Towards sustainable world food systems: drivers, key issues and research needs.

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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.

Towards sustainable world food systems: drivers, key issues and research needs

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How will it be possible to feed the world's growing population through the 21st century?

To date, the sustainability of food systems has been considered in terms of the challenges facing agriculture, but few studies have been conducted regarding sustainability of food chains from the farm gate to the consumer's plate.

In 2009, INRA and CIRAD launched the 'Dualine' project to study the evolution of world food systems from farm gate to the final consumer. The analysis focused on the contribution of food systems to the pillars of sustainability. Food sustainability is multi-dimensional and involves social, economic, environmental and health issues. Social issues concern inequalities, governance of the food system, food availability and cultural issues. Economic issues relate to firm profitability, employment and regional development. Environmental issues relate to pollution, greenhouse gas (GHG) emissions, biodiversity and resource consumption. Finally, health issues relate to the impact of diets such as undernutrition, obesity or deficiencies, as well as food safety issues.

The objectives of the project were to: make an inventory of the main drivers of the past and future evolution of food systems; specify the critical points of food systems towards sustainability, i.e. social, economic, environmental and economic issues; and identify the main research questions in order to design future programs. For each driver, a group of scientists was responsible for reviewing the scientific literature related to sustainability, synthesize what we already know and determine the key research questions (Figure 1).

Launched in November 2009 and completed in June 2011, the project involved some 125 experts, mostly scientists, divided into ten working groups. Working group seminars, two general assemblies and a public symposium to debate the preliminary findings marked different stages in the gradual integration of the results. Work in progress was regularly reviewed by a Steering Committee composed of representatives of the different stakeholders (agricultural organizations, food industry, retail industry, environmental protection associations, consumer associations, national and international government representatives and qualified personalities).

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

Resulting Vision and Priorities for Research

Food consumption patterns

Food systems in developed countries are not sustainable with respect to resource consumption and to their impacts on ecosystems and health. Generalizing food systems that prevail in developed countries to the entire world is not sustainable either.

The long-term evolution of food consumption seems rather predictable: when incomes increase we observe an increase in calorie consumption, then an increase in the share of calories from animal products and then stabilization (Figure 2 illustrates the increase of per capita availability of total calories and calories from animal products in various countries.) This trend will put strong pressure on sustainability, as it is well established that producing animal calories requires more resources than producing vegetal calories. Whereas there is some convergence in the overall structure of consumption in developed and developing countries, diets remain largely heterogeneous.

The project has also shown that diets that are better from the health point of view are not associated with lower GHG emissions. In France, a reduction in GHG emissions associated with different diets depends more on a reduction of the total amount of food rather than a modification of the diet composition. This means that improvements in one direction of sustainability might deteriorate the performance measured along another direction of sustainability.

A first set of research questions that comes from this analysis is related to consumer food choices in the long run and if and how food choices can be modified. For example, the rise in obesity in most developed countries raises a lot of questions about the ability to modify individual choices. This also questions the role of public policies and their ability to modify consumers' choices. Issues are also related to the interactions between different public policies that have an impact on food chains such as agricultural policies, environmental policies and health policies. A second set of research questions is related to the impact on sustainability of fast nutritional changes in developing countries as well as a rise in inequality with respect to food access.

Food chains and food systems

What lessons can be made from the past evolution of food systems in developed countries? Four main issues have impacts on sustainability:

First of all, the food industry is now based on the use of basic agricultural products which are transformed to produce a huge range of final food products. A second characteristic of the evolution of food systems is the increasing role of the retail industry in the chain, which has a strong impact on suppliers and consumers through the set of products that are available. The third issue is the huge amount of losses and wastes, as a rough evaluation indicates that about 30 percent of agricultural production is lost within the chain.

Fourth, the observed increase in the average distance of food products from production to consumption is the consequence of changes in food habits, but also in the specialization of agricultural production and the evolution of industrial strategies. Finally, urbanization of the world's population has strong implications in term of organization and location of the activities (including production within cities) but also in term of changes in food habits of the population.

Food systems have to adapt to this new context with lower environmental impacts. Moreover, it is very likely that food systems will face more uncertainty. This means that more flexible and robust systems should be developed and their robustness to 'shocks' should be evaluated. The increasing role of the retail industry and the possible evolution in food processing raises the issue of how added value is shared within the chain. A better understanding is needed of why losses and wastes are so large, including their characterization at every stage of the chain.

Yet, over time, more and more constraints have been progressively added to the food systems (food safety, organoleptic, nutritional). Given the numerous constraints food processes are actually facing, it is not clear if adding new constraints coming from sustainability concerns is possible without rethinking the system completely. This opens a large field of research in food science. Moreover, the increase in the costs of inputs and a lower availability of some of them is likely to lead to a complete revision of the concept of process as well as logistics. From a research point of view, this means that a systemic view of food systems should be developed.

More generally, methods and tools to integrate technological processes (based on biology, physics or chemistry) and economic aspects in indicators and models should be developed at various scales (e.g. time scale, geographical scale).
As the food systems are connected to energy and chemical systems for biomass use, the concept of bio refineries or circular economy (that is, systems where by-products of one industry are used as input for another industry to minimize the global use of resources) should be simulated. Finally, a global view on the implications of urbanization is required to develop an accurate analysis of this question by linking food with many components such as energy, transportation, urban policy and spatial organization of activities

Governance and international markets

At the international level, the increase in demand for food and non-food combined with sustainability 'constraints' and land availability are likely to lead to increased prices of agricultural products and likely increased volatility.

A major issue for future research is to identify and evaluate private and public tools in order to develop more sustainable food systems. A number of factors need to be considered, including the interactions between firms' strategies and territorial dynamics as well as the role of new actors such as cities, territorial collectivities, consumer organizations and non-governmental organizations. The impact of price shocks on food security and on the various food systems is also a key issue, along with determining a better way to manage those shocks.

What does this mean for future research?

Conceptual framework for future research: Sustainability is a multi-dimensional concept and should be analyzed along its different dimensions. To better characterize the impacts of food chains along the different dimensions, we need to develop tools that integrate the complexity of the systems. We also need to develop analysis along different time horizons and geographical scales. The efficient scale of analysis does depend on the dimension of sustainability.

Given the complexity of issues and the various dimensions of sustainability, multi-disciplinary approaches are required. This is a challenge, as scientific disciplines requested are numerous and focus on very different scales of analysis.

Prioritization of research: The analysis was designed to elaborate research needs. It contributes to define priorities in the institutions that conducted the analysis. It also contributes to design priorities at a higher level through the definitions of national or international priorities.

There is a strong need to collect data to feed the various requested analyses and simulation tools: data on processing steps, losses and wasting, consumer behavior and health indicators. Data collected in all countries needs to be harmonized. Repeated analysis of consumption in the different populations and in particular in the low- income populations should be developed and provide information on consumption and health status.

Benefiting from diversity: Food systems are diverse, have their own internal consistency and are characterized by a different positioning vis-a-vis the sustainability dimensions. The tools to be developed should help us to better consider this diversity and help policy makers and various stakeholders to make decisions.

Design of future foresights: The analysis has shown the interest in analyzing food systems from farm gate to the consumer. However, not including agricultural production also puts some limitations on the analysis. For example changes in food processes might induce changes in the characteristics of the products that are demanded by the food industry to agriculture. Are those changes consistent with a more sustainable agriculture? Future foresight analysis should integrate the whole chain to better assess the dynamics of interactions along the chain. In particular changes in food diets should be interacted with changes in agricultural production in order to evaluate their compatibility. Foresight scenarios should strive to more fully integrate their detailed analysis of consumption, taking into account the diversity of situations (e.g. income level, location) that consumers face.

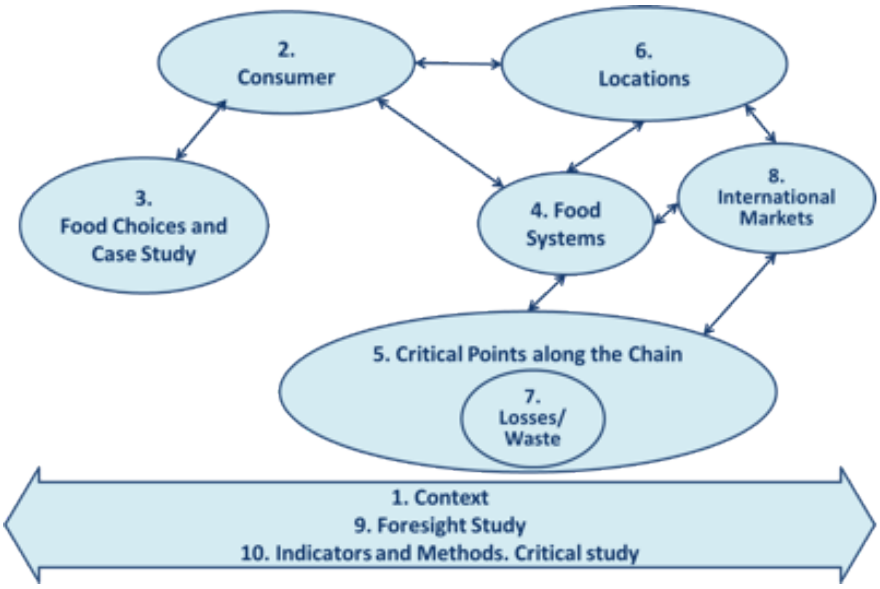

Figure 1: Organization of the Dualine analysis

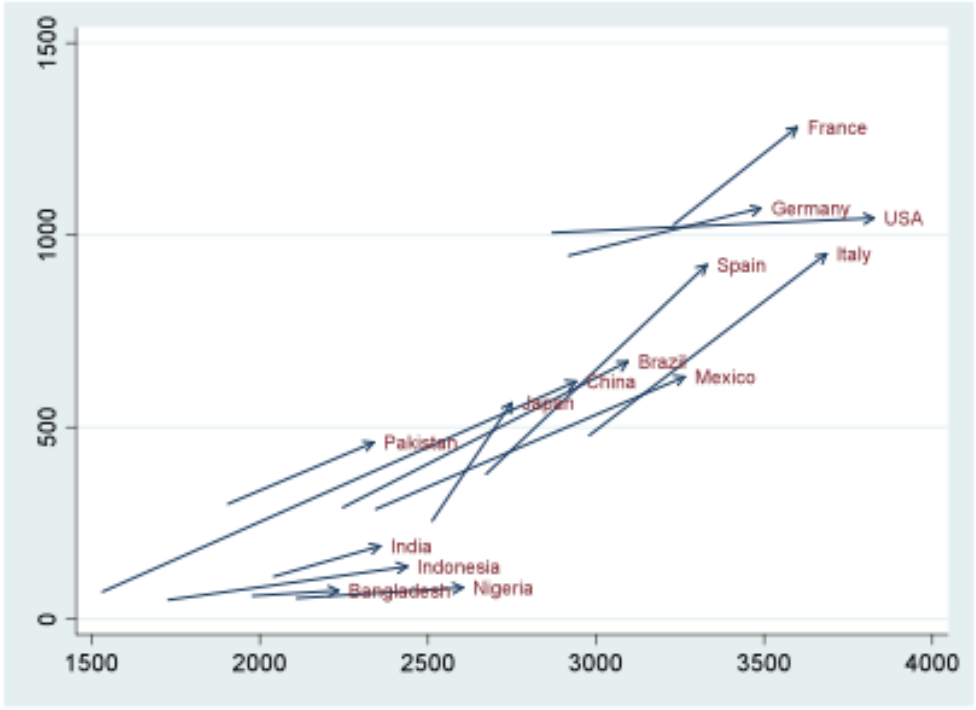

Figure 2: Consumption of animal calories and total calories between 1961 and 2005: selected examples (Source: P. Combris, from: FAOSTAT)

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