TRANSMANGO

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*Assessment of the impact of global drivers of change on Europe's food and nutrition security (FNS)*

# FIRST TRANSMANGO EUROPEAN SCENARIOS WORKSHOP

*LEUVEN, BELGIUM - SEPTEMBER 10, 2015*

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# 1 Introduction

European citizens today are generally food secure, but 80 million people live below the poverty line and 30 million suffer from malnutrition. Future food and nutrition security might be threatened by new global challenges linked to resource scarcity, environmental degradation, climate change and political and economic turmoil among other drivers. Europe is highly dependent on energy and protein imports to sustain its production methods on the one hand and its high – and unsustainable – levels of consumption on the other. Policies in Europe tend to focus strongly on agricultural production and more holistic food systems perspectives are needed to understand threats to future food and nutrition security. At the same time, innovative practices throughout the European food system offer new ways to tackle present and future food and nutrition security challenges – and these practices should become part of policy dialogues at national and European levels.

TRANSMANGO is an interdisciplinary research project funded by the EU that focuses on the vulnerability and resilience of European food systems in a context of socioeconomic, behavioural, technological, institutional and environmental change. It aims to enhance understanding of the new challenges and opportunities that the food sector will face in the future and to identify, and enable transition pathways to improved food and nutrition security for Europe's future. The TRANSMANGO process consists of the following steps:

1. Development of a range of qualitative and quantitative scenarios for the future of European food and nutrition security.
2. Participatory down-scaling of these scenarios with high-potential food initiatives in 10 case studies, to be used as contexts to explore diverse transition pathways.
3. Use of scenarios and EU-transition pathways to aid in the review and design of EU-level policies and investment.

Any planning for the future should be mindful of the context for which plans are being made. Food systems offer particularly complex, changing planning contexts. And when the goal is to explore the potential for transformative change in food systems, interactions between the (unprecedented) actions of those involved in potential transformations and their contexts become extremely hard to predict.

Therefore, those who wish to contribute to transformations to sustainable food and nutrition security should be aware of 1) what contexts should be considered and 2) how these contexts could evolve, both due to external factors and in interaction with attempts at transformational change. Scenarios are a useful tool for future-oriented thinking in a way that is mindful of future uncertainty and the multidimensional scope required to look at planning contexts. Van Notten et al. (2013) describe exploratory scenarios as ''multiple plausible futures described in words, numbers and/or images". The methodology applied is based in systems science, and systematically identifies uncertainty and complexity in context, rather than limiting and simplifying that context in order to provide a single forecast even when such predictions are not possible (van der Sluijs 2005, Kok et al. 2006). More linear sense- and decision-making processes that do not incorporate multiple scenarios still have underlying assumptions about the future, effectively operating from a single scenario that is not examined (Vervoort et al., 2014). The failure of traditional planning to engage with uncertainty has proven to be problematic in complex systems (van der Sluijs, 2005; Wilkinson and Eidinow, 2008). In multi-stakeholder contexts, exploratory scenarios can engage multiple

legitimate perspectives involved in framing and addressing messy challenges such as food security and sustainability (Reilly and Willenbockel, 2010).

This report describes the development of qualitative scenarios for the future of European food and nutritional security, which is part of step 1. This process involved engagement with a diverse range of stakeholders from across the food system over the course of one year, leading up to a one-day meeting to develop multi-dimensional scenarios which provide diverse, challenging future contexts. The meeting was conducted in Leuven, Belgium, September 10, 2015. The meeting was highly focused, building on extensive inputs provided by participants prior to the workshop. These inputs included systematic participatory analysis of key drivers for the European food system, and their interactions. The driver analyses were combined with TRANSMANGO literature and case study work to ensure a comprehensive exploration. The time horizon for the scenarios is 2050, with a strong focus on mid-term changes. This report describes the design, implementation and results of the TRANSMANGO European Scenarios process. Section 1 comprises this introduction. Sections 2 details the methods used. Section 3 provides the results, and Section 5 discusses the scenarios and their implications.

# 2 Methods

A number of experimental methods were used in the construction of the TRANSMANGO scenarios. Because the scenarios will be used in diverse case study contexts, it was seen as important to have multi-dimensional scenarios; the most common scenario approach, focusing on only two drivers to differentiate future scenarios, was seen as too limiting. Furthermore, participatory modelling techniques were used to flesh out the scenarios after scenario narratives were constructed.

## 2.1 Factor Analysis

This stage of scenario development was conducted by email prior to the workshop. During this stage, participants were asked to list the driving factors they considered both most important and most uncertain in the future of European food and nutritional security. Participant responses were compiled and compared with the factors identified through other TRANSMANGO work packages including an analysis of national media, a vulnerability framework design and a Delphi process with around 50 European food system stakeholders.

From the combined lists of factors, a shortlist of the top 8 factors was developed to be used as a frame to outline diverse scenarios. In addition, climate change was identified as an important driving factor – but climate change was brought in through different means, by introducing results from a climate change-focused research project.

## 2.2 Factor States

The word state is used to describe the condition that a factor could be in, at a given time. For example, if we decide "the economy" is an important and uncertain factor, the state of the economy could be described as either *growing*, *stable* or *declining*. We are interested in the conditions – the states – that each of the factors identified in the previous activity could be in by 2050. As these factors are uncertain they could possibly end up in a number of different conditions/states. Each of these states is to be thought of as mutually exclusive from the other states, so something is only in one state at any given time. For instance, at one moment the economy is either growing, or it is stable, or it is declining.

Though we acknowledge that there are many ways of conceiving of states, we only want one group of states for each variable. So while "economic development" could take the states [*high*, *low*] or [*stable*, *unstable*] or [*agriculture dominated*, *service sector dominated*, *industry dominated*] we ask participants to choose one group that best represents how they look at the potential futures for this factor. We need at least two possible states for each variable. Each state represents a possible value, or condition for the variable in question. If it can only take one value then there is no uncertainty. More than two states for a factor are encouraged. For factors A to D, the states of each factor are listed underneath each as shown in Figure 1.

| A | B | C | D |
|---|---|---|---|
| A1 | B1 | C1 | D1 |
| A2 | B2 | C2 | D2 |
| A3 | B3 | C3 | D3 |

***Figure 1*** *Factors and states*

## 2.3 Compatibility Matrix

A string made up of one state per factor provides a scenario skeleton, for example, the economy is 'rising', population is 'stable' and the environment is 'degraded'. Compatibility matrices are a standard method to examine plausibility of these strings of factor states by pairwise comparison. The states of each factor are compared pairwise in a matrix as shown in Figure 2. Factor A has 3 states A1, A2 and A3; factor B has 3 states B1, B2 and B3 and each of these are compared pairwise. If the two states could plausibly happen at the same time a score of 2 is given, if under no imaginable conditions the two states could ever happen together a score of 0 is given, if the respondent is uncertain a score of 1 is given. All states of all factors are compared in this way (Figure 2).

**A-B COMPATIBILITY MATRIX**

| | **B1** | **B2** | **B3** |
|---|---|---|---|
| **A1** | 2 | 0 | 1 |
| **A2** | 1 | 1 | 1 |
| **A3** | 2 | 0 | 2 |

**Question: Can states across factors happen together? 2 – yes; 1 – maybe; 0 – no**

***Figure 2*** *Comparison of each of the states of two factors*

## 2.4 Optimised Linear Diversity Field Anomaly Relaxation

The compatibility matrix and the descriptions of the factor states are then inputted into a software program OLDFAR, which stands for Optimised Linear Diversity Field Anomaly Relaxation. This program removes any strings that contain a 0 compatibility score. All other strings are retained. The OLDFAR program then uses robust optimization to choose smaller subsets from sets of plausible scenarios, where the optimization is to maximize diversity in the smaller subsets, and robustness refers to the fact that the subsets found are highly diverse for a family of alternative metrics of what makes one scenarios diverse from another, not just a single metric of difference between the skeleton scenarios strings like the Euclidean distance or the Manhattan distance between their strings.

## 2.5 Scenario Skeletons

Due to the fact that compatibility matrices only do a pairwise check of compatibility, and not a third order or a fourth order comparison check, OLDFAR was used to derive multiple highly diverse subsets of 8 scenarios. OLDFAR outputted the skeleton narratives so that these subsets of 8 scenarios could be reviewed by the TRANSMANGO team for consistency, plausibility and diversity in order to choose a final set of 4 most diverse scenarios to be developed into full narratives (Figure 3).

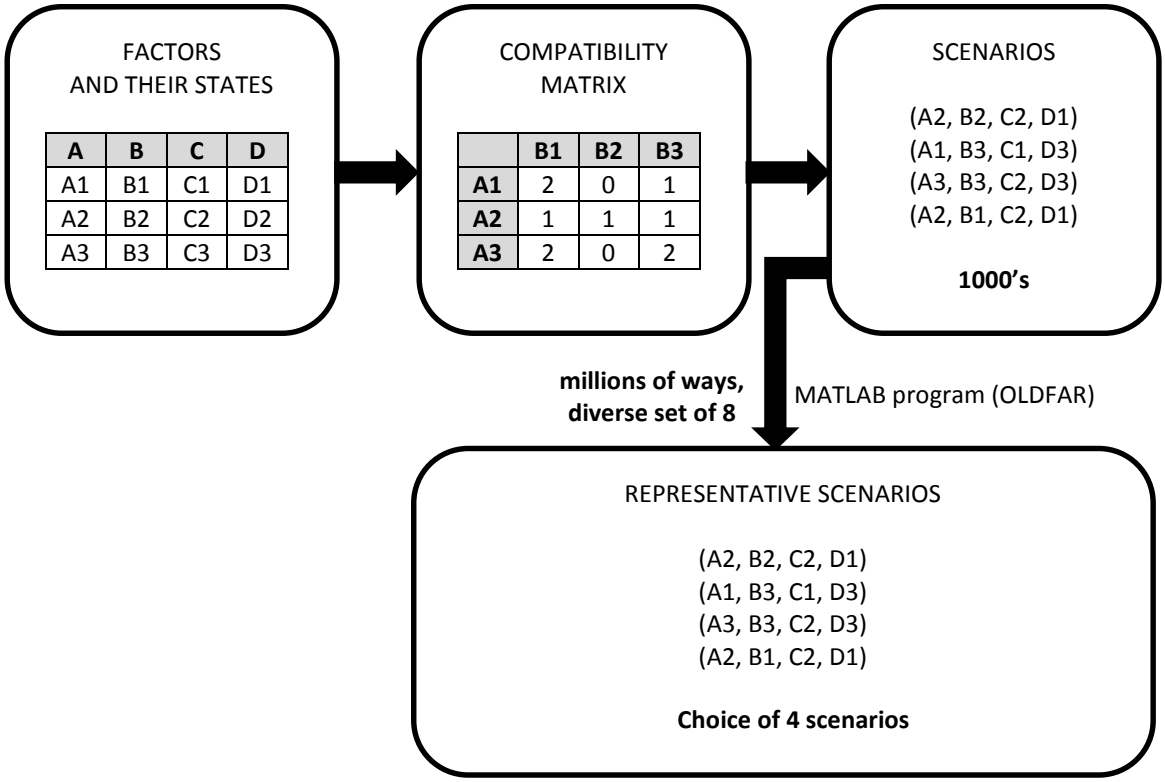



***Figure 3*** *Four representative scenario skeletons were chosen from multiple diverse sets of 8 generated by OLDFAR*

## 2.6 Scenario Narratives

The narrative development, and all subsequent activities took place during the one-day workshop in Leuven. Participants were divided into groups that each had maximum diversity across food system activities; public, private and academic sectors, age and gender. Each group was assigned one scenario skeleton and instructed to imagine 'what the world would look like with that combination of factor states'. Participants first took time to think, in silence, of 'what kind of world the combinations of states in their scenario would represent by 2050'. They wrote down individual ideas on post-its (1 post-it per idea). They then discussed their individual views on the interactions of elements of the scenario and clustered post-it notes on a large sheet of paper. The result was the creation of a vivid future world, including the core idea and dynamics of the scenario.

Participants developed the 2050 picture further by reviewing a list of key issues – a combination of other drivers that did not make it into the top 8, key food system elements, and other important themes for the future of European food and nutrition security that did not come out of the driver analysis. This list was meant to be an inspiration for developing the scenarios' narratives.

Once groups had a good sense of the 2050 'picture' of their scenario, they worked backwards in time, asking themselves: 'how can we connect this future scenario world to the present – what has happened before 2050?'. To help structure this backcasting of the scenario, participants described the period of 2040-2050, then 2030-2040, and then 2015-2030. During this session Kasper Kok visited each group with a short overview of climate projections for the

future of Europe. The group discussed the impacts of climate change within their scenario and included those considerations.

## 2.7 Semi-quantitative Causal Mapping

Participants were asked to brainstorm the relevant elements of the European Food System that are most important to represent their scenario. Participants wrote only one element per post-it note so that these could be moved around and arranged to allow linkages to be made. In the next stage of the exercise participants drew lines that indicate direct linkages between two elements as shown in Figure 4.

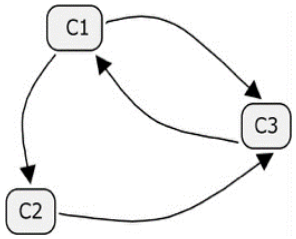



***Figure 4*** *Causal map showing linkages between system elements*

Positive and negative signs were added to the line to indicate the direction of the relationship – a positive sign indicates that an increase in the first variable results in an increase in the second and a negative sign indicates that an increase in the first variable results in a decrease in the second variable as shown in Figure 5.

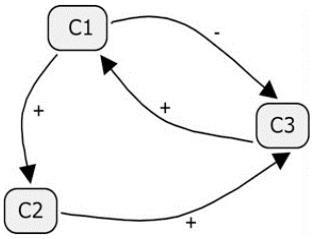



***Figure 5*** *Signed causal map indicating the direction of the relationship between variables*

Participants then assigned two sets of numbers to each link. To generate a Fuzzy Cognitive Map, participants assigned number to indicate how certain they were that each causal relationship exists. Participants gave a number between 0 and 1, 1 being completely certain and 0 meaning that there is definitely no link. To generate the System Dynamics model participants were asked to indicate the magnitude of the effect of a change in one variable has on the other. This number can be anything between 0 and infinity. A number bigger than 1 indicates that a small change in one variable produces a larger effect in the other.

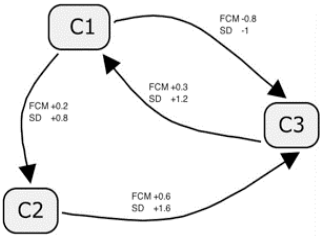



***Figure 6*** *Fuzzy Cognitive Map and System Dynamics Models*

This process simultaneously generated further development of the scenarios' narratives.

# 3 Results

## 3.1 Factor Analysis

The top eight most important and uncertain factors effecting the future of European food and nutritional security identified within the TRANSMANGO process were:

1. Consumption patterns
2. Environmental degradation
3. Poverty and economic inequality
4. Social and technical innovation
5. Urban and rural population dynamics
6. Power and market concentration
7. Trade agreements
8. Basic resource availability (water, energy, raw materials)

Climate change was also identified as a key factor, however, as climate scenarios have already been developed extensively within the IPCC, CLIMSAVE and IMPRESSIONS projects, rather than developing new climate scenarios, these scenarios were integrated into the scenarios developed from skeletons comprised of the 8 factors above.

## 3.2 Factor States

The states identified for each factor are shown in Table 1.

***Table 1*** *Factor states*

| | | | | | |
|---|---|---|---|---|---|
| **C: Consumption patterns** | | | | | |
| **C1** High animal products, high sugar (unhealthy meat eaters) | **C2** Low animal products, high sugar (unhealthy vegans and vegetarians) | **C3** High animal products (flexitarians), low sugar (healthy meat eaters) | **C4** Low animal products, low sugar (healthy vegans and vegetarians) | | |
| **E: Environmental degradation** | | | | | |
| **E1** Biodiversity loss, water pollution, soil degradation, etc. continue their unstoppable decline | **E2** Environment is stabilized but at lower levels than it is today | **E3** Environment is stabilized worldwide | **E4** Environmental degradation is reversed | | |
| **P: Poverty and inequality** | | | | | |
| **P1** High poverty, high inequality | **P2** High poverty, low inequality | **P3** Low poverty, high inequality | **P4** Low poverty, low inequality | | |
| **I: Social and technical innovation** | | | | | |
| **I1** Bottom-up (needs centred), high | **I2** Top-down (public finance centred), high | **I3** Top down (private-finance centred), high | **I4** Bottom up (needs centred), low | **I5** Top-down (public finance centred), low | **I6** Top down (private-finance centred), low |
| **U: Urban & rural population dynamics** | | | | | |
| **U1** Increase in rural, decrease in urban | **U2** Increase in rural, increase in urban | **U3** Decrease in rural, decrease in urban | **U4** Decrease in rural, increase in urban | **U5** Stability | |
| **M: Power and market concentration** | | | | | |
| **M1** Extreme concentration - several global companies completely dominate the market worldwide | **M2** Some sectors dominated by few global players, other sectors less concentrated | **M3** Healthy competition exists in all sectors: significant role for SMEs | **M4** Extreme decentralisation dominated by SMEs | | |
| **T: Trade agreements** | | | | | |
| **T1** Free markets (more free trade agreements, removal of subsidisation) | **T2** Protected markets (less free trade, more subsidisation) | | | | |
| **R: Basic resource use (water, energy, and raw product)** | | | | | |
| **R1** Resource crisis (we run out of resources) | **R2** Resource scarcity | **R3** Decoupling through use of renewables (with high metabolism/resource use) | **R4** Reduced use of energy, water, land etc. | | |

## 3.3 Compatibility Matrix

Compatibility matrices were collected from participants individually and then aggregated according in each entry to the rule that if 0 >= 25% and 2 < 25% amongst all participants implied the aggregate or joint entry is assigned 0. That is, if more than 25% thought the pairwise state combination incompatible and more than the remaining 50% thought it was maybe incompatible, we took an aggregate view that the pairwise combination was incompatible and a score of 0 was assigned in the aggregated matrix. Otherwise the combinations remained in the feasible set. The final compatibility matrix obtained is shown in Figure 7.

| | E1 | E2 | E3 | E4 | P1 | P2 | P3 | P4 | I1 | I2 | I3 | I4 | I5 | I6 | U1 | U2 | U3 | U4 | U5 | M1 | M2 | M3 | M4 | T1 | T2 | R1 | R2 | R3 | R4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 2 | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 |
| C2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| C3 | 2 | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 |
| C4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| E1 | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| E2 | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| E3 | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| E4 | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 2 | 2 |
| P1 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| P2 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| P3 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| P4 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| I1 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| I2 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| I3 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| I4 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| I5 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 |
| I6 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 |
| U1 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| U2 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| U3 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| U4 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| U5 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| M1 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 0 | 2 | 2 | 2 | 2 |
| M2 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 |
| M3 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 |
| M4 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 | 2 | 2 |
| T1 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 |
| T2 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 2 | 2 | 2 | 2 |

***Figure 7*** *Final compatibility matrix*

## 3.4 Optimised Linear Diversity Field Anomaly Relaxation (OLDFAR)

The OLDFAR algorithm (Lord et al., 2015) was used on the joint compatibility matrix in Figure 7 and '1 1 3 6 2 1 1 1' as initial scenario. The algorithm calculates the space of feasible scenarios, according to pairwise comparisons, from the compatibility matrix and outputs robust, diverse sets of scenarios for further human examination. The output from the algorithm is inserted below:

'30660 feasible scenarios in 4x4x4x6x5x4x2x4 FAR test analysis.'
'Selecting 8 scenarios took 795.889 seconds.'
'775 candidate sets of 8 scenarios during exploration in Step 3.'
'770 candidate sets of 8 scenarios in seed set for 2-criteria process, Step 3.'
'50 candidate sets of 8 scenarios after 2-criteria robust opt process, Step 4. Stochastic choice.'
'263 4-sets of candidate 8 scenarios in seed set for 3-criteria process, Step 5.'
'24-sets of candidate 8 scenarios after 3-criteria process, Step 6.'
'14 sets of 8 scenarios after SLP preference choice, Step 7.'

Output is the 4-set of 8 scenarios (scenarios are read vertically) (Figure 8):

| Set 1 | Set 2 | Set 3 | Set 4 |
|---|---|---|---|
| '1 1 2 2 3 4 4 4 | 1 1 2 2 3 4 4 4 | 1 1 1 2 4 4 4 4 | 1 1 2 2 2 3 4 4' |
| '1 2 2 3 1 1 3 4 | 1 1 2 3 2 4 1 2 | 1 2 2 4 2 3 1 1 | 1 1 1 4 4 2 2 3' |
| '3 1 2 3 3 1 1 4 | 3 2 4 2 1 4 1 3 | 3 1 2 4 2 1 1 3 | 3 3 1 2 4 2 1 1' |
| '6 4 2 1 3 2 1 3 ; | 6 6 3 2 4 1 1 5 ; | 6 4 1 2 2 1 3 5 ; | 6 1 6 3 2 2 5 1' |
| '2 4 1 3 4 5 5 1 | 2 5 1 5 1 5 4 5 | 2 5 2 5 2 1 5 1 | 2 5 1 5 3 4 3 1' |
| '1 4 2 2 4 1 4 3 | 1 4 4 2 3 4 4 2 | 1 2 4 4 1 4 4 3 | 1 4 2 4 3 2 3 4' |
| '1 1 2 1 2 1 2 1 | 1 2 1 1 2 2 1 2 | 1 2 2 1 1 2 1 2 | 1 2 2 1 2 2 1 2' |
| '1 3 2 4 1 2 4 3 | 1 2 4 3 2 4 1 1 | 1 3 1 4 3 4 1 1 | 1 2 2 3 4 1 2 4' |

***Figure 8*** *4-set of 8 scenarios based on compatibility matrix*

Set 4 was chosen after detailed discussion of second, third, up to eighth order joint state compatibility. Further discussion on diversity and the scenario skeleton narratives amongst researchers narrowed the choice to four scenarios (in **Table 2** below) from the eight scenarios in set 4 as a primary set which was used in the workshop; though the secondary set is also maintained for further consideration (in **Table 3** below).

## 3.5 Scenario Skeletons: Primary Scenario Set

Each of the scenario skeletons is summarized in Table 2. The scenarios are read across each row. This is the primary set of scenarios, chosen for maximum diversity in consumption patterns and the maximum number of other factors. These scenarios were the focus of the workshop; the secondary set is also presented in Section 3.6 (**Table 3**).

***Table 2*** *Primary scenario skeleton summaries – with added explanations of factors that have specific interpretations in each scenario*

| | Consumption Patterns | Environmental Degradation | Poverty and Economic Inequality | Social and Technical Innovation | Urban and Rural Population Dynamics | Power and Market Concentration | Trade Agreements | Resource Use |
|---|---|---|---|---|---|---|---|---|
| **Fed up Europe** | High animal products, high sugar/processed food (unhealthy meat eaters) | Biodiversity loss, water pollution, soil degradation etc. continued environmental decline | Low poverty high inequality – few are truly poor, but some are extremely rich | Low innovation, private sector driven – public and private sectors are inert, despite interest in change among a minority in the private sector | Increase in both urban and rural populations | Extreme concentration: several companies dominate the entire market worldwide | Free markets (more free trade agreements, removal of subsidisation) | Resource crisis |
| **The Retrotopia** | Low animal products, high sugar/processed food (unhealthy vegans and vegetarians) | Environmental degradation is reversed | Low poverty, low inequality | High innovation, public sector driven | Decrease in both urban and rural populations | Healthy competition exists in all sectors – significant role for SMEs | Protected markets (less free trade more subsidies) | Significant reduction in resource use/demand |
| **The Protein Union** | Meat consumption, low sugar/processed food – strong innovation on animal proteins, e.g. insects | Environment is stabilized but at lower levels than today | High poverty, low inequality – people have less assets but strong state support. | High innovation, public sector driven – the public sector stimulates innovation, but there is an important role for the private sector | Decrease in rural, increase in urban | Some sectors dominated by a few global players, others less concentrated | Protected markets (less free trade more subsidies) | Resource scarcity |
| **The Price Of Health** | Low animal products, low sugar/processed food (healthy vegans and vegetarians) | Environment is stabilized | High poverty, high inequality – incomes are low, but quality of life has been decoupled from income through other means of subsistence; the rich lead very different lives | High innovation, needs driven, bottom-up – local initiatives, local businesses and local governments | Increase in rural decrease in urban | Extreme decentralisation dominated by SMEs | Protected markets (less free trade more subsidies) | Significant reduction in resource use/demand |

## 3.6 Scenario Skeletons: Secondary Scenario Set

***Table 3*** *Secondary scenario skeleton summaries – with added explanations of factors that have specific interpretations in each scenario*

| | Consumption Patterns | Environmental Degradation | Poverty and Economic Inequality | Social and Technical Innovation | Urban and Rural Population Dynamics | Power and Market Concentration | Trade Agreements | Resource Use |
|---|---|---|---|---|---|---|---|---|
| **The Gravy Train** | High animal products, high sugar/processed food (unhealthy meat eaters) | Biodiversity loss, water pollution, soil degradation etc. Continued environmental decline | Low poverty high inequality | High innovation, bottom up and needs driven | Rural and urban populations stabilized | Extreme decentralisation, dominated by SMEs | Protected markets (less free trade more subsidies) | Resource scarcity |
| **Goodbye to All That** | Low animal products, high sugar/processed food (unhealthy vegans and vegetarians) | Biodiversity loss, water pollution, soil degradation etc. Continued environmental decline | High poverty, high inequality | Low innovation, private sector driven | Reruralisation | Some sectors dominated by a few global players, others less concentrated | Protected markets (less free trade more subsidies) | Resource scarcity |
| **Too Busy to Cook** | Low animal products, high sugar/processed food (unhealthy vegans and vegetarians) | Environment is revived | Low poverty high inequality | High innovation, private sector driven | Rural and urban populations stabilized | Extreme decentralisation, dominated by SMEs | Free markets (more free trade agreements, removal of subsidisation) | Decoupled economies |
| **The Grass is Greener** | Low animal products, low sugar/processed food (healthy vegans and vegetarians) | Environment is stabilized worldwide but at lower levels than today | High poverty, high inequality | Low innovation, public sector driven | Decrease in urban and rural populations | Competitive markets, mix of larger and smaller companies | Free markets (more free trade agreements, removal of subsidisation) | Resource scarcity |

## 3.7 Scenario Narratives: Primary Scenario Set

The narrative development followed the methodology described in Section 2.6. The scenario skeletons were written out in large text on flipchart sheets on boards facing each break out group as shown in Figure 1. Participants took time to reflect individually on what the world would look like in the case of their scenario. They recorded these thoughts on post-it notes as shown in Figure 9.

***Figure 9*** *Scenario narrative development*

After participants had clustered post-it notes, long discussions took place on the mechanisms for explaining the presence of the features of the scenario end point together, and what that world would look like as shown in Figure 10.

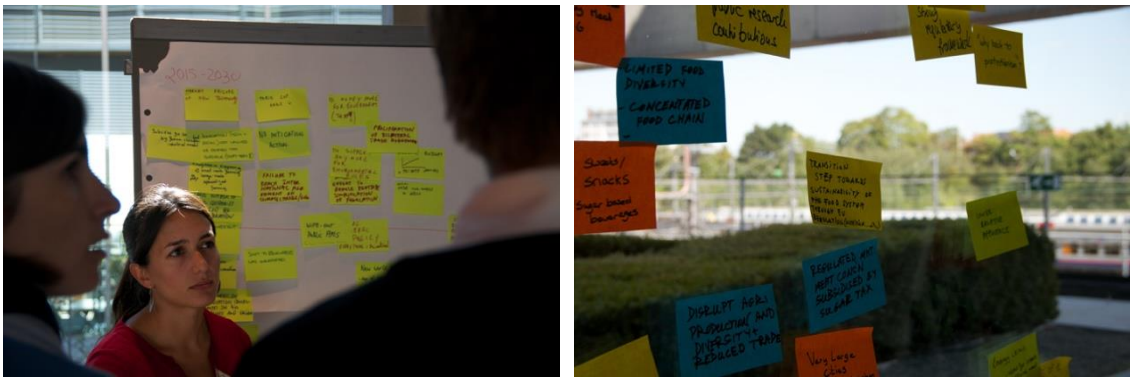



***Figure 10*** *Scenario description, post-it note clustering and discussion*

All scenarios contained many tensions and involved heated discussions. During this period note-takers recorded the narratives describing the situation and also the explanation for how it happened. Timelines were developed describing how the scenario end state, which had been envisioned, was reached from the present to 2050 as shown in Figure 11.

***Figure 11*** *Scenario narrative timeline development*

These flip chart sheets and post-it notes, together with the system maps and the notes taken by note-takers during the discussions, were developed into full narratives by the TRANSMANGO scenario team over 2.5 months following the workshop.

### 3.7.1 Scenario 1: Fed Up Europe

**The heart of the story**

Fed Up Europe is a story of inertia in the food system under global pressures. Practices and business models leading to unhealthy diets and negative environmental impacts continue. The power of EU and national policy makers to change these trends decreases over time with a combination of decreasing funds and decreasing popular support. There is a lack of leadership in the face of climate and migration crises. Consumers' incomes are enough to avoid food insecurity, but many lack the knowledge, incentives or budgets for healthy life styles. In governments and in the private sector, there are minorities interested in changing the trend, but they are fighting an uphill battle.

**The road to 2050**

In the years after 2015, support for environmental legislations decreases in the name of creating a more competitive economy, and the need to spend on military budgets in the face of international threats and tensions. Economies are organized more and more to favor large companies at the expense of small and medium enterprises. The agricultural sector is organized in a similar fashion – large, industrialized farms become more and more dominant, further bolstered by succession challenges. During the 2020s, the Common Agricultural Policy is seen as less and less relevant and affordable; and the Agricultural Knowledge and Innovation System (AKIS) also loses support.

Economic and security concerns are policy priorities because of significant global pressures on the European continent. The African continent and the Middle East are increasingly rife with violent conflicts, and this drives ever larger waves of migrating people to Europe. The EU and its national governments are unable to respond coherently. Economic competition from the BRICs increases (the G30 replaces the G8) and threatens to destabilize the European economy, resulting in tough economic policy responses; at the same time, geopolitics become

increasingly polycentric and international military tensions mount. These pressures lock Europe into reliance on an industrial scale, centrally controlled food system with only a few companies playing a significant role.

2040 offers a glimmer of hope when the UN organizes an emergency global resource conference in Stockholm. The conference fails due to unsurmountable political differences.

**Fed Up Europe in 2050**

By 2050, climate change has emerged as an additional source of migration – many in the Mediterranean are hoping to move to northern Europe, because agriculture has become increasingly difficult and living conditions in the south have deteriorated with extreme temperatures and drought.

Economically, Europe is still holding its head above the water, and most people live above the poverty line, though incomes have decreased. Healthy diets are out of reach for most; and the majority of Europeans does not have the required knowledge to care. The result is a mass consumption of cheap animal products and high-sugar, highly processed food. Obesity and non-communicable diseases have soared; life expectancy has dropped significantly – a trend exacerbated by the increasing price of quality health care and the disappearance of safety nets. These majority trends are in stark contrast with the fate of an extremely rich minority who manage to turn policymakers' dedication to keep the EU economy afloat to their benefit. In business and in governments, defensive and conservative mindsets dominate, resulting in widespread frustration and low job satisfaction in all sectors.

Concerns about European environments, as well as the impacts of European businesses on global environments are largely off the table – and the result is continuing decline, made worse by climate impacts. There is little funding going into understanding the consequences of climate change on biodiversity and environmental conditions, let alone any ability to take action.

| Food and nutrition security | Agricultural systems | Post-farm food system activities | Interactions with global food security | Environmental impacts of the food system |
|---|---|---|---|---|
| Few people are undernourished, but other malnutrition and NCDs are common. | Large-scale industrial agriculture grows, with little innovation, among other reasons because cheap labour is available; smaller farmers fail. | Several companies control post-farm food system activities; locked into historic patterns | Europe struggles with competition from other global regions; but trade agreements remain open and free, offering market opportunities due to low European wages and lax regulations | Environmental policies are weakened; land and resource use becomes more indiscriminate and damaging. |

### 3.7.2 Scenario 2: The Retrotopia

**The heart of the story**

In Retrotopia, waves of immigration, terrorist threats and increasing impacts of climate change trigger social movements and policies that aim to keep global problems out of Europe, along with a nostalgia-fueled sense of natural heritage and rural custodianship. Racism becomes more accepted; migrants are kept out, creating employment problems in greying societies, which are partly solved by robotization of work; fear of migration from Europe's southern to northern countries due to climate change prompts European policymakers to help make Mediterranean countries more climate-resilient. Environmental concerns drive down consumption of animal products; otherwise, the improvement of diets is not a priority amid concerns of European security and self-reliance.

**The road to 2050**

Continued waves of migration and fear about terrorist threats and the loss of cultural identity give rise to a stronger political position for parties that advocate closing down European borders to outsiders. Support for both a strong state and a Europe united against a dangerous world grows. At the same time, while climate change becomes a more serious threat, especially for Europe's southern nations, policies that help protect natural environments and provide greater resilience to farmers become more popular. It is one of the few issues where the political left and right come to see eye to eye – this environmental impulse is framed in terms of global responsibility by some, and by nostalgic notions of heritage and custodianship of natural environments by others.

As a result, the EU takes far-reaching initiatives to tackle environmental problems, including a high carbon tax. A landslide tax shift towards taxing pollution and resource degradation is implemented. Europeans realise that resilience and self-reliance in the face of changing environmental and social conditions require innovative economies. Innovation is driven by legislation, but also by large public investments in both technological and social innovation.

As climate change hits southern Europe in particular, a lot of investment in innovation goes to southern European countries to mitigate migration flows from the south to the north of Europe. The halting influx of immigrants means that Europe is aging, and the population is dropping. A real labour problem develops. Nutritional policies are not a political priority.

**Retrotopia in 2050**

Europe has attempted to deal with its labour shortages and demographic challenges by increased reliance on robotic replacement of human labour. This approach, combined with strong policies on the redistribution of wealth buffered by environmental taxes, means that poverty and inequality are low. Those who have moved to Europe in earlier times are the worst off – integration has largely failed.

Trade with the outside world has decreased, since the EU and national governments have both implemented heavy environmental taxes and oriented their economic growth around SMEs, the presence of large companies has been reduced, with some of them leaving Europe for easier and more profitable markets.

European agricultural production benefits from increased border protection and subsidies, such that environmentally-friendly production practices are widely adopted, thus safeguarding the resource base and food and nutrition security for future generations. Mediterranean countries become a hub for climate-smart agriculture. Environmental quality is not only stabilised but even improves because of stringent laws and the lack of population growth.

A combination of shifting cultural values and environmental policies have also greatly reduced the consumption of meat. Sugar consumption has not, however, become a policy priority and the greying population of Europe suffers from health issues such as obesity and other non-communicable diseases. The demand for health care is high.

| Food and nutrition security | Agricultural systems | Post-farm food system activities | Interactions with global food security | Environmental impacts of the food system |
|---|---|---|---|---|
| Poverty and food insecurity are low; meat consumption has dropped; but NCDs are common as sugar consumption is high and not a policy priority | Mediterranean countries become a hub for climate-smart agriculture; environmental policies have shifted Europe toward more sustainable agricultural practices. | Robotization has increased in all food system activities with decreasing labour availability. This innovation has been facilitated by public policies. | Trade with the outside world has decreased; large food companies are increasingly focusing on other global regions. Food security in other regions is threatened by economic and climatic challenges, but Europe does little to help. | Strict policies ensure low environmental impacts of food system activities. |

### 3.7.3 Scenario 3: The Protein Union

**The heart of the story**

The Protein Union is a story of a highly proactive response by the EU and its Member States, led by governments but supported by the private sector and civil society, to the challenge of changing European diets and modes of production. The focus is on creating new sources of protein, including mainstreaming insect consumption and the production of artificial quasi-meats, supported by new, more integrated means of food production and processing, at the expense of the livelihoods of smaller farmers. This is combined with strong action on reducing sugar closer to 2050, which nevertheless cannot avoid the legacy of unhealthier diets in earlier times.

**The road to 2050**

European governments, the EC and many business leaders see a number of alarming trends arising in the 2010s and 2020s. These include a continuous rise of food related health issues across the EU such as rising levels of obesity and other forms of malnutrition while more than 5% of the EU's population remain undernourished. A greater number of serious droughts and floods events occur, together with some unprecedented summer heat waves, particularly in the Mediterranean countries. These result in growing difficulties for food producers, and an increasing need for insurance payments in addition to a strong EU internal migration

movement from the southern to northern countries; and a continuing influx of migrants and refugees from Africa and the Middle East as these regions continue to be plagued by conflict and civil strife.

EU Member States, in particular the northern ones, embrace the notion that the best way forward for the European Union in reacting to these challenges is closer cooperation and integration with clearer rules, more centralized decision making authority and an increasing power of the EU parliament. They see an important role for government and public sector institutions in leading the way to solutions to these problems. They also see only a limited capacity in voluntary approaches by consumers or the industry sector in dealing for example with the emerging health crisis.

In the food and agriculture sector a number of new initiatives are launched to combat the rising health costs due to food related illnesses that both employers and governments see as an increasing burden. Many governments seek to build coalitions between the public sector, the industry and civil society as a way to foster closer collaboration and sort out problems in a joint way from the start, but with the governments setting the tone and direction of the conversation.

Governments want to stimulate a change in eating habits as well as in the EU food system orientation which is in the 2020s fueling the move of consumers towards easy accessible, seemingly healthy food which is nevertheless of low quality and often high in sugar, salt and additives. The chosen path is to stimulate new research and innovation in the food sector in a number of narrowly defined areas such as a quest for new sources of protein, such as insects or artificial meats. Both the EU commission as well as various national governments set up specific food related research funds to incentivize both the food industry and producers to search for new ways to feed an ageing EU population with lower environmental and climate impacts.

Responding to the growing obesity crisis in the 2030s, a much debated sugar tax is introduced EU wide as one of the first measures showing the ever increasing power of the EU parliament across Member States in so-called ‘areas of EU wide concern’. Regulations on maximum sugar amounts on drinks and sweets are also set in place, and funding is provided for new low-sugar products.

With increasing climate impacts, the EU Member States push for a strong climate regime for reducing GHG emissions from all sectors, including the food and agriculture sector.

**The Protein Union in 2050**

In the last decades, it has become clear that consumers do not want to abandon meat eating and change to more vegetarian diets. The food industry, encouraged by national governments, has developed new ‘designer protein foods’, using a variety of new protein sources to create a range of new products that allow consumers to choose ‘quasi-meats’ form a number of unexploited sources. Improvements in aquaculture have added to the mix of new designer meats. Larger food processing companies dominate this market and have pushed out smaller farmers. Several food scares around ‘normal’ meat have put many smaller livestock farmers out of business, solidifying the position of the food processing companies,

who took the opportunity for developing new integrated agri-food business models in which the whole production and processing process is integrated and controlled by the company. These developments are supported also by new research directions given to universities and public sector research institutions to support the integrated 'food production cum processing' approach. Environments are rewilding, but typical agricultural landscapes and their associated wildlife have been disappearing.

A slow decline in child obesity rates has been observed but the brunt of the food related health problems is seen across all EU countries. Some health and social security insurances nearly collapsed under the rising costs of the health system, that also has to take care of an ever older population. Many governments step in with new social security measures leading to high taxes and social security costs for citizens but also easing out inequalities across social groups in many instances. So though the economies of many Member States are only growing very slowly, social inequality is not worsening across the EU.

| Food and nutrition security | Agricultural systems | Post-farm food system activities | Interactions with global food security | Environmental impacts of the food system |
|---|---|---|---|---|
| People are not wealthy, but are able to meet basic needs. Innovations in meat and meat-like products ensure protein consumption; policies to control sugar consumption are in place, but rather late, and Europe struggles with a legacy of NCDs and obesity. Awareness raising policies have failed. | Agricultural systems are increasingly industrialized, and integrated economically and technologically with the rest of the food system. Smaller farmers leave the market because of competitive pressures and food crises and scares. | Major companies work closely with governments to innovate and intensify in food systems, and integrate agricultural production with other aspects. | Strict policies on food products and processes, and a highly European focus limit market interactions with the rest of the world. However, European innovations are exported to other global regions. | Concerns about environmental impacts are driving the innovation into new modes of production and processing of meat and meat-like products. Over the longer term, this leads to a relative slowing of environmental decline. |

### 3.7.4 Scenario 4: The Price of Health

**The heart of the story**

The Price of Health is a story that sees many Europeans returning to rural lives, out of necessity due to global pressures, because of changing social norms, and facilitated by technological advances in communications. These changes are supported by strong government policies regarding self-reliance and sustainability. Not everyone, however, is happy to be returning to the land – and the wealthiest do not have to follow suit.

**The road to 2050**

In the coming years there is a rapid deterioration of natural resources worldwide, of which the European population is very well aware. The Pope is making statements to this effect validating environmental fears even amongst conservatives.

By 2020 there is widespread recognition that climate change and environmental degradation are leading to high numbers of refugees, and a range of other social and economic crises. Global economic instability continues, with years of recession that see Europe struggling to keep a strong role in global markets. Fear and concern across European society has deepened, giving power to increasingly interventionist and protectionist governments. Simultaneously, and in reaction to this, many grassroots social movements advocating community, social inclusion and a strong sustainability agenda also gain prominence. There are also a number of food safety scares associated with products originating from outside of Europe. This has led to a growing preference for local foods – or at least foods produced under EU standards.

By 2030, food scares, economic crises, resource scarcity, migration and social and political instability are common. These concerns, combined with growing xenophobia and distrust of products from outside Europe, lead to the abandonment of multilateralism, and re-nationalization of many sectors.

By 2040, Europe has very strong environmental legislation in place. All activities not considered sustainable are blocked through legal and financial mechanisms. Education has been refocused around food, cooking, community, well-being and the environment. Emphasis is placed on local initiatives, policies are put in place to support local entrepreneurship and there are a growing number of SMEs catering to local needs. These SMEs are highly innovative, pressured by bottom-up social movements. This creates interesting job opportunities in rural areas and smaller communities.

**The Price of Health in 2050**

Global economic downturns, social problems and decreasingly competitive EU economies, coupled with social and environmental externalities being included in the price of goods, have increased the cost of living. Further, the localization of supply has limited economies of scale. These factors have combined to make many city dwellers financially insecure, and many responded to increasing food insecurity by moving back to the countryside where they can produce some of their basic foods themselves. Further, cheap and fast communication technologies have allowed people to be part-time farmers while maintaining aspects of other, productive career activities.

Growing social movements, where consumers aspire to becoming producers and to live more sustainably, have emerged to address the environmental and economic situations. For many, the notion of well-being is decoupled from financial wealth and overall consumption. Tensions emerge, however, because this ideological aspect is not shared by all; some resent the changes and different living standards among new rural populations.

While from a financial perspective most people are poor, re-realization combined with easy access to information and education on agricultural practices as well as diets has, however, led to the majority eating a highly nutritious vegan or mainly vegetarian diet. The low consumption of animal products is driven by both ethical concerns for animal welfare and cost. There is also little to no consumption of highly-processed or sugary foods. The majority of foods consumed are produced locally, and there is extreme market decentralization dominated by small to medium sized enterprises, empowered by flexible technologies. Increases in available information on smart farming and community organization have

promoted these changes. This approach, however, is successful in most, but not all areas in Europe, because of historic differences in technology and transport infrastructure.

National governments and the European institutions are extremely strong in this scenario, having received strong mandates to act from citizens in need of social reform in response to economic and environmental crises. Social and environmental negative externalities are heavily taxed, while sustainable products are subsidized.

From a financial viewpoint, wealthy people are few. These few can, however, afford products produced elsewhere, and remain in elite urban areas or acquire large estates as they prefer. This inequality does not go unnoticed.

Not everyone experiences the decoupling of financial wealth from human well-being; some people experience it as an oppressive regime. Not everyone sees living rurally, producing their own food, having access to almost only local products, and low levels of financial independence, as positive. Not everyone is equally willing to reduce their consumption of animal products, although government policies, poverty and lack of access force the majority of people to do so. Other people consider the transition that Europe has undergone as extremely positive, living closer to nature, in better communities with better health due to a much healthier diet. This is the dominant social narrative and is supported by strong governments and the European institutions to justify interventionist approaches that maintain this *status quo*. Note that this is also in the interests of the few who profit from it.

| **Food and nutrition security** | **Agricultural systems** | **Post-farm food system activities** | **Interactions with global food security** | **Environmental impacts of the food system** |
|---|---|---|---|---|
| Many are poor in terms of income, but rural lifestyles, smart and diverse agricultural, trade and distribution practices, combined with a shift in preferences and understanding of healthy supported by customized information technology results in good food and nutrition security for most. Cost and preferences have lowered the consumption of meat and animal products considerably. | Food produced by farmer cooperatives, and medium-sized farms, bolstered through flexible and climate-smart agricultural technologies, is integrated into short food chains, and supported by home-produced crops. | Post-farm food system activities are highly integrated with agricultural production, managed by small to medium-sized enterprises, supported by flexible agricultural, processing, transport and information technology. There are, however, some areas where such technologies are less available. | Europe has little capacity to help resolve food security issues elsewhere in the world. | Re-wilding trends due to the abandonment of rural areas are reversed, with people moving back to the land. The return to cultivated land is mostly done in a sustainable fashion; nevertheless, this leads to a stabilization, rather than a revival, of environmental conditions. |

## 3.8 Scenario Narratives: Secondary Scenario Set

These four scenarios were also part of the final eight scenarios produced by the OLDFAR method.

**The Gravy Train**

In this scenario, by 2050, there has been an economic revolution of sorts – after years of economic instability, for which large companies and banks were primarily blamed, strong political action has been taken and economies have been re-organized to allow for much more local and regional diversity. Small and medium enterprises flourish; those with good ideas and entrepreneurial energy are much more likely to succeed. Inequality is high, since some manage to take their businesses very far, becoming the new elite. But standards of living for most of the population are good, at least in an economic sense. However, there is little political and economic interest in environmental conservation and sustainable business – after economically traumatic years, regaining prosperity is the focus. The prioritization of economic growth has also taken public attention away from health concerns. Instead, standards of what is considered healthy and socially desirable have shifted.

| Food and nutrition security | Agricultural systems | Post-farm food system activities | Interactions with global food security | Environmental impacts of the food system |
|---|---|---|---|---|
| Few are food insecure, but dietary concerns are otherwise not prioritized and NCDs are high. | Smaller and medium farmers manage to find economic viability through policy support, but care little for environmental or health impacts. | Europe is a flurry of companies experimenting with approaches to making food system activities economically successful. Little regard is given to environmental or health impacts. | Policies are focused on the economic health of the European region; there is little concern for the impacts of food or feed sourced elsewhere; nor is there funding for support of other global regions. | Economic concerns dominate, and environmental conditions continue to decline while everyone is focused on making a profit and creating economic resilience after global crises. |

**Goodbye to All That**

In this scenario, by 2050, relentless global and European economic instability, crises of migration and local conflicts at the edges of Europe, climate impacts affecting the southern countries, and a prolonged crisis of EU governance around these issues have taken their toll. The EU's power has been greatly reduced. Economic shocks have led to high poverty and inequality. Natural environments decline, as they are exploited by international actors. Education and innovation have stagnated, due to lack of funds and optimism in politics. Many have moved back into the countryside in search of more stable livelihoods.

| Food and nutrition security | Agricultural systems | Post-farm food system activities | Interactions with global food security | Environmental impacts of the food system |
|---|---|---|---|---|
| Poverty is widespread, and food insecurity reaches levels that are unprecedented for Europe. Many move back into the countryside but struggle to create effective sources of food under climate change. | A combination of conventional, large-scale farmers with little innovative capacity and a new and rather inexperienced generation of small-scale farmers producing for subsistence and marginal cash flow. | Many companies in food processing, distribution etc. have failed, resulting in less diverse food products – and a food system full of opportunism and a lack of reliability. | Global food demand affects price and stability, only adding to food insecurity in Europe. | Food production and other food system activities are in survival mode, and care little for environmental concerns; nor do policy makers. |

**Too Busy to Cook**

By 2050, Europe is brimming with innovation. Facilitated by continued progress in communication technologies, local and regional initiatives and networks around energy, water, food and services have taken off, learning from innovations elsewhere in the world, and from each other. Governments are struggling to keep up with disruptive change in all sectors, and some individuals benefit far more than others. In terms of food consumption, environmental values are dominant. Meat consumption has become a social faux pas. However, Europeans have more trouble taking care of themselves – life is moving fast in these competitive economies, and local products from bakeries and breweries might be sustainable, but that does not mean they are low in calories.

| Food and nutrition security | Agricultural systems | Post-farm food system activities | Interactions with global food security | Environmental impacts of the food system |
|---|---|---|---|---|
| There is an ethical shift away from the consumption of animal products; otherwise, though, people have a hard time maintaining healthy diets in a high-pressure society. | Agricultural production is diverse, innovative and thriving, focusing on sustainable forms of production and new ways to link to consumers. | The European food system is characterized by an extreme diversity of small-scale business models supported by strong communication networks. | Europe becomes a center for food and agricultural innovations – eager to share its knowledge and technology with the world. | A strong dedication to environmentally sustainable agriculture and food system approaches among businesses across Europe leads to an environmental revival, and to positive global impacts where EU approaches are implemented. |

**The Grass is Greener**

Europe in 2050 is rather empty, apart from the sounds of birds and other wildlife. After worries of economic slowdown in the 2010s, the BRICs have taken off and outcompeted Europe in many ways. Accordingly they have created such attractive economic opportunities for many that a minor but still significant amount of the European population has migrated, at least temporarily or intermittently, to other parts of the world. Europe is struggling with

economic growth because of this brain drain. Inequality is high. Pressure on land and natural resources has decreased, however, and natural environments have flourished.

| Food and nutrition security | Agricultural systems | Post-farm food system activities | Interactions with global food security | Environmental impacts of the food system |
|---|---|---|---|---|
| There is a divide in Europe – many who were worried about the threat of poverty, but had the ability to leave have done so; those remaining are the poor with few options for employment outside of Europe, and the wealthy. Meat becomes too expensive for the poor, and environmentally taboo for the rich; strict food policies have, in the meantime, ensured a decrease in harmful and sugar-rich processed foods. | Food production in Europe has decreased significantly with stringent environmental laws and cheaper production outside of Europe. | With decreased food production, other food system activities have also been reduced, mostly focusing on processing food commodities from elsewhere. The brain drain affects Europe's ability to recruit the expertise needed in various aspects of its food system. | Europe struggles with the growing demand of other global regions for food commodities. | A decreasing population, and a decrease of agricultural production have led to a rewilding in rural areas. |

## 3.9 Climate Scenario

The scenarios as described above predominantly cover socio-economic and institutional change, but also contain information on climate change (impacts). To ensure that climate change was considered during the construction of the scenarios, the main climate change impacts by 2050 across Europe were presented during the afternoon group work sessions.

Out of a set of four recently developed emission scenarios – Representative Concentration Pathways (van Vuuren et al., 2011) – it was decided to use the most high-end climate scenario, RCP8.5. Reasons to select a rather extreme climate change scenario are multifold. Firstly, in order to generate a climate signal an extreme scenario is needed, especially because by 2050 the impacts of climate change are relatively small. Secondly, current emissions follow the most extreme trajectory making it the most likely climate future. Finally, arguably socio-economic change is faster and with stronger impacts on the food system, which makes it important to maximize the climate signal.

Figure 12 summarizes the main future climate change impacts that would hit Europe under an extreme climate change scenario, comparable to RCP8.5, as documented in a report from the European Environment Agency (2012).

A summary of the climate change impacts in Figure 12 was presented to the stakeholders in a 15 minute intermezzo during their scenario building exercises. Main impacts mentioned included:

- There is a strong gradient from north to south of Europe, with mainly beneficial climate change impacts in the north to mainly negative impacts in the south.

- In Scandinavia and the Arctic, climate change and global warming have multiple positive impacts. With the disappearance of the North Pole ice, trading routes will open, while oil and gas resources can be exploited. At the same time, temperature rise will increase yields for many crops, making agricultural expansion likely and profitable. Additionally, there is only a minor increase in flooding risks and droughts.
- In the Mediterranean, climate change has mainly negative impacts. Heat waves, droughts, high temperatures and radiation, combined with (strong) decrease in precipitation result in loss of crop yields, increase in forest fires, loss of hydropower potential, and a decrease of tourism. This will trigger land degradation and land abandonment.
- For other regions, climate change impacts are more mixed. In general, flooding risks increase in large parts of Western, Central, and Eastern Europe, accompanied by higher damages by winter storms. On the other hand, higher temperatures will decrease energy demand, and new agricultural crops will be cultivated as crop yields generally increase.

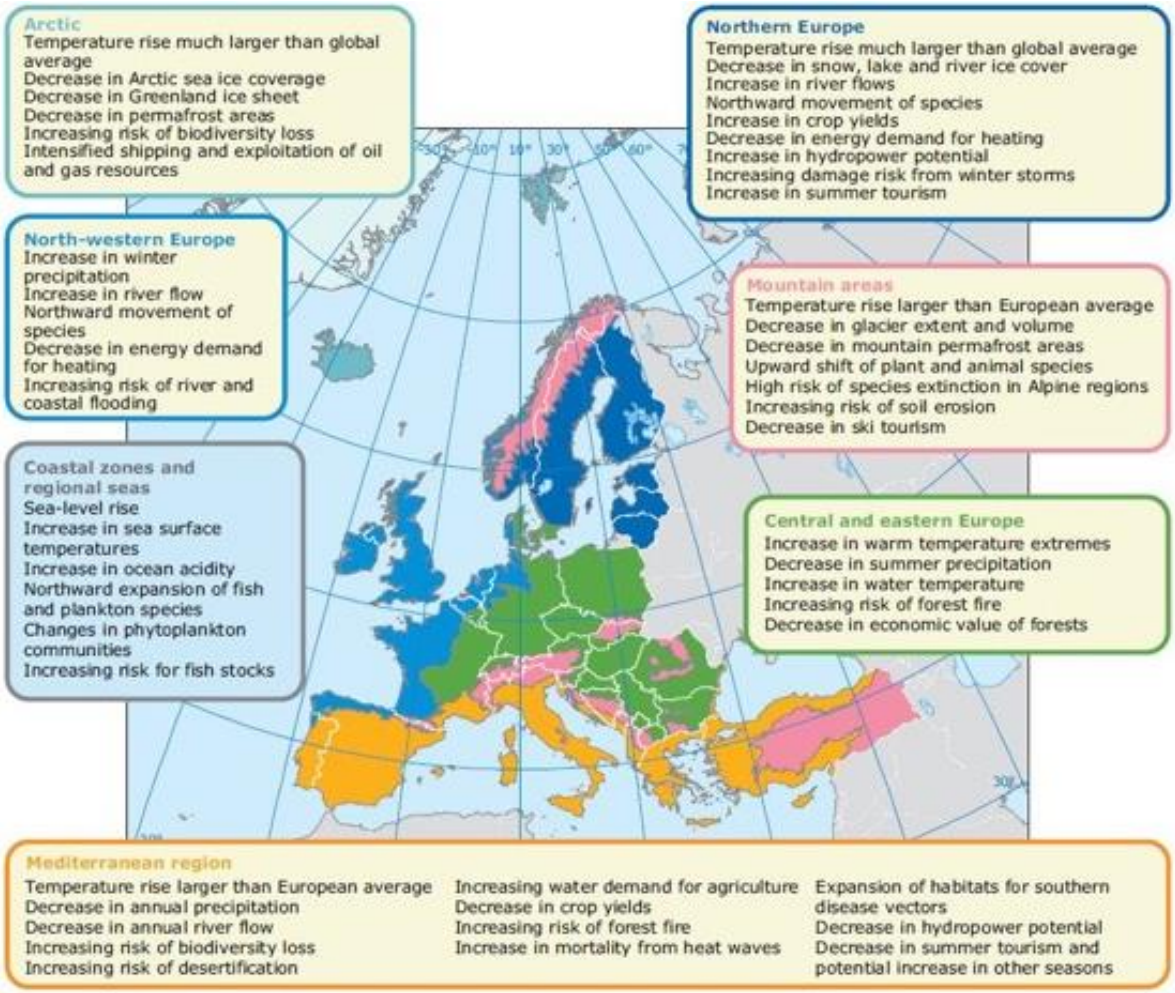



***Figure 12*** *Climate scenario for Europe (European Environment Agency, 2012)*

## 3.10 Semi-quantitative Causal Mapping

The mapping process discussed in Section 2.7 was conducted in the four scenario groups at the workshop. It yielded the system maps provided in Sections 3.10.1 to 3.10.4 for scenarios 1 to 4, respectively. These maps represent the scenario end state in 2050. The mapping technique involved large sheets of paper and enough pens for all participants. The sheets of paper were prepared before the session began. Blue post-it notes on the sheet had the eight future factors written on them, as discussed with participants during the workshop's introductory session. A red post-it note on the sheet represented the concept of food and nutritional security as the key outcomes of interest. Participants were asked to explore the chains of cause and effect through which factors effect each other and influence food and nutritional security. Influences/relationships were represented by participants drawing an arrow between post-it notes. Intermediary concepts between the factors and the outcomes were included by participants adding yellow post-it notes. Consensus on adding concepts, drawing arrows, and assigning values to the arrows was reached by a group discussion. This process is shown in Figure 13.

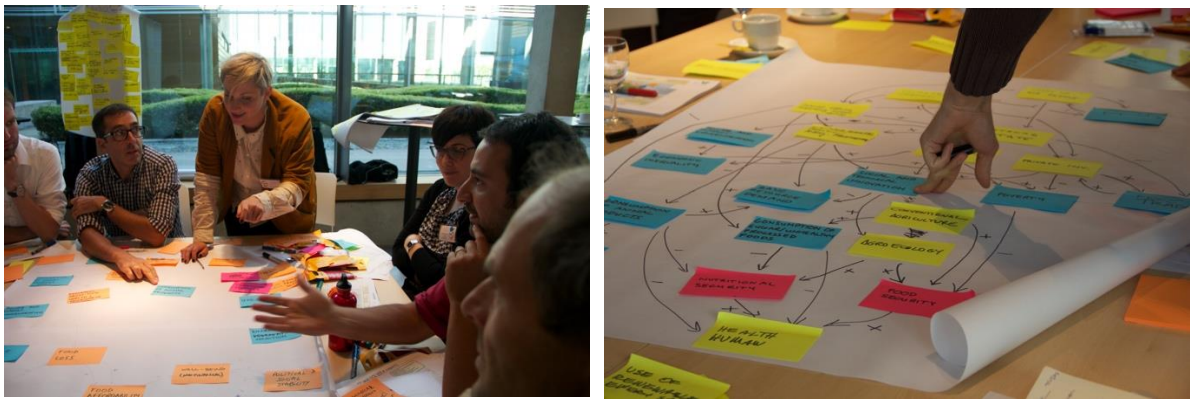


***Figure 13*** *Semi-quantitative causal mapping*

The development of the system maps was extremely useful for clarifying and specifying:

- The meaning of each of the factors in the scenario: extensive discussion took place around what is meant by each of the concepts, for example, what is meant by poverty and inequality.
- The relationship between the factors: extensive discussion took place around which concepts directly affect each other and the nature of indirect effects, that produce the scenario end point.
- The dynamics and feedbacks of the scenario.

The system maps provide a structured representation of how each of the scenarios leads to specific interactions of factors. They help to clarify how the participants understand what is happening within the scenario. Through the process of developing the system maps the logic of each of the scenarios and their narrative descriptions were refined and improved. They also describe how the factors in the scenario interact with the proxies that are inputs to GLOBIOM and as such a first link with WP4 for TRANSMANGO. For example, the system maps show how technology impacts both directly and indirectly on crop yields. The causal maps also capture many features that are not currently included in GLOBIOM. They facilitate further development of GLOBIOM and allow for external logical analysis of how outcomes that are not in GLOBIOM change.

As an initial demonstration of this type of logical analysis, Figures 14-17 in Section 3.10.5 show the causal trees for food and nutrition security in each of the scenarios from the workshop system maps. The causal trees show the primary, secondary and tertiary aspects that the participants believe influence food and nutrition security in their scenario. These causal trees are interesting but not final. Further post-workshop analysis will examine the system maps in more detail, suggest refinements, and will be sent back to participants to revise and comment. The revised and reviewed system maps will be used for feedback loop analysis, system dynamics sensitivity analysis, as well as logical structure representation by including any inputs and outputs relevant to GLOBIOM in the system mapping.

Two sets of numbers were assigned to each relationship. The first set of numbers (in black in the diagrams below in the Sections 3.10.1 – 3.10.4) relate to how certain the participants were that the source concept (tail of arrow) causes, or prevents, the end concept (head of arrow). The number represent a fuzzy binary (see Helfgott et al., 2015), which is easy to convey to participants by a sign, and a number between 0 and 1. The number 1 represents certainty that there is a relationship (in the direction indicated by a + or -), the number 0 represents certainty that there is no relationship. Numbers between 0 and 1 provide a degree of certainty between the extremes, so the number 0.5 represents the most uncertainty about the relationship. For example, participants were certain (gave +1) to social and technological innovation influencing in a positive way agricultural production. Participants were highly uncertain though (gave +0.5) to whether future conventional (industrial) food systems would influence the increase of the consumption of sugar and processed foods.

From the first set of numbers the system diagrams can use fuzzy cognitive mapping techniques to try and determine influence and causation. The second set of numbers (in green in the diagrams below in the Sections 3.10.1 – 3.10.4), conditional on a relationship existing, represent how much effect a change in a quantity of the source concept (tail of arrow) has on a quantity of the end concept (head of arrow). From the second set of numbers stocks and flows, or effects of perturbation in system state, can be calculated.

Before calculations are performed the quantification of the links will be cross-checked and processed for consistency. These semi-quantitative results also provide a first pass for quantitatively linking with GLOBIOM. The results of the processing of the maps and calculations will be provided in a subsequent report dedicated to these quantitative outputs.

There were challenges in the workshop with numerical assignments – in particular with the second set of system dynamics assignments. In using fuzzy binaries there is built-in leeway for expression of uncertainty, so vagueness or ambiguity can get incorporated to the determination of the fuzzy binary. Vagueness and ambiguity could not be captured in the second set of numbers, the system dynamics assignments. The workshop was conducted over one day, which limited the time available in the exercise.

Problems verbalized by participants included:

- The linear system dynamics model as a first approximation was seen as limiting by many participants who wanted to indicate non-linear relationships.

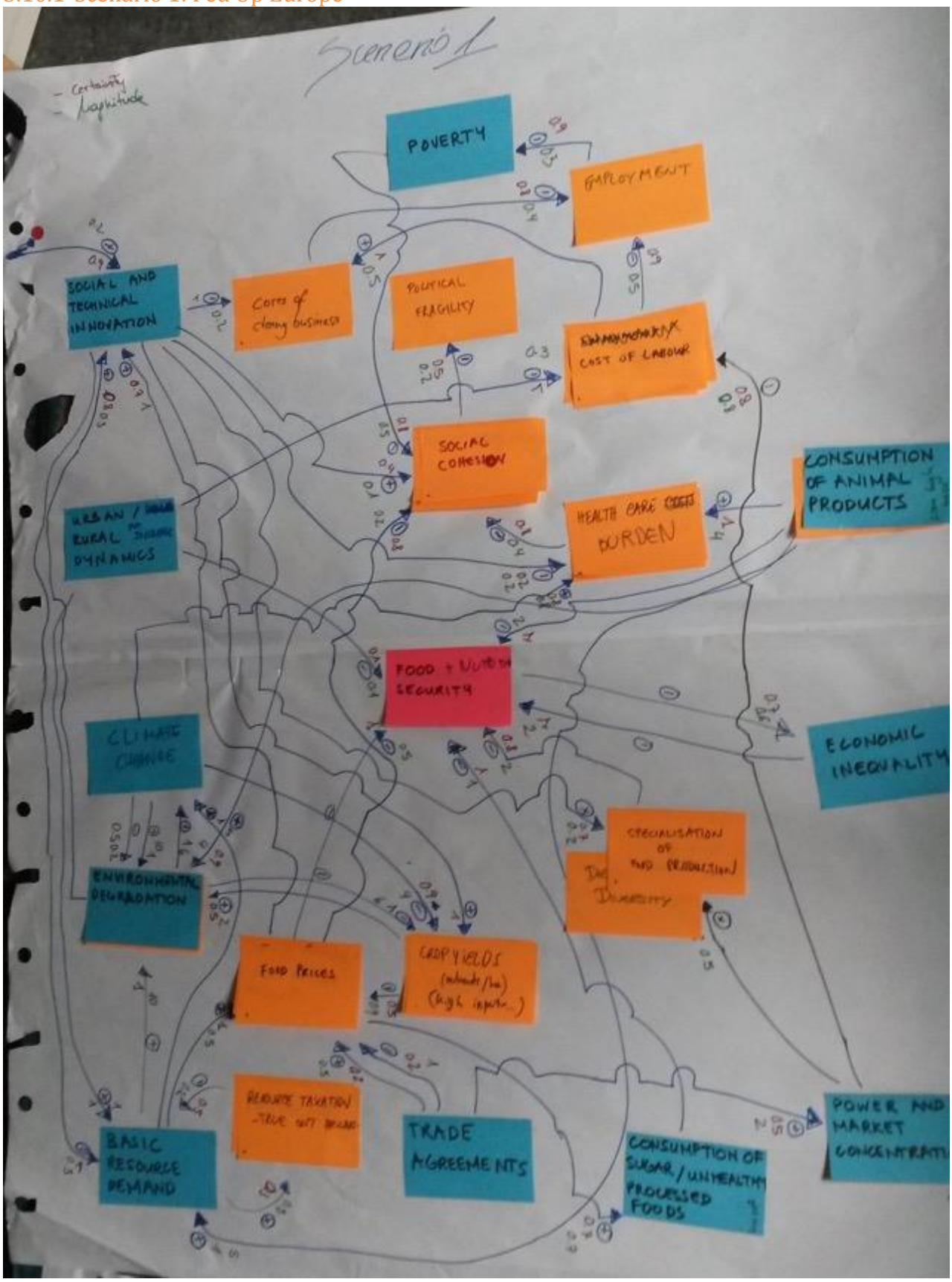
- Determining the quantities/units involved in each concept, sorting out quantities on the spot was very difficult, also there is not agreement in quantities across groups.
- Incorporation of known data/models about certain relationships (participants were reminded that this incorporation happens in the next stage and existing data and models are for the present and not for this unique scenario).
- There is no time scale to the relationships. This makes comparison of strength of effects of different links problematic.

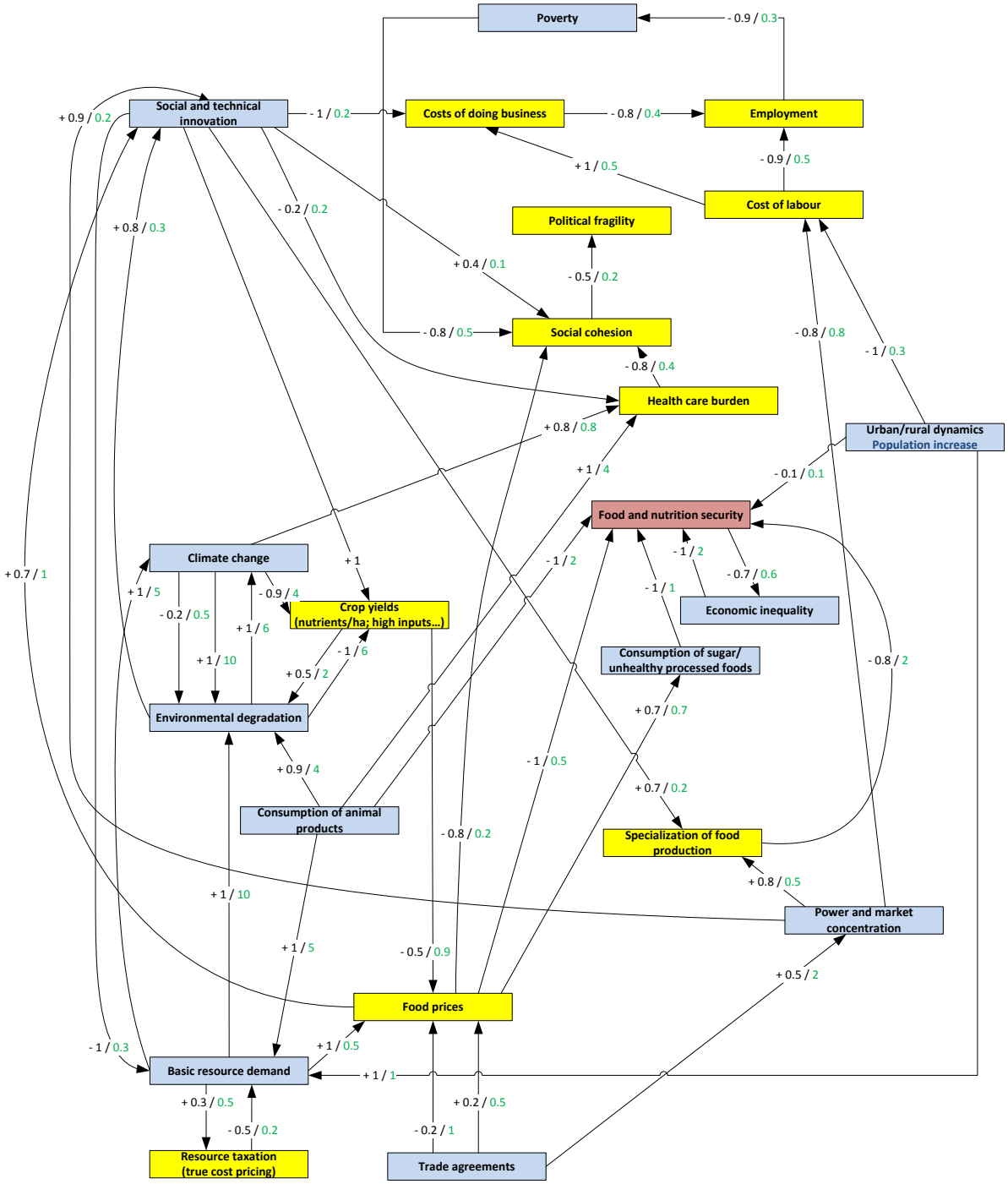
An initial list of suggested adjustments

- Allow more time, perhaps an entire day or more for semi-quantitative mapping. In current workshop there was only a twenty minute break between scenario narrative formation and the system mapping session.
- Pre-prepare long list of concepts with defined quantities that participants can place in diagrams. This does not exclude generating new concepts with quantities on the spot.
- Have a scenario facilitator and a dedicated system-mapper.
- A selection of time-scales which each relationship must be associated to.
- Capacity for participatory consensus on non-linear relationships or agreed data or model sources that potentially are filled in later. Feedback to participants.

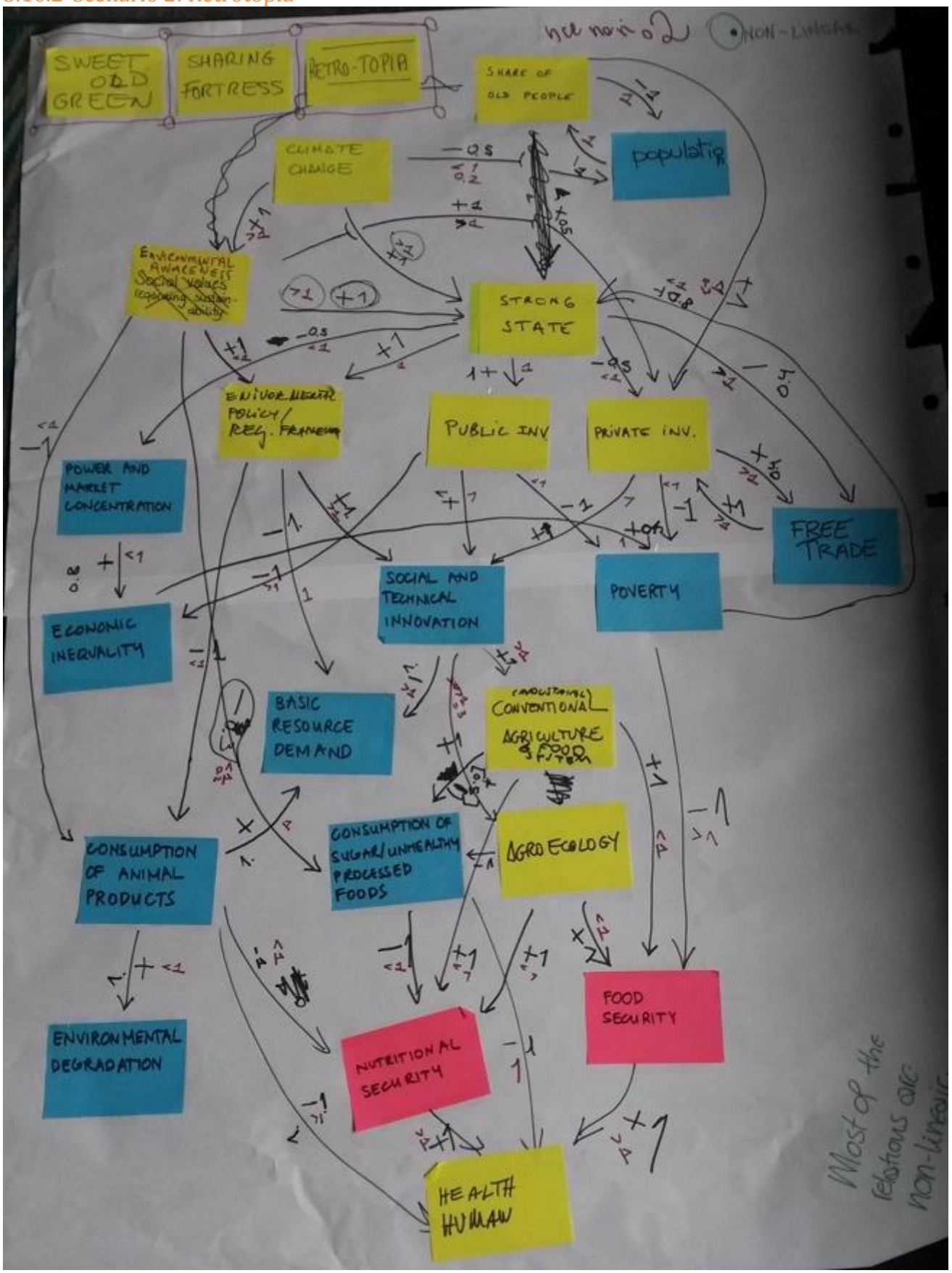
We have not explored scientifically or conceptually the suggestions, they are an initial response to the challenges of this workshop which implemented distinct FCM and SD modelling of scenarios for the first time. Under WP3 we plan to revise the semi-quantitative scenario methodology through follow up surveys and interviews with participants. Such work would explore initial feasibility of the above suggestions, new suggestions with participants and by literature review. It would contribute improvement of current practice.

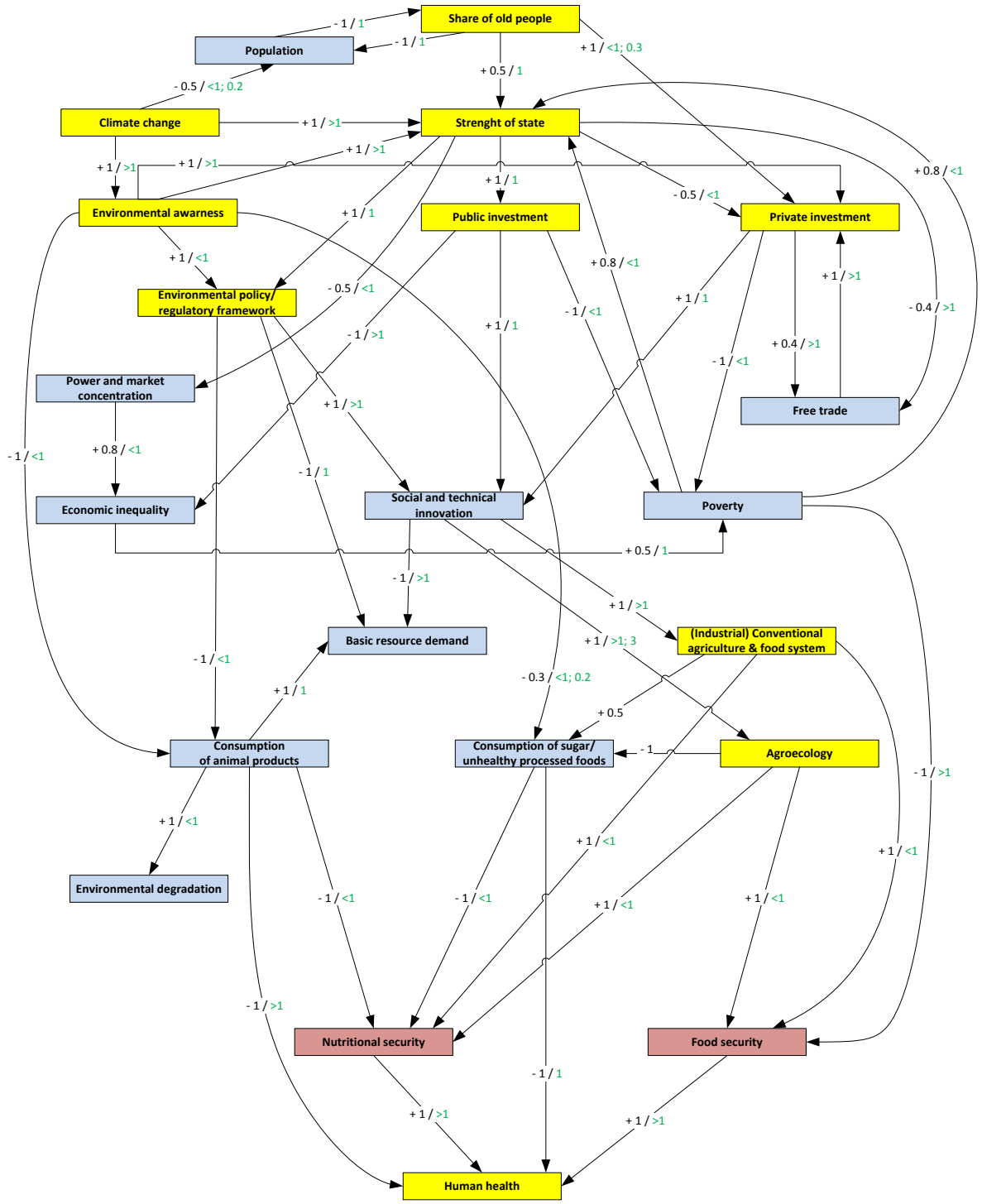
### 3.10.1 Scenario 1: Fed Up Europe



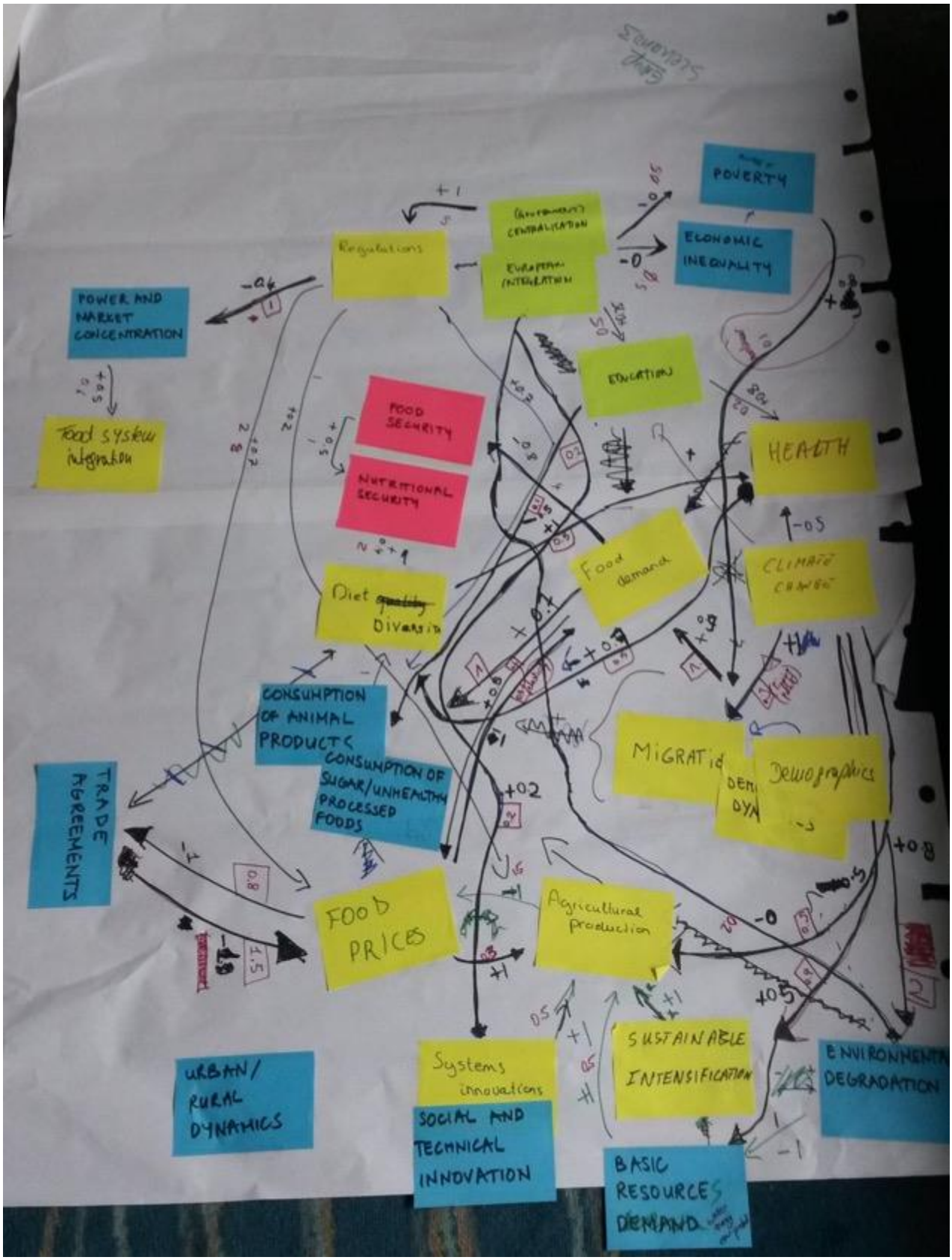

Poverty
- 0.9 / 0.3
Social and technical innovation
+ 0.9 / 0.2
- 1 / 0.2
Costs of doing business
- 0.8 / 0.4
Employment
+ 1 / 0.5
- 0.9 / 0.5
Cost of labour
- 0.2 / 0.2
+ 0.8 / 0.3
Political fragility
+ 0.4 / 0.1
- 0.5 / 0.2
- 0.8 / 0.5
Social cohesion
- 0.8 / 0.8
- 1 / 0.3
- 0.8 / 0.4
Health care burden
+ 0.8 / 0.8
Urban/rural dynamics
Population increase
+ 1 / 4
- 0.1 / 0.1
Food and nutrition security
Climate change
+ 1
- 1 / 2
- 1 / 2
- 0.7 / 0.6
+ 0.7 / 1
+ 1 / 5
- 0.9 / 4
Crop yields
(nutrients/ha; high inputs...)
- 1 / 1
Economic inequality
- 0.2 / 0.5
+ 1 / 6
+ 1 / 10
- 1 / 6
Consumption of sugar/
unhealthy processed foods
- 0.8 / 2
+ 0.5 / 2
Environmental degradation
+ 0.7 / 0.7
+ 0.9 / 4
- 1 / 0.5
+ 0.7 / 0.2
Consumption of animal
products
- 0.8 / 0.2
Specialization of food
production
+ 0.8 / 0.5
+ 1 / 10
Power and market
concentration
+ 1 / 5
- 0.5 / 0.9
+ 0.5 / 2
Food prices
- 1 / 0.3
+ 1 / 0.5
Basic resource demand
+ 1 / 1
+ 0.3 / 0.5
- 0.5 / 0.2
+ 0.2 / 0.5
- 0.2 / 1
Resource taxation
(true cost pricing)
Trade agreements

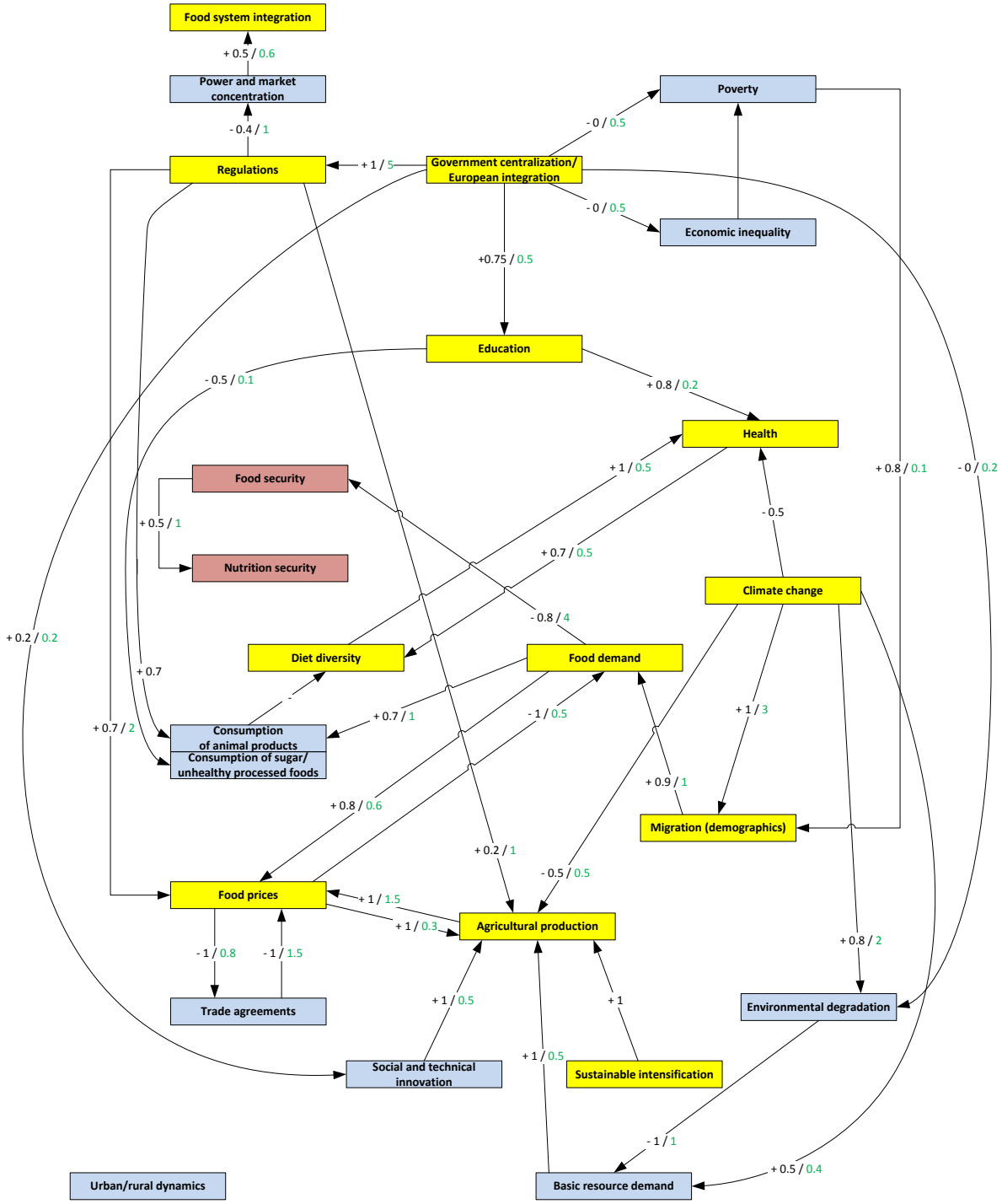
### 3.10.2 Scenario 2: Retrotopia



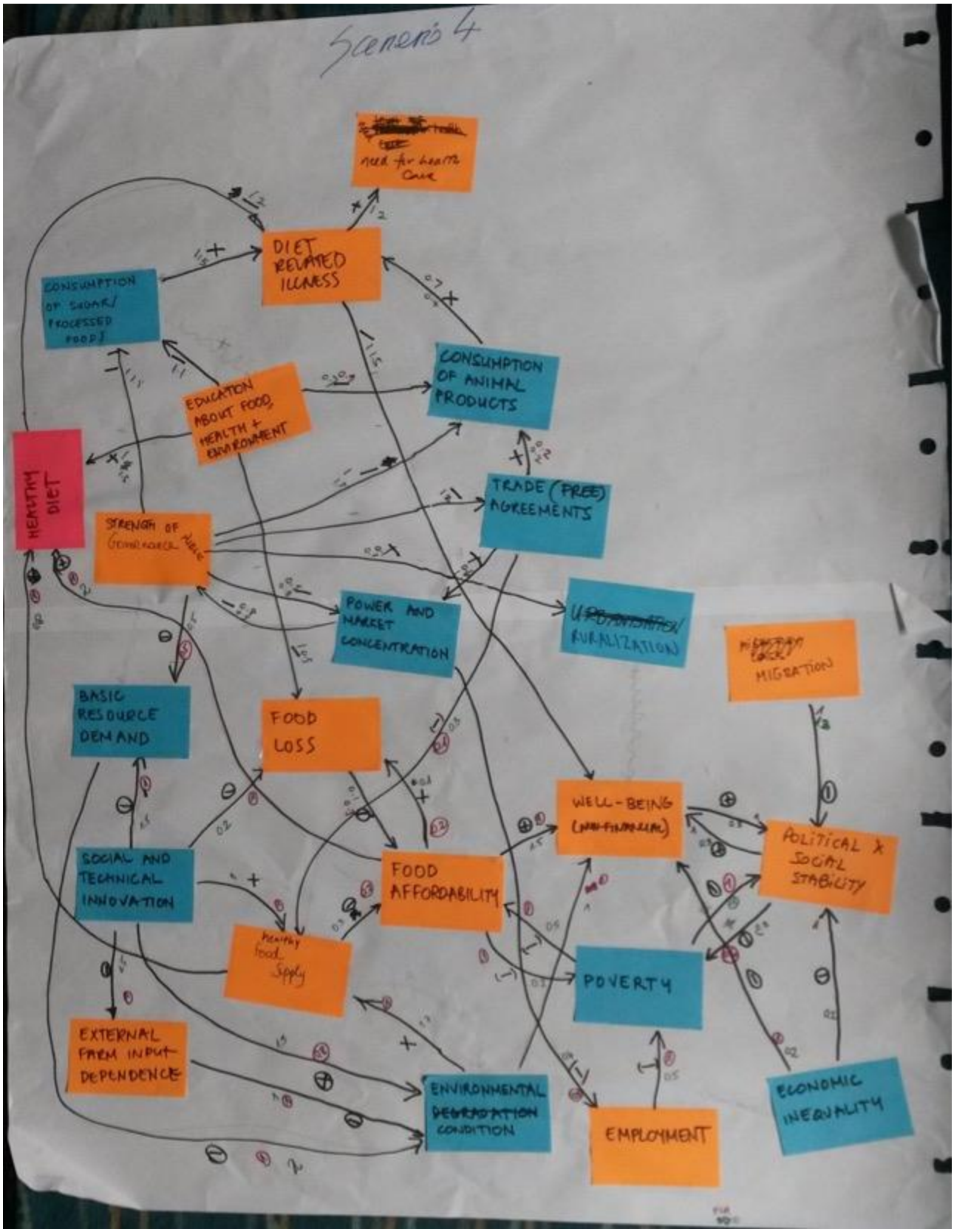

Share of old people
Population
- 1 / 1
- 1 / 1
+ 1 / <1; 0.3
+ 0.5 / 1
- 0.5 / <1; 0.2
Climate change
+ 1 / >1
Strenght of state
+ 1 / >1
+ 1 / >1
+ 1 / >1
+ 1 / 1
+ 0.8 / <1
- 0.5 / <1
Environmental awarness
Public investment
Private investment
+ 1 / 1
+ 1 / <1
+ 0.8 / <1
+ 1 / >1
Environmental policy/ regulatory framework
- 0.5 / <1
+ 1 / 1
- 0.4 / >1
- 1 / <1
- 1 / >1
+ 1 / 1
+ 0.4 / >1
- 1 / <1
Power and market concentration
Free trade
+ 1 / >1
- 1 / <1
+ 0.8 / <1
- 1 / 1
Economic inequality
Social and technical innovation
Poverty
+ 0.5 / 1
- 1 / >1
+ 1 / >1
Basic resource demand
(Industrial) Conventional agriculture & food system
+ 1 / >1; 3
- 1 / <1
+ 1 / 1
- 0.3 / <1; 0.2
+ 0.5
Consumption of animal products
Consumption of sugar/ unhealthy processed foods
- 1
Agroecology
- 1 / >1
+ 1 / <1
+ 1 / <1
+ 1 / <1
Environmental degradation
- 1 / <1
- 1 / <1
+ 1 / <1
+ 1 / <1
- 1 / >1
Nutritional security
Food security
- 1 / 1
+ 1 / >1
+ 1 / >1
Human health

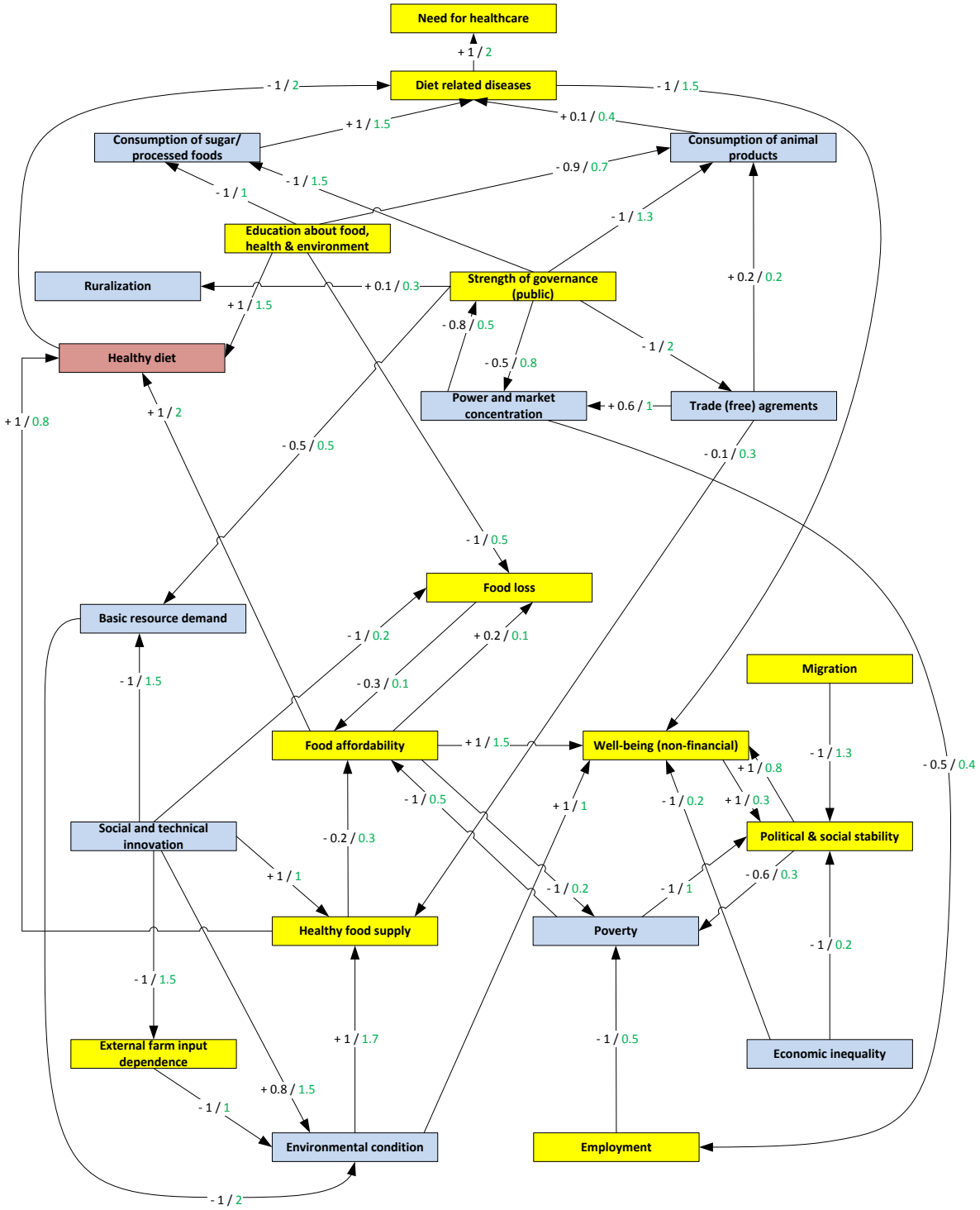
### 3.10.3 Scenario 3: The Protein Union




Food system integration
+ 0.5 / 0.6
Power and market concentration
- 0.4 / 1
Regulations
+ 1 / 5
Government centralization/ European integration
- 0 / 0.5
Poverty
- 0 / 0.5
Economic inequality
+0.75 / 0.5
Education
- 0.5 / 0.1
+ 0.8 / 0.2
Health
+ 1 / 0.5
+ 0.8 / 0.1
- 0 / 0.2
Food security
+ 0.5 / 1
Nutrition security
- 0.5
+ 0.7 / 0.5
Climate change
- 0.8 / 4
+ 0.2 / 0.2
Diet diversity
Food demand
+ 0.7
+ 0.7 / 2
+ 0.7 / 1
- 1 / 0.5
+ 1 / 3
Consumption of animal products
Consumption of sugar/ unhealthy processed foods
+ 0.9 / 1
+ 0.8 / 0.6
Migration (demographics)
+ 0.2 / 1
- 0.5 / 0.5
Food prices
+ 1 / 1.5
+ 1 / 0.3
Agricultural production
+ 0.8 / 2
- 1 / 0.8
- 1 / 1.5
Trade agreements
+ 1 / 0.5
+ 1
Environmental degradation
Social and technical innovation
+ 1 / 0.5
Sustainable intensification
- 1 / 1
+ 0.5 / 0.4
Urban/rural dynamics
Basic resource demand

### 3.10.4 Scenario 4: The Price of Health




Need for healthcare
+ 1 / 2
Diet related diseases
- 1 / 2
- 1 / 1.5
+ 1 / 1.5
+ 0.1 / 0.4
Consumption of sugar/ processed foods
Consumption of animal products
- 0.9 / 0.7
- 1 / 1.5
- 1 / 1
- 1 / 1.3
Education about food, health & environment
Ruralization
+ 0.1 / 0.3
Strength of governance (public)
+ 0.2 / 0.2
+ 1 / 1.5
- 0.8 / 0.5
- 1 / 2
Healthy diet
- 0.5 / 0.8
Power and market concentration
+ 0.6 / 1
Trade (free) agrements
+ 1 / 0.8
+ 1 / 2
- 0.5 / 0.5
- 0.1 / 0.3
- 1 / 0.5
Food loss
Basic resource demand
- 1 / 0.2
+ 0.2 / 0.1
Migration
- 1 / 1.5
- 0.3 / 0.1
Food affordability
+ 1 / 1.5
Well-being (non-financial)
- 1 / 1.3
- 0.5 / 0.4
+ 1 / 0.8
- 1 / 0.5
+ 1 / 1
- 1 / 0.2
+ 1 / 0.3
Social and technical innovation
- 0.2 / 0.3
Political & social stability
+ 1 / 1
- 1 / 0.2
- 0.6 / 0.3
- 1 / 1
Healthy food supply
Poverty
- 1 / 0.2
- 1 / 1.5
External farm input dependence
+ 1 / 1.7
- 1 / 0.5
Economic inequality
+ 0.8 / 1.5
- 1 / 1
Environmental condition
Employment
- 1 / 2

### 3.10.5 Causes Trees for Food and Nutrition Security

The causes trees show the primary, secondary and tertiary main influencers of food and nuitrition security in the scenarios as identified by the raw system diagram maps from the workshop.

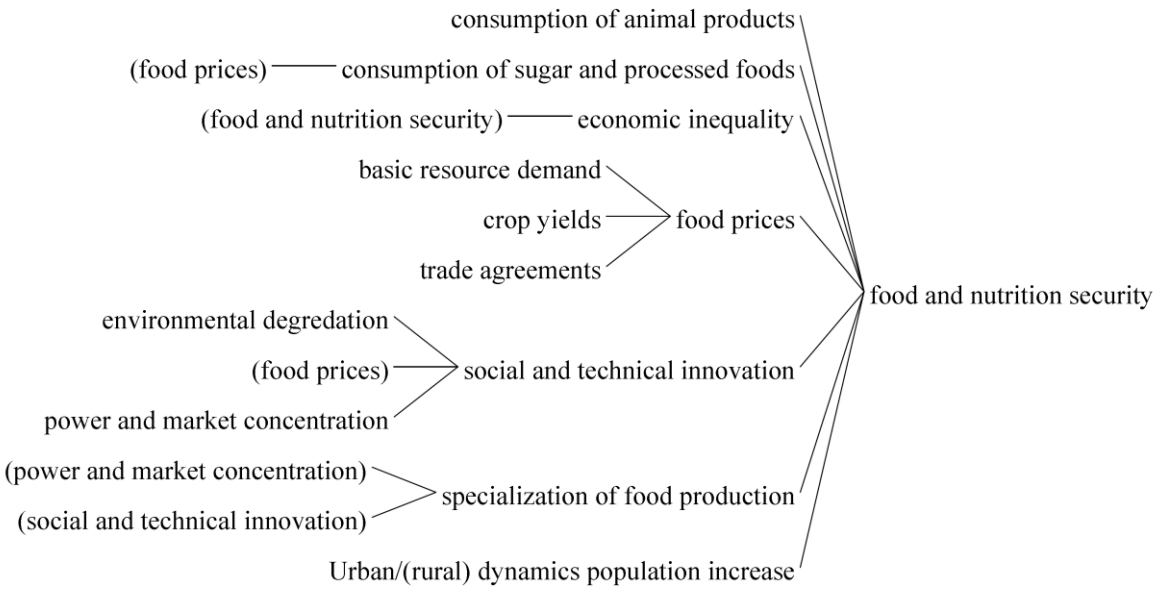



***Figure 14*** *Causes tree for food and nutrition security in Scenario 1 as identified by participants. The parenthesis indicates that the concept is involved in multiple pathways of influence*

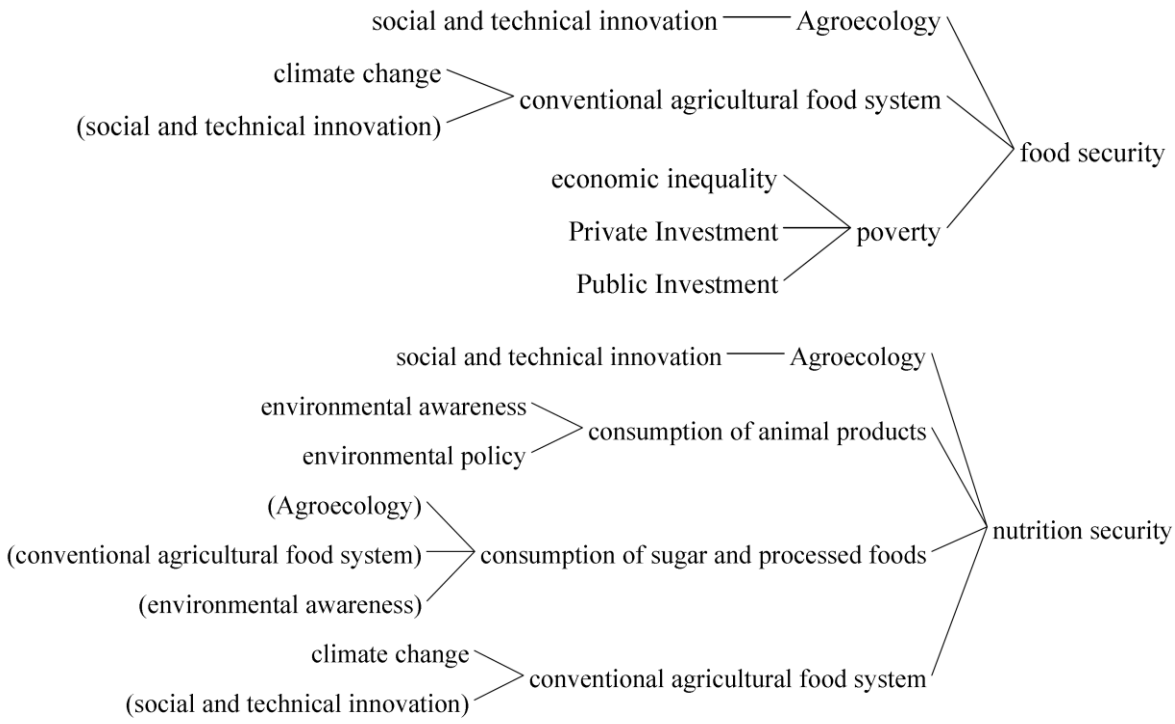



***Figure 15*** *Causes tree for food and nutrition security in Scenario 2 as identified by participants. The parenthesis indicates that the concept is involved in multiple pathways of influence*

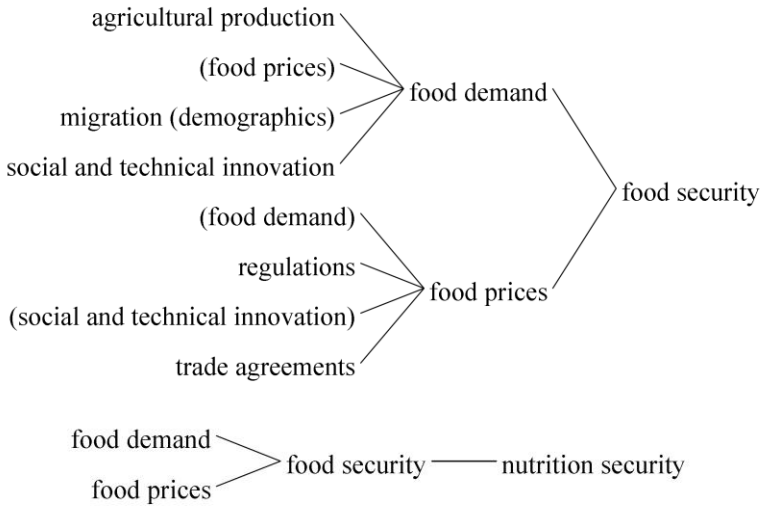



***Figure 16*** *Causes tree for food and nutrition security in Scenario 3 as identified by participants. The parenthesis indicates that the concept is involved in multiple pathways of influence*

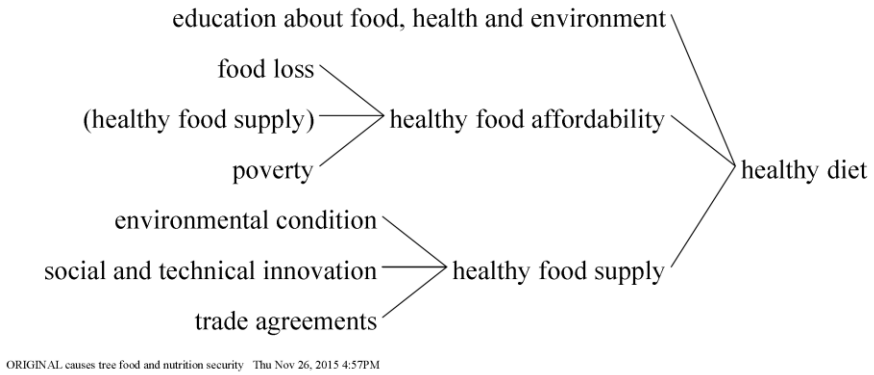



***Figure 17*** *Causes tree for food and nutrition security in Scenario 4 as identified by participants. The parenthesis indicates that the concept is involved in multiple pathways of influence*

# 4 Discussion

## 4.1 Scenario Development and Overview

The use of eight different drivers of change as a frame for each scenario posed a challenge for the participants, because while individual combinations of factor states might have been considered possible by many participants, it takes an effort to imagine how all of these different states might interact to create a future world. This makes the multi-factor approach more challenging – but it also means that the scenario skeletons create a basis for more original futures.

Eight scenarios emerged from the driver analysis; out of these, four scenarios with the most diverse consumption patterns and additional diversity in other drivers were selected as the primary set to be developed by participants; the other scenarios were developed (more briefly) by the scenario team.

Out of the drafts created by participant groups, group facilitators have developed full narratives, with support from the lead facilitators. Such narratives attempt to balance overall story with detail.

Across the different scenarios, a combination of external/global drivers and internal dynamics and policy choices plays out, with a diverse spectrum of outcomes for European and global food and nutrition security, food system activities, and environmental impacts. Consumption patterns, market structures and sources of innovation stand out as particularly strong drivers for the scenarios.

All of these scenarios will be used many times in local and European case studies – and there, they will be expanded/adapted and reviewed for their robustness.

## 4.2 Using the Scenarios for the Development of Transition Pathways at Multiple Levels

Over 2016, the scenarios produced in this workshop will form the backdrop of a range of local/sub-national case studies in TRANSMANGO with initiatives with the potential to contribute to transformative change in the European food system. In these case studies, the scenarios will be adapted to the local/sub-national level, and used as challenging backgrounds against which to test and develop transition pathways for each initiative.

In the same period, the scenarios will also be used in a number of policy case studies at the European level, to provide contexts for policy testing and development in the context of food system transitions.

Finally, the local/sub-national level will be connected to the European level in a process where the transition potential of local initiatives will be explored together and in combinations against transition pathways at the European level.

These objectives mean that the set of scenarios which has been developed in this workshop will be used to investigate the feasibility of concrete, transformative actions and strategies across multiple European levels. This use of the scenarios is where their value becomes concrete.

## 4.3 Immediate Next Steps

The workshop's products will be further developed:

- The Fuzzy Cognitive Maps and System Dynamic Models, which currently exist in draft form, will be developed further, to make them coherent – and tested/analysed to capture insights on key dynamics, bottlenecks and feedbacks in each of the maps. Insights from these FCMs/SDMs will be used for several purposes:
    - They will be highlighted in the use of the scenarios at local and European levels, to help users understand the key challenges and opportunities in the scenarios.
    - They will be used to connect the logic of the scenarios to the inputs created for the GLOBIOM model used to create quantitative scenario results.

- The scenarios will be further developed and visualized.

Results from this further work will be published in a second report, which will be shared with all participants, along with a first set of quantitative model results, in early 2016.

From January 2016 on, a series of local and EU processes will be organized where the scenarios will be used for strategic planning. Reports from such processes will be shared with the participants of the first EU scenario workshop.

The second European workshop, focused on drawing from case studies to develop European transition pathways, will be organized in late 2016. Participants from the first EU workshop reported in this document will be invited.

# 5 References


European Environment Agency. 2012. Climate change, impacts and vulnerability in Europe 2012. An indicator-based report., European Environment Agency, Copenhagen.

Helfgott, A., S. Lord, N. Bean, M. Wildenberg, S. A. Gray, S. Gray, J. M. Vervoort, and K. Kok. 2015. When fuzzy cognitive maps are not fuzzy: fuzzy cognitive maps and system dynamics models in participatory social and environmental decision-aiding processes. *Environmental Modelling & Software* Submitted.

Kok, K., D. S. Rothman, and N. Patel. 2006. Multi-scale narratives from an IA perspective: Part I. European and Mediterranean scenario development. *Futures* 38:261-284.

Kwakkel, J. H., and E. Pruyt. 2013. Exploratory Modeling and Analysis, an approach for model-based foresight under deep uncertainty. *Technological Forecasting & Social Change* 80:419-431.

Lord, S., A. Helfgott, and J. M. Vervoort. 2015. Choosing diverse sets of plausible scenarios in multidimensional exploratory futures techniques. *Futures* Submitted.

Reilly, M., and D. Willenbockel. 2010. Managing uncertainty: A review of food system scenario analysis and modelling. *Philosophical Transactions of the Royal Society B: Biological Sciences* 365:3049-3063.

van der Sluijs, J. 2005. Uncertainty as a monster in the science-policy interface: Four coping strategies. *Water Science and Technology* 52:87-92.

Van Notten, P. W. F. 2003. An updated scenarios typology. *Futures* 35:423.

van Vuuren, D., J. Edmonds, M. Kainuma, K. Riahi, A. Thomson, K. Hibbard, G. Hurtt, T. Kram, V. Krey, J.-F. Lamarque, T. Masui, M. Meinshausen, N. Nakicenovic, S. Smith, and S. Rose. 2011. The representative concentration pathways: an overview. *Climatic Change* 109:5-31.

Vervoort, J. M., P. K. Thornton, P. Kristjanson, W. Förch, P. J. Ericksen, K. Kok, J. S. I. Ingram, M. Herrero, A. Palazzo, A. E. S. Helfgott, A. Wilkinson, P. Havlík, D. Mason-D'Croz, and C. Jost. 2014. Challenges to scenario-guided adaptive action on food security under climate change. *Global Environmental Change*.

Wilkinson, A., and E. Eidinow. 2008. Evolving practices in environmental scenarios: a new scenario typology. *Environmental Research Letters* 3:045017.

# 6 Appendix 1 – Workshop Participants

| Surname | Name | Organisation |
|---|---|---|
| ACHTERBOSCH | Thom | Agricultural Economics Research Institute LEI, Wageningen University and Research Centre |
| BOSCALERI | Fabio | Tuscany Region, ERIAFF European Regions for Innovation in Agriculture, Food and Forestry |
| CHATZISTAVROU | Filippa | EAT European Agricultural Transition |
| COOPER | Karen | Nutrition and Sustainability, Nestlé |
| COTTEE | Julian | OxGrow |
| DE LATTRE-GASQUET | Marie | CGIAR Consortium and CIRAD French Agricultural Research Centre for International Development |
| DE SCHUTTER | Olivier | Catholic University of Louvain, UN Special Rapporteur on the right to food 2008-2014 |
| DEFOSSEZ | Faustine | EEB European Environmental Bureau |
| DEMONCEAUX | Anne | IPES-Food International Panel of Experts on Sustainable Food Systems |
| DESSEIN | Joost | ILVO Instituut voor Landbouw- en Visserijonderzoek |
| DöTSCH-KLERK | Mariska | Nutrition and Health, Unilever |
| ENGELEN | Gert | Vredeseilanden |
| FERNANDEZ | Rebeca | FoodDrinkEurope |
| FRANK | Markus | Global Sustainability & Product Stewardship Crop Protection, BASF SE |
| DE FRANCESCHI | Peter | ICLEI International Council for Local Environmental Initiatives |
| GOUVEIA | Paulo | COPA-COGECA European organisation representing farmers and their cooperatives |
| HILLEMANS | Tom | Dutch Food Banks Association |
| HODOSI | Robert | European Commission, DG Agriculture and Rural Development |
| JACOBS | Nick | IPES-Food International Panel of Experts on Sustainable Food Systems |
| JENS | Peter | Koppert Biological Systems and PuraNatura Foundation |
| JONES | Aled | Global Sustainability Institute (GSI) at Anglia Ruskin University |
| KAYAERT | Guido | Food industry expert |
| LACOUR VEYRANNE | Matthieu | EAT European Agricultural Transition |
| LEGOWSKI | Mariusz | European Commission, DG Agriculture and Rural Development |
| MARIEN | Nele | Friends of the Earth Europe |
| MENIDIATIS | Andreas | European Commission, DG Health and Food Safety |

| | | |
|---|---|---|
| MITTERMAYER | Felix | European Commission, DG Health and Food Safety |
| MOESKOPS | Bram | IFOAM EU International Federation of Organic Agriculture Movements, OK-Net Arable, TP Organics |
| PEDERSON | Robert | Aalborg University Copenhagen, ARC 2020 Agriculture and Rural Convention 2020 |
| POZA LORENTE | Javier | CEJA European Council of Young Farmers |
| PROSPERI | Paolo | Institut Agronomique Méditerranéen de Montpellier, Bioversity International |
| PUSHKAREV | Nikolai | EPHA European Public Health Alliance |
| ROBIJNS | Trees | BirdLife Europe |
| SOUSA LOURENCO | Joana | European Commission, Joint Research Center |
| STUBBE | Frank | European Innovation Partnership concerning Agricultural Productivity and Sustainability at the EIP DG AGRI Service Point (at VLM) |
| VAN DEN WIJNGAARD | Scherie | Yoga Therapist, EHFF European Health Futures Forum |
| VAN LOON | Jeanne | RIVM National Institute for Public Health and the Environment |
| VAN ZANTEN | Hannah | Wageningen University |
| VERCAEREN | Mieke | Colruyt |
| VIVERO POL | Jose Luis | Catholic University of Louvain |
| WOŹNIACKI | Łukasz | ECPA European Crop Protection Association |