D1.8: REPORT ON THE PROSPECTS FOR RESEARCH

LEAD AUTHOR:

Petra Salamon, Martin Banse, Laura Angulo, Max Zirngibl (Thünen)

OTHER AUTHORS:

Maria Blanco (UPM), Floor Brouwer (WR), Petr Havlik (IIASA), Roel Jongeneel, Ana Gonzalez Martinez (WR), Hans van Meijl (WR), Hans-Peter Witzke (EuroCare)

DATE: 13 – May – 2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773499 SUPREMA

PROJECT	Support for Policy Relevant Modelling of Agriculture (SUPREMA)
PROJECT NUMBER	773499
TYPE OF FUNDING	Coordination and Support Action
DELIVERABLE	D1.8 Report on the prospects for research
WP NAME/WP NUMBER	Challenges, needs and communication – topics for model improvements, applications and dissemination/ WP1
TASK	Task 1.5 Strategic prospects
VERSION	01
DISSEMINATION LEVEL	Public
DATE	26/03/2020 (Date of this version) – 28/02/2020 (Due date)
LEAD BENEFICIARY	TI
RESPONSIBLE AUTHOR	Petra Salamon, Martin Banse, Laura Angulo, Max Zirngibl (Thünen)
AUTHOR(S)	Maria Blanco (UPM), Floor Brouwer (WR), Petr Havlik (IIASA), Roel Jongeneel, Ana Gonzalez Martinez (WR), Hans van Meijl (WR), Hans-Peter Witzke (EuroCare)
INTERNAL REVIEWER	Approval by WP leader

DOCUMENT HISTORY

Version	Initials/NAME	DATE	COMMENTS-DESCRIPTION OF ACTIONS
0.1	Version 0.1	13/5/2020	Draft for revision send to Partners
0.2	Version 0.2	04/6/2020	Revised version

Table of Contents

TABLES

FIGURES

Executive summary

Changes with respect to the DoA

No changes

Dissemination and uptake

This paper is based on the third stakeholder workshop held on February 11th, 2020 in Brussels.

Short Summary of results

The deliverable D1.8 'Report on the prospects for research' concludes the three SUPREMA workshops and takes a first insight into the SUPREMA project outcomes and what is necessary to improve in future modelling. It summarizes the proceedings of the workshops, briefly describes some important interactions of stakeholders and gives an overview of the main findings of the SUPREMA project.

SUPREMA showed by a number of medium- and long-term scenario analyses which involved model linkages and limited model improvements the current possibilities of the SUPREMA toolbox to analyse policy options and support policy decisions by empirical evidences. Participants were involved in defining the needs and narratives for the scenarios to test the ability of the SUPREMA toolbox. In the end, together with participants, the achieved outcomes and improvements were validated in order to help phrasing future research prospects with respect to challenges going beyond the scope of SUPREMA. During the SUPREMA workshops, four general considerations could be worked out with regard to future modelling: (i) data requirements and availability, (ii) model linkages, (iii) harmonisation among models and model outcomes as well as (iv) communication of model outcomes and assumptions. Beyond that, during discussion also several points beyond the scope of the SUPREMA project were uncovered and discussed requiring additional efforts with respect to future research. Topics here involve policies and their implementation schemes, farming and behaviour of producers, consumer, citizens and the food system or the bio-economy and many others. This high diversity in complex connected topics brought new ideas for future research in this area to be investigated in future projects.

Evidence of accomplishment

Milestone 12

Participants list

Deliverable D1.9

Glossary / Acronyms

AECMS	AGRI-ENVIRONMENT-CLIMATE MEASURES
AGMEMOD	AGRICULTURAL MEMBER STATE MODELLING FOR THE EU AND EASTERN EUROPEAN COUNTRIES
AGMIP	AGRICULTURAL MODEL INTERCOMPARISON AND IMPROVEMENT PROJECT
AI	ARTIFICIAL INTELLIGENCE (AI)
BECCS	BIOENERGY WITH CARBON CAPTURE AND STORAGE
BMEL	(GERMAN) FEDERAL MINISTRY OF FOOD AND AGRICULTURE
CAP	COMMON AGRICULTURAL POLICY
CAPRI	COMMON AGRICULTURAL POLICY REGIONALISED IMPACT MODELLING SYSTEM
CC	CLIMATE CHANGE
CGE	COMPUTABLE GENERAL EQUILIBRIUM
DG	DIRECTORATE-GENERAL
DG AGRI	DIRECTORATE-GENERAL FOR AGRICULTURE AND RURAL DEVELOPMENT
DG CLIMA	DIRECTORATE-GENERAL FOR CLIMATE ACTION
DG ENV	DIRECTORATE-GENERAL FOR ENVIRONMENT
DG SANCO	DIRECTORATE-GENERAL FOR HEALTH AND CONSUMERS
DNH	DO NOT HARM PRINCIPLES
EAB	EXTERNAL ADVISORY BOARD
EC	EUROPEAN COMMISSION
EFA	ECOLOGICAL FOCUS AREAS
FADN	FARM ACCOUNTANCY DATA NETWORK
FP7	FRAMEWORK PROGRAMME 7
FTA	FREE TRADE AGREEMENT
GDP	GROSS DOMESTIC PRODUCT
GHG	GREENHOUSES GASES

GLOBIOM	GLOBAL BIOSPHERE MANAGEMENT MODEL
GTAP	GLOBAL TRADE ANALYSIS PROJECT
IFM-CAP	INDIVIDUAL FARM MODEL FOR COMMON AGRICULTURAL POLICY ANALYSIS
IFPRI	INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IIASA	INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
IMAP	INTEGRATED MODELLING PLATFORM FOR AGRO-ECONOMIC COMMODITY AND POLICY
IT	INFORMATION TECHNOLOGY
JRC	JOINT RESEARCH CENTRE
LCA	LIFE CYCLE ASSESSMENT
LDC	LEAST DEVELOPED COUNTRIES
LULUCF	LAND USE, LAND USE CHANGE, FORESTRY
MACSUR	MODELING EUROPEAN AGRICULTURE WITH CLIMATE CHANGE FOR FOOD SECURITY
MAGNET	MODULAR APPLIED GENERAL EQUILIBRIUM TOOL
MFF	MULTIANNUAL FINANCIAL FRAMEWORK
MITERRA	INTEGRATED NITROGEN IMPACT ASSESSMENT MODEL ON AN EUROPEAN SCALE
MT	MEDIUM TERM
NDC	NATIONALLY DETERMINED CONTRIBUTIONS
NGO	NON-GOVERNMENTAL ORGANIZATION
NTM	NON-TRADE MEASURES
NZ	NEW ZEALAND
NGO	NON-GOVERNMENTAL ORGANIZATION
OECD	ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT
PE	PARTIAL EQUILIBRIUM MODEL
SDG	SUSTAINABLE DEVELOPMENT GOAL
SLU	SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES

SSP2	SHARED SOCIOECONOMIC PATHWAY 2
SUPREMA	SUPPORT FOR POLICY RELEVANT MODELLING OF AGRICULTURE
THUENEN	JOHANN HEINRICH VON THÜNEN INSTITUTE
TRQ	TARIFF RATE QUOTAS
UPM	UNIVERSIDAD POLITÉCNICA DE MADRID
UAA	UTILIZED AGRICULTURAL AREA
VC	VALUE CHAIN
VCS	VOLUNTARY COUPLED SUPPORT
WP	WORK PACKAGE
WR	WAGENINGEN RESEARCH

1 Introduction

During the SUPREMA project, three different stakeholder workshops were conducted. They aimed to gain insights into stakeholders' perception on future challenges of the agri-food sector and related policies with respect to (i) stakeholders' needs for model-based analyses and to (ii) priorities of stakeholders. Also support requirements of evidence-based policy making of Stakeholders were supposed to be captured; shortcomings of current policy analysis and outcomes were needed to be identified. Stakeholders were also asked to define desired improvements in models better covering future needs and, last but not least, options to present outcomes in a more understandable way.

In particular, the 1st workshop 'Needs' aimed to achieve understanding of the challenges and needs posed to the future development of models and model-based support for policy actions, whereas the focus was on agri-food systems and policies influencing agri-food systems locally, nationally and on a global scale. From a policy perspective, future societal challenges of the Common Agricultural Policy (CAP) and climate related policies were identified by stakeholders as areas which should be pursued in model-based policy analysis for an evidence-based decision making. It is aimed to show the current ability of the SUPREMA tool under a medium-term perspective until 2030, respectively under a long-term perspective until 2050 under the SUPREMA project. In addition, a number of requirements were depicted to shape the future development of quantitative models so that they can deal better with the challenges and needs for policy support. It also defined priorities for model improvements and model-related actions.

During the 2nd workshop 'Narratives', selected narratives for impact analyses to demonstrate the current ability of SUPREMA toolbox were presented and discussed with stakeholders validation and further refinement. In principle, three narratives were envisaged (a) Baseline, (b) EU common agricultural policy (CAP) and (c) climate change related policies also regarding findings of the workshop 'Needs'. Applying a participatory approach by involving stakeholders ensures that insights from the "real world" were considered in the SUPREMA modelling platform and in the planned model simulations. The CAP related narrative was designed to focus on CAP measures which also address climate change and environmental issues. These are new fundamental obligation of EU Member States, setting important priority within their CAP strategic plans. A number of crucial assumptions was elaborated, especially with respect to economic elements, primary agricultural production, supply chain and consumer preferences, including sustainability considerations under the new CAP. For climate policy, simulations under SUPREMA aim at assessing potential contributions of the EU agricultural sector to climate change mitigation efforts by considering mitigation targets (e.g. various levels of ambitions for reductions on non-CO_2 emissions (methane) with respect to different agricultural sectors and measures (e.g. reflecting different types of manure management) and regions (EU versus other countries). In selected narratives, lifestyle changes reflected by adjusted consumer preferences are analysed as well. SUPREMA links narratives on climate policy to the sustainable development goals.

During the 3rd workshop 'Future Prospects', outcomes of different scenarios and issues were presented and discussed with stakeholders addressing three main areas: (i) Selected draft results on long-term baseline and climate related scenarios, (ii) selected draft results on medium-term baseline and stylized CAP related scenarios, and (iii) first insights of model improvements and linkages. In all three slots, participants' feedback was captured. Additionally, under the title 'Ways forward - where are we now, what remains to be developed, and what is missing?' participants could state their specific opinions, proposals and preferences to the following questions:

- Are farmers' decisions and their responses to changes well covered?
- Is demand adequately reflected (with respect to changing diets, product differentiation, societal demand, developing countries, and bio-economy)?

- Supply chains - what is missing in their representation (decision making, market power, structural changes, and competitiveness)?
- Are Sustainable Development Goals (SDGs) efficiently addressed by the available tools?
- By concentrating in tests strongly on Common Agricultural Policy (CAP) and climate change - what are we missing?
- What else needs to be covered?

In this report, we compile and evaluate outcomes based on all three workshops together combined with recommendations of the External Advisory Board (EAB) to provide consolidated findings of the Stakeholder workshops and to draw conclusions with respect to future research needs. The report is structured as follows: Section 2 shortly describes the findings of the three workshops. Naturally, as time passes, environment and emphasis of stakeholder continuously shift also reflecting changing preferences and priorities. Therefore, we match and oppose findings of the different workshops and depict perceived gaps in Section 3. Then, in Section 4, we derive conclusions about future research needs and enrich them with considerations from the External Advisory Board.

2 Findings of the Stakeholder Workshops

2.1 Stakeholder Workshop 'Needs'

The 1st SUPREMA workshop 'Needs' aimed at sharpening the understanding of the challenges and needs posed to future development of models and model-based support for policy actions. Hence, challenges and needs stated by stakeholders are manifold in numbers as well as the spectrum of topics to be reflected is broad. Additionally, topics are multiplied by the fact that numerous policies and measures are affecting agriculture and the linked supply chains. Some needs and topics could be covered within the project; others have clearly a scope reaching beyond possible efforts within the project because some will require considerable investments in time and resources.

Stakeholders' statements regarding the challenges and needs both, in the medium-term and in the long-term, covered a quite extensive list which was allocated into groupings regarding their content, whereas each consists of a number of different items. More details can be found in Deliverable D1.1. Challenges and needs mentioned with respect to the medium-term and long-term perspective do not depict huge differences but reveal limited divergence in scope and focus than with completely different topics (see Figure 1). Stakeholders stated the following challenges and needs:

- Policy and governance with CAP and its multidimensional indication, global governance, SDGs leading towards policy coherence and cross-sectoral;
- Climate change and mitigation, adaptation, emission reductions to climate neutral and to low carbon economy;
- Resource base with the dimensions land, soil quality, energy, water (quantity and quality), and regional productivity;
- Reflecting SDG indicators (more long-term oriented) with respect to nutrition security and reduction of inequality and a better distribution;
- Long-term sustainability aspects covering the three pillars environmental, social and economic sustainability;
- Medium-term environmental issues regarding indicators, degradation and footprints and sustainability topics on supply intensity and production cost;
- Market in the long-terms with respect to supply, demand and supply chain and on the medium-term with respect to demand, prices, risks and volatility;
- In the medium-term, social aspects like economic and social inequality across households and regions and structural change of markets and farms;
- In the long-term, changes in the societies and their behaviours including their population in size and composition;
- Technologies and innovations and their impacts in the medium and in the long-term.

Figure 1 | Challenges and needs mentioned during the 1st stakeholder workshop 'Needs'.
Source: 1st stakeholder workshop 'Needs'.

In the workshop, the discussion with the stakeholders were structured under three main topics which were

- Global perspective on addressing climate change and low carbon economy, sustainable development goals (SDGs) and resource constraints like land and water;
- Market and value chain perspective depicting international integration of agri-food sectors, its integration with up- and downstream sectors as well as societal concerns and ethical issues;
- Farming and supply adaptation comprising with new mitigation technologies and adoption of new technologies as well as restrictions farms related to environmental regulation.

When needs and challenges of the 'global' perspective with SDGs and climate change, respectively the low carbon economy were discussed in more detail, stakeholders addressed in principal two groups: One group of challenges addressed global development aspects around SDGs in combination with demographics, food demand analysis, integration of sustainability (here, including of societal demand in trade agreements should regard sustainability (societal demand)), and the coverage of an increasing number of European standards in production, processing and trade which might pose trade barriers while the CAP partly compensates production in the EU. The second group of challenges deals with climate change, especially with a focus on possible feedback loops and the implementation of the Paris Agreement. Further, also environmental feedback loops with respect to degradation and its impacts on agriculture and vice versa could be pinned in that group together with the challenge of better tailored and targeted subsidies.

As shortcomings and required improvements in model representation the stakeholders mentioned:

- Improved trade outcome;
- Representation of demand dimensions (diets, health, societal expectation, lifestyle);
- Coverage of population, migration, demographics;

- Coverage of SDGs' role (operational indicators);
- Land use in combination with land abandonment, land for biomass and land use for non-agricultural purposes;
- Interaction between growth and climate;
- Adaptations with respect to water;
- Long-term horizon should reflect circular economy, technology transfers, new manufacturing, new trade flows and policies and require respective parameters;
- Increased interaction between economists and other experts including model linkages.

With respect to the value chain, international integration and societal concerns, the stakeholder mentioned a quite diverse number of challenges and needs. One group of challenges ranged around the representation of the use/demand side of agricultural materials dealing with the competition between food, feed, bioenergy and bio material as well as food quality, nutrition, health, and especially the use of antibiotics in animal production. To handle these challenges, data availability and data quality needs to be improved. Also societal demand with respect to sustainability in the value chain is perceived as a challenge. Another challenge in close relation to sustainability is the change in priorities of society towards short, local value chains and the expected strong structural changes in agriculture and processing. Stakeholders also mentioned the increasing number of trade wars, the increased use of private standards and the long-term development of the resource basis together with long-run feedback loops between agriculture, resources and climate as further challenge.

Following shortcomings and needed improvements were given high reference:

- Coverage of productivity should encompass the entire value chain;
- Improved communication between modelers, policy makers, decision makers, and the media on one hand and improved presentations of results by provision of a coherent story is important;
- Competition between models were perceived as important together with a deeper involvement of the public;
- Impact analysis of trade agreements on specific sectors and countries were seen as scarce;
- Impact assessments on regulations, NTMs, environment, health, and Pillar 2 measures would need to be improved;
- Model outcomes should also cover additional dimensions together with economic impacts e.g. social and environmental dimensions, risk.

Regarding farming challenges and supply side representation the stakeholdes perceived challenges and needs in the implementation of different farm practices, farmers' behavior, adoption of new technologies depending on education, especially as past trends may not explain the future developments. It was seen as a move from farms to farming systems and then to distant practices. Stakeholders demanded more efforts to minimize resource inputs, to represent differentiate yields by practices and to endogenise technological changes. They also ask to model all dimensions of sustainability and public goods with respect to animal welfare, food safety, and societal needs as well as to look into the question who would pay for public goods.

Stakeholders named a number of improvements possibilities and also shortcomings. In particular, they asked for a better representation of

- Mitigation techniques
- Supply chains, its interlinkages and competitiveness in the value chain
- Industrialized farms, structural change, organization of farms
- Investments of other sectors in agriculture
- Incorporating off-farm income and of new actors from outside agriculture
- land markets and credits
- Management of water, whole carbon cycle, soil
- Impact of farmers' behavior on environmental policies
- Farmers' adaption to policies in general

In a last step, stakeholders' priorities based on the previous interventions were identified. Each participant was given five points for the three main topics Global, Value chain and Farming which they were asked to attribute to issues on the flip charts in order to mark their importance. The points could be allocated individually or aggregated.

Highly prioritized by stakeholders were items like the **income generation and growth as well as its distribution across different income groups in and outside European countries** affecting the well-being of all humans as growth and distribution as well as avoiding inequalities provide means to overcome existing problems. Future food demand developments and their implication on trade were seen as strongly linked by stakeholders. Also highly ranked by stakeholders were challenges with respect to environmental degradation of soil, water and bio-diversity and the feedback in the economy by expected cost increases on the one hand but due to induced adaptation and mitigation strategies or adoption of new technologies. Water was also mentioned as a separate topic covering quantity (shortages and sudden surplus) and quality. Another very important issue mentioned refers to data that is elaborated further below. Specifically, priority was given to the fact that the SDG indicators would need to be operational so that they could be better reflected in model outcomes: e.g. the descriptions of SDGs are often relative vague in relation to what is required for model simulations.

With respect to climate change, priority was given to the modelling of disruptive changes in consumer preferences and behaviour. Dietary changes towards lower content of animal protein might be driven by changes in consumer preferences and, that way, may have important impacts on GHG emissions. To what extent changes might materialize will depend on circumstances like e.g. availabilities, labelling and income situation. Although in general demand shifts evolve quite smoothly, disruptive changes may occur quite sudden, often in combination with quality, hygienic, diseases or animal welfare problems. Likewise, the internalization of externalities was given a high priority by stakeholders. Modelling the reduction of greenhouse gases (GHG) and the mitigation and adaptation with respect to climate change is in the focus, whereas especially disruptive technologies should be given considerations as well as technology diffusion, adoption rates and the adaptation of new activities between farms were highly ranked by stakeholders.

In the field of value chain, market, international integration changes in the political agenda for example **strategies towards a more bio-based economy** were identified as being very important and

would require model-based analysis. Here, a strong relation exists to low carbon and circular economy discussed and ranked under the global perspective. From the modelling perspective, both challenges would call for a more integrated approach of different models applied in a harmonized way. As the value chain often determines the income at farm level, distributional aspects in an international context are of concern as it was seen directly related to food access and to hunger which would require further modelling. By stakeholders, priorities were also given to the fact that private entities fulfil the role of public entities e.g. by defining and controlling standards. A growing gap is observed between increasing international supply and societal preferred regional provision of food which is seen to be engraved by structural change reducing the number of actors along the supply chain and increase asymmetries between different levels in the chain. Short supply chains are mentioned as a separate priority as well, but were not given an equal high priority. For the value chain, high priority was given to the availability of data in necessary quantity and quality where a permanent need was observed. Clearly new channels of data acquirement with a focus on the supply chain have to be formed, property right and privacy issues with respect to data require to be solved and transparency along the chain for all actors has to be established. The topic was also given some priority in the other two fields but not with that high ranking.

With respect to social concerns, analysing the impact of productivity gains on the development of employments was given quite high significance. A number of other perceived challenges were directly linked to SDGs and climate change, especially emphasised were sustainability, (im)migration, migrant labour (in food chains) and job availabilities under climate change, differentiate income groups, GHG reduction and employment transition. Hence, the focus was more on markets and supply chains with an emphasis on processing. Participants also attribute priorities to health and nutrition concerns in general, antibiotics use in husbandry related to animal welfare but also to health issues.

Modelling needs with respect to farming and supply adaptation comprise new mitigation technologies related to climate change, adoption of new technologies, including remote sensing, robotics as well as constraints in farming related to environmental regulation. Challenges were attributed to two areas; one was how to face market and behaviour adjustments of actors and the other by farming risks. The first challenges can be characterized by the behaviour of consumers and processing industries. Consumers' behaviour is perceived as disruptive and difficult to anticipate because as citizens they express a willingness to pay for organic, animal welfare and low emission products while, at the point of sale, consumers choose differently. Also high priority by stakeholders received the adoption of new innovations which will require a better representation in models. Additionally, monitoring markets is seen as an important need which forms a challenge for farmers and probably policy makers.

Priorities concerning farming risks were discussed with highest ranks allocated to water constraints and, equally important, whether to concentrate on adaptation or mitigation of climate change. Also yields, productivity gains in yields and variables contributing were perceived as important to cover, whereas efficiencies in crops are placed in livestock (feed efficiency). Also feedbacks from breeding activities and climate change needs to be covered, technologies and innovation (see also SDGs and climate change) received high perception. Further challenges are seen in development of infrastructure and related cost and in the role of farm structure and education prioritised under SDGs. Existing knowledge on GHG effects is also considered as a challenge.

Table 1 | Stakeholders' priorities identified during the 1st workshop 'Needs'

Global	
SDGs (first 5 items of 14)	points
Income distribution and growth	18
Environmental degradation (soil, water, biodiversity) impact on economy	12
SDGs indicators with limited coverage -> model outcomes	12
Future food demand -> trade	10
Water	5
Climate Change / Low Carbon Econ. (first 5 items of 14)	points
Disruptive consumer preferences and behaviour	13
Internalize externalities (positive/negative)	12
Disruptive technologies	8
Technology diffusion, adoption	7
Adaptation -> calibration of new activities (between farms)	7
Value chain	
Value chain, market, international integration (first 5 items of 27)	points
Bio economy	9
Data quantity + quality	9
Distributional aspect (in relation to hunger)	8
Private entities take the role of public entities	7
Regional vs international production	7
Social concerns (first 5 items of 9)	points
Productivity gains vs employment	9
Sustainability	9
Immigration, jobs and migrant labour in food chain	7
Climate change	6
Health, nutrition	6
Farming	
Farming challenges: behaviour – markets (first 5 items of 9)	points
Role of consumers with respect to organic, animal welfare	15
Supply chain	12
Spread of innovation	7
Monitoring useful for farmers and policy	5
New Approach integration of choice experiments	3
Farming risks (first 5 items out of 15)	points
Water constraints	18
Adaptation versus mitigation	18
Yield = f (…) e.g. fertilizer, pests, chemicals	14
Feed efficiency	10
Technology	9

Source: Own compilation

2.2 Stakeholder Workshop 'Narratives'

A participatory approach was applied at the workshop 'Narratives' to involve stakeholders and experts to get first-hand input and insights from the "real world" into the modelling undertaking in SUPREMA.

For the narratives for the baseline, the CAP scenario and the climate related policies were developed under consideration of stakeholders' and experts' inputs, as well as an assessment of the policy debate and expected policy challenges (e.g. climate change). The CAP narrative comprises a medium-term perspective, which will cover in any case the CAP budget period spanning from 2021-2027. The climate related scenario puts a focus on the long-run while baseline presents business as usual (BAU).

2.2.1 Narratives for the Common Agriculture Policy (CAP) – focus on climate and environment

In the narrative, CAP measures with respect to climate and environment were planned to be featured because the new fundamental obligation is of important priority for the EU Member States, with ambition for environment and climate within their specific CAP strategic plans. Before granting approval, the EU Commission will assess whether the proposed plans meet fundamental obligation among other targets which the EU Member States define themselves, i.e. the contents of interventions, standards of Good Agricultural and Environmental Condition (GAEC) within the conditionality system etc. Intervention strategies need to be accompanied by quantitative targets and milestones on how environment and climate objectives can be achieved and the logic of the intervention strategy will require public consultation. The CAP's future environment and climate objectives have clear thematic links to the objectives and targets set out in or arising from various items of EU legislation (details see Deliverable D1.3).

Agriculture depends on natural resources i.e. soil, water, air and biodiversity and is heavily influenced by climate and weather, but agriculture also shapes the environment by its use of resources, its influence on landscapes and by emitting greenhouse gases, but also provides significant carbon sinks. Managing this complex relationship in the interests of sustainability has costs attached. The CAP has covered some of these costs so that farmers can provide essential public goods expected by society and has also offered support to some rural-based non-agricultural businesses e.g. in the forestry sector and other parts of the bio-economy.

Three out of nine proposed key objectives of the CAP addressing environment and climate and reflect the various aspects of the interaction between environment and climate, farming and rural areas. According to the objectives, the CAP will:

- contribute to climate change mitigation and adaptation, as well as sustainable energy;
- foster sustainable development and efficient management of natural resources such as water, soil and air;
- contribute to the protection of biodiversity, enhance ecosystem services and preserve habitats and landscapes.

To achieve the objectives CAP's is operated within a "new delivery model", whereas basic rules are set at EU level and substantial flexibility is granted to Member States in the implementation. Member States need to declare for each element in their strategic plans what their intension is, and then the EU Commission will assess the proposals.

At the base of the new architecture is the system of "conditionality". It will link all farmers' income support (and other area-/animal-based payments) to the application of environment- and climate-friendly farming practices. It will take some features and content from the current systems of cross-compliance and "greening", which it replaces. The rules governing this new system will in some respects be less prescriptive at EU level than rules of the current approach (especially with regard to the current greening scheme), but the standards/requirements laid down will, nevertheless, imply higher environmental ambition.

The second layer consists of "eco-schemes" funded by the CAP's Pillar I budget. The EU Member States are required to make provision here, whereas no EU-level rules apply their content. Hence, it is essential: eco-schemes need to contribute to the CAP's environment and climate objectives. The Member States will design them according to their targets and needs in their CAP strategic plans so that they complement the other elements of environmental architecture. Participation in Pillar I eco-schemes will be voluntary for farmers.

The third main layer of the architecture consists of payments within support for rural development – CAP Pillar II – for various kinds of management commitments (especially agriculture-environment-climate (AEC)commitments). EU Member States have to offer agriculture-environment-climate (AEC) payments, but again implementation by farmers is voluntary. Agriculture-environment-climate (AEC) payments can be applied to cover a wide range of agricultural practices; as under the current approach, no restrictions will be laid down in EU rules.

In addition, the EU Member States are able to use their rural development (RDP) budgets to fund a range of other types of support relevant to environment and climate - such as funding knowledge transfer, eco-friendly investments, innovation and co-operation whereas support can be granted not only to farmers but also to forest managers and other interested parties in rural areas.

A wide range of tools might address a given environmental issue (e.g. biodiversity) in complementary ways, but under a general principle governing spending from the EU budget, "double funding" (i.e. paying twice in respect of a given cost) will remain prohibited.

Based on the described policy elements, three CAP scenarios were foreseen:

i) Strong sustainability and climate focus (a strict enhanced conditionality, and intensive use of ES and AECMs, limited use of VCS; reallocation of EU budget from direct payments to environmental program payments)

ii) Balanced sustainability and profitability approach (less strict conditionality, small role of ES and limited extension of AECMs, maximum use of VCS)

iii) As (ii), but with a consumer demand adjustment due to a diet/preference shift

Based on the workshop, the following strategy was developed: Proposed new CAP will be based on another delivery model, which puts the EU Member States in a more responsible role with respect to targeting on policy objectives and tailoring of policy measures to these objectives (subsidiarity) policies will become more heterogeneous at member state level. For this reason, it will be considered whether some more in depth-assessments at selected member states can be made, provided that sufficient information is available and cross-financing would allow detailed CAP scenario analyses, which is not possible under the SUPREMA budget.

The scenarios will involve different assumptions with respect to the modelled policy measures (ES, AECM, VCS, including enhanced conditionality) and associated productivity impacts (modelled via adjustments in productivity). In case of specific analyses for the EU Member States, the detail with respect to measures and regulatory constraints may require further refinements with respect to policy measures implementation.
The scenario results will be described with respect to their impacts on agricultural markets, EU trade, farm income, as well as with respect to a set of environmental indicators (e.g. leakages to the environment, GHG emissions).

2.2.2 Narratives for climate and policies

Agriculture is the biggest source of anthropogenic non-CO_2 emissions with increases driven by synthetic fertilizer, manure application and enteric fermentation from ruminants. While emissions increased by one third, agricultural gross production index increased by around 70% and agriculture continues to improve its GHG efficiency at the global scale. SUPREMA will assess the potential contribution of the EU's agricultural sector to climate change mitigation efforts. Impact of various levels of ambition for non-CO_2 emissions are regarded with respect to methane (from enteric fermentation, manure management, rice cultivation) and nitrous oxide (from synthetic fertilizer, manure applied to soils, manure left on pasture, manure management, cultivation of organic soils) by comparison to a counterfactual baseline. Several climate change mitigation dimensions will be implemented to assess the impact of mitigation efforts in the agricultural sector.

For the climate policies, the stakeholders expressed the need for taking the global perspective on climate change and low carbon economy, sustainable development goals (SDGs) and resource constraints like land and water, in a sufficient long time horizon, taking into account aspects such as global governance, change in consumer preferences, or development of bio-based economy. In response to those needs, long-term climate change mitigation narratives considering different climate mitigation targets, lower level of ambition in non-EU regions, shift towards healthy diets, competition for land between afforestation and bioenergy development on the one side, and agriculture and ecosystems services on the other side. In detail, scenarios will cover the following elements:

- Mitigation targets foreseen for agriculture are in line with a 2°C and 1.5°C target across sector to assess the implications for the sector and related sustainability indicators. Particular attention will be however paid to the 1.5°C target. To emulate the mitigation potentials, a carbon price on non-CO_2 emissions will be implemented in the models as a tax on agricultural non-CO_2 emissions.
- Mitigation region is primarily the EU by regarding effects of a unilateral mitigation policy in the EU on the sector while the rest of the world is assumed not to take up any or limited mitigation efforts. Then, in a second variant, the rest of the world will take coordinated efforts to achieve the climate target and apply mitigation policies, although in reality, some of the non-EU countries have already taken substantial commitments which are taken into account in the differentiated regional efforts.
- To limit climate change below 1.5 °C, total biomass demand for energy is projected to increase significantly which, in turn, may trigger environmental and social trade-offs such as increased deforestation and emissions, nitrogen losses and food prices. The analysis will assess increased competition for land related to land based mitigation policies and its potential effects for agricultural non-CO_2 mitigation. A mitigation scenario where the policy is only implemented via carbon price on agricultural non-CO_2 emissions is contrasted with a second scenario which considers increased biomass use for energy by energy plantations and afforestation.
- Demand side options through reduced consumption of livestock products may contribute to GHG savings and might benefit to health and food security. To drive impacts, a scenario with a diet shift of total livestock calorie consumption levels to recommended levels and a 50% reduction in food waste is compared to the counterfactual baseline achieved gradually by 2070.
- Climate change mitigation in need for land for afforestation and energy plantations will potentially lead to a further intensification of agricultural production and negative effects on

biodiversity, air and water pollution as well as water availability. Carbon pricing will have substantial implications for farm incomes, as well as on food security.

- Carbon sequestration and growth in bioenergy use will represent new economic opportunities which will be systematically explored for the retained scenario narratives.

2.3 Stakeholder Workshop 'Future Prospects'

Concerning the modelling and selected draft results on long-term baseline and climate related scenarios, first conclusions can be summarized as following:

1. Modellers face high challenges when addressing economic, environmental and social issues, while linkages across farming and other sectors also need to be considered.
2. It is perceived as necessary to consider consumer behaviour in more detail, and more emphasis should be put on possible adjustments of consumers' behaviour towards a more climate-friendly food diet, and how that could be achieved (price driven and other incentives (information, nudging)). This type of questions require collaboration with other scientific areas like sociology and psychology (behavioural economics).
3. For the climate scenario design, the modellers should think more out of the box and consider quite different economic systems. In particular, social and environmental externalities should be internalized (true pricing).
4. Ways to represent SDGs should be implemented in the models so that the achievement of different targets can be captured; however, due to their complexity, integration can only be achieved in a stepwise procedure.
5. Model linkages can improve model outcomes, and multidisciplinary approaches as well as links to biophysical and household models should be pursued, whereas those linkages have to consider different terminologies within sciences and need to overcome that language issue.
6. Technology and innovation processes are until now mostly exogenous in models, while both are also connected with changes in climate and offer opportunities to address changes in climate (e.g. mitigation options).
7. In the past, agricultural policies were designed with a focus on economic and social dimensions and at the expense of ecology while, currently, it might happen that the environmental dimension becomes more dominant, possibly at the expense of social aspects. Therefore, in future an integration of social together with environmental/climate change related aspects in models for assessments will likely become important.

With regard to modelling and selected draft results on medium-term baseline and stylized CAP related scenarios, the following draft conclusions can be outlined:

1. With respect to dietary adjustments some concrete proposals were made:
    a. The scenario is quite focused on EU countries; however, it could also include changes in diets and in preferences in non-EU countries.
    b. This type of assessments should be able to also consider the impact of taxes on meat.
    c. Consumption patterns are changing, whereas consumer preferences could also change by buying less products of better quality.
    d. Consumers can also pursue buying products with environmental consciences.
2. Future models improvements can be provided by

   a. Internalize external effects and
   b. the inclusion of innovations and uncertainties.

3. Considering CAP-related issues:
   a. The adoption of eco-schemes is difficult to include as schemes are voluntary for farmers and a lack of data and heterogeneity of farmer's decisions does not enable an easy implementation of farmers' adoption so that a sensitivity analysis might alleviate the problem.
   b. An assessment of impacts on biodiversity is seen as helpful.

Draft conclusions from the first insights of model improvement and linkages within the SUPREMA model family can be found below:

1. When linking MAGNET and GLOBIOM, it remains unclear how outcomes are translated and transferred between the models. One model provides results for quantities while the other expresses the same items in values.
2. It is important with respect to forestry that afforestation and its respective impacts on yield are covered.
3. Replication of e.g. organic farms of IFM-CAP in CAPRI is quite significant.
4. Defining the type of linkage used between the models is an issue, but whether soft or hard linkage is the most relevant distinction is debatable. A stronger focus could be put on other ways to characterize linkages like e.g. the degree of linkage, or whether it is one way, two ways, or circular.
5. Harmonisation between models is perceived as an area for further research especially if models are linked. Hence, as models, due to their differences in nature and structure, are often based on different databases, attempts of harmonisation face limitations. Nevertheless, models should be harmonised as far as possible.
6. Linking different types of models will also be a strong point in future because policies will get more complex.

The running world café provided outcomes of the elements 'Way forward: where are we, what do we need and what is missing' which are characterized through each poster:

Poster 1: Farmers' decision and their reactions to a changing environment?

Stakeholders mentioned that models were not representing individual behaviour and that agent based models may reflect better the heterogeneity of farmers across different EU MS and their response to policies. The representation of alternative technologies and the structural changes may need some improvements. Also the risk aversion of farmers towards volatile EU policies should be reflected. In general, the coverage of heterogeneity among farmers across the EU MS requires more emphasis.

Poster 2: Demand side adequately reflected?

Participants asked for a better representation of the whole bio-economy, including bio-materials as well as bio-energy referring also to the fact that innovations in the bio-economy were not considered. New outlets for bio-based products were perceived as still missing. It was also highlighted that consumer behavior in models should reflect both, changes in preferences for products and qualities, next to effects of economic behavior. Although green CAP is covered as a scenario, this does not include the voice of voters nor consumer response on green CAP and their potential backlash.

Poster 3: Supply chain - what is missing (decision, market power, and structure)

The participants considered that price transmission is not very well reflected along the supply chain. The model design should capture the material flows of products and also product quality should be taken into account. Another topic is to reflect properly the coordination within the supply chain and the impacts of market power on the different levels. Some attention should also be given to contracting, all three affecting the market outcomes.

Poster 4: Are SDGs addressed efficiently?

It was stated that many SDGs indicators would need a higher resolution than currently available and that to cover SDGs in more detail more biophysical and household level models should be employed. SDGs that address inequality and which deal with poverty, food security and gender issues are underrepresented in the current models. For the better integration of SDGs in models, a matrix on SDGs, indicators, sectors and their respective importance would be required.

Poster 5: Testing on CAP and climate change policies - what are we missing?

The representation of biodiversity, ecosystem services and the topic of the CAP budget are regarded as only marginally pursued. Also the employment and job creation, technology adoption and volatility aspects are perceived as missing. Modelling the circular economy includes residues and waste and to represent the food system perspective are seen as not really covered.

Poster 6: Additional issues

The participants considered that although CAP policies are included in the models, it does not consider its whole complexity. As an example, the modelling of uptake/participation decisions of farmers with respect to eco-schemes and other voluntary measures needs more research and better representation in models. Important considerations about consumers such as health impacts of diets are still missing together with how health is reflected in consumer preferences. Further, social issues as e.g. inequality are not captured. With respect to the farmers, the models do not cover the land use markets, investment required and the finance channels used. Also permanent crops and minor commodities should be represented better.

3 Mapping ‘Needs’, ‘Narratives’ and ‘Future Prospects’

In the following, we try to map the outcomes of the three different workshops to identify gaps which will require future research activities.

3.1 General issues

3.1.1 Data requirements, data availability and data gaps

Quantitative models are based on data and have enormous data requirements, on the one hand for historical data of endogenous and exogenous variables and on the other also for technical and behavioural parameters. In addition, sound and well-grounded data for assumptions on political measures, their implementation and also with respect to other exogenous variables are needed. Further, parameters are required to describe for example new and upcoming technologies, their adopting, farm practices, new supply chains, or trade flows. Those data problems are adherent in model harmonisation and need further model developments and improvements of all types of models ranging from farm via value chain to global representation. Additionally, monitoring markets and demand developments was seen as a challenge for farmers and probably policy makers, but also as a useful activity for society in general.

In all three workshops challenges and shortcomings with respect to availability of data in quantity and quality were perceived, addressed and given high ranks when evaluated with top rank concerning markets and even more in value chains. Although vast amounts of data are generated, the availability with respect to market and value chains is very restricted, as data is treated as property of those firms who generated them and, thus, access is provided only if firms have own interest or data is sold to generate additional returns. Those data limitations hinder an adequate representation of markets and value chains covering several levels. Although data is relevant for all modelling activities, it cannot be tackled within the SUPREMA project. Clearly, new channels to acquire data with a focus on the supply chain have to be formed, property right and privacy issues with respect to data require to be solved and transparency along the chain for all actors has to be established.

Numerous data gaps and data uncertainties were identified during the workshops as can be seen at the following quite fragmentary list:

- Land use information and data on unused land;
- Local land markets;
- Local/regional supply chain;
- Participation, prices and market power in the supply chain;
- Different types of demand respective use;
- Quality differences;
- Conversion rates;
- Water availability;
- Non-tariff measures (NTM);
- Fill-rates of tariff-rate quotas;
- Adoption rates and potentials;
- Implementation schemes of strategic plans under the new CAP;
- Different types of biomass;
- Payments for ecosystems;

- Biodiversity;
- Rates of precision farming;
- Operational indicators for SDGs.

Participants agreed the scarcity of information is a major problem because all models need their distinct data which may often differ between models. Modellers have to be flexible in the use of available information but in linkage, the use of different data causes also problems in harmonisation and aligning of model outcomes. To improve the situation in general, the development of a balanced data strategy for the EU would be core which also cover question-like data access and cost of data.

3.1.2 Harmonisation

Harmonisation is always a topic when conducting impact analysis with a suit of models. Then, differences in outcomes across applied models become apparent which can be caused by quite a number of differences, among others for example in

- Units applied;
- Underlying databases;
- Assumptions;
- Parameters;
- Model structure and focus;
- Base period;
- Variables implemented;
- Exogenous or endogenous variable;
- Representation of trade flows;
- Demand side representation;
- Activities covered.

All those and additional others may cause significant differences. In the design of SUPREMA, those difficulties were anticipated. The Task 3.1 compares the baselines of the different models. Conclusions from this task are not yet all available. Hence, in principle, a harmonisation across the models is difficult to achieve as most of the items listed above are at the very core of the models. Nevertheless, harmonisation between models is perceived as an area for further research, especially if models are linked. Although attempts of harmonisation may certainly face marked limitations, models should be harmonised as far as possible. Harmonised model outcomes may play a crucial role with respect to communication but stakeholders have also expressed their understanding that model results may differ and even more, they have stated their perceived need to have different models to generate the outcomes both, to shed light on impacts from specific perspectives and to steer discussions among modellers. In this context, it would also be necessary either to reconcile differences or explain differences. With respect to linkages between models and exchange of model results which may serve as input to other models it was questioned how the different units of variables would be transferred.

3.1.3 Communication

During the 1st workshop, stakeholders expressed need and gave some priority to an improved communication between modellers and decision makers in a harmonised and easy understandable way. Model results should be put forward in a coherent way so that decision makers should get clear understanding where differences in model results would come from. Especially when analyzing

complex issues like sustainability or climate change, there is a need to better explain the results, including the modelling approaches, their influences on the results and their limitations. The stakeholders for example indicated that the discussion and explanation of model results should also encompass what sustainability means with regard to model ecologic, economic and social aspects. The time horizon of the modelling has been identified as being important to modelers while for stakeholders, the differentiation between medium-term and long-term appears not to be as straightforward and relevant when it comes to model-based impact assessments from the other stakeholder groups beyond scientists. Participants perceived that definitions and implementations of scenarios would require careful handling and communication. They agreed that deforestation and afforestation would be important issues which should be reflected in simulation results.

Fulfilling these requests was not seen as unique undertaking but as a continuous process which would require some efforts. Stakeholders suggested some detailed proposals like preparing a condensed one-page outcome with an elaborated annex with detailed descriptions and explanations. In this context, an open question is still what stakeholders would expect as content of a one-pager a this may vary significantly with the background of the stakeholder, his interest and realm of decision.

3.1.4 Model linkage

Model linkages are seen as the option to overcome the huge amount of expressed needs for outcomes on a broad number of topics where model based support for decisions is seen. They are perceived as a chance to cover the increasing interaction between agriculture, agricultural and trade policies, climate policies and a number of other related policies affecting agro-food systems and to derive impacts in economic, social and environmental dimensions. Participants stated that model linkages would be required in future research since policies and policy measures tend to get more complex over time enhanced by the fact that policy areas increasingly overlap so that other policies strongly affect the agricultural sector. In addition to the presented examples of model linkages an integration of the Partial Equilibrium (PE) and the Computable General Equilibrium (CGE) models with bottom-up approach like agent based modelling (ABM) was discussed to provide more detailed insights into decision making of agents to adopt of certain measures. Further, a better interaction and integration between biophysical and socio-economic models was requested to better capture all dimensions of the sustainable development goals (SDGs) and linkages between agricultural and non-agricultural sectors in climate change mitigation. Here, an improved link to energy models was mentioned. Also the need to model the whole supply chain and its interactions with different decision units may require model linkages.

Hence, increased linkages would require improvements in particular with focus on the exchange between the different models, the databases used and how diverting units between models can be overcome. They also play a role during soft linkages, when outcomes from one model were transferred to one or several other models. Here, the development of improved methods would be helpful, especially when also biophysical models have to be linked. Some considerations should also be given to the fact that in model linkage, models would function in ‘symbiosis’ where one would not run without the other model for example as a database or calibration point for the other model. But as a consequence, models could lose the rationality behind the outcomes. Additionally, CGE models considering investments along a whole time-period would face problems to achieve this in a model linkage. In general, it was perceived that model linkages can improve model outcomes, and a combination with multidisciplinary approaches, mixed-method approaches as well as household models should be pursued whereas those linkages have to consider different terminologies within sciences and need to overcome that language issue.

3.2 Special topics

3.2.1 Policies and their implementation

Within the climate related scenario in SUPREMA, stakeholders wanted the EU to be seen in its global environment. In general, an even stronger and more pronounced emphasis on impacts on EU trading partners and developing countries was requested. As focal policies in an international context were seen:

- Sustainable Development Goals (SDGs) which cover a very wide set of aspects;
- Trade policies and issues;
- EU Climate policies with a special reference to the Paris agreement;
- EU's integration in the international supply chain in contrast to local and regional supply chains.

In all those policy areas, SUPREMA models can currently provide insights and policy support but there is also room for improvements on a number of topics reaching from the coverage of local supply change to impacts on non-EU countries, integration of SDG indicators, representation of policies, technology integration, representation of climate measures and including adoption and mitigation to climate change, and to the demand side and food security.

With respect to SDGs indicators, many stakeholders were interested in higher resolution of outcomes than currently available and also to cover SDGs in more detail. It was requested to link biophysical and household level models. SDGs that address inequality and which deal with poverty, food security and gender issues are underrepresented in the current models. For the better integration of SDGs in models, a matrix on SDGs, indicators, sectors and their respective importance would be required.

Within the SUPREMA model family and the CAP related scenario, different policy measures and regimentations can be implemented. Hence, a quite detailed implementation is hampered by not yet clarified policy schemes by EU Member States. Attempts to achieve more insights during the 3rd workshop were not granted success. Nevertheless, it became obvious during the workshops that still further details are required, especially with the increasing prominence of sustainability and climate schemes within the CAP. By now, models focus on market impacts considering other impacts only to a less extent.

However, with climate change policy taking a key role, improvements in policy representation in the models are required as currently a strong focus is on market impacts. Here, one important challenge is to better capture farmers' decision on participation in particular programmes of the CAP which is an outcome of a cost-benefit calculation under 'constraints' from farming systems including transaction cost, administrational burdens and consideration on limited trust. Also policy measures might have different contract lengths which makes it hard to implement them into models (e.g. Eco-schemes have one year duration and AECMs could have a duration of 6 years. Directly linked in modelling are the farmers' decisions and reactions which are the prerequisite for the realistic CAP modelling in case of voluntary measures.

In general, stakeholders requested a stronger embeddedness between farming and ecological issues. They also asked to internalize all externalities in the analysed scenarios which would not point, in principle, to a more detailed policy implementation but to a rephrasing of the analysis.

3.2.2 Farming and behaviour of producers

In most SUPREMA (excluding IFM-CAP) models, individual behaviour of farmers together with the farmers' heterogeneity across the EU is missing or not fully considered in models. Especially reaction on EU policies can be volatile so that understanding farmer behaviour and anticipation of farmers' uptake of for example AEC-measures and risk management tools, or the adoption of technologies is important to properly represent measures and their impacts in models. Also investment decisions and farmers' strategies towards farm size growth, structural change and diversification should be considered in new approaches. Further links and interactions between farming systems and biodiversity as wells as performance indicators are needed. Alternative production technologies together with different technical progress should be analysed to depict the structural changes within the farming sector in a more realistic way. One approach for integrating farmers' decisions is to introduce bottom-up approaches like agent-based modelling or integration of decision making units to capture the changing farmers' behaviour and farmers' heterogeneity.

With respect to farming and climate issues also additional research is required to gain insights into some aspects like the evolution of yields under climate change including effects like CO_2 fertilisation, adaptation and mitigation options under consideration of innovation options and development of risk management strategies.

3.2.3 Consumer, citizens and the food system

Stakeholders indicated that also the demand side representation in models would need some further refinements. Currently, consumers are reflected by a quite homogenous behaviour. Hence, different groups of consumers depict different needs like aging population in developed countries, but also groups with diverting ethical beliefs are impacting the overall demand developments and effects of public demand by citizens towards more animal welfare and improved footprints for climate, water and environment. It is, therefore, of high importance to understand the changing lifestyles of citizens and moreover, for future adjustments to derive the consequences for farmers and the supply side. Important improvement would be a detailed implementation of different consumption patterns and life style (changes) in models. Preferences for organic products, a range of food quality levels or a transition from animal to plant proteins transition will gain importance. They require increasing product differentiations and consumer group differentiation in models, also the representation of short supply chains and the reflection of real costs involved. Here, also a link to health consequences of consumers' choices may help to see the impacts of changing consumer behaviour, in turn, their influence on future consumption patterns, resulting demand changes and consequences to the health system can be depicted. It may also allow capturing consequences of consumers' concerns with respect to food and health.

Internationally, demand and food systems will need to be more and better integrated in models. The nature of global food challenges will be changing away from monothematic approaches regarding only economic, social or environmental problems to simultaneously solving economic, social and environmental problems.

- The food system is encompassing a holistic approach, but it is still a subsystem itself and has to consist of further subsystems.

- No model is covering the whole food system and this will also not be possible in the near future. The food system representation needs collaboration between models capturing national as well as international components.

3.2.4 Value chain

The value or supply chain spans the whole agro-food system from primary production and its inputs to the final use and consumption of products and beyond when residues or waste are regarded. They cover complex relationships between involved agents and the related decision processes. The value chain connects consumers and citizens to producers; all embedded in social, economic, and environmental surroundings, whereas consumers and producers are placed at different levels. Therefore, this network of interactions is not easy to integrate and reflect in models. At current state, the supply chains are only modelled to a very limited amount. In most CGE models, the supply chain is modelled for goods and services but at a very aggregated level. At the moment, the value chain representation can only be described as embryonal or partial with real value chain details lacking and violated assumption of perfect competition in many cases.

Price transmission is not very well reflected along the supply chain in models. Concentration, market power and specialisation in the value chain and, especially the (bargaining) position of farmers in the value as well as the role of producer organisations will need additional research attention. Here, also contracts and vertical integration in the value supply chains should be considered in modelling. Further, the role of public, private and retailer standards and labels should be addressed as they form an additional link with the demand side. They will affect price transmission along the chain differently. An improved understanding of the nature of competition in the markets and testing the implications for the results of the models suggest better impact analysis. Therefore, the model design should capture the material flows of products and also product quality should be taken into account. Critical to capture are efforts to reduce waste along the supply chain and the adaption of new food processing techniques and products.

A topic addressed by stakeholders is employment of labour in the food value chain and here, especially employment of migration. Due to the adoption of new technologies and increased productivity, a lot of labour gets unemployed and moves to other sectors or geographical migration takes place. Due to changing planting conditions also cultivation of different crops may change and could be accompanied by a labour migration. On the other hand, preferences for organic products, animal welfare, etc. can lead to new jobs and additional employment along the food chain. These effects are only partly covered within models and need further consideration for a more realistic modelling approach.

3.2.5 Bio-economy

Bio-economy describes the transition of the fossil resource-based economy into a sustainable bio-based economy. Since this process will take a long time-span with partly unknown processes, products and interactions there is a high need for modelling the transition phase. Expectations on the bio-economy are high, as it should, on the one hand, increase employment and value added, reduce dependency on non-renewables and GHG emissions while, on the other hand, additional emphasis might be put on food security, bio-diversity and prices. Therefore participants asked for a better representation of the whole bio-economy, including bio-materials as well as bio-energy referring also to the fact that innovations in the bio-economy were not considered (e.g. new technologies in bio-plastics).

Within models, bio-economy and here in particular bio-materials and bio-chemicals, are only

represented to a limited degree. For proper representation of bio-economy flows of food and feed, bio-material and bio-energy, waste, residues and other uses with substitutions of fossil based resources would need to be implemented whereas, currently, scarcity of data on bio-based materials and chemicals prove to be a big obstacle. To model the circularity, representation of waste and residues including human waste would be necessary. With regard to these circularities, leak effects would need to be identified. Also for modelling the bio-economy, it is of crucial importance that new technologies are implemented together with proper technology adoption leading to an increased share of bio-economy.

As sustainability issues receive increased priority from policy side (e.g. EU's new Green Deal and Farm to Fork strategy), a focus is put on strengthening circularity. To better reflect circularity, a more detailed representation of product-flows (including by-products, intermediate products, re-used products, product waste) is required, as well as to bring these flows together in a coherent framework like nutrient balances.

3.2.6 Sustainability

Sustainability and sustainability indicators that reflect its economic, environmental and social dimension are seen as a priority by stakeholders. In the past, agricultural policies were designed with a focus on economic and social dimensions and at the expense of ecology while, currently, it happens that the environmental dimension becomes more dominant, so that there is a perceived risk that the development might take place at the expense of social aspects. Therefore, in future an integration of social aspects together with environmental and economic aspects will possibly become more important for assessments.

Assessing sustainability with regard to climate change requires a good biophysical representation of agricultural production, including its interaction with the biosphere and will design indicators for the attainment of sustainability. Within SUPREMA, efforts were put on sustainability indicators at the primary production level for example to account for the CO_2-equivalent emissions related to production of agriculture, notably the LULUCF and also to account for international (trade related) leakage effects. However, the coverage of CO_2 or methane footprints along the whole supply chain provides room for improvements.

Integration of sustainability would allow to consider additional co-benefits of CO_2 reduction on other environmental indications, and especially should reflect for example trade-offs between feed reduction and crop prices. A circularity approach should model effects of closing nutrient cycles in agriculture combined with a reduction in mineral fertilizer use in particular addressing phosphor, reduced import of feed and cutting losses to the environment on nutrient flows and emissions and there are already steps taken to realize such approches which model effects and solutions with respect to nutrient flows and related emissions. Hence, the current strength of the models is the availability of a set of sustainability indicators mainly putting a focus on primary production level. Further room for improvements is exhibited by modelling pesticides use, also an important topic by the society. Coverage of footprints associated with complete supply chains and the consumer by models may require strengthening, whereas a combination with LCA studies may be a solution.

3.2.7 Technological progress and technology adoption

Technologies, innovation processes and adoption play an important role in agriculture GHG mitigation and, thus, in adjusting to climate change. Better technology and technical progress can help to reduce emissions and even reach negative levels. In SUPREMA, some efforts were put on technical progress and supply adaptation comprising mitigation technologies and adoption of new technologies.

However, technology and innovation processes are, until now, often or mostly exogenous in models. Implementation of new technologies within models currently incorporates the uptake under scenario conditions by endogenous model mechanism. Therefore, the uptake is potentially restricted over time by some assumed technology adoption rates. Stakeholders requested that models should consider adjustments due to innovation in inputs, input use and in production systems with respect to climate change in more detail to ensure realistic outcomes and to enable technology adjustment to differ between countries.

Additional points raised by the stakeholders that need to be covered is the need to model adoption of new technologies concerning digitalization, micro robots and automated processes at farm level and, in principle in the supply chain and their determining multiple factors. In this context, arranged factors will play a role and need to be considered such as farm characteristics, technology attributes, public and private norms and institutions but also societal acceptance. Diffusion processes of technology uptake may vary over space and time and may, additionally, involve feedback processes so that endogenizing adoption in models appear as a quite favourable approach. Revolutionary technologies play a critical role in the climate change stabilization and also in achieving SDGs. As endogenizing of technical progress and their adoption will require extensive preparatory research, a short-term solution could be the use of a stronger empirical base for scenario design or model specification based on intensive literature review about precision agriculture as well as digital technologies and diffusion rates linked to technology attributes and other factors.

3.2.8 Other topics

Another important point for stakeholders is a stronger regionalization of scenarios and outcomes. Participants mentioned in this context detailed policies and feedbacks between land use change, emissions and agricultural markets on regional base as helpful. To this end, it would be worthwhile to analyse different strategies for different regions within the same scenario. Since for example CAP policies often apply only on voluntary base and are in parts very regionalised, a highly aggregated model cannot depict the effects on country level in a realistic manner.

Also a number of other, not fully satisfying issues were mentioned, among others

- Water availability, water rights and water use;
- Land use, fallow land, land quality, and conversion between different land uses;
- Volatility markets and their representation;
- Treatment of minor products;
- Modelling the circular economy including residues and waste.

4 Conclusions

SUPREMA showed by a number of medium-term and long-term scenario analyses which also included linkages between different models and limited model improvements the current possibilities of the SUPREMA toolbox to analyse policy options and support policy decisions by empirical evidences. Stakeholders participated in the process to identify challenges and needs of anticipated future policy support and their requirement of model-based policy analysis. They were also involved in defining the narratives for the scenarios to test the ability of the SUPREMA toolbox and finally, to validate the achieved outcomes and improvements in order to help phrasing future research prospects with respect to challenges going beyond the scope of SUPREMA. The whole process of identifying future research needs led to a number of general considerations with respect to modelling and also identified a number of specific topics.

General considerations

During the SUPREMA workshops, four general considerations could be worked out:

- Data requirements and availability
- Model linkages
- Harmonisation among models and model outcomes
- Communication of model outcomes and assumptions

Scarcity of information and its quality is a major problem with respect to nearly all models while they require distinct data which may often differ between models. Modellers have to be flexible in the use of available information but in linkage, the use of different data may cause also problems in harmonisation and alignment of model outcomes. Data limitations are far reaching and encompass wide gaps in diverse areas ranging as far as from biodiversity indicators, over adoption rates of farms, over local market information and information on supply chain, to SDG indicators and NTMs. To improve the situation in general, the development of a balanced data strategy for the EU would be core. The strategy has to reflect different and new data sources, regional differences in availability and to cover questions like data ownership, data access and costs of data.

In general, model linkages are seen as a possibility to overcome expressed support needs on a broad number of topics. Model linkages are perceived as a chance to cover increasing interactions between agriculture, agricultural and trade policies, climate policies and a number of other related policies affecting agro-food systems and to derive impacts in economic, social and environmental dimensions. Participants stated that model linkages would be required in future research since policies and policy measures tend to get more complex over time and at the same time with other policy areas strongly affecting the agri-food sector. In general, it was perceived that model linkages can improve model outcomes and, in combination with biophysical models, multidisciplinary approaches, with mixed-method approaches as well as household models that should be pursued. Those linkages have to consider different terminologies and need to overcome a “language” issue between scientists.

Harmonisation is always a topic when conducting impact analysis with a suit of models. Then, differences across applied models become apparent which can be caused by quite a number of reasons, ranging among others from databases involved, assumptions made, parameters applied, model structures used to time frame regarded and activities covered. Harmonisation between models is perceived as an area for further research, especially if models are linked. Although harmonisation has clear limitations, models should be harmonised as far as possible as harmonised model outcomes are crucial for communication. Nevertheless, stakeholders expressed their understanding that model results may differ and to have different models to shed light on impacts under distinct perspectives.
Model linkages and model harmonisation are strongly related to an improved communication between modellers and stakeholders who would like to be informed in an easy, understandable way. Definitions and implementations of scenarios would require careful handling and communication. Model results should be put forward coherently so that decision makers can understand where differences in model results would come from. Explanations should encompass what sustainability means with regard to model ecologic, economic and social aspects. Fulfilment of those requests is not seen as unique measure but as a continuous process which would require some efforts and time resources.

Special topics requiring efforts beyond the duration of the SUPREMA project

A number of topics was identified requiring additional efforts with respect to future research:

- Policies and their implementation schemes
- Farming and behaviour of producers
- Consumer, citizens and the food system
- Value chain
- Bio-economy
- Sustainability
- Technological progress and technology adoption

Policy measures and their implementation schemes are important elements for deriving model based impacts and are key for model based policy assessment. Agriculture related policy span a wide field of policies ranging from Sustainable Development Goals (SDGs) over trade policies and trade issues, CAP instruments and their implementation schemes together with a special reference to the "Farm to Fork" strategy and the "Green Deal", EU budget and rural policies to Climate Change policies with a special reference to the Paris agreement, up to general economic policies, energy policies and health policies to name at least some. It is the nature of policies to adapt constantly to a changing environment and together with these changes also their implementation and representation in models require adjustments and improvements. A precondition to necessary model improvements is a good system to monitor likely policy changing with their related instruments so that preparatory steps for impact assessments can be taken and linkages of different types of models can be prepared.

In most models, individual behaviour of farmers together with the farmers' heterogeneity across the EU is missing or is not fully considered in models. Reaction to policies can be volatile so that understanding farmer behaviour and farmers' uptake measures and risk management tools or the adoption of technologies is an important condition to properly represent measures and their impact in models. Also investment decisions, strategies with respect to farm size developments, structural change and diversification should be improved. Further links to farming systems and biodiversity as well as to performance indicators are needed. One approach for integrating farmers' decisions is to

introduce bottom-up approaches like agent-based modelling or integration of decision making units to models

Currently, consumers in models are reflected mostly by homogenous behaviour. Demand side representation in models would need some further refinements. Hence, different groups of consumers depict different health needs, diverting ethical beliefs and effects of public demand. More animal welfare and improved footprints for climate, water and environment require an improved representation. Preferences for organic products, differences in food quality land, a more plant-based nutrition may gain importance but deserve reflection in product differentiations and consumer group differentiation in models. A link to health consequences of consumers' choices may help to see the impacts of changing consumer behaviour. Internationally, demand and food systems will need to be more and better integrated in models whereas different types of use will be regarded and economic, social and environmental problems can be considered simultaneously.

In this respect, regarding the whole value or supply chain would help, as it spans the whole agro-food system from primary production and its inputs to the final use and consumption of products and beyond when residues or waste are regarded. They cover complex relationships between involved agents and the related decision processes. The value chain connects consumers and citizens to producers; all embedded in social, economic, and environmental surroundings, whereas consumers and producers are placed at different levels. At current state, the supply chains are only modelled to a very limited amount and if, at a very aggregated level. Price transmission, concentration, market power and specialisation in the value chain and especially the (bargaining) position of farmers in the value as well as the role of producer organisations will need additional research attention. Here, also contracts and vertical integration in the value supply chains should be considered in modelling. Further, the role of public, private and retailer standards and labels should be addressed.

Bio-economy describes the transition of the fossil resource-based economy into a sustainable bio-based economy to increase value added and employment, to reduce dependency on non-renewables and GHG emissions. Since this process is partly unknown and expected interactions are manifold, research is needed for modelling the transition. Within models, bio-economy and, here, in particular bio-materials and bio-chemicals, are only represented to a limited degree. For proper representation of bio-economy, flows of food and feed, bio-material and bio-energy, waste, residues and other uses with substitutions of fossil-based resources data and parameters are scarce, coverage of new technologies and technology adoption is important. To better reflect circularity, a more detailed representation of product-flows (including by-products, intermediate products, re-used products, product waste) is required.

Sustainability and sustainability indicators need to reflect its economic, environmental and social dimension. Assessing sustainability with regard to climate change requires a good biophysical representation of agricultural production, including its interaction with the biosphere and will design indicators for the attainment of sustainability. Currently, efforts on primary production are on CO_2-equivalent emissions; however, the coverage of CO_2 or methane footprints along the whole supply chain provides room for improvements. A circularity approach should model effects of closing nutrient cycles in agriculture combined with a reduction in mineral fertilizer use, in particular addressing phosphor, reduced import of feed and cutting losses to the environment on nutrient flows and emissions and there are already steps taken to realize such approches. Further room for improvements is exhibited by modelling pesticides use. Coverage of footprints may be strengthened in combination with LCA studies.

Technologies, innovation processes and adoption play an important role in agriculture GHG mitigation and, thus, in adjusting to climate change. Better technology and technical progress can help to reduce emissions and even reach negative levels. However, technology and innovation processes are, until

now, often or mostly exogenous in models. Therefore, the uptake is potentially restricted over time by some assumed technology adoption rates. Stakeholders requested that models should consider adjustments due to innovation in inputs, input use and in production systems with respect to climate change in more detail to ensure realistic outcomes and to enable technology adjustment to differ between countries. Additional points raised by the stakeholders covered the need to model adoption of new technologies concerning digitalization, micro robots and automated processes at farm level and, in principle in the supply chain and their determining multiple factors.

5 References

- SUPREMA Deliverable 1.1
- SUPREMA Deliverable 1.3
- SUPREMA Deliverable 1.9

suprema

Annex A: Gaps for future research

Broad topic	Needs	Further followed (in topic)		Narratives	Imple-mented?	Implementation and presentation in 'Strategic prospects'	Comments during ‚Strategic prospects'
Global perspective	**SDGs**						
	• Income distribution and growth	x	Economic elements	• This may be connected to and thus measured by GDP growth • In case of scenarios: include different growth paths for the global economy or certain countries	Implemented	• MAGNET reruns scenario with exogenous area information from GLOBIOM and provides adjusted effects on GDP to CAPRI+GLOBIOM	
	• Environmental degradation	x	Primary agriculture / Supply Chain	• Which is the behaviour of the different actors of the supply chain to reduce the negative impact on degradation? • How to define sustainability? Probably it should be defined in a broader sense, covering both technical aspects and financial aspects. If economic activities are not viable without public support, are they really sustainable in the long run?	Roadmap		
	• SDGs indicators with limited coverage	Beyond scope					• Participants asked to integrate all SDGs in the models, and to calculate indicators to reflect the economic, environmental and the social dimension • Integration should be achieved in a stepwise approach due to its complexity, interaction and divers targets • Necessity to differentiate between developed economies, emerging countries and least developed countries with regard to food security and carbon prices • For scenarios: include different growth paths for the global economy or certain countries
	• Future food demand	x	Consumer preferences	• Preferences for organic products, animal welfare, etc.	Implemented	• Medium-term baseline introduced with a consumer preferences scenario assuming	• Consider consumption pattern change but also consumer

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773499 SUPREMA

				• Social trends, e.g. it is trendy to become vegan • This change in demand can speed up the transition process and 'force' the adjustment of the agricultural sector • Due to new consumer preferences protein transition may occur or demand for local protein production may arise		decreasing meat demand. • However scenario focused on EU-countries • Taxes on meat need to be considered in future scenarios • For long-term scenarios examining possible mitigation strategies emphasis should be put on changes in consumer behaviour to more climate friendly food diet and how to achieve this	preferences for better products occur • Also consumer preferences for environmental products have to be considered in the future • Models should be able to reflect dietary substitutions and to derive impacts thereof (animal vs. plant-based proteins) • Participants highlighted the importance to cover fruits, vegetables, nuts and other commodities (additionally their impact on GHG)
	Climate Change / Low Carbon Economy						
	• Disruptive consumer preferences / behaviour	x	Consumer preferences	• See "future food demand" • In which sense is consumers' behaviour changing? How strong/fast is this change happening?	Implemented	See points under consumer preferences	• How far substitutions between products avoiding greenhouse gases intensive produce is captured in models? • Currently, protein supply in EU is livestock dominated. Models should be able to capture impacts of transition to more alternative protein sources.
	• Internalize externalities (positive/negative)	Beyond scope					
	• Disruptive technologies	x	Supply Chain / Primary agriculture	• Identification of realistic patterns for adoption of new food processing technology • Important issues: evolution of yields, CO2 fertilisation, feed efficiency, adoption of new technology, etc. • Which are the trends that are expected in the agricultural sector? What is the uptake of new technologies that we are expecting?	Partly implemented	• In all model runs to this time technological process is not considered endogenously • Therefore this point is further missing to be implemented in detail within the scope of this project	• Stakeholders requested that models need to consider adjustments due to innovation in inputs, input use and in production systems with respect to climate change • Role of biogenic methane also questioned under technologies: need for consideration in models
	• Technology diffusion, adoption	Beyond scope					• See also "disruptive technologies"
Value chain, market, integration and social concerns	**Value chain, market and international integration**						
	• Bio economy	Beyond scope					
	• Data quantity and quality	x	Only discussed	• Although the use is relevant for all modelling activities it cannot be tackled within the SUPREMA project.	Roadmap		• Participants agreed the scarcity of information is a major problem while all models need their distinct data which may often differ

							between models
	• Distributional aspect of hunger	x	Primary agriculture	• Water availability: To which extend water availability will cause a displacement of production? • Should organic products be subsidised for not excluding low-income classes? What are the specific challenges of small famers?	Partly implemented	• Due to mitigation policies a shift in food availability is projected for some non-EU countries within the models • Downward shift is projected for total calories taken up across GLOBIOM and MAGNET	
	• Private entities take the role of public entities	Beyond scope					
	Social concerns						
	• Productivity gains vs employment	Beyond scope					
	• Sustainability	x	Primary agriculture / Supply Chain	• Main topic GHG • Interaction of EU agriculture versus ROW agriculture. • 'Punishing' EU agriculture to reduce production can be controversial if less 'emission efficient' production is imported • Subsidies/taxes to alter innovation/mitigation strategies but: “Polluter pays” or “Provider gets”? • How to define sustainability? Probably it should be defined in a broader sense, covering both technical aspects and financial aspects. • Land use competition agricultural use versus non-agricultural use (urban, forestry, infrastructure) • Nitrogen use efficiency: Impact of N • Is production consume locally? Would the CAP favour that to reduce emissions related to transport? To which extend is feasible? • Reduction of food waste: Are there any joint interventions that we could assume? Impact on demand strong enough to affect production? • Resource base and degradation: soil situation, emissions: Behaviour of supply chain actors to reduce neg. impact	Partly implemented	• Also important for the topic “climate change” • Long-term scenarios combining the models GLOBIOM, MAGNET, CAPRI and IMAGE on agricultural GHG mitigation strategies comparing an EU carbon tax and its effect in different markets and the RoW • In the future, climate scenario designs have to consider different economic systems in a more consistent way • Model linkages showed a high value for the mitigation scenario (e.g. GLBIOM delivers data on afforestation and energy crop areas which can be used by MAGNET and CAPRI). However, this needs further improvement also to model multidisciplinary issues like climate change in a more consistent way • In the past, agricultural policies designed with a focus on economic and social dimensions and at the expense of ecology • Currently, environmental dimension becomes more dominant, possibly at the expense of social aspects • Therefore, in future an integration of social together with environmental\climate change related aspects in models for assessments will become important • Also an organic conversion scenario with IFM-CAP and CAPRI linkage was	• Participants perceived the integration of sustainability to allow consideration of additional co-benefits of CO_2 reduction on other environmental indications • True pricing of social and environmental externalities necessary • Implementation of SDGs in climate mitigation and sustainability scenarios • The representation of biodiversity, ecosystem services and the topic of the CAP budget as well as topics like employment and job creation or technology adoption are only covered to a limited level or not at all • Additionally it is required to see consumer behaviour in context of its influence on climate change and sustainability

						investigated	
	• Immigration, jobs / migrant labour in food chain	x	Primary agriculture	• Increase in productivity • Adoption of new technology may lead to migrant labour in the food chain • Preferences for organic products, animal welfare, etc. can change production leading to new jobs and migration along the food chain	Roadmap		
	• Climate change	x	Primary agriculture	• Key question: 'what to assume with regard to climate change?' • Extreme weather events • See sustainability	Mostly implemented	• See aspects on sustainability • Model linkage of AGMEMOD and MITERRA brings impact assessment on climate action and nutrient flows • However, no results presented (only tested in Baseline) • Extreme weather events partialy addressed in AgCLim50-3	• Sequestration of carbon and afforestation planting should be also included (partially it is within GLOBIOM) • Integrating land use and land use change • Better implementation of the role of methane • Distinction between long-term GHG emissions and short-term biogenic methane emissions • include the impact of CO_2 on crop production itself • Consider the CO2 pollution from agricultural machinery use and the shorter lifespan of methane • Three main ponts were made: (i) to differentiate the • impact by degree of intensification (e.g. grass based/grain-protein based livestock systems) (ii) to compare a total carbon tax to plan the multiannual financial framework (MFF) budget for climateaction (iii) to define approaches that link models to participate in milestone projects
	• Immigration	Beyond scope					
	Farming challenges: behaviour – markets						
Farming and supply adaptation	• Role of Consumers with respect to organic, animal welfare	X	Consumer preferences	• In which sense is consumers' behaviour changing? How strong/fast is this change happening? • Preferences for organic products, animal welfare, etc. • Social trends, e.g. it is trendy to become vegan • See above		• Medium-term baseline introduced with a consumer preferences scenario assuming decreasing meat demand. • Thus a first insight in changing consumer preferences was realised through a change in consumers' behaviour towards a more climate friendly food diet, and how that	• This type of questions requires collaboration with other scientific areas like sociology and psychology (behavioural economics) • Importance to consider non-EU countries when assessing diets and consumption patterns and

						could be achieved (price driven and other incentives (information, nudging)).	evaluating the effect of the changes in meat consumption trends
	• Supply chain	X	Supply chain	• Which is the behaviour of the different actors of the supply chain to reduce the negative impact of soil degradation situation, emissions etc. • Trade wars • Reduction of waste along the supply chain: Which is the level of cooperation between actors that we could assume? Are there any joint interventions that we could assume? • Adressing of new consumer preferences • Adaption of new food processing techniques (see technical issues in other points)	Less implemented due to data lack		• Changes in consumer behaviour may lead to non-classical market effects (increased demand for local produce) • Effect on supply chain? -> short supply chains • Therefore, also better representation of trade in models required • Improve the implemented behaviour of farmers • Adoption rates of voluntary measures would differ across the EU MS (also effect on GHG emissions)
	• Spread of innovation	Beyond scope					
	Farming risks						
	• Water constraints	x	Primary agriculture	• To which extend water availability will cause a displacement of production?	Not implemented		
	• Adaption vs. Mitigation	Beyond scope					
	• Yield = f (…) e.g. fertilizer, pests, chemicals	Beyond scope					
	• Feed efficiency	Beyond scope					
	• Technology	Beyond scope					
	Other topics raised						
	• CAP policy implementation and changing farmer behaviour	X	Primary agriculture	• Financing: is the availability of finance going to speed up (or curb) the adoption path of new technology and innovation? • Synergies of CAP with other policies might save costs • Representation of the CAP needs definition which measures (and targets) are going to be incorporated • Brexit will impose a challenge with a lot of uncertainty around	Only partially covered		• For the EU, participants requested to analyse adaptation, mitigation, and taxonomy with respect to sustainable finance and sustainable contribution to the society following DNH principle • Future research should not only pursue assumptions based on the shared socioeconomic pathway 2 (SSP2) as those assumptions would be to rigorous and would only allow limited options for endogenous model adjustments • Integration of social together with

							environmental\climate change related aspects in models will likely become important • Necessary to distinguish between voluntary from mandatory measures regarding Eco-schemes • Eco-schemes need a further detailed coverage • Especially with regard to ineraction with AECMs • Separate role of organic farming needs representation in models
	• CAP and climate change	X	Primary agriculture / Supply Chain	• Waste and nutrient recycling within the CAP • Key dimensions of biodiversity within the CAP? • Would the CAP favour that to reduce emissions related to transport?	Implemented	• Addressed within a first stylized scenario: • Different assumption on eco-schemes and the change in EFAs • Change in VCSs is assumed • However results only imposed a first insight and a complete scenario needs to be implemented first where all aspects of the new CAP can be considered	• Difficulties with regard to eco schemes are faced right now: • Adoption of eco-schemes is difficult to include as schemes are voluntary for farmers • Lack of data and heterogeneity of farmer's decisions makes it difficult to implement -> sensitivity analysis? • Assessment on impact on biodiversity of CAP necessary
	• Changing energy prices	x	Economic elements	• changes in energy prices affect consumers and producers	Implemented	• Implemented within the MAGNET-CAPRI-GLOBIOM model linkage • MAGNET can deliver the change in energy prices to GLOBIOM and CAPRI and GLOBIOM delivers forest data • In the end CAPRI processes both model inputs and the effect of model linkage is shown through a CAPRI run without the linkage and exogenous energy prices	• Model linkages and implemented interactions between agricultural and energy models were mentioned a possibility to improve impact assessment
	• Model improvements	x	Model linkages and harmonisation	• Generally raised during needs workshop with no specific challenges	Implemented	Improvements during SUPREMA: • AGMEMOD: consolidation of market network • GLOBIOM and MAGNET: Focus on SDGs • CAPRI: Land use and carbon in non-European regions • MITERRA: Update of LULUCF accounting rules • IFM-CAP: Reduction of execution time	• There is a further need for clarification of the difference between soft- and hard-linkages • Regarding the role of methane in models: establish a methane trade board to avoid the short half-life of it in the atmosphere • Still a problem: insufficient harmonisation of macroeconomic assumptions for EU countries and the RoW • How to integrate Partial Equilibrium (PE) and Computable General Equilibrium (CGE) models in a

							bottom-up approach? • Interaction of Biophysical and socio-economic models? • Harmonisation of different units of variables in models to improve comparability • On the long run, it might be more helpful to differentiate between conventional and organic products allowing different yields, but also in cost of production • Extension of models to cover forestry important also for climate impacts • This would require to model deforestation and afforestation
	• Regionalization	Not considered at this point of the project					• Further regionalization important • Enables an improved connection between consumers and global markets • Allows analysing strategies of different countries in the same scenario