milk powder		Dairy Products
Emmenthal cheese		Dairy Products
Butter		Dairy Products
Cream		Dairy Products
Other fresh dairy products		Dairy Products

AGMEMOD	GLOBIOM	MAGNET
Drinking milk		Dairy Products
Casein		Dairy Products
Other dairy products		Dairy Products
-	Sawn wood, Wood pulp	*not mapped*
-	Fuel wood	*not mapped*
-	Energy wood	*not mapped*
-	Other industrial round wood	*not mapped*
-	Heat	*not mapped*
-	Electricity	*not mapped*
-	Gas	*not mapped*

*for EU only

3.2.3.2 Geographic level

AGMEMOD covers the member states in the European Union, Turkey, Macedonia, Russia and Ukraine. The database of MAGNET consists of 135 regions covering the whole world and its economy, while GLOBIOM covers 179 countries of the world. Both models have a flexible regional aggregation option. For AGRICISTRADE purposes, the regional aggregation of MAGNET is based upon the countries represented in AGMEMOD, while the rest of the world is highly aggregated. GLOBIOM also shows the EU member states, Russia, Ukraine and Kazakhstan separately. The rest of the eastern neighbours of the EU are in one aggregate (Table 3.6). This means that the regions are similar across the three models, while that was not the case for the products.

Table 3.6 Mapping of regions in AgriCisTrade project

AGMEMOD	GLOBIOM	MAGNET
Austria	Austria	Austria
Germany	Germany	Germany
Denmark	Denmark	Denmark
Spain	Spain	Spain
Finland	Finland	Finland
France	France	France
Ireland	Ireland	Ireland
Italy	Italy	Italy
Netherlands	Netherlands	Netherlands
Portugal	Portugal	Portugal
Sweden	Sweden	Sweden
United Kingdom	United Kingdom	United Kingdom
Belgium (includes Luxembourg)	Belgium (includes Luxembourg)	Belgium (includes Luxembourg)
Greece (includes Malta and Cyprus)	Greece (includes Malta and Cyprus)	Greece (includes Malta and Cyprus)
Bulgaria	Bulgaria	Bulgaria
Czech Republic	Czech Republic	Czech Republic
Croatia	Croatia	Croatia
Hungary	Hungary	Hungary
Estonia	Estonia	Estonia
Lithuania	Lithuania	Lithuania
Latvia	Latvia	Latvia
Romania	Romania	Romania

AGMEMOD	GLOBIOM	MAGNET
Slovenia	Slovenia	Slovenia
Slovak Republic	Slovak Republic	Slovak Republic
Poland	Poland	Poland
Russia	Russia	Russian Federation
Turkey	Turkey	Turkey
Ukraine	Ukraine	Ukraine
Macedonia	Australia and New Zealand	
Rest of World		Rest of former Soviet Union
	Pacific Islands	
	China	China
	India	India
	Japan	Japan
	South Korea	Korea
	Rest of Asia	Rest of Asia
	South East Asia	
	USA	USA and Canada
	South America	
	Central America	
	Africa	Africa

3.2.3.3 Time path

The base year in MAGNET was 2008 because it used the GTAP database Version 8. AGMEMOD is based on time series data which ends for the different countries in different years, i.e. 2004 to 2017. GLOBIOM started in 2000. From these points, projections in AgriCIsTrade start in 2000 and go until 2030. While AGMEMOD can project on a yearly basis, GLOBIOM normally projects in ten year steps. MAGNET is flexible in period definition (one year to several years) and can project until 2030.

3.2.3.4 Variables and indicators

In general, models make use of two types of variables, i.e. exogenous and endogenous variables.

Exogenous variables
The three models involved in the AgriCisTrade project use following exogenous variables:

- AGMEMOD is calibrated to world market prices for agricultural products. The future developments of GDP, inflation rate and population are exogenously captured and are member state dependent. Furthermore, exchange rates between the different currencies are taken into account. Agricultural market and trade policies are modelled extensively, like coupled and decoupled payments, production quota, product specific premiums, other subsides, intervention prices, export subsides, tariff rate quotas, CAP budget, modulation. Environmental targets have been introduced as well.
- MAGNET contains country specific GDP developments, population growth and technological progress in agriculture, which are based on external sources. The exogenous GDP development is achieved by endogenously determined technical progress given the exogenous estimates on factor endowments (skilled labour, capital and natural resources) and population. Conform to stylised facts of long-term economic growth, capital is assumed to grow at the same rate as GDP and long term employment growth is equal to population growth. Tariffs are represented as ad valorem tariff rates for each sector and between countries. Policies such as required biofuel share in transport, CAP budget of the EU, and production quotas are modelled.

- GLOBIOM includes GDP developments and population as exogenous drivers. Part of the technological change in crop and livestock production is exogenous. Furthermore, agricultural production depends on the available resources, which are exogenously given, i.e. usable land, water supply, soil properties.

Tables 3.7 and 3.8 give the common and policy drivers that influence the output of respectively AGMEMOD, MAGNET and GLOBIOM.

Table 3.7 Common drivers influencing the output in models of AgriCisTrade project

Common drivers	AGMEMOD	MAGNET	GLOBIOM
GDP	in national currency, globally and per represented country, based on EC	in percentage change for all regions, based on USDA	in USD, for all represented countries, based on SSP2 scenario
Population	In heads, based on Eurostat and FAO	in percentage change for all regions, based on World bank	in heads, for all represented countries, based on SSP2 scenario
Technological change	yield improvements based on econometric estimations	for land using sectors based on FAO, for other inputs per sector based on GDP and MAGNET internal distribution	for land using sectors based on econometric estimations

Table 3.8 Policy and other assumptions influencing the output in models of AgriCisTrade

Common drivers	AGMEMOD	MAGNET	GLOBIOM
CAP budget	for each EU country and distributed based on area used of the sector	distributed between countries and sectors	-
CAP production quota	for milk and sugar in the EU	for milk and sugar in the EU	-
Tariffs	agricultural sectors, including TRQ	all sectors and countries	agricultural sector
Biofuel policies	biodiesel and ethanol demand	mandates in form of % in transport sector	total demand

Exogenous variables have to be compared and adjusted across the models. In case the exogenous variable is identical like GDP and population development in MAGNET and AGMEMOD, both models have to use the same value for the exogenous variable. In cases where the exogenous variable is comparable but slightly different such as the technology change in crop production in MAGNET and GLOBIOM, the difference has to be identified and the parameters have to be adjusted but do not need to be identical. If a specific exogenous variable is only present in one model, there is no need to have it included in the other models. They are indirectly accounted for by the data exchange of the models after simulation.

Additionally, further assumptions having an impact on model outcomes have been unitized. For example, assumed exogenous changes in consumer preferences over time need to be harmonized in all models (e.g. reduced meat consumption because of a new attitude based on health concerns).

The better the models are harmonized, the more likely the results will converge after iteration. Hence, efforts have been put into understanding the models and identifying the common drivers and results.
To facilitate this approach, a simple, stylized baseline for all models has been developed; i.e. the three models have been run individually but under harmonized data and similar assumptions. Harmonized data have been taken for population growth, GDP growth and the exogenous part of yield development. Similar assumptions have been regarded for biofuel policies and the CAP, as far as present in the models. Next step was the comparison of results and finding reasons for different outcomes.

Endogenous variables
Driven by the exogenous variables, the models provide outcomes that are expressed by endogenous variables. Endogenous variables which are projected in more than one model, such as agricultural production or land use, have to be harmonized in their initial values. Table 3.9 lists variables which are an outcome of more than one model in AgriCisTrade project, together with the unit of the initial value.

With regard to the mentioned products/sectors in table 3.3, these are not always represented in the same way across the three models: some products are represented in detail through endogenous variables like price, production, domestic use and land use); other products are only represented by their supply and use balance variables.

Table 3.9 Common output of models in AgriCisTrade project

Common output	AGMEMOD	MAGNET	GLOBIOM
Production	in tons, most important crops in Europe	percentage change of volumes, 2007 US$ values, highly aggregated products	in tons, most important global crops
Land use	area for represented agricultural products per country in hectares	area for all agricultural products per country in square kilometres	area for represented agricultural products per supply unit, other land cover – pasture, forest, other natural vegetation
Product demand	In tons for feed, food, fuel	percentage change of volumes, 2007 US$ values for feed, food, fuel	for feed, food, biofuel
Prices	in euro	in percentage change of real prices	in US$
Trade	total exports and imports of represented countries	bilateral, all regions, in 2007 US$	bilateral net (homogenous good assumption) between regions

4 SUPREMA template

4.1 Stakeholder workshop

For three models of the SUPREMA model family, i.e. MAGNET, CAPRI and GLOBIOM, the AgClim50 has mapped its:

- Type of data(bases) used
- Type of output generated, in form of indicators that are measurable and comparable across models
- Time frame used
- Geographic level used

The same exercise has been done in the AgriCisTrade project for three models of the SUPREMA model family, i.e. MAGNET, AGMEMOD and GLOBIOM.

In principle the mapping of the models discussed in Chapter 3 summarizes to what extent models can address state-of-art questions on respectively policies and/or socio-economic and environmental conditions that relate to the agro-food sector. However, this doesn't mean that the SUPREMA models are fully ready for addressing required future needs as well.

Deliverable 1.1 on *The needs-scope to address new challenges in modelling* describes the scope and outcomes of the 1st SUPREMA Workshop 'Needs'. The aim of the discussion was to sharpen the understanding of the challenges and needs posed to future development of models and model-based support for policy actions. Its focus is on the area of agri-food systems and policies influencing the agri-food system locally, nationally and at global scale. It establishes perceived requirements to shape the future development of quantitative models so that they can deal better with the challenges and needs for policy support and defines priorities for model improvements and model related actions.

Stakeholders from different actor (organisation) groups along the agri-food value chain gave their view on the future societal challenges of the Common Agricultural Policy (CAP) and other related policy areas. They also identified needs for model-based analyses, both at medium-term and long-term, which may affect future agri-food systems and may require adaptation in model-based policy analyses for an evidence-based decision making. It was not an aim of the workshop to seek for consensus among the participants, but definitely the most important thing was to clarify different points of views and arguments. The stakeholders' perceptions of key focus areas with respect to required future policy analysis have been allocated under headers Global (Table 4.1), Value chain (Table 4.2) and Farming (Table 4.3). Note that some of the issues mentioned by stakeholders are exogenous variables (or drivers) for which models usually need assumed values taken from other sources (literature, other models, etc.).

Many of the topics listed can be regarded as a sort of 'business-as-usual' issues on which SUPREMA models in their current status can provide outcomes in form of indicators. These usual topics have already been captured by the AgClim50 and AgriCisTrade mapping exercises. On the other hand, several new topics have been addressed by the stakeholders that are not covered yet by those two mapping projects (chapter 3). If that is the case, the word (**New**) has been added to the specific topic mentioned. Though some of the highlighted areas were not directly assessed in AgClim or AgriCisTrade, some of them were in other projects at least partly considered (personal note from consortium member).

Table 4.1. Topics mentioned on Global perspective

SDGs	Points	Climate Change / Low Carbon Economy	Points
Income distribution / growth	18	Disruptive consumer preferences / behaviour (this is a model driver)	13
Environmental degradation + feedback to economy (soil, water, biodiversity)	12	Internalize externalities (positive/negative) **(New)**	12
SDGs indicators with limited coverage -> model outcomes	12	Disruptive technologies (this is a model driver)	8
Future food demand -> trade	10	Technology diffusion, adoption	7
Water	5	Adaptation -> calibration of new activities (between farms)	7
Holistic model approach -> global beyond Europe (this is methodology)	3	How to anticipate future shocks -> Policy shock (this is a model driver)	7
Holistic model approach -> bilateral impact Europe <-> global (this is methodology)	3	How to anticipate future shocks-> climate change shock (linking with biophysical models)	6
Food chain -> sourcing of products -> impact on SDGs	3	Going beyond the scope of agriculture	5
SDG targets / goals set for 2030 -> models needed for 2050 **(New)** 1)	2	Adaptation -> calibration of new trade flows	2
Long term for 2070 **(New) 2)**	1	Adaptation versus mitigation (this is a model driver)	1
Rural <-> urban developments	1	Disruptive policies in general (this is a model driver)	1
Land abandonment/people abandonment (social element) **(New)**	1	Modelling endogenous technical change **(New)**	
Inequality	1	Soil	
Spatial dimension (region, country)	1	Landscape	

Source: Deliverable 1.1. **New**: new topic compared to the reference AgClim50 and AgrCIsTrade scopes.

1) There are some new indicators that can be linked to SDGs in particular for food security, sustainable consumption/production patterns, biodiversity, water use, climate change mitigation, etc.
2) GLOBIOM can be run up to 2100.

Table 4.1. Topics mentioned on Value chain, market, integration and social concerns

Value chain, market and international integration	Points	Social concerns	Points
Bioeconomy **(New) 1)**	9	Productivity gains vs employment	9
Data quantity + quality	9	Sustainability	9
Distributional aspect (-> hunger) **(New)**	8	Immigration, jobs /migrant labour in food chain	7
Private entities take the role of public entities **(New)**	7	Climate change	6
Regional vs international production	7	Health, nutrition **(New)**	6
Structural change in the chain **(New)**	6	Rural/urban relationships	6
Model + question should fit	6	Differentiate by income groups	5
Climate change –> quantity + quality needed-	5	Generation change (renewable) **(New)**	3
Market power and concentration **(New)**	3	Antibiotics use **(New)**	3
Resource degradation	3	Jobs **(New)**	3
Transparency	3	GHG reduction	2
Competitiveness	2	Public-modelling, teaching for stakeholders **(New)**	2
NTMs **(New)**	2	Employment transition	1
Consistency vs competition of model	2	Cultural patrimony (slow food) **(New)**	
Storyline, thinking out of the box, people together	2	Trade balance problems	
CAP more on farm focused **(New)**	2		
Artificial intelligence **(New)**	2		
Short supply chains	1		
Geographical indications	1		
Uncertain / unknown items in models	1		
Communication to policy and public, logical explanation **(New)**	1		
Communication to policy and public, simple vs complex	1		
Health issues **(New)**	1		
Feedback loop	1		
Productivity gain in chain more important than in agriculture			
Credibility + economic basics			
Brexit – FTAs			

Source: Deliverable 1.1. **New**: new topic compared to standard AgClim50 and AgrCIsTrade scopes.

1) Has a quite good track record in GLOBIOM.

Table 4.3 Topics mentioned on Farming and supply adaption

Farming challenges: behaviour – markets	Points	Farming risks	Points
Role of consumers wrt organic, animal welfare **(New)**	15	Water constraints	18
Supply Chain	12	Adaptation versus mitigation. This is a driver for models	18
Spread of Innovation	7	Yield = f (…) e.g. fertilizer, pests, chemicals	14
Monitoring useful for farmers / policy	5	Feed efficiency	10
New Approach integration of choice experiments This is new methodology	3	Technology	9
Monitoring in general	3	Infrastructure, transport costs **(New)**	9
Non-Standard	1	Role of farm structure **(New)**	6
New Approaches in general, This is new methodology	1	Role of education **(New)**	5
New Approach integration of focus groups This is new methodology	1	Knowledge on GHG effects	1
		Endogenous breeding	1
		Role of age **(New)**	

Source: Deliverable 1.1. **New**: new topic compared to standard AgClim50 and AgrCIsTrade scopes.

Note that also current short-comings in impact assessment and desired improvements in applied models to covering better their (future) needs have been considered, as well as to invest in options that can better present outcomes in a more understandable way. Both issues have been addressed by stakeholders.

4.2 Indicators for measuring new SUPREMA topics

Section 4.1 has indicated the research and policy topics (or challenges) that have been prioritized by stakeholders in the SUPREMA Needs workshop and which are **NEW compared to the topics that the AgClim50 and AgriCisTrade projects** take into account. In principle each topic/challenge should be linked to output variables or indicators in order to measure the impact of economic, demographic, technology and policy drivers on the topic addressed. This type of inter-actions is indirectly beyond Table 3.4 (for AgClim50) and Table 3.8 (for AgriCisTrade) that contain a set of outcome variables i.e. indicators that can measure impacts on topics and challenges addressed there. Table 4.4 summarizes the newly addressed topics for future research in the SUPREMA project which are linked to potential new indicators on top of the ones available in AgClim50 and AgriCisTrade. Note that **an indicator** must have both **a clear/uniform definition** and a **metrics** in order to make it comparable across regions, sectors, and periods. The choice for an indicator might be arbitrary or it might be that the data beyond deriving the indicator are not or partly available. In these cases it is a challenge to find solutions or alternatives based on common agreements. For example, the indicators of the Sustainable Development Goals is a good practice of commonly decided on indicators.

In Milestone 3, the SUPREMA consortium has provided an additional set of indicators compared to the sets of AgClim50 and AgriCisTrade. So far it is still a draft list which is under continuous discussion and needs to be further improved, especially when it comes to clear/uniform definitions and metrics for the new indicators addressed. Milestone 3 is verified by the Excel file named *MS3_DataTemplate_forSupremaModels_07Dec18.xlsx* that is available in the SUPREMA cloud **(in ….WP2\Suprema mapping template folder).**

Table 4.4 New variables (policy, macroeconomic, technology, consumer preferences) and indicators for models in SUPREMA

Variables/Indicators	Unit	Related topic in Tables 4.1, 4.2 and 4.3
Prices and (farm) Income variables		
Livestock input costs (including feed costs and other costs)	euro/ton	Farming and supply adaption: innovation, feed efficiency, technology
Farm sector income (gross income: sector returns -/- intermediate costs)	th euro/farm	Farming and supply adaption: yield =f (…), feed efficiency, income
Area and yield variables		

Market variables		
Seed use	1000 t	Provides information on the market
Other industrial use	1000 t	Provides information on the market
Biodiesel/bioethanol for industrial use	1000 t	Value chain: bioeconomy; employment transition, generating change (renewable); resource degradation
Stocks	1000 t/1000 h	Provides information on the market
Slaughterings	1000 h	Provides information on the market
Self-sufficiency rate (production/domestic use)	Ratio	Market information; trade balance
Food security (need for good definition)	Index	Distributional aspect (hunger), resource degradation; food chain; future food demand; nutrition and health
Environmental variables		
Total NH3 emissions	1000 kg N	Climate change,
Total N leaching and runoff	1000 kg N	Resource degradation, Climate change
NO3 concentration groundwater	mg NO3/liter	Resource degradation, Climate change; soil
Soil organic carbon balance	kg C/ha/year	Resource degradation, Climate change; soil
Energy use	*PJ*	Resource degradation, Climate change
Water use	*1000 m3*	Resource degradation, Climate change
Weather volatility/climate change (need for good definition)	*Index*	Climate change
Biodiversity change	Yrly change	Resource degradation, Climate change; landscape
Soil erosion (need for good definition)	Index	Resource degradation, Climate change
Technological innovation variables		
Internet of things/digitalisation (need for good definition)	*Index*	Disruptive technology
Nitrification inhibitors (need for good definition)	*Index*	Disruptive technology
Precision/smart farming (need for good definition)	*Index*	Disruptive technology
Antibiotic use reduction (need for good definition)	*Index*	Disruptive technology; health
Macroeconomic variables		
World prices	usd/1000 kg	Market; new trade flows
GDP deflator (national inflation rate in yr t, compared to base year)	index (2015=100)	Economic conditions; income growth; difference by income groups
Exchange rate	euro/dollar	New trade relations
Labour productivity (labour units/turnover)	Lab units/turnover	Efficiency, employment
Employment	Million	Jobs; Regional development; spatial region/country
CAP policy variables		
Ecological focus area	%	Policy support; measures
Budgetary national envelope	thsd euro	Policy support; measures
Voluntary coupled payments	thsd euro	Policy support; measures
Young farmers payments	thsd euro	Policy support; measures
Greening payments	thsd euro	Policy support; measures
Price support (from envelope)	euro/100 kg	Policy support; measures
Environmental policy variables		
Climate policy targets	MtCO2e	Disruptive policies; internalize externalities; GHG reduction
Energy policy targets	*PJ*	Disruptive policies;
Positive/negative externalities	euro/100 kg	Disruptive policies; GHG reduction; climate change
Trade policy variables		
Tariff rate quotas	*1000 t*	New trade flows
Non-tariff measures (nr of different measures imposed on agric products)	*number/agr product*	Legislation, health

Consumer preference variables		
Regional food products	*Share in total products*	Regional development; spatial region/country
Qualitative variables		
Animal welfare concerns (need for good definition)	Index	Antibiotics use
Ethical issues (need for good definition)	Index	
Soil quality (need for good definition)	Index	
Water quality (need for good definition)	Index	

4.3 Mapping of models' databases

The SUPREMA model family includes a set of seven core models that are already extensively used in support of key European impact assessments in agriculture, trade, climate and bioenergy policies:

- CAPRI (Common Agricultural Policy Regionalised Impact Modelling System) is a regionalised partial equilibrium model representing the agricultural sector from global to regional scale with a focus on the EU (Member States, regions, farm types, grid, etc.).
- GLOBIOM (Global Biosphere Management Model) also is a partial equilibrium model, with more detail in terms of land use modelling and consistent representation of the agriculture and forestry sectors.
- MAGNET (Modular Applied GeNeral Equilibrium Tool) is a global computable general equilibrium (CGE) model, with a modular structure and a focus on the bioeconomy (incl. bioenergy, biomaterials, biobased chemicals).
- AGMEMOD (AGriculture MEmberstates MODelling) provides within the Agricultural Outlook of the European Commission results on market outcomes and price formation in absolute terms, and at Member State levels.
- AGLINK-COSIMO is a partial equilibrium model to simulate developments of annual market balances and prices for the main agricultural commodities produced, consumed and traded worldwide.
- MITERRA-EUROPE is a deterministic environmental assessment model of agriculture, at Member States and regional levels, developed for assessments of policy options, scenarios and measures.
- IFM-CAP (Individual Farm Model for Common Agricultural Policy) is a static positive mathematical programming farm-level simulation model, which builds on the EU-FADN data, complemented by other relevant EU-wide data sources such as the Eurostat, Farm Structure Survey (FSS) and CAPRI databases.

SUPREMA models have been linked in various ways in previous and ongoing projects. WP3 will investigate possible (soft) linkages between models in order to sort out if they add value to policy and research questions when regarded in combination. Following linkages will be studied:

- Between IFM-CAP and CAPRI for the EU focussed scenario
- Between GLOBIOM and CAPRI on land use
- Between AGMEMOD, AGLINK-COSIMO and CAPRI for EU aspects of the baseline
- Between AGMEMOD and MITERRA for interactions of economic aspects and environmental impacts and constraints
- Between MAGNET and GLOBIOM and CAPRI for nexus and mitigation related issues
- Between MAGNET and AGMEMOD for supply chain and bioeconomy issues

Next subsections will map three sets of model combinations to the list of indicators (existing and new). This will provide insight in which SUPREMA indicators can be captured and quantified by the considered set of models, i.e. which policy and research topics can (not) be addressed, and which indicators can (not) be measured yet. This knowledge shows where the SUPREMA model gaps are and helps to prioritise where to put future efforts in order to improve them.

4.3.1 AGMEMOD and MITERRA linkage

Linkage activities between AGMEMOD and MITERRA are foreseen for interactions of economic aspects and environmental impacts and constraints. Table 4.5 maps the two models to the complete set of indicators (existing and new) that have been investigated in Table 4.4 of section 4.2. When an indicator is captured by a model it is highlighted in green (e.g. AGMEMOD, MITERRA), and if it is not captured it is highlighted in red (e.g. AGMEMOD, MITERRA). Though standard data update activities are not part of SUPREMA, this activity of Task 2.1 helps to identify useful opportunities for productive communication and data exchange.
The product/sector/industry coverage of both AGMEMOD and MITERRA is at the agricultural commodity level, see Excel file named *MS3_DataTemplate_forSupremaModels_07Dec18.xlsx* that is available in the SUPREMA cloud (in ….WP2\Suprema mapping template folder).

Table 4.5 Mapping AGEMEMOD and MITERRA to SUPREMA variables, indicators and sectors

Variables	Unit	Captured by models (yes, no)	Comments
Prices and (farm) Income variables			
Real producer price/input price	USD/t	AGMEMOD; MITERRA	Crops and animal products; member states (MS) level
Real export price	USD/t	AGMEMOD; MITERRA	
Livestock input costs (incl feed costs, other costs)	euro/ton	AGMEMOD; MITERRA	
Farm sector income (gross income: sector returns -/- intermediate costs)	th euro/farm	AGMEMOD; MITERRA	
Area and yield variables			
Area harvested	1000 ha	AGMEMOD; MITERRA	Crops; MS
Area harvested – rainfed	1000 ha	AGMEMOD; MITERRA	
Area harvested – irrigated	1000 ha	AGMEMOD; MITERRA	
Land cover	1000 ha	AGMEMOD; MITERRA	Total land; MS
Crop yield	dm t/ha, fm t/ha	AGMEMOD; MITERRA	Crops; MS
Crop yield – rainfed	dm t/ha, fm t/ha	AGMEMOD; MITERRA	
Crop yield – irrigated	dm t/ha, fm t/ha	AGMEMOD; MITERRA	
Exogenous crop yield	dm t/ha, fm t/ha	AGMEMOD; MITERRA	Crops; MS
Climate change shifter on crop yield	%	AGMEMOD; MITERRA	
Livestock yield (endogenous)	kg prt/ha	AGMEMOD; MITERRA	Milk, meat; MS
Exogenous livestock yield trend	kg prt/ha	AGMEMOD; MITERRA	Milk, meat; MS
Feed conversion efficiency (endogenous)	kg prt/kg prt	AGMEMOD; MITERRA	Ruminants; MS
Feed conversion efficiency trend	kg prt/kg prt	AGMEMOD; MITERRA	
Market variables			
Food use	1000 t	AGMEMOD; MITERRA	Crops and animal products; MS
Feed use	1000 t	AGMEMOD; MITERRA	Crops, MS
Feed use	1000 t prt	AGMEMOD; MITERRA	Crops, MS
Other use (seed /industrial use, losses)	1000 t	AGMEMOD; MITERRA	Crops, MS
Imports	1000 t	AGMEMOD; MITERRA	Crops and animal products; MS
Exports	1000 t	AGMEMOD; MITERRA	Crops and animal products; MS
Production	1000 t	AGMEMOD; MITERRA	Crops and animal products; MS
Domestic use (total use = food+feed+other	1000 t	AGMEMOD; MITERRA	Crops and animal products; MS
Net trade	1000 t	AGMEMOD; MITERRA	Crops and animal products; MS
Feed use ruminant meat	1000 t	AGMEMOD; MITERRA	Animals; MS
Feed use ruminant meat	1000 t prt	AGMEMOD; MITERRA	Animals; MS
Feed use dairy	1000 t	AGMEMOD; MITERRA	Animals; MS
Feed use dairy	1000 t prt	AGMEMOD; MITERRA	Animals; MS
Feed fish sector	1000 t	AGMEMOD; MITERRA	Fish families; MS
Feed fish sector	1000 t prt	AGMEMOD; MITERRA	

Seed use	1000 t	AGMEMOD; MITERRA	Crops, MS
Other industrial use	1000 t	AGMEMOD; MITERRA	Crops, MS
Biodiesel/bioethanol for industrial use	1000 t	AGMEMOD; MITERRA	Crops, MS
Stocks	1000 t/1000 h	AGMEMOD; MITERRA	Crops, MS
Slaughterings	1000 h	AGMEMOD; MITERRA	Animals; MS
Self-sufficiency rate (production/domestic use)	Ratio	AGMEMOD; MITERRA	Crops and animal products; MS
Food security *(need for good definition)*	*Index*	AGMEMOD; MITERRA	
Environmental variables			
Fertiliser N	1000 t	AGMEMOD; MITERRA	Crops and animals, MS
Water for irrigation	km3	AGMEMOD; MITERRA	Crops and animals, MS
Total GHG emissions	MtCO2e	AGMEMOD; MITERRA	Crops and animals, MS
Total CO2 emissions	MtCO2e	AGMEMOD; MITERRA	Crops and animals, MS
Total CH4 emissions	MtCO2e	AGMEMOD; MITERRA	Crops and animals, MS
Total N2O emissions	MtCO2e	AGMEMOD; MITERRA	Crops and animals, MS
Total NH3 emissions	1000 kg N	AGMEMOD; MITERRA	Crops and animals, MS
Total N leaching and runoff	1000 kg N	AGMEMOD; MITERRA	Crops and animals, MS
NO3 concentration groundwater	mg NO3/liter	AGMEMOD; MITERRA	Crops and animals, MS
Soil organic carbon balance	kg C/ha/year	AGMEMOD; MITERRA	Crops and animals, MS
Energy use	*PJ*	AGMEMOD; MITERRA	
Water use	*1000 m3*	AGMEMOD; MITERRA	
Weather volatility/climate change *(need for good definition)*	*Index*	AGMEMOD; MITERRA	
Biodiversity change	% ch/yr	AGMEMOD; MITERRA	Total crops; MS
Soil erosion *(need for good definition)*	Index	AGMEMOD; MITERRA	Total crops; MS
Technological innovation variables			
Technical mitigation options – Production	1000 t	AGMEMOD; MITERRA	Crops and animals, MS
Technical mitigation options – Emissions	MtCO2e	AGMEMOD; MITERRA	Crops and animals, MS
Technical mitigation options - CO2	MtCO2e	AGMEMOD; MITERRA	Crops and animals, MS
Technical mitigation options - CH4	MtCO2e	AGMEMOD; MITERRA	Crops and animals, MS
Technical mitigation options - N2O	MtCO2e	AGMEMOD; MITERRA	Crops and animals, MS
Internet of things/digitalisation *(need for good definition)*	*Index*	AGMEMOD; MITERRA	
Nitrification inhibitors *(need for good definition)*	*Index*	AGMEMOD; MITERRA	Crops and animals, MS
Precision/smart farming *(need for good definition)*	*Index*	AGMEMOD; MITERRA	Crops and animals, MS
Antibiotic use reduction	*% change*	AGMEMOD; MITERRA	
Macroeconomic variables			
Total population	Million	AGMEMOD; MITERRA	Total country; MS
Total GDP (MER)	bn USD 2005 MER	AGMEMOD; MITERRA	Total country; MS
World prices	usd/1000 kg	AGMEMOD; MITERRA	Crops and animals, MS
GDP deflator (national inflation rate in yr t, compared to base year)	index (2015=100)	AGMEMOD; MITERRA	Total country; MS
Exchange rate	euro/dollar	AGMEMOD; MITERRA	Total country; MS
Labour productivity (labour units/turnover)	Lab units/turnover	AGMEMOD; MITERRA	
Employment	Million	AGMEMOD; MITERRA	
CAP policy variables			
Ecological focus area	%	AGMEMOD; MITERRA	Total country; MS
Budgetary national envelope	thsd euro	AGMEMOD; MITERRA	Total country; MS
Voluntary coupled payments	thsd euro	AGMEMOD; MITERRA	Crops and animals, MS

Young farmers payments	thsd euro	AGMEMOD; MITERRA	Crops and animals, MS
Greening payments	thsd euro	AGMEMOD; MITERRA	Crops and animals, MS
Price support (from envelope)	euro/100 kg	AGMEMOD; MITERRA	Crops and animals, MS
Environmental policy variables			
Carbon tax level	USD/tCO2e	AGMEMOD; MITERRA	
Climate policy targets	MtCO2e	AGMEMOD; MITERRA	Total country; MS
Energy policy targets	*PJ*	AGMEMOD; MITERRA	
Positive/negative externalities	euro/100 kg	AGMEMOD; MITERRA	
Trade policy variables			
Tariff rate quotas	*1000 t*	AGMEMOD; MITERRA	Crops and animals, MS
Non-tariff measures (nr of different measures imposed on agric products)	*number/agr product*	AGMEMOD; MITERRA	
Consumer preference variables			
p.c. calory availability	kcal/cap/d	AGMEMOD; MITERRA	
Regional food products	*% in total products*	AGMEMOD; MITERRA	
Qualitative variables			
Animal welfare concerns *(need for good definition)*	Index	AGMEMOD; MITERRA	
Ethical issues *(need for good definition)*	Index	AGMEMOD; MITERRA	
Soil quality *(need for good definition)*	Index	AGMEMOD; MITERRA	Crops; MS
Water quality *(need for good definition)*	Index	AGMEMOD; MITERRA	Total country; MS

4.3.2 MAGNET, GLOBIOM and CAPRI linkage

Linkage activities between MAGNET, GLOBIOM and CAPRI are foreseen for interactions of economic aspects and environmental impacts and constraints. Table 4.5 maps the two models to the complete set of indicators (existing and new) that have been investigated in Table 4.4 of section 4.2. When an indicator is captured by a model it is highlighted in green (e.g. MAGNET, GLOBIOM, CAPRI), and if it is not captured it is highlighted in red (e.g. MAGNET, GLOBIOM, CAPRI). Though standard data update activities are not part of SUPREMA, this activity of Task 2.1 helps to identify useful opportunities for productive communication and data exchange.
The product/sector/industry coverage of MAGNET, GLOBIOM and CAPRI is at different agro-food aggregation levels; see Excel file named *MS3_DataTemplate_forSupremaModels_07Dec18.xlsx* that is available in the SUPREMA cloud (in ….WP2\Suprema mapping template folder).

Table 4.6 Mapping AGEMEMOD and GLOBIOM to SUPREMA variables, indicators and sectors

Variables	Unit	Captured by models (yes, no)	Comments
Prices and (farm) Income variables			
Real producer price/input price	USD/t	MAGNET; GLOBIOM;CAPRI	Crops and animal products; member states (MS) level
Real export price	USD/t	MAGNET; GLOBIOM; CAPRI	
Livestock input costs (incl feed costs, other costs)	euro/ton	MAGNET; GLOBIOM;CAPRI	
Farm sector income (gross income: sector returns -/- intermediate costs)	th euro/farm	MAGNET; GLOBIOM; CAPRI	
Area and yield variables			
Area harvested	1000 ha	MAGNET; GLOBIOM;CAPRI	Crops; MS
Area harvested – rainfed	1000 ha	MAGNET; GLOBIOM; CAPRI	
Area harvested – irrigated	1000 ha	MAGNET; GLOBIOM; CAPRI	
Land cover	1000 ha	MAGNET; GLOBIOM;CAPRI	Total land; MS
Crop yield	dm t/ha, fm t/ha	MAGNET; GLOBIOM;CAPRI	Crops; MS
Crop yield – rainfed	dm t/ha, fm t/ha	MAGNET; GLOBIOM; CAPRI	

Crop yield – irrigated	dm t/ha, fm t/ha	MAGNET; GLOBIOM; CAPRI	
Exogenous crop yield	dm t/ha, fm t/ha	MAGNET; GLOBIOM; CAPRI	Crops; MS
Climate change shifter on crop yield	%	MAGNET; GLOBIOM; CAPRI	
Livestock yield (endogenous)	kg prt/ha	MAGNET; GLOBIOM;CAPRI	Milk, meat; MS
Exogenous livestock yield trend	kg prt/ha	MAGNET; GLOBIOM;CAPRI	Milk, meat; MS
Feed conversion efficiency (endogenous)	kg prt/kg prt	MAGNET; GLOBIOM; CAPRI	Ruminants; MS
Feed conversion efficiency trend	kg prt/kg prt	MAGNET; GLOBIOM;CAPRI	
Market variables			
Food use	1000 t	MAGNET; GLOBIOM;CAPRI	Crops and animal products; MS
Feed use	1000 t	MAGNET; GLOBIOM;CAPRI	Crops, MS; MAGNET in usd
Feed use	1000 t prt	MAGNET; GLOBIOM;CAPRI	Crops, MS; MAGNET in usd
Other use (seed /industrial use, losses)	1000 t	MAGNET; GLOBIOM;CAPRI	Crops, MS; MAGNET in usd
Imports	1000 t	MAGNET; GLOBIOM;CAPRI	Crops and animal products; MS; MAGNET in usd
Exports	1000 t	MAGNET; GLOBIOM;CAPRI	Crops and animal products; MS; MAGNET in usd
Production	1000 t	MAGNET; GLOBIOM;CAPRI	Crops and animal products; MS; MAGNET in usd
Domestic use (total use = food+feed+other	1000 t	MAGNET; GLOBIOM;CAPRI	Crops and animal products; MS; MAGNET in usd
Net trade	1000 t	MAGNET; GLOBIOM;CAPRI	Crops and animal products; MS; MAGNET in usd
Feed use ruminant meat	1000 t	MAGNET; GLOBIOM;CAPRI	Animals; MS; MAGNET in usd
Feed use ruminant meat	1000 t prt	MAGNET; GLOBIOM; CAPRI	Animals; MS; MAGNET in usd
Feed use dairy	1000 t	MAGNET; GLOBIOM;CAPRI	Animals; MS; MAGNET in usd
Feed use dairy	1000 t prt	MAGNET; GLOBIOM; CAPRI	Animals; MS; MAGNET in usd
Feed fish sector	1000 t	MAGNET; GLOBIOM; CAPRI	MAGNET in usd
Feed fish sector	1000 t prt	MAGNET; GLOBIOM; CAPRI	MAGNET in usd
Seed use	1000 t	MAGNET; GLOBIOM; CAPRI	Crops, MS; MAGNET in usd
Other industrial use	1000 t	MAGNET; GLOBIOM; CAPRI	Crops, MS; MAGNET in usd
Biodiesel/bioethanol for industrial use	1000 t	MAGNET; GLOBIOM; CAPRI	Crops, MS; MAGNET in usd
Stocks	1000 t/1000 h	MAGNET; GLOBIOM; CAPRI	Crops, MS; MAGNET in usd
Slaughtering	1000 h	MAGNET; GLOBIOM; CAPRI	Animals; MS; MAGNET in usd
Self-sufficiency rate (production/domestic use)	Ratio	MAGNET; GLOBIOM; CAPRI	Crops and animal products; MS
Food security *(need for good definition)*	*Index*	MAGNET; GLOBIOM;CAPRI	MAGNET in usd
Environmental variables			
Fertiliser N	1000 t	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Water for irrigation	km3	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Total GHG emissions	MtCO2e	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Total CO2 emissions	MtCO2e	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Total CH4 emissions	MtCO2e	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Total N2O emissions	MtCO2e	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Total NH3 emissions	1000 kg N	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Total N leaching and runoff	1000 kg N	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
NO3 concentration groundwater	mg NO3/liter	MAGNET; GLOBIOM; CAPRI	Crops and animals, MS
Soil organic carbon balance	kg C/ha/year	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Energy use	*PJ*	MAGNET; GLOBIOM; CAPRI	
Water use	*1000 m3*	MAGNET; GLOBIOM; CAPRI	
Weather volatility/climate change *(need for good definition)*	*Index*	MAGNET; GLOBIOM;CAPRI	

Biodiversity change	% ch/yr	MAGNET; GLOBIOM; CAPRI	
Soil erosion *(need for good definition)*	Index	MAGNET; GLOBIOM; CAPRI	
Technological innovation variables			
Technical mitigation options – Production	1000 t	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Technical mitigation options – Emissions	MtCO2e	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Technical mitigation options - CO2	MtCO2e	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Technical mitigation options - CH4	MtCO2e	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Technical mitigation options - N2O	MtCO2e	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Internet of things/digitalisation *(need for good definition)*	*Index*	MAGNET; GLOBIOM;CAPRI	
Nitrification inhibitors *(need for good definition)*	*Index*	MAGNET; GLOBIOM; CAPRI	Crops and animals, MS
Precision/smart farming *(need for good definition)*	*Index*	MAGNET; GLOBIOM; CAPRI	Crops and animals, MS
Antibiotic use reduction	*% change*	MAGNET; GLOBIOM;CAPRI	
Macroeconomic variables			
Total population	Million	MAGNET; GLOBIOM; CAPRI	Total country; MS
Total GDP (MER)	bn USD 2005 MER	MAGNET; GLOBIOM; CAPRI	Total country; MS
World prices	usd/1000 kg	MAGNET; GLOBIOM; CAPRI	Crops and animals, MS
GDP deflator (national inflation rate in yr t, compared to base year)	index (2015=100)	MAGNET; GLOBIOM; CAPRI	Total country; MS
Exchange rate	euro/dollar	MAGNET; GLOBIOM; CAPRI	Total country; MS
Labour productivity (labour units/turnover)	Lab units/turnover	MAGNET; GLOBIOM; CAPRI	
Employment	Million	MAGNET; GLOBIOM; CAPRI	
CAP policy variables			
Ecological focus area	%	MAGNET; GLOBIOM; CAPRI	Total country; MS
Budgetary national envelope	thsd euro	MAGNET; GLOBIOM; CAPRI	Total country; MS
Voluntary coupled payments	thsd euro	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Young farmers payments	thsd euro	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Greening payments	thsd euro	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Price support (from envelope)	euro/100 kg	MAGNET; GLOBIOM; CAPRI	Crops and animals, MS
Environmental policy variables			
Carbon tax level	USD/tCO2e	MAGNET; GLOBIOM; CAPRI	
Climate policy targets	MtCO2e	MAGNET; GLOBIOM;CAPRI	Total country; MS
Energy policy targets	*PJ*	MAGNET; GLOBIOM;CAPRI	
Positive/negative externalities	euro/100 kg	MAGNET; GLOBIOM;CAPRI	
Trade policy variables			
Tariff rate quotas	*1000 t*	MAGNET; GLOBIOM;CAPRI	Crops and animals, MS
Non-tariff measures (nr of different measures imposed on agric products)	*number/agr product*	MAGNET; GLOBIOM;CAPRI	
Consumer preference variables			
p.c. calory availability	kcal/cap/d	MAGNET; GLOBIOM; CAPRI	
Regional food products	*% in total products*	MAGNET; GLOBIOM;CAPRI	
Qualitative variables			
Animal welfare concerns *(need for good definition)*	Index	MAGNET; GLOBIOM;CAPRI	
Ethical issues *(need for good definition)*	Index	MAGNET; GLOBIOM;CAPRI	
Soil quality *(need for good definition)*	Index	MAGNET; GLOBIOM; CAPRI	Crops; MS
Water quality *(need for good definition)*	Index	MAGNET; GLOBIOM;CAPRI	Total country; MS

4.3.3 AGMEMOD and MAGNET linkage

Linkage activities between AGMEMOD and MAGNET are foreseen for interactions of economic aspects and environmental impacts and constraints. Table 4.7 maps the two models to the complete set of indicators (existing and new) that have been investigated in Table 4.4 of section 4.2. When an indicator is captured by a model it is highlighted in green (e.g. AGMEMOD, MAGNET), and if it is not captured it is highlighted in red (e.g. AGMEMOD, MAGNET). Though standard data update activities are not part of SUPREMA, this activity of Task 2.1 helps to identify useful opportunities for productive communication and data exchange. The product/sector/ industry coverage of AGMEMOD and MAGNET is at different agricultural commodity levels; see Excel file named *MS3_DataTemplate_forSupremaModels_07Dec18.xlsx* that is available in the SUPREMA cloud (in ....WP2\Suprema mapping template folder).

Table 4.7 Mapping AGEMEMOD and MAGNET to SUPREMA variables and indicators and sectors

Variables	Unit	Captured by models (yes, no)	Comments
Prices and (farm) Income variables			
Real producer price/input price	USD/t	AGMEMOD; MAGNET	Crops and animal products; MS and world regional level;
Real export price	USD/t	AGMEMOD; MAGNET	
Livestock input costs (incl feed costs, other costs)	euro/ton	AGMEMOD; MAGNET	
Farm sector income (gross income: sector returns -/- intermediate costs)	th euro/farm	AGMEMOD; MAGNET	
Area and yield variables			
Area harvested	1000 ha	AGMEMOD; MAGNET	Crops; MS
Area harvested – rainfed	1000 ha	AGMEMOD; MAGNET	
Area harvested – irrigated	1000 ha	AGMEMOD; MAGNET	
Land cover	1000 ha	AGMEMOD; MAGNET	Total land; MS
Crop yield	dm t/ha, fm t/ha	AGMEMOD; MAGNET	Crops; MS
Crop yield – rainfed	dm t/ha, fm t/ha	AGMEMOD; MAGNET	
Crop yield – irrigated	dm t/ha, fm t/ha	AGMEMOD; MAGNET	
Exogenous crop yield	dm t/ha, fm t/ha	AGMEMOD; MAGNET	Crops; MS
Climate change shifter on crop yield	%	AGMEMOD; MAGNET	
Livestock yield (endogenous)	kg prt/ha	AGMEMOD; MAGNET	Milk, meat; MS
Exogenous livestock yield trend	kg prt/ha	AGMEMOD; MAGNET	Milk, meat; MS
Feed conversion efficiency (endogenous)	kg prt/kg prt	AGMEMOD; MAGNET	
Feed conversion efficiency trend	kg prt/kg prt	AGMEMOD; MAGNET	
Market variables			
Food use	1000 t	AGMEMOD; MAGNET	Crops and animal products; MS;
Feed use	1000 t	AGMEMOD; MAGNET	Crops, MS; MAGNET in usd
Feed use	1000 t prt	AGMEMOD; MAGNET	MAGNET in usd
Other use (seed /industrial use, losses)	1000 t	AGMEMOD; MAGNET	Crops, MS; MAGNET in usd
Imports	1000 t	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd
Exports	1000 t	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd
Production	1000 t	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd
Domestic use (total use = food+feed+other	1000 t	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd
Net trade	1000 t	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd
Feed use ruminant meat	1000 t	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd
Feed use ruminant meat	1000 t prt	AGMEMOD; MAGNET	MAGNET in usd
Feed use dairy	1000 t	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd

Feed use dairy	1000 t prt	AGMEMOD; MAGNET	MAGNET in usd
Feed fish sector	1000 t	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd
Feed fish sector	1000 t prt	AGMEMOD; MAGNET	MAGNET in usd
Seed use	1000 t	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd
Other industrial use	1000 t	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd
Biodiesel/bioethanol for industrial use	1000 t	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd
Stocks	1000 t/1000 h	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd
Slaughtering	1000 h	AGMEMOD; MAGNET	Crops and animal products; MS; MAGNET in usd
Self-sufficiency rate (production/domestic use)	Ratio	AGMEMOD; MAGNET	Crops and animal products; MS
Food security *(need for good definition)*	*Index*	AGMEMOD; MAGNET	
Environmental variables			
Fertiliser N	1000 t	AGMEMOD; MAGNET	
Water for irrigation	km3	AGMEMOD; MAGNET	
Total GHG emissions	MtCO2e	AGMEMOD; MAGNET	Crops and animals, MS
Total CO2 emissions	MtCO2e	AGMEMOD; MAGNET	Crops and animals, MS
Total CH4 emissions	MtCO2e	AGMEMOD; MAGNET	Crops and animals, MS
Total N2O emissions	MtCO2e	AGMEMOD; MAGNET	Crops and animals, MS
Total NH3 emissions	1000 kg N	AGMEMOD; MAGNET	Crops and animals, MS
Total N leaching and runoff	1000 kg N	AGMEMOD; MAGNET	
NO3 concentration groundwater	mg NO3/liter	AGMEMOD; MAGNET	
Soil organic carbon balance	kg C/ha/year	AGMEMOD; MAGNET	
Energy use	*PJ*	AGMEMOD; MAGNET	
Water use	*1000 m3*	AGMEMOD; MAGNET	
Weather volatility/climate change *(need for good definition)*	*Index*	AGMEMOD; MAGNET	
Biodiversity change	% ch/yr	AGMEMOD; MAGNET	
Soil erosion *(need for good definition)*	Index	AGMEMOD; MAGNET	
Technological innovation variables			
Technical mitigation options – Production	1000 t	AGMEMOD; MAGNET	
Technical mitigation options – Emissions	MtCO2e	AGMEMOD; MAGNET	
Technical mitigation options - CO2	MtCO2e	AGMEMOD; MAGNET	
Technical mitigation options - CH4	MtCO2e	AGMEMOD; MAGNET	
Technical mitigation options - N2O	MtCO2e	AGMEMOD; MAGNET	
Internet of things/digitalisation *(need for good definition)*	*Index*	AGMEMOD; MAGNET	
Nitrification inhibitors *(need for good definition)*	*Index*	AGMEMOD; MAGNET	Crops and animals, MS
Precision/smart farming *(need for good definition)*	*Index*	AGMEMOD; MAGNET	Crops and animals, MS
Antibiotic use reduction	*% change*	AGMEMOD; MAGNET	
Macroeconomic variables			
Total population	Million	AGMEMOD; MAGNET	Total country; MS
Total GDP (MER)	bn USD 2005 MER	AGMEMOD; MAGNET	Total country; MS
World prices	usd/1000 kg	AGMEMOD; MAGNET	Crops and animals, MS
GDP deflator (national inflation rate in yr t, compared to base year)	index (2015=100)	AGMEMOD; MAGNET	Total country; MS
Exchange rate	euro/dollar	AGMEMOD; MAGNET	Total country; MS

Labour productivity (labour units/turnover)	Lab units/turnover	AGMEMOD; MAGNET	
Employment	Million	AGMEMOD; MAGNET	
CAP policy variables			
Ecological focus area	%	AGMEMOD; MAGNET	Total country; MS
Budgetary national envelope	thsd euro	AGMEMOD; MAGNET	Total country; MS
Voluntary coupled payments	thsd euro	AGMEMOD; MAGNET	Crops and animals, MS
Young farmers payments	thsd euro	AGMEMOD; MAGNET	Crops and animals, MS
Greening payments	thsd euro	AGMEMOD; MAGNET	Crops and animals, MS
Price support (from envelope)	euro/100 kg	AGMEMOD; MAGNET	Crops and animals, MS
Environmental policy variables			
Carbon tax level	USD/tCO2e	AGMEMOD; MAGNET	
Climate policy targets	MtCO2e	AGMEMOD; MAGNET	
Energy policy targets	*PJ*	AGMEMOD; MAGNET	
Positive/negative externalities	euro/100 kg	AGMEMOD; MAGNET	
Trade policy variables			
Tariff rate quotas	*1000 t*	AGMEMOD; MAGNET	Crops and animals, MS
Non-tariff measures (nr of different measures imposed on agric products)	*number/agr product*	AGMEMOD; MAGNET	
Consumer preference variables			
p.c. calory availability	kcal/cap/d	AGMEMOD; MAGNET	
Regional food products	*% in total products*	AGMEMOD; MAGNET	
Qualitative variables			
Animal welfare concerns *(need for good definition)*	Index	AGMEMOD; MAGNET	
Ethical issues *(need for good definition)*	Index	AGMEMOD; MAGNET	
Soil quality *(need for good definition)*	Index	AGMEMOD; MAGNET	
Water quality *(need for good definition)*	Index	AGMEMOD; MAGNET	

5 Conclusions on model gaps

5.1 AGMEMOD and MITERRA linkage

In combination, AGMEMOD and MITERRA can provide quantifications for a high number of economic, market and environmental indicators. In principle, these outcomes are driven by macro-economic, technological and demographic trends, as well as by CAP and environmental policy assumptions. Details are in Table 4.5 of chapter 4.

Table 5.1 contains the SUPREMA indicators on which both AGMEMOD and MITERRA provide outcomes at common product levels in EU member states up to 2030. Note that the variables in green are those added from the topics mentioned in the SUPREMA Needs Workshop. All the other variables – with its codes - have been directly taken from the AgClim50 and AgriCisTrade projects.

Table 5.1 Common SUPREMA variables and indicators in AGEMEMOD and MITERRA

Variables	Unit	Captured by models (yes, no)	Comments
Area and yield variables			
Area harvested	1000 ha	AGMEMOD; MITERRA	Crops; MS
Land cover	1000 ha	AGMEMOD; MITERRA	Total land; MS

Crop yield	dm t/ha, fm t/ha	AGMEMOD; MITERRA	Crops; MS
Market variables			
Feed use	1000 t	AGMEMOD; MITERRA	Crops, MS
Feed use ruminant meat	1000 t	AGMEMOD; MITERRA	Animals; MS
Feed use dairy	1000 t	AGMEMOD; MITERRA	Animals; MS
CAP policy variables			
Voluntary coupled payments	thsd euro	AGMEMOD; MITERRA	Crops and animals, MS
Young farmers payments	thsd euro	AGMEMOD; MITERRA	Crops and animals, MS
Greening payments	thsd euro	AGMEMOD; MITERRA	Crops and animals, MS

Table 5.2 contains the SUPREMA indicators that are neither in AGMEMOD nor in MITERRA. Depending on the considered policy or research topic issue to be analysed by the combined set of models, there might be a need to extend or improve one or both model(s) in order to close the gap and make it/them suitable for answering the question. Again, note that the variables in green are those added from the topics mentioned by stakeholders in the SUPREMA Needs Workshop. All other variables – with its codes – and mappings have been directly taken from the AgClim50 and AgriCisTrade projects.

Table 5.2 Model gaps for AGEMEMOD and MITERRA on SUPREMA variables and indicators

Variables	Unit	Captured by models (yes, no)
Prices and (farm) Income variables		
Real export price	USD/t	AGMEMOD; MITERRA
Area and yield variables		
Climate change shifter on crop yield	%	AGMEMOD; MITERRA
Feed conversion efficiency trend	kg prt/kg prt	AGMEMOD; MITERRA
Market variables		
Food security *(need for good definition)*	*Index*	AGMEMOD; MITERRA
Environmental variables		
Energy use	*PJ*	AGMEMOD; MITERRA
Water use	*1000 m3*	AGMEMOD; MITERRA
Weather volatility/climate change *(need for good definition)*	*Index*	AGMEMOD; MITERRA
Technological innovation variables		
Internet of things/digitalisation *(need for good definition)*	*Index*	AGMEMOD; MITERRA
Antibiotic use reduction	*% change*	AGMEMOD; MITERRA
Macroeconomic variables		
Labour productivity (labour units/turnover)	Lab units/turnover	AGMEMOD; MITERRA
Employment	Million	AGMEMOD; MITERRA
Environmental policy variables		
Carbon tax level	USD/tCO2e	AGMEMOD; MITERRA
Energy policy targets	*PJ*	AGMEMOD; MITERRA
Positive/negative externalities	euro/100 kg	AGMEMOD; MITERRA
Trade policy variables		
Non-tariff measures (number of different measures imposed on agric products)	*number/agr product*	AGMEMOD; MITERRA
Consumer preference variables		
p.c. calory availability	kcal/cap/d	AGMEMOD; MITERRA
Regional food products	*% in total products*	AGMEMOD; MITERRA
Qualitative variables		
Animal welfare concerns *(need for good definition)*	Index	AGMEMOD; MITERRA
Ethical issues *(need for good definition)*	Index	AGMEMOD; MITERRA

This exercise is an inventory step towards conducting tasks 2.2 and 2.3, in which the further process of which models – in combination - can (not) address the existing indicators (directly taken from AgClim50 and AgriCisTrade) and/or the new indicators that result from SUPREMA's Needs workshop. It gives insight in where the models gaps are with respect to (in)ability to address specific research and policy topics, which of the gaps can be easily solved (i.e. on short term; and some within the project) solved, and which need more time to close the gaps (i.e. beyond project duration).

5.2 MAGNET, GLOBIOM and CAPRI linkage

In combination, MAGNET, GLOBIOM and CAPRI can provide quantifications for a high number of economic, market and environmental indicators. In principle, these outcomes are driven by macro-economic, technological and demographic trends, as well as by CAP and environmental policy assumptions. Details are in Table 4.6 of Chapter 4.

Table 5.3 contains the SUPREMA indicators on which the three models MAGNET, GLOBIOM and CAPRI provide outcomes at the sector or product level in EU member states up to 2030. Note that the variables in green are those added from the topics mentioned in the SUPREMA Needs Workshop. All other variables – with its codes – and mappings have been directly taken from the AgClim50 and AgriCisTrade projects.

Table 5.3 Common SUPREMA variables and indicators in MAGNET, GLOBIOM and CAPRI

Variables	Unit	Captured by models (yes, no)	Comments
Prices and (farm) Income variables			
Real producer price/input price	USD/t	MAGNET; GLOBIOM;CAPRI	Crops, Animal, MS
Real export price	USD/t	MAGNET; GLOBIOM; CAPRI	Crops, Animal, MS
Area and yield variables			
Area harvested	1000 ha	MAGNET; GLOBIOM; CAPRI	Crops; MS
Land cover	1000 ha	MAGNET; GLOBIOM; CAPRI	Total land; MS
Crop yield	dm t/ha, fm t/ha	MAGNET; GLOBIOM; CAPRI	Crops; MS
Exogenous crop yield	dm t/ha, fm t/ha	MAGNET; GLOBIOM; CAPRI	Crops; MS
Climate change shifter on crop yield	%	MAGNET; GLOBIOM; CAPRI	Crops; MS
Market variables			
Self-sufficiency rate (production/domestic use)	Ratio	MAGNET; GLOBIOM; CAPRI	Crops, Animals, MS
Environmental variables			
Total GHG emissions	MtCO2e	MAGNET; GLOBIOM;CAPRI	
Total CO2 emissions	MtCO2e	MAGNET; GLOBIOM;CAPRI	
Total CH4 emissions	MtCO2e	MAGNET; GLOBIOM;CAPRI	
Total N2O emissions	MtCO2e	MAGNET; GLOBIOM;CAPRI	
Macroeconomic variables			
Total population	Million	MAGNET; GLOBIOM; CAPRI	
Total GDP (MER)	bn USD 2005 MER	MAGNET; GLOBIOM; CAPRI	
World prices	usd/1000 kg	MAGNET; GLOBIOM; CAPRI	Crops and animals, MS
Environmental policy variables			
Carbon tax level	USD/tCO2e	MAGNET; GLOBIOM; CAPRI	
Consumer preference variables			
p.c. calory availability	kcal/cap/d	MAGNET; GLOBIOM; CAPRI	

Table 5.4 contains the SUPREMA indicators that are neither by MAGNET nor by GLOBIOM or CAPRI. Depending on the considered policy or research topic issue to be analysed by the combined set of models, there might be a need to extend or improve one or both model(s) in order to close the gap and make it/them suitable for

answering the question. Again, note that the variables in green are those added from the topics mentioned by stakeholders in the SUPREMA Needs Workshop. All other variables – with its codes – and mappings have been directly taken from the AgClim50 and AgriCisTrade projects.

Table 5.4 Model gaps for MAGNET, GLOBIOM and CAPRI on SUPREMA variables and indicators

Variables	Unit	Captured by models (yes, no)
Market variables		
Feed fish sector	1000 t	MAGNET; GLOBIOM; CAPRI
Feed fish sector	1000 t prt	MAGNET; GLOBIOM; CAPRI
Environmental variables		
NO3 concentration groundwater	mg NO3/liter	MAGNET; GLOBIOM; CAPRI
Biodiversity change	% ch/yr	MAGNET; GLOBIOM; CAPRI
Soil erosion *(need for good definition)*	Index	MAGNET; GLOBIOM; CAPRI
Technological innovation variables		
Internet of things/digitalisation *(need for good definition)*	*Index*	MAGNET; GLOBIOM; CAPRI
Antibiotic use reduction	*% change*	MAGNET; GLOBIOM; CAPRI
Environmental policy variables		
Positive/negative externalities	euro/100 kg	MAGNET; GLOBIOM;CAPRI
Trade policy variables		
Non-tariff measures (number of different measures imposed on agric products)	*number/agr product*	MAGNET; GLOBIOM;CAPRI
Qualitative variables		
Animal welfare concerns *(need for good definition)*	Index	MAGNET; GLOBIOM;CAPRI
Ethical issues *(need for good definition)*	Index	MAGNET; GLOBIOM;CAPRI

This exercise is an inventory step towards conducting tasks 2.2 and 2.3, in which the further process of which models – in combination - can (not) address the existing indicators (directly taken from AgClim50 and AgriCisTrade) and/or the new indicators that result from SUPREMA's Needs workshop. It gives insight in where the models gaps are with respect to (in)ability to address specific research and policy topics, which of the gaps can be easily solved (i.e. on short term; and some within the project) solved, and which need more time to close the gaps (i.e. beyond project duration).

5.3 AGMEMOD and MAGNET linkage

In combination, AGMEMOD and MAGNET can provide quantifications for a high number of economic, market and environmental indicators. In principle, these outcomes are driven by macro-economic, technological and demographic trends, as well as by CAP and environmental policy assumptions. Details are in Table 4.7 of chapter 4.

Table 5.5 contains the SUPREMA indicators on which both AGMEMOD and MAGNET provide outcomes at sector/product levels in EU member states up to 2030. Note that the variables in green are those added from the topics mentioned in the SUPREMA Needs Workshop. All other variables – with its codes – and mappings have been directly taken from the AgClim and AgriCisTrade projects.

Table 5.5 Common SUPREMA variables and indicators in AGEMEMOD and MAGNET

Variables	Unit	Captured by models (yes, no)	Comments
Prices and (farm) Income variables			
Real producer price/input price	USD/t	AGMEMOD; MAGNET	Crops and animals; MS
Livestock input costs (incl feed costs, other costs)	euro/ton	AGMEMOD; MAGNET	Crops; MS
Farm sector income (gross income: sector returns -/- intermediate costs)	th euro/farm	AGMEMOD; MAGNET	
Area and yield variables			
Area harvested	1000 ha	AGMEMOD; MAGNET	Crops; MS

Land cover	1000 ha	AGMEMOD; MAGNET	Total land; MS
Crop yield	dm t/ha, fm t/ha	AGMEMOD; MAGNET	Crops; MS
Exogenous crop yield	dm t/ha, fm t/ha	AGMEMOD; MAGNET	Crops; MS
Market variables			MAGNET has feed use, imports, exports, domestic use in USD
Food use	1000 t	AGMEMOD; MAGNET	Crops, MS
Self-sufficiency rate (production/domestic use)	Ratio	AGMEMOD; MAGNET	Animals; MS
Macroeconomic variables			Animals; MS
Total population	Million	AGMEMOD; MAGNET	
Total GDP (MER)	bn USD 2005 MER	AGMEMOD; MAGNET	
World prices	usd/1000 kg	AGMEMOD; MAGNET	Crops and animals, MS
GDP deflator (national inflation rate in yr t, compared to base year)	index (2015=100)	AGMEMOD; MAGNET	
Exchange rate	euro/dollar	AGMEMOD; MAGNET	

Table 5.6 contains the SUPREMA indicators that are neither by AGMEMOD nor by MAGNET. Depending on the considered policy or research topic issue to be analysed by the combined set of models, there might be a need to extend or improve one or both model(s) in order to close the gap and make it/them suitable for answering the question. Again, note that the variables in green are those added from the topics mentioned by stakeholders in the SUPREMA Needs Workshop. All other variables – with its codes – and mappings have been directly taken from the AgClim50 and AgriCisTrade projects.

Table 5.6 Model gaps for AGEMEMOD and MAGNET on SUPREMA variables and indicators

Variables	Unit	Captured by models (yes, no)	Comments
Area and yield variables			
Area harvested – rainfed	1000 ha	AGMEMOD; MAGNET	
Area harvested – irrigated	1000 ha	AGMEMOD; MAGNET	
Crop yield – rainfed	dm t/ha, fm t/ha	AGMEMOD; MAGNET	
Crop yield – irrigated	dm t/ha, fm t/ha	AGMEMOD; MAGNET	
Feed conversion efficiency (endogenous)	kg prt/kg prt	AGMEMOD; MAGNET	
Feed conversion efficiency trend	kg prt/kg prt	AGMEMOD; MAGNET	
Market variables			
Feed use	1000 t prt	AGMEMOD; MAGNET	
Feed use ruminant meat	1000 t prt	AGMEMOD; MAGNET	
Feed fish sector	1000 t prt	AGMEMOD; MAGNET	
Food security *(need for good definition)*	*Index*	AGMEMOD; MAGNET	
Environmental variables			
Fertiliser N	1000 t	AGMEMOD; MAGNET	
Water for irrigation	km3	AGMEMOD; MAGNET	
Total N leaching and runoff	1000 kg N	AGMEMOD; MAGNET	
NO3 concentration groundwater	mg NO3/liter	AGMEMOD; MAGNET	
Soil organic carbon balance	kg C/ha/year	AGMEMOD; MAGNET	
Energy use	*PJ*	AGMEMOD; MAGNET	
Water use	*1000 m3*	AGMEMOD; MAGNET	
Weather volatility/climate change *(need for good definition)*	*Index*	AGMEMOD; MAGNET	
Biodiversity change	% ch/yr	AGMEMOD; MAGNET	
Soil erosion *(need for good definition)*	Index	AGMEMOD; MAGNET	
Technological innovation variables			
Technical mitigation options – Production	1000 t	AGMEMOD; MAGNET	

Technical mitigation options – Emissions	MtCO2e	AGMEMOD; MAGNET	
Technical mitigation options - CO2	MtCO2e	AGMEMOD; MAGNET	
Technical mitigation options - CH4	MtCO2e	AGMEMOD; MAGNET	
Technical mitigation options - N2O	MtCO2e	AGMEMOD; MAGNET	
Internet of things/digitalisation *(need for good definition)*	*Index*	AGMEMOD; MAGNET	
Nitrification inhibitors *(need for good definition)*	*Index*	AGMEMOD; MAGNET	
Precision/smart farming *(need for good definition)*	*Index*	AGMEMOD; MAGNET	
Antibiotic use reduction	*% change*	AGMEMOD; MAGNET	
Macroeconomic variables			
Employment	Million	AGMEMOD; MAGNET	
Environmental policy variables			
Climate policy targets	MtCO2e	AGMEMOD; MAGNET	
Energy policy targets	*PJ*	AGMEMOD; MAGNET	
Positive/negative externalities	euro/100 kg	AGMEMOD; MAGNET	
Trade policy variables			
Non-tariff measures (nr of different measures imposed on agric products)	*number/agr product*	AGMEMOD; MAGNET	
Consumer preference variables			
Regional food products	*% in total products*	AGMEMOD; MAGNET	
Qualitative variables			
Animal welfare concerns *(need for good definition)*	Index	AGMEMOD; MAGNET	
Ethical issues *(need for good definition)*	Index	AGMEMOD; MAGNET	
Soil quality *(need for good definition)*	Index	AGMEMOD; MAGNET	
Water quality *(need for good definition)*	Index	AGMEMOD; MAGNET	

This exercise is an inventory step towards conducting tasks 2.2 and 2.3, in which the further process of which models – in combination - can (not) address the existing indicators (directly taken from AgClim50 and AgriCisTrade) and/or the new indicators that result from SUPREMA's Needs workshop. It gives insight in where the models gaps are with respect to (in)ability to address specific research and policy topics, which of the gaps can be easily solved (i.e. on short term; and some within the project) solved, and which need more time to close the gaps (i.e. beyond project duration).

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Annex 1 Non-SUPREMA models in AgClim50

IMAGE and MAgPie belong to the model platform in AGClim50, but are not member of the SUPREMA model family, Their features are described here.

IMAGE (see: www.iiasa.ac.at./GLOBIOM . The Integrated Model to Assess the Global Environment (IMAGE) framework (Stehfest et al. 2014) describes various global environmental change issues using a set of linked submodels describing the energy system, the agricultural economy and land use, natural vegetation and the climate system. The socioeconomic models distinguish 26 world regions, while the natural ecosystems mostly work at a 5x5 minutes and 30x30 minutes grids. Agricultural demand, production and trade are modelled via the MAGNET model, which is integral part of the IMAGE framework in most scenario studies. Bio-energy potential is determined using the land use model, taking into account several sustainability criteria, i.e. the exclusion of forests areas, agricultural areas and nature reserves. The demand for bio-energy is assessed by describing its cost-based competition versus other energy carriers (mostly in transport, electricity production). This is combined with demand for other agricultural products in a region to determine future land use. Emissions from land use (change) and the energy system are used in the climate model (MAGICC-6) to determine climate change, which then affects all biophysical submodels.

MAgPIE. The Model of Agricultural Production and its Impacts on the Environment (MAgPIE) is a partial-equilibrium agriculture and land use model (Bodirsky et al. 2015). It generates optimal land use patterns by minimizing global production costs. The recursive dynamic nature of the model is reflected in a 10-year time-step optimization, where optimal land use patterns from the previous period are taken as a starting point for the current period. The initial period is calibrated to the arable area reported by the FAO. MAgPIE operates on ten socioeconomic regions. The demand for food is regionally defined and given as an exogenous trend to the model, encompassing 16 crop and 5 livestock types. Estimates for calorie intake for each region are obtained from a country cross-section regression analysis on population and GDP (Bodirsky et al. 2015). In addition to food, the agricultural demand consists also of feed, material and bioenergy demand. The supply side is determined by different production costs, biophysical crop yields and availability of water. All MAgPIE regions fulfil part of their demand by domestic production, which is founded on regional self-sufficiency ratios.