IDS Bulletin
Transforming Development Knowledge
Volume 47 | Number 4 | September 2016

FORESIGHT IN INTERNATIONAL DEVELOPMENT

Editors **James Sumberg and Gioel Gioacchino**

Agrimonde and Agrimonde-Terra: Foresight Approaches Compared

Marie de Lattre-Gasquet and Sébastien Treyer

Abstract Over a ten-year period, two French agricultural research organisations have jointly undertaken two foresight exercises. Agrimonde was about scenarios and challenges for feeding the world in 2050, while Agrimonde-Terra was about land use and food security in 2050. This article compares and contrasts these two exercises, in terms of context and objectives, method, scenarios, and how they grapple with global regions. The comparison illustrates how the context, the objectives and the desired changes influenced the choice of foresight methodology, and the results. While Agrimonde is focused on shifting the forefront of the debate on agricultural models for global food security, decision-makers at various geographical levels can seize the Agrimonde-Terra method and results to have discussions about the future uses of their land.

Keywords: policymaking, scenario, method, global, regional.

1 Introduction

Foresight is 'a systematic, participatory and multi-disciplinary approach to explore mid- to long-term futures and drivers of change' (FTP 2014) that is meant to lead to change. The three philosophical precepts behind foresight are that the future is a realm of freedom, a realm of power, and a realm of will (de Jouvenel 2000). Or, to cite Gaston Berger, father of foresight in France: 'Consider the future not as something already decided, something revealed bit by bit, but rather as something to be created' (Berger 1958). Four attitudes are often found when faced with the uncertainty of the future: passive (submit to change); reactive (await change to react); preactive (preparing for an anticipated change); and proactive (acting to provoke a desired change) (Godet 1994).

It is against this backdrop that two foresight exercises – Agrimonde and Agrimonde-Terra – were undertaken by the French agricultural research institutes, CIRAD (Centre de coopération internationale en recherche agronomique pour le développement) and INRA (Institut national de la recherche agronomique). Agrimonde was launched in 2006 with a focus on the possible futures of agriculture and food security worldwide to 2050. The aim was to pinpoint the fundamental questions agricultural

The *IDS Bulletin* is published by Institute of Development Studies, Library Road, Brighton BN1 9RE, UK
This article is part of *IDS Bulletin* Vol. 47 No. 4 September 2016: '**Foresight in International Development**'; the Introduction is also recommended reading.

research will have to answer, so as to provide CIRAD and INRA with the means to anticipate and prepare for the future. The final report of Agrimonde was published in 2011 (Paillard, Treyer and Dorin 2011). Agrimonde-Terra is a foresight exercise focused on land use and food security to 2050. It was launched in 2012 and finished in mid-2016 (CIRAD and INRA 2016). The two authors of this article were involved – with many other colleagues – in the design and implementation of both foresight exercises. Marie de Lattre-Gasquet was a member of the Agrimonde expert panel and one of the coordinators of Agrimonde-Terra. Sébastien Treyer was a coordinator of Agrimonde and a member of the Agrimonde-Terra Scenario Advisory Committee.

This article compares and contrasts these two foresight exercises, with a particular focus on the methods used. Subsequent sections discuss the contexts, objectives and theories of change of the studies, the methods used for building the scenarios, the resulting scenarios, the geographical approach, and lessons learned.

2 Context, objectives and theories of change

The objective of Agrimonde was to inform research programming (Schoen *et al.* 2011), and focused on a specific international policy debate (what innovation pathways in agriculture and food could assure global food security?). In contrast, Agrimonde-Terra sought to inform policy, to embed participation in policy processes (Da Costa *et al.* 2008) by proposing a process and results that serve to prepare new land use scenarios at various geographical scales. Both exercises aimed at broadening the discussion of methods for thinking about futures scenarios.

2.1 Agrimonde: new research questions and contributing to global debates

The Agrimonde[1] initiative reflected ongoing changes in the early to mid-2000s. It was influenced by the Millennium Ecosystem Assessment (2005), which drew scientific and public attention to the implications of ecosystem change for human wellbeing, and the need to use the earth's ecosystems sustainably. The first plenary meeting of another important global initiative – the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD 2009) – took place in September 2004. Several French researchers were involved in the IAASTD, and the Agrimonde foresight exercise was meant to help them take a more proactive stand in this expert process, possibly contributing to pluralise the visions and the scenarios discussed in this arena. Also, in the mid-2000s, the French government was setting new objectives for INRA and CIRAD, and seeking a closer relationship between these organisations. The competitiveness of agri-food markets; the conservation of natural resources; the high prices of fossil fuel; the quality of human food and nutrition; and climate change were all recognised as key challenges. After a period of neglect, agriculture and investment in international agricultural research were also moving up the development agenda. In this context, what might be the new innovation pathways for agriculture? CIRAD, through its scientific director Michel Griffon, had been associated with the vision of

a 'doubly green revolution' (Conway 1997) in the mid-1990s. Was this vision relevant in the mid-2000s and beyond?

Thus, Agrimonde was launched in 2006 with three objectives. First, to explore different possible futures of food and farming systems to 2050. Second, to guide INRA and CIRAD's research in the field of agronomy and food, broadly speaking. Third, to structure discourse within CIRAD and INRA on global food security, and to build capacity so that French experts could participate more effectively in international debates on the futures of agriculture (Paillard *et al.* 2011; Treyer 2011). To meet these objectives there was an interest in comparing a business-as-usual scenario with an agro-ecological scenario built on hypotheses and calculations done by Michel Griffon in his book *Nourrir la planète* (Griffon 2006). Two questions were at centre stage: how and through what innovation pathways could a population of 9 billion people be adequately fed, while preserving ecosystems integrity? What should be the priority issues for agricultural research?

Agrimonde was also intending to pluralise not only the substance of the scenarios considered, but also the methods to develop and represent them. Its methodological design was intending to question the dominance of economic models of global commodity markets as the basis for assessing global food security. These models, and in particular the IMPACT model developed at IFPRI[2] (Rosegrant *et al.* 2008) were highly influential because they modelled the link between scarcity, prices and technological progress. In order to account for different types of technological progress (e.g. conventional versus agroecology) through more transparent assumptions, Agrimonde developed an alternative quantitative framework, based on physical balances between biomass resources and uses (Dorin and Le Cotty 2011). Four years after launching the Agrimonde foresight exercise, the results were published in the book *Agrimonde. Scenarios and Challenges for Feeding the World in 2050* (Paillard *et al.* 2011).

2.2 Agrimonde-Terra: participation, land use policy and improved food security

Agrimonde-Terra[3] is essentially a continuation of Agrimonde. However, the focus shifted to land use and its implications for food security. Launched six years after Agrimonde, the context for Agrimonde-Terra was already quite different. Demographic and economic growth and growing demand for meat and for renewable energy were resulting in increased competition for land. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007) drew attention to the need to integrate climate change and sustainable development policy, as well as to the links between mitigation and adaptation. The notion of 'planetary boundaries', first introduced in 2009, was by 2012 increasingly accepted (Rockström *et al.* 2009). The Sustainable Development Goals and COP21 were being prepared. Finally, there was increasing concern about the loss of natural habitat and biodiversity associated with the intensification of agriculture (Millennium Ecosystem Assessment 2005). At the same time, many

regions of the world were continuing to suffer from nutritional deficiencies due to diets based on relatively few species (WHO 2008). Diet-related chronic diseases in developing countries were the subject of increased research and policy attention.

In this context, Agrimonde-Terra set out to address a series of questions including: what impacts will population growth, urbanisation, lifestyle changes, climate change and growing energy and meat demands have on land use to 2050? How can we ensure that land use will provide nutritional and food security for all to 2050? How should land, water and biodiversity be used to meet the demands of the planet's inhabitants in 2050? How can we ensure that the land will provide sustainable incomes for farmers and affordable prices for consumers? Which public policies should be implemented at different scales and in the different sectors?

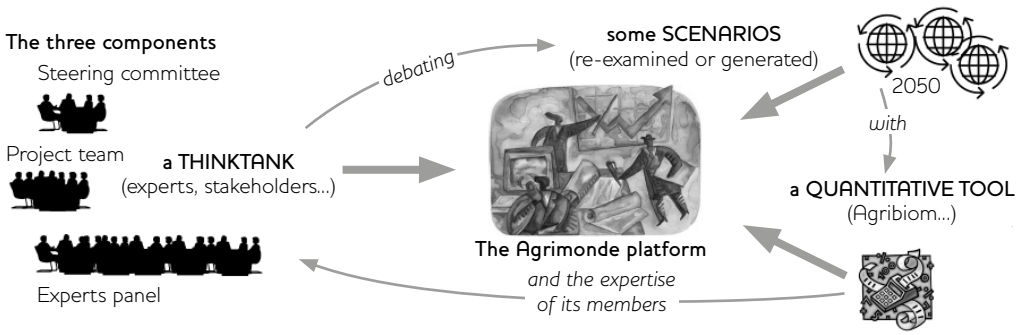
The aim of Agrimonde-Terra is to prepare rigorous and coherent land use scenarios with a stepwise and participatory process that will (a) help develop a shared understanding of the links between the natural and human processes at different levels; (b) contribute to international debates on land use and food and nutrition security; (c) help international, regional and national decision-makers in their discussions on public policies and investments relating to land use with a focus on food and nutrition security; and (d) help identify relevant questions for future research. The scenarios were seen as constituting 'learning machines' (Berkhout, Hertin and Jordan 2002), i.e. tools to raise awareness and encourage debate. The foresight exercise was designed not only to explore a range of possible futures, but also to provide the public and decision-makers with a tool that could be used to facilitate conversations about future land use in particular regions or countries. A workshop was held in Tunisia to see if the Agrimonde-Terra method and results could be easily adapted to a country's situation to build local scenarios. The resulting scenarios are currently used for discussions on research strategy which is a sign of usefulness.

Agrimonde-Terra also had the objective of demonstrating how a step-by-step foresight process, using a pluridisciplinary approach of systemic inspiration, integrating the long-term dimension, past and future, as well as breakdowns (de Jouvenel 2004), and linking qualitative and quantitative approaches could be useful when thinking about the futures of a complex question such as land use.

3 Methods for scenario building

The two programmes used different methods to build scenarios. Agrimonde was designed as a platform for discussion among French researchers, whereas Agrimonde-Terra was conceived as a forum for discussions among French and international researchers, policymakers and representatives of the civil society. Moreover, in Agrimonde the quantitative work came first and was complemented by a qualitative analysis, while in Agrimonde-Terra the focus was on system analysis and causal relationships.

Figure 1 Agrimonde: a three-component platform



Source Reproduced by kind permission of Dorin (2009).

3.1 Agrimonde: a platform for collective analysis

Agrimonde was designed as a platform for the preparation, analysis and discussion of scenarios to facilitate the collective analysis of the challenges facing the world's food and agricultural systems. The platform (Figure 1) consisted of:

- A project team representing six full-time staff for two years from INRA, CIRAD and AgroParisTech;
- An expert panel of 17 French researchers and decision-makers who met once a month over an 18-month period;
- A steering committee consisting of two staff from INRA, two from CIRAD and a representative of the French Initiative for International Agricultural Research (FI4AR).

The platform was designed to respect the basic principles of a foresight approach (Paillard *et al.* 2011). Among these principles are the inclusion of a plurality of worldviews and a diversity of scientific and institutional positions. Other important principles are the recognition and integration of uncertainty; collective learning by actively involving experts and stakeholders; and transparency through reference to the best scientific studies, and being explicit about the simplifications and assumptions made.

Agrimonde started with a review of the world food economy over four decades (1961–2003) including human population, food consumption, land use, food production and productivity, food use and food trade. This proved a very useful exercise and constituted an important output. Subsequent scenario building consisted of three main steps: (1) choosing the scenarios and the principles underlying their construction; (2) building quantitative scenarios and checking the consistency of major assumptions; and (3) building complete scenarios, by integrating quantitative scenarios with qualitative assumptions. This method, not commonly used, puts the emphasis on the quantitative framework for comparison between the scenarios, both at global and regional scales.

Step one – choosing scenarios and principles: One of the specificities of Agrimonde was the strong relationship with the four scenarios of the Millennium Ecosystem Assessment (Carpenter *et al.* 2005). These scenarios are distinguished by their geopolitical framework (regionalisation versus globalisation) and by the proactive or reactive nature of policies and regulations towards ecosystem protection. They are characterised by different societal priorities, especially in terms of poverty alleviation and the protection of ecosystems and natural resources. Their principles were not necessarily the most relevant for discussing the future of food and agricultural systems, but the interplay of ecosystems and human activities was certainly relevant for the questions that Agrimonde sought to explore. The Millennium Ecosystem Assessment (MA) scenarios were therefore used as reference scenarios, to which the alternative scenarios developed in Agrimonde could be compared.

In order to build two quantitatively comparable scenarios, Agrimonde adopted two principles. In both scenarios, each major region of the world had to try to satisfy its own food requirements in 2050. Inter-regional trade would be considered only after the evaluation of the extent to which agricultural production in each region covered local needs. Also, future demographic trends could not be masked by migratory flows. The implications of expected population growth, mainly in sub-Saharan Africa, Asia and Latin America were thus fully examined with regard to each region's capacity to feed its own population.

Step two – building quantitative scenarios: A specific quantitative tool called *Agribiom* was developed and used to produce quantitative scenarios concerning world food production, trade and use of biomass (Dorin and Le Cotty 2011). The data used relate to human population, national production of plant, animal and aquatic products which were transformed into kilo calories and areas of land cultivated for food and non-foodstuffs. Physical balances (past and future) between food biomass resources and their use are at the heart of Agribiom. Such balances were reconstructed from the 1960s and simulated for six regions of the world (the same ones used by the MA – members of the OECD[4] in 1990; the Former Soviet Union; Latin America; sub-Saharan Africa; the Middle East and North Africa; and Asia). To assess biomass uses a number of explicit assumptions had to be made. The two quantitative scenarios were built as the result of the interaction and adjustments between the modellers of Agribiom and the expert panel.

Step three – building complete scenarios: The variables considered in the Agrimonde scenarios were: global context, international regulations, dynamics of agricultural production, actors' strategies, knowledge and technologies, and sustainable development. When the experts formulated assumptions on diet, land use, yields or inter-regional trade, they had to analyse all their implications and ramifications. Through this process, they enhanced the basic quantitative assumptions. More specifically, the quantitative scenarios were analysed for each region in relation to three groups of questions: (a) Is the quantitative scenario

consistent with the scenario-building principles defined at the outset? If not, which qualitative assumptions would make it consistent? (b) What does the comparison of the various scenarios teach us? What qualitative assumptions would be needed to ensure that they represented clearly different pictures of the future? (c) What are the main challenges of this scenario? What are the main drivers of change that should be activated for it to become reality? This analysis enabled the experts to consider qualitative assumptions for each of the Agrimonde variables and then to produce complete scenarios.

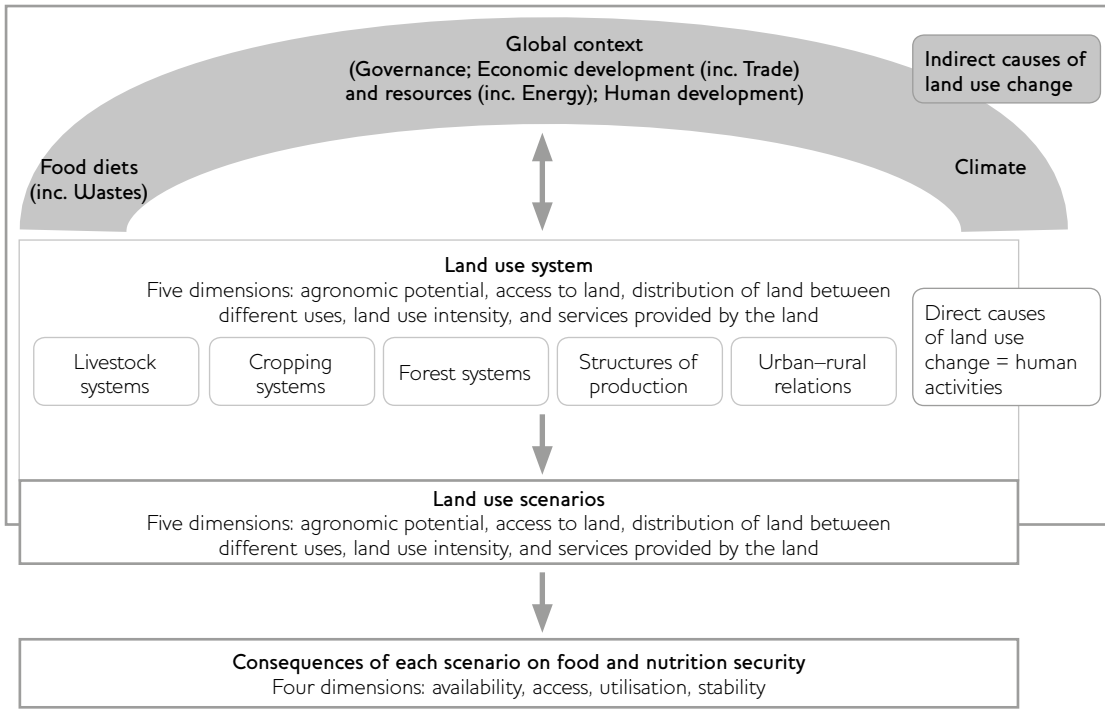
3.2 Agrimonde-Terra: system analysis with an international forum

The Agrimonde-Terra foresight exercise was conceived as a forum for discussion between researchers and decision-makers, and the forum was animated by a project team of staff from CIRAD and INRA, assigned to the project for three years (de Lattre-Gasquet, Le Mouël and Mora 2016). Initially four thematic workshops were organised, on urban–rural relationships, farm structure, cropping systems, and livestock systems. Eighty international experts participated and helped frame the issues and prepare the micro-scenarios on direct causes of land use change. A Scenario Advisory Committee made up of 15 researchers and policymakers met four times to give advice to the project team about the scenarios.

Agrimonde-Terra considered that land use systems, which are characterised by bio-physical and socioeconomic factors (Stomph, Fresco and van Keulen 1994), influence food and nutrition security. The method for scenario building involved four steps: description of the land use system; building micro-scenarios of each cause (or driver) of change; combining micro-scenarios to develop contrasting land use scenarios and building scenarios for global regions; and carrying out a qualitative and quantitative impact analysis of each and all land use scenarios on food security at global and regional levels. The approach was systemic in that it recognised complexity and established causal relationships between the variables.

Step one – describing the land use system: Retrospective analyses of land use and literature reviews were carried out to identify the main direct (5) and indirect (3) causes of land use change. Emerging trends and potential disruptions were identified. In terms of direct causes, the focus was on agriculture and forestry (cropping, livestock and forestry systems); structures of production; and urban–rural relationships. Indirect causes included climate change, diets and the global context (i.e. political governance, economic development including trade, resources including energy, and human development including demography). A brief analysis of civil society actors, policy actors, economic, business, and research and innovation actors who influence changes in land use was also carried out. As shown in Figure 2, land use change (a) may be characterised using five complementary and interlinked dimensions; (b) results from complex interactions between indirect and direct causes; and (c) have an impact on food security at different scales ranging from household to global.

Figure 2 The Agrimonde-Terra land use and food security system



Source de Lattre-Gasquet *et al.* (2016).

Step two – building micro-scenarios using morphological analysis: For the four direct causes, micro-scenarios were built during thematic workshops with international experts. In the case of the indirect causes, micro-scenarios were built on the basis of literature reviews. To build the micro-scenarios, a morphological approach was used based on that developed by Fritz Zwicky in the 1940s as 'a general method for structuring and investigating the total set of relationships contained in multi-dimensional, usually non-quantifiable, problem complexes' (Ritchey 1998; see also Godet 1997; de Jouvenel 2004; Álvarez and Ritchey 2015). The analysis consisted of identifying and analysing a range of variables influencing each cause of land use change. Hypotheses of how each variable might evolve were imagined. A morphological box was constructed, with each line devoted to a variable. Within a line, each cell contained one of the hypotheses. The micro-scenarios were built by combining one or several hypotheses per variable in the most logical fashion, respecting causal relationships. The Scenario Advisory Committee reviewed all of the micro-scenarios.

Step three – building land use scenarios: Contrasting land use scenarios were also built with the help of a morphological box by combining micro-scenarios for each direct and indirect cause in the most logical fashion. The land use scenarios were built in close collaboration with the Scenario Advisory Committee. They were called 'generic

scenarios' because they do not apply to a specific region. The generic scenarios are described through narratives. Scenario building started with a representation of the current situation and an analysis of the long-term dynamics. Some events are seen to create pathways of change. The final picture presents the situation in 2050. The representation of the current or initial situation, as well as the final land use scenarios are described according to the five dimensions of land use change. Land use scenarios for the global regions were also built and these were described through short narratives and the consequences of each scenario were illustrated with the GlobAgri-AgT platform. For the quantitative scenarios it was assumed that all regions followed the same scenario.

Step four – analysis: When examining the impact of each scenario on the four dimensions of nutrition and food security Agrimonde-Terra has been at pains to take scale fully into account. The governance of land use tends to be local or national, although the international scale can be important, while the governance of food security is both national and international. Agrimonde-Terra has also used a quantitative platform called GlobAgri for generating databases and biomass balance models from FAOStat[5] and other data. Biomass balance models provide a balance between resources (domestic production plus imports minus exports) and utilisation (food, feed, other) for each region and each agri-food product. The system of balance equations can simulate land use change and greenhouse gas (GHG) emissions induced by changes in the uses of agri-food products, provided hypotheses on the evolution of a set of variables are available. The GlobAgri platform has been used to generate a database and a biomass balance model which are specifically customised for Agrimonde-Terra. It is named GlobAgri-AgT and it considers 32 aggregates of agri-food products (25 plants and 7 animal aggregates) and covers 14 broad regions. GlobAgri-AgT is used to conduct quantitative analysis of the impact of each scenario on food availability and utilisation on a global and regional level. A qualitative analysis is conducted on the impact of each scenario on food access and stability.

4 The scenarios

Whereas Agrimonde built two contrasted scenarios, one baseline and one normative, Agrimonde-Terra has explored a wider range of possible futures.

4.1 Agrimonde: two contrasted scenarios

In order to contribute to debates on innovation pathways to ensure global food security, the two scenarios chosen for Agrimonde were:

- A business-as-usual scenario, **Agrimonde GO**, for which assumptions were taken from the 'Global Orchestration' (GO) scenario of the Millennium Ecosystem Assessment (2005), assuming green revolution-type innovation and no structural change in food systems;
- An alternative scenario, **Agrimonde 1**, for which assumptions were inspired by the 'doubly green revolution' scenario of Michel Griffon (Griffon 2006), assuming agroecology innovation with the possibility of structural changes in the food system.

For the business-as-usual scenario, the expert panel decided to ensure comparability with the scenarios of the MA and particularly 'Global Orchestration'. This scenario starts from the current situation and is trend-based, i.e. it assumes continued liberalisation of trade and major technological advances. Priority is given to economic development, and management of ecosystems and environmental problems is reactive. It is characterised by a sharp rise in crop yields between 2000 and 2050, both in developed and developing countries, owing to major investments in agricultural research, a vast increase in irrigated areas, more efficient use in water and energy, and investments in support infrastructure. New technology includes genetically modified organisms (GMOs), more intensive crop farming and increased use of fertilisers. Almost all farms, small and large, become highly mechanised. Farmers who do not practise intensive farming – either by choice or because they are on marginal land – have very little weight in their country's agricultural sector. Local knowledge is replaced by standardised methods and practices. Environmental problems are approached with the certainty that they can always be overcome once they become acute, and trade is not regulated (Paillard *et al.* 2011: 124).

The experts chose to construct only one other scenario, 'Agrimonde 1', which applied the principles of sustainable development but also included nutrition. This scenario tested the possibility that the 'doubly green revolution' would constitute a better model to deliver jointly ecological, social and economic performance. Agrimonde 1 is a normative scenario that proposes ecological intensification and a reduction in the current inequalities as regards consumption. As such it entails radical change in food production and in food consumption. This scenario assumed that by 2050 the world would be able to create sustainable food and agricultural systems. The aim was to provide insight into such a development pathway including dilemmas, challenges, changes and discontinuities.

Both Agrimonde scenarios pointed to a future where it would be possible to feed the world. But each scenario highlighted weaknesses: the business-as-usual scenario because it seems over-optimistic in relation to yield increases, the alternative scenario because it relies on a radical change in food consumption patterns. But interestingly, in both scenarios, three regions – sub-Saharan Africa, Asia and North Africa/Middle East – would become net structural food importers by 2050, although the scenarios were first built on the basis of regional self-sufficiency. Both scenarios also pointed out the importance of changes in food consumption patterns, which influence production choices, as well as the organisation of the agro-food industry (Hubert and Caron 2009). The contrast between the two scenarios highlights the fact that the agroecology paradigm should receive as high a priority in agronomic research as the green revolution paradigm (*ibid.*).

4.2 Agrimonde-Terra: exploratory scenarios

The Agrimonde-Terra scenarios are exploratory and are illustrated quantitatively as a means of validation. Five scenarios have been built to demonstrate that there is a vast array of possible futures that we cannot see because of ideologies, mental constructions, etc.

The scenario '**Land use driven by metropolisation**' is an ongoing scenario in many regions of the world. The main driving forces of this scenario are market forces and international trade, agri-food companies proposing ultra-processed foods, large metropolitan regions, and rapid climate change. Four other scenarios have been imagined.

Land use for food quality and healthy nutrition: The main triggers of the scenario are globalisation and cooperation, stabilisation of climate change, and changes in diets due to public policy and consumer awareness about health. In 2050, diets are lower in fats, ultra-processed foods, sugars and sweeteners, and higher in fresh products, coarse grains, and pulses. In developed countries, the proportion of animal products has decreased but it has increased in certain developing countries. Crop systems have diversified, incorporating techniques from agroecology, and livestock systems are re-associated with crop production. This array of measures contributes to both limiting agricultural GHG emissions and increasing carbon storage in soil, increasing per hectare yields. Better organised food systems have also reduced food losses and waste, particularly by improving food storage and preservation capacities in countries in the global South.

Land use for regional food systems: Regional agreements and regional food systems are the main triggers of this scenario. In 2050, each region has broadened the range of foods offered. Food industries, in collaboration with agricultural cooperatives and other actors, have adapted to local food products and habits. Production and consumption of roots and tubers, coarse grains, pulses, fruits and vegetables has increased. Crop and livestock systems are transformed. Animal feed is expressly sourced from regional plant production, and trade in organic fertiliser between livestock and crop farms is organised on small and medium scales. Farmers use varieties adapted to local agro-climatic conditions. These changes have positive impacts on agricultural revenues and for rural development.

Land as commons for rural communities in a fragmented world: The main triggers for this scenario are the fragmented world context which has led to the development of smaller towns and new forms of farm organisation. Due to crises, in 2050 land use has become highly diversified from one region to another. Low yield increases have contributed to deforestation in certain regions. Through self-governing institutions defining rules for managing common property, local communities ensure a certain level of food security by turning to agro-ecological practices. Conversely, regions with subsistence farming face repeated episodes of food insecurity.

Land use for multi-active and mobile household: The main triggers of the scenario are the context (globalised, dynamic but unstable because non-state players gradually supersede the power of sovereign governments) and urban–rural relations (high mobility within households to diversify sources of income). In 2050, households aim at the resilience of farming structures to maintain productive capital for all generations. Farming systems are flexible and farming structures are diverse, ranging from small farms with family labour to large, highly capitalised farms. Production systems are intensive, either due to greater use of cutting-edge technologies, or because of techniques relying on a plentiful supply of labour (e.g. agroecology) in response to public demand.

5 Global and regional views

Whether we will be able to feed the world in 2050 is at the heart of Agrimonde and Agrimonde-Terra. But the answer rests in the situation and practices of territories, countries and regions and their relationships. Therefore, both Agrimonde and Agrimonde-Terra had a regional approach: Agrimonde is focused primarily on quantitative upscaling whereas Agrimonde-Terra is focused on the ongoing trends in each region.

5.1 Agrimonde: quantitative assumptions at regional level

For the Agrimonde scenarios, the quantitative assumptions were first developed at regional level. For example, assumptions for human populations and food consumption per inhabitant were developed at regional level by analysing past trends, existing data and references in the literature, as well as the assumptions of scenarios of the MA. Agrimonde's assumptions for the alternative scenario were then developed (Chaumet, Ghersi and Rastoin 2011). Once a scenario was built and tested for its internal coherence for each region and globally, the qualitative dimensions left undetermined by the quantitative analysis were presented mainly at a global scale (i.e. no regional narratives were written).

5.2 Agrimonde-Terra: regionalised global scenarios

The analysis of past and ongoing trends in different regions for all direct and indirect causes of land use change were the basis for the construction of the five 'generic scenarios', i.e. scenarios that identified the drivers and pathways of change and the interactions between the direct and indirect drivers (of change). The regionalised global scenarios were built by looking at current and emerging trends towards each scenario and potential disruptions in each region. There is a presentation of the dimensions of land use in 2050 for each region. The agronomic potential, access to land and land use intensity depend on the hypotheses of the scenario. Distribution of land is the result of the quantitative simulations, and services provided by the land are also the results of the scenario. The four dimensions of food security in each region in 2050 are also presented. Utilisation depends on the food diets in the region, and availability is the result of the scenario simulation.

6 Lessons learned

Above all, a foresight exercise is a process, and three lessons can be drawn from the comparison of Agrimonde and Agrimonde-Terra.

6.1 The foresight process depends on the objectives and the desired changes

The first lesson is that the foresight method is closely linked to the objectives set by the commissioning body and the desired changes. Future studies are a mosaic of approaches, objectives and methods (FTP 2014), and the two Agrimonde foresight exercises demonstrate that the methods should be chosen in relation to the objectives. This is not always done, nor is it necessarily easy. As far as global food security is concerned, most foresight is done with quantitative models so that at the 2nd Global Conference on Agricultural Research for Development (GCARD2) in 2012, the necessity of a plurality of foresight approaches was acknowledged to feed global debates on innovation pathways.

Agrimonde's objectives were set by a leadership of INRA and CIRAD to help programming and inform research policy at national and global levels. The method led to two contrasting scenarios from the comparison of which it was rather easy to draw lessons. The alternative agroecology scenario appeared sufficiently relevant to inspire research agendas built around agroecology as a priority at both INRA and CIRAD (see also SCAR 2011). Furthermore, the two scenarios drew an explicit link between changing food consumption patterns and challenges to agronomic research in terms of agricultural production, yields, areas cultivated, etc. (Hubert and Caron 2009; Treyer 2011). In recent years, the idea that trends in demand for food need to be open to public debate has become increasingly accepted, which provides an opening for agronomic research and policy debate. Agrimonde-Terra's objectives were also set by the institutions' leaderships, but the Scenario Advisory Committee played an important role in linking the foresight exercise to policy discussions. Therefore, the goal of informing policy and embedding participation in policymaking became more important over time. The range of scenarios facilitates the participation of some members of civil society in the policy process.

6.2 A foresight process occurs on a 'sea' of expectations

The second lesson is that foresight necessarily occurs on a sea of expectations (van Lente 2012) which can lead to creativity but also to vulnerability, i.e. not adding much new because of the necessity to compromise. In both Agrimonde and Agrimonde-Terra, there was a leadership team, a steering committee, a group of participants, and each participant had expectations, i.e. 'images of the futures where technical and social aspects are tightly intertwined' (Borup *et al.* 2006) which were not necessarily shared. The exercises drew on existing 'repertoires' and were able to generate alternative ideas. The participatory approach facilitated 'new combinations' between elements of the repertoires, thus enlarging the range of futures.

Behind the understanding that different visions of innovation pathways in agriculture and food systems need to be explicitly discussed, some of the participants in Agrimonde had strong views about ecological intensification and its potential contribution to global food security. They managed to discuss, share and improve these ideas during the course of Agrimonde but also in other instances such as IAASTD, the European Union's Standing Committee on Agricultural Research (SCAR) and the GCARD, where some of them were simultaneously involved. In Agrimonde-Terra, the international experts and committee members brought a wide diversity of points of view which contributed to the construction of the scenarios. Some had expectations about getting out of a purely agricultural point of view on land use, on regional approaches based on ongoing trends, and on usefulness to policymaking. The scenarios approach not only enables thinking outside the box but in new boxes (de Brabandere and Iny 2010).

6.3 The attention given to actors' strategies has been insufficient in both processes

In the French foresight community, the analysis of the strategies of actors is considered important (Crozier and Friedberg 1980; Hatem 1993; Godet 1997; de Jouvenel 2004). Michel Crozier and Erhard Friedberg, in their book *Actors and Systems* (1980), consider not only the set of factors but also the actors as essential to any futures-thinking exercise. If the future is a 'realm of power', then there is the question of the coexistence of various actors who exercise different powers – some conflictual – simultaneously. The power of various actors is unequal, and the distribution and growth of power influences strategies of alliances and conflicts. Despite the fact that they knew and explicitly stated that the analysis of actors' strategies was important, the Agrimonde and Agrimonde-Terra methodological frameworks insufficiently covered this critical dimension. In Agrimonde, a specific workshop was devoted to past trends and future changes in power relations within global food value chains. However, the resulting chapter of the report, though important for the consistency of the whole scenario exercise, has never been considered a central point of discussion. In Agrimonde-Terra, power relations around local land access and management systems – and more broadly – were also put at the centre of the analysis from the beginning. The Agrimonde-Terra narratives help to illustrate that similar exercises cannot avoid looking at these power relations at different scales. Nevertheless, the Agrimonde-Terra scenarios do not themselves give enough attention to issues around power.

Both exercises have opened space for more diverse visions in global and national debates on food security and land use change. To do so, they were designed to maintain a link and some comparability with widely used global quantitative modelling exercises (Labbouz 2014). A next useful step would be to design foresight exercises incorporating as the central feature the capacity to describe and discuss the critical role of actors' strategies and power relations, thus focusing more on pathways than on the descriptions.

Notes

1 Agrimonde was a CIRAD and INRA project under the responsibility of a steering committee composed of Patrick Caron (CIRAD), Catherine Esnouf (INRA), Hervé Guyomard (INRA), Bernard Hubert (INRA) and Alain Weil (CIRAD). The project leader was Sandrine Paillard (INRA) and the methodological coordinator Sébastien Treyer (AgroParisTech), and the team was composed of Maryse Aoudaï (INRA), Jean-Marc Chaumet (INRA), Bruno Dorin (CIRAD), Tristan Le Cotty (CIRAD) and Tévécia Ronzon (INRA), with the collaboration of Rémi Barré (INRA and Cnam), Isabelle Karcher (INRA) and Laurent Parrot (CIRAD).
2 International Food Policy Research Institute.
3 Agrimonde-Terra is also a joint project of CIRAD and INRA. The concepts presented here have been developed by the project team composed of Marie de Lattre-Gasquet (CIRAD, coordinator), Chantal Le Mouël (INRA, coordinator), Olivier Mora (INRA, organiser for scenario building), Catherine Donnars (INRA), Patrice Dumas (CIRAD) and Olivier Rechauchère (INRA), in collaboration with Marco Barzman (INRA), Thierry Brunelle (CIRAD), Agneta Forslund (INRA), Elodie Marajo-Petitzon (INRA), Stéphane Manceron (INRA), Pauline Marty (INRA) and Clémence Moreau (CIRAD).
4 Organisation for Economic Co-operation and Development.
5 FAOStat offers free and easy access to data for 245 countries and 35 regional areas from 1961 through to the most recent year available. See http://faostat.fao.org/.

References

Álvarez, A. and Ritchey, T. (2015) 'Applications of General Morphological Analysis. From Engineering Design to Policy Analysis', *Acta Morphologica Generalis (AMG)* 4.1: 1–40

Berger, G. (1958) 'L'attitude prospective', *Prospective* 1: 4

Berkhout, F.; Hertin, J. and Jordan, A. (2002) 'Socio-economic Futures in Climate Change Impact Assessment: Using Scenarios as "Learning Machines"', *Global Environmental Change* 12: 83–95

Borup, M.; Brown, N.; Konrad, K. and van Lente, H. (2006) 'The Sociology of Expectations in Science and Technology', *Technology Analysis and Strategic Management* 18.3/4: 285–98

Carpenter, S.R.; Pingali, P.L.; Bennett, E.M. and Zurek, M.B. (eds) (2005) *Ecosystems and Human Well-being: Scenarios*, Volume 2, Millennium Ecosystem Assessment, Washington DC: Island Press

Chaumet, J.M.; Ghersi, G. and Rastoin, J.L. (2011) 'Food Consumption in 2050', in S. Paillard, S. Treyer and B. Dorin (eds), *Agrimonde. Scenarios and Challenges for Feeding the World in 2050*, Versailles: Quae Ed.

CIRAD and INRA (2016) *Agrimonde-Terra: Foresight Land Use and Food Security in 2050*, Short Report of the Foresight, June 2016, Paris: CIRAD and INRA, www.cirad.fr/en/publications-resources/publishing/studies-and-documents/prospective-agrimonde-terra (accessed 18 July 2016)

Conway, G. (1997) *The Doubly Green Revolution*, London: Penguin Books
Crozier, M. and Friedberg, E. (1980) *Actors and Systems: The Politics of Collective Action,* Chicago IL: University of Chicago Press
Da Costa, O.; Warnke, P.; Cagnin, C. and Scapolo, F. (2008) 'The Impact of Foresight on Policy-making: Insights from the FORLEARN Mutual Learning Process', *Technology Analysis and Strategic Management* 20.3: 369–87
de Brabandere, L. and Iny, A. (2010) 'Scenarios and Creativity: Thinking in New Boxes', *Technological Forecasting and Social Change* 77.9: 1506–51
de Jouvenel, H. (2004) '*Invitation à la Prospective. An Invitation to Foresight*', Paris: Futuribles Perspectives
de Jouvenel, H. (2000) 'A Brief Methodological Guide to Scenario Building', *Technological Forecasting and Social Change* 65: 37–48
de Lattre-Gasquet, M.; Le Mouël, C. and Mora, O. (2016) 'Agrimonde-Terra, a Foresight Exercise on Land Use and Food Security in 2050: Scenario-building Method and Conceptual Framework', *Brief* 1, www.foncier-developpement.fr/wp-content/uploads/Agrimonde-Terra-Brief-1-Anglais.pdf (accessed 11 June 2016)
Dorin, B. (2009) 'Agrimonde: Scenarios and Challenges for Feeding the World in 2050', FAO Expert Meeting 'How to Feed the World in 2050', Rome, 24–26 June 2009
Dorin, B. and Le Cotty, T. (2011) 'Agribiom: A Tool for Scenario-building and Hybrid Modelling', in S. Paillard, S. Treyer and B. Dorin (eds), *Agrimonde. Scenarios and Challenges for Feeding the World in 2050*, Versailles: Quae Ed.
FTP (2014) *A Glossary of Terms Commonly Used in Futures Studies*, Rome: Forward Thinking Platform
Godet, M. (1997) *Manuel de prospective stratégique*, Paris: Dunod
Godet, M. (1994) *From Anticipation to Action*, Paris: UNESCO
Griffon, M. (2006) *Nourrir la planète. Pour une révolution doublement verte*, Paris: Odile Jacob
Hatem, F. (1993) *La prospective: pratiques et methods*, Paris: Economica
Hubert, B. and Caron, P. (2009) 'Imaginer l'avenir pour agir aujourd'hui, en alliant prospective et recherche: l'exemple de la prospective Agrimonde', *Natures Sciences Sociétés* 17: 417–23
IAASTD (2009) 'Agriculture at a Crossroads, Global Report', in B.D. McIntyre, H. Herren, J. Wakhungu and R. Watson (eds), *International Assessment of Agricultural Knowledge, Science and Technology for Development*, Global Report, Washington DC: Island Press
IPCC (2007) *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment*, Report of the Intergovernmental Panel on Climate Change, Geneva: IPCC
Labbouz, B. (2014) 'Sécurité alimentaire et futurs de l'agriculture mondiale – comprendre un forum prospectif international en pleine émergence et réfléchir aux façons d'y intervenir', doctoral thesis, CIRED, AgroParisTech
Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: Synthesis*, Washington DC: Island Press

Paillard, S.; Treyer, S. and Dorin, B. (eds) (2011) *Agrimonde. Scenarios and Challenges for Feeding the World in 2050*, Versailles: Quae Ed.

Ritchey, T. (1998) 'Fritz Zwicky, Morphology and Policy Analysis', presented at the 16th Euro Conference on Operational Analysis, Brussels, 12–15 July 1998

Rockström, J. *et al.* (2009) 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity', *Ecology and Society* 14.2: 32

Rosegrant, M.W.; Ringler, C.; Msangi, S.; Sulser, T.B.; Zhu, T. and Cline, S.A. (2008) *International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT): Model Description*, Washington DC: International Food Policy Research Institute (IFPRI)

SCAR (2011) *Sustainable Food Consumption and Production in a Resource-constrained World*, European Commission: Standing Committee on Agricultural Research (SCAR), The 3rd SCAR Foresight Exercise, Luxembourg: EUR-OP

Schoen, A.; Könnöla, T.; Warnke, P.; Barré, R. and Kuhlmann, S. (2011) 'Tailoring Foresight to Field Specificities', *Futures* 43: 232–42

Stomph, I.; Fresco, L.O. and van Keulen, H. (1994) 'Land Use System Evaluation: Concepts and Methodology', *Agricultural Systems* 44: 243–55

Treyer, S. (2011) 'Comment se nourrira la planète en 2050? La place de l'exercice Agrimonde dans la multiplication récente des prospectives agricoles et alimentaires mondiales', *Agronomie, Environnement et Sociétés* 1.2

Van Lente, H. (2012) 'Navigating Foresight in a Sea of Expectations: Lessons from the Sociology of Expectations', *Technology Analysis and Strategic Management* 24.8: 769–82

WHO (2008) *The Global Burden of Disease: 2004 Update*, Geneva: World Health Organization

This page is intentionally left blank