This brief series was developed in preparation for the Foresight Breakout Session of the Global Conference on Agricultural Research for Development (GCARD 2012) and the Global Foresight Hub[1]. The briefs were written to communicate to a wider audience, such as policy makers, civil society organizations, researchers, and funders. The briefs were classified into three categories: Future Studies, Regional Update, and Visioning.

Exploring futures of food and farming systems: the Agrimonde scenarios

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Will we be able to feed nine billion people in 2050? What could be the impacts of our diet patterns future human health and land use? Will the development of biofuels worsen food insecurity? Is agro-ecology able to feed the humankind? In order to anticipate the future challenge of feeding the world in a sustainable way, the two main French agricultural research institutes, INRA[2] and CIRAD[3], launched the Agrimonde foresight project in 2006.

Exploring pathways to feed nine billion people in 2050 in a sustainable way was not the only objective of the project. The results were expected to highlight new research questions and contribute to define research orientations in both institutes. Furthermore, the analysis of the trade-offs in these pathways were meant to fuel national and international food security debates.

To explore the pathways, two scenarios were developed: Agrimonde GO and Agrimonde 1. A panel of experts proposed two sets of qualitative and quantitative assumptions based on their analysis of past trends, a literature review, and driving forces and constraints. The resulting levels of caloric (un)balance were quantified for each region[6] and for the planet. For this purpose, a model called "Agribiom" was specifically designed (for more details, see the section "Lessons learned from the process").

Priority to growth or to the environment?

Agrimonde GO[7] (AGO): feeding the world by making global economic growth a priority

Agrimonde GO is characterized by fast technological advances, trade liberalization and managing ecosystems as a reaction to threats.

Regarding uses of food biomass, in this scenario diets are richer, in particular regarding their animal content, according to the elevation of individuals' income. The world average of per capita food availability increases by 20 percent between 2000 and 2050 (from 3000 kcal/cap./day to 3600 kcal/cap./day), with a share of animal products increasing from 16 percent to 23 percent. Regarding resources of food biomass, in 2050 yields improve by 75 percent thanks to important progress in biotechnologies. The intensification of agriculture is part of a land-sparing strategy. Consequently, cultivated land expands only by 23 percent between 2000 and 2050.

[1]http://www.egfar.org/our-work/shaping-future-together/global-foresight-hub

[2]INRA is the National Institute for Agricultural Research in France.

[3]CIRAD is the International Research Center on Agriculture for Development, based in France.

[4]ANR is the French National Research Agency

[5]IDDRI is the Institute of Sustainable Development and International Relationships.

[6]In the Agrimonde scenarios, the world is split into six regions : Asia, Latin America and the Caribbean (LAM), Middle East – North Africa (MENA), Sub-Saharan Africa (SSA), Former Soviet Union (FSU) and the OECD countries (OECD)

[7]Agrimonde GO is a reprocessing of the Global Orchestration (GO) scenario of the Millennium Ecosystem Assessment. The quantitative assumptions on level of calorie intake, crop yields and cultivated land are all derived from the original scenario.

Agrimonde 1 (AG1): feeding the planet by preserving ecosystems

Agrimonde 1 is the first scenario built with the Agrimonde methodology. It is a normative scenario since it assumes that global sustainable development will be achieved in 2050. The goal of such a strong assumption was to analyze the dilemmas, synergies, dynamics and ruptures that sustainable development entails. Then, Agrimonde 1 can be considered as one illustration of sustainable food and farming systems in 2050. Many other ones could have been proposed according to the different visions of sustainable development.

Sustainability can be achieved in Agrimonde 1 through two main ruptures (see box 1):

• Food consumption – a drastic reduction in both undernourishment and excessive calorie intake. The underlying assumptions are that global per capita food consumption and animal share remain stable, thanks to an increase in per capita food consumption in poorest countries (e.g.+30 percent in Sub-Saharan Africa) and a decrease in the richest ones (-25 percent in OECD countries).

• Farming systems – a change in agricultural paradigm toward the diffusion of ecological intensification[8] practices and technologies in order to enable agriculture to meet growing needs and be a driving force of development, and to be respectful of the environment. Considering the past regional dynamics of agriculture intensification and the potential of ecological intensification practices, the experts envisaged that global crop yields would increase by only 7 percent between 2000 and 2050 in this scenario in spite of substantial increases in LAM, FSU and SSA. In addition, cultivated land expands by 39 percent between 2000 and 2050.

Box 1: Agrimonde 1, a new vision of food and agriculture

Massive public funds towards sustainable agro-food systems and international aid for developing countries are initiated and secured investments in rural areas. They have been accompanied by regional planning and the improvement in supply chain infrastructures as well as services in health, education and training. In addition to the resulting growth of the developing economies, access to food has improved and diets are enriched through diversified food. At the same time, food systems have evolved with the merging of multinational agro-food firms with more local enterprises. In OECD countries, rising health and environmental awareness has boosted existing programs of waste reduction and the implementation of ambitious nutrition policies. The latter has also helped to diminish costs of food-related disease that healthcare systems incur.

Between 2000 and 2050, multilateral initiatives on trade and the global environment have been enhanced. International trade regulations have been implemented principally to enable the least productive countries to develop local markets, and to take environmental issues into account.

The practices of ecological intensification develop thanks to greater attention to end-users' needs through more participatory research programs, but also owing to public policies promoting agriculture multi-functionality and payments for environmental services in the wealthiest countries. These practices have spread through international networks of practitioners.

Food for all, but different paths

In both scenarios, according to the quantitative assumptions on crop yield, land use and level of calorie intake, farmers will be able to produce enough calories to feed 9 billion people in 2050. However, like today, the first barrier to achieve global food security will not be a lack of production but economic access to food.

Indeed, the two different dietary patterns presented in the Agrimonde scenarios result in a huge difference in the need for agricultural intensification: by 2050 the total use of vegetal calories (including wastes, non-food uses and feed) will increase by 90 percent in Agrimonde GO, while only by 35 percent in Agrimonde 1. Therefore, the way farmers will produce our food will greatly depend on our future food habits and waste management.

[8]"Ecological intensification consists in increasing yields by using the ecological and biological functionalities of ecosystems to the greatest extent" (Paillard et al. 2011). Biodiversity and biological synergies are central as in the "agroecological perspective" (M. Altieri, 1998) and the "Doubly-Green Revolution" (M. Griffon, 2006), beside social and development issues.

Moreover, the calorie requirements of the Agrimonde 1 scenario (3000 kcal/cap./day) can be met thanks to a rather low increase in yield (+7 percent between 2000 and 2050), achievable with ecological intensification practices and technologies. Ecological intensification could be an alternative model of agricultural development.

At the regional level, in both scenarios the agricultural potential of Asia and MENA will be constrained by a lack of water and fertile land, while their populations will greatly increase by 2050. Moreover, this situation will worsen because of the adverse effects of climate change on agricultural assets. In the case of SSA, its agricultural potential is still huge but development takes times and this region will not be able to achieve its own self-sufficiency until 2050. As a result, Asia, SSA and MENA should continue to import calories from the rest of the world to feed their own population. The economic access to food of their populations will have to be guaranteed by the development of local opportunities for wealth creation, especially in rural areas.

As structural food shortages are expected in Asia, SSA and MENA in both scenarios, food trade will be necessary to secure regional food needs. But the geopolitical stability of the world will rely on trade regulations in order to prevent exporting regions from putting high political, economic and commercial pressure on importing ones, but also to prevent uncompetitive small-scale farmers from being pushed out of the markets. In addition, trade regulations will be required to encourage producers and other stakeholders of the food chain to reduce their impact on natural resources.

Box 2: What the Agrimonde scenarios tell us

- It is possible to feed 9 billion people until 2050. Global food security in 2050 is primarily a matter of food access, not of agronomic potential
- Diets and waste are key determinants of resource-use balances of food biomass
- Ecological intensification could be an alternative model of agricultural and rural development
- Food trade will be necessary to secure regional food needs, but social and environmental sustainability will require the implementation of trade regulations

The Experts and the Model: tying the knot

The Agrimonde methodology combined the qualitative analysis of a panel of experts with a soft modeling provided by the Agribiom quantitative tool.

The quality of the outcomes of the panel of experts was a result of the variety of backgrounds, skills and disciplines represented and of their early involvement in the process: from the validation of the methodology, to the development of scenario assumptions, to the consistency analysis. Relying on a small group of experts (15 to 20) also simplified the logistics (e.g. frequency of meetings, rate of participation, working papers reviews).

During this first round of the Agrimonde project, the experts involved were French. Because of the scope of the study, more international scientists are expected to be involved in the second round in order to widen the plurality of visions of the world. International stakeholders could also be asked to discuss the future scenarios once they are developed.

The Agribiom model has been designed to facilitate the expert understanding of the quantitative part of their scenarios. Its first quality is to rely on a very reduced number of variables to calculate the physical balances between future resources of food biomass (cultivated land, pasture area, crop yield, net imports…) and uses of biomass (population, per capita consumption, feed for livestock, wastes…). This way, each variable could be quantified by the experts after an in-depth analysis of past trends, future constraints and the literature review. Its second quality and originality lies in its interface, which allows the model to be used during the expert meetings and for the quantitative assumptions of the scenarios to be adjusted.

Finally, this methodology turned out to be an efficient way to propose new rupture scenarios to the foresight community. It could be interesting to reprocess them with the more sophisticated models that exist. For example, for the Agrimonde 1 scenario, it could be of great interest to assess the level of food prices of such a scenario in 2050, as well to quantify its water and energy uses, or its greenhouse gas emissions.

Box 3: What makes Agrimonde remarkable

- A large diversity of disciplines and a plurality of visions of the world represented in the panel of experts
- A modelling tool (Agribiom) with a friendly interface, transparent and easily understandable by the experts
- An iterative process between the panel of experts and the Agribiom model

Agrimonde, the follow-up

The Agrimonde study has become a landmark study in the foresight community. Since its publication, the Agrimonde scenarios have been cited and commented on in various scientific articles. The controversies provoked by the Agrimonde scenarios about their plausibility and environmental impacts have also contributed to structure the food security debate. The foresight study has been presented and discussed in political circles (e.g. the French Ministry of Agriculture), the French research community, international organizations (e.g. FAO, IFPRI, OECD, World Bank) and French civil society organizations. Another indicator of its large diffusion are the numerous articles published in French and international media and on websites.

The Agrimonde foresight study coincided with the 2007/08 food crisis and consequently in a context of renewed attention to food security issues. It is difficult to evaluate the extent to which the Agrimonde project induced the introduction of food security issues in the research agenda of agricultural research institutes like INRA and CIRAD. However, it would be safe to assume that it helped to clarify research questions on this topic. The Agrimonde project has certainly been an important incentive to launch new projects on sustainable food issues as well on the links between food security and animal production, between food security and climate change and between food security and land use.

A follow-up of the project is expected with the launching of a new round: Agrimonde-Terra, focused on food security and land-use change.

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