D1.1: THE NEEDS – SCOPE TO ADDRESS NEW CHALLENGES IN MODELLING
DRAFT

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Executive summary

Changes with respect to the DoA

No changes

Dissemination and uptake

This Deliverable is based on the first Stakeholder Workshop held on 1st March, 2018 in Brussels. This Deliverable will be made available to all participants but also to invitees and put on the SUPREMA website.

Short Summary of results

The Deliverable describes the intended scope of the SUPREMA Project. It addresses different areas discussed at the 1st SUPREMA Workshop 'Needs' where the understanding of the challenges and needs posed to the future development of models and model based support for policy actions was emphasised and achieved. The focus was on agri-food systems and policies influencing the agri-food system locally, nationally and on a global scale. A first part comprises the stocktaking which was conducted by a questionnaire to the SUPREMA Partners. The responses were compiled together in a first scoping paper which, in turn, was used to develop the interactive 1st SUPREMA Workshop 'Needs' and to define the roles of Partners within the Workshop. Two objectives were addressed from a policy perspective: We aimed to capture views of stakeholders on the future societal challenges of the Common Agricultural Policy (CAP) and other related policy areas as well as to identify stakeholder needs for model-based analysis (both medium-term until 2030 and long-term until 2050) which may affect the future agri-food system and may require model based policy analysis for an evidence-based decision making.

Evidence of accomplishment

Deliverable D1.1

Glossary / Acronyms

AGMEMOD	AGRICULTURAL MEMBER STATE MODELLING FOR THE EU AND EASTERN EUROPEAN COUNTRIES
AGMIP	AGRICULTURAL MODEL INTERCOMPARISON AND IMPROVEMENT PROJECT
AI	ARTIFICIAL INTELLIGENCE (AI)
BMEL	(GERMAN) FEDERAL MINISTRY OF FOOD AND AGRICULTURE
CAP	COMMON AGRICULTURAL POLICY
CAPRI	COMMON AGRICULTURAL POLICY REGIONALISED IMPACT MODELLING SYSTEM
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
EC	EUROPEAN COMMISSION
FADN	FARM ACCOUNTANCY DATA NETWORK
FP7	FRAMEWORK PROGRAMME 7
FTA	FREE TRADE AGREEMENT
GCM	GLOBAL CLIMATE MODELS
GDP	GROSS DOMESTIC PRODUCT
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	INTEGATED MODELLING PLATFORM FOR AGRO-ECONOMIC COMMODITY AND POLICY
IO	INPUT-OUTPUT

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
MITERRA	INTEGRATED NITROGEN IMPACT ASSESSMENT MODEL ON AN EUROPEAN SCALE
MT	MEDIUM TERM
NDC	NATIONALLY DETERMINED CONTRIBUTIONS
NGO	NON-GOVERNMENTAL ORGANIZATION
NTM	NON TARIFF MEASURES
NZ	NEW ZEALAND
NGO	NON-GOVERNMENTAL ORGANIZATION
OECD	ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT
PE	PARTIAL EQUILIBRIUM MODEL
RTA	REGIONAL TRADE AGREEMENT
SANCO	HEALTH AND CONSUMERS
SDG	SUSTAINABLE DEVELOPMENT GOAL
SLU	SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES
SUPREMA	SUPPORT FOR POLICY RELEVANT MODELLING OF AGRICULTURE
THUENEN	JOHANN HEINRICH VON THÜNEN INSTITUTE
TRQ	TARIFF RATE QUOTAS
UPM	UNIVERSIDAD POLITÉCNICA DE MADRID
VC	VALUE CHAIN

WP	WORK PACKAGE
WR	WAGENINGEN RESEARCH
WTO	WORLD TRADE ORGANIZATION

1 Introduction

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

The Deliverable captures views of stakeholders on the future societal challenges of the Common Agricultural Policy (CAP) and other related policy areas as well as to identify stakeholder needs for model-based analyses (both medium-term until 2030 and long-term until 2050) which may affect future agri-food systems and may require adaptation in model-based policy analyses for an evidence-based decision making.

Prior to the Workshop a number of areas had already been anticipated as likely candidates with respect to required future policy analysis:

(i) climate change and low carbon economy;
(ii) land and water constraints;
(iii) sustainable development goals (SDGs);
(iv) international integration of the agri-food sectors;
(v) integration of agriculture with up- and downstream sectors;
(vi) societal concerns and ethical issues; and
(vii) adoption of new technologies, including remote sensing, robotics and new mitigation technologies related to climate change.

However, stakeholders' perceptions partly differ from the researchers' point of views. Therefore, the Deliverable tries to capture their unbiased perspectives. Also current short-comings in impact assessment and desired improvements in applied models to cover better their (future) needs are tackled as well as option to present outcomes in a more understandable way. Carefully attempts to shape stakeholders' view were avoided. Hence, challenges already mentioned by the SUPREMA Partners were also addressed during discussion with the participating stakeholders. It was not an aim to seek for consensus among the participants, but definitely it was a key to clarify different points of views and arguments.

In the first phase a questionnaire was developed and distributed among the SUPREMA Partners to detail their considerations along an already set suite of issues. Section 2 comprises this stocktaking of already identified needs and challenges featuring the SUPREMA partners' perspective. Based on these outcomes, Section 3 describes the set-up for the 1st SUPREMA Workshop 'Needs', its logic as well as the related instructions. Section 4 details the outcomes of the Workshop. Some first conclusions are compiled in Section 5.

2 Needs and challenges from the SUPREMA partners' perspective

2.1 Approach

To serve as input for the Workshop a questionnaire was developed and distributed among the SUPREMA Partners to detail their considerations for the suite of issues discussed before. All Project Partners returned their responses. Issues mentioned in the responses were allocated to the topics already selected to be relevant. In most cases subgroups are formed. Issues mentioned are depicted below in section 2.2 to section 2.10.

2.2 Climate change and low carbon economy

SUPREMA Partners considered different challenges in climate change debate and their representation in models as an issue in future assessment for policy-support. Among those *treatment and representation of uncertainties in climate change* have been mentioned covering topics like:

- Climate impacts on agriculture and effects of climate mitigation;
- Uncertainties in global climate models (GCM) and in crop models;
- Global climate policy projections;
- Occurrence and intensity of extreme events.

Additional *uncertainties arising from feedbacks* need to be analysed as well, such as:

- CO_2 fertilization effects;
- Cost-effectiveness of mitigation technology options;
- Adaptation to climate change in the agri-food sector.

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Another area that will need further investigation and implementation is the future *share of different uses of agri-(food) products, their importance and their allocation* under climate change and under the concept of low carbon economy:

- Food versus feed versus energy versus other bio-economy uses of agriculture raw material;
- Demand of biomass for low carbon targets development in other sectors outside agri-food;
- Sustainable bioenergy potentials;
- Feedbacks from energy and other sectors.

A third area of challenges deals with the *policy design and its implementation in models*:

- Designing policies that are efficient for society;
- Greenhouse gas emissions mitigation policies and their combination with CAP;
- National Energy Plans;
- National Climate Plans or representation of current country commitments i.e. Intended Nationally Determined Contributions;
- Real world climate policies.

Several models covered in SUPREMA deal with climate impact assessment. However, all these models provide only point estimates. The underlying technical coefficients are highly uncertain, and so those uncertainties are reflected in simulation model outcomes themselves. Furthermore, the relation between climate gas emissions and climate change is non-linear in such a way that the damage respectively cost of 'unlikely outcomes' (the fat tail) are sufficient to influence the efficiency of evaluated policies for the 'expected outcome'.
Impact analyses will benefit from improved uncertainty analyses. To alleviate these problems model-based analyses should rely on a combination of theoretical and numerical work, e.g. analytical derivation of the distribution of model outcomes as a function of the distribution of parameters and of model marginal behaviour combined with numerical methods or sampling routines.

2.3 Sustainable development goals (SDGs)

A number of topics mentioned can be attributed to *the macro-economic environment and the differentiation of different population groups* and their representation in the models

- Distribution of resources, income and equity of population groups;
- Economic growth;
- Distribution of income and assets;
- Land ownership;
- Poverty;
- Employment, unemployment and hidden unemployment.

Another group of challenges covers *directly populations' situation with respect to its wellbeing*:

- Ending Hunger;
- Climate;
- Distribution micro nutrients and proteins;
- Health;
- Improved food security indicators and food quality.

The third group captures challenges with respect to the *coverage of supply and its representation* in models:

- Fishery and aquaculture;
- Productivity development and components;
- Waste;
- Biodiversity respectively improved biodiversity representation.

The last group of challenges under this topic put focus on the SDGs themselves, how and to what extent they could be integrated in the models:

- Cover all the SDGs within a consistent framework that allows to analyse trade-offs and complementarities;
- Inclusion of SDGs;
- Reduction of complexity of SDG indicators;
- SDG-13: 13.2 integrate reducing pressure on environment in national policies;

- SDG-9: 9.1 build innovative, resilient and sustainable agro-food industry to support economic development;
- SDG12-12.3 reduction of food waste along production and supply chain, including post-harvest losses;
- To understand the conflicts and synergies between climate policies and poverty globally.

2.4 Land and water constraints

Constraints on land and water availability provide significant challenges for future agri-food systems. Here a number of improvements are required.

With respect to land the following issues have been mentioned:

- Accurate land use information and data on unused land;
- Uncertainty and gaps in global data on land including conversions aspects;
- Multi-cropping index unknown and yields in multi-cropping;
- Yields on currently non-agricultural land;
- Model local land markets: Does brute-force modelling of local land use based on satellite image data make sense?
- Land dynamics with respect to artificial, developed and urban land;
- Agriculture land loses to non-agriculture purposes.

In the representation of water and water use also a number of unsolved issues exist:

- Uncertainty and gaps in global data on water availability;
- Spatial and temporal resolution of water availability and requirements;
- Potential for irrigation expansion;
- Impact of water availability on yields;
- Irrigation technologies: current status, effectiveness, cost;
- Water market modelling for agriculture and non-agriculture;
- Adaptation and investment in irrigation and water use;
- Climate extreme events' impacts on irrigation;
- Irrigation system parameterization incl. adoption;
- Water pollution.

In addition, changes and interaction with forestry have been mentioned

- LULUCF (land use, land use change, forestry) – 2030 targets;
- Topic of soil and water quality and ways to Improve water, air, and soil quality

2.5 International integration of the agri-food sectors

Challenges in international trade are high.

They cover topics with respect to *data availability and technical issues* with respect to

- Non-tariff measures (NTM) in place;

- Tariff-rate quotas and their usages (fill-rate);
- Handling of zero trade and potential rise in trade;
- Treatment of quality differences.

And topics with respect to the *international value chain, (market) power and firm size*

- Ownership of land in a land (land grapping) versus increasing trade;
- Market power and standard setting of international firms;
- Growing size of firms and imperfect competition;
- International value chain;
- Efficiency gains from trade (Melitz) and rents in trade.

A number of issues exist on the *global demand side*

- Projections of global demand with convergence of diets;
- Different types of foot prints (emission, water, energy, land) and to develop policies that are efficient on the global perspective.

And on the *global supply side*

- Technology transfer and yield gap analysis;
- Understanding cost competitiveness of different countries;

With respect to *policy design and implementation* challenges deal with

- More or less protectionism;
- New protection policy;
- EU agri-food trade potential with 3rd countries in relation to protectionism (Brexit, USA) and food distribution (zero hunger);
- Trade policies driving international trade or vice versa;
- Link between trade openness and competitiveness.

Designing efficient policies for global issues requires us to consider the interaction of the agri-food sectors of different countries while policy makers shape policies only with respect to mall parts of the world. Unilateral policies applied for global public goods such as reduction in climate gas emissions are likely to become inefficient. One opening to overcome such problems could be to compute 'content of externalities' in traded commodities. While running a risk of conflict with international trade agreements, it would nevertheless be of scientific interest to apply such computations to find ways to tax/reward public-good-deliveries at the border between markets. This approach would also allow individual countries to proceed with *unilateral* policies without damaging competitiveness (no race to the bottom).
It might be feasible to develop a generic IO-model that takes global production and trade data, such as outputs from CAPRI or MAGNET, together with production-based coefficients of any kind, such as some emissions caused by production, and computes the implied "content" of the emissions in the traded commodities, i.e. a kind of flexible life cycle assessment model.

2.6 Integration of agriculture with up- and downstream sectors

The integration of agriculture with up- and downstream sectors is important as decisions and market outcomes are strongly influenced by it, as well as externalities are generated or avoided within the chain. Whereas agriculture represents only a limited slice of the chain while main income is generated in processing and distribution.

Challenges are in the *representation of the market structure*

- Market imperfections;
- Power asymmetry in the chain;
- Market power of the processing and retail chains insufficiently modelled;
- Information asymmetries;
- Projections of regional cluster developments;
- Impact of value chain on producer prices.

Challenges also provide *the coordination of value chains and their affects*

- Vertical integration;
- Coordination and digital coordination of in the value chains;
- Pricing respective cost on different levels and their transmission along the value chain;
- Product differentiation and branding becomes increasingly important;
- Efficiency gains through integration;
- Environmental problems through integration;
- Integration as condition for adoption (2nd generation biofuels).

Additional topics with respect to the value chain are

- Genome-editing;
- Waste treatment along the chain;
- Developing a Circular economy will require insights in new technologies that can either reduce losses (other harvest methods); close nutrient cycles; and/or lead to re-use waste (new bio-based industry options);
- Improving the efficiency of the food systems especially in developing countries.

2.7 Societal concerns and ethical issues

Societal concerns arise from consumer *perception of agriculture production systems*

- Animal welfare, free ranging, antibiotics;
- Size of GHG emission;
- Organic agriculture;
- Gen-techniques;
- Bioenergy production (food versus feed versus bio energy);
- Biodiversity as a societal objective;
- Circular economy, closing the system i.e. fertilizer etc.

Societal concern may cover with *individual diets and their compositions*

- Healthy and sustainable diets;
- Share of conversional versus vegetarian versus vegans diets;
- Diets and behavioural change;
- Differentiated demand for differentiated products.

Also *quality aspects* are of societal concern

- Food quality;
- Label of origins, other labels - revealed versus stated willingness to pay;
- Controls in food production and processing.

Another group comprise

- Different measures to limit disease
- Or the spread of diseases.

These measures may interact with aspects of international trade.

Additional topics of societal concern can be summarized by the equity debate

- Smallholder – land ownership inequality;
- Size of holdings and changes hereof;
- Equality: intra- and inter-regional, land grabbing etc.;
- Zero hunger versus food waste

2.8 New mitigation technologies related to climate change

Challenges in new mitigation technologies are missing knowledge on their *adoption, impacts and cost*

- Technological effectiveness and side effects (yields);
- Adoption and enabling conditions;
- Country level particularities;
- Combined effects unknown;
- Cost unknown;
- Adoption of new technologies by applying multiple linear technologies and accept that reality may be non-convex and develop corresponding models/solution methods;
- Precision farming;
- Nitrification inhibitors;
- Accurate parameterization of currently available mitigation options i.e. adoption rates, costs;
- Representation of new options i.e. algae, vertical and urban agriculture etc.;
- Soil carbon sequestration options, soil degradation, restoration etc.

2.9 Adoption of new technologies, including remote sensing, robotics

Challenges in new technologies are similar to mitigation technologies. Also here knowledge on their *adoption, impacts and cost* is missing

- Technology effectiveness;
- Costs;
- Transferability of current or historical observations into future;
- Dealing with unpredictability and jumpiness of innovations;
- Relevance of farm structure for application of new technologies;
- Appropriate modelling of the adoption of new mitigation (or other) technologies faces a multitude of challenges;
- Behaviour of agents to adoption of technologies is unknown;
- Internet of things;
- Smart farming;
- Adoption potentials and scaling, data availability.

Uncertainty on the technical effects and costs of single technologies and their combinations needs to be addressed. This may be predominantly a problem of stocktaking of the technical literature but also one of treating of uncertainties in economic modelling. Topics may suffer from "waves of support" say for bioenergy crops or for carbon sequestration through tillage options, where initial optimism had been replaced by widespread rejection and now some cautious reanimation.

A second layer of complexity is introduced by farmers' behavior. Each Farmer has a personal background in education, capabilities and preferences and may not follow the simple cost benefit calculation as hypothesized by the researcher. While given data and econometrics may reveal other determinants an ex-ante statistical analysis is impossible for unknown or hardly know technologies. Instead it might be possible (or not) to transfer experience from other (older) adoption cases. Adoption may also be linked to farm structure which is changing over time, but only slowly. Also policy constraints might be targeting the largest farmers predominantly such that the adoption issue is interlinked with some hypothesis on farm structural change.

Furthermore adoption of technologies may be influenced by network problems which may be partly influenced by political support (RD policies). It has frequently been argued that a key explanation why second generation biofuel feedstocks have hardly been used is because they require coordinated efforts on the part of clients (biofuel producers) and a fragmented group of potential suppliers (famers). These coordination problems may also hamper the further expansion of anaerobic digestion plants if the gas is of insufficient quantity for the public network.

2.10 Other topics

Genetic base, new diseases and regional movement of species may cause serious yield losses:

- Narrowing of genetic base as a risk (banana example);
- Spreading of diseases (bees) or pop-up of new diseases;
- Spreading of invasive species

Environmental issues

- Environmental problems of aquaculture;
- Farm level environmental policies;
- Environmental constraints in regions.

Pesticides and fertilizers

- Pesticides impact on yields;
- Pesticides impact on production cost;
- Transport of pesticides in water;
- Health and biodiversity impacts of pesticides;
- Regional surplus of manure;
- Limitations in phosphor availabilities.

Fish

- Interaction between the fish sector and agriculture;
- Substitutions between aquaculture, fisheries and livestock products;
- Limitations and options in aquaculture.

3 Concept of the Workshop “Challenges and Needs”

3.1 Objective

Following the inventory of challenges from the modelers’ perspective the objective of the Stakeholder Workshop “Needs” was organized to get insights into the view of stakeholders with respect to their view on future challenges of the agri-food sector and related policies and to identify stakeholders’ needs for model-based analyses, both in medium-term until 2030 and in long-term until 2050, to support evidence based on policy making. Also current short-comings in impact assessment and desired improvements in models to better cover future needs were emphasized as well as option to present outcomes in a more understandable way. In addition priorities of stakeholders were identified. Not in all cases a consensus among the participants was achieved and also not aimed at because different stakeholders may follow diverging objectives; however different arguments were clarified.

3.2 Participants

In total, about 50 participants respectively organizations were invited to the Workshop. In a first go, lists of 42 designated stakeholder organizations were compiled and were invited per email. If there was no reaction, a second email with a reminder was send. In course of time additional organizations were addressed and persons were also contacted on an individual, bilateral basis to guarantee broad participation which was significant to conduct a successful Workshop. However, in total 36 persons participated, hereof 15 from the Partnership, 6 persons from the External Advisory Board and 15 stakeholders. The Workshop “Need” required participation of each project partner which had been assigned active and passive roles which explains the relatively high participation rates of partners. In contrast, stakeholder participants are in one way or the other active in a policy environment so that their final participation depended on the daily business and no-show numbers are mostly quite high.

Stakeholder participants came preferable from different actor groups along the agro-food supply chains including actors and stakeholders like farmer organisations, industries, NGOs and society, policy makers and public officials, as well as the scientific community. The group of invited persons also includes participants from the Validation Workshop ‘Medium-term development of agri-food markets in EU Member States’ held on February 28, 2018 in Brussels actively contributing to the validation of the Baseline projected by the AGMEMOD model.

3.3 Design of the Workshop “Needs”

The Workshop “Need” was planned as an interactive Workshop with an active participation of each attendee. The design includes the following components:

- Introduction of the project by the SUPREMA partners;
- Round table introduction of the participants;
- Initial statements concerning the topic by the External Advisory Board (EAB);
- Setting the scene by stakeholders: defining of future challenges for agriculture and agri-food systems by writing topics on cards with respect to challenges and needs

  - in the medium-term (up to 2030)
  - in the long-term (up to 2050).

  Each participant got a set of yellow and green cards (with a maximum of 5 each) to note challenges and needs with regard to the medium-term up to 2030 (yellow) and to long-term up to 2050 (green), and then they were asked to put the cards to two separate flipchart sheets which was done in plenary.
- Interactive session with three parallel expert group discussions on different selected aspects whereas challenges, needs, and shortcomings of the current model outcomes were discussed. Following aspects were grouped under three following headers:
  - Global perspective on
  - climate change and low carbon economy;
  - sustainable development goals (SDGs);
  - land and water constraints;
  - Market and value chain perspective depicting;
  - international integration of agri-food sectors;
  - integration of agriculture with up- and downstream sectors;
  - societal concerns and ethical issues;
  - Farming and supply adaptation comprising;
  - new mitigation technologies related to climate change;
  - adoption of new technologies, including remote sensing, robotics;
  - restrictions in farming related to environmental regulation.

Given that under the Chatham House rules no recording of any part of the Workshop "Needs" were taken, a moderator and a rapporteur were allocated for each discussion group. Rapporteurs took notes of the discussion groups and prepared an overview of the group discussions. Moderators and rapporteurs were given detailed instruction on how to conduct respectively to Deliverable on the expert groups.

These expert groups were held in parallel for 60 minutes. Participants of each group were defined prior to the Workshop to avoid choosing of participants. The moderator was supposed

- to ensure the questions are discussed adequately, taking into account the planning of time;
- to facilitate each participant to come-up with contributions (e.g. What is your idea about …),
- to ask and discuss issues that were unclear (e.g. I understood that you want XYZ? Is that correct? Or could you please provide an example?),
- to raise obstacles when needs cannot easily be achieved (e.g. to cover the need we will require data which we currently do not have. Do you have any idea how to deal with it?), and
- to steer the discussion that all questions were covered.

The moderators were asked to act relatively guarded and to minimize their personal interventions.
Questions which were addressed in the discussion were the following:

- Which future challenges do you see in the area of the indicated topic (mentioned above) which will require model based analysis?
- If you need to take a decision what would you need to do that?
- Which shortcomings to do see with respect to already available results?
- What options do you see to overcome obstacles to achieve the required outcomes?

Based on the notes of the rapporteurs, with the help of the moderator and of other participants from the partnership first results of the discussion groups were compiled and put in key words on six flip charts (two per heading). Preliminary wrap-ups of outcomes were shortly presented by the moderators of the expert groups. Afterwards the six flip charts were used as starting points for the running world café.

- Running World Café

Each of the three headers had two flip charts with preliminary outcomes from a stakeholder perspective and again moderators respectively rapporteurs were assigned. The external participants were asked to go from flip chart to flip chart and to provide additional challenges and needs, supplements or comments to the different flip charts and to discuss the topic with others at the flip chart.

- Two members of the EAB gave some insights and observations from their perspectives.
- Priorities

Finally stakeholders' priorities were identified. Each participant were handed five points in different colours (assigned to the different headers global, value chain, 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.

4 Outcomes

4.1 Setting the scene by stakeholders - defining of future challenges and needs

4.1.1 Medium-term

With respect to the medium-term related challenges and needs the following issues came up which were aggregated in the following groups (pictures of the flip charts can be found in annexe A). The items represent unguided perception of the different participants which in combination not always provide an aligned view or may even contradict each other depending on the specific perspective. It was not aim to achieve a consensus among participants with quite different background. However, the list does not reflect "the" group perception but a perception of one distinct participant within the group.

- Policy and governance
    - EU leading science and policy globally is on the way
    - CAP in general
    - CAP after 2020 and multidimensional indication
    - Global governance
    - SDGs leading towards policy coherence
    - Account for cross-sectoral effects of policies
- Climate change and climate change mitigation
    - Full carbon cycle consideration for agri-food
    - Transition to low carbon economy
    - Climate neutral (production/consumption)
    - Biogenic emission versus fossil emission
    - Fossil sector hijacking agriculture / GHG removals off the hook
    - Climate change impact on agricultural production
    - Climate change adaptation
- Boundaries and availabilities
    - Planetary boundaries and resource scarcity in general
    - Energy
    - Water (quantity and quality)
    - Nexus approach – food – water – development
    - Regional productivity threats from resource degradation
    - Land use
- Addressing SDGs
    - Hunger
    - Power
    - Economic development
    - Distributional consequences on welfare (rural – urban discrepancies; with respect to different income classes
    - Dietary transitions and its implications for nutrition and health
    - Undernutrition, over nutrition

- Safe guarding environment under SDGs
- Environment
  - Impact of agriculture on environment (and farm practices that reduce its impact)
  - Environmental problems solved
  - Environmental degradation
  - Environmental indicators linked with economic output
  - Environmental footprints of food production
- Sustainability
  - How will sustainability impact agricultural products supply
  - Who will pay for sustainability?
  - Sustainable intensification
  - Environmental and social sustainability
  - Will it (sustainability) be a cultural change?
- Market with respect to demand and prices
  - Agricultural product demand at different (regional) scales (what do farmers needs to produce)
  - Markets and prices
  - Higher consumer demands in food
  - Dealing with volatility e.g. weather
  - Agricultural quality of raw material for food safety
- Social aspects
  - Inequality across households and regions
  - Economic and social inequality
- Structure
  - Market structures
  - Farm structure
  - Structural changes
- Rural situation
  - Rural economy thriving
  - Rural abandonment
- Ensure resilience
  - Price volatility
  - Young farmers
  - To improve risk management
- Behaviour
  - Basic economics
  - Consumer behaviour
- Technologies and innovations
  - Transition in employment caused by IT (digital revolution)
- Modelling
  - Models facing sport similar crisis – modellers generation change
  - Integration of technology in EU farming (family) model

4.1.2 Long-term

Long-term challenges and needs are treated in the same way than medium-term related issues (pictures of the flip charts can be also found in annexe A). Items mentioned from participants were

- Governance and political environment
  - Geopolitical conflicts
  - Coordination with other global regions
- Population and demography
  - Change in population
  - Rural population
  - Demography
  - Poverty and failed current demographic trends
- Climate change, emissions and mitigation
  - Climate (development)
  - Complete decarbonisation versus security in supply of food, energy, eco-system services
  - Mitigation
  - Climate change and weather shocks
  - Fossil emissions 80-95% reduction, biogenic emissions balancing with removals
  - Circular economy fully interpreted in biogenic emission removals
  - Circularity
- Resource base (land, water, fertility of soils, etc.)
  - Natural resources
  - Availability of agricultural land
  - Land use
  - Agriculture and food production without land
  - Energy – transition to renewables
  - Water scarcity
  - Water (quantity, quality)
- Environment and sustainability
  - Sustainability of pre-conditions, a lot of external effects internalised
  - Environmental sustainability
  - Environmental needs
  - Environmental impact on use and production
- SDGs
  - Zero hunger
  - Follow first degree carbon pattern while not violating all other SDGs
  - SDG Indicators
  - Food security and water supply
  - Food security
  - Welfare
  - Undernutrition
  - Over nutrition
  - Inequalities

- Economic development
- How will the demand from developing countries change

- Changing society
  - Distributional issues and growth
  - Employment
  - Food demand
  - Personalised diets
  - Nature of jobs
  - Over nutrition
  - Inequalities
  - Economic development
  - Emotional intelligence playing bigger role
- Markets, value chain and structures
  - How will the demand from developing countries evolve (dairy markets)?
  - Agricultural raw materials (quality and quantity)
  - Imperfect competition
  - Structural changes from family farms
  - More industrial agriculture
- Technologies
  - New technological challenges – food on Mars
  - Role of artificial intelligence (AI) in the sector
  - Modelling technologies – new

4.2 Expert Group Discussions

4.2.1 Global

The expert group "Global" concentrated on the issues with a strong global perspective comprising topics like climate change and low carbon economy, sustainable development goals and constraints in resources like for example land and water. Following questions were addressed and discussed:

- Which future challenges do you see in the area of the indicated topic (mentioned above) which will require model based analysis?
- If you need to take a decision what would you need to do that?
- Which shortcomings do you see with respect to already available results?
- What options do you see to overcome obstacles to achieve the required outcomes?

The following statements reflects the view of stakeholders' participants; however, it may not have been the consensus in the group but it does captures at least single views within the group which may indicate the diversity and the range of topics of interest which might come up later as questions for policy analysis.

Participants mentioned that – on a perspective of 15 years - future projections would be unreliable with respect to trade outcome. Especially in fast growing countries Income growth would be very high and how this growth would translates in food demand and other use is unreliable as the development would be non-linear. Also the future situation in other sectors like in energy and services would be important for the baseline. Participants emphasised that demand based on income projections may be tricky because income distribution and its development will play an important part in future food demand globally. In this context a participant indicated that Japan has developed a simple indicator "food security" which might be worthwhile to consider. Deeper food demand analysis in combination with already mentioned challenges will be key for baselines; similar like the development of the GDP itself.

Participants also discussed that environmental back loops should be taken into account as environmental degradation would have impacts on agriculture and vice versa and would lead to opportunities and constraints. If environmental degradation would be societal unacceptable new or changed legislation would follow imposing constraints on agriculture like e.g. less inputs which would in turn reduce environmental degradation and at the same time would induce benefits for agricultural economy. Hence, those types of feedback loop(s) would be difficult to model. Damage to the environment can affect water, soil, biodiversity which would be needed to be integrated into economic models. It would be good to have such loops already in the baseline, but it might be easier to have them in a scenario. At Member State level, it appears quite fuzzy how developments in certain sectors might be restricted therefore it was considered to be easier done by scenario analysis.

Another view was that environmental restrictions would affect the output and that environmental degradation itself would have a negative impact on economy, e.g. water over-extraction, soil degradation, water pollution. Also climate change feedbacks should be considered which would be very complicated but would be required. In this context it is questionable what the baseline should cover. The example of the Paris agreement (1.5 °C) was raised and asked whether this would be considered in the baseline or in a scenario. For an impact assessment it would be very important whether a full implementation of the legislations would be simulated in the baseline (and otherwise the need for other measures would arise) and whether legislation would be implemented as binding or as non-binding. The topic low carbon economy was mentioned and how it would affect the sector also in connection - from a policy point of view – with the biofuel and the bioenergy issue.

From a decision perspective it was regarded necessary to zoom into the topic of global ramifications of increased European standards in production and processing which may lead to more trade or may act as trade barriers. Within the EU, the CAP would compensate for higher standards in raw material production. With respect to SDGs demographic issue in Africa were discussed.

In the case of trade agreements sustainability aspects should be addressed more deeply. Participants saw that societal demand would exist for healthy food but whether this is equivalent to sustainable food was discussed. There was a perception of "pesticide polluted" food produced outside the EU which might induce a "snowball effect" of increased societal worries outside the EU.

Participants stated that to their mind policy should be about people and that subsidies could have opposing effects by hampering people as sometimes subsidies are (too) simplistic constructed in respect to targeting and tailoring. Researchers and policy makers should be more active and should additional approaches like carbon tariffs, carbon taxes and international pricing of carbon.

Some participants perceive trade policies would only provide limited options with regard to bilateral agreements therefore multilateral approached should be pursued. Others stated that food security would be strongly influenced via non-tariff barriers on trade flows.

Weaknesses and shortcomings of models for current policy decisions are seen in a limited reflection of demand dimensions in the models as well as in data unavailability and data limitations.

Participants pointed out that agricultural trade should reflect better empirical results. If outcomes were unreliable it might be a better option to ignore those outcomes and to turn – instead - to qualitative analysis often provided from consultants. To revise parameter estimates to achieve better fitting results might be a long way to go.

Participants presumed an implementation of the Paris agreement would have greater impact than any trade agreement and would affect also trade balances.

Needed improvements were seen by participants also in the area of land use in general. Rural abandonment in Europe and outside of Europe should be better explained. Also issues like land use in competing sectors, land withdrawal and urban sprawl on agriculture land and maintenance of traditional landscape should be tackled in a more detailed way. Also changes in policies in a kind of non-intervention direction which could lead to a more sustainable land use where not all hectares would need to have a function. But some functions are exclusive and should not be hampered. Yet another issue discussed was to provide insights where the land for massive growth of biomass would be planted. Also the loss of certain habitats, not only forests, where discussed while currently the EU protects "man-made" habitats (keep them managed) which would contrast positions of other countries.

Several contributions dealt with climate change and climate mitigation. Here the interaction between growth and climate change were addressed and that growth would be still more relevant at policy level driven by e.g. fear of "slowdown of growth". Insights were required in "quasi competing " versus "complementary activities". Mitigation should be analysed more, but not on aggregated level with models for trade agreements. Also reductions of GHG emissions from livestock should be studied more whereas marginal improvements may already have significant effects. Harmonizing rules for investment upfront was also discussed as helping climate change mitigation.

Participants saw it as relevant to do model adaptations with respect to water to allow studying effects like, e.g. change to less water intensive crops or to withdrawal more water. In this context a better link

between hydrological and economic model(s) was asked for. Participants requested to handle spatial issue of water like water basins, like for example in Morocco which would be very data intensive. Issues of water quality and water quantity were regarded as key as well as modelling water markets.

Some model specific problems were mentioned: like the estimation or calibration of certain model parameters, e.g. if new technologies, new products, new policies, new activities should be integrated cannot be observed or the resolution of models.

In the view of the participants a number of topics are implemented only partly, not satisfactorily or not at all:

- Population developments, migration rates and changes, demography;
- Models should go far beyond the representation of the agricultural sector to cover, e.g. employment;
- Distributional issues and 2nd pillar measures;
- Loss in social capital (demographic in regions and movements of people);
- Representation of biodiversity in models;
- SDGs' role which have very big mandate and would require to study sustainability across different topics;
- Deeper environmental analysis;
- Regional equity which could be acquired by sharing and sparing (example: actively put policy in place to reduce meat consumption which would allow developing countries to increase meat consumption);
- Lifestyle developments;
- Legal difference of between different types of subsidies to derive whether they are crop specific or not with respect to WTO
- Input – output database
- The use of pesticides which could make use of a huge monitoring network where as a concentration should be on hot spots and less on modelling flows
- Interaction between economists and other experts

With respect to the long-term horizon it was deeply discussed what long-term would mean and should be modelled with respect to long-term. 2050 should reflect more strategic developments and should be used more for strategic communication, whereas a desired future should be checked for consistency by model results. With time horizon of 2020 many impacts would lag behind while when shocks would be implemented today effects could be considered in the year 2030 or 2050. Whether SDGs should be considered the long term or in 2030 was an open topic. Additionally there was a debate if long-term would not better be regarded in 2070. For low carbon economy, a development path was discussed between 2030 and 2050. However, it was unclear whether climate change would not be required to the reflected not only in scenarios but in the baseline as well or only in explorative scenarios. Until new geopolitical conflicts would pop-up and it is unclear how they can be modelled. Different SSP would be inconsistent with real world. Participants also presumed that diets and health would change dramatically until 2050. In all, medium and long-terms simulations would be needed. But a circular economy would require not the business as usual options but thinking out of the box. In this context, the focus should be on the global level and models would be made fit enough to take on board technology transfers from developed countries to developing countries, additional migration or increasing productivity. Technology diffusion in models would be technology dependent. To reflect (international) share efficient technologies in contrast to trade options would require that trade

models could start new manufacturing sectors; new productions or new trade flows from zero and also to cover imperfect competition. The question was raised how the models could deal with to major shocks and changes in the dynamics of the systems as only average price responsiveness is represented. Also a conversion of "unused" land to agricultural land and the switch from forestation to deforestation and the other way round should be implemented in models for future use. Participants would also like to see economic impacts of biodiversity degradation.

4.2.2 Value chain

The expert group "Value Chain" concentrated on the area of markets and value chains depicting in more detail the international integration of agri-food sectors, the integration of agriculture with up- and downstream sectors, as well as societal concerns and ethical issues. Like in the expert group "Global" the following questions were addressed and discussed:

- Which future challenges do you see in the area of "Value Chain" which will require model based analysis?
- If you need to take a decision what would you need to do that?
- Which shortcomings do you see with respect to already available results?
- What options do you see to overcome obstacles to achieve the required outcomes?

Participants stated that models should be prepared to cover on the medium-term (10-15 years) the following issues:

- Productivity should be covered in entire value chain and not only in the primary sector;
- Qualified labour would be or would become a topic in future in developed countries as well as the transition of employment;
- Models should be prepared for BREXIT and FTAs, RTAs;
- GHG emissions and the soil situation and their imparts would need to be captured;
- Sustainability in the value chain would be asked for by customers (e.g. dairy), which would require additional efforts and accrued cost should be integrated in models at every level of the value chain;
- Food and nutrition would need to be prepared for climate change while most models only have represented agriculture;
- Health issues;
- In addition, competition between biomass and other uses than food and feed should be analysed by going beyond the agricultural sector;
- Major challenges would be seen data availability and data quality. It would be important for developing strategic plans under the new CAP. Especially the use of FADN data should be improved;
- Use of antibiotics challenges to reduce it and developments in microbe-resistance would have impacts on markets and models should reflect on them;
- Consumers would ask increasingly for shorter and local value chains;
- Strong structural changes in agriculture and processing (induced by new technologies, innovations, digitising, generational renewable at farms) would be expected which cannot be covered by models yet; especially as it would be unclear what would drive those structural changes.

On the medium-term participants perceived the following risks:

- BREXIT specifically and trade agreements in general would have a huge influence on the value change;
- Weather circumstances and extreme weather events like droughts (also influenced by climate change) could have big impacts on yields and shorten supply for the value chains;
- Increasing lack of cooperation between countries and groups of people (BREXIT is a symptom) with the growing risk of trade wars and dispersion of technological changes hampered;
- Private entities could take over the role of public entities inducing more technological changes;
- Renationalization of food supply with regional food production systems although there is no evidence this would be more sustainable;
- Climate changes and it emphasis on dairy trade was mentioned as well;
- Feedback loops could have mitigating effects, but also enhancing effects. The question was raised what changes in technologies could be done for the climate and what it would mean for productivity.

To tackle these challenges and risks models should focus under limited resources on

- On items on which they have ideas and not on items where they have no clue about;
- Depict results in a way so that people understand what the result means;
- Concentrate on resource degradation in quantity and quality;
- Distributional aspect with respect to food security because if the situation looks globally good it does not mean it is everywhere good thus it should be ensured production is dispersed and not just concentrated;
- Implement linkages between several models (so that models start to speak to each other)
- Improve communicate to policy makers in a harmonized and easy understandable way as often results are not understood, additionally model results should be coherent (not one model for biofuels and one for agricultural production). Policy makers should have clear ideas where result differences come from. Therefore it is Important that model results are understandable. If policy makers, companies and media do not understand outcomes of model simulations their policy relevance might be limited or counteracting. With respect to communication, modelers should focus
- On what the input is, how the model works, and how the results are achieved;
- When new policy issue are discussed new studies should be conducted but taking into account work already been done;
- Improve credibility of model so that model results are independent from the researchers doing the analysis (outcome should not depend on who does the analysis using the same data);
- Should provide logical explanations for model results;
- In presenting outcomes a balance needs to be stroked between straightforwardness/simplicity and coverage of relevant issues;
- Provide a rich depth in detail depending on the research question (coverage of new technology, reality is much more complex than modelling one region, one farmer is not like the other farmer);

- Future values of exogenous variables put in models should be quite sure (e.g. environmental restrictions are fixed, but future exchange rate are very uncertain and should be only used in scenarios), out of e.g. 20 factors, in the end only 3 are used to do projections because others are too uncertain. Policy makers and other decision makers need to anticipate uncertainties
- Basic economics should be correctly inserted in the models so that maybe complex model need to give a simple message otherwise the public will lose interest; however, most decisions are taken under a lot of uncertainties. To communicate uncertainties to policy makers is not primarily a modelling question but way of communication, therefore packages are required to deal with uncertainties;
- Determine which model to use for what research question;
- Focus on the CAP and CAP reforms which intend to go more on local or farm levels (on the supply side).

If one looks more than 20 to 30 years ahead a number of changes would come additionally like increasing uncertainties due to more choices, growing white noise. Scenario should reflect more of different worlds, requiring to think out of the box and to provide more foresights. Participant mentioned it might make more sense not to conduct scenario analysis in models but to bring together people with room for imagination, doing more of a brainstorming. It would be more like a joint foresight and storytelling activity than modelling. Others rejected the opinion especially models would fulfil the task described. Also in this contest communication was seen as important. Other aspects mentioned and discussed by participants were:

- Change in priorities of the society could affect basic interactions between inputs and outputs, sectors, drivers which, then, are not reflected model results. Thus longer time scales would need more reflection how the society should shaped in future and by which policy design that aim could achieved accordingly. Models could be useful to assess different future societies but it would be a long time frame to go there. Policies have the opportunities and the obligation to adjust certain things year by year or decade by decade.
- Human brainstorming could be replaced by machine brainstorming in the future. Participants presumed that there would be more data in the future; but machine would be better equipped or better tools to analyze the processes involved.
- On the long-term models would be extremely important and strong tools for quantifying the storytelling => here models are strong
- On the long-run feedback loops between agriculture impact on resources and climate change on one hand and on the other hand impacts of resources and climate change on agriculture would be required.

As an important shortcoming, insufficient communication between modelers, policy makers, decision makers, and the media have been discussed in detail. Another divergent topic participants mentioned was whether models need to align their outcomes or not. Some expressed their opinion that convergence would only be good if a mistake would have been discovered but “an outlier” would be not necessarily wrong because other models show different results. Models should not be “unified” but consistent with respect to basic parameters and assumptions. Other participant rejected the idea of a one and only true model by using the same parameters. Models should start at least with the same set of assumption e.g. policy representation. One participant saw it as risky to link models because it would remove competition between them. It would be better to use models in parallel and determine which model would be best in a few years. But it would be important to transport the idea that results are uncertainties, some expectations could not be met but e.g. could provide support by showing alternatives. Participants also discussed whether a deeper involvement of the public in the

modelling would be a helpful approach or not, but that might depend on the topic and for who would be the addressee of the model outcomes (policy makers or private companies). Other participants requested transparency and then one could not differentiate between clients. It would also prove to be a challenge between model outcomes for policy makers and those for the public and it would be difficult in the end to bases political decision hereon.

When asked for their wish list when participants receive model results the listed the following items:

- Write result in one page with an extended appendix giving detail;
- Improve communication of results by provision of a coherent story covering all results;
- Impact analysis of trade agreements at member state level and for specific sectors;
- Plug-in a "Google translator" so that all can have access to the non-English studies in English (with main results) and no duplicate research would be done;
- Conduct impact assessment on regulations and NTMs and reflect impacts on environment and health, provide assessments on Pillar 2 measures;
- Models optimize in economic way but should cover other dimensions as well e.g. risk, social dimensions.

4.2.3 Farming

The expert group "Farming" concentrated on the area farming and supply adaptation comprising new mitigation technologies related to climate change; adoption of new technologies, including remote sensing, robotics; restrictions in farming related to environmental regulation. Like in the expert group "Global" the following questions were addressed and discussed:

- Which future challenges do you see in the area of "Value Chain" which will require model based analysis?
- If you need to take a decision what would you need to do that?
- Which shortcomings do you see with respect to already available results?
- What options do you see to overcome obstacles to achieve the required outcomes?

Participants perceived the following issues as challenges:

- Modelling of farm practices and farmers behavior which may change with farmers' education;
- Adoption of new technologies, e.g. block chain technologies into account; incorporating educational levels of farmers into technological adoption
- Endogenisation of technological change (not only adoption but also development of new technologies as response to policy or markets);
- Minimization of resource inputs;
- Modeling of public goods like animal welfare, food safety, needs with respect to societal and cultural changes in the whole supply chain and related to those an adaption to consumers' needs (organic products, animal welfare);
- Need to move from markets to farms and even beyond to farming systems and from prices and quantities (profit maximizing) to practices and sustainability (driven by farmer behavior and some other maximization objective function);
- Covering all three dimensions of sustainability (ecological, economic and social);
- Introducing of the "culture" of sustainability into the modelling (both in terms of product differentiation and consumer demand);

- Who will pay for public goods? (EU-COM, national and international consumers, national governments) Here, the need arises to measure the cost of provision of different public goods and to see who would pay for them. Differentiated costs of provision occur across farm types;
- Differentiated yields by practices (organic, no pesticides, irrigation) and uncertainty how key parameters may change;
- Past trends may not explain the future

Participants saw as the following foci of future model development:

- Modeling of water management, whole carbon cycle, soil management, positive externalities
- Need to model whole supply chain and interlinkages as decision unit is no longer the farm, but the whole chain
- Impact of farmers' behavior on environmental goods;
- Better representation of
    - Mitigation techniques;
    - Industrialized farms (large farms), structural change and organization of farms, modelling big farms with respect to production, but all farms with respect to environment;
    - Investments of other sectors in agriculture;
    - Incorporating the persistence of negative income farming (off-farm income);
- Modeling of income differences among farmers;
- Move from modeling the impact of policies to model how farmers adapt to policies which may require new approaches;
- One model or different types of models to answer different questions was considered. Combination of different approaches might also be needed, e.g. models and choice experiments;
- Introduction of market demand for bioenergy;
- Capture the role of market size and impacts on competitiveness via the value chain;
- Distribution of value generation and distribution along the value chain for different products – organic might mean higher prices for farmers, but also additional costs imposed by retail;
- Better reflection of land markets and access to credit, new actors from outside agriculture are active owning increasing parts of agricultural land

4.3 Priorities

Preliminary outcomes of the expert group discussions reflecting the stakeholder perspective were noted on flip charts by the moderator and the rapporteur of the group. Each of the three groups (global, value chain and farming) had two flip charts each. Then participants were asked to go from flip chart to flip chart and to provide additional challenges and needs, supplements or comments to the different flip charts and to discuss the topic with other participants standing at the flip chart.

Then stakeholders' priorities were identified. Each participant were handed five points in different colours (assigned to the different headers Global, Value chain, 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. Outcomes of the Running World Café could be found in Table 1 (Global), Table 2 (Value chain) and Table 3 (Farming). Outcomes between the different groups cannot be compared as the number of stated topics was quite different. Results could be summarized as following:

With respect to the area of global perspective covering climate change and low carbon economy, sustainable development goals (SDGs), land and water constraints high priorities are put on income generation and distribution affecting the well-being of all humans on the planet as growth and distribution provides the means to deal and overcome existing problems. Additionally also inequality is mentioned as further challenge. Income and its distribution are also strongly linked to the topic future food demand development and its implication for trade which is found on rank 4. Also highly ranked are challenges with respect to environmental degradation of soil, water and bio-diversity and the feedback to the economy in general by increasing cost on one hand but on the other by inducing adaptation and mitigation. Water is also mentioned as separate topic on rank 5 whereas quantity and quality of water needs to be captured as well as not only its scarcity but also sudden surplus. As a further very important issue is seen in defining SDG indicators as description of SDGs is often relative vague in relation is required for model simulations. In addition, some contradictions between different SDGs may arise depending on their interpretation. Participants asked for a holistic approach that will go beyond the consideration of Europe alone but covers also the interaction between European trade and the situation in the rest of the world. In the similar direction but from a different perspective the stated challenge of "food chain" is pointing which captures the international sourcing of (raw) materials and its impact on the SDGs. Here not only quantities but also quality issues in relation to standards need to be considered. A further issue is the time horizon of models and model outcomes. Although SDG targets and goals are defined for the year 2030 model should be required to reflect the situation in 2050 to allow for the necessary time to adjust to changes. Some participants found it also important to go beyond 2050 up to 2070 with model simulations. Another challenge is the perceived divergence in developments of rural and urban areas which may result in changed abandonment of land which is also combined with people's abandonment of regions which may result in social tensions between rural and urban areas. With respect to developments in SDGs it is a key issue to define the spatial dimension (region, country) for which the analysis should be conducted.

Talking about climate change and low carbon economy different challenges are perceived by participants with high priorities. In this context, an emphasis is put on consumer preferences and consumer behaviour which are seen as key elements whereas both depict different perspectives. Consumer preferences and behaviour may be reflected in changes towards a more sustainable lifestyle, e.g. by eating less or no meat, wasting lesser products and buying with more consciousness towards productions system with lower emissions. But to what extent changes will materialize may depend on the circumstances like e.g. their availabilities, labelling, and income situation. Although demand shifts are evolving quite smoothly disruptive changes may occur quite sudden, often in combination with quality, hygienic, disease or animal welfare problems which are reflected in and

fuelled by interests of media. In important challenge is to internalize positive and negative externalities.

Table 1. Global perspective

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

Source: Own compilation.

To model public goods like animal welfare, food safety, needs arising with societal and cultural changes requires a representation of whole supply chain. Any adjustment implemented in models needs to reflect consumers' needs (organic products, animal welfare). Further elements of disruptive character which may provide a challenge are sudden technologies shifts (e.g. digitalising agriculture, chain technologies) and are related to technology diffusion and adoption. As these particular events have not been observed in the past the models need to be adapted by calibration of new activities (farms, processing) or new trade flows but perceived with high priority. For other challenges (new) approaches are necessary to anticipate future shocks e.g. policy shocks if new policies are implemented or e.g. climate change shock which could be achieved by linking with biophysical models.

Some participants saw that to go beyond the scope of agriculture has a high priority. Further adaptations are prioritised to better reflect mitigation aspects.

The area of market and value chain perspective depicts international integration of agri-food sectors, integration of agriculture with up- and downstream sectors as well as societal concerns and ethical issues. Here, participants stated more challenges than in the other two areas (global, farming).. Whether this is driven by the more diverse interests of participants present or other circumstances is currently unclear. Highly ranked in the area of value chain are challenges with respect to the representation of bio economy and the integration of this newly developing sector in models. A relation exists to the global low carbon economy and topic of related adaptations already discussed under the global perspective. Equally top ranked is the issue data availability and data quality in market 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 an own interested or data is sold to generate additional returns. Those data limitations hinder an adequate representation of markets and value chains covering several levels. Participants also ranked highly the challenge to cover distributional aspect as this is directly related to access to food and therefore hunger, but also affects international demand developments. Some considerations and priorities are given to the development that private entities take over the role of public entities e.g. by defining and controlling standards. The gap between increasing international supply and societal preferred regional provision of food are perceived as so important be reflected in models as well as structural change in the supply chain which reduce the number of actors along the chain and increase asymmetries between different levels in the chain. This issue is directly related to market power and concentration as well as transparency which are both on rank 9. Short supply chains are mentioned as a separate challenge additionally. Communication issues are given priority as well: First of all, model and question should fit together, but also transparency plays a role. An open question requiring further considerations is whether it would be better to have consistency among models or a competition of models should be preferred. The same applies to the question whether uncertain variables or unknown items should be included in models or better not as users may have problems to understand the approach. Priorities are also defined for storyline, thinking out-off the box, bringing people together to convene model outcomes, and to give logical explanation in the communication to policy and public and to evaluate whether to put a preference on the simple versus the complex. Participants put priorities to climate change and resource degradation which will influence the quantity and quality of product available in supply which is also featured under the area global. Priorities were also defined for competitiveness, NTMs, shift in CAP towards a stronger farm focus, artificial intelligence, geographical indications, health issues due to nutritional problems and feedback loops.

With respect to social concerns a one of the highest priorities was allocated to emphasize the implementation and analysis of productivity gains versus development in employments. A number of also very markedly ranked challenges were already stated under SDGs and climate change like sustainability; (im)migration ad migrant labour in food chain, climate change, rural versus urban relationships, differentiate income groups, jobs, GHG reduction and employment transition. However, here the perspective with most challenges is more on the market and supply chain putting additional emphasis on processing. Participants also attribute priorities to health and nutrition concerns in general, generation change (renewable) on farms, antibiotics use in husbandry which is strongly related to aspects of animal welfare but also related to health issues. Public-available models and teaching of stakeholders to understand models and results have already been discussed in the paragraph above.

Table 2. Value chain, market, integration and social concerns

Topics	Points
Value chain, market and international integration	
Bio economy	9
Data quantity + quality	9
Distributional aspect (-> hunger)	8
Private entities take the role of public entities	7
Regional vs international production	7
Structural change in the chain	6
Model + question should fit	6
Climate change –> quantity + quality -> availability	5
Market power and concentration	3
Resource degradation	3
Transparency	3
Competitiveness	2
NTMs	2
Consistency vs competition of model	2
Storyline, thinking out of the box, people together	2
CAP more on farm focused	2
Artificial intelligence	2
Short supply chains	1
Geographical indications	1
Uncertain / unknown items in models (or better not)	1
Communication to policy and public, logical explanation	1
Communication to policy and public, simple vs complex	1
Health issues	1
Feedback loop	1
Productivity gain in chain more important than in agriculture	
Credibility + economic basics	
Brexit – FTAs	
Social concerns	
Productivity gains vs employment	9
Sustainability	9
Immigration, jobs /migrant labour in food chain	7
Climate change	6
Health, nutrition	6
Rural/urban relationships	6
Differentiate by income groups	5
Generation change (renewable)	3
Antibiotics use	3
Jobs	3
GHG reduction	2
Public-modelling, teaching for stakeholders	2
Employment transition	1
Cultural patrimony (slow food)	
Trade balance problems	

Source: Own compilation.

Challenges 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 restrictions in farming related to environmental regulation. Compared to the other two groups fewer challenges were expressed. Farming challenges are attributed to two areas one faced by market and behavioural challenges and the other by farming risks.

With respect to market and behavioural challenges highest priorities a given to capture supply chains and especially the finally receiving part of the chain, the consumer. His behaviour is perceived as disruptive when it comes to organic, animal welfare and low emission production. Consumer behaviour is difficult to anticipate. Often citizens express a willingness to pay for such products while, in the end, consumer choose differently at the point of sale. Also high priority is given to the spread of Innovation which will require a better representation in models and will needs to be studied also with respect to impacts on jobs (supply chain) and mentioned adoption issues (global). Additionally, monitoring markets is seen as a challenge for farmers and probably policy makers, but also as a useful activity. Some priorities are put on the implementation of new approaches in general or with respect to integration of choice experiments or focus groups.

When farming risks are discussed highest priorities are allocated to water constraints and equally important to considerations whether to concentrate on adaptation or mitigation of climate change. Both are already discussed in SDGs and climate change issues. Yields and variables contributing to yield developments gain also high priorities whereas efficiencies in crops (yield = f (…) e.g. fertilizer, pests, chemicals) are placed somewhat higher than for livestock (feed efficiency). Technology which is detailed under SDGs and climate change receives a bit low priority. Newly mentioned are challenges in infrastructure and related transport costs respectively transaction cost. Participants put priorities to the role of farm structure and to the role of education both also stated and prioritised under SDGs. Challenges are seen in existing knowledge on GHG effects and in the implementation of endogenous breeding activities (yield developments) under climate change.

Table 3. Farming and supply adaptation

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

Source: Own compilation.

5 First conclusions

The 1st SUPREMA Workshop 'Needs' aimed to sharpen the understanding of the challenges and needs posed to future development of models and model-based support for policy actions. The focus was set on the area of agri-food systems and policies influencing the agri-food system at local, national and at global scale. 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.

From the results of our Workshop some preliminary conclusions can be drawn which will be amended, adapted, extended and deepened during the course of the project. To comprise challenges and needs stated during the Workshop is a cumbersome because the challenges and needs and manifold. Some can 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. So conclusions will cover different types:

a) General consideration
b) Challenges which might be covered during the duration of the SUPREMA project
c) Challenges going beyond the scope of SUPREMA but on the roadmap for near future developments
d) Challenges which will require an even longer perspective.

General considerations

The time horizon has been already discussed during our kick-off meeting and in the preparation of the proposal seems to be quite important for modellers. With regard to the feedback of stakeholders who attended to our Workshop the time horizon was not declared as a relevant criterion for model-based impact assessments. However, communication and explanation of modelling methods and outcome gained much more attention. Keeping model outcome understandable and transparent has been mentioned as an important issue. Explaining becomes also relevant when model-based analyses build on complex issues, e.g. sustainability or climate change. Here stakeholders indicate that the discussion and explanation of model results should also encompass what sustainability means with regard to model ecologic, economic and social aspects.

The availability of data of high quality not only for the farm level but also along the value chain has been regarded as one of the most relevant issue which should be considered as a 'permanent' need.

Challenges which might be covered during the duration of the SUPREMA project

Immediate 'needs' with regard to the planned work in SUPREMA is related with the coverage of global aspects with respect to future food demand. Thus, trade and feedback of European trade on trade the global situation are aspects modelling work in SUPREMA should cover already in planned scenarios. This also includes issues like income generation and its distribution across different income groups in and outside European countries.

Environmental constraints, like future water and land availability and quality are another issue the SUPREMA model family should take on board. Here modelling of GHG reduction and adaptation towards climate change have been identified as important for our work in SUPREMA. But this work requires due to its high degree of complexity not a single model but a set of models which are linked and coupled.

Higher standards in animal welfare or an increase in demand for organic climate friendly products are also triggered by changes in consumer preferences and behavior which are also considered as relevant for the work plan in SUPREMA.

Changes in the political agenda e.g. due to strategies towards a more bio-based economy are mentioned as very important which also needs a more integrated approach of different models applied in a harmonized way.

With regard to market structure and power the increasing concentration and the ongoing structural change in the food value chain are also determining income at farm level. Here, the models applied in SUPREMA should be extended.

Challenges going beyond the scope of SUPREMA

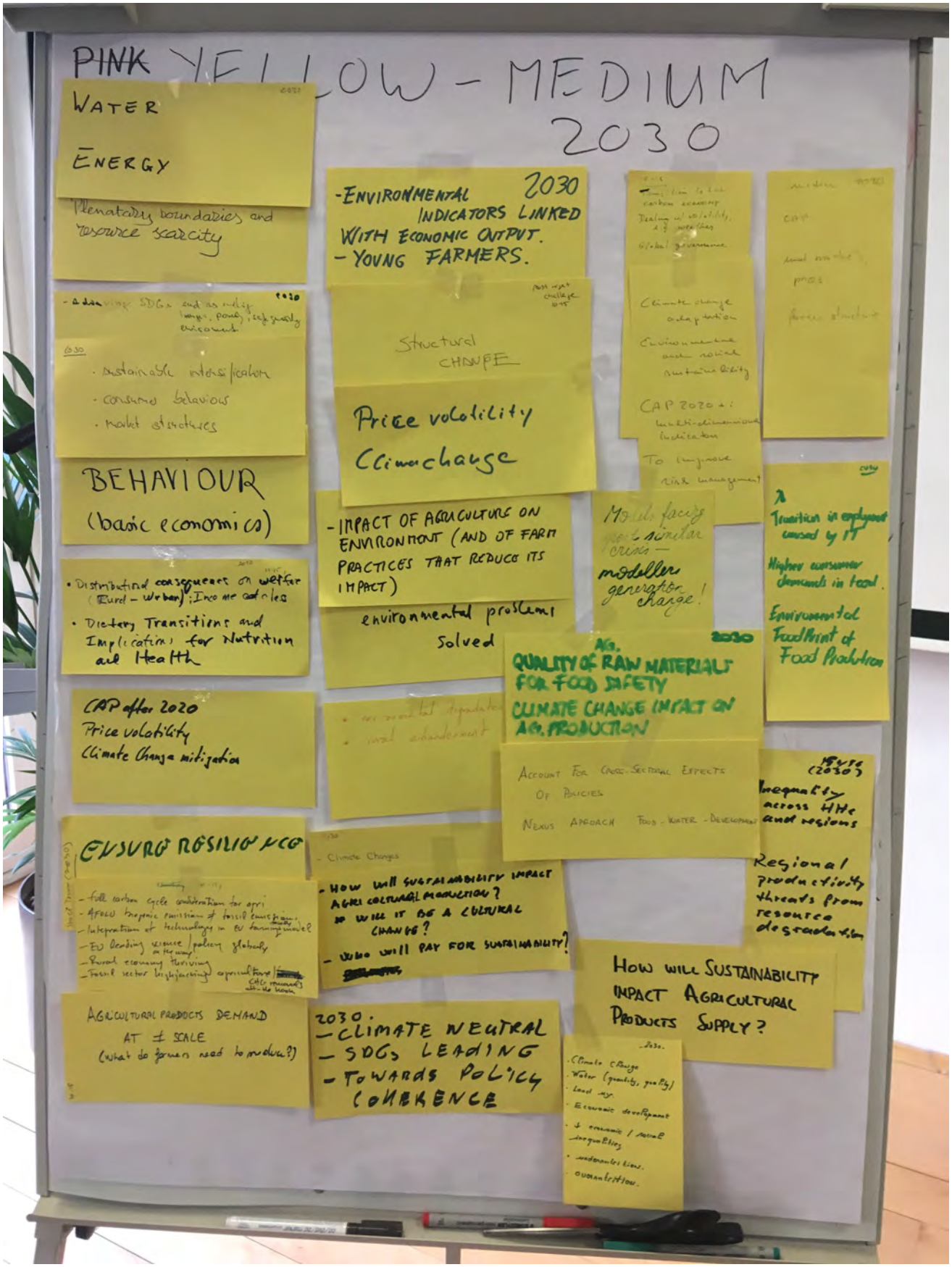
The Workshop also addressed challenges and needs for model-based analyses which are relevant but which go beyond the current scope of SUPREMA. These topic includes the following items:

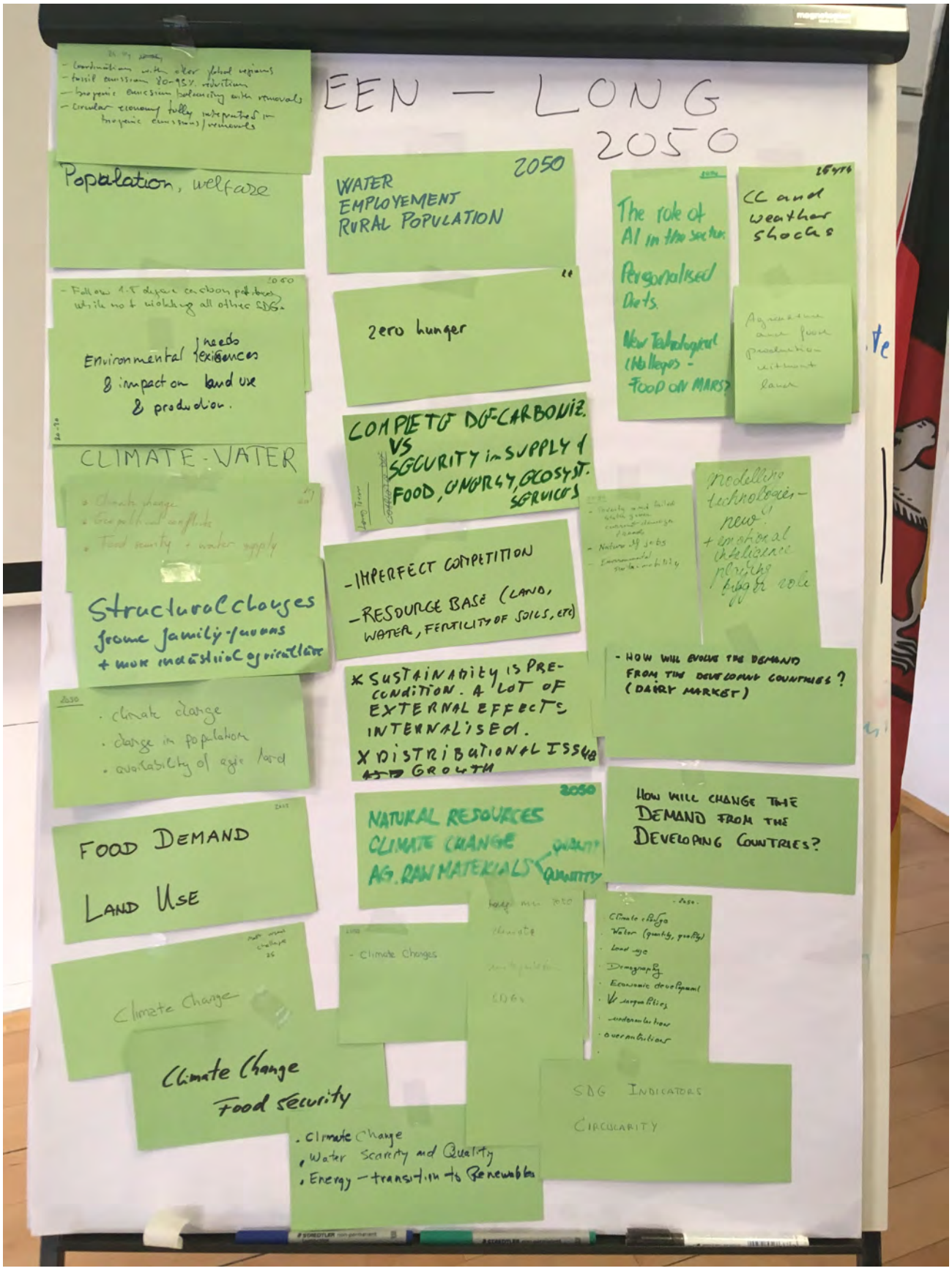
- Rural versus urban development,
- Land abandonment as well as people abandonment as a social element of structural changes across different regions
- Immigration, migrant labour in food chain, coverage of health
- Degradation of resources and adaption technology to fight this development
- Biodiversity
- Internalization of positive and negative externalities
- Calibration and modeling of shocks such as natural disasters and diseases
- Modelling endogenous technical change, the coverage of artificial intelligence as well as the spread of Innovation and new approaches

This list indicates and illustrates first ideas of future needs which are identified as highly relevant of agro-food modelling. But due to its complexity and the required theoretical concepts and data, these relevant topics will not be covered in SUPREMA – but maybe in other follow-up projects.

6 References

Appendix A: Photos of Posters




EEN — LONG
2050
Population, welfare
WATER
EMPLOYEMENT
RURAL POPULATION
2050
zero hunger
The role of AI in the sector
Personalised Diets
CC and weather shocks
Environmental needs & impact on land use & production.
CLIMATE - WATER
COMPLETE DE-CARBONIZ. VS SECURITY in SUPPLY of FOOD, ENERGY, ECOSYST. SERVICES
Structural changes
-IMPERFECT COMPETITION
-RESOURCE BASE (LAND, WATER, FERTILITY OF SOILS, etc)
Modelling technologies - new
- HOW WILL EVOLVE THE DEMAND FROM THE DEVELOPING COUNTRIES? (DAIRY MARKET)
* SUSTAINABILITY is PRE-CONDITION. A LOT OF EXTERNAL EFFECTS INTERNALISED.
X DISTRIBUTIONAL ISSUE
. climate change
. change in population
. availability of agric land
FOOD DEMAND
LAND USE
2050
NATURAL RESOURCES
CLIMATE CHANGE
AG. RAW MATERIALS
QUALITY
QUANTITY
HOW WILL CHANGE THE DEMAND FROM THE DEVELOPING COUNTRIES?
Climate Change
Climate Change
Food Security
. Climate Change
. Water Scarcity and Quality
. Energy - transition to Renewables
SDG INDICATORS
CIRCULARITY

Appendix B: Photos of the Running World Cafe

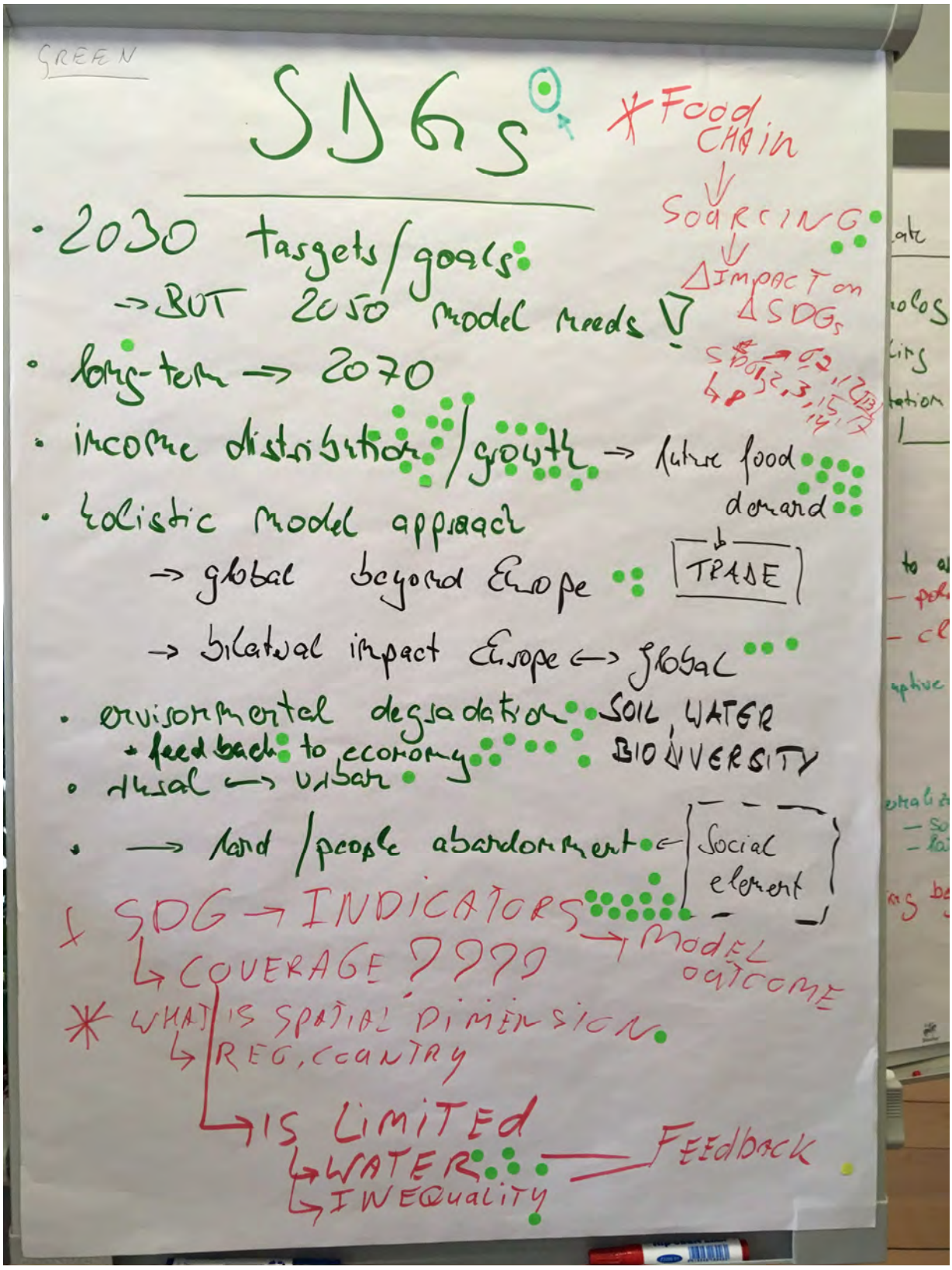
Wrap-up of medium-term and long-term challenges, ©Tania Runge (Thuenen).

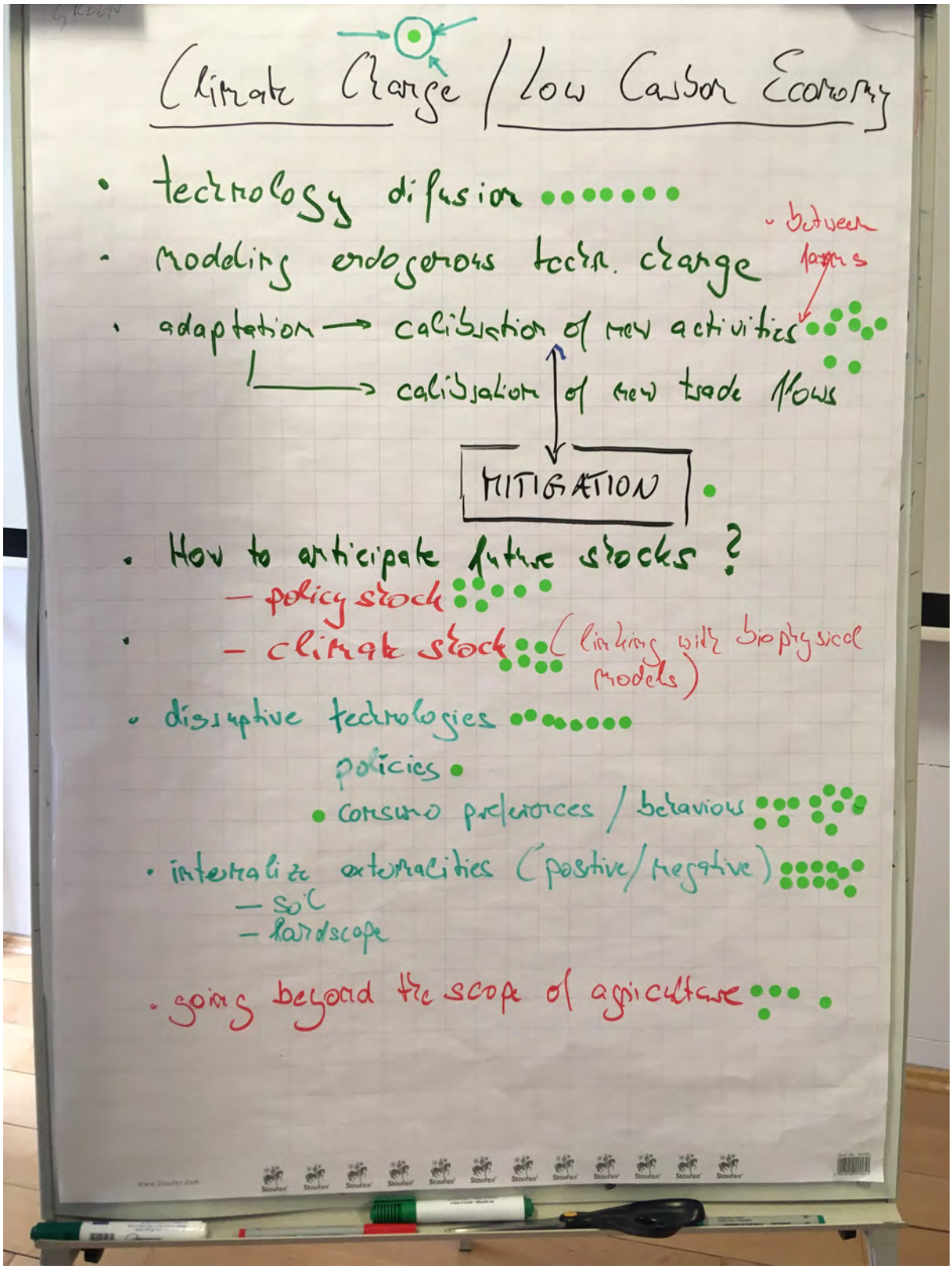
Group "Global" ©Martin Banse (Thuenen).

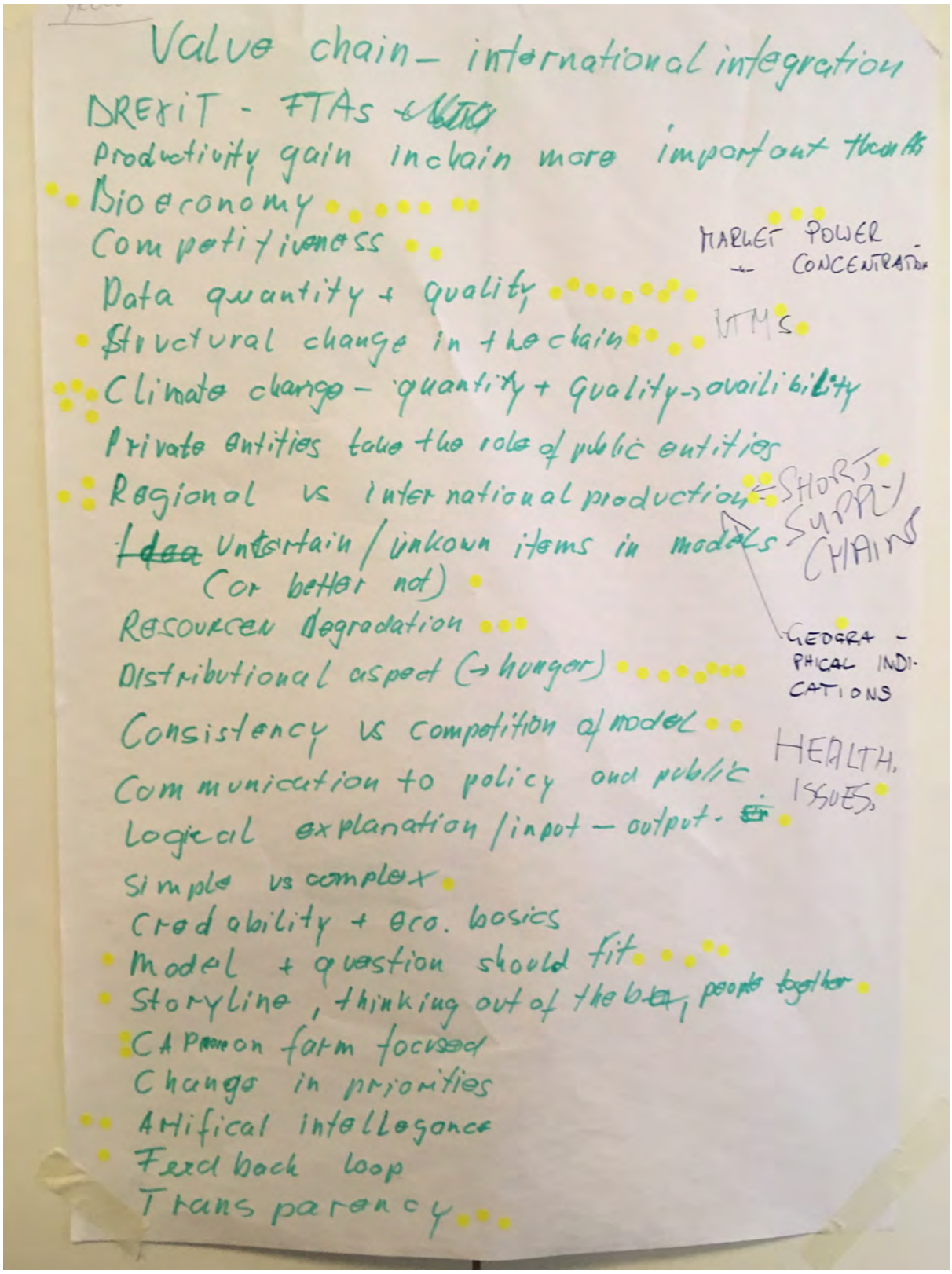
Group “Value chain” ©Tania Runge (Thuenen).

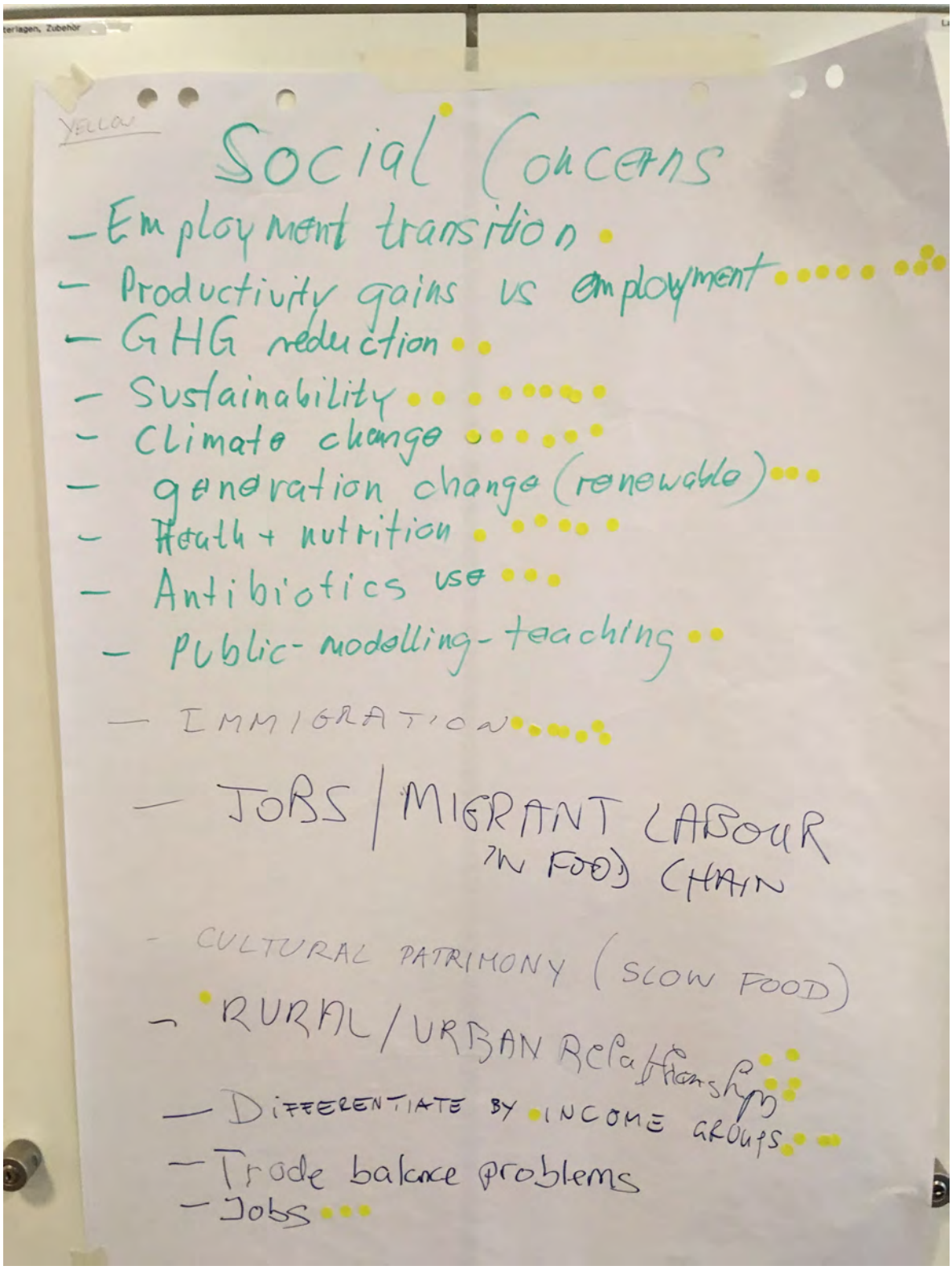
Group “Farming” ©Martin Banse (Thuenen).

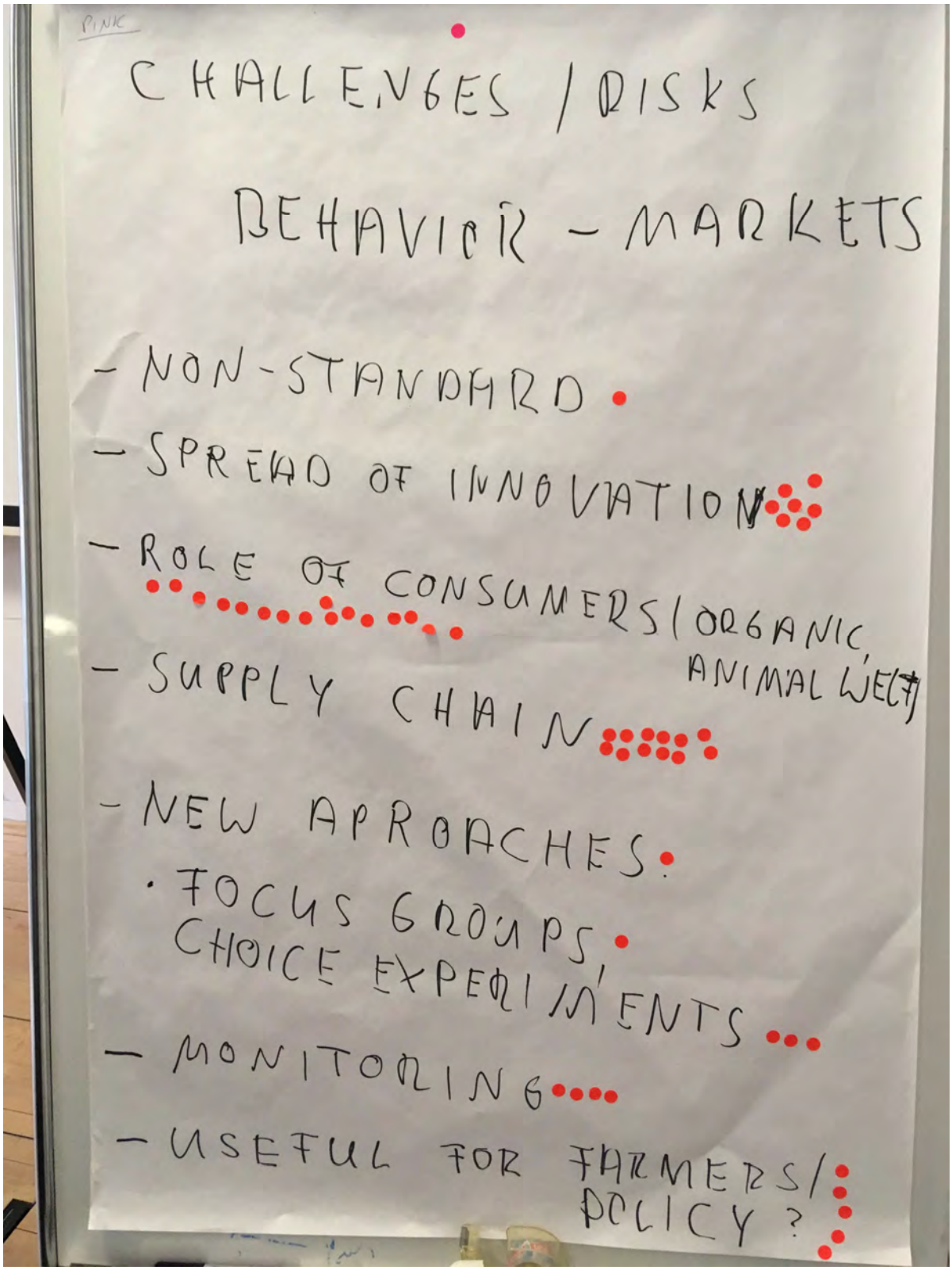
Appendix C: Photos of Priorities

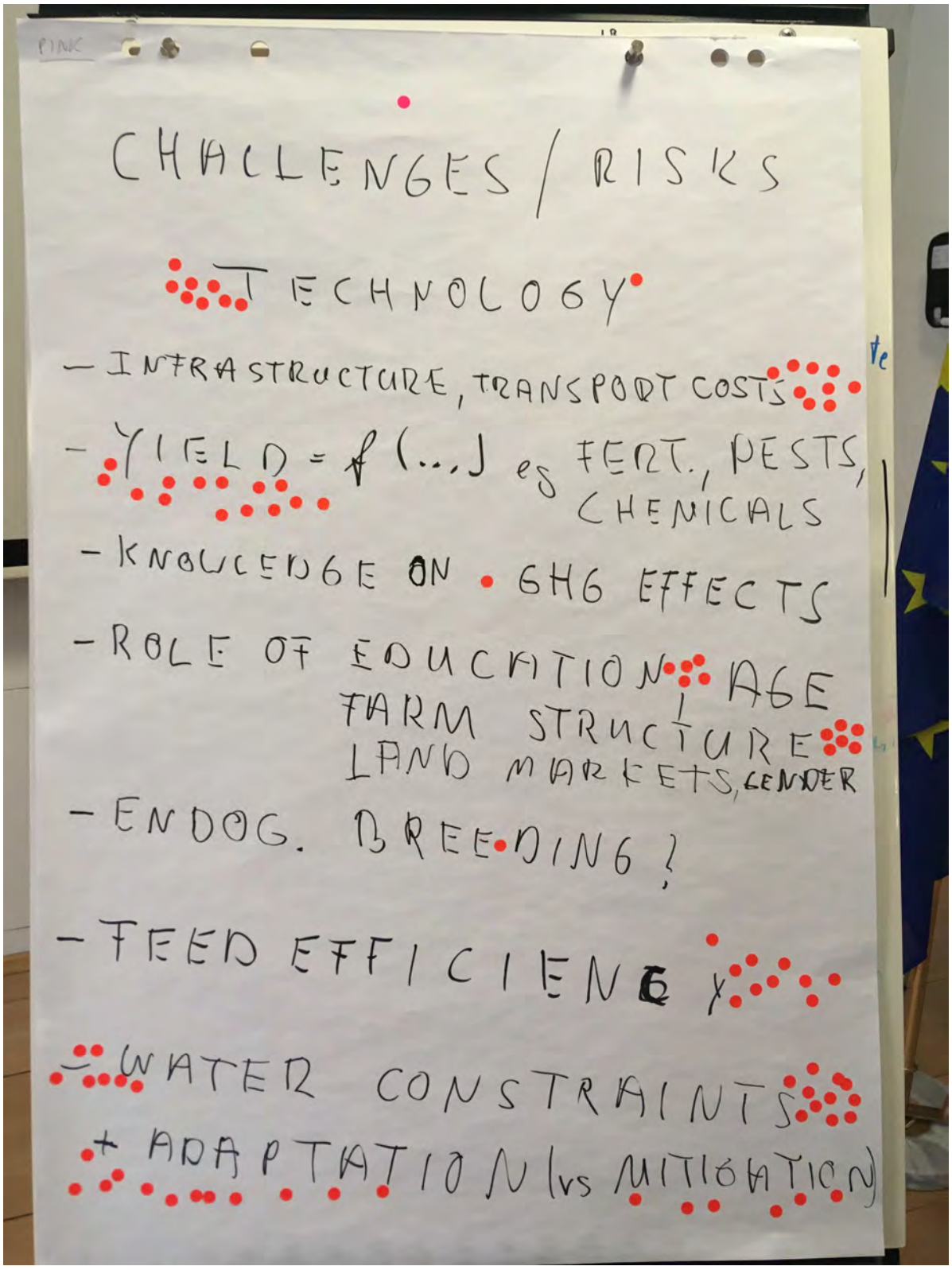



Climate Change / Low Carbon Economy
• technology diffusion
• modeling endogenous techn. change
• adaptation → calibration of new activities
→ calibration of new trade flows
MITIGATION
• How to anticipate future stocks ?
– policy stock
– climate stock (linking with biophysical models)
• disruptive technologies
policies
• consumo preferences / behaviours
• internalize externalities (positive/negative)
– soil
– landscape
• going beyond the scope of agriculture


Value chain – international integration
BREXIT - FTAs
Productivity gain in chain more important than
Bioeconomy
Competitiveness
Data quantity + quality
Structural change in the chain
Climate change – quantity + quality → availability
Private entities take the role of public entities
Regional vs international production
Idea Uncertain / unknown items in models
(or better not)
Resources degradation
Distributional aspect (→ hunger)
Consistency vs competition of model
Communication to policy and public
Logical explanation / input – output
Simple vs complex
Credability + eco. basics
Model + question should fit
Storyline, thinking out of the box, people together
Common farm focused
Change in priorities
Artifical intelligence
Feed back loop
Transparency
MARKET POWER – CONCENTRATION
ITMS
SHORT SUPPLY CHAINS
GEOGRAPHICAL INDICATIONS
HEALTH ISSUES


YELLOW
Social Concerns
- Employment transition
- Productivity gains vs employment
- GHG reduction
- Sustainability
- Climate change
- generation change (renewable)
- Health + nutrition
- Antibiotics use
- Public - modelling - teaching
- IMMIGRATION
- JOBS / MIGRANT LABOUR IN FOOD CHAIN
- CULTURAL PATRIMONY (SLOW FOOD)
- RURAL / URBAN Relationships
- DIFFERENTIATE BY INCOME GROUPS
- Trade balance problems
- Jobs


PINK
CHALLENGES / RISKS
BEHAVIOR - MARKETS
- NON-STANDARD
- SPREAD OF INNOVATION
- ROLE OF CONSUMERS (ORGANIC, ANIMAL WELF)
- SUPPLY CHAIN
- NEW APPROACHES
· FOCUS GROUPS, CHOICE EXPERIMENTS
- MONITORING
- USEFUL FOR FARMERS/ POLICY ?


PINK
CHALLENGES / RISKS
TECHNOLOGY
- INFRASTRUCTURE, TRANSPORT COSTS
- YIELD = f(...) eg FERT., PESTS, CHEMICALS
- KNOWLEDGE ON GHG EFFECTS
- ROLE OF EDUCATION AGE FARM STRUCTURE LAND MARKETS, GENDER
- ENDOG. BREEDING ?
- FEED EFFICIENCY
- WATER CONSTRAINTS
+ ADAPTATION (vs MITIGATION)