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Future Agriculture
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Five Scenarios for 2050

– *Conditions for Agriculture and Land Use*



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Summary

Creating scenarios is one method of studying the future. Within the framework of the research programme "Future Agriculture – livestock, crops and land use", five scenarios have been developed for 2050 to illustrate how conditions for agriculture and land use can develop and change. The aim of the study has been to present a number of possible and differing future scenarios to stimulate new thoughts and ideas on future challenges and to identify gaps in knowledge and broad-ranging research issues. The future scenarios have been developed by a group of researchers from the Swedish University of Agricultural Sciences, Stockholm University, University of Gothenburg and Chalmers University of Technology under the leadership of the Swedish Defence Research Agency. General morphological analysis has been used to build the scenarios. The method has been developed to analyse complex problems in which the causal links between contributory factors are not necessarily known, and in which quantitative as well as qualitative factors may be included.

The work started with the identification of different drivers and factors that affect food production. Possible combinations of the factors were analysed and became the basis for the five scenarios. Each scenario has a global and a regional (European) component. The global scenarios are based on eight main factors: *Human population growth*; *Distribution of power*; *Economic development*; *Climate change*; *Natural resources*; *Access to energy resources*; *Development and dissemination of new technology* and *Consumption patterns*. The factors can assume different states (values) which build on existing knowledge, published scenarios and prognoses. Some main factors are constructed using sub-scenarios with a higher level of resolution. The regional scenarios are constructed from seven main factors: *Power of states and intergovernmental organisations*; *Human population*; *Economic development*; *Agricultural policy*; *Natural resources*; *Consumption patterns* and *Consumption of different animal products*. Some of these are also constructed from sub-scenarios. The different factors can be combined in many ways. In the analysis the aim is for each scenario to be very different from the others but, nevertheless, still within the realm of possibility.

Five global and regional scenarios are described in this report. They are called: An overexploited world, A world in balance, Changed balance of power, The world awakes and A fragmented world. In the global scenarios world population ranges between 8 and 11 billion, a range that has its starting point in the UN's prognosis of 9 billion for 2050. There are climate changes in all scenarios. They extend from moderate (1–2 °C) to large (3–4 °C) changes in mean annual temperature for the time period 1990–2090 and consequently accompanying changes in precipitation patterns, based on the work of the Intergovernmental Panel on Climate Change (IPCC). Included in the factor Access to energy resources are whether supply is large or small, the price high or low and how large a land area is required for energy production. Natural resources has sub-scenarios which are built up of the factors: Area of agricultural land; Fertility of arable land, potential for production and ecosystem services; Availability of agricultural inputs; Access to water and Availability of wild fish and aquaculture.

In the regional scenarios the factor Natural resources is also constructed from sub-scenarios. The included factors on which these are built are very similar to the factors in the global scenarios, but the sub-scenarios are markedly different. Where the population lives is included in the regional scenarios. The scenarios include high urbanisation with growing cities, increased urban living where small towns are growing and a developed rural area. Meat consumption ranges from 10 to 30 % (calculated in calories) of total food consumption and the proportion of pork, poultry meats and egg varies from 25 to 60 % of protein from animal products intake in the regional scenarios.

The scenarios presented in this report have been used as a starting point to identify future challenges for food production and land use and to identify the knowledge and research which is needed to meet these challenges.

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Creating images of the future

Five scenarios have been constructed as starting points for identifying challenges facing food production and land use, and as a basis to formulate research issues within the research programme "Future agriculture – livestock, crops and land use" (Bengtsson et al. 2010). The scenarios have been developed from a global and a regional (European) perspective and have 2050 as a time horizon.

The aim has been to present a range of possible and different scenarios to freely stimulate new thoughts and ideas about future challenges, gaps in knowledge and research issues. The scenarios are examples of possible future worlds, but they are neither target scenarios nor have they been chosen as desirable visions of the future. The scenarios have been constructed by a group of researchers from different disciplines (Appendix 1) guided by the Swedish Defence Research Agency (FOI). The report first gives an introduction to scenario methodology with the emphasis on morphological analysis, which is the method that has been used in this study. Then the social, political and environmental factors and driving forces that make up the scenario models are presented as well as key references which have been used as basic data and possible sub-scenarios. Finally five possible future scenarios are presented.

Scenario methodology

There are different methods of doing studies of the future in which scenario construction is the most usual approach. The method chosen for constructing scenarios depends not only on the aim of the scenario development but also on the subject's complexity and time horizon (Dreborg 2004). There are historically based future studies, for example Myrdal's work on global development and rural communities in the Nordic countries, "Framtiden om 50 år" (Myrdal 2007; 2008). The Intergovernmental Panel on Climate Change (IPCC) presented four global scenarios (IPCC 2000) that have been adapted and scaled down to European land-use scenarios (e.g. Rounsevell et al. 2006). The IPCC scenarios are developed as four narrative storylines where the main factors which drive the scenario development are clustered in two dimensions, e.g. global versus regional, and strong environmental policy and rapid technological development versus weak environmental policy and slow technological development. The method with four scenarios created from drivers clustered along two axes was also used in the Millennium Ecosystem Assessment (MA 2005) and within research programmes on forest futures (Sustainable forest management network 2010).

In the Swedish Environmental Protection Agency's future study 2021 desired conditions in the future were envisaged and then the steps needed to achieve these conditions were defined. This is known as back-casting (SEPA 1997; 1998). Visions of what is desired (Sonesson et al. 2003; Gunnarsson et al. 2009) were also used within the MISTRA funded Food 21 research programme to design different alternative systems for pork, beef, milk and potato production and to evaluate the sustainability of these systems (Gunnarsson et al. 2005; Kumm et al. 2005; Stern et al. 2005; Wivstad et al. 2005).

The method that has been used in this study is called general morphological analysis (Zwicky 1969; Ritchey 1997a; 2006). It was developed to analyse complex and multi-dimensional problems in which several of the factors to be analysed are not quantitative (Ritchey 1997b; Carlsen & Dreborg 2008). With morphological analysis very complex problem areas can be disassembled into different factors which are analysed piece by piece and then combined into different scenarios. The method allows for full traceability of all the decisions made and makes it possible to analyse the connection between the different factors. Morphological analysis does not require causal relationships between influencing factors to be known; it is necessary only that the factors are related to each other in some way.

Changes and adaptations within crop and livestock production, and changes in land use can take time. Research on food production thus has to take a long-term perspective. Consequently a time horizon of 40 years (2050) was chosen for this study.

How the scenarios were created

Each scenario consists of a global and a regional component constructed from a number of factors that can assume different states (values). Eight main factors were analysed for the global scenarios (Figure 1), and three to six states were

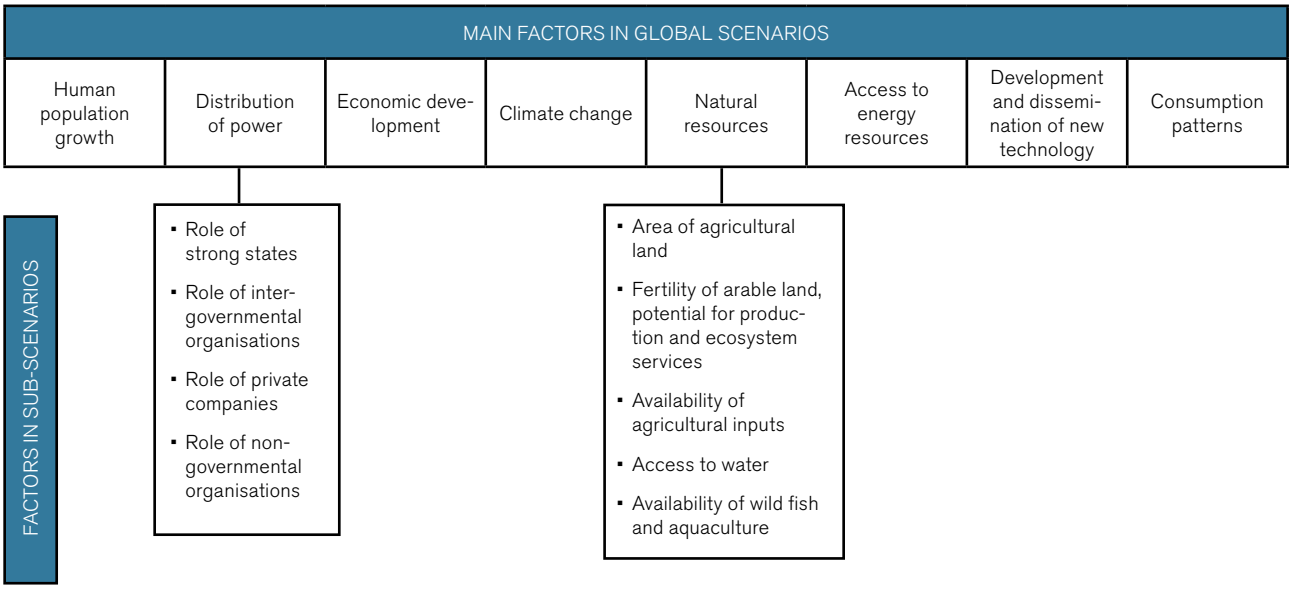


Figure 1. Factors analysed in the global scenarios.

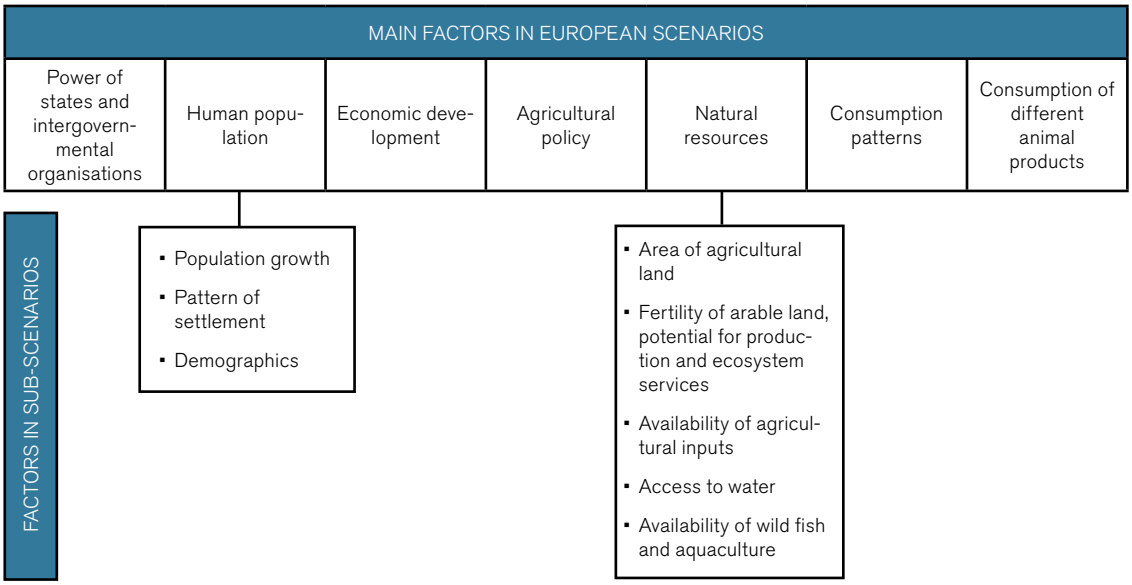


Figure 2. Factors analysed in the European scenarios.

analysed for each factor. The factors *Distribution of power* and *Natural resources* were constructed from four and five sub-scenarios, respectively. The factors in these sub-scenarios are also described in Figure 1.

For each global scenario, the situation in Europe in relation to the global factor and some further regional factors was analysed (Figure 2). Each factor had two to five states. The factors *Human population* and *Natural resources* were constructed from three and five sub-scenarios respectively. The factors analysed in these sub-scenarios are described in Figure 2. In the European scenarios, the factors *Climate change*, *Access to energy resources* and *Development and dissemination of new technology* have the same states as in the global scenarios because these factors were considered to depend mainly on global development. The regional consequences can, however, be specific and this is developed in several cases in the narratives written for each scenario. Sweden was the starting point for some factors in the construction of the regional scenarios, even if this is not apparent in the scenario descriptions.

The complete scenario laboratory and the skeleton of the final scenarios are detailed in Appendix 2.

Description of the factors in the scenarios

Sub-scenarios for *human population* were constructed from UN information and forecasts (UN 2009a; 2009b) and divergences from these forecasts that were considered possible. For human population growth in Europe, migration is an important component that influences the different factors over time (Salt 2006). Therefore, in some of the scenarios, migration, climate refugees, or immigrants in search of work are the main cause of a large population increase. These are affected to a large extent by political systems and decisions. Also included in the regional scenarios are where people live, how urban and rural areas are developed and what the infrastructure in rural areas is like (Reginster & Rounsevell 2006).

Future *global and regional power relations* have been much discussed, but the time perspective is nearly always less than that used in this study (e.g. Dadush & Stancil 2010; Fogel 2010). Global power relations were taken as the starting point and a number of different combinations of power relations were used. One alternative is that the global balance of power remains unaltered and the Western countries retain dominance. Another alternative is a shift of power to countries in Asia due to their ever stronger economies. There may also be several centres of power that balance each other. An important factor is whether supranational bodies such as the UN are strong enough to enforce global agreements on, for example, environmental and climate measures or trade. Business and commercial interests and non-governmental organisations, such as environmental organisations and those working for human rights and global justice, as well as religious movements may also have differing levels of influence in the future. The combinations considered to be most likely for each scenario were used, but there may be considerably more possible combinations than those discussed.

It is difficult to construct scenarios for *economic development* because most economic forecasts are only for a few years rather than decades. Bagnoli et al. (2005) at the OECD published a forecast leading up to 2030. In this, three scenarios were simulated with high, moderate and low economic growth, based on, among other things, population forecasts from the UN. What all three scenarios have in common is the fact that the fast but variable growth rate of the last decade will decrease and stabilize at a moderate and even level. In none of these scenarios is there any large or sudden change in the economy during the period forecast.

Agriculture and rural development policies of the future are actively discussed both internationally (OECD 2010) and regionally within the EU (European Parliament 2010) and this naturally has an influence on the development of the agriculture, as well as on the climate and environment. However, the time perspective of these discussions is often considerably shorter than the 40-year perspective of the scenarios in this report. Different premises for agricultural, rural development and environmental policies in the scenarios that concern regional development in Europe are discussed in detail in the scenario descriptions.

Existing *global and regional climate scenarios* for 1990-2090 were used (IPCC 2000; 2007). According to IPCC there will be a global warming in all possible scenarios. Up to 2050 the temperature increase is estimated within the range 1 to 2 °C for all the IPCC scenarios but thereafter it will diverge rapidly between the scenarios with an exponential increase in some cases. To clearly visualize the long-term effects of the different climate scenarios we have chosen to give the expected temperature change to 2090 for the different scenarios presented in this report. Our climate scenarios are ranging from moderate (1-2 °C) to high (3-4 °C) increases in annual mean temperature and the changes in precipitation following these scenarios. The climate scenarios in the final report from the Swedish government's commission on climate and vulnerability (SOU 2007:60) provided one basis for the regional scenarios. In large areas of Sweden precipitation is expected to increase, especially in the winter, resulting in periods with higher levels in watercourses as a result of intensive and persistent rainfall. In southern Sweden, however, it may be drier in the summer as a result of persistent heat waves. The new levels of precipitation will lead to revised requirements for both irrigation and drainage. In these climate scenarios the growing season is expected to be longer resulting in higher yields and the possibility of growing new crops; at the same time more pests and weeds will be introduced. Within livestock farming there will be risks of heat stress and new infectious diseases (Lundström et al. 2008). These scenarios were assumed to apply to large areas of northern Europe. In southern Europe higher temperatures are expected to lead to deterioration in growing conditions.

Access to natural resources such as agricultural land, fresh water, fish and many ecosystem services[1] will be more important in the future than now. These issues have been discussed

1 Ecosystem services are goods and services provided by the ecosystems which humans make use of. Examples of ecosystem services are insect pollination, the work of earthworms in the soil and water purification.

in the Millennium Ecosystem Assessment (MA 2005) and in reports from, for example, the OECD-FAO (2009). There will be competition between land use for food production and, above all, the needs of forestry and biofuel production as well as building and infrastructure development as a result of urbanisation and expanding cities (OECD-FAO 2009). Furthermore, agriculture affects many of the ecosystem services which are needed for a sustainable society, while being at the same time dependent on these services (MA 2005).

Food production and productivity will need to increase to feed a growing world population (OECD-FAO 2009). Improvement of *soil fertility and other ecosystem services as well as access to water* are considered to be increasingly important factors that contribute to this (MA 2005; Schroeter et al, 2005; Rockström et al. 2009). In some of the scenarios increased production occurs to the detriment of ecosystem services, biological diversity and the environment.

Today 38 % of *global land resources* are used for agriculture (WDI 2009). The largest proportion of agricultural land is used for grazing, and barely a third is arable, which is 11 % of the global land resources. Of the arable land 33 % is used for animal feed production (FAO 2006). According to Rockström et al. (2009) 15 % of the earth's land resources can be used for cultivation, in other words, there is still some scope to increase the area under cultivation in a sustainable way.

In Europe approximately 40 % of the land area is used for agriculture whereas the corresponding figure for Sweden is 8 % (EC 2010). Of the *agricultural land* in Europe approximately 60 % is arable, 30 % pasture and barely 10 % is used for perennial crops. In Sweden the largest proportion of agricultural land is arable (2.6 million ha) and a smaller proportion is permanent pasture (0.5 million ha) (SCB 2010). A large proportion of the arable land (45 %) is used to produce grass or grass/clover ley (as a part of the crop rotation) to be harvested for animal feed, but the ley is also grazed during part of the year. Furthermore, a large proportion of the cereals produced as well as pulses (peas and beans) and some oil crops are used as feed for livestock. The largest proportion of Swedish arable land, approximately 70 %, is used to produce feed crops (Lundström et al. 2008).

Regarding *access to inputs* it is expected that current phosphorus sources are to run out in 50 to 100 years (Cordell et al. 2009; Vaccari 2009). There is an obvious risk for shortage of good quality phosphorus supplies because it is anticipated that the production will peak around 2030. A shortfall of nutrients such as potash is expected to come later than that for phosphorus. There is no problem supplying nitrogen for agricultural purposes as long as there is access to energy. Increased applications of nitrogen may, however, be problematic for the environment due to eutrophication (Rockström et al. 2009).

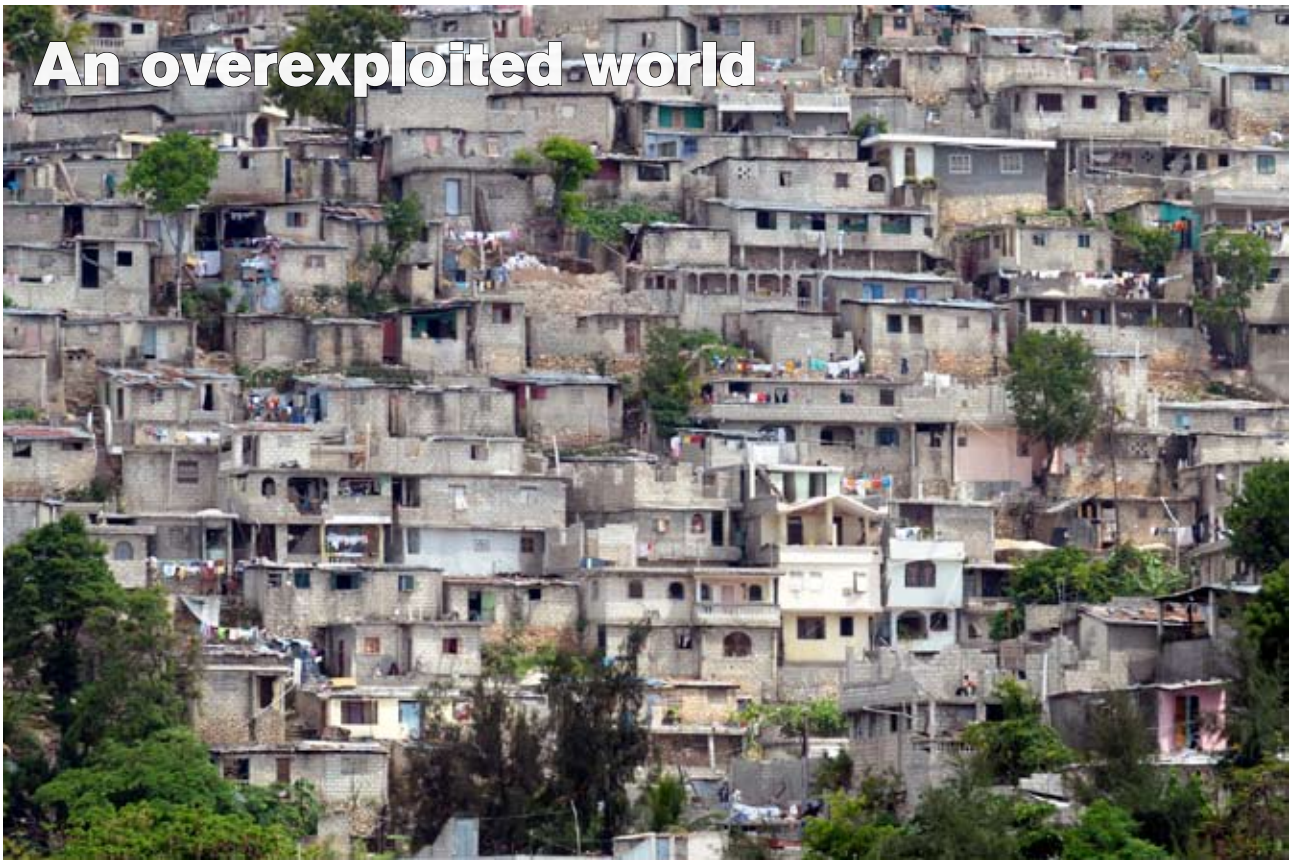
There has been much discussion about *energy supply* in the future (e.g. WEC 2007; Aleklett et al. 2010; OECD 2010), and it is difficult to analyse this subject in isolation from climate issues and technological development. Energy resources will not run out in the period up to 2050, but energy may become more expensive and the balance between different types of energy sources may change (Brandt et al. 2010). In the scenarios it has been assumed that energy policies may be either weak or strong, which can lead to environmental tariffs and subsidies. This in turn will affect the extent to which fossil fuels are used. The technological development of renewable energy sources will also affect energy supply. Moreover, energy may also be affected by power relations and regional conflicts (Correlje and van der Linde 2006).

Technological development in sectors relevant to agriculture, such as biotechnology and resource cycle technology, is difficult to predict. When constructing the scenarios it was assumed that it could happen either quickly or slowly, and independently of this be evenly or unevenly distributed at a global level. Technology for more efficient energy use and reducing climate effects has in some scenarios been assumed to be developed quickly and spread globally.

Global and regional patterns of consumption of food have been published by the FAO from the middle of the 1960s (FAOSTAT; FAO Statistical Yearbook 2009). There are also forecasts for 2030 based on FAOSTAT (WHO 2003). These reports were, in part, the basis for the consumption patterns in the global and regional scenarios, which consider the distribution of foods of plant or animal origin on basis of their energy contents. In the regional scenarios the relation between different food protein sources is included, i.e. beef and lamb; milk; pork, poultry and eggs; fish and shellfish. Present food consumption globally and in Europe was taken from FAOSTAT 2007 and has been used as one of the starting points for the relative changes in consumption patterns in the scenarios for 2050. The compiled scenarios for consumption patterns are shown in Appendix 3.

In addition to the different factors included in the analysis, storylines have been written to provide the reader with images of the different plausible future scenarios. These added storylines are based on group discussions during the work of formulating the scenarios.

Five scenarios for 2050



An overexploited world

Population growth is high and poverty is prevalent in the world. There is a unipolar world order in which the USA dominates and the Western world shows relatively strong economic development. Political interest in the climate and environment is low. Climate change is large and there is considerable pressure on land resources. In Europe there is a strong supranational institution.

Global

Population growth has exceeded the UN's forecast mainly due to a reduction in infant mortality. In 2050 the global population is 11 billion. There are no political cooperation on global level, and a tendency towards regional market protectionism with large associations such as the North American Free Trade Agreement (NAFTA) and the Association of Southeast Asian Nations (ASEAN). The UN and intergovernmental institutions such as the World Trade Organisation (WTO) and the World Bank are weak. Private commercial actors have great power and occupy much of the market. Non-governmental actors such as environmental and human rights organisations have approximately the same position as today. There is a unipolar world in which the USA dominates and the Western world shows relatively strong economic growth. The economies of India and China are, however, developing more slowly than expected. In the developing countries economic growth is also weak, and the standard of education is low.

The global temperature increase is high (3–4 °C), which results in higher sea levels, intense heat waves and torrential rainfall. Technological development is slow and the distribution of new technology around the world uneven. Nuclear power and fossil fuels are widely used. There is relatively good access to cheap energy because energy use is not politically regulated. This means that it is still commercially viable to transport goods over long distances. However, conflicts within and between countries put access to energy resources at risk, which leads to increased use of biofuels in countries without uranium, oil or gas resources.

In this scenario pressure on land resources is very high and environmental objectives are low. This is due partly to increased cultivation of bioenergy crops and enhanced soil erosion, but above all to the enormous demand for food as a result of population increase. The total area of arable and grazed land has increased. However, land that is being cultivated for the first time or land that is once again considered as viable for agricultural is often not very fertile. In this scenario the area of rainforest declines as the land is used for agricultural purposes, including production of livestock feed. Fertility of agricultural soils and their production potential also decrease because of short-sighted exploitation of land with, for example, monocultures, soil compaction, widespread use of pesticides and low quality chemical fertilizers. This also has a negative affect on biodiversity and availability of ecosystem services. Moreover, intensive irrigation leads to salinization of agricultural soils in dry areas. Availability of inputs to agriculture (mainly phosphorus) is low, which means prices are high.

Clean water is a scarce resource and there are inequalities in water distribution around the world. Overexploitation of fish resources combined with acidification of oceans mean that availability of fish and shellfish is poor. Just over 80 % of global food consumption is plant-based calculated in calories. This means that the proportion of animal- and plant-based products are approximately the same as today.

Europe

Population growth in Europe is low and age distribution is relatively even. This means that a large proportion of the population consists of elderly people. People in Europe are generally fairly ignorant about and uninterested in issues to do with sustainable use of resources and global justice. There is a functioning infrastructure throughout Europe. Urbanization is high with migration occurring mainly to large cities. The increasingly dense urbanization results in people having ever less understanding of the role and importance of agriculture to society. Considerable power is at a supranational level and Europe has a protected market. This regional market has common rules for issues such as agricultural subsidies, food safety and animal protection. Economic development has been equalized throughout Europe through interventions from the supranational institution.

Climate change in Europe follows global warming trends. This brings drought to the Mediterranean region and major agricultural production shifts to the north and east. The expansion of agriculture in Eastern Europe contributes to strong economic growth in the area. Use of biofuels increases mainly due to the insecurity of imported energy supplies. This leads to greater competition for land resources, in spite of the larger area of cultivated land. Deforestation makes more land available for growing crops and for grazing. Availability of phosphorus and other inputs follows the global trend and is low. Precipitation increases in some parts of northern Europe putting a strain on drainage. Overexploitation of land leads to decline in fertility and production potential of agricultural soils. The size of agricultural units continues to increase and production becomes more and more specialized. Ecosystem services decline largely as a result of large fields with a limited range of crops. Availability of clean water is also low and unevenly distributed.

Availability of wild fish declines as overfishing and acidification affects all the oceans, but aquaculture increases correspondingly. People's eating habits in Europe change very little. Consumption consists of 30 % animal-based and 70 % plant-based foods calculated in calories, which is approximately the same as today. The proportion of food from animals, calculated in % protein, is also approximately the same as today, in other words, mainly pork products, poultry, eggs and milk.



A world in balance

Economic development is strong in large areas of the world and population increase is lower than the UN's forecast. Strong intergovernmental actors are reaching global agreements on important issues. A global environmental policy has contributed to keeping global warming relatively low and pressure on land resources has been limited.

Global

Population growth has been lower than the UN's forecast, mainly because a decrease in poverty has led to fewer children per family. In 2050 the world population is 8 billion. Global politics are characterized by strong regions that cooperate. This means that different regions in the world are finding their own solutions for such as securing food supplies and therefore are developing independently, while at the same time intergovernmental cooperation functions well. The UN and strong intergovernmental institutions such as the World Trade Organisation (WTO) and the World Bank reach political agreements that are honored. Private commercial actors have approximately the same power and influence in the market as today. Non-governmental actors such as environmental and human rights organisations play a very important role in the direction society is taking. Standards of living are improving for the majority of the world's population and education levels are generally high. There is strong economic development in most parts of the world.

The increase in world temperature is fairly low (1–2 °C) because climate effects have been successfully reduced through a combination of reinforced climate policies and new technologies. There is rapid technological development within the energy and agricultural sectors and new technological solutions are rapidly disseminated and applied in large parts of the world. Among these solutions is the capture and storage of carbon dioxide. The price of energy is high and energy use relatively low. Development and expansion of alternative energy sources, such as wind, solar and wave power combined with more efficient energy utilization means that use of uranium and fossil fuels declines and oil is mainly just used for transport.

Due to the relatively small increase in population and modest amount of arable land being used for bioenergy crops,

pressure on agricultural land resources is low. The total area of arable and grazing land is the same as today and mainly to be found in the same regions. Consequently, there is scope to use land for other rural business enterprises than food production. Availability of clean water and distribution of water resources is approximately the same as today. Soil fertility and production potential as well as availability of ecosystem services are good as a result of diversified production methods and well developed systems for use and management of the agricultural land. In this scenario new products and new markets combined with improved knowledge and training for farmers are important factors for development. There is good availability of inputs (phosphorus and other nutrients) to agriculture because the latest technology makes recycling of, for example, phosphorus possible.

Overexploitation of fish resources and marine pollution has been reduced so that wild fish stocks are approximately the same as today. Plant-based foods make up just over 80 % of the world food consumption calculated in calories, which means that consumption of animal-based foods is on average much the same as today.

Europe

Population growth in Europe is low, in other words approximately the same as today. Age distribution is relatively even, which means that there is a high proportion of elderly people. Many people are actively involved in issues to do with sustainable use of resources, biological diversity and global justice. Urbanization is high and most migration is to large cities, but rural areas are also flourishing. In rural areas there is a well developed infrastructure and good public and private services. Business enterprises that are not dependent on close proximity to towns are developing as new technology reduces the importance of workplace location.

Europe is one of several regions in the world where considerable power is at the supranational level. Economic divides between countries are becoming smaller and many countries are able to influence development within Europe. Agricultural subsidies are small and policies are governed by global agreements which provide all countries with more equal conditions than today.

Climate change follows global warming trends and signs of a changing climate have produced the momentum for binding climate policies in Europe. The price of energy is high because it is used as a policy control measure. Less use is made of fossil fuels and they are used in more efficient and environmentally adapted systems. The total area of cultivated land is unchanged, but its location has shifted more to the north and east due to climate change resulting in improved growing conditions in northern and eastern Europe and growing drought problems in the south. The potential of fertile soils in the east is utilized to the full. Availability of agricultural inputs is good and prices relatively low. Soil fertility and production potential are good and ecosystem services increase as a result of strong environmental policies. Availability of clean water and distribution of water resources are fairly good (approximately the same as today). Stabilization of the wild fish population is also noticeable in Europe. The use of wild fish for animal feed has decreased markedly.

The amount of animal-based foods consumed has decreased radically and only makes up 10 % of total food consumption calculated in calories. The proportion of animal products is also lower in Europe than the average for the rest of the world, which is partly a result of changes in values and eating habits. In relative terms, consumption of fish (especially farmed fish) has increased while consumption of pork and poultry products has decreased.



Changed balance of power

Population growth is relatively low. The balance of power has moved from the West to China and India, countries whose economies are developing fast. Economic development is weaker in Europe. Political ambitions regarding climate and the environment are low. A marked increase in global warming results in that the main agricultural areas are moved towards the north and the equator where rainforest is being felled.

Global

Economic growth in Asia is very strong while it is weaker in the Western world. Population growth is lower than the UN's forecast. This is mainly because of increased standards of living in some of the bigger and more populous countries. In 2050 the world population is 8 billion.

China's ambition and expansion has resulted in a change in the world order. Power has moved from the West to China and other large countries, such as India. A condition for this altered balance of power is that the UN and inter-governmental institutions like the World Trade Organisation (WTO) and the World Bank are able to influence nations. Private commercial actors are also relatively powerful (similar to today), while non-governmental, non-commercial actors, for example religious movements and human rights and environmental organisations, play a less important role in global development. The world economy is characterized by deregulation and free trade. In many Asian countries standards of education are high and technological advances very rapid. Poorer education in the West and continuing slow development in many African countries result in uneven distribution of new technology around the world.

There is a sharp rise in the global temperature (3-4 °C), which leads to rising sea levels, intense heat waves and frequent heavy rainfall. Despite such marked climate effects, environmental objectives are comparatively low on the political agenda. Economic growth is linked to short-term solutions designed to meet the needs of the day rather than those of future generations. Supplies of fossil fuels, especial coal, are still plentiful. Fuel is relatively cheap because its use is not regulated at a political level. Consequently, only a small proportion of agricultural land is used to grow bioenergy crops. Global trade in food products is based on energy-

intensive transport systems.

The total area of arable and grazed land is approximately the same as today, but climate change, with severe drought in large areas, has resulted in the displacement of agriculture towards the north and south poles and the equator. In regions with plentiful rainfall around the equator, rainforest has been cleared to make way for arable land. Availability of agricultural inputs (e.g. phosphorus) is still adequate and inputs are relatively cheap because they are not the target of environmental policies. Fertility and production potential of agricultural soils diminishes as a result of weak environmental policies leading to extensive use of pesticides and low quality chemical fertilizers. This also results in decreased availability of ecosystem services, such as water purification, and pollination because of the decline in numbers of some insects.

Climate change and environmental problems lead to an acute shortage of clean water in many regions. Availability of water is very unevenly distributed. Use of fossil fuels results in large emissions of carbon dioxide causing acidification of the oceans. Emission of different types of pollutants, acidification and overexploitation of fish stocks lead to the collapse of marine ecosystems, and availability of wild fish decreases. However, at the same time, aquaculture is being developed and therefore availability of fish for consumption remains unchanged. Plant-based food makes up 75 % of global consumption calculated in calories and consumption of animal-based products is therefore on average higher than today. This increase, a result of improved living standards particularly in Asia, leads to a reduction in malnutrition and improved conditions for development in many areas.

Europe

The search for work and improved living standards leads to a large wave of migration to Europe. The number of people living in Europe therefore rises dramatically (by just over 20 %) and immigration means a plentiful supply of labour. The average age of the population is low. The economy is weak and people are mostly concerned about the struggle to have a good life today; few take active responsibility for the needs of future generations.

The rapid climate change, e.g. rise in temperature, leads to large numbers of climate refugees in the world. Because they are not given asylum by the strong countries of Asia, these refugees find their way to Europe. However, Europe has some kind of supranational organisation that prevents uncontrolled immigration. This organisation also acts as a common European negotiator with the stronger economies. Deregulation means that there are no agricultural subsidies or any strong regional policies for Europe. The balance of power has also changed in Europe. The Mediterranean region has a weaker economy due to intense drought while eastern Europe benefits from, among other things, extremely fertile soils and becomes economically stronger. In these countries education standards improve in contrast to the rest of Europe where standards decline.

Climate change in Europe follows the global trend, in other words temperature rise is high. The effects of a change in climate are obvious, but the political will to reduce or slow down warming decreases as the European economy becomes weaker. There are still plentiful supplies of fossil fuels (especially coal) which are relatively cheap.

The land area used for production of food and animal feed as well as grazing is approximately the same as today, but it has shifted to the north where availability of water is better. Arable land is exploited more intensively than today (e.g. more than one crop harvested per year) and disused arable land is being brought back into use. Availability of inputs in Europe follows the global trend; there is a plentiful supply at relatively low prices. Thus, soil fertility and production potential in Europe remain on average at the same level as today. Technological developments within agriculture are slow. Availability of clean water is relatively low and water resources are unevenly distributed. Availability of wild fish has also declined and this is compensated for in Europe by increased aquaculture. European fish consumption thus contributes to a further collapse of the oceans' fish stocks.

In this scenario urbanization is high and migration occurs both to large cities and smaller towns that are growing fast. Many people commute to work. The countryside is being rapidly depopulated, particularly those areas suffering from drought. There is a working infrastructure throughout Europe, but interest in rural issues is low. Food consumption consists (like today) of 30 % animal-based and 70 % plant-based foods calculated in calories. Large-scale immigration leads to changes in eating patterns and people consume a greater proportion of beef and, in particular, lamb, while milk consumption decreases. ●



The world awakes

Population growth is as the UN forecast. People and their rulers have realised at last how serious the consequences of climate change and the global environmental problems are, and are therefore taking more responsibility for achieving long-term, sustainable development. There are several centres of power in the world and agricultural policy is characterized by deregulation and free trade. Rural areas in Europe are flourishing and have well developed business enterprises.

Global

In this scenario the current pattern of global development with accompanying large climate and environmental effects continues for some decades to come. When the consequences of this become increasingly obvious people's attitudes begin to change, and the political will to ensure enforcement of international agreements on the environment and climate develops. Population growth follows the UN's forecast and the world population in 2050 is 9 billion. There is a multi-polar world order with several centres of power that balance each other. Brazil, Russia, India and China (the BRIC countries) are now the equals of North America and Europe. Economic development in the West is weak, in contrast to, for example, India and China where it is very strong. Economies are growing even in the developing countries. Standards of education among a large proportion of the population are improving and poverty is decreasing in large parts of the world. The gulf between the developing countries on the one hand and the BRIC countries and the Western world on the other is however very large.

People become involved in non-profit-making NGOs and equal rights organisations which have a large influence on societies in many countries. The UN and global inter-governmental institutions such as the WTO and the World Bank have a relatively large influence on global development. Actors from private business enterprise also play a very important role in development.

There is a global temperature increase of 2-3 °C, which is the "midway" climate scenario. Climate change has at last acted as driving force for realisable climate policies with the world community agreeing on effective policy measures. Technological development is slow, but the new technology and knowledge does spread rapidly around the world. En-

ergy sources that do not take up agricultural land are being developed, while at the same time effective climate policies reduce emissions of greenhouse gases and increase interest in growing energy crops and other forms of bioenergy. Fossil fuels are expensive and used mainly for transport.

The total area of cultivated land is the same as today, but has shifted towards the north and south poles as a result of drought and other climate changes. Due to the lack of new land for cultivation in the south, expansion is greater in the northern hemisphere. Tropical rainforests are protected from deforestation as a result of greater environmental awareness. Availability of agricultural inputs is low and prices are high. Despite this, soil fertility and the production potential are largely maintained thanks to sustainable methods of cultivation and the environmental awareness of agricultural policies. This also has a positive effect on ecosystem services.

Availability of clean water is low and unevenly distributed. In some areas it is no longer possible to use irrigation. Availability of wild fish continues to decrease because the oceans have not recovered from the long period of environmental degradation and overfishing. However, aquaculture is being developed and compensates for this decrease. Global food consumption consists of just over 80 % plant-based foods calculated in calories, which is approximately the same as today; the difference being that people in the richer countries eat less meat while those in poorer countries eat more.

Europe

Many people of working age immigrate to Europe and the population increases by 20 %. A large proportion of Europe's inhabitants are young. Many are very involved in issues to do with the environment and human rights. Political power in Europe lies in strong "regions" that cross today's national borders. Examples of these new constellations are the Baltic region and Central Europe. Commercial and agricultural policies change several times between now and 2050. For a period the regions set up trade barriers, but there are no direct production subsidies. Closer to 2050 there is less interest in national and regional agricultural policies and global trade agreements replace European agreements. Over the course of time the global economy becomes characterized by deregulation and free trade and thus, there are no longer any European agricultural subsidies and only a little regional policy making.

Climate change in Europe follows global warming trends and the rise in temperature is 2–3 °C. This provides new opportunities for cultivation and grazing land in northern Europe where new and former arable land is brought in production. The Mediterranean region becomes weaker economically due to drought, and agriculture faces increasing competition from eastern Europe. Countries such as Ukraine and Belarus become stronger economically and their agricultural production increases rapidly. The proportion of arable land used for grass and forage crops and animal grazing decreases, and grazing animals are kept on more marginal land.

The consequences of global warming have finally led to enforceable environmental and climate policies in Europe with strict rules governing environmental impacts. These policies are widely supported by citizens and sustainable development has become a catchword in society. Energy prices are high and tariffs on emissions from fossil fuels result in their limited use. The area of land used for agriculture is the same as today and by setting high environmental objectives, fertility of soils and their production potential improves, as does the availability of ecosystem services. Availability of inputs to agriculture is limited because only high quality materials are permitted and prices are therefore high. Availability of clean water is approximately the same as today, but distribution is uneven. Supplies of wild fish decrease as they do in the rest of the world, but the demand for farmed fish and shellfish is large and aquaculture is on the increase in many European countries. There has been a marked decrease in the use of wild fish as animal feed.

The pace of creating ever larger agricultural units has been slowed down through legislation on the environment and infectious diseases. There is large-scale urbanization and people move both to large cities and smaller towns which consequently grow fast. Rural areas around these built-up areas have well developed public and private services. The proportion of people who work in enterprises in rural areas therefore increases alongside urbanization. New technology has made the physical location of work places less important and moreover, commuting by car is very expensive. Societies are investing in infrastructure for such as communication services.

The proportion of plant-based food in the diet increases to a level equivalent to the average consumption in the world today, that is just over 80 % calculated in calories. The consumption of animal-based products changes with a decrease in consumption of milk, while consumption of eggs, poultry, pork and fish goes up. Lamb comes mostly from animals grazed on semi-natural pastures and production of beef is closely linked to milk production.



A fragmented world

Population growth is high. There are no strong nations or supranational actors, which means that power relations are unclear. Thus, there are no global agreements on measures to regulate climate change or protect the environment. Private enterprise strongly influences development. Europe is forced to be largely self sufficient in food. Pressure on land resources is very high.

Global

Population growth is higher than the UN's forecast, mainly due to widespread poverty and low standards of education in populous countries. There are 11 billion people in the world in 2050. In this scenario there is no institutionalized legitimacy, and power relations are unclear. Globally the power of individual states has decreased. Even the UN is weak and intergovernmental organisations such as the World Trade Organisation (WTO) and the World Bank are no longer able to affect global development. Private commercial entities are important power factors. Free trade prevails, but corporate opportunities for international trade are hampered due to the lack of a common regulatory framework. Religious and political movements as well as militant groups are strong. Economic development is slow in the Western world, and even slower in the developing countries. Even countries such as India and China have considerable economic problems. Standards of education are low and poverty widespread in many countries. In this uncertain world, few people have the time or energy to become involved in working for sustainable development.

Global climate agreements are not realisable in this fragmented world where both nations and intergovernmental organisations are weak. The global temperature rise is high (3–4 °C), which leads to higher sea levels, intensive heat waves and frequent downpours. Technological development is sluggish and new technology spreads very slowly between countries. There are still plentiful energy resources and prices are relatively low because there is no political control of the market. Electricity from nuclear power and fossil fuels (especially coal) is the main form of energy. Due to the low price of energy, it is not economically viable to grow bioenergy crops on agricultural land. Availability of energy is maintained and controlled by private entities. Pressure on land resources

is very high and the area under cultivation has increased due to the pressing need to feed a rapidly growing population. Forests (including rainforest) are cleared and the land made available used to grow food and animal feed. Grazing animals can only be kept on the most marginal land. Availability of inputs such as phosphorus and other nutrients is low, which leads to high prices. Low quality fertilizers and pesticides are used, which results in pollution of soils and foods.

Availability of clean water is very restricted and water resources are unevenly distributed. Water is often of poor quality due to pollutants, flooding and lack of functioning sewage systems. Short-term solutions with irrigation in dry areas lead to salinization of soils. Intensive exploitation of soils means that fertility and production potential decrease and erosion devastates many fields. Large areas can no longer be used for agriculture. Absence of environmental policies also hits biological diversity hard and availability of ecosystem services declines. Over fishing and acidification of oceans reduces stocks of wild fish. Global consumption of animal-based food is low (10 % of total food consumption in calories) due to poverty.

Europe

Many people are forced to flee because of armed conflicts and the effects of global climate change (e.g. drought and flooding). Uncontrolled migration means that population growth in Europe is extreme: the population increases by 50 %. This population consists of a disproportional number of young, uneducated people whose main objective is to find work, food and accommodation. There is no strong supranational institution in Europe. The bigger countries dominate, but governments are generally weak. Environmental and welfare issues are low down on the political agenda. Trade between Europe and the rest of the world is not regulated. Agricultural policies are focused on national food security, but political controls are weak. Europe is mainly self sufficient in consumables such as food with over 90 % produced within its borders. The Mediterranean region becomes weaker economically because of drought. Absence of intergovernmental cooperation means that development aid for poorer countries in, for example, eastern Europe is small, which results in weak economic development in this region.

Climate change in Europe follows the global trend. The pressing need to provide food for Europe's growing population leads to an increase in the total area of cultivated and grazed land, which expands towards the north and east. On the whole, agriculture is fairly inefficient. Soil fertility and production potential as well as availability of ecosystem services decline because of short-sighted overexploitation. Availability and prices of agricultural inputs follow developments in the rest of the world, which means low availability, poor quality and high prices. This accelerates depletion of agricultural soils. Most electricity is produced in coal and nuclear power stations. Availability of clean water is low and, above all, unevenly distributed. In southern Europe large areas of arable land are abandoned because of drought, and in northern Europe field drainage deteriorates because of heavy rainfall. Partially inefficient agriculture combined with little economic aid from supranational institutions means that eastern Europe cannot take advantage of the benefits that climate change could bring due to a shift in the area of cultivated land.

Urbanization is extremely rapid and people move mainly to big cities. In town centres this takes place in a planned fashion by building more densely, but in the outskirts there is uncontrolled and unorganized urban sprawl. These societies are inefficient in terms of energy use, water management and waste water purification. There is a working infrastructure in town centres but the outskirts and rural areas are poorly served. To ensure their food supply, many people grow their own fruit and vegetables and keep smaller domestic animals even in built-up areas. A new form of small-scale agriculture develops. At the same time the creation of ever larger commercial agricultural units occurs even more rapidly. Many of the employees on the larger farms do not have any relevant education.

The proportion of plant-based foods in the diets is 80 % calculated in calories, which is higher than today but still less than the world average. The consumption of animal-based products changes from milk and beef to the smaller animals that are more suitable for household production and intensive production in large units.

Scenarios as a starting point for identifying challenges and research areas

Five very different but nevertheless plausible scenarios for 2050 are presented in this report. This has been the starting point for identifying future challenges, gaps in knowledge and research issues. The knowledge and research needed to meet future challenges have been identified in cooperation with stakeholders from trade and industry, authorities and society at large as well as researchers, and formulated in a strategic research programme (Bengtsson et al. 2010). The research programme focuses on research from a European and Swedish perspective, in a global context.

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Appendix 1

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Prof. Lotta Rydhmer, Department of Animal Breeding and Genetics, SLU. Lotta is an agricultural scientist specialised in animal science and works as a researcher and lecturer. Her research is on a breeding programme for sustainable production of animal-based food. Lotta is a member of the Future Agriculture steering group.

Associate Prof. Katarina Vrede, Future Agriculture, SLU. Katarina has a background as a researcher in limnology. She is a member of the steering group and works as the programme secretary for Future Agriculture.

Prof. Charles Westin, Centre for Research in International Relations and Ethnic Relations (CEIFO), Stockholm University. Charles helped to build up CEIFO, which was established in 1983, and he was its director 1994-2008. He has worked with projections of future migration and he was editor-in-chief of the book Identity Processes and Dynamics in Multi-Ethnic Europe (2010).

Prof. Ingrid Öborn, Department of Crop Production Ecology, SLU. Ingrid is an agricultural scientist specialist in soil science and agronomy. Her research and lecturing is on agricultural cropping systems, soil-plant interactions, flows of nutrients and pollutants in agricultural systems. Ingrid is programme director for Future Agriculture.

First researcher Maria Stenström (project manager), **Analysts Benny Jansson** and **Liselotte Dahlén** from the Swedish Defence Research Agency (FOI) were facilitating and leading the process during the development of the scenarios.

Appendix 2 Factors and states used to construct the scenarios

An overexploited world

GLOBAL PERSPECTIVE

Scenario	Land-water resource availability, global scenarios (sub-scenarios)	Power relations, global scenarios (sub-scenarios)	Global population 2050	Global economic development	Global climate scenarios (1990–2090)	Global energy supply	Global technological development and distribution	Global food consumption (calories)
An overexploited world	GR1 Less of all except land area	GM1 Fragmentation	Slower growth. 8 billion	High north Low south	Min effect, 1–2 °C	Large area Little availability/high price	Rapid development. Even distribution	Animal-based 25 % Plant-based 75 %
A world in balance	GR2 Good availability of all resources	GM2 Unipolar world order, Asia dominates	UN's forecast. 9 billion	Low north High south	Moderate effect, 2–3 °C	Large area Large availability/low price	Rapid development. Uneven distribution	Animal-based 17 % Plant-based 83 %
Changed balance of power	GR3 Weak biological systems, plentiful inputs	GM3 Unipolar world order, the West dominates	Faster growth. 11 billion	Low north Low south	Max effect, 3–4 °C	Small area Large availability/low price	Slow development. Even distribution	Animal-based 10 % Plant-based 90 %
The world awakes	GR4 Production closer to polar regions	GM4 Multipolar world order		High north High south		Small area Little availability/high price	Slow development. Uneven distribution	
A fragmented world		GM5 Regional protectionism						
		GM6 Adapting mosaic – strong regions that cooperate						

Sub-scenarios

Land-water resource availability, global scenarios	Global potential grazing and arable land	Soil fertility Production potential Ecosystem services	Availability of agricultural inputs	Global access to water	Fish and aquaculture
GR1 Less of all except land area	Area as today, situated as today	Increased	Good Low prices	Access to water as today, distributed as today	Availability of wild fish as today
GR2 Good availability of all resources	Area as today displaced towards the polar regions	As today	Little High prices	Access to water as today, more unevenly distributed	Less availability of wild fish. Aquaculture makes up the difference
GR3 Weak biological systems, plentiful inputs	Area as today displaced towards the equator	Decreased		Less access to water than today, distributed as today	Less availability of fish
GR4 Production closer to polar regions	Increased area			Less access to water than today, more unevenly distributed than today.	

Power relations global scenarios	Role of large (strong) states	Supranational institutions that affect food supply	Role of private (commercial) actors	Role of non-governmental (political) actors
GM1 Fragmentation	The USA dominates	Strong globally	Stronger than today	Strong
GM2 Unipolar world order, Asia dominates	Multipolar	Functioning globally	As today	As today
GM3 Unipolar world order, the West dominates	China–India dominate	Functioning regionally	Weaker than today	Weaker than today
GM4 Multipolar world order	No strong states	Weaker than today		
GM5 Regional protectionism				
GM6 Adapting mosaic – strong regions that cooperate				

(Continued: An overexploited world)

REGIONAL PERSPECTIVE

Scenario	Population, regional scenarios (sub-scenarios)	Land-water resource availability, regional scenarios (sub-scenarios))	Agricultural policy	Regional power relations	Economic development in Europe	Regional food consumption (calories)	Animal-based food consumption (protein)
An overexploited world	RB1 Continuing urbanisation	RR1 Increased area grazing and arable land	Global trade agreements replace European agreements	Strong supranationalism in Europe	Equalized development in Europe	Animal-based 30 % Plant-based 70 %	Beef & lamb 10 % Milk products 35 % Pork & poultry & eggs 25 % Fish & shellfish 30 %
A world in balance	RB2 Labour migration	RR2 Increased production in the east	Deregulation between Europe and the world	Strong nation states in Europe	Economic balance of power as today	Animal-based 20 % Plant-based 80 %	Beef & lamb 25 % Milk products 25 % Pork & poultry & eggs 40 % Fish & shellfish 10 %
Changed balance of power	RB3 Urban and rural development	RR3 Weak biological systems, plentiful inputs	Europe a protected market	Weak states. Weak supranationalism in Europe	Stronger in east Weaker in south	Animal-based 10 % Plant-based 90 %	Beef & lamb 15 % Milk products 35 % Pork & poultry & eggs 40 % Fish & shellfish 10 %
The world awakes	RB4 Controlled migration and rural policies	RR4 Decreased production in the south, increased in the north and the east.	National agricultural policies				Beef & lamb 10 % Milk products 20 % Pork & poultry & eggs 50 % Fish & shellfish 20 %
A fragmented world	RB5 Uncontrolled migration						Beef & lamb 10 % Milk products 20 % Pork & poultry & eggs 60 % Fish & shellfish 10 %

Sub-scenarios

Population regional scenarios	Housing patterns in the regions	Population size in the regions	Demographics in the regions
RB1 Continuing urbanisation	High urbanisation Large cities growing	Approximately as today	Even age distribution Obelisk
RB2 Labour migration	Urban concentration Small towns growing	Large increase 20–50 %	Pyramid with a broad base Many young people
RB3 Urban and rural development	Urban sprawl		
RB4 Controlled migration and rural policies	Developed rural areas		
RB5 Uncontrolled migration			

Land-water resource availability, regional scenarios	Potential grazing and arable land in the regions	Soil fertility Production potential Ecosystem services	Availability of agricultural inputs	Access to water in the regions	Fish and aquaculture
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RR4 Decreased production in the south, increased in the north and the east.	Increased area			Less access to water than today, more unevenly distributed than today.	

A world in balance

GLOBAL PERSPECTIVE

Scenario	Land-water resource availability, global scenarios (sub-scenarios)	Power relations, global scenarios (sub-scenarios)	Global population 2050	Global economic development	Global climate scenarios (1990–2090)	Global energy supply	Global technological development and distribution	Global food consumption (calories)
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A fragmented world		GM5 Regional protectionism						
		GM6 Adapting mosaic – strong regions that cooperate						

Sub-scenarios

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GM6 Adapting mosaic – strong regions that cooperate				

(Continued: A world in balance)

REGIONAL PERSPECTIVE

Scenario	Population, regional scenarios (sub-scenarios)	Land-water resource availability, regional scenarios (sub-scenarios))	Agricultural policy	Regional power relations	Economic development in Europe	Regional food consumption (calories)	Animal-based food consumption (protein)
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A fragmented world	RB5 Uncontrolled migration						Beef & lamb 10 % Milk products 20 % Pork & poultry & eggs 60 % Fish & shellfish 10 %

Sub-scenarios

Population regional scenarios	Housing patterns in the regions	Population size in the regions	Demographics in the regions
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RB3 Urban and rural development	Urban sprawl		
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RB5 Uncontrolled migration			

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Changed balance of power

GLOBAL PERSPECTIVE

Scenario	Land-water resource availability, global scenarios (sub-scenarios)	Power relations, global scenarios (sub-scenarios)	Global population 2050	Global economic development	Global climate scenarios (1990–2090)	Global energy supply	Global technological development and distribution	Global food consumption (calories)
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A fragmented world		GM5 Regional protectionism						
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Sub-scenarios

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GM5 Regional protectionism				
GM6 Adapting mosaic – strong regions that cooperate				

(Continued: Changed balance of power)

REGIONAL PERSPECTIVE

Scenario	Population, regional scenarios (sub-scenarios)	Land-water resource availability, regional scenarios (sub-scenarios))	Agricultural policy	Regional power relations	Economic development in Europe	Regional food consumption (calories)	Animal-based food consumption (protein)
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Sub-scenarios

Population regional scenarios	Housing patterns in the regions	Population size in the regions	Demographics in the regions
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RB5 Uncontrolled migration			

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The world awakes

GLOBAL PERSPECTIVE

Scenario	Land-water resource availability, global scenarios (sub-scenarios)	Power relations, global scenarios (sub-scenarios)	Global population 2050	Global economic development	Global climate scenarios (1990–2090)	Global energy supply	Global technological development and distribution	Global food consumption (calories)
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GM5 Regional protectionism				
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(Continued: The world awakes)

REGIONAL PERSPECTIVE

Scenario	Population, regional scenarios (sub-scenarios)	Land-water resource availability, regional scenarios (sub-scenarios))	Agricultural policy	Regional power relations	Economic development in Europe	Regional food consumption (calories)	Animal-based food consumption (protein)
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A fragmented world

GLOBAL PERSPECTIVE

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(Continued: A fragmented world)

REGIONAL PERSPECTIVE

Scenario	Population, regional scenarios (sub-scenarios)	Land-water resource availability, regional scenarios (sub-scenarios))	Agricultural policy	Regional power relations	Economic development in Europe	Regional food consumption (calories)	Animal-based food consumption (protein)
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Appendix 3

Food consumption globally and in Europe in five scenarios for 2050

	Global (%)*		Europe (%)*		Animal-based food consumption in Europe (%)**			
Scenario	Animal-based	Plant-based	Animal-based	Plant-based	Beef & lamb	Milk products	Pork & poultry & eggs	Fish & shellfish
An overexploited world	20	80	30	70	15	35	40	10
A world in balance	20	80	10	90	10	35	25	30
Changed balance of power	25	75	30	70	25	25	40	10
The world awakes	20	80	20	80	10	20	50	20
A fragmented world	10	90	20	80	10	20	60	10
Current daily consumption assumed in the scenario work	17	83	30	70	15	35	40	10
Current daily consumption***	17	83	28	72	14	34	41	11

* Food consumption calculated in calories.
** Consumption of animal-based food calculated in protein
*** FAOSTAT 2007

SLU

Future Agriculture
FRAMTIDENS LANTBRUK

Future Agriculture – livestock, crops and land use is a strategic multi- and interdisciplinary research initiative in which researchers, together with industry, stakeholders and nongovernmental organizations, will develop a new research programme to address the sustainable use of natural resources with emphasis on agricultural production, including farm animals, and land use.

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