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Analysis

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FOOD

Demand for food in 2050: figures, uncertainties and leeways[1]

"By 2050, global agricultural production must increase by 70%, and double in the developing world, in order to meet the demand from a population of nine billion". This assertion, based on the work of FAO, is frequently brought out in debates on food security, usually without making it clear that this is simply a conjecture based on a number of assumptions. However, other strategic foresight studies exist and comparison of four of these reveals a wide range of estimates of future demand for food, and especially for animal products. These differences stem from very different hypotheses for major variables: demographics, economic growth and dietary regimes. Substantial uncertainty surrounds each of these, radical shifts are possible, and means do exist that can be brought to bear. The changing level of demand for food is also responsive to more immediate issues such as public health, the environment and development. Although the question of how to increase food production to meet future demand is often asked, it is equally crucial to look at how that demand can be shaped.

Will we be able to feed tomorrow's world, and cope with the growth in population and the increasing scarcity of natural resources? The food crisis in 2008 helped reawaken our fears of insufficient supply and brought this long-standing issue back into the spotlight. While the figure of a 70% increase in agricultural production based on the FAO analysis is often a starting point in current reflection on the question, several recent exercises in strategic foresight analysis suggest rather more mixed results. The purpose of the present note is to compare, contrast and comment upon the changing demand for food in the world anticipated by those analyses.

Following a description of the differences in approach between these exercises, the first part of this note summarises the possible changes in demand over the period to 2050. The purpose of the second section is to arrive at a better understanding of the source of the differences in outcomes. And finally, the last section covers various means for action, some of which are already being used in certain countries.

1 - Different approaches and a wide range of estimates of future food demand

This note compares four foresight studies on food security over the period to 2050. The most recent FAO *Outlook*[2] is a predictive exercise based on extrapolation of current trends. The other approaches use the scenario method, which builds very different pictures of the future, identifying the major variables and levers for change where food security to 2050 is concerned. The Agrimonde (INRA-CIRAD)[3] foresight analysis constructs two scenarios and simulates their quantitative consequences for food supply and demand: AG0, considered as a baseline scenario matching current trends (and based on the *Global Orchestration* scenario of the *Millennium Ecosystem Assessment*), and AG1, a normative scenario describing a transition to sustainable food demand and agricultural production (through a "doubly green revolution"). As for the Institute of Social Ecology in Vienna (ISV), this sets out to compare and contrast four food consumption hypotheses (one based on the trends, along FAO lines, and three hypotheses with specific differences in terms of consumption of animal products), applying a range of contrasting assumptions for agricultural land and yields[4]. And lastly, the International Food Policy Research Institute (IFPRI)[5] proposes three scenarios for agricultural policy and analyses their effects in terms of economic development: a scenario with strong political engagement (*progressive policy*) in favour of rural and agricultural development, resulting in strong economic growth; a scenario involving political failure (*policy failure*) resulting in crises, a return to protectionism and slower growth; and, lastly, a scenario based on technological failure (*techno failure*) in which low yields and environmental damage result in declining income levels and weak economic growth.

Looking beyond such differences of objective, these reports also differ in the methods they apply to arrive at their quantitative estimate of the food supply

1. A forthcoming note by the Centre for Studies and Strategic Foresight will look in addition at the various scenarios for *food supply*, in particular in terms of production systems, changing yields and expansion in land used for crops.
2. J. Bruinsma, 2010, *The resource outlook to 2050. By how much do land, water use and crop yields need to increase by 2050?*, FAO. ftp://ftp.fao.org/docrep/fao/012/ak971e/ak971e00.pdf.
3. INRA, CIRAD, 2009, *Agrimonde. Agricultures et alimentations du monde en 2050: scénarios et défis pour un développement durable*. [Agrimonde. World farming and food in 2050: scenarios and challenges for sustainable development]. http://www.paris.inra.fr/prospective/projets/agrimonde.
4. Institute of Social Ecology, Vienna 2009, *Eating the Planet: Feeding and fuelling the world sustainably, fairly and humanely - a scoping study*. http://www.uni-klu.ac.at/socec/downloads/WP116_WEB.pdf.
5. IFPRI (2005), *New Risks and Opportunities for Food Security Scenario Analyses for 2015 and 2050*. http://www.ifpri.org/sites/default/files/pubs/2020/dp/dp39/2020dp39.pdf

required over the period to 2050, especially in the manner in which they take the economic parameters into account. IFPRI and FAO use models in which price is an endogenous variable: tension between supply and demand leads to rising prices; this reduces demand, increases production and leads to a point of "balance". While this integration of the price factor is interesting, most models already have trouble accounting for the present-day operation of markets and their sources of instability. The use of such tools with a horizon in 2050 should therefore be considered with some caution, especially as by its very nature such an approach rules out the possibility of radical breaks in continuity and global food system reconfiguration. As for the Agrimonde and Vienna Institute foresight studies, these use biomass models to calculate how demand and production balance out on the basis of assumptions as to yield, areas under crops and dietary regimes. The task is then, in a second stage, to look at the economic and political conditions that allow such scenarios actually to come about[6].

The various scenarios used expect increases in global food demand between 2000 and 2050 to be possibly in the range + 40% to + 68% in calorie terms, according to a range of assumptions for population, diet and food waste, assumptions which are themselves dependent in part on the changing economic, political and social context (cf. Table 1).

2 - Major uncertainties preventing prognostication

All the foresight studies examined here take only limited consideration of demographic uncertainties and their complex links with economic growth and consumption .

Most go no further than to apply the United Nations' central variant for population growth: 9.1 billion people in 2050, representing a 43% increase over 2005. However, the variation in such predictions in fact ranges from 8 billion to 11 billion by 2050, the precise figure being dependent on a highly diverse range of assumptions as to fertility and mortality rates. Moreover, between 1994 and 2002, the central variant for the 2050 horizon was revised downward by nearly one billion, thus pointing up the lack of robustness of this type of projection[7].

If the various demographic hypotheses by IFPRI (an increase of 26% to 49%) are taken into account, this helps smooth the effects of differing demographic and nutrition transitions: scenarios based on strong economic growth and food consumption are also scenarios involving low population growth (8 billion people in 2050). Conversely, scenarios based on more limited economic growth and consumption are coupled with high population growth (9.56 billion). While these combinations of assumptions seem reasonable, they nevertheless fail to cover all the probabilities. Indeed, the most recent UNDP report[8] notes that the correlation between rate of growth and improvements in health and education, major determinants for population growth, is "*surprisingly weak*". It is therefore possible to imagine strong economic development going hand in hand with sustained population growth, but also with weak growth coupled with a decline in fertility (with for example improved access to contraception in some developing countries).

Changing levels of inequality have a major but complex impact on the distribution of consumption, on its median level and on levels of malnutrition. Food insecurity depends by its very nature[9] on a combination of average food availability and its allocation between the various economic categories in the population, which will in turn depend on inequality. The more unequal a society, the greater in principle food insecurity will be for the same average diet. For example, at the same stable level of average food consumption of 3,000 kcal in 2050, IFPRI would expect greater food insecurity due to a worsening of inequality, whereas the Agrimonde AG1 and ISV *Less Meat but Fair* scenarios hypothesise a lessening of inequality, allowing a reduction in global food insecurity. Furthermore, the relationship between inequality and diet are complex. In some quarters it is felt that rapid growth in the income of the poorest households would be reflected in higher demand for food in the short term, while a scenario involving "unequal" income growth would entail a less marked increase in food demand in the short term, although extending into the

6. M. Reilly, D.Willenbockel, 2010, *Managing uncertainty: a review of food system scenario analysis and modelling,* Philosophical Transactions of the Royal Society. http://rstb.royalsocietypublishing.org/content/365/1554/3049.abstract.
7. C. Laisney, 2009, *9 milliards d'habitants à nourrir en 2050 : est-ce si sûr ?,* [Nine billion people to feed by 2050: can we be so sure?] Centre for Studies and Strategic Foresight. http://agriculture.gouv.fr/IMG/pdf/Note_veille_28.pdf
8. UNDP (2010), The Real Wealth of Nations: Pathways to Human Development. http://hdr.undp.org/en/reports/global/hdr2010/
9. Cf. the calculation method employed by the FAO to estimate levels of food insecurity.

Table 1 - **Estimates of food demand to 2050, taking all calorie sources - plant or animal - together**

Data source	FAO 2009	Agri-monde GO	Agri-monde G1	CIWF *trend*	ISV *higher meat*	ISV *less fair meat*	ISV *less meat*	IFPRI *progressive policy*	IFPRI *policy failure*	IFPRI *techno failure*
Increase in population 2005-2050	43%	43%	43%	43%	43%	43%	43%	26%	49%	49%
Change in individual and mean demand for food	+ 11,4%	+ 19%	Stable	+ 7%	+ 14%	Stable	+ 7,6%	+ 30%	+ 5%	Stable
Change in individual and mean demand for food of animal origin	+ 40% (37 to 52 kg/per person/per year)	+ 78% (500 à 892 kcal/person /day)	Stable (around 500 kcal/ personn/ day	+ 7% (457 to 489 kcal)	+ 48% (457 to 678 kcal)	− 49% (457 to 233 kcal)	− 21% (457 to 360 kcal)	+ 54% (37 to 57 kg/person /year)	Stable	− 14% (37 to 32 kg/person /year)
Overall increase in food requirement by 2050 (Kcal)	+ 58%	+ 68%	+ 40%	+ 54%	+ 63%	+ 44%	+ 54%	+ 64%	+ 58%	+ 52%

Source: Extracts from the reports cited; calculations by the authors.

longer term[10]. Conversely, the more normative Agrimonde and ISV scenarios envisage a reduction in inequality leading to a convergence of food intake between developed and developing countries, the ultimate outcome being lower global demand for food.

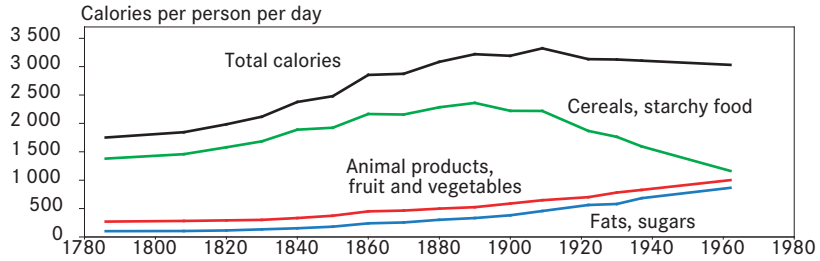
The variance in the hypotheses for mean individual consumption ranges between stabilisation and an increase of nearly 30%. Moreover, this average change masks even bigger differences in the consumption of products of animal origin, which varies between – 50% and + 80 % depending on the foresight study. However, between 3kg and 14kg of plant products are required to produce 1kg of meat (depending on production type and system). Looking beyond the change in the average calorie intake, this will also affect the demand for animal products, which in turn will entail a major impact on future agricultural production.

Such variance stems essentially from differences in the assessment of **the relationship between economic growth, urbanisation and the adoption of a westernised diet rich in fats and animal products.** This is a phenomenon that has indeed been observed in a number of countries and referred to as the "nutrition transition" by analogy with the "demographic transition" (cf. graph 1). Whether it occurs early, as was the case in England, or a little later, as in the countries of Southern Europe, the nutrition transition came to completion during the second half of the 20th century in most of the developed world. It is now spreading to the developing world[11].

However, there is nothing deterministic about this given that very different levels of meat consumption are observed at the same level of development (cf. graph 2). The Chinese nutrition transition for example has been advancing more swiftly that in Europe. Since the 1980s, meat consumption per capita of the population has increased fourfold, milk consumption tenfold and egg consumption eightfold. Per-capita consumption of products from livestock farming has also increased markedly in the rest of East and Southeast Asia. On the other hand, cultural and religious preferences can hold back nutrition transition, and more particularly the rise in meat consumption. This has been the case in Japan, a highly developed country but one that consumes very little meat[12]. It is also true of India, where vegetarianism linked to Hinduism continues to be important and may also be a way of resisting westernisation[13]. However, increasing consumption of milk and butter there will require the raising of cattle. From the general standpoint, given its demographic importance, changes in Indian dietary patterns will have a major impact on world food demand.

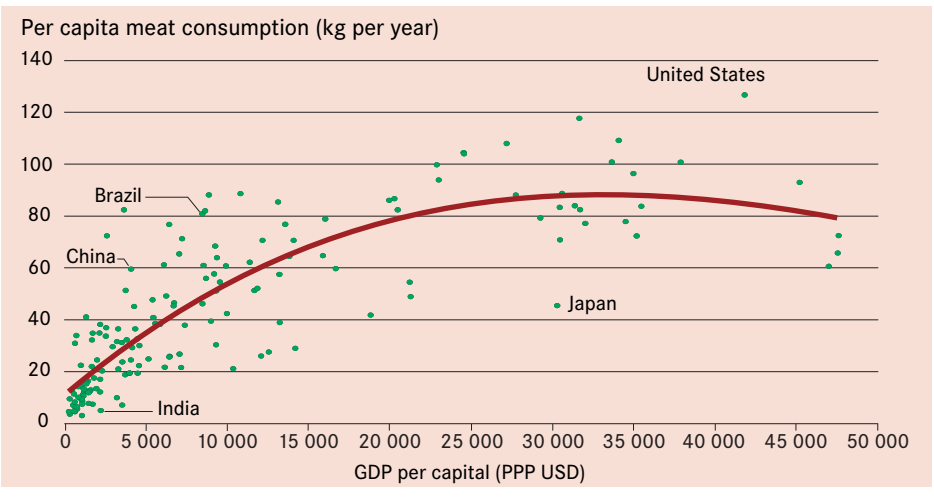
While the nutrition transition has occurred very rapidly in some emerging countries, there is no reason to assume that other major shifts will not come about between now and 2050. Indeed, a second nutrition transition is to be seen in the developed world: well-off categories in the population and the upper middle social classes are usually the first to assimilate messages on healthy nutrition and reduce their consumption of fats and meat, and the other social groups often adopt their patterns of consumption, after a time lag. Several factors might therefore foster a growing awareness of the health impact of diets excessively rich in meat products: rising incomes, longer life expectancy (the longer this is, the more long-term concerns are taken into account, and therefore the benefits of a healthy diet) and rising educational level in the population (which should be a particularly powerful factor in China and India[14]).

Graph 1 - **Changing levels of energy input in France**



Source: P. Combris adapted from J. C. Toutain.

Graph 2 - **GDP and meat consumption per capita and per country in 2005**



Source: FAO, SOFA 2009.

3 - Real room for manoeuvre for shaping demand

Improved access to contraception and education and the provision of social safety nets are effective tools for **accelerating the demographic transition**, even in countries with weak economic growth. Based on an analysis of human development trajectories that are very different, and only

10. X. Cirera, E. Masset, 2010, *Income Distribution Trends and Future Food Demand*, Philosophical Transactions of The Royal Society.
11. P. Combris, 2006, "Le poids des contraintes économiques dans les choix alimentaires", [The influence of economic constraints on dietary choices], *Cahiers de Nutrition et de Diététique*.
12. Thus is however offset by very high consumption of fish.
13. B. Sebastia, 2010, "Be a vegetarian! Discours en Inde sur les bienfaits du végétarisme pour un corps pur et sain", [Speech in India on the Benefits of Vegetarianism for a Pure and Healthy Body], *Le Mangeur Ocha*. http://www.lemangeur-ocha.com/fileadmin/images/sciences_humaines/Be-a-vegetarian.pdf
14. http://www.demographic-research.org/Volumes/Vol22/15/

weakly correlated with economic changes, the most recent human development report thus confirms that such development is different from economic growth and that substantive results are possible even in the absence of rapid growth[15]. Effective, ambitious development policy based on strong institutions and focused on education and health plus a reduction in inequality between countries and within countries are claimed to be able to exert a major influence over demographic development over the period to 2050 and, by the same token, on world food requirements.

It seems unlikely that dietary choices can be changed massively on the basis of environmental considerations, especially in developing countries. Conversely, **the strong and increasingly widely acknowledged link between the nutrition transition and public health issues is likely to lead to radical shifts.** In Europe for example recent history shows that information on nutrition can play a major role in dietary choices. Thus from the 1980s on, scientific publications on the health impact of cholesterol in food has influenced consumption of certain products of animal origin (red meat, butter, eggs, whole milk). Whereas previously the level of consumption was moving in the direction of the highest-consuming countries (i.e. around 40% of calories from animal sources in the diet), it now seems to be stabilising at around 25% to 30% (cf. graph 3).

For this reason, a shift in the trend scenario in the emerging countries is not unlikely in view of the health issues already becoming obvious there with the adoption of diets richer in animal fats, sugars and salt (cardiovascular disease, diabetes, hypertension). In China today nearly 25% of the adult population is overweight or obese. The cost of this epidemic is estimated at between 4% and 8% of China's GDP[16] and its foreseeable spread constitutes a serious threat to the public health system. It is difficult to imagine trends of this kind continuing without policies being put in place to curb them. Some countries have already become aware of the problem, among them Brazil where 49% of the 20+ age group are overweight. Numerous steps have been taken to teach children about healthy diets from the very youngest ages[17].

One final area offering room for manoeuvre is the reduction of waste. The demand for food calculated in the various strategic foresight studies includes wastage and losses throughout the food supply chain. A UK study estimates that a quarter of all foodstuffs purchased by households end up in the bin[18]. The equivalent percentage in the USA is said to be 30%. Only Agrimonde scenario AG1 assumes a reduction in wastage and this paves the way for the stabilisation of mean individual demand for food.

There are however several ways of reducing wastage or promoting the recycling of unconsumed foodstuffs. Public policies are being implemented with this in mind in the United Kingdom on the website www.lovefoodhatewaste.com and more recently in the Netherlands, where the Ministry of Agriculture, Nature and Food Quality has set itself the target of reducing waste by 20% by 2015. In France, actions on this topic are planned under the National Food Programme launched in September 2010: collection of fruit and vegetables on street markets, consumer education, research to enable more accurate measurement of the phenomenon and assessment of potentially recoverable types of waste.

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Although increasing demand for food appears ineluctable, the range of estimates for that increase over the period to 2050 is nevertheless wide. The field of probabilities is even broader where the consumption of animal products is concerned, and this has a major influence on agricultural demand. While it is of course necessary to act on supply, it is also important to make use of the means for avoiding the least sustainable demand scenarios combining major population growth and rapid nutrition transition. There is genuine room for manoeuvre to avoid just that: development policies to provide access to education and contraception, nutritional policies to guide dietary choices towards more sustainable, healthier consumption, combating loss and waste, and so on. Such action to control demand constitutes a "no regrets" strategy enabling more than one issue to be addressed simultaneously (environment, food security and public health). For that, it is necessary for countries to make such considerations part of their development strategies. A dynamic worldwide diet observatory could in this way make it possible to monitor more effectively the rate and the nature of nutrition transitions, their impacts on public health, to compare projections and actual changes in consumption, to measure changing levels of waste and to share the lessons learned from policies directed at reorienting such trends.

15. UNDP, *op. cit.*
16. B. Popkin, 2008, *Will China's Nutrition Transition Overwhelm Its Health Care System And Slow Economic Growth?* , Health Affairs. http://content.healthaffairs.org/cgi/content/abstract/27/4/1064.
17. Chamber of deputies, bills against obesity. http://www2.camara.gov.br/agencia/noticias/SAUDE/noticias/SAUDE/150524-CONHECA-ALGUNS-PROJETOS-DE-LEI-QUE-VISAM-COMBATER-A-OBESIDADE.html.
18. WRAP, 2009, *Household Food and Drink Waste in the UK*. http://www.wrap.org.uk/retail/case_studies_research/report_household.html.

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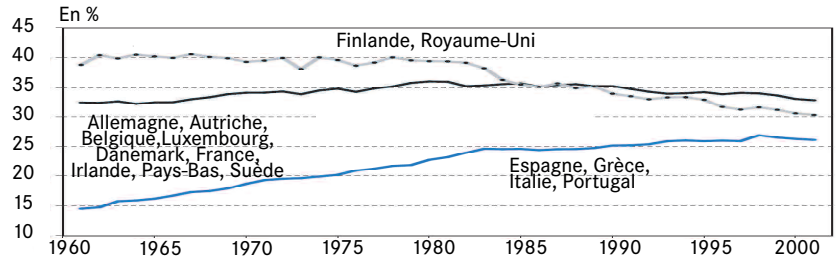
Graph 3 - **The percentage of animal-sourced calories in the diet of various European countries**



Sources: P. Combris, adapted from FAO Stat, DUALINE INRA working document.

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