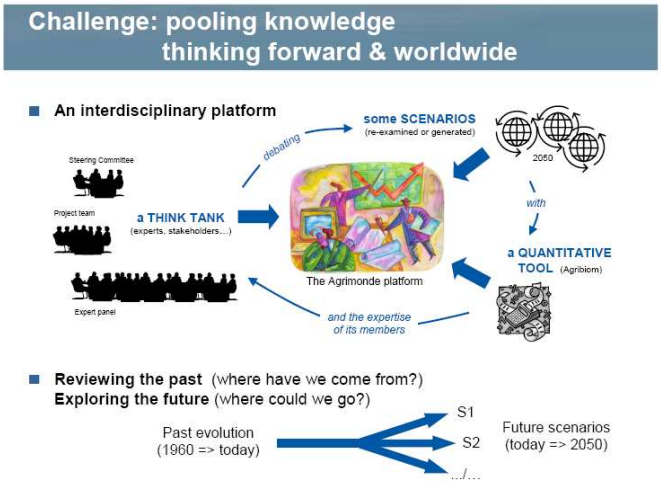
Agrimonde
Scenarios and challenges for feeding the world in 2050

Press conference, Paris, 12 January 2011

Part I – Bruno Dorin (CIRAD)

Agrimonde is a foresight exercise, where we try to imagine different possible states of food and agriculture in 2050 in order to better understand and debate where we would like to go in the future, and how. It's a brainstorming exercise, a forum for discussion, whose primary ambition is not to answer questions, but to raise, share and debate on what we hope are good questions, both for our research institutions and the rest of the society.



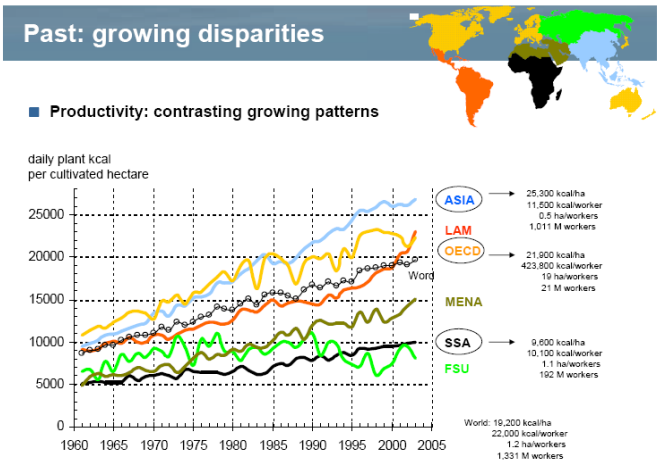
Agrimonde is a three-component platform: a think-tank, debating some scenarios, with a quantitative tool and the expertise of its members.

(1) The think-tank gathered experts from different fields and institutions. These experts met almost once a month for more than 2 years, in Paris or Montpellier

(2) The scenarios we choose to work on are only two in number while we could have explored many others. These scenarios show two very different views on the future. We called them "Agrimonde 1" and "Agrimonde GO". In the second part of this talk, Sandrine will present you these scenarios and what we learnt from them

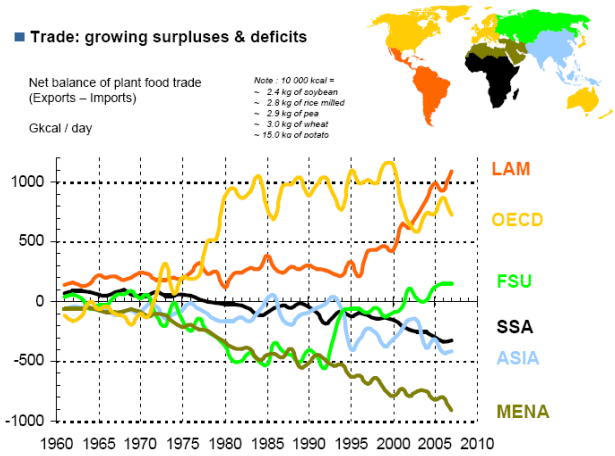
(3) The name of the quantitative tool we used is "Agribiom". Agribiom was designed for analysing and debating past and future production, trade and utilisation of food biomass, from a single country to the whole world. It's not an economic model. With Agribiom, you give your assumptions on consumptions, yields, cropped areas, etc., and it tells you if there is a global equilibrium between all regional supplies of edible biomass and their use as food, feed, seed, agrofuels, etc. This equilibrium is in kilocalories. The use of this unit led us to convert and aggregate in calories millions of data from the FAO. In other words, the estimates in calories that you'll see in this presentation as well as in the book are unique.

Let's go now to the heart of the subject. Before exploring the future, it was important for the Agrimonde team to first review the past, together, and worldwide. We worked on the scale of six regions delineated by the *Millennium Ecosystem Assessment* => Sub-Saharan Africa, Asia, Former Soviet Union, Latin America, Middle East & North Africa, OECD countries in 1990.

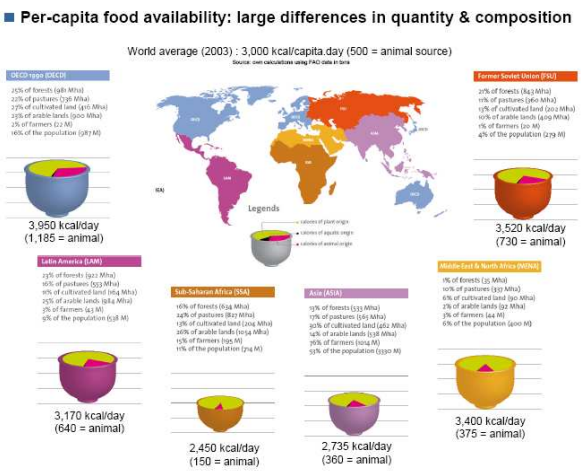


With 3 graphics only, I will try to show you progresses but also growing disparities amongst regions since the beginning of what we can called the "modernization of agriculture". Since the 1960's, the world population doubled but the average per-capita of food calories increased from 2500 to 3000 kcal => it's really an amazing accomplishment, hard to believe 50 years ago! As you know, it did not solve under and malnutrition, but the Malthusian prediction proved to be wrong. Science and technology really help to eradicate large-scale famines. Cheap oil too, for processing fertilizers and pesticides, pumping water, making and using roads, tractors and combine harvesters, transporting inputs and food, etc.

This first graph shows you how has increased the production of plant food calories per hectare => tremendously in Asia, as you can see, from less than 10,000 kcal a day in 1961 to more than 25,000 today. This "green revolution" combined high-yielding seeds for a few plant species with massive use of fertilizers and irrigation. Irrigation helped not only to increase crop yields but also the number of crops per year. But unlike in OECD, the chemicalization of agriculture with fertilizers and pesticides was not accompanied by a motorization with tractors and combine harvesters. In Asia, it would have taken the job of hundred millions of poor farmers and pushed them into urban shantytowns that are already crowded. Motorization of agriculture is a key variable to understand the striking difference between OECD agriculture and the rest of the world. Today, in OECD, each farmer produce everyday more than 400,000 kcal while this figure is below 12,000 in Asia or Africa. In Asia and Africa, we now have one billion farmers working with less than 1 ha on average.



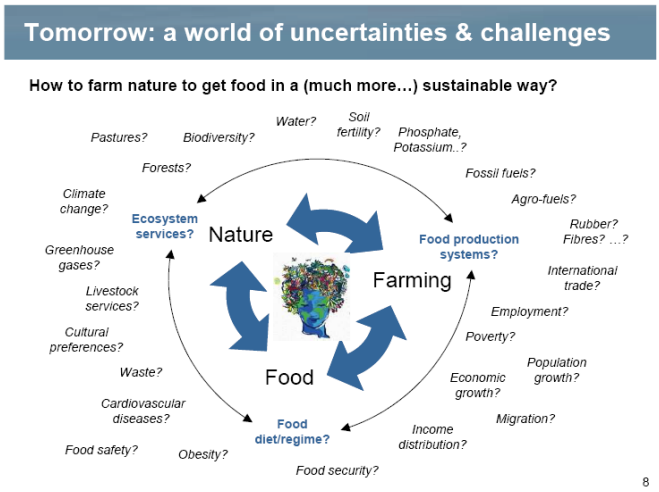
This second graph shows you how the net trade balances of plant food calories have evolved over 50 years. You see growing surpluses of food calories in LAM, OECD and FSU, and growing deficits in other regions. I will comment this graphic by just saying that despite this boom of food trade clearing surpluses and filling some deficits, and despite the boom of food yields as shown before, there are still striking differences in food consumption at the beginning of the 21st century, as shown in the next slide.



The bowls drawn on this slide show you what are the today's averages of food availabilities in total kilocalories per capita => almost 4000 per day in OECD but less than 2500 in SSA. These averages are problematic in both regions:
(1) in SSA, we are well below the level of 3000 under which, according to the FAO, there is a higher probability of having people suffering from hunger
(2) in OECD, we are well above what human-beings really need and ingest, which is between 2000 and 2500 kcal/day, depending on age, sex, size and physical activity. Here, we have in fact an important waste of food, which is also a waste of fertilizer, water, pesticide, fossil fuel, and of all other rare resources used to produce and process food.

Moreover, in OECD countries, you can see that about 1,200 kcal out of 4,000 (30%) are today provided by animals, that is to say in the form of milk, meat and eggs. Such a high consumption level of animal food may not be so good for health, as many studies suggest it, while in Africa and Asia, poor families would certainly enjoy consuming more milk, meat and eggs. Besides, according to our

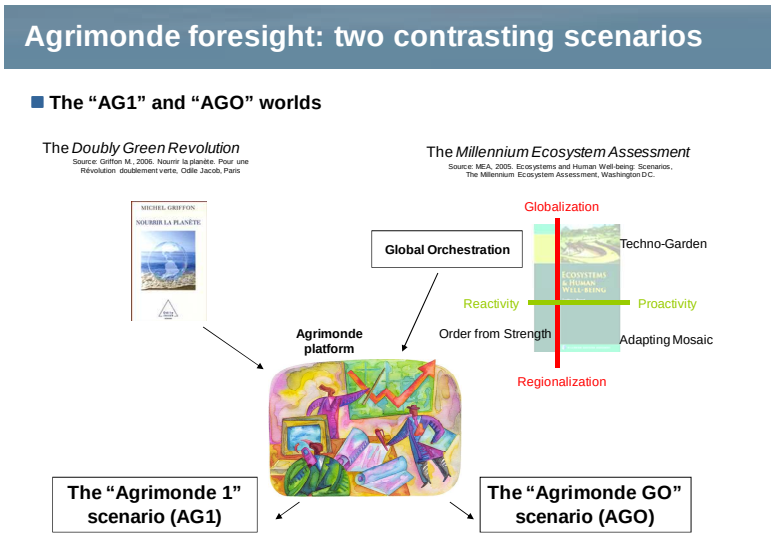
own calculations, OECD countries use today about 3 kcal of plant food such as cereals or oilseeds to produce 1 kcal of animal food => in other words, the 1 200 kcal of animal food in OECD represent three times more kcal in plant food equivalent, and therefore as much water, fertilizers and pesticides to produce these crops.



Are the past trends that were shown before really sustainable? Socially? Economically? Environmentally? Past yield increase help to save forests and to provide cheap calories to a vast majority of people, but it did not solve malnutrition and seriously threaten ecosystem services. In many part of the world, we observe erosions of biodiversity, of soil fertility, groundwater depletion, pollution by nitrates and pesticides, etc. The “modern agriculture” of the past 50 years relies also on a massive use of non-renewable resources such as fossil fuels, phosphate or potassium, whose prices will be much higher in the decades to come. Motorization boosted labour productivity and food surpluses of some countries but how can the billion of very small-scale farmers concentrated in Asia and Africa escape from poverty? How can they produce more and diversified food for themselves as well as for urban citizens which now represent more than half of the world population? What will be the economic and population growths in these developing countries? Will there be huge local and international migrations due to poverty? What additional production of plant food is required to meet the increasing demand for eggs, meat and milk? Will we have enough land to produce this food but also agrofuels, fibres, rubber and many other non-food products? Can agriculture and agro-industries release less methane, nitrous oxide and carbon dioxide into the atmosphere while preserving carbon and biodiversity pools in forest and pasture lands? What will be the impact of climate change on agriculture and international trade?

All these future uncertainties and challenges have been subject of hot discussions during more than two years within our Agrimonde group. From these discussions emerged two scenarios, two contrasting visions of food and agriculture in 2050.

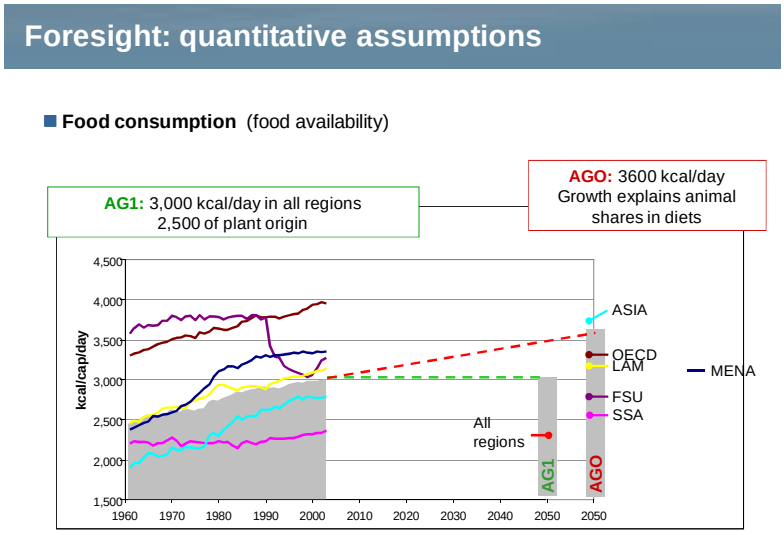
Part II – Sandrine Paillard (INRA)



After the presentation by Bruno which gave you an overview of the world food economy, I will now turn to the 2 scenarios we have developed. We named the first scenario "Agrimonde 1" (AG1) In this scenario, the world in 2050 is characterised by sustainable development. Sustainability means here a drastic reduction of both under-nourishment and excessive calorie intake and for farming systems, a move towards ecological intensification. It means that agriculture will have to meet three challenges:

1: to meet growing needs,
2: to be a driving force of development and
3: be respectful of the environment.

We chose to build a second scenario by adapting Global Orchestration which is one of the scenarios of the MEA, the international assessment on the ecosystems. We chose GO because it is a trend-based scenario, which provides a good reference point. In this scenario, technological advances are very fast, trade is further liberalised but the preservation of the environment is not a priority. We named this scenario "Agrimonde GO" (AGO).



I won't enter into the details of our assumptions except for diets since AGO and AG1 show very contrasting patterns, as shown on the slide. For AGO, economic growth explains consumption trends; as you can see on the graph, the red line representing per capita consumption at the global level. In AG1, in 2050 the

per capita food consumption at the global level will be roughly the same as today but - unlike today - it will be equal in all regions. It means a reduction of 25% of food consumption in OECD and an increase by 30% in Sub-Saharan Africa between 2000 and 2050.

■ **Resource-use balance**

Quantitative scenarios (2000-2050)

		World	AGO	AG1
Use		Population	+47%	
Use	Consumption	Kcal/cap/day	+20%	stable
Use	Consumption	Animal share	from 16% to 23%	stable
Resource	Land use	Cultivated land 1961-2000 : +4 M ha per year	+ 23% + 7 M ha per year	+ 39% +12 M ha per year
Resource	Land use		11% non food	
Resource	Land use	Forest	stable	
Resource	Land use	Pasture	+7%	-15%
Resource		Yield 1961-2000 : +2% per year	+ 75% +1,14% per year	+7% +0,14% per year

In both scenarios, at the global level, resources meet needs in 2050

But 3 regions remain net importers of food calories : SSA, MENA, ASIA

I will now turn to the complete and worldwide scenarios. In both scenarios the world population will have increased by almost 50% between 2000 and 2050. Per capita food consumption will have increased by 20% in AGO, with a share of food from animal increasing from 16 to 23 %. In contrast, per capita food consumption and the animal share will have been stable in AG1. On the resource side, cultivated land will have increased much faster in AG1 with 12 million hectares of new cultivated land per year (mostly in SSA and LAM) compared to a growth of 7 million per year in AGO. In AG1, land conversion to food crop has been the principal means of increasing production. In contrast, in AGO yields have been the driving factor. The increase in Yield has been very fast in this scenario: +1.14% per year over 50 years against 0.14% in AG1. What is the output of these evolutions in terms of resource-use balance? In both scenarios food resources meet needs in 2050. But 3 regions remain net importers of food calories: SSA, MENA, ASIA

Main conclusions

The planet can properly feed 9 billion people in 2050 but it will depend on…

■ **What is on our plates**

…and what is lost before & after reaching our plates

■ **Food trade under 2 conditions :**

- fair & secure trade regulation system with environmental regulation
- local wealth creation

■ **Ecological intensification**

- technological innovation,
- spatial re-organisation,
- social change

Diets (and waste) are key determinants of resource-use balances

World	AGO 2050	AG1 2050
Food consumption per cap. & per day	+ 20%	stable
Animal share	23%	stable (15%)
Total use of plant cal. (Gkcal/day) (28,100 in 2000)	53,600 (+90%)	37,600 (+35%)

I'd like now to highlight the main conclusions we can draw from this scenario building.

First conclusion: in 2050 as it is today, the main challenge behind food security won't be a question of lack of production but will remain a problem of access to food by the poorest populations. The

planet can properly feed 9 billion people in 2050, but the way it will do it (regarding sustainability criteria) will greatly depend on the content of our plates and on what is lost before and after reaching our plates.

Our second conclusion is then that diets and consumption patterns (including waste) are key determinants of resource-use balances:
- In AGO, the increase of 20% of per capita food consumption implies an increase by 90% of the total plant production.
- In AG1 where per capita consumption remains stable at the global level, the increase in production is limited to 35%.
These figures can be compared to the figure that FAO proposed in 2009 with the expectation that food production will have to increase by 70% by 2050.

Third conclusion: Food trade can secure regional food needs. The rationale behind this result is twofold.
- On the one hand, natural resources are not distributed in the same way as the human population. This is especially true for MENA and ASIA which have limited production potential.
- On the other hand, trade can secure regional food needs because development takes time. This is especially true for Sub-Saharan Africa.
Food trade is necessary to secure regional food needs on two conditions.
1: a fair and secure trade regulation system must be established, combined with environmental regulation
2: local opportunities for wealth creation must be developed to guarantee access to food and in many developing countries these opportunities are mainly to be found in agriculture.

Thus our fourth conclusion is that present and future investments in agriculture in developing countries will have a dramatic impact on food balances and on our ability to end undernourishment. This conclusion is particularly strong for Africa which will experience the steepest increase in population by 2050.

Fifth conclusion: to be sustainable, Agrimonde 1 requires radical innovations in farming systems. These innovations will be necessary to maintain yields while using much less chemical fertilizers and pesticides in OECD or ASIA. They will be necessary to increase yields in spite of climate change in regions such as MENA or LAM. These innovations are also required to overcome biodiversity loss and GHG emissions caused by large land conversion. Whatever happens, AG1 must be seen as a scenario of radical innovations and these innovations in S&T are strongly related to innovations in spatial and social organisation. For instance, agro forestry, which mixes forest and crop, may be developed to limit biodiversity loss or to optimise water management. As for social change, farmers in Agrimonde 1 are remunerated for the goods they produce but also for

maintaining ecosystem services, such as landscape, water resource regulation, carbon storage, biodiversity…

As a final conclusion, the 70% increase in food production put forward by the FAO is a business-as-usual scenario. As our study shows, other scenarios are possible and must be explored since levers of change exist to act on our diets and consumption patterns, on production (through investment and innovations) and on trade.