Watch Letter

CIHEAM

Feeding EXPO Milano with Mediterranean perspectives

www.ciheam.org
International Centre for Advanced Mediterranean Agronomic Studies

N° 32
April 2015

CIHEAM
International Centre for Advanced Mediterranean Agronomic Studies

About CIHEAM

Founded in 1962, the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) is an intergovernmental organisation composed of thirteen member states (Albania, Algeria, Egypt, France, Greece, Italy, Lebanon, Malta, Morocco, Portugal, Spain, Tunisia and Turkey).

The CIHEAM is at the service of its member states to promote multilateral cooperation in the Mediterranean in the fields of agriculture, food, fishery, and rural territories, aiming to respond to the needs of the States. The CIHEAM works for the Mediterranean and therefore with Mediterranean populations. Providing concrete solutions, sharing experiences and avoiding the waste of knowledge are among the main objectives of each one of its actions.

The CIHEAM pursues this cooperation mission through specialised training, networked research, scientific diplomacy and political partnership. Thanks to its activities, the CIHEAM therefore contributes to the elaboration of a global, structural and engaging vision for development in the Mediterranean.

170 permanent agents and hundreds of consultants regularly work within the 5 headquarters of the Organisation: the 4 Mediterranean Agronomic Institutes (MAI) based in Bari (Italy), Chania (Greece), Montpellier (France), and Zaragoza (Spain); the General Secretariat is located in Paris (France).

The Watch Letter

This Quarterly Letter has been published since 2007 and is devoted to major topics in Mediterranean Agriculture, Food and Environment.

While enabling the CIHEAM to gain a widespread recognition, it circulates analyses aimed at a heterogeneous public (policymakers, researchers, journalists, etc.) on emerging agricultural and food issues. The objective of the Watch Letter is to provide brief analyses which will fuel both the discussion on the Mediterranean and the broader global debate on food and agriculture.

The General Secretariat of Paris is responsible for the direction and the management of this bilingual publication (English and French), also available in Arabic.

Watch Letter's Organization Chart

Watch Letter N°32

Special Assistant in this Issue
Audrey Petiot

Collaborators in this Issue
Amr Farouk Abdelkhalik, Caroline Delassade, Vincenzo Fersino Elizabeth Grech, Gianluca Manganelli, Martine Padilla, Paolo Prosperi, Pedro Reis, Christine Ton Nu

ISSN 2114-3129

How to quote this document:
Feeding Expo Milano with Mediterranean Perspectives. Paris: CIHEAM, April 2015 - Watch Letter n°32

Contact & Subscription

CIHEAM, General Secretariat
Sébastien Abis
11 rue Newton, 75116 Paris, France
+33 (0)1 53 23 91 00 - abis@ciheam.org

To subscribe to this publication register on **ciheam.org**

Table of Contents

Editorial

Cosimo Lacirignola
CIHEAM Secretary General

2015 is a crucial year as several major international events placing issues related to agriculture, food and rural affairs at the heart of the new Sustainable Development Goals (SDGs) will take place. These goals are part of the new Post-2015 Global Sustainable Development Agenda that will be adopted in September 2015 at the General Assembly of the United Nations. This Agenda constitutes one of the main frameworks for international cooperation during the next 15 years.

Taking place from May to October 2015, the Milan Expo entitled "Feeding the Planet. Energy for Life" is mobilising both Italian authorities and society and is expected to be another highlight of this year. The Milan Universal Exhibition provides an important opportunity to discuss common solutions to the challenge of global food security. This year, the 21st Conference of Parties on Climate Change (COP21) will also be held in Paris in December. Agriculture will have its rightful place as various French ministers, convinced of the interdependency between agricultural diplomacy and climate negotiations have emphasised its importance. Moreover, agriculture will also play an important role during the 7th World Water Forum that will be held from 12 to 17 April in South Korea. Launched by the United Nations, 2015 is also the International Year of Soils where the essential role of agriculture in soil conservation will be highlighted. Issues related to natural resources, climate change, agricultural production, inclusive growth (social and territorial) and food security (necessary basis for human security) will therefore be at the heart of an eventful 2015 that is also intended to find solutions for a more sustainable development.

Milano Expo 2015's theme "*Feeding the Planet. Energy for Life*" - addressing food security and nutrition, sustainability, poverty reduction, development and cooperation - is at the heart of the United nations' founding principles to combat hunger and poverty, and represents a prime opportunity for creating dialogue and building understanding with stakeholders and policymakers. Though there exists a definition recognised at the UN level, food security is a concept without operational definition. Since indicators inform action, considerable efforts in current research aim at enhancing food insecurity measurement for implementing diagnosis and response. Policy-makers need to know how many people are at risk, who and where they are, and how to reach them.

As global attention revolves around food security, new opportunities arise to further develop its measurement. For this purpose, major investments and efforts have been made in developing appropriate indicators and data. Given food security's multifaceted aetiology there is no simple single indicator that could be consistently applied, for instance, to both identify food insecurity and assess its prevalence and intensity. The search for new indicators for food security is a critical step. Furthermore, it is necessary to support this research through innovative actions in the fields of agriculture, food, economy, nutrition, health, development, etc. In particular, agricultural innovation and the improvement of performance and productivity are essential to meet the challenges and current global issues (climate change, increasing global population...). But it is not enough. Incomes and access to food have proven to be the major determinants of food insecurity in the world. Food quality, nutrition, health and care are also crucial when addressing food security.

It is of utmost importance to address sustainable development with more synergy and by considering the interdependence between economy, society and the environment, its three components. Preserving the planet is essential and this is not debatable. However, the generation of wealth and its equitable distribution is just as important. It would be a serious mistake to give priority only to the environmental component in the Post-2015 development agenda. Too related to the concerns of rich countries, such a possibility would indeed ignore the most pressing and urgent human needs. People should remain the highest priority of the SDGs. It is thanks to the human ability to invent solutions and accumulate knowledge that we succeed in adapting to change. People themselves play a key role in finding solutions to overcome the problem of underdevelopment. This positive reading of the state of the planet is not intended to fight the pessimistic situation. It is resolutely focused on human ingenuity and its capacity to reverse trends, to create and find tailored local solutions, and to meet global challenges.

This is a plea proposed for a Post-2015 Agenda that would include four main aspects: the economy, the environment, social affairs and also innovation. For many years, innovation has been closely related to sustainable development and it is now high time to position it more clearly. We define "innovation" in two ways. Firstly, it is the human ability to create change, advance science, feed knowledge and bring about historical turning points that enable to achieve giant leaps for mankind. Secondly, the implementation of the SDGs must consider the cultural, economic, social and geographic characteristics of the different societies at local level. Innovation for development is necessarily local and distinctive. We cannot wave a magic want. We must adapt to the realities of the regions in order to efficiently link knowledge with the practices, needs, and constraints of the context in which the action must give tangible results for the local population. Each region must therefore develop its own model (or models!), at its own pace with its actors, its difficulties and its history.

This proposal for a sustainable development based on the above-mentioned four complementary aspects supports people and future generations. The issue of food security gives this proposal a concrete meaning. How could SDGs be indeed totally disconnected from the issue of employment and the people's daily security? This is no easy task as meeting such a challenge depends on the people's will, on the public policies that will be implemented, and on the future involvement of young people. Regarding agriculture, the time for questioning whether to produce better or whether to produce more has passed since a global consensus has been reached on the urgent need to reconcile the two approaches in a common movement. New agricultural models and diversification of rural economies could be effective to mitigate unemployment in countries where agriculture can remain a source of employment and income and where other sectors cannot absorb all potential labour. Feeding 9 billion people in 2050 with a faceless agriculture would involve serious social and economic consequences.

However, fostering socio-economic development models able to provide rural population with a decent life (requiring a clear support of family farming), would certainly alleviate rural exodus towards cities and its negative impact. It is therefore geopolitically important to promote agricultural and rural development strategies that do not sacrifice human factors for environmental preservation. Let us make ourselves clear: by saying this, we neither ignore nor deny the environmental emergency. We are simply suggesting that human beings should be given first priority in discussions on sustainable development and food security. We should not forget that the main purpose of agriculture is to feed people and that sustainable agriculture implies preserving the natural resources so that the future generation can be fed too (in that way, environmental and social aspects are not in contradiction but have to be addressed with different time scales in mind).

In this perspective, waste reduction is a determining factor. Across the world, including Europe, people should better manage natural resources, decrease the waste of water, arable land, soils, and biodiversity. In their daily lives, people will have to reduce waste resulting from the loss of agricultural products during harvest, transportation, storage and consumption. These individual actions will certainly contribute to reducing and limiting collective food insecurity. Nevertheless, we should also fight against the waste of knowledge. In agriculture, this is a crucial issue. Traditional skills deserve greater attention and locally found solutions should be better and more broadly disseminated thanks to modern communication technology. Thus, knowledge should be promoted. Experiences, and ideas should be increasingly shared. The circular economy of knowledge is incredibly powerful. Innovation is not only the creation of "unprecedented actions", but above all, it is the power of federating energies and intelligence put at the service of common goals such as SDGs.

CIHEAM is convinced that agriculture and food security are two key elements for sustainable development and stability across the Mediterranean and across the world. After years of awareness, 2015 is the year which should give way to action taking up responsibility for global changes. This is an important opportunity for CIHEAM to put forward and consolidate the efforts it has been deploying since 1962 in favor of agriculture, fishing, rural development and food security in the Mediterranean. On 28 November 2014, at the Euro-Mediterranean Conference on Agriculture organized by the Italian authorities as part of their Presidency of the Council of the European Union, countries stressed the role of knowledge sharing. Thus, they focused on the needs of a better Euro-Mediterranean dialogue in agriculture and the importance of international cooperation in addressing food security challenges. Finally, delegations wanted to focus in particular on the role of sharing experiences, enhancement of good practice and innovation to adapt to climate change and economic and environmental transformations that undermine food security in some countries. It was one of the main objectives of the French programme established in the perspective of Expo Milano 2015 and developed by "Feeding knowledge" project to enhance scientific diplomacy in Agriculture between Mediterranean countries and to create a Euro-Mediterranean Centre of Knowledge for Food Security.

CIHEAM Watch Letter n°32 grasps the evolution, the dynamics and the trends of innovative indicators of Food Security in the Mediterranean countries. It focuses in particular on the initiatives and good practices of assessment, innovative methodologies and interest of policy-makers. It also analyses the sustainability of food value chains and projects to adapt agriculture to climate change. Exploring innovative indicators and initiatives for sustainable food security in a broad perspective is addressed through nutritional, socioeconomic, environmental, and innovation challenges, at the level of global governance as well as at the local level. I would like to express my sincere thanks to the 51 authors and to all those who have contributed to this new Watch Letter composed of 18 relevant articles.

Election of Pr. Masum Burak as new President of CIHEAM Governing Board

At its 133rd meeting in Cairo on 26th March 2015, the Governing Board of CIHEAM, formed by delegates of its 13 member countries, has elected **Pr. Masum Burak** (Turkey) as the new President of the Board. He will begin his four-year term on 1 April 2015, succeeding **Pr. Adel El-Beltagy** (Egypt).

Pr. Masum Burak is the General Director of Agricultural Research and Policies at the Turkish Ministry of Food, Agriculture and Livestock.

During the meeting, the Board also elected the delegates of Egypt, Italy, Morocco and Spain as new Vice-Presidents. They are now members of the Steering Committee of the Board with the President and the Secretary General.

The Governing Board of the CIHEAM is the managing body where political, financial and administrative strategic decisions are taken. Composed of one delegate from each of the thirteen member countries, the Board meets twice a year.

Short Biography

Pr. Masum Burak has a PhD from the Uludag University. He started his career in 1980 as a researcher and then Head of Department, Deputy Director and Acting Director at the Yalova Atatürk Central Horticultural Research Institute, until 2005. In 1993, he was awarded as Associate Professor by the Turkish Higher Education Council. Deputy Director General of Agricultural Research and Policies at the Ministry of Food, Agriculure and Livestock during one year and a half, he became Director General in October 2006.

Concerning his international activities, Pr Masum Burak was the President of CIHEAM Advisory Committee from 2009 to 2012. Since 2007, Masum Burak is the Delegate of Turkey in the FP 7 of European Union in Theme 2 (agriculture, food, fisheries and biotechnology) and in the Standing Committee for Agricultural Research of the European Union since 2008. Member of ExCo of Borlaug Global Rust Initiative and of the Advisory Board of the Turkish Scientific and Technological Council, he is also since 2010 member of Board of Trustees of ICARDA.

Since 2013, he is Member of Board of EXPO 2016 in Antalya and Delegate of Turkey in Horizon 2020of the European Union SC2 since 2014. At last, Pr Masum Burak is member of the International Society for Horticultural Science, of the Turkish Society for Horticultural Science and of the Chamber of Agricultural Engineers. He has authored about 100 publications in Turkish and English.

Pr Masum Burak is married and has two children. He speaks Turkish, English and French.

Feeding the Mediterranean through knowledge

The Policy Paper of Feeding Knowledge Programme

Felice Adinolfi
Professor at University of Bologna, Italy

Damiano Petruzzella
Project Manager at CIHEAM-Bari

Marinella Giannelli
Project Officer at CIHEAM-Bari

FEEDING KNOWLEDGE

In Collaboration with EXPO MILANO 2015
FEEDING THE PLANET
ENERGY FOR LIFE

CIHEAM BARI

POLITECNICO DI MILANO
METID

The policy paper will be part of Expo Milano 2015 legacy. It will be presented to the public in a dedicated event during the Universal Exhibition, in September 2015.

More informations available at
www.feedingknowledge.net

About Feeding Knowledge Programme

Today, food security is still a promise. Knowledge is the way to make it real. Based on this concept, Expo Milano 2015, whose claim is "Feeding the Planet, Energy for Life" decided to launch an ambitious programme for supporting cooperation on research and innovation in the field of food security: "Feeding Knowledge". Developed and implemented jointly by CIHEAM-IAMB and Politecnico di Milano, this initiative, started in 2012, will run until the end of the Universal Exhibition and will contribute to building up Expo Milano 2015 legacy.

Since 2012, "Feeding Knowledge" has contributed to the strengthening of Mediterranean cooperation on knowledge sharing for food security. It has produced some noteworthy results, namely 5 white papers on research priorities for food security, 10 local offices (Local Points) in 10 Mediterranean countries[1], a network of more than 2000 researchers, a database of around 800 research works, 3400 organizations/entities registered on the on-line collaborative platform (*www.feedingknowledge.net*) and more than 780 Best Practices for Sustainable Development collected under the International Call of Expo Milano 2015.

These elements are a valuable store of experience on Mediterranean knowledge system. Building on them, the FK ambition is to contribute to the international efforts aimed at reducing food insecurity in the Mediterranean with concrete recommendations gathered in a policy paper, which will be part of Expo Milano 2015 legacy. In the upcoming months, "Feeding Knowledge" will work on the creation of a Euro-Mediterranean Centre of Knowledge for Food Security: a *hub* of knowledge and expertise based on a consolidated network of research organizations and national institutions. The Centre will have its main base in Italy (Milano and Bari) and local offices in other Mediterranean countries to facilitate its role of "knowledge mediator".

Background: the path towards the policy paper

In February 2014, representatives of "Feeding Knowledge" Local Points as well as of ministries, institutions and international organizations from several Mediterranean countries gathered in Bari, at CIHEAM-IAMB, to comment and share ideas on a preliminary draft of the policy paper, based on the recommendations outlined in the 5 white papers of the Programme scientific network and on the results of an on-line survey on the needs for food security involving about 200 stakeholders in the Mediterranean region.

During the last year, "Feeding Knowledge" activities concentrated on collecting relevant inputs to draft an updated version of the policy paper which was discussed with Euro-Mediterranean institutions and organizations in an ad-hoc round table (Rome, 26 January 2015) and which will be finally presented during the Universal Exhibition.

[1] The target countries of the Programme are: Albania, Algeria, Italy, Jordan, Lebanon, Macedonia (representing SWG countries), Morocco, Palestine, Tunisia, Turkey.

The updated version of the policy paper has been built following a comprehensive analysis of different elements of the knowledge chain in the Mediterranean region, with a particular focus on food security. Four main elements have been taken into account: first, a literature analysis of the state of the art of knowledge & innovation transfer; second, a comparative analysis of problems, strategies and tools of Euro-Mediterranean agricultural extension services; third, a quantitative and qualitative analysis of the problems and solutions highlighted by more than 780 candidates who applied for the International Call on Best Sustainable Development Practices for Food Security of Expo Milano 2015; fourth, an analysis of the results of an Open Consultation launched through "Feeding Knowledge" Platform on the problems and priorities perceived by more than 100 Euro-Mediterranean research and innovation stakeholders and on possible tangible solutions. The results of this analytical work – which are briefly reported below – have further been deepened by Feeding Knowledge experts in order to draw some key recommendations which were discussed and shared with representatives of Euro-Mediterranean institutions and organizations during the Round Table organized in Rome on January the 26th, 2015.

A picture of knowledge and innovation transfer in the Mediterranean

In the last decades, the resources allocated to research and development in agriculture has increasingly been invested in knowledge transfer, reflecting growing attention to this issue in developing and developed countries. At the same time, there has been a gradual shift from the traditional linear model of innovation transfer to systemic approaches, where innovation is seen as a complex interactive process involving not only the technological and scientific sphere, but also the social one. As a consequence, the importance of communication and of the involvement of end users through specific activities (e.g. brokerage) has significantly increased.

Hence, the concept of innovation itself has become strictly connected with the local context to which it refers, stressing the importance of participatory processes such as the co-creation of knowledge. In this scenario, agricultural extension services have evolved towards pluralistic supply models, where the public component is increasingly giving way to private agents and NGOs. In addition to this, the changes in modern agro-food systems, as well as issues regarding food safety, climate change, the role of multi-functional agriculture and the development of rural areas, are redrawing the boundaries of knowledge information in agriculture, fuelling the complexity of the governance of extension services.

With particular reference to developing countries, the importance of the processes of adoption of innovations has climbed up to the top of the international development policy agenda. Southern Mediterranean countries are no exception to this scenario. In most of them the traditional approaches based on technology transfer and delivery have gradually changed, fostering decentralization, involving private actors and civil society organizations, improving institutional capacity. However, despite the various reform processes of innovation and knowledge systems, there are still several constraints that limit the concrete possibility for some groups of adopting innovations (e.g. smallholder farmers, marginal livestock producers and women farmers). Also, this process presents some criticalities due to constraints of the institutional, economic and financial context of some Mediterranean countries. To this regard, literature case studies show that the simultaneous presence of key conditions might lead to interesting experiences of innovations adoption. Some of these conditions are the following: effective participatory approaches, activation of appropriate financial and credit facilities, reactive institutional framework.

Yet, as highlighted on the occasion of an intensive workshop organized in 2014 by Feeding Knowledge and attended by representatives of the agricultural extension services of 8 Euro-Mediterranean countries, there are other constraints which negatively affect the effectiveness of extension process, such as weak linkages and coordination among researchers, extension staff and farmers; limited budget allocation; low acceptance of changes adoption in some farming systems; no tradition of on-farm experimentation. Surprisingly, according to the extensionists interviewed, there is little articulated connection between extension and food security. More attention is given to market orientation – but the potential for this to undermine food security needs to be kept in mind.

Building up a new paradigm for knowledge: a Mediterranean laboratory

In the upcoming years, food security will be one of the main global challenges, equally urgent both for developed and developing countries. According to FAO estimates, the global demand for food products will increase by 70% by 2050, sided by a substantial increase in demand for seeds, fibers, biomasses and biomaterials. At the same time, there will be a slow-down of the food production growth rate – mainly due to the reduction of investments in agricultural research and to a growing pressure on the environment and on natural resources. An answer to this challenge is undoubtedly represented by the development of research and innovation and by an increase in the degree of research actors' awareness on the needs of the food chain operators. Accordingly, knowledge and innovation transfer should be effective and supported by appropriate policies and investments. This implies the creation of stronger linkages between research and end users, a shortening of the knowledge chain.

The need for a "short" knowledge chain becomes increasingly urgent even in the context of the Southern Mediterranean. Successful research is in fact more able to address the needs expressed by operators and better tailored to the regional context, so that it is possible to measure its effectiveness, to identify its criticalities and to trace its future developments. Thus, innovation becomes the result of the creation of a network, of an interactive learning process, of a negotiation among heterogeneous stakeholders.

A valuable support to the development of such a dialogue can today originate from new forms of spreading information. Thanks to their wide usability, they allow the exchange of all kinds of news and cognitive experiences, as well as of ideas and best practices, through a direct engagement in debates about the issues proposed. In the agricultural sector, these systems can enhance or even create new links between agriculture and local area, area and consumers, while their use not only allows the sharing of innovations and continuous updating, but also helps reach directly the user with precise and personalized messages.

Furthermore, thanks to these new systems and to the development of web networks and communities in all countries of the Southern Mediterranean area, users are becoming - from passive or uninformed actors - active participants and promoters of information, as the latest events involving those countries have showed. Therefore, the contents of communication, once launched, are gradually enriched thanks to the contribution of all users, thereby creating a valuable exchange of opinions, experiences and information.

This represents a crucial asset for the Mediterranean, where the main problem today seems to be not the lack of knowledge but the need to make good use of it. Therefore, strengthening local capacities to use modern information systems at a wider scale should become one of the policy priorities of knowledge transfer and innovation in agriculture, in order to fill the "information gap", so often mentioned by research stakeholders.

Inputs from "Feeding Knowledge"

In order to enhance the dialogue among research actors, policy makers, farmers and all the other stakeholders involved in the food security domain, "Feeding Knowledge" Programme has developed several activities aimed at: identifying research areas/topics of mutual interest in the Mediterranean region, collecting inputs on the main needs and solutions in the food security domain, collecting examples of best practices (in terms of projects, products, processes, know-how) related to food security. Building on the results of these activities and despite the differences and peculiarities of each country targeted by the Programme, in some key common areas the need for new knowledge and the importance to enhance the knowledge in use have been identified.

At the same time, most recurrent problems and suggested solutions pertaining to key priority themes related to food security have been identified and highlighted by the Programme. Furthermore, thanks to the valuable set of data and information collected by the Programme, a comprehensive analysis of methods and tools to implement suggested solutions has been carried out, trying to stress the added value of the presence of an effective knowledge chain. The results of this work are briefly summarized below and are divided into five key thematic areas.

Managing ecosystem services

The main challenge seems to be the enhancement of ecosystem services, whilst maintaining productive agriculture. Intensifying production, within environmental boundaries - given that little, if any, extra land is available - requires that research deepens into the practical assessment and application of technologies such as conservation agriculture, no till or reduced tillage, agro-forestry, mulching, cover crops, controlled grazing, integrating crop and livestock production, well-designed terracing to control soil erosion and the use of halophyte crops in saline areas. Agricultural and innovation policies should be based on the principle of "sustainable intensification", requiring significant efforts in research as well as in knowledge transfer.

With particular reference to the Mediterranean, both research actors and local operators highlight the need to manage scarce water in a sustainable manner. Suggested solutions are: strengthening rain-fed agriculture production systems, increasing productivity in irrigated areas and improving water use efficiency at different scales from crop to irrigation systems, reducing water losses and wastage, increasing water resources availability through the use of non-conventional water, promoting policies that support water governance. The Open Consultation carried out within "Feeding Knowledge" Programme also highlighted the need to improve the effectiveness of extension activities as well as the importance of conducting awareness & knowledge raising activities.

Qualitative and Quantitative Enhancement of Crop Products

Sustainable integrated management and control of biotic and abiotic factors (both during pre-harvest and post-harvest stages) are fundamental to enhance quantity and quality of products. To this aim, research should focus on the efficiency of Integrated Pest Management and organic production systems under an eco-functional intensification approach. At the same time, food loss and waste have many negative economic and environmental impacts. Actions in this regard should be directed towards the whole food chain, since strengths and weaknesses affecting one part of the chain often have consequences at all other levels. As pointed out by the FAO and World Bank, investments in reducing postharvest losses can be as cost-effective as other agricultural investments and can provide good returns, especially when food prices rise.

In this field it is also necessary to harmonize the laws that set a limit to the possible presence of mycotoxins in the main food products. This complex perspective needs to be accompanied by actions aimed at developing a better knowledge about where food is lost and wasted throughout the supply chains, and therefore where the pinch points for action are. According to the responses given within "Feeding Knowledge" Open Consultation, useful solutions to develop effective integrated pest management and organic production systems are also the increase of farmers knowledge and awareness, including better access to information. Also, new national and local policies are deemed necessary to be adopted in order to ensure more incentives to farmers and speed-up the adoption of organic farming.

Managing food in an increasingly globalized food system

A main topic for future research in this domain is to strengthen the availability of both quantitative and qualitative information as prerequisite to afford appropriate policy analysis. To this regard, an important priority is to set up tools that help understand how local and regional food systems might be affected by hitherto unexperienced events such as multiple bread-basket failure and what would then happen to trade, price, food access and local land-use decision.

Another problem is the changing nature of price volatility, which is now becoming a structural factor in a globalized food system, and one of the main sources of risks for farmers. To face this issue, agricultural policies should offer more opportunities for risk management and promote new tools for coping with risk. Public intervention should stimulate more opportunities in this sense. The Open Consultation highlighted also the need to promote actions of institutional capacity building in order to reduce the fragmentation of policy-making decision process and to enable the adoption of targeted policies alternatives.

Fostering sustainable development of small rural communities in marginal areas

Liberalization of agricultural markets and globalization have generally increased economic differentiation among communities and households. As a consequence, remote communities in low potential areas and households lacking adequate human, financial and structural resources, faced serious difficulties to cope with the new global scenario. A viable solution to this bottleneck is the creation and sharing of knowledge on sustainable agro-ecosystem and natural resources management aimed at promoting preservation and protection of fragile rural environments and groups. In these contexts the mechanisms of learning and innovation transfer are of pivotal importance in maintaining the health of local communities.

Another feature of marginal rural areas in the Mediterranean region, like elsewhere, is the increasing male migration and the consequent rising number of households run by women. This important phenomenon calls for social and agricultural policies aiming at a concrete enhancement of the role of women in agriculture. In this context the Open Consultation underlined the importance of "farmers empowerment", intended as creating enabling conditions to facilitate access to credit and subsidies, to provide technical support and knowledge development, to reinforce the public extension strategy and to establish local incubators for cooperative actions.

Promoting sustainable food consumption patterns

There is an urgent need to assess the environmental, economic, social, cultural, health and nutritional sustainability of the current food consumption patterns and diets in order to design comprehensive, coherent and multifaceted nutrition-sensitive policies. These research activities should deal among others with: diet nutritional and health implications, food-related environmental footprints, economics of the Mediterranean food consumption patterns, food cultures and sociology in the Mediterranean, food system governance and food policies.

The Open Consultation of the Programme revealed a general consensus on the importance of promoting economically, socially, culturally and healthy sustainable food consumption patterns in the Mediterranean region. To this end, suggested solutions are: raising public awareness through large scale campaigns and through the promotion of food education in schools. Also, awareness building actions addressed to farmers are seen as a potential solution to increase their income through know-how, innovation and post harvesting techniques. Consumption of locally produced commodities should also be encouraged.

Significant inputs for the development of a knowledge system for food security in the Mediterranean also derive from more than 400 Best Sustainable Development Practices submitted by applicants of Mediterranean countries, which represent about half of the total Best Practices submitted to the International Call launched by Expo Milano 2015 worldwide. In fact, a good number of candidate Best Practices (35%) focuses on knowledge development and raising awareness, carrying out activities such as workshops, training, awareness campaigns and implementation of new knowledge development instruments.

Key messages: a knowledge system for food security in the Mediterranean

Based on the issues outlined in the previous sessions, the following options should be further explored to build up an effective knowledge system for food security in the Mediterranean:

Renewing tools and approaches for re-designing social and agricultural policies

Today, in the Mediterranean region, a high number of people is employed in agriculture with widespread family-run farms. Therefore, the target of social and agricultural policies often coincides and a consistent combination of these two levers is pivotal in mitigating the risks connected to price volatility and in creating long-lasting development conditions. In this context, fostering innovation and knowledge development in building agricultural and social policies is a priority. In fact, in order to make these two policies effective and mutually coherent, the decision making process should be based on accurate and comprehensive information and should be re-organized according to innovative strategies.

At the operational level, it could be expedient to develop less expensive and more efficient subsidy schemes, accurately tailored to the status and conditions of beneficiaries. At the same time, such schemes should be backed by judicious social measures, such as the promotion of diversification of diets notably in those countries where food habits are based on one or two main products: these countries are in fact more exposed to inflation risks. One more need is the development of infrastructure in rural areas, the setting up of efficient organizations between farmers and end users and the promotion of risk management mechanisms. In this context, another factor that deserves attention in the elaboration of social and agricultural policies is the role of women in agriculture and in all the sectors linked to food security. Adopting mechanisms that enhance women's skills and knowledge and provide support to forms of women's aggregations, and to the promotion of female entrepreneurship in the agro-food sector, may be effective solutions to favour social inclusion and cohesion.

Supporting new paradigms for access to innovation

The adoption of innovations is decisive for development strategies of the Mediterranean area. Traditional linear approaches have proved to be less effective; the necessity to build systems capable to put needs and solutions into perspective is widely recognized. Although several countries have already initiated innovation policies reform processes, a lot of criticalities still persist. There is a need to strengthen decentralization processes of national systems for the spread of innovations, to promote local institutional capacity building and to develop a participatory approach able to link needs and solutions thereby enhancing formal and informal knowledge resources. This results in a short knowledge chain, in new mechanisms of knowledge co-creation and in the transfer of research results also to marginal organizations.

Opening up knowledge for food security

All the potential of new tools and methods for the collaborative creation and sharing of knowledge have to be exploited with the specific aim of opening up knowledge for food security. The common objective has to be the inclusion - in the knowledge-sharing process - of every person who holds knowledge that really matters with food security and nutrition, even those social groups which traditionally do not play this role. At the same time, access to knowledge should be guaranteed to whoever is interested in, regardless of his/her previous formal achievements, age, gender or language. Massive Online Open Courses allowing social learning, event-based learning paths, peer-to-peer learning processes, citizen science initiatives developed in an integrated way might set the toolbox for opening up a new knowledge eco-system for food security. This is particularly true for the Southern Mediterranean region, where the propensity to the use of new technologies is rapidly increasing and where the number of people with less than 25 years is about one half of the population.

All these statements intend to contribute to the establishment of a sound strategy for reducing the waste of knowledge in the Mediterranean, building on the unique features and potentials of this region. After three years of intense activities, "Feeding Knowledge" Programme calls for the creation of a permanent Euro-Mediterranean Centre for knowledge development and sharing on food security, able to intervene at all levels of the knowledge "short" chain, from needs assessment to the development of solutions and transfer of research results.

Bibliography / More d'informations

- R. Birner, K.Davis, J.Pender, E.Nkonya, P.Anandajayasekeram, J.Ekboir, A.Mbabu, D.J.Spielman, D.Horna, S.Benin, and M.Cohen (2009). "From best practice to best fit: A framework for designing and analyzing pluralistic agricultural advisory services worldwide". *Journal of Agricultural Education and Extension*. 15(4), 341-355.
- Birner R., Anderson J.A. (2007). How to Make Agricultural Extension Demand-Driven?, IFPRI Discussion Paper 00729.
- Coudel E., Devautour H., Soulard C. T., Faure, G., Hubert B. (2013), *Renewing innovation systems in agriculture and food. How to go towards more sustainability?* Wageningen Accademic Publishers. ISBN: 978-90-8686-768-4.
- De Rosa M., G. La Rocca, S. Longordo (2011), "Organizational models in the supply of agricultural extension services: the Italian case", in Savisalo L. (ed.): *Private - public partnerships for advisory services in Europe*, proceedings of the 20th European seminar of extension education, Finland.
- Dockés A.C., Tisenkopfs T., Bock B. (2012); "The concept of agricultural knowledge and innovation systems", in EU SCAR: *Agricultural knowledge and innovation systems in transition – a reflection paper*, Brussels.
- Engel, P.G.H., (1995). Facilitating Innovation: An action-oriented approach and participatory methodology to improve innovative social practice in agriculture. PhD thesis, Wageningen University. Wageningen, The Netherlands.
- Fattouh B. and El-Katiri L. (2012), Energy Subsidies in the Arab World. United Nations Development Programme. Regional Bureau for Arab States. Arab Human Development Report. Research Paper Series 2012Oxford Institute for Energy Studies 57 Woodstock Road, Oxford OX2 6FA, United Kingdom.
- Geels, F.W., 2004. From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy* 33 (6-7): 897-920.
- Genilo, J.W. 2005. Community-based Communication: A New Approach to development Communication, The Philippines: Great Books Publishing.
- Hall, A. (2009), Public Private Sector Partnerships in an Agricultural System of Innovation: Concepts and Challenges, in: N. Janardhan Rao & Amit Singh Sisodiya, *Public-Private Partnership Model in India. Concepts, Issues and Outlook*, The Icfai University Press, Hyerabad, India, 220-242.
- Hermans, F., Stuiver, M, Beers, P.J., Kok, K. (2013).The distribution of roles and functions for upscaling and outscaling innovations in agricultural innovation systems. *Agricultural Systems*, Volume 115, February 2013, 117–128.
- Juma, C. (2011). *The New Harvest: Agricultural Innovation in Africa*. Oxford: Oxford University Press.
- Klerkx L. and Leeuwis C. (2008), "Matching demand and supply in the agricultural knowledge infrastructure: experiences with innovation intermediaries", *Food Policy* 33 (3): 260–276.
- Klerkx L., A.Hall and C.Leeuwis (2010), Strengthening Agricultural Innovation Capacity: Are Innovation Brokers the Answer?, *International Journal of Agricultural Resources, Governance and Ecology*, Vol. 8, Numbers 5-6, pp. 409-438(30).
- Knickel, K., Brunori, G., Rand, S., & Proost, J. (2009). Towards a Better Conceptual Framework for Innovation Processes in Agriculture and Rural Development: From Linear Models to Systemic Approaches. *Journal of Agricultural Education and Extension*, 15(2): 131-146.
- IFPRI (2012), *2012 Global Food Policy Report*, Washington, DC 20006-1002 USA
http://www.ifpri.org/sites/default/files/publications/gfpr2012.pdf
- OECD (2011), Towards Green Growth - OECD Rights and Translation unit (PAC), 2 rue André-Pascal, 75116. Paris, France. ISBN 978-92-64-094970
- OECD (2013), Better Policies for Development, In Focus: Policy Coherence for Development and Global Food Security 2013 http://www.oecd.org/pcd/PoliCoh_PDFforWeb_270513.pdf
- Oudshoorn, N., and T. Pinch, eds. (2003). How users matter: The co-construction of users and technologies. Cambridge, MA: MIT Press.
- Rogers, E. M. (1962). *Diffusion of innovations*. New York: Free Press of Glencoe.
- Röling, N. and W.A.E. Wagemakers (eds.) (1998) Facilitating sustainable agriculture: participatory learning and adaptive management in times of environmental uncertainty. Cambridge University Press, Cambridge, UK.
- Smits, R. 2002. Innovation studies in the 21st century: Questions from a user's perspective. Technological Forecasting and Social Change 69 (9): 861-883.
- Sulaiman R.V. (2012), "Agricultural extension in India: current status and ways forward",Background Paper prepared for the Roundtable Consultation on Agricultural Extension, Beijing, March 15-17.
- Sulaiman, R. and Hall A. (2005), "Extension Policy at the National Level in Asia", *Plant Production Science*, Vol 8. No 3.: 308-319.
- Sumberg, J. (2005). Systems of innovation theory and the changing architecture of agricultural research in Africa. *Food Policy* 30 (1): 21-41.
- Sumberg, J., and Reece, D. (2004). Agricultural research through a new product development lens. *Experimental Agriculture*, 40(3): 295-314.9.
- World Bank (2013), *The World Bank Annual Report 2013*Washington, DC 20433.
http://siteresources.worldbank.org/EXTANNREP2013/Resources/9304887137720121237 8/9305896137754475343 1/1_AnnualReport2013_EN.pdf

Food Security in Arab Countries: Efficiency, Productivity, and Shifting Dietary Habits

Najib Saab
Secretary General of the Arab Forum for Environment and Development (AFED)

Introduction

Reports of the Arab Forum for Environment and Development (AFED) have repeatedly warned that demand on resources and eco-services by Arab countries is double what the region's natural systems can provide. Key challenges include food security, water and energy. Arab countries today import more than half of their needs of basic foods, while an Arab individual's share of renewable fresh water is less than one-tenth of the world average. This discrepancy between domestic supplies and demand on resources threatens growth opportunities, let alone the quality of life.

However, the overall situation described by AFED reports in previous years was not fully bleak. Despite critical conditions, it was established that challenges could be tackled with wise management of resources and regional economic cooperation among Arab countries. Since food productivity levels were in most Arab countries very low compared to the world average, and water use for irrigation was characterized by extremely low efficiency, improving food productivity and enhancing water efficiency could lead to quick results. Achieving good quality of life on the long term for people of the region requires working on attaining economic integration and allowing for free trade across the borders of the region, since the free influx of products, capitals and human resources helps improve the conditions in all countries.

Najib Saab, Secretary-General of the Arab Forum for Environment and Development (AFED), is co-editor of the series of annual reports on the state of Arab Environment, launched by AFED in 2008. He prepared this article based on the 2014 AFED report entitled Food Security: Challenges and Prospects, which he co-edited with Abdul-Karim Sadik and Mahmoud El-Solh. AFED annual reports can be downloaded from www.afedonline.org

AFED's report *Food Security: Challenges and Prospects*, released in November 2014, confirmed similar findings. It pointed out that Arab countries, in their quest to enhance food self-sufficiency, face serious challenges emanating from a backdrop of constraining factors, including aridity, limited cultivable land, scarce water resources and serious implications of climate change. Weak policies, insufficient investment in science and technology and agricultural development in the past have contributed to the impoverished state of agricultural resources and to their inefficient use and low productivity. Population growth, rising demand for food, degradation of natural resources, and conversion of farmland to urban uses, pose further challenges to the enhancement of the food self-sufficiency goal in the Arab region. The food deficit is underscored by a self-sufficiency ratio of about 46 percent in cereals, 37 percent in sugar, and 54 percent in fats and oil.

The Food-Water nexus

Food and water are inextricably linked. The Arab region faces the dilemma of water scarcity, reflected in the fact that the annual renewable water resources per capita are less than 850m^3, compared to a world average of about 6,500 m^3. This regional average masks the widely varying levels among countries, of which 13 are classified in the severely water scarce category, at less than 500 m^3 per capita. The situation is so alarming in six of these countries (Bahrain, Kuwait, Qatar, Saudi Arabia, United Arab Emirates and Yemen), with availability of renewable water less than 100 m^3 per capita, that this report has created a special "exceptionally scarce" category for them.

Water scarcity in the Arab region is accentuated by the utilization of about 85 per cent of total water withdrawals for the agriculture sector, which is characterized by low irrigation efficiency and crop productivity. Immense pressure has been exerted on the scarce water resources, including non-renewable groundwater, as reflected in the high rates of water withdrawals for agriculture, averaging about 630 percent of total renewable water resources in the Gulf Cooperation Council (GCC) countries, reaching about 2,460 percent in Kuwait. According to FAO, countries are in a critical condition if they use more than 40 percent of their renewable water resources for agriculture and could be defined as water-stressed if they abstract more than 20 percent of these resources. Based on this definition, 19 Arab countries could be defined as water-stressed, because their current abstraction rates from their renewable water resources for agriculture greatly overshoot the defined limits. Only Lebanon, Djibouti and Mauritania fall outside this category.

Improving the state of food security in Arab countries through domestic production, under limited cultivable land, highly stressed and dwindling water resources, coupled with an impoverished bio-capacity of agricultural resources, is a challenging task. Nevertheless, considerable prospects do exist for enhancing the food self-sufficiency ratio through adoption of the right policies and improved agricultural technologies, and setting up an integrated food value chain capable of ensuring food security built on the pillars of availability, accessibility, stability, and utilization of food.

Improving the self-sufficiency aspect of food security requires an all-inclusive regionally integrated approach, recognizing the interdependence of the food-water-energy nexus, and a new paradigm of agricultural sustainability, based on economic, social, and environmental considerations. Within this framework, a number of options can be identified to enhance the food self-sufficiency ratio, particularly through the efficient utilization of available agricultural resources, in addition to livestock and fisheries resources. These options include the following:

Improving Irrigation Efficiency

Producing more agricultural outputs with less water is an option of significant importance for enhancing food security in water-scarce countries. It depends on the right type of canals used to deliver water to the field, more efficient irrigation methods, such as sprinkler and drip irrigation, raised broad-bed planting and the level of farmer organization and discipline.

Average irrigation efficiency in 19 Arab countries is below 46 percent, dropping to below 40 percent in some of them. It is estimated that raising this figure to 70 percent would save about 50 billion m^3 of water annually. With an irrigation requirement of 1,500 m^3 of water per ton of cereals, this would be enough to produce over 30 million tons, equivalent to 45 percent of cereal imports with a value of about $11.25 billion at 2011 import prices.

Boosting Crop Productivity

Crop productivity in the Arab region is generally low, particularly that of staple cereals, averaging about 1,133 kg/ha in five major cereal producers (Algeria, Iraq, Morocco, Sudan, and Syria), compared to a world average of about 3,619 kg/ha. Ongoing research by the International Center for Agricultural Research in the Dry Areas (ICARDA) has shown considerable increases in wheat yield at demonstration fields versus farmers' fields in both irrigated and rain-fed systems in countries such as Egypt, Morocco, Sudan, Syria, and Tunisia. For example, rain-fed planting in Egypt resulted in a 30 percent increase in grain yield, 25 percent saving in irrigation water, and 72 percent in water use efficiency.

It is critically important to improve crop productivity in rain-fed areas, which constitute over 75 percent of the cultivated area in the Arab region. FAO and ICARDA refer to various forms of rain-water harvesting including in situ water conservation, flood irrigation, and storage for supplementary irrigation. Work in some developing countries has shown that yields can be increased two to three times through rain-water harvesting, compared with conventional dry farming. Increasing average rain-fed cereal yield from its current level of about 800 kg/ha to two to three times would add between 15 to 30 million tons of cereal to current annual production of about 51 million tons in the Arab region.

Improving crop yield in irrigated and rain-fed areas has a considerable potential for enhancing food self-sufficiency in the Arab region, through promoting research, technology transfer and investment in rain-fed agriculture. Application of best agricultural practices is crucial, including optimization of the use of fertilizers, pesticides and other inputs, coupled with good management of the available agricultural resources. However, the impact of climate change in the Arab region is expected to be manifested in drastic decline in crop productivity, and needs to be addressed through the adoption of effective adaptation and mitigation measures.

Improving Water Productivity

In addition to increasing irrigation efficiency, water productivity can be increased in either economic or physical terms, through the allocation of water to higher value crops or by achieving 'more crop per drop' of water, respectively. The choice of which of these options to pursue depends on whether crop value or quantity is more relevant to a country within the broader political, economic, social, and environmental context.

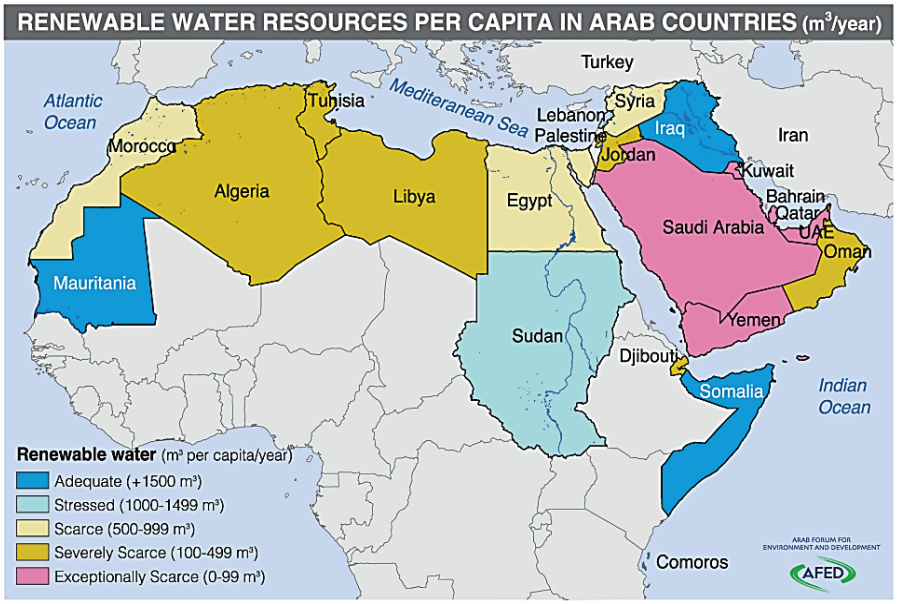
Water productivity can be enhanced by a combination of factors, including improved agricultural practices, such as modern irrigation methods, improved drainage, conservation agriculture or no-till farming, utilization of the available improved seed, optimizing fertilizer use, innovative crop protection techniques, and effective extension services. Such farming practices as water harvesting, supplemental and deficit irrigation, water conservation, and organic agriculture are not only conducive to raising water productivity, but they are also very important for enhancing agricultural sustainability. In addition, water productivity can be further improved by shifting consumption habits towards crops of similar nutritional value but with less virtual water content.

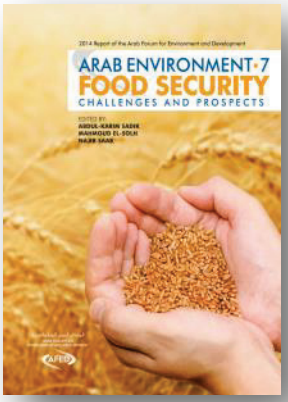
Water Reuse

Wastewater remains largely untapped for agricultural use in Arab countries. Only about 48 percent of municipal wastewater of about 14,310 million m^3 annually is treated, with the remaining amount discharged without treatment. The amount used for agricultural irrigation does not exceed 9 percent of the treated wastewater in countries such as Egypt, Jordan, Morocco and Tunisia, while GCC countries use about 37 percent of treated wastewater for agriculture.

Food Security in Arab Countries

The 2014 report of the Arab Forum for Environment and Development (AFED) on Food Security points out that the Arab region imports about half the food it needs. However, Arab countries can boost their food production, primarily by improving crop productivity and irrigation efficiency, in addition to regional cooperation.





■ **Scarce water:** The average annual renewable water resources per capita in the Arab region is less than 850 m³, compared to a world average of 6000 m³. 13 countries are classified in the severely water scarce category, at less than 500 m³. The situation is so alarming in 6 of these countries, with less than 100 m³, that AFED report created a special "exceptionally scarce" category for them. 85% of fresh water is used in agriculture

■ **Self-sufficiency:** 46% in cereals, 37% in sugar, and 54% in fats and oils. The Arab region imports about half its food. Cereal annual production: about 51 million tons

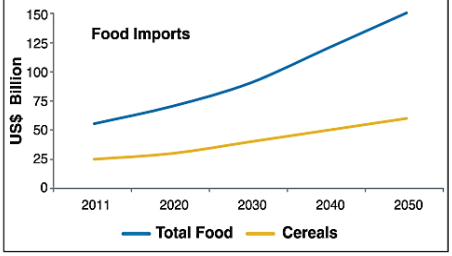
■ **High losses:** Grain post-harvest and wheat import losses: US$4 billion at 2011 import prices. This represents 40% of wheat produced in Arab countries or 4-month worth of wheat imports

■ **Low wastewater treatment:** 48% of 14 billion m³ annually in the Arab region. Only 9-37% of treated wastewater used in agriculture

■ **Low cereal productivity:** Average 1133 kg/ha in five major producers (Algeria, Iraq, Morocco, Sudan and Syria), compared to a world average of 3619 kg/ha. Egypt is an exception, with 7269 kg/ha

■ **Low irrigation efficiency:** Below 46% in 19 Arab countries. Raising this figure to the world average of 70% would save 50 billion m³ of water annually, enough to produce over 30 million tons of cereals, equivalent to 45% of cereal imports

■ **Food imports** of Arab countries amounted to US$56 billion in 2011, projected to shoot up to US$150 billion in 2050. Staple cereals constituted about 63% of the total



■ **Changing food habits: Arab countries, as a group, are self-sufficient in fish, but 25% of meat demand is imported. AFED report calls for increasing the production of fish and poultry and shifting towards less water-thirsty and more nutritive crops. This requires changes in food consumption habits**

Source: AFED Report 2014, *Arab Environment: Food Security*. Map: AFED-Geoinformatics/ICARDA
(Divisions between countries may not precisely reflect internationally recognized boundaries)

The fact that a higher percentage of treated wastewater is used for agriculture in GCC countries than in other Arab countries is prompted by the severe scarcity of freshwater resources, and the enormous pressure impacted on them through withdrawal for agriculture use, in addition to adopting improved treatment standards to ensure safe use of treated wastewater.

Where food production is heavily dependent on rain-fed agriculture and freshwater resources are declining rapidly, the alternative of water reuse for irrigation in Arab countries should be encouraged and supported. According to FAO, by converting from rain-fed to irrigated agriculture, it is possible not only to increase yields of most crops by 100 to 400 percent, but can also allow for the growth of alternative crops with higher income and value.

Reducing Post-harvest Losses (PHL)

The main causes of these losses are attributed to improper methods used in the harvesting, processing, transportation, and storage of the crops, as well as inefficient import supply chain logistics. It is estimated that the annual losses of grains in Arab countries amounted to about 6.6 million tons in 2012. In addition, loss in imported wheat in some Arab countries translates to about 3.3 million tons due to inefficient import logistics. The combined value of grain PHL and wheat import losses amount to about $3.7 billion at 2011 import prices.

A reduction in cereal losses along the food supply chain cannot be overemphasized, because such losses represent not only a waste in food supply and other natural resources, including land, water, energy, fertilizers, pesticides, and labor, but can also cause damage to the environment, arising from gas emissions.

Regional Cooperation

Cooperation among Arab countries based on comparative advantage in agricultural and financial resources is a key option for enhancing food security at the regional level. To be effective it requires an approach based on the harmonization of national agricultural strategies and policies; more investment in science and technology and agricultural development; regulations, measures and incentives conducive to the efficient use of resources; and the conservation of the productive bio-capacity of land and water resources which constitute the cornerstone for food production at the national, sub-regional, and regional levels. A wider regional cooperation should stretch across the Mediterranean and cover neighboring countries in Africa.

Development of Livestock and Fisheries

Arab countries have considerable livestock and fisheries resources. They are almost self-sufficient in fish, but about 25 percent of meat demand is being met through imports. This percentage is expected to increase in the future driven by population, wealth and urban growth.

The productivity of the livestock sector in the Arab region is hampered by the scarcity of natural resources, in particular of feed and water. Lack of supporting infrastructure and services and arbitrary policies have affected the sector negatively. Only four major feed ingredients were imported by the Arab countries at a cost of about $10.4 billion in 2012. Producing feed locally has resulted in the deterioration of non-renewable water resources, and the degradation of the natural feed resources, leading to loss of biodiversity, soil erosion, and consequently livestock productivity. In the face of high aridity and vast areas of marginal land, pastoralists and rain-fed livestock production systems remain the most resilient, thus policies supporting their movement and access to grazing lands are needed.

The fisheries sector in Arab countries has a great potential not only to meet domestic demand, but also to be exported. In 2013, fish exports amounted to 912,460 tons, with a value of about $3 billion. However, there is potential to further growing these exports; unlocking the potential of the fisheries sector requires addressing the various problems and bottlenecks facing its development. Most importantly, there is a need for investing in the fishing industry and, among other things, enacting laws and legislation with respect to fishing in natural grounds and in fish farming activities.

Fish is not a less important source of protein intake than meat. Consuming fish should be encouraged to reduce excessive consumption of meat for economic and health reasons, as well as considering the impact of livestock production on the scarce water resources and the environment. In general, an awareness campaign is needed to encourage consumers to adapt their food consumption habits towards healthier patterns, and more conducive to the sustainability of agricultural resources.

Virtual Water

Despite reservations about the virtual water concept as a policy tool for addressing challenges related to the water-food nexus, it remains useful in the context of a country's specific water situation, and the overall role of agriculture in economic and social development. The virtual water concept can be an important tool for cooperation on food security between regions based on their geographical proximity, and comparative advantage in agricultural resources. This could for instance mean expanded cooperation between Arab and African countries, where limited land and water scarcity in Arab countries can be compensated by the comparative advantage of African countries in natural and agricultural resources.

Conclusion

AFED report confirmed that achieving food security in the Arab region is doable. Some may perceive this as unrealistic, in a region that is currently struggling with major problems. However, in the aftermath of wars and conflicts, 400 million people will still need to be fed. This is feasible by increasing land productivity, improving irrigation efficiency and changing food consumption patterns, in parallel with enhanced regional cooperation.

This coincides with the fifth anniversary of UNESCO's recognition of the Mediterranean Diet as a Cultural Heritage, and its potential role in sustainable food consumption. Changing lifestyle habits needs persistent educational and public awareness efforts, sound government policies and business strategies, in combination with the encouragement of individual and society actions, and involvement of civil society and academia, together with media.

A public opinion survey running concurrently with the report will examine to what extent Arab individuals are prepared to change their consumption habits and lifestyles towards a more sustainable and resource-friendly direction. Let's wait and see whether Egyptians are ready to replace rice with pasta, and what are the chances of more fish and chicken on a Saudi plate rather than red meat!

All these measures can be successful only if coupled with environment protection, given that the preservation of natural resources remains at the heart of promoting sustainable production and attaining food security.
Recognizing that changing consumption habits is indispensable tool for balanced resource management and protection of the environment, AFED chose Sustainable Consumption as topic for its 2015 annual report, which will cover water, energy and food, and link them as nexus.

Arab Forum for Environment and Development (AFED)

It is an independent international organization headquartered in Beirut, Lebanon, working in the 22 member countries of the League of Arab States (www.afedonline.org).

AFED members include corporations, universities, research centers, media networks and civil society, alongside government entities as observers. Since it started its operations in 2007, AFED has become a public forum for influential eco-advocates, and a major player in the global environmental arena. The flagship product of AFED is an annual report on the state of Arab environment, tracking developments and proposing policy measures. Topics covered so far by the reports included: Future Challenges, Impact of Climate Change on Arab Countries, Water, Green Economy, Ecological Footprint, Sustainable Energy and Food Security. Initiated by Mostafa Kamal Tolba and Najib Saab as editors, AFED reports have attracted leading experts from the region and beyond, gained respect as credible and independent sources of information and analysis, and triggered various policy changes at the national and regional levels. Other AFED initiatives include Green Economy, Corporate Environmental Responsibility, Public Awareness and Environmental Education. AFED publishes a pan-Arab mass circulation magazine, Al-Bia Wal-Tanmia (Environment & Development), with print and online editions (www.afedmag.com)

Produire mieux en s'adaptant au changement climatique
Des Groupements Paysans au Maghreb s'engagent dans des agro-systèmes innovants

Hassan Benaouda
Ingénieur en Chef Principal, Chercheur en Agro-Climatologie, Institut National de la Recherche Agronomique (INRA)
Chef du Centre Régional de la Recherche Agronomique de Kénitra, Maroc

El Hassane Bourarach
Enseignant-chercheur au Département Energie et Agroéquipements à l'Institut Agronomique et Vétérinaire Hassan II, Directeur de l'Ecole de Génie Rural, Maroc

Bruno Vadon
Ingénieur agronome
Animateur du réseau méditerranéen RCM (Réseau Innovations Agro-Systèmes Méditerranéens)
Chargé de Projets Méditerranée pour Fert

Les informations contenues dans cet article sont issues d'actions menées, depuis plus de dix ans auprès de groupements paysans au Maghreb, par Fert et ses partenaires : l'INRA (Institut National de la Recherche Agronomique, l'IAV Hassan II (Institut Agronomique et Vétérinaire), et l'ENA (Ecole Nationale d'Agriculture) au Maroc ainsi que l'INGC (Institut National des Grandes Cultures) en Tunisie, sur la thématique de l'Agriculture de Conservation (AC).

Fert est une association de coopération internationale créée en 1981. Elle est issue de la profession agricole française et a pour mission de contribuer à instaurer, dans les pays en développement, les conditions permettant aux paysans de mieux assurer l'approvisionnement de leurs pays en améliorant leurs conditions de vie et de travail. A cette fin, Fert promeut la création, par les producteurs, d'organisations qui leur apportent des solutions durables aux problèmes qu'ils rencontrent dans l'exercice de leur métier et la défense de leurs intérêts.

Pour plus d'informations

http://www.fert.fr/

Des sols dégradés par des pratiques inappropriées et un climat aléatoire

Des problématiques diversifiées mais un défi prioritaire

Les pays du Maghreb sont globalement déficitaires en céréales, légumineuses et fourrages. Les évolutions techniques récentes ne suffisent pas à satisfaire les besoins alimentaires d'une population rurale et urbaine en augmentation. Les systèmes agricoles prédominants dans la région (polyculture-élevage) doivent bénéficier de réelles innovations pour pouvoir améliorer de façon durable la production. Aujourd'hui, les paysans du Maghreb sont confrontés à des défis très divers : climat aléatoire et de plus en plus extrême, hausse des coûts de production, manque de main d'œuvre et de matériel adapté, isolement face aux progrès techniques (d'où une agriculture à deux vitesses), débouchés limités pour certaines productions (légumineuses), omniprésence de troupeaux qu'il faut alimenter, préservation des ressources naturelles (eau, biodiversité), etc.

Parmi ces nombreux défis à relever, la préservation des sols est trop souvent négligée. Elle est pourtant fondamentale, car c'est la base de la production agricole, et donc un pilier de la souveraineté alimentaire des pays. Les questions liées à la perte de fertilité ainsi qu'à l'érosion des sols préoccupent depuis longtemps certains agronomes et chercheurs, mais les politiques agricoles et les programmes de développement sont encore faibles sur le sujet. La dégradation des sols résulte d'une combinaison de facteurs dont notamment l'impact des pratiques agricoles (travail intensif du sol, monoculture, surpâturage) et l'effet des pluies ou du vent.

Les paysans qui en ont les moyens compensent la baisse de fertilité de leurs sols par des apports d'engrais chimiques, trop rarement par des apports d'engrais organiques. Mais avec le renchérissement tendanciel des intrants et de l'énergie, beaucoup subissent maintenant la situation et voient stagner ou baisser leurs rendements, et donc leurs revenus. Quant aux effets physiques de l'érosion, ils les constatent chaque année davantage dans leurs parcelles ravinées. A l'échelle des bassins versants ce sont les collectivités publiques qui doivent intervenir sur les routes couvertes de coulées de boue ou quand la terre finit dans les barrages. Pour les paysans, la dégradation inexorable de leurs sols est une menace pour la pérennité de leur activité et donc une épée de Damoclès pour les générations futures.

Figure 1
Erosion hydrique dans le Moyen Atlas

La variabilité et l'impact du climat s'accentuent au Maroc

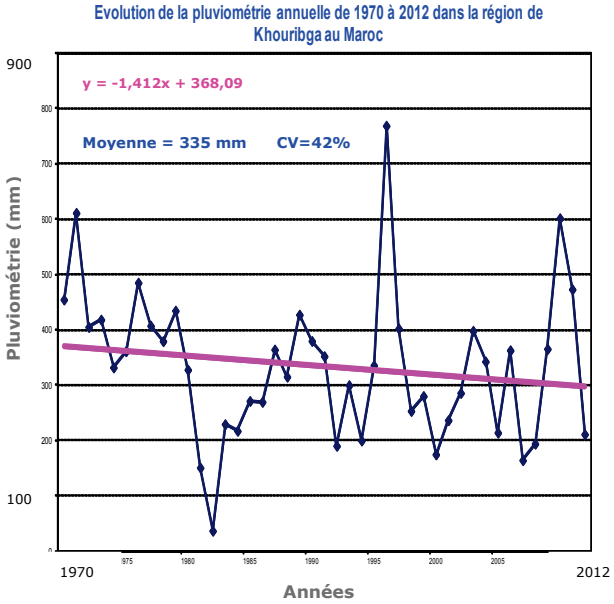
Au Maroc, l'eau constitue le facteur majeur limitant la production agricole. Les disponibilités hydriques sont déterminées par une pluviométrie faible et aléatoire, des sols généralement peu profonds à capacité de stockage insuffisante, et une température élevée en fin du cycle des cultures.

Dans la majorité des régions les quantités de pluies annuelles reçues connaissent de grandes fluctuations dans le temps et dans l'espace. Des périodes de déficits hydriques plus au moins longues peuvent intervenir à tout moment de l'année. Les sécheresses de fin de cycle sont les plus fréquentes, celles de milieu de cycle sont rares mais sont les plus dangereuses. La distribution intra- annuelle des pluies peut être très différente d'une année à l'autre. La moyenne annuelle de la pluviométrie dans la majorité des régions marocaines se situe entre 200 et 400 mm. La variabilité interannuelle de la pluviométrie est très forte (coefficient de variation allant jusqu'à 45 %). La pluviométrie connaît une nette tendance vers la baisse (figure ci-dessous). Sur la période considérée, de 1970 à 2012, cette réduction est d'environs 1,4 mm/an.

Depuis quelques années, les périodes sèches sont suivies par des périodes de pluies excessives, entrainant des inondations dans les plaines, mais emportant aussi des milliers de tonnes de terre dès que le relief s'accentue.

En agriculture pluviale, ces situations très contrastées et aléatoires, rendent très difficiles l'amélioration et surtout la stabilisation des rendements des céréales (la moyenne nationale se situe aux alentours de 15 qx/ha en Blé tendre et 9 qx/ha en orge). Dans ces conditions, les producteurs minimisent les risques en limitant les intrants, en optant pour la monoculture des céréales, ou en ne recherchant la biomasse que pour l'alimentation du cheptel (en cas de pluviométrie insuffisante pour la production des grains). Rares sont ceux qui pensent pouvoir améliorer leur production en se préoccupant d'avantage de leur sol et en diversifiant les espèces cultivées.

Figure 2



Des pratiques qui favorisent l'érosion

Actuellement les itinéraires techniques les plus utilisés pour l'installation des cultures sont basés sur les outils à disques (environ 80% de la SAU), principalement les pulvériseurs à disques moyens (cover-crops) qui sont les plus répandus. L'utilisation des charrues à disques en tête d'assolement est courante, les grandes exploitations ont plutôt recours aux pulvériseurs à disques lourds (stubble-plows) pour leur rapidité de travail et leurs coûts plus faibles. Les travaux du sol en début de campagne sont conditionnés par l'arrivée des premières pluies. Or, celles-ci étant très variables, l'installation des cultures est tantôt précoce (exigeant une bonne maitrise des adventices), tantôt tardive (décalage du cycle cultural).

L'attente des premières pluies, combinée à la faible mécanisation (0,48 CV/ha, 6 tracteurs/1000ha), se traduit par un goulot d'étranglement en début de campagne qui contraint les agriculteurs à travailler dans de mauvaises conditions: compaction du sol et gâchage de sa structure[1] en condition humide ou production de terre pulvérisée en sol sec. Notons que c'est la production de terre fine, voire de poussière, nécessitant du reste de grandes quantités d'énergie fossile, qui est à l'origine des phénomènes d'érosion éolienne et hydrique. Tout ceci se traduit *in fine* par des rendements limités.

Figure 3
Passage de « cover crop » et érosion éolienne

Atouts et contraintes des alternatives basées sur l'Agriculture de Conservation (AC)

Buts et principes de l'AC

Face aux impasses auxquelles peuvent mener les systèmes de production « conventionnels », des pratiques alternatives (souvent englobées dans la dénomination « agro-écologie ») se sont développées à travers la planète afin de réduire l'impact des interventions humaines sur le potentiel agronomique du sol. Parmi celles-ci la réduction, voire l'élimination, du travail du sol est à la base des systèmes de production en AC. Ces systèmes développent des pratiques qui visent non seulement à maintenir physiquement la terre en place sur les parcelles (lutte contre l'érosion), mais aussi à redynamiser l'activité biologique des sols (en favorisant le travail naturel de la macrofaune, en activant la vie microbienne et le fonctionnement des mycorhizes, ainsi que toutes les synergies si mal connues qui existent au niveau des racines des plantes). Le principal moteur du système est la matière organique du sol qui est fondamentale pour la stabilité structurale, la rétention de l'eau et plus globalement pour la vie du sol.

Afin d'atteindre ces objectifs, la mise en place de ces systèmes innovants passe par les trois piliers suivants :

- Suppression du labour et si possible de tout travail superficiel du sol (passage au « Semis Direct ») ;
- Introduction de rotations culturales longues et variées (céréales, légumineuses, fourrages) ;
- Maintien d'un couvert végétal sur le sol (résidus de cultures et/ou plantes de couverture).

Ces systèmes sont développés depuis des décennies dans d'autres régions du monde. Dans la zone méditerranéenne, l'Espagne est le pays le plus avancé en termes de surfaces. Au Maghreb, des recherches ont été menées depuis longtemps mais la diffusion au niveau des producteurs reste encore limitée. Parmi les contraintes du système « semis direct », la disponibilité de semoirs adaptés aux capacités des petites et moyennes exploitations est un élément déterminant. Parmi les divers acteurs qui se préoccupent de la conservation des sols au Maghreb, Fert et ses partenaires professionnels et institutionnels, tentent de trouver des solutions validées par les paysans eux-mêmes afin de mettre ces innovations à la portée du plus grand nombre.

Abandonner le travail du sol et passer au semis direct

Les contraintes climatiques et économiques, présentées plus haut, ont poussé certains agriculteurs à simplifier leurs pratiques. Mais, la solution ultime réside dans l'adoption du semis direct sans travail préalable (No-Till). Cette technique nécessite un semoir spécifique permettant d'intervenir en sol sec si possible, avant l'arrivée des premières pluies, sans trop perturber le sol et, de pouvoir semer dans les résidus des cultures précédentes ou sous couvert végétal entretenu. Le sol n'étant pas remanié, ce type de semoir doit incorporer également les engrais. Ces caractéristiques exigent la conception de semoirs robustes et relativement lourds. Compte tenu du morcellement des exploitations agricoles (en moyenne 0,8 ha par parcelle et 6 parcelles par exploitation), le semoir tracté est recommandé, avec des largeurs de travail de 2 à 3 mètres. Cependant, pour un semoir plein, prêt à semer, ces exigences mènent à la limite des capacités de relevage des tracteurs les plus courants au Maroc (70-85 CV).

Figure 4
Le prototype de semoir SD testé au Moyen Atlas

[1] Le passage des engins motorisés en conditions humides compacte le sol et détruit sa structure de manière difficilement réversible et diminue sa porosité (gâchage), ce qui se traduit par une circulation plus difficile de l'air et de l'eau dans le profil cultural et une inhibition du développement racinaire.

Au Maghreb en général, l'offre en semoirs spécialisés « semis direct » est limitée et n'est adaptée qu'aux gros tracteurs. Le développement de semoirs directs adaptés aux spécificités méditerranéennes et en particulier celles du Maghreb, impose une approche intégrant les exigences techniques susmentionnées, tout en respectant les conditions socioéconomiques locales et donc en associant les paysans à la démarche de conception.

Suite à un premier travail allant dans ce sens et réalisé par le CRRA[2] de Settat ainsi que par l'IAV Hassan II[3] dans les années 2000, de nouvelles initiatives émergent depuis quelques années. Actuellement, un système innovant et prometteur de semoir direct avec disque incliné et poussé (principe de la brouette), issu d'un concept de l'IRSTEA[4] (ex-CEMAGREF[5] en France) est en cours d'introduction et de développement auprès de coopératives dans des régions de montagne au Maroc (Moyen Atlas et Rif) et récemment dans le nord-ouest de la Tunisie (actions Fert en partenariat avec ENA[6]-IAV-INRA/Maroc et INGC[7]-INRAT[8]-ESIER[9]/Tunisie). Ce concept original assure au semoir une bonne pénétration dans le sol, sans besoin de poids important (donc moins de puissance de traction) et permet l'ouverture d'un sillon dans lequel l'engrais puis la semence sont disposés dernière le disque. La terre soulevée retombe sur l'engrais et la semence après le passage du disque et une roue termine le travail en appuyant sur le sillon.

Depuis 2011, sur la base de ce concept, plusieurs prototypes de semoir porté pour cultures d'automne (céréales, féveroles) ou de printemps (maïs, sorgho, pois-chiche) ont été introduits au Maroc et en Tunisie. Un prototype pour la traction animale est encore en cours d'amélioration au niveau de notre partenaire AFDI-Touraine[10] en France. Dans un souci de durabilité, des artisans-réparateurs locaux ont été associés à l'utilisation et à la réparation des semoirs introduits. Une fois les prototypes mis au point, et en fonction des spécificités du marché, de petits industriels seront identifiés en vue de fabriquer ces semoirs localement.

Allonger les rotations et couvrir le sol

Le raccourcissement de la période de croissance au niveau de plusieurs régions du Maroc devient un phénomène inquiétant menaçant l'agriculture pluviale. Seule la région nord ouest dispose d'une période de croissance suffisante pour offrir la possibilité d'un grand choix de cultures. Ce phénomène, très lié aux changements climatiques de ces dernières années, mérite des réflexions approfondies et la définition de nouvelles stratégies agricoles adaptées à ces nouveaux environnements.

Vues les conditions climatiques, il devient indispensable d'adopter des techniques culturales permettant une économie et une utilisation efficiente de l'eau. L'utilisation de variétés à cycles courts, caractérisées par une plus grande plasticité vis-à-vis des fluctuations environnementales, et installées précocement permet d'échapper aux sécheresses fréquentes de fin de cycle. Ceci est possible grâce à l'introduction du semis direct et à la réduction des doses de semis qui contribuent fortement à réduire les effets des déficits hydriques.

Figure 5
Semis sur résidus de culture

Dans les régions semi-arides du sud de la Chaouïa ou du Moyen Atlas, les agriculteurs ont pu constater que dans les conditions de sécheresse, les parcelles en semis direct résistent beaucoup plus longtemps que celles en semis conventionnel. Ils ont compris l'intérêt de la présence des résidus de cultures à la surface du sol pour minimiser l'évaporation et maintenir l'humidité du sol (bien que le pâturage rentre en concurrence avec cet objectif). Ils ont aussi remarqué l'intérêt des faibles doses de semis dans le système semis direct (elles sont passées de 180-200kg/ha à 120-130kg/ha). Ces producteurs ont aussi redécouvert l'intérêt agronomique d'introduire des légumineuses dans leur rotation, bien que ces cultures nécessitent de la main d'œuvre et ont des débouchés aléatoires.

Ainsi, la pratique du semis direct dans le respect des principes de l'Agriculture de Conservation, s'avère être un système d'avenir pour l'amélioration et surtout la stabilisation des rendements dans ces régions où l'aléa climatique prime. Le point faible reste le contrôle des adventices qui nécessite, au moins durant les premières années car la couverture du sol est insuffisante, une utilisation d'herbicides souvent mal maîtrisée. Des travaux sur le sujet sont en cours pour réduire l'enherbement par des associations d'espèces adaptées, notamment en lien avec des paysans et des chercheurs français de l'Institut ARVALIS[11].

[2] Centre Régional de la Recherche Agronomique
[3] Institut Agronomique et Vétérinaire Hassan II (Rabat)
[4] Institut National de Recherche en Sciences et Technologies pour l'Environnement et l'Agriculture
[5] Centre d'Etudes du Machinisme Agricole
[6] Ecole Nationale d'Agriculture de Meknes
[7] Institut National des Grandes Cultures
[8] Institut National de la Recherche Agronomique de Tunisie
[9] Ecole Supérieure des Ingénieurs de l'Equipement Rural
[10] Agriculteurs Français pour le Développement International

[11] ARVALIS Institut du Végétal, Institut de recherche appliquée géré par la profession agricole française.

Rompre l'isolement et promouvoir l'innovation par une approche collective

Le passage d'une agriculture conventionnelle à un système innovant comme l'Agriculture de Conservation oblige les acteurs à changer complètement de paradigme. Pour le paysan qui s'y engage, et qui prend certains risques techniques et économiques dans la phase de transition, il y a aussi un risque d'isolement vis à vis de son environnement institutionnel. Il est donc primordial que le changement de système se fasse dans le cadre d'un groupe où chacun peut exprimer ses problèmes et échanger concrètement sur de bonnes pratiques. Les visites de parcelles de références chez les paysans et les « tours de plaine » en groupe, accompagnés d'un technicien ou d'un chercheur, sont des activités de base dans les programmes que nous mettons en œuvre.

L'acquisition et la gestion en commun du matériel est un autre élément clé de la réussite. En effet, que ce soit pour tester progressivement le système, ou parce que le matériel est trop coûteux, le groupement est un bon moyen de s'équiper et de mutualiser l'investissement ainsi que les frais d'entretien nécessaires. Les divers projets menés par Fert et ses partenaires se font toujours avec des groupes de base informels ou structurés sous forme d'associations ou de coopératives.

Enfin, les regroupements de producteurs, en lien avec les chercheurs, peuvent devenir des interlocuteurs des pouvoirs publics dont le soutien est indispensable à l'extension de ces systèmes innovants. Démontrer la faisabilité du semis direct à l'échelle d'un territoire donné est indispensable, mais son développement à grande échelle nécessite une recherche agronomique et un accompagnement technique poussés, des programmes de formation adaptés à divers publics (agriculteurs, techniciens, étudiants) et enfin des politiques publiques d'incitation (subventions du matériel, primes à l'hectare).

Entre Recherche, Formation et Politiques agricoles, le rôle des Groupes Paysans sera déterminant

Des groupes de producteurs engagés dans l'AC existent depuis des années au Maroc, en Algérie et en Tunisie. Ils sont en lien avec des instituts nationaux de recherche appliquée et font partie, avec d'autres groupes du Portugal, d'Espagne et de France, du réseau méditerranéen RCM (Réseau Innovations Agro-Systèmes Méditerranéens) animé par Fert (wwwrcmed.org). Ce réseau favorise les échanges d'expériences entre les pays de la région et a déjà organisé depuis 2001 quatre « Rencontres Méditerranéennes du Semis Direct », notamment avec l'appui du CIHEAM. Dans ce contexte, le CIHEAM-Zaragoza, Fert et l'ICARDA prévoient d'organiser en avril 2016 à Saragosse une nouvelle session de formation de haut niveau sur l'Agriculture de Conservation en zone méditerranéenne.

Mais c'est à partir de l'expérience des groupes paysans locaux qu'il faut sensibiliser et former un large public dans chaque pays de la région. C'est dans le but de promouvoir ces innovations technologiques, au-delà des parcelles d'agriculteurs, que nous mettons progressivement en place des plateformes de démonstration sur des sites d'Instituts (comme l'ITA[12] de Tiflet au Maroc) ou sur des fermes de référence (comme celle d'Adnane Abderrabou au Krib en Tunisie). Elles sont destinées à affiner les acquis tout en offrant un espace de sensibilisation et de formation pour agriculteurs, étudiants, conseillers, chercheurs et décideurs.

Les expériences acquises sur le terrain par des « pionniers » de l'AC accompagnés par des agronomes motivés, au nord comme au sud de la Méditerranée, ont tracé de nouvelles pistes pour la recherche et le développement agricoles. Les groupements paysans qui s'y engagent sont des vecteurs efficaces pour diffuser ces pratiques innovantes qui redonnent du sens à leur métier tout en contribuant à améliorer de façon durable une production alimentaire stratégique pour la région. Il conviendrait que les pouvoirs publics en soient davantage convaincus et puissent ainsi soutenir ces démarches porteuses d'avenir. Mettons à profit l'année 2015 en tant que « année internationale des sols », pour y contribuer.

Bibliographie / Plus d'informations

- Balaghi R. et Benaouda H. Conférence Nationale : « Les changements climatiques au Maroc : défis et opportunités ». *Changements climatiques et agriculture au Maroc: impacts et incertitudes*. Rabat, 11-12 février 2009. Centre d'Accueil et de Conférence CAC-Hay.
- Balaghi R., Jlibene M., Benaouda H., Kamil H., Debbarh Y. 2011. *Projet d'Intégration du Changement Climatique dans la mise en œuvre du Plan Maroc Vert /(PICCPMV)*. Agence pour le Développement Agricole. Maroc.
- Benaouda.H, M. El Mourid, M. Boutfirass. *Climate Risk Analysis and Crop Management Decision Making Tools in Explore on Farm: Adoption of GAP for Wheat*, FAO – ICARDA.
- Bourarach El H. et al, *Agriculture de Conservation* (N° spécial). In Hommes Terre et Eaux. ANAFIDE, 149/150 Sept / Déc 2011.
- Bourarach El H. , *Mécanisation de l'installation des céréales d'automne en zones semi-arides du Maroc : aspects techniques et économiques*.Doctorat ès-Sc. Agronomiques, Juin 1989, IAV Hassan II, Rabat, Maroc.
- Fert, *Rapports d'activité de projets réalisés au Maroc et en Tunisie sur la période 2002-2014* : « Coopérative Khemisset Chaouia », « Coopératives et Blé », « AC Maroc-Mali », « AC Maghreb ».
- Vadon B.- Fert/RCM, Benaouda H., « *Organisations paysannes : un levier pour développer l'agriculture de conservation au Maghreb* » 3èmes Rencontres Méditerranéennes du Semis Direct, Saragosse Espagne, Mars 2006.

[12] Institut Technique Agricole (centre de formation professionnelle)

Sharing Knowledge Agrifood Networks - Bridging the gap, a Portuguese project with a global focus

Duarte Bué Alves
Senior Diplomatic Adviser of the Minister
of Agriculture and Sea, Portugal

Luís Mira da Silva
President of INOVISA,
Associate Professor – ULisboa / School of Agriculture
Coordinator of the SKAN platform

More information

www.skanplatform.org

One year ago, the Portuguese Government officially launched the SKAN initiative – Sharing Knowledge Agrifood Networks (www.skanplatform.org). This was done in an auditorium full of farmers, researchers, representatives of academia, civil society, diplomatic corps, three ministers and few journalists. The initiative fully emerged in mid-2014, precisely in the International Year of Agricultural Farming, according to the decision of the United Nations.

It is not usual to bring together diplomacy and agriculture but it is exactly not only what CIHEAM has been doing for decades but also what SKAN promotes – international dialogue between relevant players both at political and diplomatic level, the business community, universities and academia from all over the World, with a main focus on three continents: Europe, Africa and Latin America.

Why the SKAN initiative?

SKAN is an answer to global challenges, emerging needs and has a great potential.

Nowadays, the main challenge is the World population growth in the coming decades and the associated food security problem, namely in developing countries, that has to be addressed in a sustainable and responsible manner.

The efficiency of agrifood and forestry systems and the optimization of resource use, aimed at a green (and blue!) economic growth and social development are needed. The scenario is, of course, changing every day, but global international competition and emerging markets are a reality that has to be faced with creativity and resilience.

The potential is what we want it to be – a scientific and technological platform based on knowledge sharing, with room for valorisation to satisfy not only the existing needs but also those which are emerging.

SKAN's main objective is to promote knowledge and technology transfer and sharing between Europe, Africa and Latin America in the agriculture, food and forestry sectors. It aims to achieve this goal through an integrated approach that is focused on:

1) Strengthening the interplay between science and industry;
2) Integrating available resources, such as other networks and platforms, existing know-how, available scientific knowledge and funding sources for development and cooperation;
3) Enabling the development of international projects in consortium through a result oriented strategy;
4) Empowering local agents to ensure the sustainability of these projects.

Portugal has decided to launch this initiative for historical and political reasons: centuries of history have enriched our archives with a significant 'acquis' of knowledge that is extremely relevant to agriculture and forestry. Portuguese universities and research institutions have been developing for decades a structured and comprehensive approach to tropical agriculture, merging local know-how with international in-depth research. In fact, Portugal has a long history of looking abroad to create critical mass in scientific and technological development. This may explain why Portuguese universities and research institutions in the agrifood and forestry sectors have so many and so solid links with international partners. This is particularly true in Europe, Africa and America Latina, where it is possible to find numerous research projects and partnerships with Portuguese institutions.

In a diversified and every day more competitive World, Portugal has recognized that something had to be done with such 'acquis': it wouldn't make any sense to preserve it in dark libraries, miles away from where the fields are, where investors look at and – to sum up – where the needs are felt. Sharing knowledge and technology is therefore sharing what we are, because existing scientific and technological skills and knowledge can only be useful when applied to respond to real challenges, such as food safety and nutrition, food security, sustainable resource management or climate change.

Advantages of SKAN initiative

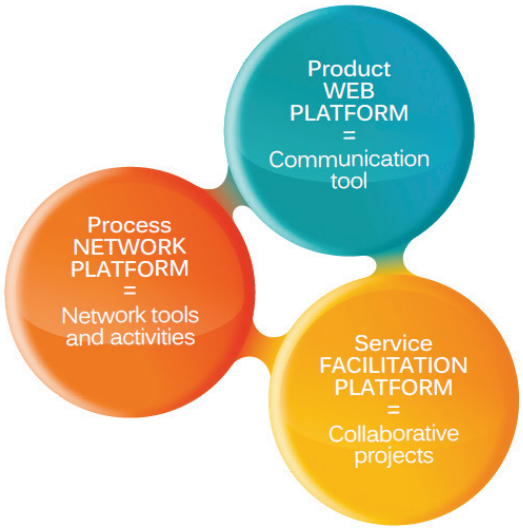
The vast majority of the research undertaken in the agrifood and forestry sectors do not belong to anyone – and in fact it is not to be owned. It is, by its nature, to be shared, and to be at the service of the international community. That is at the core of the SKAN initiative.

In a World full of complexities and uncertainties, one thing can be taken for sure: either we are able to innovate in every step of the way or someone will do it for us, take our place and go further. SKAN is also an engaged promoter of innovation, because creativity meets no boundaries when it comes to finding new answers to the needs of people in a World that is always reinventing itself.

We are fully aware, though, that in our societies financial resources are very limited. SKAN does not want to duplicate structures – on the contrary. It works mainly as an integrated Web and networking platform, where people can meet virtually, as in a social network, and presentially, in networking events (see Figure 1). Its Website is its basic tool, where not only information is shared but also where people can interact and projects initiated. It focuses on communication, bringing stakeholders together as a channel for sharing digital contents and information about agriculture and food. In addition, SKAN is also a platform to develop initiatives that put together a diversity of actors that may contribute to the development of the agrifood and forestry sectors, including farmers, business leaders, and researchers.

The third component of SKAN is a facilitation platform, a structure to promote the development of projects in consortium between international institutions from the research, business or public sectors, enhancing the potential of knowledge sharing and technology transfer. This facilitation platform can help to select partners, identify sources of financing, and structure the application, monitoring and evaluation of projects. It is therefore a natural extension of the Web and the networking platforms, increasing the overall potential of the SKAN initiative.

Figure 1
The three SKAN Platform components



SKAN aims at working as a wealth and job promoter, hand in hand with the development of science and business promotion, in the context of a growing World population whose needs have to be met. SKAN is a tool to be used by Governments as well as civil society, whether these are farmers, companies, NGOs or associations in the agrifood and forestry sectors. It is also, openly, an instrument that Portugal wants to promote to bridge gaps between regions of the World that are geographically distant but close in science and research.

Though the SKAN initiative is a long term project that is just at its beginning, some positive outcomes can already be claimed for. Formal partnerships have already been developed with several countries, including Mozambique, Angola, Cape Verde and Brazil. In only one year, already two large scale projects have been developed in Africa with the collaboration of the SKAN team. A new initiative, focused on the Community of Portuguese Speaking Countries (SKAN – CPLP), has recently obtained financing to pursuit the same objectives in these countries. Leadership workshops for higher education and research institutions in the agrifood sector have been organized in several countries in Africa. And several workshops, seminars and technology brokerage events have been, and are currently being organized, in several countries in Africa and Latin America. All this has been undertaken while creating new or strengthening existing links with African and Latin American partners, but also with European institutions.

An initiative like this one usually takes time to take off and sometimes struggles to find its place amid the multiple networks and international partnerships that are created every year. This has not been the case with the SKAN platform. In fact, we believe that there is so much yet to be done when it comes to global challenges such as food security, agriculture development, or technology and knowledge transfer, that any initiative that is open, collaborative and functional can have an important contribution to our common future. We expect that this initiative can have a positive impact in these global challenges, having the capacity of strengthening the links and the collaboration between Europe, Africa and America Latina in the agrifood and forestry sectors. And in fact, if the SKAN Platform continues the fast track that has been achieved in the recent past, it will surely have a role to play.

As we approach the Ministerial meeting of CIHEAM in Portugal, later this year, it may be relevant to say that the geographical configuration of SKAN is far from static. We do not have in mind rigid models – on the contrary. SKAN is able to accommodate different views and to answer evolving needs. The "Mediterranean platform", in its variety and richness, can also be a very challenging task for our project, bringing together the two different margins of our common sea.

Next CIHEAM Ministerial Meeting in Portugal

The 11th meeting of the Ministers of Agriculture of the 13 Member countries of CIHEAM is being prepared. It will take place in Cascais on September 22 and 23, 2015, at the invitation of the Portuguese Authorities. It will focus on the theme "Better Mediterranean agriculture and food for better live", addressing the need to implement applied agricultural research models based on Mediterranean networking and partnership.

As expressed by the Portuguese Minister of Agriculture and Sea, Mrs Assunção Cristas, 2015 is very rich in international events linked to the agricultural, food, fisheries and rural challenges. The Expo Milan 2015, the Blue Week in Lisbon, the Climate Conference in Paris or the definition of the agenda post-2015 will be at the core of the 2015 Year. Moreover, 2015 is the 20th Anniversary of the Barcelona Declaration and the Euro-Mediterranean Partnership.

In this perspective, the 11th meeting of the Ministers of Agriculture of CIHEAM's member countries could be an opportunity to reaffirm the Mediterranean issues within the global agenda for development and to reinforce the place of food security for a better Euro-Mediterranean cooperation.

Blue Week 2015

In June 2015, Portugal will host the Blue Week, a meeting platform for all of those who care about the ocean. The Blue Week has three dimensions business dynamics, strategic thinking and political discussion. For a week, Portugal will become the world capital of the Ocean.

This will give rise to three important meetings:

1. World Ocean Summit (3rd to 5th June)
2. Ministerial Meeting (5th June)
3. Blue Business Forum (4th to 6th June)

www.blueweek.pt

The Ecological Footprint of Mediterranean Diets

Nicole Grunewald
Research Economist, Global Footprint Network

Alessandro Galli
Director Mediterranean-MENA Program, Global Footprint Network

Katsunori Iha
Research Economist, Global Footprint Network

Martine Halle
Policy Analyst, Global Footprint Network

Global Footprint Network®
Advancing the Science of Sustainability

www.footprintnetwork.org

Michel Gressot
Senior Economist, Global Footprint Network

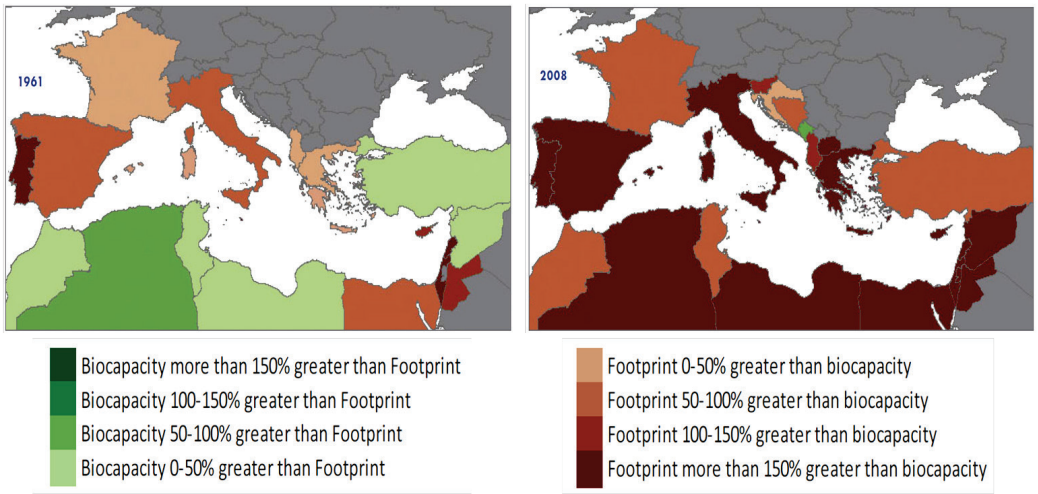
The provision of food is one of the vital services that nature provides to humanity. Conversely, the exploitation of nature to meet humanity's demand for food is one of the major causes of environmental degradation. In order to shed some light on this crucial interaction, we analyze the Ecological Footprint and biocapacity of 15 Mediterranean countries[1] and examine how the food sector contributes to the overall demand these countries place on our planet's natural capital. We discuss each Mediterranean country's efficiency in providing food to its residents by comparing the ratio of the Ecological Footprint of food demanded to the amount of food energy provided.

The Mediterranean Ecological Footprint and Biocapacity

Introduced in the early 1990s by Mathis Wackernagel and William Rees[2], Ecological Footprint accounting constitutes an accounting system to track human demand on (namely *Ecological Footprint*) and nature supply of ecosystems' resource provisioning (e.g., food) and climate regulating services (namely *biocapacity*)[3]. A country's Ecological Footprint of consumption is derived by tracking ecological assets in terms of different land types – which generate consumption goods and absorb wastes – and adding the imported goods in terms of ecological assets as well as subtracting the exported goods. For each produced or traded product, the Ecological Footprint is calculated by dividing the product amount by the yield of the land producing that product. Two factors are then used to convert actual physical hectares of land into an area of world average bio-productivity[4]. Biocapacity on the other hand reflects the ability of the ecosystem to produce consumption goods for human needs. Globally, population growth and a shift towards a more protein-based diet in emerging countries (e.g., China) are likely to increase the pressure on ecosystems to provide those consumption goods[5].

Figure 1 provides an overview of the Ecological Footprint and biocapacity in 24 Mediterranean countries[6] between 1961 and 2008[7]. The green colour indicates that the biocapacity is higher than the Ecological Footprint of consumption in the specific year and country; a red colour indicates a biocapacity deficit. Between 1961 and 2008 all countries in the Mediterranean have either turned into a biocapacity deficit or grown deeper into deficit than they were in 1961. Algeria experienced the greatest change from biocapacity 50-100% greater than its Footprint in 1961 to a Footprint more than 150% greater than its biocapacity in 2008.

Figure 1
Ecological deficit (red) or reserve (green) status of the Mediterranean countries in 1961 (left) and 2008 (right)



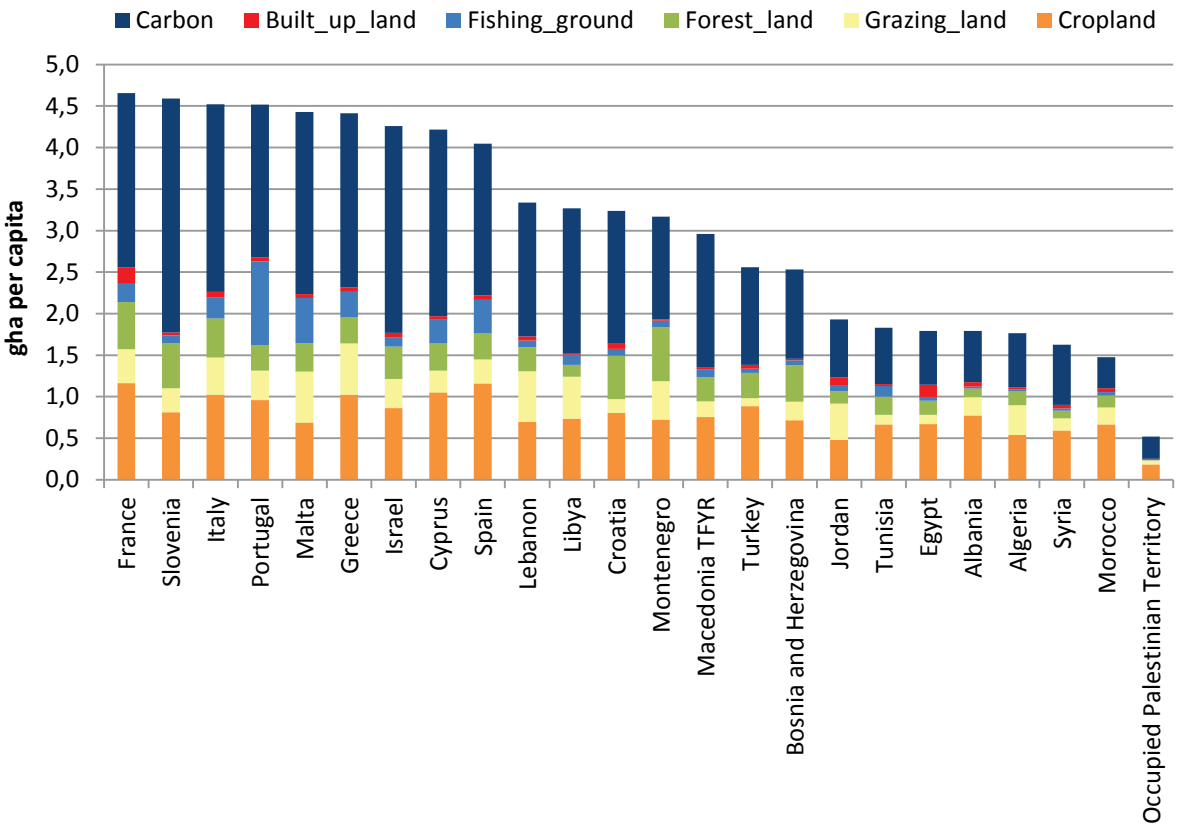
Ecological reserve (deficit) is defined as a domestic Ecological Footprint of consumption less (greater) than domestic biocapacity.
Source: Galli and Halle, 2014.

[1] For the analysis of the food sector only 15 Mediterranean countries have been analyzed due to data limitations, namely Albania, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Malta, Morocco, Portugal, Slovenia, Spain, Tunisia, and Turkey.
[2] Wackernagel, M., Rees, W.E., 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth*. New Society Publishers, Gabriola Island, BC.
[3] Galli, A., Wackernagel, M., Iha, K., Lazarus, E., 2014. Ecological Footprint: Implications for biodiversity. *Biological Conservation* 173, 121–132.
[4] For a detailed description of Ecological Footprint Accounting see Borucke et al., 2013. Accounting for demand and supply of the Biosphere's regenerative capacity: the National Footprint Accounts' underlying methodology and framework. *Ecological Indicators*, 24, 518-533.
[5] Odegard, I.Y.R. and van der Voet, E., 2014, The future of food — Scenarios and the effect on natural resource use in agriculture in 2050. *Ecological Economics* 97, 51-59.
[6] Ecological Footprint and biocapacity values are available for 24 countries in the Mediterranean region – all the countries that directly border the Mediterranean Sea plus three countries, Jordan, Macedonia and Portugal, which are ecologically characterized by typical Mediterranean biomes. However, due to data limitations, the food sector analysis was possible for only 15 of them.
[7] Galli, A., Halle, M., 2014. Mounting Debt in a World in Overshoot: An Analysis of the Link between the Mediterranean Region's Economic and Ecological Crises. *Resources*, 3(2), 383-394. Available at: http://www.mdpi.com/2079-9276/3/2/383

The Ecological Footprint analyzes demand on six different land types. The first three, namely crop and grazing lands and fishing grounds, are primarily demanded by the agriculture and food industry. The forest and built-up land provide construction material and the necessary ground for building infrastructure such as cities and roads. The carbon-uptake land – also referred to as carbon Footprint – reflects the waste absorption capacity in terms of forest land that would be required to sequester all anthropogenic CO_2 emissions released every year in the atmosphere.

Figure 2 gives an overview on the Ecological Footprint of consumption by different land types for each country in the Mediterranean in 2010. In this year, the Ecological Footprint of an average Mediterranean person was approximately 3.02 gha[8], slightly higher than that of an average world inhabitant (2.67 gha).

Figure 2
Ecological Footprint of consumption by land type of 24 Mediterranean countries, in 2010



The countries with highest incomes also have the highest resource demand in terms of Ecological Footprint. The Occupied Palestinian Territory has a very low Ecological Footprint, which is the result of its low disposable income and limited access to resources or consumption goods. The carbon Footprint varies the most between countries and rises with higher per capita income as people tend to consume more and more carbon-intensive products (e.g., electronics and luxury goods). Crop and grazing land demands vary less over the entire sample except the Occupied Palestinian Territories. Lower-income countries also show different dietary habits as they demand significantly less grazing land and fishing ground, indicating a diet based on carbohydrates rather than protein (see section 3).

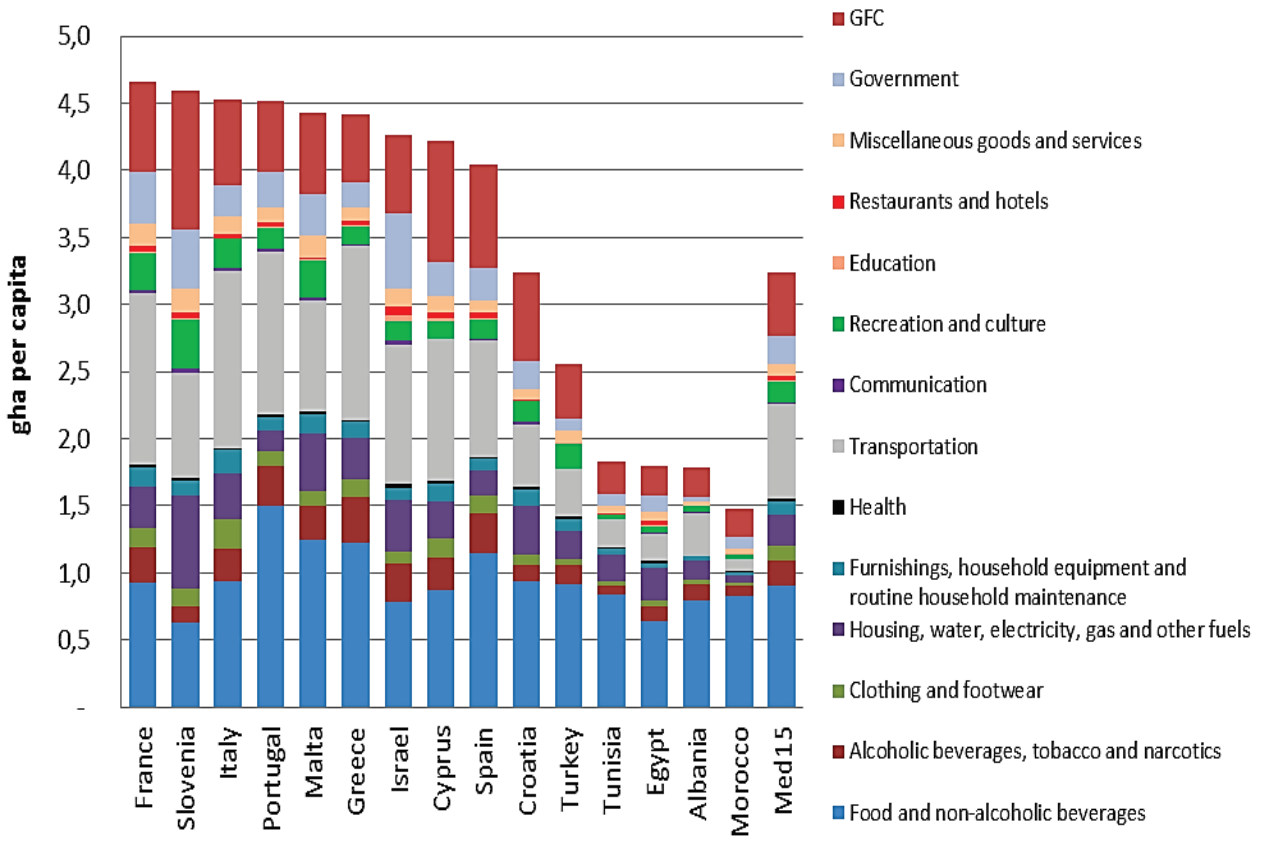
[8] Galli, A., Halle, M., Grunewald, N., *submitted for review*. On the physical limits to resource access and utilization and their economic implications in Mediterranean economies.

Household Resource Demand

Figure 3 gives an overview on the resource demand from household consumption (by COICOP category) as well as government consumption and gross fixed capital investment for 15 Mediterranean countries in addition to the average of all 15 countries[9] (Med-15) in 2010. The calculations are based on the Global Trade Analysis Project (GTAP)[10], a multi-regional input-output model, which allows calculating direct and indirect resource requirements embedded in consumption[11]. Household demand is then disaggregated by the Classification of Individual Consumption According to Purpose (COICOP) and divided into 12 categories. The Ecological Footprint of an average Med-15 person is approximately 3.24 gha. Household demand is the primary driver of consumption of goods and services, accounting for 2.56 gha (≈79% of the overall Footprint). Government spending accounts for 0.2 gha while GFC – which represents investments by firms – acccounts for 0.48 gha on average in the Mediterranean region.

France has the highest (4.6 gha) and Morocco the lowest (1.5 gha) per capita Ecological Footprint in the region. Interestingly, France and Morocco have about the same resource requirements for food and non-alcoholic beverages (about 1 gha). Food is a basic need and represents an indispensable share of monthly expenses. The difference between the two countries' resource requirements is mostly driven by all other consumption categories apart from food, particularly housing, transportation and recreational goods; the consumption of all three increases with higher income. Slovenia's high gross fixed capital formation seems to imply strong investments by firms, and Israel's high government consumption is likely due to spending on national security.

Figure 3
Ecological Footprint of consumption for 15 Mediterranean countries, by COICOP categories, in 2010



[9] The GTAP model has only data for 15 of the 24 Mediterranean countries considered, which limits the analysis in section 2 and 3.
[10] Narayanan, G.B., Aguiar, A., McDougall, R., 2012. *Global Trade, Assistance, and Production: The GTAP 8 Data Base*. Purdue University: Center for Global Trade Analysis.
[11] Indirect resource requirements refer to the resources needs which occur throughout the production processes of intermediate goods and represent a substantial share of total resource requirements when producing one final product for consumption. The GTAP model has a 57 sector resolution, and information on imports and exports of goods and services between 129 countries and regions, which allows accounting for the different resource intensities of imported and domestically produced goods of the same kind.

Food Resource Demand

Upon closer investigation, per capita resource demand from food consumption varies among countries mostly because of the type of food consumed rather than its quantity. The share of food Footprint as a percentage of a country's overall Ecological Footprint ranges from as low as 20% (Slovenia) to as high as 70% (Morocco). FAO estimates[12] that the minimum daily dietary energy requirement is 2500 kcal. Different countries satisfy those calorie requirements with different types of food, which vary in terms of the share of protein. Protein-intensive food products such as meat and dairy require more resources in terms of bio-productive land in order to produce the same amount of calories as with plant-based food products (see Figure 4)[13,14].

Figure 4
Direct Ecological Footprint requirements (in global hectare per 1'000 kcal produced) of a selected sample of products

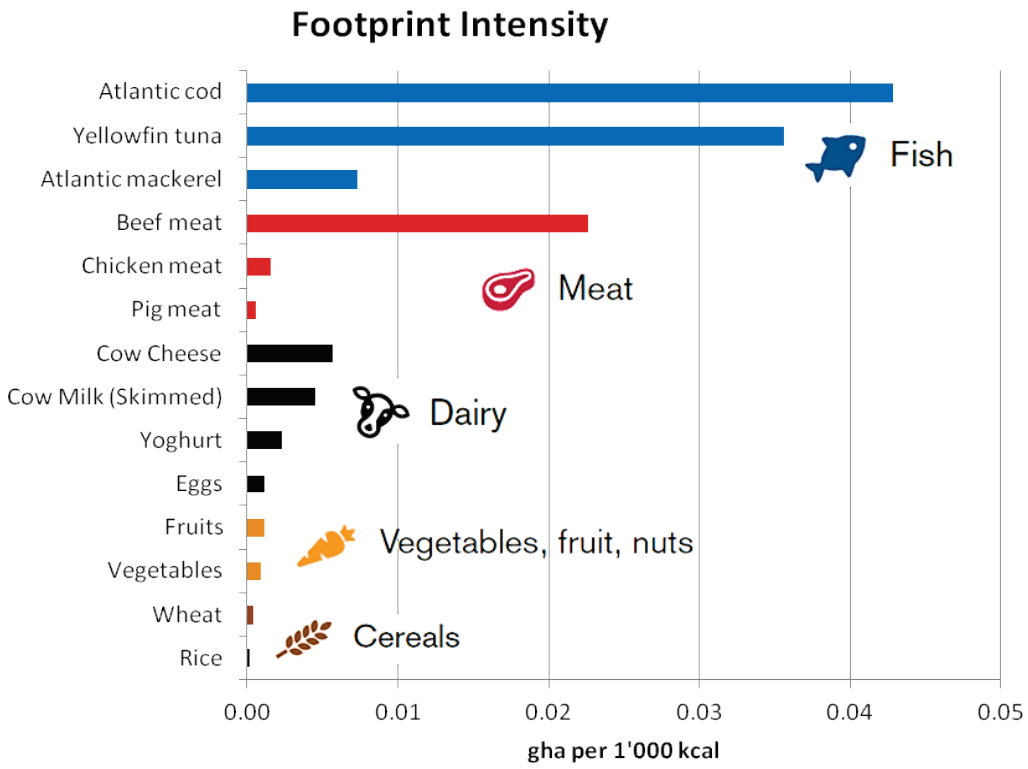
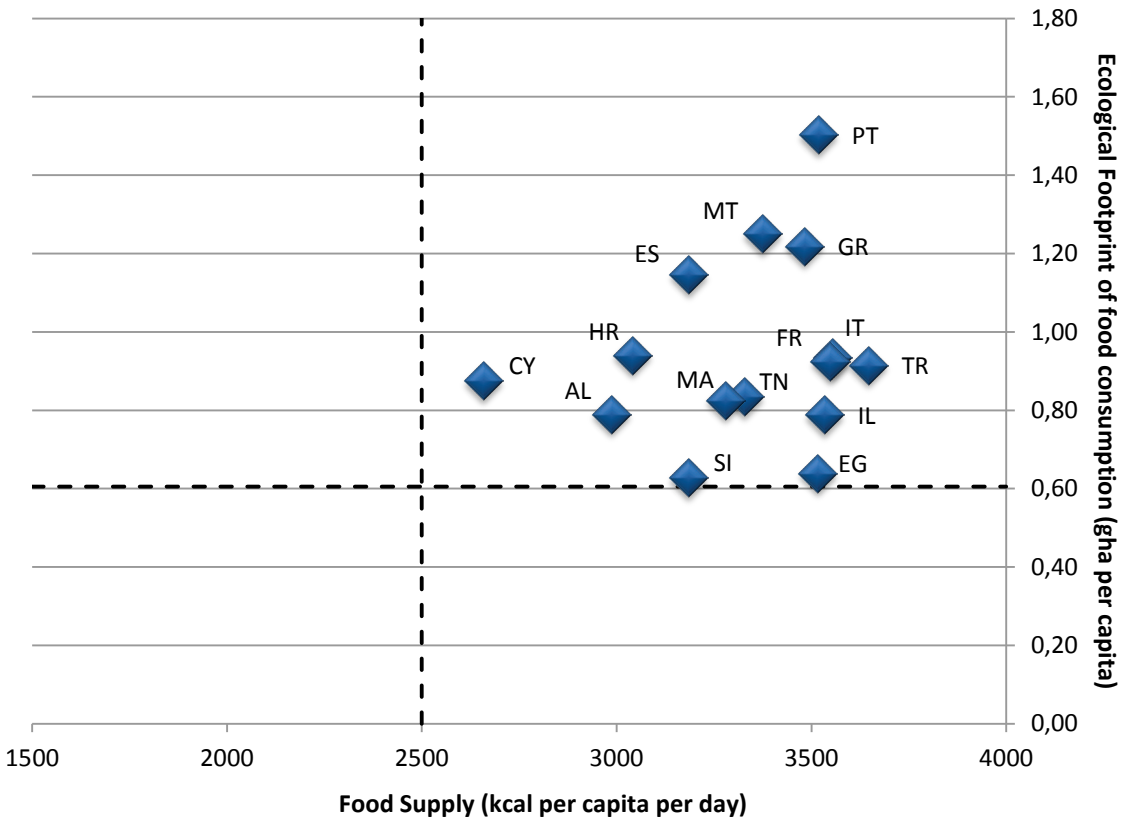


Figure 5 shows countries' per capita Ecological Footprint of consumption plotted against the calories they provide to their residents, on a per capita daily basis. The dotted vertical and horizontal lines indicate a minimum intake of 2500 calories per capita per day – the current minimum average caloric supply required for less than 5 percent undernourishment across all countries – and the most efficient food Footprint (0.60 gha)[15] globally observed.

[12] FAO/WHO/UNU, 1985. *Protein and Energy Requirements*. Food and Agriculture Organization, World Health Organization, United Nations University, Rome.
[13] Pimentel, D., Pimentel, M., 2003. "Sustainability of Meat-Based and Plant-Based Diets and the Environment." *The American Journal of Clinical Nutrition* 78 (3): 660S – 663S.
[14] Peters, C.J., Wilkins, J.L., Fick, G.W., 2007. Testing a Complete-Diet Model for Estimating the Land Resource Requirements of Food Consumption and Agricultural Carrying Capacity: The New York State Example. Renewable *Agriculture and Food Systems* 22 (02): 145–53.
[15] Costa Rica was found to be the most efficient world country in terms of calorie provision with the lowest resource requirements. Source: Global Footprint Network, and WWF. 2012. *Japan Ecological Footprint Report 2012*.

Figure 5
Ecological Footprint of food consumption and daily calories provision for 15 Mediterranean countries, in 2010. 2-digit ISO country-codes used to indicate country names

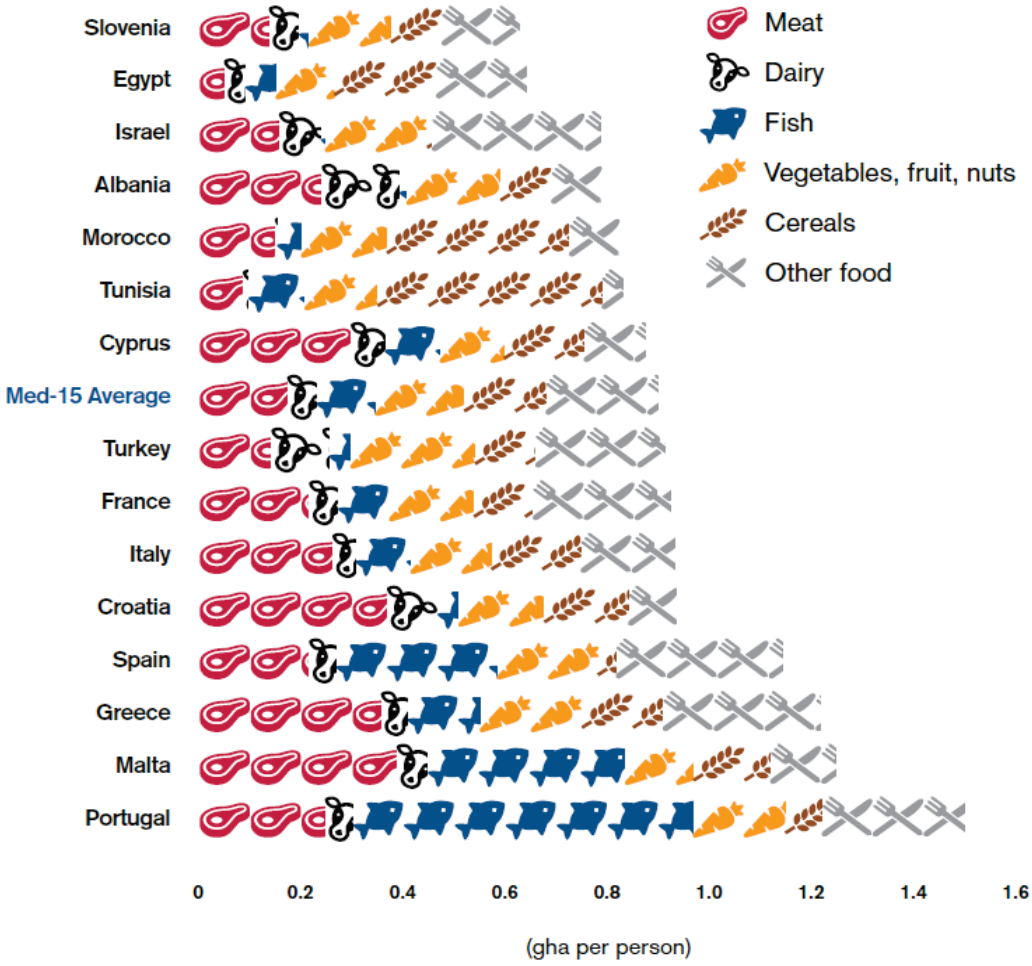


Egypt has a considerable high calorie provision (3517 kcal) with a low Ecological Footprint of consumption (0.64 gha), which is due to the low protein diet of its population and the high productivity of its croplands, which reduce its dependence on imported food (and in turn reduces the carbon Footprint embedded in imported goods through trade). Egypt's food Footprint is primarily composed of products with a low Footprint intensity such as cereals (32% of overall food Footprint) and vegetables, fruits and nuts (18%), while Footprint-intensive meat products contribute to a very small share (8%) of the country's food Footprint (see Figure 6). A similar pattern is found in Slovenia, where a big portion of the diet is due to consumption of low Footprint-intensive vegetables, fruit and nuts (26% of overall food Footprint) and cereals products (15%).

Portugal, on the other hand, consumes a similar amount of calories as Egypt (3518 kcal) but places a much higher demand on biocapacity, as demonstrated by its per capita food Footprint of 1.5 gha – more than double that of Egypt. This is due to the protein-intensive diet of Portugal's residents, characterized by a high consumption of fish products (44% of food Footprint) and meat products (16%) and a very low consumption of low Footprint-intensive cereals or vegetables, fruits and nuts (less than 17% of food Footprint) (see Figure 6). A similar pattern is also found in Malta.

As already noted, Portugal and Malta have a high protein diet, which is based largely on food produced by the fishing industry and accounts for about 0.67 gha and 0.39 gha of the Ecological Footprint of consumption respectively. In Morocco and Tunisia, on the other hand, the biggest share of the food Footprint comes from cereal consumption, at 0.36 gha and 0.44 gha respectively, and a small share from the fishing industry.

Figure 6
Ecological Footprint of food consumption - by five main food product categories - of 15 Mediterranean countries, in 2010



Conclusion

Food is a substantial share (between 20% and 70%) of the Mediterranean countries' overall resource requirements. With rising per capita income, food resource requirements do not necessarily increase as populations tend to shift toward consuming goods of higher quality and price. The main drivers of resource use as a result of food consumption are dietary habits on the consumption side – in low-income countries, diets are primarily carbohydrate based and the consumption of proteins is limited – and land productivity on the production side. The higher the yield, the more food products can be produced with one hectare of bio-productive land[16].

The overall high resource requirements of Portugal for food are driven by dietary habits, which clearly favour a protein-based diet. Egypt, on the other hand, has a plant-based diet, which is less resource intensive. While our aim is not to judge consumption habits, we want to point to the importance of resource use for food provision since this latter is one of the few basic needs in addition to shelter and clothing. Our main finding is that the resource needs from food consumption can only be shifted by small amounts and heavily depend on dietary habits as well as production efficiency. Therefore the main mechanism for providing food security in the future cannot only rely on efficiency improvements in agricultural production but must also consider reducing food waste and promoting healthier and less resource-intensive diets.[17, 18]

[16] A high level of food self sufficiency reduces transport and therewith fossil fuel requirements for imported goods.
[17] West, P.C. et al. 2014. Leverage points for improving global food security and the environment. *Science* 345, 325–328.
[18] Mediterra 2012. The Mediterranean Diet for Sustainable Regional Development / International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM). – Paris: Presses de Sciences Po, 2012.

VIENT DE PARAITRE

Terre et Mer
Ressources vitales pour la Méditerranée

Sous la direction de Cosimo Lacirignola
CIHEAM-iReMMO, Editions L'Harmattan, Paris, Avril 2015

Dans un contexte mondial marqué par de nouvelles tensions géostratégiques, l'augmentation de la population et la montée des inégalités (socio-économiques et spatiales), l'accès aux ressources naturelles (eau et terre) et à l'alimentation demeure au cœur des débats contemporains.

A travers cet ouvrage collectif centré sur l'espace méditerranéen, les auteurs se proposent d'analyser les dynamiques d'une activité agricole certes sous contraintes et à forts enjeux politiques, mais ouverte aux innovations et aux adaptations pour répondre aux défis de la durabilité du développement.

La sécurité alimentaire en Méditerranée est fragile. Elle peut toutefois s'améliorer en luttant contre les gaspillages, en préservant les sols, en valorisant davantage les produits de la mer et en responsabilisant le comportement des acteurs. Ces enjeux sont abordés dans cet ouvrage qui s'inscrit dans le cadre des réflexions sur une croissance qui soit plus inclusive en Méditerranée, mais aussi plus verte et plus bleue.

Le potentiel socio-économique des secteurs agricoles et halieutiques doit en effet être considéré à sa juste valeur stratégique à l'aune de la définition des Objectifs du Développement Durable et de la mise en place de l'Agenda post-2015. En Méditerranée, il est temps de questionner nos habitudes alimentaires et notre responsabilité sociale et environnementale face aux ressources vitales que sont la terre et la mer.

Editions L'Harmattan
www.editions-harmattan.fr

Librairie Méditerranée Moyen-Orient
5, rue Basse des Carmes - 75005 Paris – France
harmattan.mediterranee@orange.fr

Egalement disponible dans toutes les librairies de France et sur Internet

Metrics of Sustainable Diets and Food Systems
Insights from a multi-institutional research partnership

Martine Padilla
Professeure Associée
CIHEAM-Montpellier

Paolo Prosperi
CIHEAM-Montpellier
Montpellier SupAgro, Moïsa
University of Catania, Di3A, Italy

Acknowledgements

Bruce Cogill and Thomas Allen's work was supported by The Daniel and Nina Carasso Foundation and the Agriculture for Nutrition and Health Research Programme of the CGIAR.

Bruce Cogill
Bioversity International,
Nutrition and Marketing Diversity Programme
Programme Leader

Thomas Allen
Bioversity International,
Nutrition and Marketing Diversity Programme
Postdoctoral Research Fellow

Iuri Peri
Professor
University of Catania, Di3A, Italy

Joint efforts towards sustainable food security

Global and regional food consumption trends and climate change are critical for sustainability. The dynamic linkages between food consumption patterns and environmental concerns have recently received considerable attention from the international and scientific community. Sustainable diets and food systems have emerged as central issues. In particular, the Mediterranean region presents several socioeconomic and biophysical conditions leading to food insecurity and unsustainability, jeopardizing ecosystems, and affecting society with significant social and economic implications such as obesity and non-communicable food-related diseases.

The *Metrics of Sustainable Diets and Food Systems* project is a multi-institutional initiative realized in partnership by Bioversity International and CIHEAM-Montpellier (2013-2014) that aims at exploring the different approaches to the assessment of sustainability of diets and food systems, establishing a multidisciplinary taskforce of experts and identifying a shortlist of indicators for sustainable diets and food systems to inform policy-makers. The initial focus was on the Mediterranean region. The research approach builds on the assumptions that sustainability assessment aims at capturing the ability of a system to maintain and enhance its essential functions over time, and that sustainability addresses threats to preserving life support systems, including their capacity to withstand and adjust.

Assessment of stocks of and changes in human and natural assets was considered crucial. Derived from sustainability sciences, the scientific approach was based on the theories of vulnerability and resilience within the social-ecological systems frameworks, in order to analyze the sustainability of critical food and nutrition security issues. A double set of drivers of change and context-specific food and nutrition security issues were identified at a sub regional or national level. This theoretical modeling exercise allowed the identification of a first suite of indicators. A reduced pool of metrics was then obtained through an expert-based elicitation process (Delphi Survey), moving beyond subjective evaluation and reaching consensus.

Background

Today almost 800 million people worldwide are chronically undernourished and more than 2 billion are malnourished, of which approximately 500 million are obese. Unsustainable models of development are depleting the natural environment, jeopardizing ecosystems and biodiversity that are necessary for our future food supply. Claims for deep changes in our agricultural and food systems are being increasingly and strongly reiterated. Sustainable food systems and diets are, therefore, increasing the awareness from the scientific community and policymakers, acknowledging that the cross-cutting issues through agriculture, nutrition and health, are getting more and more important for identifying solutions to malnutrition. Concurrent undernutrition, nutrient deficiencies, overweight and obesity – the triple burden of malnutrition – is calling for reconsidering health and nutrition as the primary aim of food systems.

Although the extraordinary progress of agriculture and food industry during the 20th century, still health and nutritional needs have not been wholly achieved, and unexpected consequences, including environmental losses, have been generated. Most of the world's biogeographical regions, including the Mediterranean area, are experiencing exceptional weather events caused by climate change and habitat loss, in turn further threatening global food and nutrition security. The co-existence of food crises with rising environmental depletion urgently calls for finely exploring and understanding the causes and facilitating adaptation and mitigation, through novel analyses and new paradigms.

Food security and Food system sustainability

Building on the 1987 Bruntdland Report, actions following the 1996 World Food Summit were directed for reaching food and nutrition security through an environmentally and socially sustainable way. The Sustainable Development Goals proposals are strongly confirming the initial Sustainable Development precepts of maintaining and enhancing economic, social, and environmental conditions for present and future generations.

Along this understanding of sustainability, participants at the 2010 international conference organized by Bioversity International and the Food and Agriculture Organization (FAO) of the United Nations defined Sustainable Diets as "*those diets with low environmental impacts which contribute to food and nutrition security and to a healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy while optimizing natural human resources*". This concept emphasizes the food and nutrition security purpose of food systems, and the need to maintain or enhance this outcome over time - across generations - by preserving essential human and natural assets and the flows of services they provide. The concept of Sustainable Diets promotes economically, socially and environmentally sustainable food systems that concurrently ensure food and nutrition security.

Working on sustainable diets and food systems demands taking complexity seriously and considering different causes and outcomes of the socioeconomic and biophysical aspects under global change conditions. Economic growth, climate change, and dietary transitions represent major trends that need to be understood through developing models for sustainable diets.

Analyzing the intertwining of the several dimensions, around and within food production and consumption and the environmental and socioeconomic boundaries, requires going beyond one-dimensional solutions, but rather focusing towards strong system thinking. Integrated metrics, in a multidisciplinary way, are key for identifying interventions on sustainable diets accounting for the issues related to access and affordability of foods, environmental sustainability, cultural acceptability, and also for considering how the environment, cost, access, culture, policies and other factors impact our nutrition and health.

The triple burden of malnutrition is rising through undernutrition, obesity and also hidden micronutrient deficiencies. By focusing on food and nutrition security as ultimate goal of food systems, the sustainability of diets addresses the challenges of undernutrition, dietary transition and nutrition related chronic diseases and obesity. A comprehensive, sustainable approach to the factors that promote healthy diets and lifestyle can help tackling the nutritional imbalance and the unintended consequences of the global shifts in consumption.

The increasing need of the research community for trans-disciplinary work on food systems encouraged the rapid development of new research fields. The intensive activity of monitoring realized through the several United Nations' assessment initiatives on ecosystem conservation, climate change and sustainable development, such as the Millennium Ecosystem Assessment, the Intergovernmental Panel on Climate Change (IPCC) and the Sustainable Development Goals recent proposals, provide valuable examples for tackling the understanding of the global dynamics of complex systems. Integrating existing modeling tools to complex food systems can help to properly use metrics for informing policy-makers.

A wide theory-driven and dynamic approach to sustainability

For this study we consider that modern societies depend on complex agro-ecological and trading systems to provide food. The move to sustainable diets calls for changes in the agricultural and food systems. Policy-makers and other stakeholders need evidence-based information and assessment tools to lead public policy interventions. Metrics, as an organized information system combined to provide a perspective, target three principal objectives:

- Inform civil society, industry, public officials and all stakeholders;
- Measure progress toward defined goals;
- Aid decision-making processes.

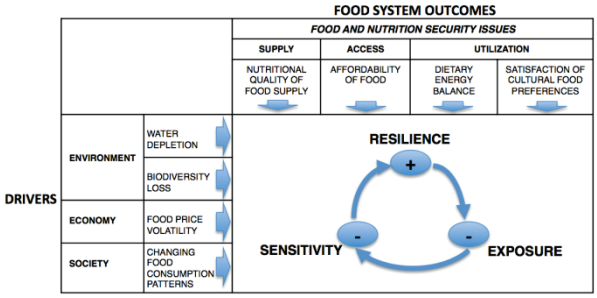
For moving forward on the understanding of sustainable diets and food systems, an enhanced capacity of describing, monitoring and assessing them is needed. Identifying a framework through which develop metrics is then considered key. A sound theoretical framework is the starting point in constructing metrics.

Sustainability – or Sustainable Development – is a necessarily complex concept that can have different understandings. We assume that a sustainability assessment aims at capturing the ability of a system to maintain and enhance its essential functions over time. Sustainability addresses threats to preserving life support systems, including their capacity to withstand and adjust. It is then key to assess stocks of and changes in human and natural assets. Derived from Sustainability sciences, the vulnerability and resilience approach, proved relevant to analyze the sustainability of critical food and nutrition security outcomes.

Vulnerability is the degree to which a system is likely to experience harm due to exposure to a perturbation or stress, and resilience represents the ability of a system to anticipate, absorb, accommodate, or recover from the effects of a potentially hazardous event in a timely and efficient manner, through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.

Within a complex interconnected food system, several global and regional drivers of change affect the structure and processes of the food systems, putting at risk context-specific food and nutrition security outcomes. The consequent identification of the vulnerability and resilience variables can help to proxy the metrics of sustainable diets and food systems.

Vulnerability/Resilience framework
(From Allen & Prosperi, 2014)



Starting from a case study on the Mediterranean Region, but thinking globally, it is observed an ongoing dietary transition coupled with changing life and consumption patterns. In this particular context, rising food cost especially in nutrient-rich and diverse foods, and increasing poverty, is accompanied by increasing consumption of nutrient-poor energy-dense foods and beverages, and widespread obesity and overweight.

Data retrieved from the United Nations Environment Programme, the International Union for Conservation of Nature, the World Health Organization and the International Centre for Advanced Mediterranean Agronomic Studies show that in the last 50 years, in this region, water demand doubled, 19% of the species are threatened (declining of biodiversity). Also at least 44% of the inhabitants of this region are food and nutrition insecure, mainly suffering from overweight and obesity. (Prosperi et al., 2014).

Selecting indicators through expert opinion

The suggested framework and an initial short-list of indicators were developed in discussions with selected expert focus groups and then submitted to a large panel of experts for further discussion. Following the protocol of the Delphi Survey approximately 50 experts from more than 40 academic and policy institutions in the world were asked to discuss and complement the framework and the underlying assumptions, and to test the framework by selecting *proxy* indicators. A Delphi Survey is an acknowledged research technique whose aim is to obtain a reliable group opinion from experts; it is a group interaction process directed in iterative rounds of opinion collection and feedback. After a first open-ended round, panelists were presented with the opportunity to justify or amend their first choices. Succeeding rounds have been designed to bring the group to focus or consensus. An upgraded framework and a restricted set of indicators were reached, after three rounds, from this consultation process.

The importance of a multi-institutional initiative

The scientific community is strongly encouraged, by policy-makers and stakeholders, for assessing the multiple impacts of the food we produce and consume. The Bioversity International and CIHEAM Montpellier's initiative proposes an innovative and challenging program to analyze and measure sustainable diets and food systems.

In November 2014, Bioversity International and CIHEAM Montpellier, with the support of The Daniel & Nina Carasso Foundation and CGIAR, gathered approximately 30 people from various academic and policy organizations mainly from the Mediterranean Region, Europe, North Africa and North America to learn about our work focused on studying and promoting sustainable diets and food systems. The issue of food and nutrition security, as a final outcome of food systems, and the form of the contribution of dietary pattern changes to sustainability goals, were explored. The concepts of vulnerability and resilience were further analyzed as an approach to capture the food system as a whole, think prospectively and identify the system elements that policy can leverage.

Decision-makers need accurate description and monitoring of changes over time through metrics of sustainable food systems. This research partnership is providing useful scholarly publications that acknowledge the scientific basis and robustness of the conceptual and methodological framework to assess sustainable diets and food systems. The Delphi method, and the participation of several experts coming from different institutions, concerned with topics and various experiences related to the sustainability of food systems from multiple disciplines and regions, help advance in the process of providing policy-makers with transparent and effective information.

Consensus on information to transfer to policy-makers is key. These new partnerships and networks around Sustainable Diets and Food Systems imply strong transdisciplinary participation with experts in metrics, nutrition, economics, ecology and agriculture called to select a reduced set of 24 metrics from an initial list of 136 and identify consensus and further openings. Only eight interactions between drivers and food system outcomes within a set of sixteen were studied. Consensus is finally reached for 14 of the 24 desired indicators: 8 indicators have met the high threshold consensus criteria (80%), 3 the medium threshold consensus criteria (70%) and another 3 the low threshold consensus criteria (60%). Another 4 indicators have been selected by the majority of the participants (above 50%). For 5 dimensions, clear bipolarity can be reported. All these indicators will soon be published and made available to analysts and policy makers. Joint efforts and integrated interventions allow developing sustainable actions and science needs discussion between and within disciplines, stakeholders, and agreements on evidence, common references and approaches.

Inputs from the multidisciplinary group of Delphi participants globally acknowledged the importance of analyzing the potential impacts of a set of global and regional biophysical and socioeconomic changes on a set of food and nutrition security issues specific to the area considered, and the related recovery potentials. In particular, the analysis of issues related to the nutritional quality of food vis-à-vis biophysical changes, such as water depletion and biodiversity loss, allowed the identification of specific metrics. Also, the study of issues related to the affordability of food confronted with food price volatility has brought to the definition of the indicators needed. Still, further research is needed for analyzing the potential impacts of the loss of biodiversity on issues related to the satisfaction of food preferences, and the potential interactions between the changes in consumption patterns and the dietary energy balance, in order to identify the most valuable and specific metrics.

Food security and food system sustainability dynamics are still not adequately seized through integrated models because of the lack of quantitative metrics. Also various sources of information and data are still not considered at different stakeholders levels by decision- and policy-makers. Researchers are challenged to join efforts with stakeholders of the food systems to identify gaps in data use and availability to adequately inform policy-makers.

Global change impacts and responses necessitate to be characterized in specific socioeconomic and biophysical context. There is a persistent call for a strong interdisciplinary effort implicating life science, earth and environmental science, agriculture and nutrition, and social and sustainability science to better understand the issues of global change and food security, not merely in integrating multiple biogeophysical and socioeconomic factors into global change and food and nutrition security analysis, but also in interchanging and networking current evidences and knowledge in various disciplines.

MoU between CIHEAM and IEMed

On March 18, 2015, in Barcelona, CIHEAM signed a Memorandum of Understanding (MoU) with the European Institute of the Mediterranean (IEMed) in order to reinforce the relationships between the two organisations for scientific and research programmes in the Mediterranean region.

CIHEAM and IEMed agreed that some issues are main areas of common interest to pursue collaborations (Euro-Mediterranean Relationships, Food Security, Food Safety and Mediterranean Diet, Climate Change and Environment, Trade Markets, Rural Development, Youth Employment and Empowerment, Agenda post-2015/Sustainable Development Goals (SDGs) and the Mediterranean Dimension…)

The MoU was signed in the frame of a joint seminar organized in Barcelona on March 18, 2015, in which different high-level speakers coming from Mediterranean countries discussed the main food challenges in the region.

IEMed. European Institute of the Mediterranean

IEMed is a public consortium formed by the Government of Catalonia, the Spanish Ministry of Foreign Affairs and Cooperation and Barcelona City Council, acting as a centre of studies and Mediterranean prospective analysis at the service of public authorities, enterprises and bodies and associations whose field of action is the Mediterranean area, and as an observatory of the Euro-Mediterranean Process and migrations in the Mediterranean, fostering exchanges and mutual awareness between the Mediterranean societies and cultures, thereby contributing to the construction of a Euro-Mediterranean space of peace, stability and shared prosperity and cooperation and dialogue between cultures and civilisations.

Bibliography / More information

- Allen, T. & Prosperi, P. (2014). *Metrics of Sustainable Diets and Food Systems*. Workshop Report. November 4-5, 2014 – Montpellier, France. Bioversity International & CIHEAM-Montpellier.
- Allen, T., Prosperi, P., Cogill, B., & Flichman, G. (2014). Agricultural biodiversity, social–ecological systems and sustainable diets. *Proceedings of the Nutrition Society, 73*(04), 498-508.
- Bioversity International & CIHEAM-Montpellier (2014). *Identifying appropriate Metrics of Sustainable Diets and Food Systems: a Delphi expert consultation*. Technical Brief 1.0-2014. 12 March 2014. Bioversity International & CIHEAM-Montpellier.
- CIHEAM (eds), *Mediterra 2012. La diète méditerranéenne pour un développement régional durable*, CIHEAM, Presses de Sciences Po, Paris, 2012.
- Cogill, B. (2015). *Reaching Across the Metaphorical Divide: Understanding Sustainable Diets and Food Systems. Landscapes for People, Food and Nature*. [online] http://peoplefoodandnature.org/blog/reaching-across-the-metaphorical-divide-understanding-sustainable-diets-and-food-systems/ (Accessed March 2015).
- Giorgi, F. (2006), Climate change hot-spots, *Geophysical Research Letters*, 33, L08707.
- Fanzo, J., Cogill, B., & Mattei, F. (2012). Metrics of sustainable diets and food systems. *Technical Brief*. Rome: Bioversity International.
- Food and Agriculture Organization of the United Nations & Bioversity International (2012). Sustainable diets and biodiversity: Directions and Solutions for Policy, Research and Action. *Proceedings of the International Scientific Symposium: Biodiversity and sustainable diets united against hunger.* 3–5 November 2010 - FAO Headquarters. Rome: FAO.
- Johnston, J. L., Fanzo, J. C., & Cogill, B. (2014). Understanding sustainable diets: a descriptive analysis of the determinants and processes that influence diets and their impact on health, food security, and environmental sustainability. *Advances in Nutrition: An International Review Journal, 5*(4), 418-429.
- Padilla, M. (2008). 'Dietary patterns and trends in consumption', in CIHEAM (Eds) *Mediterra 2008: The future of agriculture and food in Mediterranean countries*, CIHEAM, Presses de SciencesPo, Paris, pp.149-170.
- Prosperi, P., Allen, T., Padilla, M., Peri, I., & Cogill, B. (2014). Sustainability and Food & Nutrition Security: A Vulnerability Assessment Framework for the Mediterranean Region. *SAGE Open, 4*(2).
- Sustainable Development Solutions Network. (2015). *Indicators and a Monitoring Framework for Sustainable Development Goals: Launching a data revolution for the SDGs*. A report by the Leadership Council of the Sustainable Development Solutions Network. Revised working draft fro consultation 16 January 2015.

Webography

- www.bioversityinternational.org/metrics-sustainable-diets-symposium/

Sustainability of typical quality products for food and nutrition security in the Mediterranean: Lessons from the case of Apulia region in Italy

Cosimo Lacirignola
CIHEAM Secretary General

Roberto Capone
Principal Administrator, CIHEAM-Bari

Francesco Bottalico
Consultant and Researcher, CIHEAM-Bari

Hamid El Bilali
Consultant and Researcher, CIHEAM-Bari

Philipp Debs
Consultant and Researcher, CIHEAM-Bari

Relation between food security and food system sustainability

Food consumption patterns are critical for sustainability. Current Mediterranean food consumption patterns are not sustainable and are putting increasing stress on Mediterranean ecosystems and social systems. They are important drivers of environmental degradation. The social and economic costs of diet-related illnesses are straining individuals, families and national healthcare budgets (Capone et al., 2014).There are strong linkages between food security, responsible environmental stewardship and greater fairness in food management. They intersect in agricultural and food systems at global, national and local levels. A sustainable food system supports food security. Changes in both food consumption and food production are important to ensure more sustainable food systems and to achieve food security in the Mediterranean region. Diets sustainability is crucial for achieving food and nutrition security (Capone et al., 2014b).

There is today a better understanding of what characterizes unsustainable food systems and why this unsustainability is the main reason for the existence of food insecurity and nutrition: if food systems do not perform adequately in their environmental, economic and social dimensions, food security and nutrition are threatened (HLPE, 2014). According to the High Level Panel of Experts on Food Security and Nutrition (HLPE), sustainable food systems should ensure food security and nutrition for present and future generations (HLPE, 2014a). According to the Rome Declaration on Nutrition, one of the main outcomes of Second International Conference on Nutrition (ICN2), all components of food systems - including production, processing and distribution - should be sustainable, resilient and efficient in providing more diverse foods in an equitable manner, with due attention to environmental and health impacts (FAO and WHO, 2014).

Sustainable diets are the cornerstone of sustainable food systems while diets are in turn based on a series of agro-food products that are consumed in a certain way so integrating not only nutritional aspects, i.e. meeting dietary needs, but also socio-cultural ones reflecting personal and collective food preferences.

Activity background and context

Agriculture & Quality is a programme of Apulia Region supported by CIHEAM-Bari. Its main objective is the enhancement of typical food products of the Apulia region (Region of Puglia, 2010) , through the creation of the quality scheme "Prodotti di Qualità Puglia" (Quality products of Apulia, PdQP). In the framework of the programme, CIHEAM-Bari has started a pilot project to assess the sustainability of the products belonging to the quality scheme in order to ensure that these products comply not only with the quality requirements detailed in product specifications but also with sustainability requirements. Specifically, the aim of this activity is to develop guidelines and a methodological approach (with appropriate indicators) to assess the environmental, economic, nutritional-health and socio-cultural sustainability of the Apulian quality typical products, which are the cornerstone of the regional Mediterranean diet and food system.

One of the challenges for Apulian and Italian agro-food products is to combine tradition and innovation, ensuring not only production quality but also sustainability. The agro-food supply chains have to generate positive impacts for the producers and the territory. To ensure obtaining a product that can be defined sustainable it is necessary to shift attention to the production processes. The pilot project is one of the activities started after the international seminar on Mediterranean food systems sustainability organized by CIHEAM and FAO in Malta in 2012. It is carried out in collaboration with the Research Centre on Food and Nutrition (CRA-NUT), the National Research Council (CNR), the National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), the Forum on Mediterranean Food Cultures (FMFC), the University of Bologna and the University of Naples Federico II.

Methodological approach

The starting building blocks for methodological approach elaboration were the results of the international workshop on diets' sustainability, held at CIHEAM-Bari in November 2011, and the conclusions of the international seminar held in Malta in September 2012 (Lacirignola et al., 2012; Dernini et al., 2013).It was decided to use the term "sustainability" only when all the three pillars are considered (environment, economy and society-culture), supplemented by the nutritional-health component. The environmental pillar includes biodiversity while the socio-cultural pillar comprises also ethical aspects.

The methodological approach development was based on the adoption of a hierarchical approach (cf. FAO, 2013) i.e. from sustainability themes to indicators for each dimension/pillar. Sustainability is assessed separately for each of the four pillars (environmental, economic, socio-cultural and nutritional-health) and each of them has the same weight as the others. For each sustainability pillar some criteria/themes were identified and for each criterion have been selected some indicators that are suitable and measurable at corporate level, for each agro-food supply chain. The selection of indicators should be considered just a phase of the methodological approach development that includes the following tasks: justification of the choice of sustainability themes and indicators based on the concept of sustainability; description of indicators (cf. indicator sheets); and development of a method for the aggregation of indicators. The selection of sustainability criteria and themes was based on the understanding of agro-food sustainability for each pillar and the characteristics of a sustainable agro-food product and/or a process.

The identified indicators must be well defined, relevant, specific and easily measurable at farm level, appropriate and easy to understand and communicate to all stakeholders, including farmers, politicians and consumers. In line with SAFA approach (FAO, 2013), different types of quantitative and qualitative indicators were considered: performance-based, practice-based and target-based. Most of the developed indicators refer to products (cf. product-based approach) but some of them refer to the producing farms/companies (cf. corporate-based approach) as they are not specific to single products and depend on the whole management of the agro-food company.

For each indicator a sheet was prepared including the following information: definition of indicator; method of calculation; sustainability benchmark; and other useful information (e.g., applicability of the indicator to different types of products, links with other indicators, references).The sustainability benchmark value, which is defined for each indicator and for each supply chain, expresses in a simple, objective and numerical way the threshold of sustainability beyond which a product, and/or the company that produces it, can be considered sustainable. This value is defined taking into account the average performance of the Apulian agro-food enterprises.

The methodological approach can be applied to who demand, from the regional authorities, the use of the additional requirement "sustainability" for the products that adhere to the regional quality scheme or to other quality schemes recognized at EU level.

Sustainability pillars: themes and indicators

Environmental pillar

Environmental sustainability is the capacity to preserve the three environment functions through time: i) as supplier of resources, ii) as receptor of waste and iii) as direct source of goods. Environmental sustainability is also meant as the capacity to add value to the environment of the community area, while ensuring the protection and renewal of natural resources and heritage. Considering sustainability in relation to the environment and the natural resources means taking into account the impacts that the production processes may cause, the use of low impact cropping practices and tools, and the presence - within the businesses - of plans, policies or environmental monitoring systems involving the achievement of environmental objectives towards environmental sustainability.

Special emphasis is to be laid on agro-biodiversity, by applying an ecosystem-based approach taking into account the preservation of the agricultural landscape as well. Biodiversity is meant from a genetic and nature point of view and is both an environmental sustainability index and a resource to preserve. Biodiversity is to be managed and preserved at various levels, from the plot to the farm agro-ecosystem, through the ecological infrastructures that ensure the presence of on-farm associated biodiversity and contribute to the supply of environmental services.

The supply chain should commit to implement an environmental management system targeted to reduce the environmental impact and preserve biodiversity. The main objectives are to improve the efficiency in the use of resources, above all water resources and energy, as well as chemical inputs (fertilizers, pesticides). Inevitably agriculture has a significant impact on the soil; for this reason it is requested to adopt all measures and techniques aimed at reducing any form of degradation and soil impoverishment by using cropping techniques and a proper fertilization plan. Pollution should be minimised and production by-products and waste should be managed in a responsible way and, where applicable, recovered, re-used or re-cycled. It is also important to favour a farm and chain organization keen to reduce losses throughout the agro-food chain.

With regard to the environmental pillar of sustainability, proposed indicators include the following:

- Crop species and cultivar diversity
- Use of local crop cultivars and animal breeds
- Share of semi-natural habitats surface
- Soil improvement practices
- Soil erosion protection practices
- Soil compaction from machinery
- Rotation duration
- Nitrogen fertiliser consumption
- Plant protection products input
- Direct and indirect energy consumption
- By-products and waste management practices

Sociocultural pillar

Social sustainability is defined as the capacity to ensure equity in life quality and human well-being conditions, independently of class and gender. It involves workers, entrepreneurs, citizens-consumers and local community in a general sense. Within a community-based system, social sustainability is meant as the community's ability to operate together, effectively, sharing the same concept, encouraged by concerted efforts. The sociocultural pillar should be framed within the sociocultural context in which it is applied. As to the food-related cultural dimension, it is important to take into account the community's own distinctive and traditional elements that form its original identity.

Food products and the businesses may be considered as sustainable from a sociocultural point of view if they satisfy the following requirements:

1. Access to the resources, social services and human capital based on equity among social groups, actors and between men and women involved in the agro-food chain;

2. Cultural value recognized by the community (use of local resources, unicity in the production history and tradition, shared knowledge at the local level, close link with the community-based area, etc.);

3. Product capacity and potential to maintain its sociocultural peculiarities over time, to spread among present generations and be handed down to future generations.

Sociocultural criteria concern, among others, the protection of workers (safety and health conditions at work, training and skills) and the world of relations (community, legality, family, transparency and communication due diligence) as well as animal welfare. In fact, actors should commit to implement an ethically sustainable management system through the whole chain. It must also be ensured to prevent discrimination practices.

Skills and knowledge of operators, including workers, should be fostered by means of training courses. In this area it is important to encourage all initiatives aimed at favouring women's involvement in work and the social inclusion of the most vulnerable groups of the local community.

The chain should put in place communication actions to involve the local community thus contributing to create channels for the exchange and dialogue on production activities, their impacts and externalities. Incentive and encouragement measures should be taken to support the establishment of farmers' organizations or associations not only to improve the quality of local products and keep them competitive on the market, but also to facilitate social relationships between the different chain actors.

Since sustainability also means maintaining the culture and local traditions over time, it is important to promote typical and traditional products as elements of identity formation and to transmit their value and the knowledge related to them to the new generations.

Based on the above, the sociocultural indicators taken into account include the following:

- Voluntary integration of and sensitiveness to social concerns and issues
- Presence of women in production and management contexts
- Social inclusion of the most vulnerable groups and people of the community
- Good relations with and involvement of local communities and authorities
- Social capital of agro-food companies
- Corporate social and ethical responsibility
- Farm activities to promote typical products as an expression of local identity
- Adoption and safeguarding of traditional production methods for quality typical products
- Transmission of knowledge to new generations
- Training of workers along the supply chain
- Inclusion of foreign workers
- Animal welfare (only for animal husbandry farms)

Economic pillar

The economic sustainability is defined as the capacity to generate durable growth of economic indicators, notably the capacity to generate income and employment for the livelihood of populations. In a community-based system by economic sustainability is meant the capacity to produce and maintain within the community area the highest value added, by combining resources effectively, with a view to enhancing the specificity of products and community services.

The economic sustainability of a product or an agro-food chain is the capacity to generate income and employment on a continual basis through production, processing and distribution activities. This would derive, on one hand, from the capacity to improve production techniques so as to cut production costs and increase the production efficiency and, on the other, from the ability to improve quality standards from a commercial point of view, while maintaining the intrinsic features of the original product.

One of the main sustainability criteria concerns labour profitability as well as the revenue-generating ability of other production factors (i.e. land, labour). Another important factor is productivity, meant as the effectiveness by which agriculture and the food industry convert the production factors. The rise in productivity means that higher yield may be obtained using the same amount of production factors.

Another element of sustainability is related to the correct and effective transmission of prices and distribution of the created value along the components of the agro-food chain with income-stabilising consequences both for entrepreneurs and workers. This enables an equitable allocation of the added value among the operators, thus strengthening the relational links within the community area and greater stability in trade.

Another important element for economic sustainability is the propensity to investment both for the corporate development and the positive externalities for the local economy. The latter element is crucial for sustainability because the corporate activity durability may be ensured only through investments in technical and organisational innovations.

As for the economic sustainability, proposed indicators and indices include:

- Diversification index: number of company products and services, distribution of revenues between different company products and services, heterogeneity of offered products and services
- Index of commercial risk (suppliers and customers)
- Localisation index (distance to main raw materials suppliers and consumers)
- Incidence of specific investments for improving sustainability performance
- Family work profitability index
- Index of gross profitability per working unit
- General profitability index
- Product valorisation index (value added / production value)

Nutrition-Health pillar

Agro-food products are sustainable from a nutritional-healthy point of view if they meet healthiness (safety and hygiene standards) and quality criteria (organoleptic, nutritional and dietary characteristics). The actors of the certified chain should undertake to reduce the addition of saturated fats, trans fats, sodium and sugars in processing. Moreover, these actors should supply information and nutritional advice, indicated in the label, on the optimal consumption frequency and the recommended intake amounts for each typical product. This should be implemented to ensure transparency and traceability.

Food quality and safety within a business is not a merely technical issue but is related to organizational and management aspects that involve the whole business. Quality should involve a corporate choice so that the quality level requested by the customer can be achieved on a permanent basis, rather than sporadically. The criteria of nutrition-health sustainability range from the obvious applications of current regulations and mandatory prerequisites (e.g. HACCP system, traceability, labelling) to a series of certifications and voluntary requirements - held by the business – that enhance its value added.

With regard to the nutrition-health pillar, the minimum criteria taken into account include: food safety (compliance with safety and hygiene requirements); quality (quality of raw materials, organoleptic properties); traceability; transparency of label information about the nutritional quality of fresh and processed produce as well as nutritional advice to consumers and on sustainability.

Concluding remarks

A growing body of evidence shows that there can be no food security and nutrition without improving the current food systems sustainability. Therefore, any future initiative on food and nutrition security should embrace the sustainability paradigm, involve all the relevant actors along the food chain, create linkages with the existing multi-stakeholder processes and develop a multi-faceted research agenda. Achieving sustainable food security will require getting the priorities right and acting upon them. These priorities should necessarily include transition towards more sustainable food consumption patterns and diets. The focus on sustainable diets - based on high quality typical, local and seasonal agro-food products -integrated in a wider food system is original in this sense.

The present pilot project has contributed to the development of a methodological approach for the assessment of quality agro-food products sustainability. The methodological approach will be improved and refined by calculating contextualized sustainability benchmark values for all indicators; developing an appropriate rating/scoring system to ease the aggregation of indicators within sustainability pillars; and validation on Apulian typical quality products and supply chains.

Furthermore, in view of Expo Milan 2015, on April 23-24, 2015, CIHEAM-Bari will organize in collaboration with FAO an international workshop entitled "Mediterranean Sustainable Food Systems - Towards Expo Milan 2015; From Theory to Practice: Linking Territory, Food Quality Production, Food Consumption and Dietary Patterns for Improving the Sustainability of the Mediterranean Diet. Apulia Case Study"

Acknowledgements

The authors would like to thank the following experts for their contribution to the selection of sustainability criteria and themes and the development of indicators:

- *Environmental pillar: Massimo Iannetta and Milena Stefanova (ENEA), Generosa Calabrese and Gaetano Ladisa (CIHEAM-Bari), and Flavio Paoletti (CRA-NUT).*
- *Economic pillar: Giulio Malorgio and Felice Adinolfi (University of Bologna), Fabian Capitanio (University of Naples Federico II) and Gianluigi Cardone (CIHEAM-Bari).*
- *Socio-cultural pillar: Silvana Moscatelli and Mauro Gamboni (CNR) and Sandro Dernini (FMFC).*
- *Nutrition-health pillar: Giuseppe Maiani, Angela Polito and Aida Turrini (CRA-NUT), and Sandro Dernini (FMFC).*

Thanks go also to Fabrizio De Castro, Vincenzo Lorusso and Luciana Pannarale for their technical and administrative assistance and Matteo Sisto for his valuable support.

Human Resources Capacity Building

New Academic-Year 2015-2016 Catalogue

Since its inception, the CIHEAM has trained more than 30,000 people. It provides an original and complementary education to that offered by national institutions in member countries. This training is offered mainly by our four Institutes but also by other partner organisations located in member countries of our organisation. The CIHEAM provides both graduate and specialised training.

Graduate training: Master of Science (120 ECTS)

The structure of the graduate programs offered by the CIHEAM is based on the recommendations formulated in the framework of the Bologna Process. They are organised in accordance with the ECTS, European Credit Transfer System. In order to improve the clarity and transparency of the obtained credits, the CIHEAM issues a diploma supplement. The CIHEAM currently offers twenty different MSc courses in the four following priority areas:

- Food production and quality management.
- Environment and natural resources management.
- Development economics, management and policies.
- Fisheries and aquaculture.

More information on
ciheam.org

Food Security and its Measurement in Egypt

Racha Ramadan
Assistant professor at Faculty of Economics
and Political Science-Cairo University (Egypt)

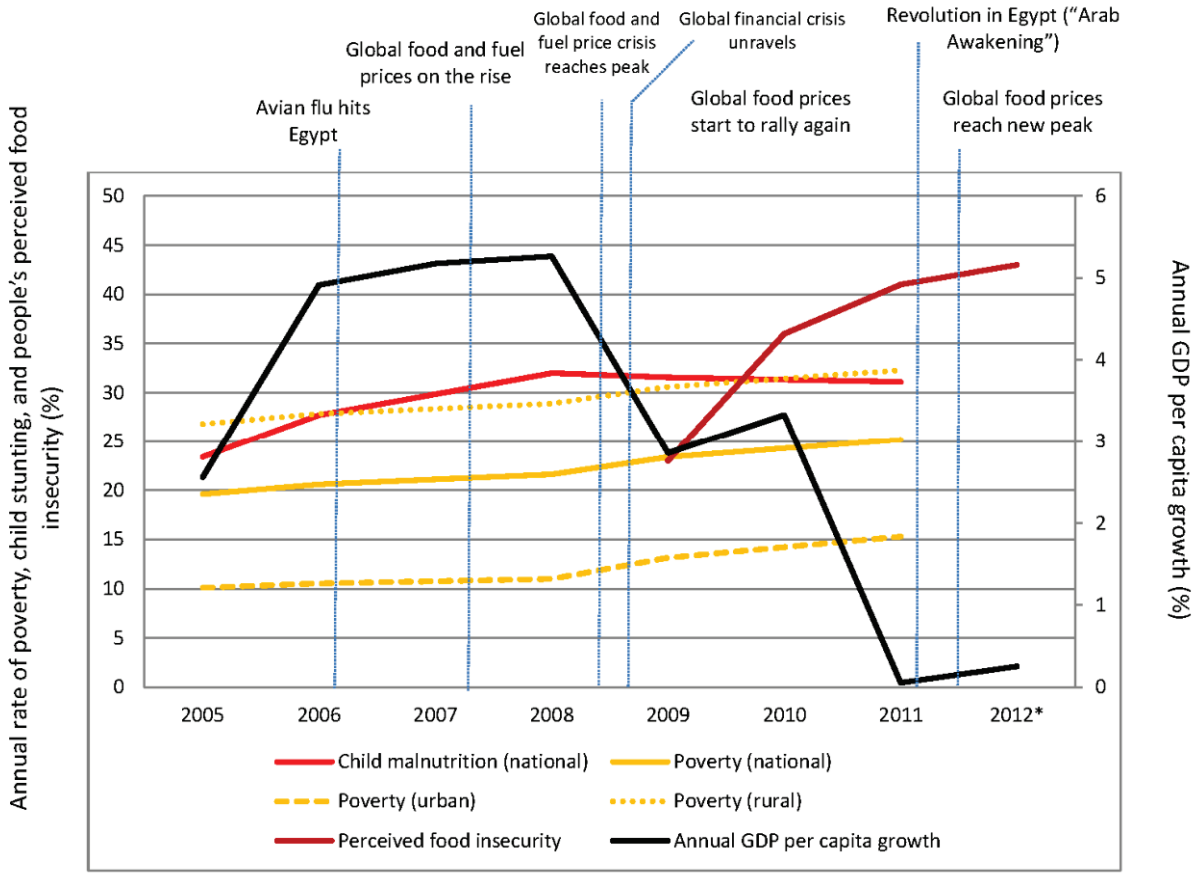
By 2050, around 9 billion people will need to be fed. Food security is becoming a global challenge, especially for net food importers. Developing Countries, and mainly the African ones are net food importers suffering from food insecurity. According to the Food and Agriculture Organization's estimates (FAO, 2014), 33 countries, including 26 Africans, need external food assistance due to conflicts, crop failures and high domestic food price.

For the Middle East and North Africa countries, they suffer from triple burden of Malnutrition: *under nutrition, overweight and obesity*. The prevalence of overweight and obesity are above 50% in all countries of the region. In 2014, 16.9% of children are stunted and 7.3% of children are underweight. Such burden has large social and economic losses; productivity losses and direct health care costs (The Economist Global Food Security Index, 2014, Fan, 2014 and Tielens and Candel, 2014). Moreover, Conflicts and civil insecurity are important driven of food insecurity in the MENA region. Around 50% of the Yemeni population is in need of food assistance. More than 20 % of the population is food insecure in Iraq (World Bank, 2012 and OuldAhmed, 2014)

Egypt is not an exception. As a Low Income Food Deficit Country (LIFDC), Egypt is facing high rates of poverty and unemployment, with 17% of the Egyptians suffering from food insecurity in 2011. Child stunting rate, in Egypt, is above the regional average, ranging from 28% to 58%. (FAO, 2014, IFPRI, 2014, United Nations Newsletter, 2013 and Ghoneim, 2014).

Figure 1, borrowed from Breisinger et al (2014) showed the different crises, faced by the Egyptian population starting from 2005, causing in deterioration of the food security situation. Annual per capita economic growth reached almost 0% in 2011-2012, compared with an annual average of 4.5% between 2005-2008. Poverty rate increased from approximately 20% in 2004-2005 to reach 25% in 2010-2011. This rising of poverty was accompanied by an increase of the prevalence of stunting children and the perceived of food insecurity to more than 30% and 40% respectively. Hence, food insecurity in Egypt can be seen, mainly, as an economic access problem. There is high correlation between poverty and food insecurity with 74% of chronically food insecure households living in the poorest Egyptian region, Rural Upper Egypt (Breisinger et al, 2014 and 2013).

Figure 1
Economic Growth, Poverty and Food Security in Egypt (2005-2012)



Source: Breisinger et al, 2014

The Gap between food supply and food demand is covered by food imports. For instance, wheat imports represent more than 50% of its consumption, making Egypt the largest wheat importer in the World. Being net food importer, make food security in Egypt vulnerable to volatility of international food price, which increases government budget and living costs of the Egyptian population contributing to poverty, under nutrition and other negative social welfare effects (FAO, 2003, Breisinger et al, 2013 and FAO, 2014).

Imported wheat is mainly used for the production of the subsidized bread. Food subsidy is an important component of the social safety programs in Egypt. It ensures the basic food nutrients at low prices, especially for poor households. It used to be seen as a protective tool against food insecurity, especially during crisis period. However, in addition to its large budget, such universal subsidy has a negative impact on the nutrient diet of the poor households, as the subsidized products are energy rich but nutritionally poor carbohydrates, which yield to obesity and malnutrition (World Bank, 2012, Smulders et al., 2013 and Ramadan. 2014).

Food Security Measurement

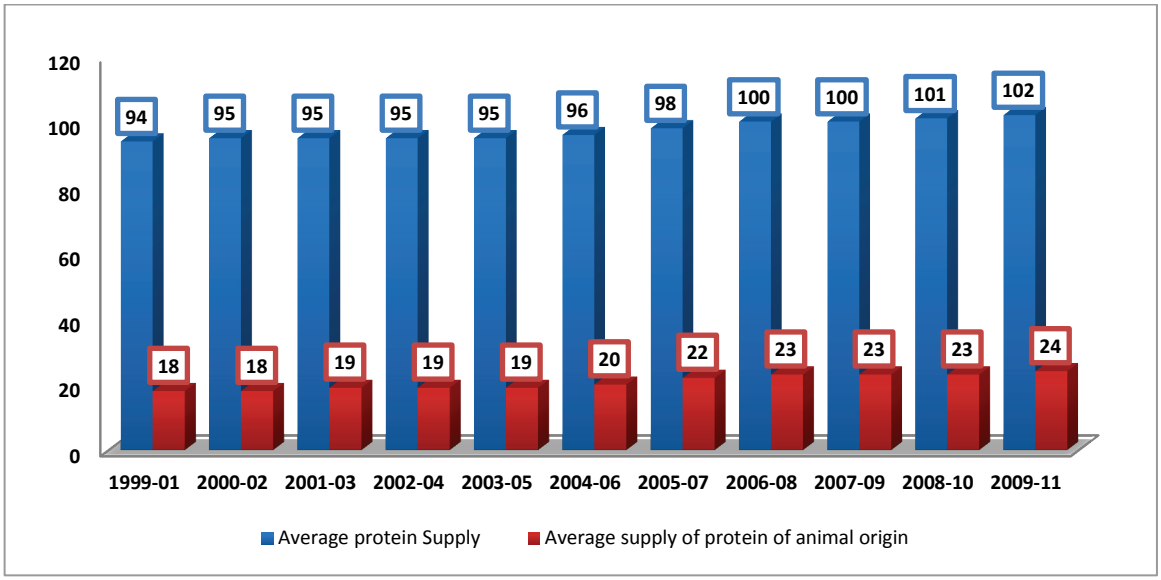
Food security is multidimensional aspect. However, the food security indicators, available in the literature, do not capture all these aspects. There is no agreement on what indicators to use. In addition, there is no consistent way to define where the food security has been affected exactly, when using such indicators. Moreover, food security measures are constrained by the availability of data and the different challenges related to the household surveys used in their construction. Such challenges include the use of food acquisition not food consumption and the unavailability of the different usage of food other than consumption (FAO, 2008 and Carletto et al, 2012).

Egypt's Food security measures are not an exception of these challenges and drawbacks. However, the available indicators would give an overview of food security situation in Egypt. According to the available measures, food security situation in Egypt is alarming and still a lot of work should be done.

Food security, as it is defined in the World Food Summit, in 1996, is verified "*when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*" (WHO, 2014, Tielens and Candel, 2014). From such definition, we can conclude that, in addition to the nutrient aspect of food security, it is a tripartite concept reflecting three criteria: Food availability, Food access and Food use. Food insecurity indicators, available in the literature, include prevalence of Malnutrition, which is abnormal physiological condition caused by deficiencies, excess or imbalances in energy, protein or other nutrients. Under nourishment means that food intake is insufficient to meet the dietary energy requirements for the individual, continuously. In other words, it is a condition of continued inability to obtain enough food. Other food security indicators include the prevalence of overweight and obesity that measure the percentage of population whose weight is above normal due to an excessive accumulation of fat (example of over nutrition). Wasting, which is the case of low weight for height resulted of weight loss associated with a recent period of starvation or disease. And Stunting, that is the case of low height for age reflecting a sustained past episode or episodes of under nutrition (FAO, 2006 and FAO, 2014).

In Egypt, 5% of the population is under nourished, in 2012 and 40% of adult population is already stunted by poor nutrition (Power, 2013 and World Bank Development Indicator, 2014). In Egypt, households' consumption is not diversified, characterized by poor dietary with high dependence on cereals and cheap food. In 2011, 35% of the total population were found to have poor dietary diversity, reflecting poor access to food (Breisinger et al, 2013). The share of dietary energy supply derived from cereals, roots and tubers in Egypt is around 65% in 2009-2011, higher than the World rate, which is 52% (FAO, 2014). This means high dependence on cereals products. This can be explained by the importance of subsidized bread in the Egyptian diet, especially the poor. While average protein supply is higher than the World average (79 gr/capita/day in 2009-2011), but it is not from animal origin. Average protein supply from animal origin, is 24 gr/capita/day in Egypt, compared with 31 gr/capita/day for the World (Figure 2). According to the World Food Program (2013), consumption of cheaper calorie-dense food and reduction of certain items are kind of negative coping strategies applied by Egyptian households, especially in time of crisis. Such strategies in addition local dietary habits and nutritional awareness resulted in poorer dietary diversity and high dependence on food with lower nutrients, especially among the poor. There is 58% of the poor households have poor dietary diversity, compare to 23% of the non-poor.

Figure 1
Average Protein Supply in Egypt (gr/capita/day) 1999-2011

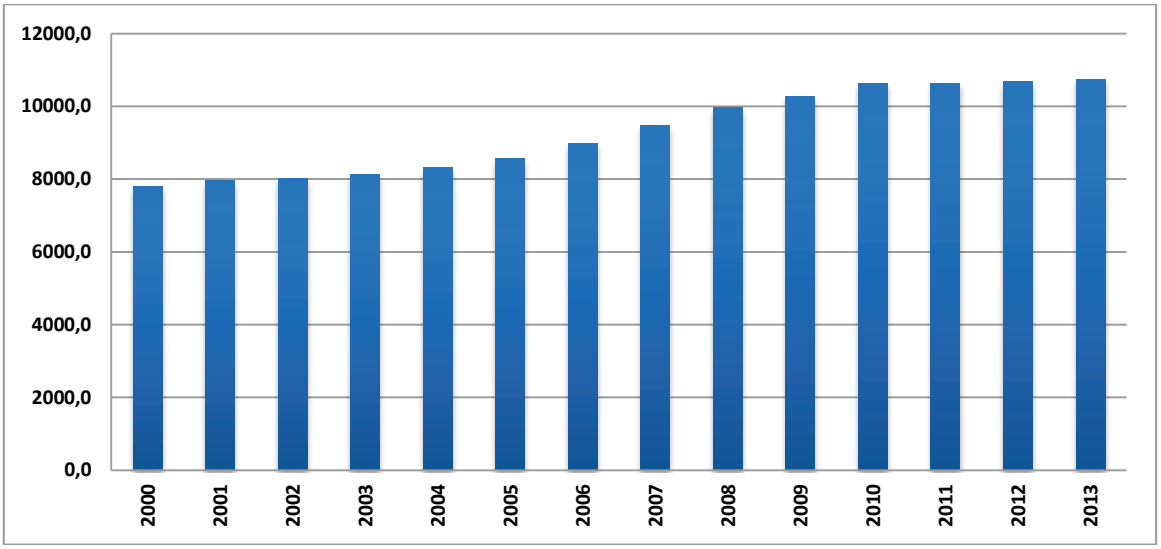


Source: FAO, Food Security Indicators, 2014

An important aspect of food security is food access; it consists of having sufficient resources to obtain appropriate foods for a nutritious diet. Accessibility includes both physical and economic access to food that meets people's dietary needs as well as their food preferences. High poverty rate is an indicator of limited access of some income groups to food. Hence, the stability of these two elements is crucial for food security.

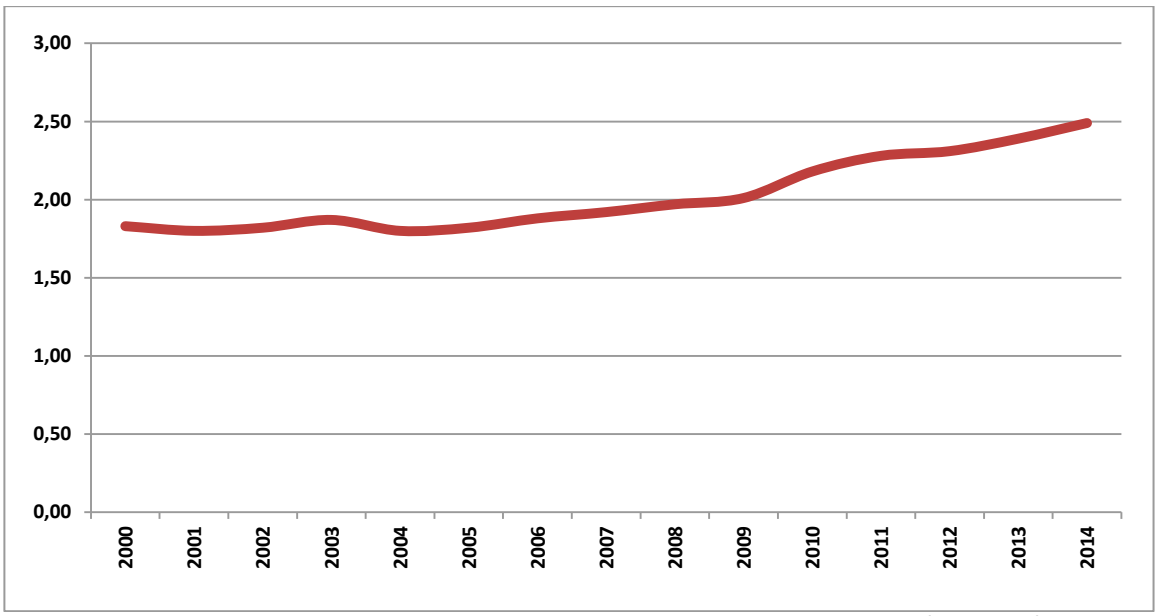
In Egypt, the Gross Domestic Product (GDP) in Purchasing Power equivalent increased over the period from 2000 to 2013 by 37% reaching 10,731 in 2013 (Figure 3). However, this increase in GDP was accompanied by an increase in domestic food price index (Figure 4) resulted in decrease in food access, especially poor households whose food expenditure represented around 49% of their expenditure (Figure 5). This makes the poor households more vulnerable to any change in their income or food prices.

Figure 2
Gross domestic product in Egypt in Purchasing Power equivalent in USD



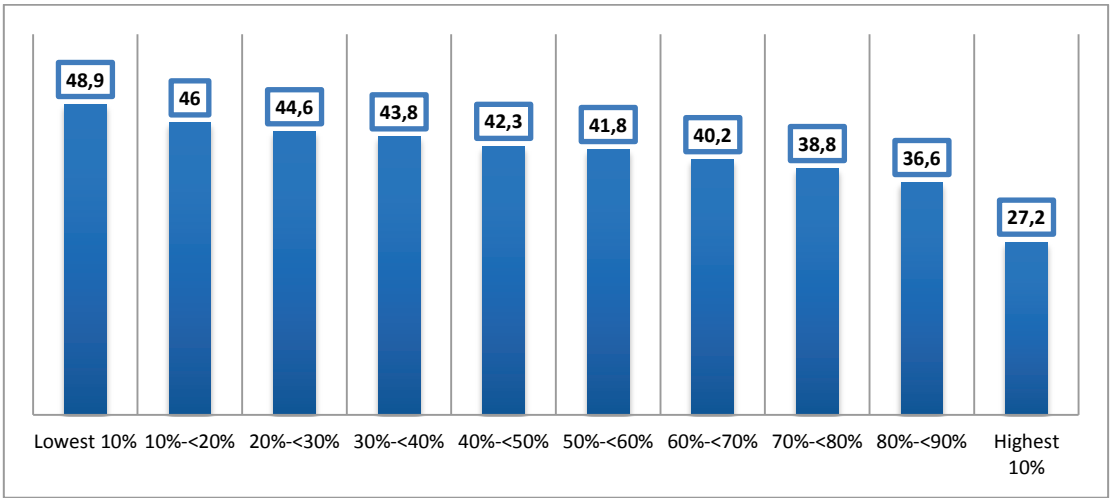
Source: FAO, Food Security Indicators, 2014

Figure 3
Domestic Food Price Index



Source: FAO, Food Security Indicators, 2014

Figure 4
Share of Food and Drink Expenditure by Expenditure Deciles (2012/2013)



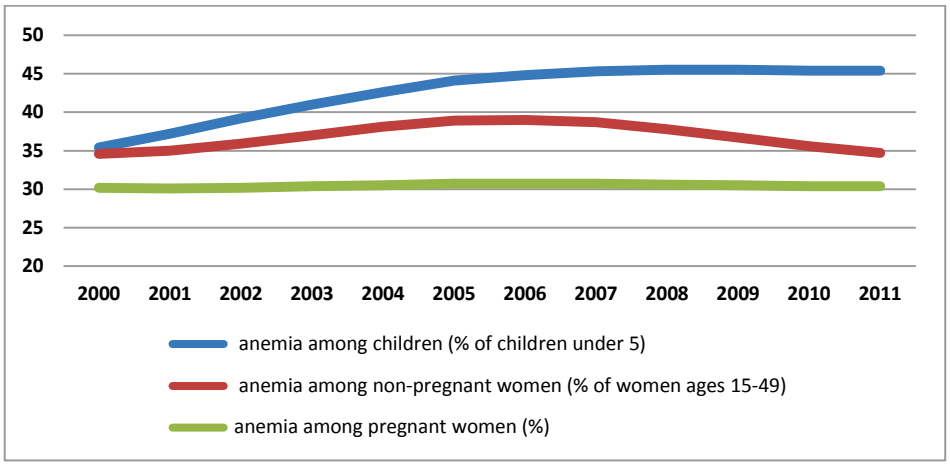
Source: CAPMAS-2012/2013

For the appropriate use of food based on knowledge of basic nutrition and care, as well as adequate water and sanitation, we found that Egypt suffers from triple burden of malnutrition: obesity, stunting and micronutrient deficiencies (*Anaemia*). This burden is very important and economically costly especially for children. Children under nutrition, alone, reduce national GDP by around 2% (IFPRI, 2014).

The prevalence of anaemia is increasing over the years, especially for children under five. Between 2000 and 2011, the prevalence of aneamia among children, under five, increased by 28%, reaching 45% in 2011. For non-pregnant women, this rate reached its maximum in 2007 with 39%, then start to decrease again to reach 35% in 2011. While for pregnant women, the prevalence remains around 305-31% (Figure 6).

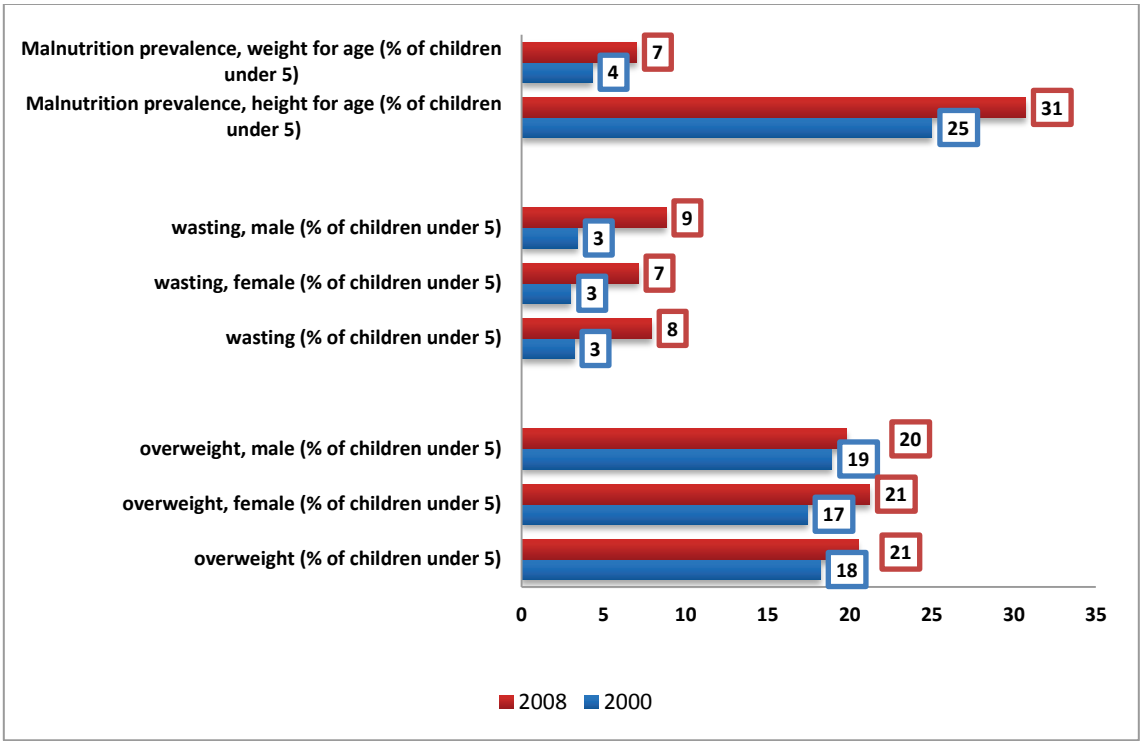
Figure 7 shows the deterioration of several food security indicators in Egypt during the period from 2000 to 2008. The prevalence of children below five years old, suffering from malnutrition (height for age), increased from 25% in 2000 to reach 31% in 2008. While for weight for age, these rates are 4% and 7% in 2004 and 2008 respectively. In 2014, the prevalence of stunted children and the prevalence of underweight remains 31% and 7%, respectively in 2014 (The Economist, 2015). The prevalence of wasting increased from 3%, in 2000 to 8% in 2008, for children below five years old. Taking gender into consideration, we found that the prevalence of wasting more than doubles between 2000 and 2008 for both males and females.

Figure 5
Prevalence of Anemia in Egypt (2000-2011)



Source: Word Bank Development Indicators, 201

Figure 6
Food Security Indicators (2000-2008)



Source: Word Bank Development Indicators, 2014

Challenges of food insecurity in Egypt

Based on the food security indicators represented above, we can conclude that food security situation is alarming in Egypt. According to UN Egypt (2014), high population rates, increasing per capita income and urbanization are major factors for rising food demand, especially cereals. While at the food supply side, Egypt is facing important challenges with diminishing agriculture potential, water scarcity, climate change, deficit on its food balance and rising imports bills. Moreover, with a poverty rate around 26% in 2012/2013, food insecurity in Egypt can be seen as an economic access problem. There is a high correlation between poverty and food security in Egypt. The low earnings and high unemployment rate, combined with fluctuation of food prices, limit Egyptians' access to food. Between 2009 and 2011, 12% of the population became both food insecure and income poor (transient food security) (Breisinger et al, 2013).

According to the Household Expenditure, Income and Consumption Survey (HEICS- 2012/2013), Egyptian households spend on average 38% of their total expenditure on food and drink. This share decreases with the household's income level, reaching 27% for the highest income decile compared with 49% for the lowest income decile. These make it difficult to poor households to adjust their budget in times of food crises, like what happened during the Financial- Food Crisis in 2008 (Power, 2013).

In addition, the poor nutritional awareness, bad dietary habits, increasing waste in food preparation and access to clean water are other factors negatively affecting Egyptian food security. While at the supply side, we found that the agricultural production in Egypt is mainly concentrated along the Nile Valley and Nile Delta, given its high fertility, making expanding agriculture in the rest of Egypt more challenging for water scarcity and lake of fertility.

Agriculture production in Egypt is facing different challenges; climate change, soil desertification, salinization and urbanization. Construction on agriculture land is threatening the land availability. Between 2010 and 2011 the total cultivated area decreased by 1% because of such construction particularly in Greater Cairo and Nile Delta (Breisinger et al, 2013 and Deng et al, 2014). Water shortage and the degradation of water quality is another major challenge facing Egyptian agriculture. According to the Ministry of Water Resources and Irrigation, agriculture consumes the largest amount of the available water in Egypt, with a share that exceeds 85% of the total demand for water[1]. The gap between the needs and availability of water is about 20 BCM/year. These requirements are expected to increase by 20% (15 BCM/year), by the year 2020 (Hamza and Mason, 2005 and MWRI, 2014).

[1] The production of 1 Kg of wheat requires 1300 Liter of water.

Therefore, water shortage has negative impact on agriculture production and constraints its extension required to face increasing demand. The potential decrease in Egypt Nile's share because of the construction of the Ethiopian Renaissance Dam and the present rate of deterioration of surface and ground water quality will certainly increase the severity of the water scarcity problem and add to the cost of its treatment (Hamza and Mason, 2005 , FAO, 2013 and MWRI, 2014). This increasing gap between the local supply and demand yields to raising dependence on food imports adding more pressure on the government's budget and foreign currency reserves.

Concluding Remarks

At the micro level food insecurity in Egypt can be seen as a problem of economic access, while at the macro level, it is multi aspect problem; geography, demography and natural resources. Poverty and food security are highly correlated in Egypt representing major challenges for the Egyptian economy. Although the food subsidy system had played an important role in providing poor households with their basic nutritional needs, especially time of crisis, such a system cannot be maintained for long time given its increasing budget and inefficiency.
The recent reforms conducted by the Government of Egypt in 2014, is an important step toward improving the food subsidy system and reducing its budget. More reform are required in addition to the implementation of other social programs such as conditional cash transfer that may yield to an improvement in health and education of children in order to put an end to the intergenerational poverty.

More actions should be taken to increase local food production and decrease food demand in order to reduce the food gap and secure food for all Egyptians. Suggested actions include the use of new agricultural techniques, improving infrastructure and credit access for small farmers in addition to efficient use of scarce water resource. Improving storage facilities to reduce grain wastage and reduce leakage of the food supply chain will yield to an increase in food availability, which is an important pillar for food security. Improving education level and providing more job opportunities through pro poor growth would increase households access to food by reducing poverty. Finally, raising awareness to nutritional and food habits is important for nutrient diversity and achieving food security.

Bibliography / More information

- Breisinger, C., Al-Riffai, P., Ecker, O., Abuismail, R., Waite, J., Abdelwahab, N., Zohery, A., El-Laithy, H. and Armanious, D. , (2013). "Tackling Egypt's Rising Food Insecurity in a Time of Transition". Joint IFPRI-WFP Country Policy Note.
- Breisinger, C., Ecker, O., Maystadt, J.F., jean, Trinh Tan, J.F., Al-Riffai, P., Bouzar, K., Sma, A. and Abdelgadir, M., 2014, "Building Resilience to Conflict through Food-Security Policies and Programs: An Overview". Building Resilience for Food and Nutrition Security. 2020 Conference Brief 3.
- Carletto, C., Zerra, A. and Banerjce, R., 2012: " Towards Better Measurement of Household Food Security: Harmonizing Indicators and the role of Households Surveys". Global Food Security.
- Central Agency for Public Mobilization and Statistics (CAPMAS), 2013, Poverty indicators according to the Egyptian Household Income, Consumption and Expenditure Survey (HIECS, 2012/2013).
- Fan, S., 2014, "Overcoming the triple burden of malnutrition in the MENA region". International Food Policy Research Institute.
- Food and Agriculture Organization (FAO), 2008: "Deriving Food Security Information from National Household Budget Survey: Experiences, Achievements, Challenges".
- Food and Agriculture Organization (FAO), 2013, The Report of Expert Consultation Meeting on Food Losses and Waste Reduction in the Near East Region: Towards a regional comprehensive Strategy. Sharm EL Sheikh, Egypt, 18-19 December 2012
- Food and Agriculture Organization of the United Nations (FAO), Egypt Country Brief, 2014
http://www.fao.org/giews/countrybrief/country.jsp?code=EGY
- Food and Agriculture Organization of the United Nations, " Trade Reforms and Food Security: Conceptualizing the linkage", 2003.
- Power L., "Egypt Faces Food Insecurity and Social Unrest as Strategic Grain Stocks Fall", in Future Directions International, 13 March 2013.
- Ghoneim, A. F., 2014, "Egypt and Subsidies: A Country living beyond its Means". Middle East Institute.
- Hamza W. and Mason S, "Water availability and food security challenges in Egypt". In: Hamdy A. (ed.), Monti R. (ed.). Food security under water scarcity in the Middle East: Problems and solutions. Bari: CIHEAM, 2005. p. 249-259 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 65).
- Minsitry of Water Resources and Irrigation in Egypt (MWRI), 2014, "Water Scarcity in Egypt".
- Power, L., July 2013. "Food Crises and Political Turmoil: The impact's of Egypt's Military Interventions on National Food Security".
- Independent Strategic Analysis of Australia's Global Interests. Future Direction International. Strategic Analysis Paper.
- Ramadan, R., 2014, " Where Does Food Subsidy Go?" CIHEAM Watch letter No. 30.
- Smulders, M., Aw Dahir, M., Dunn, K. and Verduijn, R., 2013. "Food Security and Nutrition in the Southern and Eastern Rim of the Mediterranean Basin". Food and Agricultural Organization of the United Nations, Regional office in Near East.
- The Economist, 2015: Global Food Security Index.
- Tielens, J. and Candel, J., 2014. "Reducing Food Wastage, Improving Food Security?" Food & Business Knowledge Platform.
- UN Egypt, Food Security and Nutrition in Egypt: http://www.un.org.eg/UNInner1.aspx?pageID=118.
- World Bank, 2012,"Inclusion and Resilience. The Way Forward for Social Safety Nets in the Middle East and North Africa". MENA Development Report.

La durabilité des filières alimentaires
Des pistes d'action à partir du programme FLONUDEP

Giulia Palma
Chargée de recherche
CIHEAM-Montpellier

Martine Padilla
Professeure associée
CIHEAM-Montpellier

Depuis le milieu des années 1980, la question de la durabilité n'a cessé d'acquérir de l'importance et occupe aujourd'hui une place centrale dans les discours de développement ainsi que dans l'agenda de politique internationale.

Le développement durable est communément constitué de trois dimensions fondamentales et complémentaires: environnementale, économique et sociale. Cependant, la nutrition ainsi que la gouvernance sont aussi considérées comme des composantes incontournables. Un développement dit « durable » se trouve à la croisée de ces différentes sphères : il est le résultat du compromis entre les exigences de, ainsi que les conséquences sur, chacune de ces dimensions.

La durabilité ainsi définie, a interpellé les chercheurs sur son application aux filières agro-alimentaires. En effet, les systèmes alimentaires, par leurs activités production, transformation, distribution et de consommation, génèrent une partie importante des impacts environnementaux, sociaux et économiques. En ce qui concerne les impacts environnementaux, selon l'étude (JRC, 2006) réalisée dans les 25 pays de l'Union Européenne, la production et la distribution sont responsables (sur l'ensemble des impacts de la consommation de la population) d'environ 20 à 30% des impacts. L'alimentation représente un tiers (22-30%) des gaz à effet de serre, entre 20 à 30% de la consommation des ressources abiotiques, de l'acidification, de l'écotoxicité et de la toxicité humaine, ainsi que de plus de la moitié des effets en eutrophisation[1].

Dans cet article nous allons nous limiter aux conséquences de l'alimentation sur l'environnement en termes d'impacts (tels que les émissions de gaz à effet de serre). Les aspects nutritionnels seront également traités comme des compromis entre choix alimentaires permettant de suivre les recommandations nutritionnelles, tout en limitant les effets néfastes sur l'environnement.

Il existe d'autres aspects importants liés à la durabilité des filières qui pourraient être développés mais que nous ne traiterons pas ici : la perte de la biodiversité, ou encore l'empreinte eau (*water footprint*) ou le phénomène des pertes et gaspillages alimentaires. De plus, la durabilité « sociale » des filières, concernant par exemple les conditions des travailleurs, mériterait également d'être traitée.

Plusieurs interrogations surgissent sur la question de la durabilité des filières, car chacun de nos choix alimentaires est lié à des enjeux importants. Tout d'abord, le choix entre une diète à base de produits animaux et une diète végétarienne - végétalienne. Au- delà des préoccupations liées à la santé, si on prend en compte les seuls impacts environnementaux, il parait assez clair que le choix de la diète végétarienne est préférable.

[1] *Catégories d'impact environnemental normalement prises en considération.*

Selon l'UNEP (2010), mais également selon l'Institut International de Recherche sur l'Elevage (ILRI), les produits animaux, la viande ou bien les produits laitiers, demandent plus de ressources et génèrent plus d'émissions que les produits végétaux. L'élevage est ainsi un contributeur important au réchauffement climatique. Il est responsable de 8.5 à 18% des gaz à effet de serre d'origine anthropogénique (ILRI). De plus, si on adopte une perspective de sécurité alimentaire, les émissions par kcalorie d'un produit animal sont bien plus élevées que celles d'un produit végétal (ILRI).

La comparaison entre la production biologique et la production conventionnelle est un autre point qui fait controverse. Le débat est encore ouvert, car les réponses ne sont pas toujours univoques. Freyer (2008) a évalué les émissions des gaz à effet de serre par groupes d'aliments selon le type de production (conventionnelle et biologique), par quantités (kcalories) consommées ainsi que par quantités recommandées. Les impacts varient bien évidemment en fonction des groupes d'aliments. Ceci vient renforcer les conclusions précédentes concernant les niveaux élevés d'impacts environnementaux des produits animaux. De manière générale, les émissions liées aux produits conventionnels sont plus élevées que pour les produits biologiques, mais avec des écarts plus importants pour les aliments d'origine animale.

Toutefois, une autre étude (Foster et al., 2006), met en évidence que la réponse à la question « quel type de production est préférable ? » n'est pas toujours simple. En effet, il y a une grande variabilité selon la catégorie d'impact environnemental choisie et selon le type d'aliment. Par exemple, parmi les fruits et légumes, la consommation d'énergie est très variable, car elle dépend des méthodes de production et de son lieu géographique. En ce qui concerne les carbohydrates, s'il est vrai que le blé biologique est moins impactant que le conventionnel, cela n'est pas vrai pour les pommes de terre. Ce discours reste valable si l'on compare une production biologique de viande de bœuf, de porc et de mouton avec une production conventionnelle, mais ce n'est pas le cas si on prend en considération la production de poulet.

D'après cette même étude (Foster et al., 2006), une autre idée jusqu'à présent considérée comme évidente, est mise en discussion : celle de l'impact environnemental des produits importés considérés comme plus polluants que les aliments produits localement. En effet, ce n'est pas la distance géographique entre les lieux de production et de consommation qui joue sur l'impact environnemental mais plutôt le moyen de transport ou la méthode de production.

D'autres auteurs (Schilch and Fleissner, 2005) montrent aussi qu'un produit local n'est pas systématiquement préférable à un produit importé, et qu'on peut avoir des impacts différents pour une même culture dans des endroits différents du globe (par exemple l'impact sur la consommation d'eau) ce qui rend plus intéressant de produire un aliment dans un pays plutôt que l'autre (Foster et al., 2006).

Un autre point est celui de la consommation des produits saisonniers. En effet, il est démontré (Milà i Canals et al., 2007) que les produits importés peuvent avoir un impact environnemental moindre que les mêmes produits cultivés localement hors-saison. C'est le cas, par exemple, de la salade importée en Allemagne d'Espagne hors saison, face à une salade produite « localement » sous serre (Muller-Lindernlauf et Reinhardt, 2010).

Jusqu'à maintenant nous avons traité les enjeux environnementaux liés aux choix alimentaires. L'autre composante de la durabilité qu'est la nutrition mérite aussi d'être prise en compte, cependant cela rajoute de la complexité dans la prise de décisions des mangeurs. En effet, il n'est pas évident de faire coïncider les préoccupations environnementales avec les préoccupations nutritionnelles et de santé.

S'il est vrai qu'une alimentation pauvre en produits animaux tels que la viande rouge et la charcuterie est en même temps bénéfique pour la santé et l'environnement, cela n'est pas le cas pour la consommation de poisson. Recommandé au moins 2-3 fois par semaine, notamment si on privilégie une diète s'inspirant du « régime méditerranéen » qui a fait preuve de nombreux mérites, la consommation de poisson peut entrainer une surexploitation des ressources marines ainsi qu'engendrer des impacts environnementaux importants (par exemple dans le cas de l'élevage).

Cependant, dans certains cas les conséquences sur l'environnement et sur l'état nutritionnel évoluent négativement dans le même sens. White et Broadley (2005) ont montré que depuis les années 1930 la densité moyenne de micronutriments contenus dans les fruits et les légumes a diminué drastiquement. C'est ce que l'on appelle « les aliments creux ». Parmi les causes possibles, figurent les modes de production intensives, dont les traitements avec des excès d'engrais accélèrent la croissance au détriment du temps nécessaire pour développer les teneurs nutritionnelles. De plus, selon Halweil (2007) les traitements de conservation appliqués aux fruits et légumes ainsi que le rallongement des temps de transport, typiques des filières modernes, impactent négativement la qualité nutritionnelle de ces produits.

Enfin, il est intéressant de remarquer que, contrairement aux idées courantes, les aliments issus de l'agriculture biologique ne sont pas toujours plus riches nutritionnellement que les produits conventionnels. Une étude récente (Guégen et Pascal, 2010) montre que les différences observées par rapport au statut nutritionnel entre les aliments biologiques et non biologiques ne sont pas significatives. Les céréales biologiques sont plus pauvres en protéines et les fruits et légumes moins riches en caroténoïdes. De leur côté, les produits animaux biologiques sont souvent plus riches en certains acides gras polyinsaturés, et cela est probablement dû au type d'élevage (extensif). Par contre ce qui joue en faveur des fruits et légumes biologiques c'est le faible niveau de résidus phytosanitaires ainsi que leur contenu plus élevé en vitamine C et antioxydant. Toutefois il est clair que l'on ne maitrise pas tout dans ce domaine.

L'actuel projet ANR Bionutrinet (mené en symbiose avec l'enquête épidémiologique Nutrinet) portant sur 54311 consommateurs de produits bio versus non bio, contredit ces résultats (Kesse, 2013). En effet les résultats montrent un effet très positif de l'alimentation bio sur l'adiposité des consommateurs qui diminue d'environ 50% toutes choses étant égales par ailleurs. Si les apports caloriques moyens journaliers sont identiques entre consommateurs de produits bio et non bio, les apports des consommateurs de bio sont plus élevés pour les vitamines et minéraux (+10 à 20%), les acides gras oméga-3 (+20%) et les fibres (+27%). Enfin, après ajustement (prise en compte des différences observées par ailleurs entre les non-consommateurs et consommateurs), les consommateurs de bio ont une moindre probabilité d'être en surpoids (H-36% et F-42%) ou d'être obèses (H-62% et F-48%).

L'approche filière : le projet FLONUDEP

L'intérêt d'une approche filière dans l'étude de la durabilité des systèmes alimentaires c'est qu'elle permet non seulement de mesurer les impacts des différentes activités mais permet de mettre en évidence quel est le/s stade/s clé de la filière, le « hot spot ». Cela veut dire qu'elle indique le « poids » respectif de chaque étape de la filière et permet d'identifier où il faut agir pour limiter les impacts.

En France en 2000 (Monnot, 2000), le coût énergétique de l'alimentation a été estimé à 41 millions de tonnes équivalents pétrole. Si on veut savoir à quelle étape, de la production jusqu'au consommateur, ces impacts sont générés, nous nous apercevons qu'ils sont à peu près distribués de manière équilibrée : un quart au niveau de l'agriculture, 22% au niveau de l'industrie de transformation, 26,5% au niveau des transports et de la distribution, ainsi que 26,5% au niveau du consommateur.

Toutefois, comme le montre une étude conduite au Pays Bas (ESF, COST, 2009) il existe des différences en fonction des produits alimentaires pris en compte. Bien que le stade agricole apparaisse toujours comme étant le responsable principal des impacts, les résultats montrent que pour les fruits et légumes ce stade compte pour 46% des impacts, alors que pour les pommes de terre et la viande il ne compte que pour 31% et 21% respectivement. Il faut considérer toutefois que cette étude ne prend pas en compte le stade du consommateur.

D'autres travaux (Marletto and Silling, 2010) montrent que c'est au niveau du consommateur et plus précisément au niveau du transport entre le lieu de distribution et le foyer que se trouve une partie importante des impacts. Selon une autre étude portant (Brodt et al., 2013) sur la filière tomates transformées, c'est le transport dans son ensemble qui est à l'origine des plus grands effets.

En général peu d'études portent sur une filière alimentaire prise dans sa totalité. Elles concernent le plus souvent soit le seul niveau agricole, soit également la partie conditionnement ou transformation au niveau de l'usine. Au contraire, le projet FLONUDEP est l'une des rares études qui regarde la filière dans son ensemble, de la production jusqu'au consommateur.

Ce projet[2], financé par l'Agence Nationale de Recherche en France (ANR) et coordonné par le CIHEAM- Montpellier, s'est déroulé entre 2010 et 2013. Il avait comme objectif principal de promouvoir des filières alimentaires durables à travers la création d'un outil d'aide à la décision à destination des professionnels afin qu'ils puissent prendre des choix informés quant à l'organisation de leur production. L'idée était de réaliser une évaluation simultanée des filières sur 3 dimensions de la durabilité (environnementale, sociale et nutritionnelle) depuis l'exploitation agricole jusqu'au consommateur.

L'approche ACV (Analyse de Cycle de Vie, en anglais *Life Cycle Assessment*) a servi de fil conducteur à l'étude des différentes composantes du développement durable des filières. Ce cadre a été appliqué à la filière tomate fraîche en France et au Maroc et à la filière tomate transformée en France et en Turquie (pour l'exportation vers la France). Cette méthode a permis de mesurer les performances environnementales des différentes activités et de comparer différents circuits; mesurer l'évolution de la qualité nutritionnelle des tomates le long des circuits et enfin mesurer les impacts socio- économiques des filières. Nous allons nous limiter ici aux résultats concernant la composante environnementale et nous traiterons moins en profondeur les aspects nutritionnels.

Pour ce qui est de l'environnement, les résultats de la comparaison entre les impacts engendrés par la production française de tomate hors-saison et la production marocaine exportée en France qui a été conduite dans le cadre du projet (Payen et al., 2015) rejoignent les paragraphes précédents. Sur l'ensemble du cycle de vie des tomates, la comparaison des deux systèmes pris en compte (tunnel au Maroc et serre chauffée en France) montre que si on prend en compte l'énergie consommée, le réchauffement climatique et l'eutrophisation, il est préférable d'importer des tomates marocaines, et cela même en tenant compte du transport entre le Maroc et la France. Ceci est lié à la nécessité de chauffer les serres en contre-saison en France. Cependant, les effets sur la disponibilité en eau bien plus importants au Maroc, favorisent de fait la production française.

[2] *http://flonudep.iamm.fr/index.php/component/content/frontpage*

En ce qui concerne la tomate transformée, les résultats concernent deux études de cas : l'une étant constituée de la sauce tomate en boîte de conserve vendue en France réalisée à partir de concentré fabriqué en France et emballé en fût, et l'autre réalisée à partir de concentré en fût en provenance de Turquie. Globalement, la boite de 1kg de sauce telle qu'achetée, utilisée par le consommateur et ensuite recyclée, est légèrement plus favorable à la filière strictement française pour les GES et la toxicité humaine. La filière turque et la filière française sont identiques pour l'eutrophisation. Cela montre bien que la différence attendue entre les impacts de la filière « locale » et celle « importée » n'est pas si significative que cela et ne se place pas là où on l'attendait (Palma et al., 2014). Bien qu'intuitivement plus le trajet parcouru par un produit, à savoir la distance entre son lieu de production et le lieu de vente au consommateur, est long, plus important sera l'impact, les résultats de l'étude montrent que plus que la distance, c'est le moyen de transport avec lequel cette distance est parcourue qui a un rôle déterminant dans l'impact.

Prenons pour exemple le concentré de tomates produit en Turquie et ensuite transporté en France par bateau. L'impact environnemental est principalement engendré par le transport camion ou tracteur entre l'exploitation agricole et l'usine de transformation plus que le trajet entre l'usine et le port d'arrivée en France (ce trajet inclut le transport par TIR entre l'usine et le port en Turquie ainsi que le trajet par bateau jusqu'en France). Cela est vrai pour les 3 catégories d'impact choisies (Palma et al., 2014).

La question des effets des conditions de transport sur la qualité nutritionnelle des aliments, a été également abordée dans le cadre du projet FLONUDEP, dans son axe « nutrition ». Comme évoqué précédemment, aux composantes environnementales et socio-économiques du projet, s'ajoute également l'évaluation de la qualité nutritionnelle des tomates. Pour la tomate fraîche, trois types de transport (avion, bateau et camion réfrigéré) des tomates marocaines importées en France ont été étudiés et l'évolution, entre autres, des teneurs en vitamine C et en β-carotène mesurés.

En effet, au cours de leur voyage, les tomates « subissent » des variations de température, ce qui peut impacter leur maturation et par conséquent leur « qualité ». Parmi les principaux résultats on observe que la teneur en fibres et folates (vitamine B9) est peu variable, quels que soient les traitements. Les passages au froid intense (4°C) court ont généralement eu des effets positifs sur la teneur en vitamine C, mais la conservation longue à cette même température réduit la teneur en β-carotène. Les stockages courts ou longs à 32 °C ont favorisé les teneurs en β-carotène mais en même temps ils n'augmentent pas la teneur en vitamine C. (Padilla et al., 2014).

Conclusion

La sécurité alimentaire repose certes sur le choix des consommateurs mais aussi sur la bonne organisation des filières qui mettent à disposition des produits sûrs, nutritionnellement denses, culturellement adaptés et durables sur le plan environnemental. Savoir mesurer la durabilité des filières dans toutes ses composantes globalement et à chacun des segments de la filière, est important pour que professionnels et décideurs agissent. Les quelques études scientifiques menées sur les filières montrent des résultats controversés et il peut exister des « conflits » entre les différentes composantes de la durabilité, qui impose que des compromis soient faits. Le défi pour la recherche et le développement est justement de trouver un équilibre entre l'environnement, le social, l'économique et la nutrition.

Savoir mesurer la performance des filières permettra d'agir et de répondre aux défis et enjeux mondiaux actuels (changement climatique, augmentation des besoins alimentaires liés à l'évolution de la population mondiale, plus de biodiversité dans l'alimentation pour mettre fin à la faim cachée, préserver les ressources en eau, assurer le bien-être des travailleurs…). La recherche a là une immense tâche à assurer.

Bibliographie / Plus d'informations

- Brodt S, Kramer KJ, Kendall A, Feenstra G, (2013). *Comparing environmental impacts of regional and national-scale food supply chains: A case study of processed tomatoes*, Food Policy N° 42: 106-114.
- ESF/COST, (2009). *European food systems in a changing world*, Science Policy Briefing, 36 – March 2009.
- Foster C, Green K, Bleda M, Dewick P, Evans B, Flynn A, Mylan J, (2006). *Environmental impact of food production and consumption.* A report to the department of environment, food and rural affairs. Manchester Business School. Defra, London.
- Freyer B and Weik S, (2008). *Impact of different Agricultural Systems and Patterns of Consumption on Greenhouse-Gas Emissions in Austria*. 16th IFOAM Organic World Congress, Modena, Italy, June 16-20, 2008. Archived at http://orgprints.org/13672 and http://orgprints.org/13674
- Guéguen L, Pascal G. (2010). *Le point sur la valeur nutritionnelle et sanitaire des aliments issus de l'agriculture biologique*. Cahiers de nutrition et de diététique, 45 (130-143).
- Halweil B, (2007). *Still No Free Lunch*, Worldwatch Institute, Washington.
- ILRI http://www.ilri.org/ilrinews/index.php/archives/10776
- Eder P and Delgado L (eds); Tukker A, Huppes G, Guinée J, Heijungs R, de Koning A, Van Oers L, Suh S, Geerken T, Van Holderbeke M, Jansen B, Nielsen P, (2006). *Environmental Impact of Products (EIPRO). Analysis of the life cycle environmental impacts related to the final consumption of the EU-25*. Main report.

- Kesse-Guyot E, Péneau S, Méjean C, Szabo de Edelenyi F, Galan P, Hercberg S, Lairon D, (2013). *Profiles of organic food consumers in a large sample of French adults: results from the NutriNet-santé cohort study*. PLoS One. 2013 8(10):e76998

- Marletto G, Silling C, (2010). *Distance matters – The environmental impact of regional and national supply chains of canned tomatoes*, Working papers 2010/25. CRENoS, CUEC, Cagliari, 32p.

- Mila i Canals L, Cowell SJ, Sim S, Basson L, (2007). *Comparing local versus imported apples: a focus on energy use*. Env Sci Pollut Res, 14(5), 338-344.

- Monnot C, (2000). *Le coût énergétique de notre alimentation*, CNRS-ECODEV, Juin 2000.

- Muller-Lindenlauf M, Reinhardt G, (2010). *Food import versus regional production: comparison of energy demand and greenhouse gas emissions*. VII international conference on life cycle assessment in the agri-food sector, Bari, Italy, 22 - 24 September 2010.

- Padilla M (coord), Basset-Mens C, Belhouchette H, Colvine S, Essecofy G, Fort F, Garrabé M, Georgé S, Le Bail- Declerck V, Nicol D, Page D, Palma G, Portal S, (2014). *Durabilité environnementale, qualité nutritionnelle, impacts socio-économiques dans les filières fruits et légumes : la tomate sous la loupe*. Rapport du projet FLONUDEP. CIHEAM-IAMM.

- Palma G, Padilla M, Saheb M, Tatar Y, Tugulay A, Kellou I, Colvine S, (2014). *Environmental impact of processed tomato in France and in Turkey*. Proceedings of the 9th International Conference on Life Cycle Assessment in the Agri-Food Sector. San Francisco, 8-10 October 2014.

- Payen S, Basset-Mens C, Perret S, (2015). *LCA of local and imported tomato: an energy and water trade-off*. Journal of Cleaner Production. Volume 87, 139–148.

- Schlich EH, Fleissner U, (2005). *The ecology of scale: assessment of regional energy turnover and comparison with global food*. International Journal of Life Cycle Assessment, 10, 219-223.

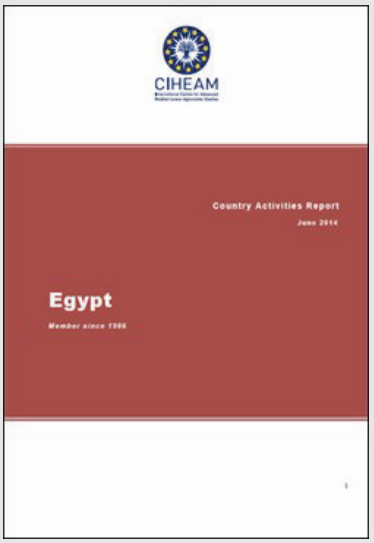
- UNEP (2010). *Assessing the Environmental Impacts of Consumption and Production: Priority Products and Materials*. A Report of the Working Group on the Environmental Impacts of Products and Materials to the International Panel for Sustainable Resource Management.

- White PJ and Broadley MR, (2005). *Historical variation in the mineral composition of edible horticultural products*. The Journal of Horticultural Science & Biotechnology, 80, 6.

CIHEAM
Country Activities Reports

The Country Activities Reports (CAR) are summary documents that have been proposed in order to enhance the communication policy of the CIHEAM and to improve the circulation of information on the actions developed in each of its thirteen Member States.

The CAR are divided into sections portraying: political relations; education; focus on former students; research and technical projects as well as networks for development, operating in the concerned country, and in which CIHEAM's 4 Mediterranean Institutes are coordinators, or partners; the most important agricultural, economic, and demographic statistics.



The first edition was elaborated during the year 2014 in the frame of a better Corporate Strategy for CIHEAM. The CAR will be updated on a yearly basis. They are prepared by the General Secretariat of CIHEAM in a collaborative framework associating the Organization's Four Institutes.

The CAR are available in free access on
www.ciheam.org

Assessment of sustainable food security in the Mediterranean with an aggregated indicator

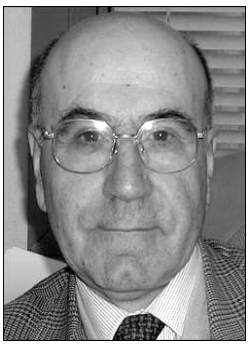
Jose Soler-Rovira
School of Agricultural Engineering,
Technical University of Madrid

Juan Manuel Arroyo-Sanz
School of Agricultural Engineering,
Technical University of Madrid

Francisco González-Torres
School of Agricultural Engineering,
Technical University of Madrid

Carlos Rojo-Hernández
School of Agricultural Engineering,
Technical University of Madrid

Antonio Marquina-Barrio
Faculty of Political and Social Sciences,
Complutense University of Madrid



The aim of this work is to measure at a national level food security and agricultural sustainability in the Mediterranean Region with an aggregated indicator using the multivariate statistical tool Principal Components Analysis (PCA). This is a statistical multivariate methodology used to study large sets of data and it should be applied to synthesize all that information in a formalized way, instead of doing it intuitively and subjectively, in order to generate a unique aggregated indicator.

Methodology

In the development of aggregated indicators problems arise when the indices that build up the indicator and the weights of each index have to be selected. Therefore, Principal Components Analysis (PCA) can be used as an objective approach to choose the indices that show higher variability within the studied observations and to set the weights as a incoming function of the explained variance. Additionally, this analysis allows making an internal sustainability or food security evaluation between countries, giving a relative value of sustainability or security.

PCA is a statistical multivariate methodology used to study large sets of data. This method reproduces a great proportion of variance among a big number of variables by using a small number of new variables called principal components (PCs). The PCs are linear combinations of the original variables, and the analysis of multidimensional data is simplified when these are correlated. The first PC explains maximum variance between data, while the second component is a new combination of the original variables being orthogonal to the first component and explaining the second largest value of variation among observations, and so forth. The absorption of variance in each component is computed with the so-called eigenvalues. One property of the PCs is that they are uncorrelated between them, and then each component is measuring a different dimension in the data.

High absolute values of loadings of the variables on the PCs imply that the indicator has a large bearing on the creation of that component. Thus, the most important indicators in each component, that best explain variance; will also be more useful in explaining variability between observations. Each component will be a linear combination of variables multiplied by their loadings on that component. Observations will have coordinates in each axis or component, computed with the standardized value of each variable (zero mean and unit variance) for that observation using the linear combination of variables with PCs obtained in the analysis. These coordinates can be used in the aggregation method of the indicator and also eigenvalues can be used as weight factor of each variable.

The selected variables were organized according to Bossel´s seven basic orientors (table 1): existence, effectiveness, freedom of action, security, adaptability, coexistence and psychological needs. The hierarchical structure of the framework was based upon three dimensions: food security, environmental sustainability and economic sustainability.

All Countries from the Mediterranean basin were included in this study and other 39 countries were selected in order to include diverse agricultural, economic and environmental conditions (table 1). There were used 21 indicators (3 dimensions x 7 orientors) from the 60 selected countries (table 2). An initial screening of variables assigned to each orientor was done with PCA of a high number of preliminary variables, selecting those that showed the higher variability within the studied observations (countries).

Before developing the PCA, all the variables were signed as positive or negative in order to make them unidirectional. PCA was performed with STATGRAPHICS software, standardizing data to zero mean and unit variance. Eigenvalues and the amount of variance explained by each principal component (PC) were calculated. The number of components retained in the analysis was assessed by Cattel's scree plot, which indicates that we should retain i components because, after the i+1 component, the plot becomes flat, corresponding to eigenvalues lower than one. The value of the eigenvectors and loadings of variables with PCs were computed. Coordinates of each country with each axis were determined. The aggregation of data into a single Sustainable Food Security Index (SFSI) was calculated as:

$$SFSI = \frac{\sum_{k=1}^{j} F_{ki}\sqrt{\lambda_k}}{\sum_{k=1}^{j}\sqrt{\lambda_k}} \qquad i = 1,...,60(countries)$$

Where, F_{ki} is the coordinate of the country i in the component k (and j components are retained) and λ_k is the eigenvalue of the component k. This index should give information about the relative value of sustainable food security between the studied countries.

An aggregated index was also computed for each individual dimension (food security, environmental sustainability and economic sustainability) in the same way, so each index should give information about the relative value of each dimension of sustainable food security between the studied countries.

Results

The values of the Sustainable Food Security Index (SFSI) for the 60 studied countries are shown in table 2. The positive values indicate sustainable food security and the higher the value, the greater the relative value of food security.

European developed countries showed high relative SFSI values, while Middle East and Maghreb countries showed a worse performance, although Sahel countries showed the worst. Almost all the countries form the north Mediterranean basin showed relative sustainable food security but those form the south side showed negative values of the index and therefore relative unsustainable food security.

Not all developed countries showed positive values in the individual indexes, mostly the environmental one. Thus, their strengths are food production and food supply but with a high ecological footprint. In table 3 standardized values of the 21 studied variables of Spain and Algeria are shown, as an example of Mediterranean countries.

Water and ecological footprint are the weak variables of environmental sustainability (high negative values) in Spain, but they are strengths in Algeria (high positive values). Besides, energy and protein intake are scarce in the Maghreb country, but sufficient in Spain, with a high share of cereals in energy supply. Cereal production variables are inadequate in Algeria and there is dependence of external imports.

The aggregated SFSI computed in these study showed a high correlation with other well known and widely used socioeconomic indicators as GDP per cápita and Human Development Index (HDI) (figures 1 and 2).

There is an exponential relationship between the SFSI and the GDP per cápita (figure 1), hence sustainable food security enhances when the national economic product increases. SFSI positive values (relative sustainable food security) are reached when a threshold of circa 10,500 US dollars/cápita is exceeded, so countries with a lower income per cápita will show a relative unsustainable food security.

By the other hand, if we take only the environmental dimension of sustainability (natural system in table 1) and the subsequent computed Environmental Sustainability Index, the relation of this index with per cápita GDP is inverse (figure 2). The figure indicates a decline of environmental sustainability when the economic size of the country increases, because there is an increment of environmental impact of agriculture. In figure 2 when wealth increases above 10,500 US dollars appears environmental unsustainability (negative values of the index), Thus, in developed countries food supply is held but with a high ecological footprint.

Conclusions

The computed index is a good indicator of sustainable food security and differences between countries can be analyzed, and also strengths and weaknesses of each one. Developed countries showed relative sustainable food security while in less developed countries there was a relative insecurity. However, in the former the strengths were food production and food supply but with a high ecological footprint, whereas in the last the sustainable production does not ensure food security and external imports are needed.

Table 1
Values of the aggregated Sustainable Food Security Index (SFSI) of the 60 studied countries

Orientor	Indicator	Variable	Source
Natural system	***Environmental sustainability***		
Existence	Impact of agricultural production	Water footprint of food production per capita	1
Effectiveness	Eco-efficiency of agriculture	Water footprint of food production per dollar of net value	1
Freedom of action	Dependence of external resources	Ratio external vs internal water footprint of consumption	1
Security	Own resources	Ratio water footprint of food production vs national rainfall	1
Adaptability	Global footprint	Ecological footprint of food	2
Coexistence	Structure	Harvested area per capita	3
Psychological needs	Limitation	Ecological footprint versus national biocapacity	2
Human system	***Food security***		
Existence	Supply of energy intake requirements	Dietary energy supply per capita vs minimum renergy equirement	3
Effectiveness	Social efficiency of agriculture	Agricultural production vs agricultural population	3
Freedom of action	Food commodities in diet	Share of cereals and roots & tubers in dietary energy supply	3
Security	Food Supply for Human Consumption	Total protein consumption	3
Adaptability	Food needs	Minimum dietary energy requirement	3
Coexistence	Food deprivation	Food deficit of undernourished population	3
Psychological needs	Perceived personal status	Well being	4
Support system	***Economic sustainability***		
Existence	Productivity	Cereal production per capita	3
Effectiveness	Eficiency	Inverse of cereal yield	3
Freedom of action	Dependence of external resources	Net cereal imports per capita	3
Security	Stability and variability	Cereal yield stability (VC)	3
Adaptability	Technology and innovation	Cereal yield trend over time	3
Coexistence	Production gap	Cereal yield gap (% maximun yield vs average)	3
Psychological needs	Work in agriculture	Agricultural workers per ha	3

Sources: (1) Waterfootprint Network, (2) Global Footprint Network, (3) FAOSTAT, (4) NEF Happy Planet Index.

Table 2
Variables included in the framework

Country	Indicator	Country	Indicator
Denmark	3,47	*Albania*	*-0,21*
France	3,28	South Africa	-0,32
Hungary	2,71	*Lebanon*	-0,34
Austria	2,14	Ecuador	-0,37
Germany	2,12	*Tunisia*	-0,55
Luxembourg	2,06	Iran	-0,62
Finland	2,06	Un. Arab Emirates	-0,68
Czech Rep.	1,87	Kuwait	-0,95
Lithuania	1,80	Saudi Arabia	-0,99
Sweden	1,75	*Egypt*	-1,05
Ireland	1,73	*Cyprus*	-1,10
Greece	1,70	*Algeria*	*-1,28*
UK	1,66	*Libya*	-1,48
Italy	1,63	Nigeria	-1,48
Belgium	1,49	*Syria*	-1,66
Poland	1,41	*Morocco*	-1,92
Slovenia	1,27	Mali	-1,92
Latvia	1,24	Mauritania	-2,32
Romania	1,21	*Jordan*	-2,59
Croatia	1,17	Sudan	-2,74
Norway	1,12	Senegal	-2,76
Spain	1,07	Chad	-2,78
Serbia-Montenegro	1,07	Niger	-3,15
Estonia	1,03	Angola	-3,64
The Netherlands	0,79	Yemen	-3,87
Malta	0,76	Eritrea	-6,60
Turkey	0,69		
Portugal	0,68		
Slovakia	0,66		
Bulgaria	0,65		
Bosnia-Herzegovina	0,43		
Mexico	0,27		
Israel	0,04		

Table 3
Standardized value (z-scores) of each variable (zero mean and unit variance) of Spain and Algeria included in the study

Indicator	Variable	Spain	Algeria
Environmental sustainability			
Impact of agricultural production	Water footprint of food production per capita	-0.98	0.77
Eco-efficiency of agriculture	Water footprint of food production per dollar of net value	0.51	0.03
Dependence of external resources	Ratio external vs internal water footprint of consumption	0.08	-0.25
Own resources	Ratio water footprint of food production vs national rainfall	-0.30	0.45
Global footprint	Ecological footprint of food	-0.95	0.93
Structure	Harvested area per capita	0.41	-0.38
Limitation	Ecological footprint versus national biocapacity	-0.09	0.12
Food security			
Supply of energy intake requirements	Dietary energy supply per capita vs minimum renergy equirement	0.22	0.30
Social efficiency of agriculture	Agricultural production vs agricultural population	0.55	-0.72
Food commodities in diet	Share of cereals and roots & tubers in dietary energy supply	-1.24	1.21
Food Supply for Human Consumption	Total protein consumption	0.92	-0.23
Food needs	Minimum dietary energy requirement	0.69	-0.64
Food deprivation	Food deficit of undernourished population	0.67	-0.38
Perceived personal status	Well being	0.50	-0.28
Economic sustainability			
Productivity	Cereal production per capita	0.29	-0.76
Eficiency	Inverse of cereal yield	0.42	-0.44
Dependence of external resources	Net cereal imports per capita	-0.73	-0.69
Stability and variability	Cereal yield stability (VC)	0.06	-0.51
Technology and innovation	Cereal yield trend over time	-0.85	0.23
Production gap	Cereal yield gap (% maximun yield vs average)	-0.24	-0.24
Work in agriculture	Agricultural workers per ha	-0.68	0.33

Figure 1
Relationship between the computed Sustainable Food Security Index and the GDP per capita

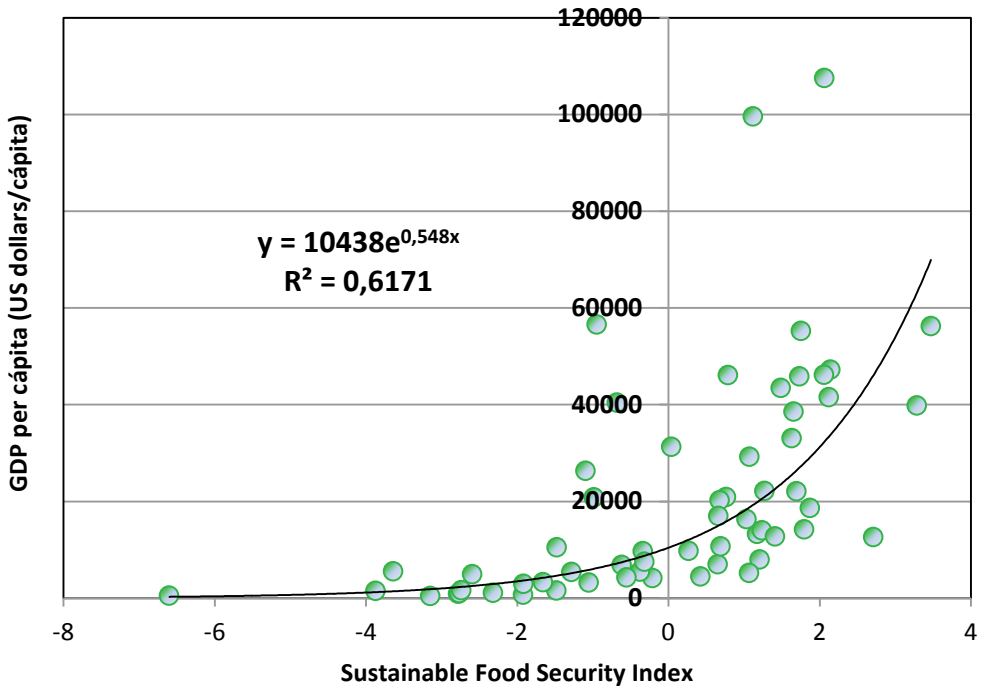
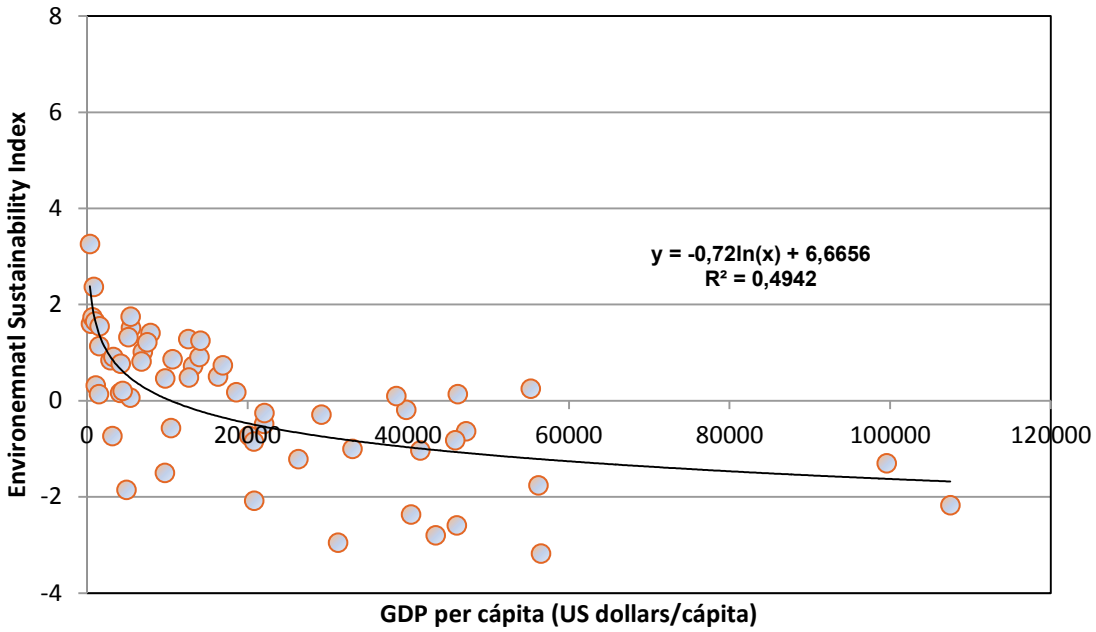


Figure 2
Relationship between the computed Environmental Sustainability Index and the GDP per capita



Sécurité alimentaire: orientation de la politique publique portugaise et défis à l'élaboration d'indicateurs

Alexandra Seabra Pinto
Instituto Nacional de Investigação Agrária e Veterinária, I.P. (INIAV), Portugal

Joaquim Cabral Rolo
Instituto Nacional de Investigação Agrária e Veterinária, I.P. (INIAV), Portugal

L'évolution de la politique alimentaire au Portugal

Les évolutions socio-économiques et environnementales ainsi que la santé de la population sont aujourd'hui prises en considération dans les politiques publiques alimentaires du Portugal. Ces dispositifs intègrent désormais les aspects multidimensionnels de la sécurité alimentaire, en tenant compte des contraintes économiques, biologiques, sociales et culturelles[1]. Les feuilles de route des politiques, avec la construction d'indicateurs sur la sécurité alimentaire ou plus largement sur les enjeux de la qualité de la vie, ont tenu compte du contexte international et des relations avec les autres pays.

L'entrée du Portugal dans l'Union Européenne (UE) en 1986 a entraîné la mise en conformité des critères de mesure et la recherche d'indicateurs communs d'évaluation, nécessitant la collecte d'informations pertinentes par des entités qui sont en charge de ces politiques, en particulier par les organismes officiels de mise en place et de diffusion des statistiques. Il est à souligner que même avant son entrée dans l'UE, le Portugal participait déjà au sein des organisations internationales aux travaux liés à la question de la sécurité alimentaire. En effet, c'est le cas par exemple de son adhésion à des organismes des Nations Unies tels que l'Organisation pour l'Alimentation et l'Agriculture (FAO) et l'Organisation Mondiale de la Santé (OMS). A partir des années 1970, ceci a permis de définir les lignes directrices des mesures pour la politique de l'alimentation. Les résolutions adoptées lors de la première conférence mondiale de l'alimentation (Nations Unies, Rome, 1974) dont le Portugal était signataire, conseillaient déjà la mise en œuvre de politiques actives pour lutter contre la faim et la malnutrition. C'est dans ce contexte international que le concept de sécurité alimentaire a ainsi été défini comme « *la capacité de tout temps d'approvisionner le monde en produits de base, pour soutenir une croissance de la consommation alimentaire, tout en maîtrisant les fluctuations et les prix*».

Ainsi, au début des années 1970 la politique agro-alimentaire portugaise concernait essentiellement le seul secteur de l'agriculture, avec comme priorité l'augmentation de la disponibilité des aliments, l'autosuffisance du pays et le contrôle des prix des matières premières. Néanmoins, après la révolution de 1974 de nouvelles orientations ont été définies avec essentiellement des initiatives telles que la création des Instituts et organismes liés à la qualité et la surveillance alimentaire et nutritionnelle, des études techniques sur la composition des aliments et des campagnes nationales pour encourager l'éducation nutritionnelle.

C'est ainsi qu'en 1980, le gouvernement portugais a créé un organisme consultatif interministériel : le *Conselho Nacional de Alimentação e Nutrição* (Conseil National de l'Alimentation et de la Nutrition), responsable de la coordination des études sur les habitudes alimentaires et de la formulation et la mise en œuvre d'une politique alimentaire et nutritionnelle. L'entrée du Portugal dans l'UE, avec ses engagements législatifs, a également fortement contribué à l'évolution de la politique alimentaire.

[1] Cette première partie est basée sur les références bibliographiques : Gaspar, S., 2009. *Segurança Alimentar e Nutricional no contexto do direito humano à alimentação adequada*. Monografia, Faculdade de Ciências da Nutrição e Alimentação, Universidade do Porto; Graça, P., Gregório, M.J., 2012. "Evolução da Política Alimentar e de Nutrição em Portugal e suas relações com o Contexto Internacional". *Revista SPCNA* 2012, 18 (3), 79-96 ; Gregório, M. J. *et al.*, 2014. "Proposta Metodológica para a Avaliação da Insegurança Alimentar em Portugal". APN, *Revista Nutrícias* 21: 4-11, APN - www.apn.org.pt.

En effet, à la fin des années 1980 les questions alimentaires européennes étaient encore orientées sur l'autosuffisance alimentaire, liée aux aspects quantitatifs de la production, et n'accordant pas une grande importance aux questions de sécurité des aliments et d'équilibre nutritionnel de l'alimentation. C'est seulement avec le traité de Maastricht de 1993, que la question de la santé des consommateurs a été fortement prise en compte, dans le cadre des politiques européennes sur l'alimentation et la nutrition.

Tout d'abord, les crises sanitaires des années 1990 ont de fait entraîné une réorientation de la politique européenne en mettant au centre des débats des États membres les questions liées à la garantie sanitaire des denrées alimentaires. C'est dans ce contexte que le concept de « sécurité sanitaire des aliments » émerge, défini comme « *l'assurance que les aliments sont sans danger pour le consommateur quand ils sont préparés et/ou consommés conformément à l'usage auquel ils sont destinés* ». Au « Sommet mondial de l'alimentation » de 1996, a ainsi été défini les contours du concept actuel de sécurité alimentaire.

Dans le cadre européen, la politique alimentaire portugaise se concentre ainsi sur le contrôle officiel et l'inspection des aliments, en mettant l'accent sur la protection des consommateurs et sur la garantie de la sécurité sanitaire. Néanmoins le terme de « Sécurité alimentaire » est utilisé à la fois pour qualifier les aspects quantitatifs de l'alimentation et les aspects sanitaires en lien avec la sécurité des aliments. Au début du nouveau millénaire cette nouvelle orientation de la politique alimentaire portugaise a abouti à la création de l'*Autoridade de Segurança Alimentar e Económica* (Autorité de la Sécurité Alimentaire et Economique, ASAE) pour favoriser la coordination avec l'Autorité européenne de sécurité des aliments (EFSA). Plus récemment, en 2014, les ministères d'économie, de l'agriculture et de la santé ont créé la *Comissão de Segurança Alimentar* (Commission de la Sécurité Alimentaire) dont la mission est d'accroître la confiance des consommateurs et l'adoption d'une approche globale fondée sur la sécurité sanitaire.

En 2006, dans une conférence ministérielle européenne de l'OMS, s'est déclaré que l'obésité était l'un des plus graves problèmes de santé public auxquels la Région européenne de l'OMS devait faire face. Comme dans bon nombre de régions du monde, l'UE est en effet confrontée à ce problème important de santé publique (qualifiée d' « épidémie » par l'OMS) ce qui l'a conduit à réorienter sa politique publique du point de vue des questions nutritionnelles. Il s'agissait de mettre en œuvre des politiques intégratrices et intersectorielles, pour satisfaire aux objectifs définis dans le cadre de la charte européenne sur la lutte contre l'obésité. Le ministère de la santé portugais a ainsi présenté un plan national définissant les mesures de prévention pour tenter de réduire cette épidémie.

En 2012, sur la base des orientations de l'OMS et de l'UE, le Portugal a défini formellement une stratégie nationale sur les questions alimentaires/nutritionnelles, publiée dans le Programme national pour la promotion d'une alimentation saine et équilibrée. Sur ce point la Diète Méditerranéenne et sa reconnaissance en 2010 en tant que patrimoine immatériel de l'Humanité par l'Unesco constitue un élément important du dispositif de réflexion de la politique gouvernementale. Notons qu'à l'instar de bons nombres de pays européens, la mise en œuvre du plan reste fondée sur la collaboration entre organismes publics et privés.

Les questions environnementales en lien avec la santé publique ont été également abordées par la communauté internationale. C'est à la 5ème Conférence ministérielle sur l'environnement et la santé de l'OMS que sont pris des engagements pour la prévention, le contrôle et la réduction des risques sanitaires en lien avec des facteurs environnementaux. De ce compromis, auquel le Portugal est signataire, a émergé le *Plano Nacional de Acção Ambiente e Saúde* (« Plan National d'Action pour l'Environnement et la Santé », PNAAS), en 2008, co-coordoné par les ministères de l'environnement et de la santé, en étroite collaboration avec d'autres ministères. L'alimentation est l'un des domaines d'intervention du PNAAS qui concerne aussi d'autres domaines tels que : la recherche appliquée, la formation, l'éducation et la concertation des politiques nationales et internationales.

Au Portugal, comme dans d'autres pays européens, la crise financière et économique depuis 2008 a fait émerger de vieux débats, et précisément ceux touchant à la souveraineté alimentaire et à l'insécurité alimentaire. En effet, les conséquences de cette crise ont eu de graves répercussions sur sa structure économique et la vie des citoyens. Le chômage, qui en 2008 s'élevait à 8% de la population active, atteignait 14% en 2014. De graves problèmes sociaux ont alors émergé touchant les personnes sans emploi, mais aussi les personnes âgées à faible retraites. De plus, les travailleurs avec des emplois précaires représentant une part importante de la population ont également subi les conséquences de cette crise. Ainsi, cet ensemble important de la population portugaise, vulnérable à la pauvreté est donc soumis à l'insécurité alimentaire. Noter que le taux de risque de pauvreté d'environ 18% dans les années 2008-2011, est passé à 19,5% en 2013[2].

Le Portugal, en tant que signataire de la Déclaration du Millénaire de 2000 s'est engagé à atteindre l'objectif d'éradiquer la faim et l'extrême pauvreté, avec en outre la réduction des gaspillages alimentaires. Par ailleurs, le pays a approuvé en 2011, dans le cadre de la stratégie de sécurité alimentaire et nutritionnelle de la CPLP (Communauté des Pays de Langue Portugaise créée en 1996) un nouveau modèle de gouvernance de l'alimentation.

[2] Le taux de risque de pauvreté *correspond à la proportion de la population dont le revenu équivalent, après les transferts sociaux, est en dessous du seuil de la pauvreté.* INE, 2015. *Destaque*, "Inquérito às Condições de Vida e Rendimento das Famílias".

Il faut également souligner que la sécurité alimentaire et la lutte contre la faim sont intégrées à la stratégie de coopération portugaise avec les pays africains lusophones et la République Démocratique du Timor oriental. En vertu du concept élargi et finalement complexe de la sécurité/insécurité alimentaire, le Portugal s'efforce ainsi d'articuler les politiques, programmes et actions entre le gouvernement, les organisations non gouvernementales, le secteur privé et la société civile.

Les défis à l'élaboration des indicateurs au Portugal

Dès lors, un effort scientifique et technique important a été effectué, en particulier dans le cadre des organisations internationales, par la mise en place d'indicateurs pour mesurer la sécurité alimentaire. Les indicateurs sous le format de panel regroupent divers domaines bien différenciés ou au contraire correspondent à la construction d'indicateurs synthétiques, tels que, par exemple, l'indice de la sécurité alimentaire mondiale[3]. Cet indice construit à partir de la définition de la sécurité alimentaire adoptée au sommet mondial de l'alimentation de 1996, rassemble des indicateurs sur la disponibilité, l'accessibilité, la qualité et la sécurité.

En tant que partenaire de la CPLP, le Portugal se réfère aux documents de la réunion scientifique de la FAO de 2011 concernant le thème « *Mesurer l'insécurité alimentaire* »[4] et où sont résumés les différents indices synthétiques qui ont été proposés pour une utilisation à l'échelle macro (comparaisons/classifications des pays ou régions) ou au niveau micro (situation des individus ou des ménages). Il s'agit en outre d'intégrer les travaux complémentaires concernant un ensemble d'indicateurs de la sécurité alimentaire (classés selon les quatre dimensions « disponibilité », « accès », « utilisation » et « stabilité »), qui permettent des comparaisons ponctuelle et de long terme entre les pays ou au niveau régional nous faut également mentionner la configuration des indicateurs pour renseigner les objectifs du millénaire pour le développement[5].

Au Portugal, l'information officielle sur la consommation alimentaire date des années 1960, avec la publication par l'Institut National de la Statistique (INE) de la *Balança Alimentar* (« Balance Alimentaire »). En 1980, l'enquête alimentaire nationale a été mise en place et à partir des années 1990, un autre dispositif fournit tous les cinq ans des données pour l'élaboration des indicateurs à partir de l'Enquête sur les dépenses des familles.

Cependant, la mesure de la sécurité alimentaire (ou de façon plus juste de l'insécurité alimentaire) s'inscrit aujourd'hui dans le domaine plus général de l'évaluation de la qualité de vie et du développement durable. La qualité de vie inclut à la fois les dimensions de confort matériel, une alimentation équilibrée ancrée dans la « vision globale » de la santé humaine et des critères plus généraux avec des objectifs de bien-être et de développement. Le concept est donc multidimensionnel et nécessite une observation des conditions matérielles de la vie, de la participation dans des projets sociaux et de la jouissance des biens culturels.

Ces aspects font partie de *la Stratégie portugaise pour le développement durable 2015* basée sur trois piliers : « développement économique », « cohésion sociale » et « protection et valorisation de l'environnement ». Ce document stratégique suit les recommandations internationales du Sommet mondial de l'ONU de 2005 et du Conseil européen de 2006, où la stratégie européenne pour le développement durable a été révisée. A partir de ces trois piliers structurants, la mesure de la qualité de vie et du développement durable doit prendre en compte les différentes « tendances lourdes » qui structurent l'évolution des sociétés, telles que les conséquences du changement climatique, le vieillissement de la population, et l'intensification de la concurrence mondiale pour l'accès aux ressources[6]. Sur ce dernier point, les contraintes du système financier sur l'économie sont particulièrement importantes, notamment pour ce qui concerne la connexion des prix des denrées alimentaires avec le pouvoir d'achat des citoyens.

Toutefois, le choix des indicateurs statistiques reste un point crucial de la mesure de la sécurité et de la qualité de vie. Selon l'importance des critères, de leur pertinence et de leur utilité, il doit être possible d'effectuer une mesure de la situation à un moment spécifique (à l'échelle mensuelle ou pour une année donnée) et aussi de la suivre dans le temps. Cela nécessite l'accès à des données fiables, régulièrement mises à jour au niveau national et international. D'où l'importance d'utiliser des données des organismes officiels de statistique.

Les indicateurs de sécurité alimentaire

Le contexte portugais sur les indicateurs et leur systématisation peut être résumé de la façon suivante. Tout d'abord, on retiendra l'indicateur de disponibilité des aliments, sur la dimension nucléaire de la sécurité alimentaire d'un pays ou d'une société humaine (pour un groupe bien défini ou une région géographique). Plutôt que de se positionner par rapport à une référence en termes d'autarcie, nous préférons adopter un positionnement sur « la sécurité de l'approvisionnement » des aliments.

[3] Cf. The Economist Intelligence Unit, 2014. *Global food security index 2014. An annual measure of the state of global food security* - http://foodsecurityindex.eiu.com/; PNUD, *Relatório do Desenvolvimento Humano* (anual, 1990-2013). - hdr.undp.org.

[4] *Mesurer l'insécurité alimentaire : des concepts et des indicateurs pertinents pour l'élaboration de politiques fondées sur des données probantes*. Document d'information. ROME, Italie, 12 – 13 septembre 2011 *www.fao.org/fileadmin/templates/cfs_roundtable/Round-Table_….pdf*

[5] ONU, 2013. *Relatório Sobre os Objectivos de Desenvolvimento de* Milénio 2013 - www.unric.org/html/….pdf; et mdgs.un.org/unsd/mdg/….

[6] Cf. APA (R. Ribeiro e S. Rodrigues, Coord.), 2014. *Relatório do Estado do Ambiente 2014* [*REA2014*]. Agência Portuguesa do Ambiente [APA]/Depart. de Estratégias e Análise Económica. Ed. APA - www.apambiente.pt/.

Cette démarche implique de s'attacher à la valeur économique des biens alimentaires (produits de l'agriculture et de la pêche et de l'aquaculture) en produits frais et transformés, les composants de la production interne (P), la consommation apparente (Ca) et la balance commerciale (Sc) qui s'exprime par l'indicateur nommé « degré de la sécurité d'approvisionnement alimentaire » (GSA) : GSA=P/(Ca-Sc)[7].

En lien étroit avec cet indicateur, il est nécessaire de souligner l'importance d'un autre indicateur qui permettra de clarifier la relation entre les prix des produits alimentaires dans la production, dans les marchés nationaux et internationaux, et de la consommation[8]. En second lieu, il est nécessaire de faire référence au système *InfoFamília* (« InfoFamille »), qui utilise, à travers une échelle psychométrique, une méthode d'auto perception des individus sur l'insécurité alimentaire. Cette échelle couvre quatre niveaux biens différenciés d'autosuffisance, à partir de la situation où les revenus de la famille permettent « *l'accès régulier et permanent à une alimentation de qualité, en quantité suffisante, sans compromettre l'accès à d'autres besoins essentiels* » jusqu'à l'étape à laquelle se déclare l'existence de « *périodes de restriction en termes de quantité d'aliments par des contraintes financières* »[9].

Les indicateurs de la qualité de vie et du développement durable

Dans le contexte plus large de la qualité de vie, le système d'indicateurs de développement (SIDS) a été mis en place par des organismes officiels liés à l'environnement. Il est aujourd'hui sous la responsabilité de l'INE, dans le contrat cadre avec l'Eurostat, pour le suivi de la stratégie de développement durable (portugaise et UE28)[10]. Ce système se compose d'un ensemble d'indicateurs, axé sur les objectifs stratégiques de « société de la connaissance », « croissance, compétitivité et efficacité énergétique », « environnement et patrimoine naturel», «équité et cohésion sociale », « valorisation du territoire et connectivité internationale », « participation active dans la coopération internationale » et « efficacité des services publiques ». Ceci faisant référence à trois indicateurs liés à la production agricole durable. C'est le cas de la valeur économique des engrais et des produits phytopharmaceutiques par hectare de superficie agricole utilisée (SAU, l'exclusion de la dimension du pâturage pauvre) ; la part de la surface consacrée à la production alimentaire en agriculture biologique ; et l'équilibre de nutriments azote et phosphore dans l'agriculture[11].

Pour conclure la référence à l'indice de bien-être (IBE), mis en œuvre par l'INE[12] suite à la crise sociale de l'après 2008 et le consensus international sur l'urgence d'avoir des informations sur *la qualité de vie* des familles et des individus. L'IBE pour le Portugal est le résultat de l'articulation des travaux méthodologiques de divers instituts statistiques à l'échelle mondiale avec des organisations internationales (ONU, OCDE, Eurostat, FMI, Banque mondiale). Cet indice est construit à partir des données provenant de divers sous-systèmes d'information officielles, notamment, les résultats des enquêtes sur les conditions de vie et revenus des ménages[13]. L'IBE est un indice global sur la base de deux niveaux de « perspective » (qualité matérielle de la vie et de la qualité de vie) et synthétise dix indices spécifiques:

- Les conditions matérielles de la vie : « le bien-être économique » ; « la vulnérabilité économique » ; « le travail et le salaire ».

- La qualité de vie : « santé » ; « l'équilibre travail-vie » ; « l'éducation, les connaissances et compétences » ; les relations sociales et le bien-être subjectif » ; « la participation civique et la gouvernance » ; « la sécurité personnelle » ; « l'environnement ».

Pour mesurer la qualité de vie et du développement durable au Portugal à une échelle plus fine (régionale/locale), il faut mentionner simplement l'indice synthétique de développement régional (ISDR) mis en place par l'INE qui prend en compte l'échelle méso (les unités territoriales de niveau III dans la classification Eurostat). L'ISDR compile 65 indicateurs statistiques en trois dimensions, convertis en indices composites : la compétitivité, la cohésion et la qualité environnementale[14].

[7] Cf. Avillez, F. 2013. "Autossuficiência alimentar: mitos e realidades" AA.VV., 2013. *O futuro da alimentação: ambiente, saúde e economia.* Fundação Calouste Gulbenkian. www.gulbenkian.pt/....pdf: 112-122; INE, 2013. *Destaque*: "Abastecimento Alimentar em Portugal".

[8] Sur la volatilité des prix alimentaires : « Agricultural Market Information System - AMIS » (FAO: SICIAV) et « Agricultural Markets Brief » in : ec.europa.eu/agriculture/analysis/....

[9] Gregório, M. J. *et al.*, 2014.

[10] Cf. Gomes, M.ª L. *et al.* 2000; APA, 2010, *Sistema de Indicadores de Desenvolvimento Sustentável (SIDS) Portugal.*

[11] Ces deux derniers indicateurs qui appartiennent au système d'indicateurs de l'APA sont publiés par l'INE.

[12] INE, 2013. *Documento Metodológico. Índice de Bem-Estar, versão 1.0*. Id. 2013. *Destaque* "Índice de Bem-estar 2004-2012", - www.ine.pt.

[13] Cf. EUROSTAT, 2010. *Income and living conditions in Europe* (ed. A. B. Atkinson and E. Marlier) - ec.europa.eu/eurostat.

[14] Cf. INE, 2014. *Destaque* "Índice Sintético de Desenvolvimento Regional 2011", - www.ine.pt.

Food reformulation: more healthy nutrients and food consciousness

Michele Sechi Gatta
Health Economist
CEIS EEHTA, Tor Vergata University, Rome

Introduction

We live in a world surrounded by an unsustainable paradox: for every undernourished person, there are two who are overweight or obese. As highlighted by the World Health Organization in 2014, there are more than 1.9 billion adults overweight; 600 million people of these are obese and since 1980 the number of cases has more than doubled. Obesity is one of the major public health concerns, because it is a risk factor for several chronic diseases, like diabetes, cardiovascular disease, breast and colorectal cancer. Considering that chronic diseases are the main cause of disability and death in the world, the effort to tackle obesity should generate positive effects on health and longevity (with a ten-year increase in lifespan) and reduce economic costs (an obese person requires higher health care expenditure) also in the future. To achieve these goals, prevention can be one of the most effective ways to improve health, even if it requires time to contrast social constraints like lifestyle and human behaviour.

Governments can play a key role in promoting healthy diet through taxes on food and beverage, advanced nutrition labelling, regulation of food advertising, school-based interventions, physician counselling (Sassi, 2010). The private sector has the possibility to contribute to improving individual lifestyle and encouraging more healthy diets. Industries can take action by working on Food Reformulation (referred to also as "change in composition of food"), one of the most potentially effective policies that should be implemented.

The definition provided by the National Heart Foundation of Australia (Heart Foundation, 2012) explains that it consists in "changing the nutrient content of a processed food product to either reduce the content of negative nutrients such as sodium, sugar, saturated fat, trans fat or energy (kilojoules) or to increase the content of beneficial nutrients such as dietary fibre, wholegrains, fruit, vegetables and unsaturated fats".

The focus is on processed food because most primary food commodities result processed in some way (changed with chemical or biological items or through cooking) to obtain nutritious substances. This article aims to improve nutrient content of food through actions taken by food and beverage companies. By purchasing processed products, people consume the majority of unhealthy ingredients and consequently the role of the private sector in defining healthy food offer is crucial (Capacci *et al*., 2012).

Companies are involved in two different aspects: on one hand they have to follow (voluntary or mandatory) government guidelines on limiting the use of unhealthy ingredients such salt and sugar (useful for taste), or trans fats (used for economic convenience). On the other hand they want to guarantee consumer demands for their products. The work in changing the composition of food concerns several agents, involves social and economics aspects and can be obtained in different ways.

Type of Food Reformulation

Table 1 shows a summary of possible interventions, considering selected food categories and items. This initial stage proposition, presents actions taken by industries to reduce trans fat, saturated fat, salt, sugar or increasing fibre.

Table 1
Interventions on food reformulation by key nutrients and food category/items

Food category	Food items	1. Trans fatty acids (TFA)	2. Saturated fatty acids (SFA)	3. Salt	4. Sugar	5. Fibre
Cereals and cereal products	Bread			Reduced by 25%		
	Breakfast cereals			Reduced by 15-38%		Whole grain ranging from 15-100%
Meat	Processed meat			Reported reductions		
Milk and milk products	Milk		Reported reductions			
	Cheese		Reported reductions	Reported reductions		
	Yoghurt				Reported reductions	
Fats and oils	Margarines	Elimination				
	Fats	Elimination	Reduced by 20 to 80%			
Beverages	Sugary drinks				Reduced by 10-40% in light products	
Other foods	Snacks		Reduced by 30-70% in chips	Reduced by 25% in chips		
	Sweets					
	Soups			Reduced by 10-30%		
	Sauces			Reduced by 30%		
	Cakes and biscuits	Reduced below 1g/100g	Reduced by 15-18% in biscuits	Reduced by 20-40%		

Source: Van Raaij *et al*.

Reductions of fat in products or its replacement for lower fat alternatives are the most common solutions. In general fat can be replaced for potato, egg or soy, trying to maintain the same taste, as well as quantity of calories and volume.

The first initiative focuses on the removal or reduction of trans fatty acids (TFA), a type of fat that is naturally present in cow's milk and beef. It can also be obtained as result of an industrial process called "hydrogenation". Overconsumption of TFA can be a determinant to high risk of cardiovascular disease (CVDs), diabetes and cancers (Menaa *et al*., 2013). The elimination of TFA is more easily achieved in margarines and fats, while there are cases of reduction in cakes and biscuits. To reduce the presence of TFA, which is present largely due to the use of partially hydrogenated oils, food manufactures can also decide to replace it with alternative fats and oils (Mozaffarian and Clarke, 2009).

The second intervention allow for reduced saturated fatty acids (SFA), a kind of fat that is found in animal food and in palm or coconut oils. Food industries can replace SFA with unsaturated fatty acids. This produces effects also on milk, thanks to a change in the diet of cows through the use of linseed oil that increases unsaturated fatty acids in milk (van Raaij *et al*., 2008). In this case, the risk of unsaturated fat is a change in consistency of the fat (softer) and the risk of increase in rancidity.

The third option, the most developed, is linked to processed food that is a major contributor to dietary salt intake of the population. Salt is a key determinant to diseases like Coronary Heart Disease (CHD). The salt content in Europe exceeds 1.8g/100 g, which represents 30 % of the targeted daily intake level. Reduction in dietary salt of up to 3g per day should be considered a target for the improvement of public health (Bibbins-Domingo *et al*., 2010). This initiative can involve wide food categories (i.e. by flavouring in chips). There is a risk of diminishing taste, but for a few nutrients results can also reach 40% in salt reduction. This policy is implemented in Europe by governments (UK, France, Finland) and food companies (Netherlands), with bread as the most targeted product.

Another intervention is based on decreased sugar utilization in drinks and yogurt. Sugar contributes to food texture and volume. Sometimes added sugar can often just be taken out. In other cases, if there are limits to reducing the amount of sugar, some food and beverage companies have introduced new light products where artificial sweeteners (isomalt) replace sugar. Nowadays many sugar-free and sugar reduced foods are available, but most of the time the replacement leads to a sort of compensation with other carbohydrates to maintain the same volume of food.

The last option presents a policy that target, in particular, breakfast cereals, which have been reformulated introducing wholegrain items. Fibre can be added, as well as water and air, to reduce energy density (Kj/g food).

Consumers, Food companies and Government

Food reformulation involves many agents who are complementary to the implementing of a successful intervention.

Consumers are the beneficiaries of this policy and they have the possibility to accept reformulated food or change their demand depending on personal interest, taste or appreciation. They can consider the "new" product too different in terms of taste from the previous one, which will bring them to the conclusion that they do not like it and will buy something else. On the other hand consumers can decide that it is better to have natural ingredients (fat, sugar) instead of artificial components as replacement. Consumers can also be influenced by price increase, because healthier foods may require more expensive input and procedure, and they may be unwilling to pay more for a healthier choice. Another option is related to psychological circumstances. In fact, if purchasers decide that a reformulated product is healthier but that it loses out in terms of taste, due to the perception that "low fat has poor taste", they will move on to other food items.

This consumer perception leads to the dilemma of the manufacturer, called "health or stealth": food companies can introduce reformulated foods as an opportunity to market new healthier nutrients or decide not to inform consumers of their change. In countries where governments invest in mass media campaigns to increase awareness about reduction in salt, fat and sugar intake, industries should promote their healthier options in the market. Otherwise, many private companies prefer the "stealth" choice as a successful strategy to achieve reformulation, to be sure not to have a "new" product which is considered inferior (Webster and Hawkes, 2009).

Recently, Unilever has confirmed "they are re-introducing some products into the market avoiding special labelling". And Nestlé has highlighted how they work on food reformulation for the entire portfolio through "stealth" strategy and not only for specific segment of products (A European Platform for Action, 2014). The change in the composition of food requires time and investment by industries, and sometimes they prefer to introduce a brand- new product into the market instead of working on reformulation of "old" food item. Costs to ensure taste, texture and safety for consumers in food reformulation are high, and they vary depending on types of products, companies and techniques implemented. Nestlé created is own Research Center in 1987, which represents the world's largest private food nutrition research institute. This power and capacity to define own standards on food safety could jeopardize the efficacy and influence of public norms.

Governments have a key role in boosting and supporting the food reformulation. There are laws already in place that define compositional standards for certain foods or for selected parts of the population. For instance, in 2005 the UK government introduced a salt reduction program that influenced food industries to set certain levels of nutrients in some products. Another option is to establish criteria for a targeted population, for example to reduce fat consumption in food in schools. In cooperation with governments, industries can be encouraged to change the composition of food with more healthy ingredients. And government regulations can generate new market opportunities for food companies, who can "reformulate products in way that may justify health claims" (Sassi, 2010).

Successful examples, food labelling and education

To promote and facilitate the development of healthier composition of food, there are a few actions suggested by the literature that can improve this process. It could be important to focus on and spread the news of successful examples where the reduction of unhealthy elements is possible and effective. This is the case in the reformulation of bread and biscuits, the most mentioned areas of intervention in many countries. A second improvement is shown by studies on food labelling, where some governments have introduced policies to increase information about products and quantity of ingredients. A labelling intervention produces effects and leads to change in composition of food, in particular referring to salt reduction and increase in fibre (Vyth *et al*., 2010). This interaction among different health policies can also be seen in in education campaigns (van Raaij *et al*., 2008). If a consumer chooses to buy reformulated food, his decision will be based on the selling price and whether or not the original product is still in the market. But more relevant for the effectiveness of the policy will be whether communication and education on health benefits in fat, salt and sugar reduction have reached the population.

Limits and Risks

Reformulation differs in each category of products and is not always possible. The limit of change in composition of nutrients concerns food safety. Due to the reduction of sodium in one product, industries have had to find an effective replacement for salt capacity to prevent food spoilage. Another issue is to achieve healthier nutrient through proper technological support, which guarantees the structure of food with alternative ingredients that replace saturated fat for instance. In fact, the question "what replaces the substituted product is necessarily better for health?" is relevant (Traill *et al*., 2012). An evidence based example proves that a risk for consumers occurs when private companies decide to replace trans fat with saturated fat: this intervention could mitigate positive effects on health because the combined content of these fats in the food could remain about the same or even increase (Mozaffarian *et al*., 2010). If we consider soft drinks, where the presence of sugar has been reduced thanks to sweetening agents, there are still some questions about the long-term health impact on diet.

Outcomes

The literature documents some results achieved after the introduction of food reformulation policy. In 2005 the Food Standards Agency (FSA) and UK government set a salt reduction target and they established commitments towards food companies that collaborated in reducing levels of fat, salt and sugar. In 2009 they reported achievement on reduction of salt intake in breakfast cereals (-44%), sliced bread (-33%), and cakes and biscuits (up to -55%). The UK population changed its level of daily personal consumption from 9.5 g to 8.6 g (Traill *et al*., 2012).

Starting from 1975, Finland introduced the same policy with positive effects, reaching 9g per day per person and a reduction of 3g in average population salt intake. These are two countries that have already demonstrated the impact of salt reduction intervention on public health: they reported effectiveness of a policy combination of food reformulation, food labelling and initiatives to raise consumer awareness (Kanzler *et al*., 2014). Also in Sweden, thanks to a previous introduction of food labelling intervention, food companies were encouraged to reformulate their products to reduce fat ingredients.

In addition to results in terms of quantity decrease, the UK government presented estimation on health benefits due to saturated fat reduction of 0.5%, which could produce over 200,000 Quality Adjusted Life Years (QALYs). OECD estimates that "a regulatory intervention designed to achieve a reduction in salt intake of 3g per day would save 194,000 to 392,000 QALYs and $10 billion to $24 billion in health care costs annually".

At European level, the EU Platform for Action on Diet, Physical Activity and Health is working on a tax for food reformulation and selecting target of products. Thanks to recommendation and assessment of the Irish Special Action Group on Obesity, the introduction of a tax (10%) on sugar-sweetened drinks (SSDs) could achieve a reduction of 10.000 cases of obese adults. Concerning reduction of saturated fat content, Romania reported a decrease up to 5% between 2007 and 2011. And Slovenia approved a national plan to decrease the content of SFA by 10% by 2020 without any increase to the total sum of TFA + SFA (High Level Group on Nutrition and Physical Activity, 2013).

Some countries, like Australia, reported less positive data in terms of effectiveness. The lack of coordination in salt reduction strategy among public institutions and private sector, combined with the absence of reduction targets for ready meals, have reduced the positive impact of this policy (Kanzler *et al*., 2014).

Conclusion

There is evidence that food reformulation alone will not be effective, and it should be implemented in combination with food labelling and public campaigns (food education) to increase people awareness and widen their set of choices. To reduce the information asymmetry between consumers and companies, the latter should proceed to change the composition of products while reducing "stealth" strategy. It is only thanks to information campaigns that the change in composition of food can be an effective policy, which will allow companies to gain a competitive advantage. This means that all agents need to work together to create a healthier diet, which is one of the key policies in which governments expect a contribution from the food and beverage industry. If the private sector acts in collaboration with and in response to government pressure, the food reformulation policy is bound to work.

Thanks to Expo Milano 2015 (where the core theme is "Feeding the Planet, Energy for Life"), the focus on food safety and security will be a great opportunity to gain the *momentum* about introduction of innovative food policies. In particular, food issue in the Mediterranean region will be presented at the Cluster "Bio-Mediterraneum", where over ten countries will propose possible solutions to increase participation and integration through healthy food.

Bibliography / More information

- Bibbins-Domingo K *et al*. *Projected Effect of Dietary Salt Reductions on Future Cardiovascular Disease*. N Engl J Med 2010;362:590-9.
- Capacci S *et al*. *Policies to promote healthy eating in Europe: a structured review of policies and their effectiveness*. Nutrition Reviews Vol. 70(3):188–200. 2012.
- European Platform for Action - *Diet, Physical Activity and Health* - 25 September 2014. Flash report and minutes.
- High Level Group on Nutrition and Physical Activity 7 February 2013. Flash report.
- Kanzler S, Hartmann C, Gruber A, Lammer G, Wagner KH. *Salt as a public health challenge in continental European convenience and ready meals*. Public Health Nutrition: 17(11), 2459–2466. 2014.
- Marotta G, Simeone M, Nazzaro C. *Product reformulation in the food system to improve food safety. Evaluation of policy interventions*. Appetite 74 (2014) 107–115.
- Menaa F *et al*. *Technological Approaches to Minimize Industrial Trans Fatty Acids in Foods*. Journal of Food Science r Vol. 78, Nr. 3, 2013.
- Mozaffarian D, Clarke R. *Quantitative effects on cardiovascular risk factors and coronary heart disease risk of replacing partially hydrogenated vegetable oils with other fats and oils*. European Journal of Clinical Nutrition (2009) 63, S22–S33.
- Mozaffarian D *et al*. *Food Reformulations to Reduce Trans Fatty Acids*. n engl j med 362;21. 2010.
- National Heart Foundation of Australia. *Effectiveness of food reformulation as a strategy to improve population health*. 2012.
- Sassi F. *Obesity and the Economics of Prevention* – Fit Not Fat. OECD 2010.
- Traill WB *et al*. *Reformulation for healthier food: a qualitative assessment of alternative approaches*. 2012.
- van Raaij J, Hendriksen M, Verhagen H. *Potential for improvement of population diet through reformulation of commonly eaten foods*. Public Health Nutrition: 12(3), 325–330 , 2008.
- Vyth EL *et al*. *Front-of-pack nutrition label stimulates healthier product development: a quantitative analysis*. International Journal of Behavioral Nutrition and Physical Activity 2010, 7:65.
- Webster J, Hawkes C. *Reformulating food products for health: context and key issues for moving forward in Europe*. European Commission 2009.

L'agriculture et l'enjeu de l'innovation : dimensions générales et éclairage méditerranéen

Thierry Pouch
Responsable du service études, références et prospective
Assemblée Permanente des Chambres d'Agriculture, Paris
Chercheur associé au Laboratoire REGARDS, Université de Reims Champagne Ardenne

Depuis qu'il s'est affirmé comme le mode privilégié d'organisation des sociétés humaines, le capitalisme est appréhendé comme une grande force motrice pour la transformation régulière de ces sociétés, largement aiguillonnée par des innovations technologiques régulières. On peut prendre la mesure de cette dimension du système économique en suivant la succession des innovations qui, depuis la fin du XVIII^{ème} siècle, ont fait rupture et ont durablement modifié les structures mêmes de l'économie. Plusieurs économistes, et non des moindres, à l'instar de l'autrichien J. A. Schumpeter (1883-1950), ont même fait des crises du capitalisme des moments à partir desquels se préparaient de nouvelles innovations de nature à enclencher un nouveau cycle de croissance.

En quoi le secteur agricole est-il de près ou de loin, concerné par la mutation en cours des économies ? En quoi s'imprègne-t-il des innovations situées plus en amont et en quoi apporte-t-il lui-même ses propres innovations à l'aval ? L'usage des nouvelles technologies pourrait-il se propager dans tout le secteur agricole, à l'instar du drone pour la surveillance des cultures. Toutefois, l'innovation en agriculture doit s'entendre comme devant déboucher sur une rupture plus profonde des méthodes et des finalités de la production agricole.

Le projet agroécologique, tel qu'il est actuellement promu par les autorités françaises, constituera-t-il un système d'innovations qui va faire éclore un nouveau paradigme productif ? Depuis les années 1990 une voie s'est en effet ouverte visant à promouvoir une production agricole plus soucieuse de l'environnement, suscitant au passage de nombreux échanges sur le qualificatif à adopter (Griffon, 2013). Questions d'autant plus importantes que, historiquement, l'agriculture fut l'un des secteurs à connaître des phases intensives d'innovations. Serions-nous dans une phase de ce type (Mazoyer, Roudart, 2006) ?

L'innovation : une question d'échelle

L'agriculture constitue un secteur devant répondre à l'impérieuse nécessité d'innover, afin de renforcer non seulement les performances économiques des exploitations, mais aussi leur efficacité sociale et environnementale. Tel est l'objectif fixé par la *Loi d'avenir* : « développer le potentiel et la diversité de notre agriculture et combiner compétitivité économique et préservation de l'environnement », mais aussi par un nombre croissant d'institutions agricoles afin d'accompagner la transition vers un nouveau modèle agricole, au travers notamment du conseil agricole. La difficulté réside toutefois d'une part dans la définition et la mesure de l'innovation.

Depuis J. A. Schumpeter, la théorie économique nous livre une information importante. L'innovation émanerait de l'activité de l'entrepreneur. En tant qu'acteur économique créateur de richesses, il serait en quelque sorte l'élément déclencheur du processus d'innovation. Pour peu qu'elle aboutisse, l'innovation procurera à l'entrepreneur un monopole temporaire lui permettant de dégager une rentabilité suffisamment élevée pour couvrir son investissement initial. En supposant que les agriculteurs soient désormais tous des entrepreneurs, il semblerait logique qu'ils entrent dans la catégorie des innovateurs. La production agricole a connu depuis quelques années maintenant des mutations profondes, se distinguant par davantage de capitaux mobilisés, davantage de technicité émanant des progrès scientifiques, agronomiques, biologiques, économiques et financiers. De telles mutations affectent nécessairement l'identité même de l'agriculteur dont l'image ne correspond plus à celle du paysan sédentaire, dont l'activité économique était presque totalement rythmée par le cycle des saisons. Le référentiel semble basculer de l'agriculteur vers l'entrepreneur.

Sauf que, au même titre que le secteur de l'industrie ou des nouvelles technologies, ils peuvent innover sans provoquer de rupture particulière dans leur activité économique. Ils peuvent innover de façon incrémentale. Il faut entendre par là le fait qu'une innovation, allant dans le sens d'un meilleur usage d'un produit agricole (en diminuant par exemple la probabilité d'un risque sanitaire), ou d'une amélioration des conditions de production de ce produit agricole ou alimentaire (économies d'intrants par exemple afin de réduire le coût de production et/ou de respecter l'environnement), ne conduit pas toujours à une rupture globale du mode de production en vigueur, à un changement radical de paradigme productif.

Il reste de plus à déterminer si l'innovation résulte d'un comportement stratégique individuel ou si elle provient d'une impulsion donnée par l'extérieur. Une demande émanant de la société, par exemple pour davantage de traçabilité d'un produit ou pour un produit d'origine biologique, peut exercer une telle impulsion, amplifiée par des dispositifs de soutiens publics estimant qu'il s'agit d'un projet économique viable. Cela conduit à inscrire l'innovation sur une autre échelle, beaucoup plus vaste, dans la mesure où elle implique, de près ou de loin, une multitude d'acteurs, le défi étant pour les pouvoirs publics de concilier leurs intérêts contradictoires.

Pour innover, l'entreprise/exploitation agricole mobilise certes des connaissances qui lui sont propres, au regard de son parcours et de son expérience, mais se nourrit tout autant d'apports extérieurs, soit parce qu'ils lui indiquent l'orientation à prendre, soit parce que le profil de l'innovation qu'elle affiche nécessite des ressources externes (financiers, connaissances, recherches, techniques, apports du conseil agricole…). De plus, l'innovation semble étroitement liée à la taille de l'entreprise tout comme à son implantation/localisation territoriale. S'agissant de la taille, plus elle est importante, plus la mobilisation des ressources internes sera facilitée (ressources humaines, R-D, moyens financiers…). Il s'ensuit cependant que, en matière de mesure de l'intensité d'innovation de l'entreprise, mesurée par exemple par unité de travail, la taille peut aussi constituer un obstacle, car une firme de petite taille dégagera une intensité d'innovation par salarié plus élevée. L'implantation spatiale joue également un effet d'entraînement, selon que l'entreprise est plongée dans un environnement propice au déploiement des innovations. On dépasse ici le cadre de la seule agriculture, obligeant à élargir l'analyse au cas des industries de la transformation des produits bruts, dont l'intensité innovatrice peut exercer des répercussions directes sur l'agriculture.

L'innovation est par ailleurs trop souvent réduite à sa seule dimension *techno-économique*. Une innovation aura sans doute un fondement et un sens *techno-économique*, dans la mesure où elle peut constituer un levier pour pérenniser une exploitation agricole et faire qu'elle soit en mesure de s'adapter à un marché évolutif sur lequel se déploie une concurrence exacerbée. Il en sera ainsi d'une innovation portant sur la réduction du coût des intrants, permettant de conjuguer efficacité économique et environnementale. L'innovation technique consisterait alors à penser la production et le débouché autrement. Il n'en demeure pas moins que l'innovation *techno-économique* provient également de l'extérieur, notamment par le biais en particulier de la recherche (nouvelles variétés de plantes par exemple).

De l'innovation au paradigme productif

L'innovation doit donc être entendue en un sens très large et selon une perspective multidimensionnelle. Une innovation doit être porteuse d'une *situation de rupture par rapport à l'organisation productive antérieure*. Il est alors indispensable de s'interroger sur les conditions de la diffusion de l'innovation à l'ensemble d'un secteur voire du système économique, de façon à construire un *paradigme socio-économique*, et donc de réguler les conflits qui émaneraient de l'application et de la généralisation d'une innovation. *Par paradigme socio-économique, il faut entendre une manière de penser et de pratiquer la production – ici agricole – suffisamment admise et dominante pour pouvoir s'imposer et faire système* (Dockès, 1990).

Un *paradigme socio-économique* renferme ainsi plusieurs dimensions, à la fois organisationnelle (organisation du travail, propriété du capital, rapport entre les facteurs de production, conditions d'accès au foncier, aux moyens de financement…), scientifique et technique (recherche, procédés de cultures, de fabrication, recours à la mécanisation…), économique (relations avec l'amont et l'aval, marchés sur lesquels sont écoulés les produits, état de la concurrence…). Il doit être porté par une fraction majoritaire des acteurs qui y sont impliqués, en ayant pour objectif de voir s'imposer ce paradigme, sachant que le précédent rencontre des limites insurmontables. Les innovations partielles, prises isolément, ne sauraient faire système sans l'intervention d'acteurs prenant à leur compte l'enjeu du basculement vers un nouveau modèle de production, afin de répondre à de nouvelles préoccupations et finalités. Elles ne seront alors que des greffes sur un système en vigueur. Faut-il innover pour apporter des corrections au système agricole intensif, ou bien changer radicalement d'orientation et promouvoir un nouveau mode de production ?

Les innovations que le secteur agricole a connues et appliquées, qu'il a enclenchées durant les années 1930 aux États-Unis, et qui se sont étendues après la seconde guerre mondiale notamment en Europe, ont formé un tel paradigme productif qui, on le sait, a permis par exemple à l'agriculture française de devenir l'une des plus performantes du monde.

Motorisation/mécanisation, procédés de fertilisation, progrès en matière de variétés végétales et de races animales, irrigation… autant d'innovations ayant conduit à une croissance fulgurante des rendements et des productions. C'est ce que Michel Griffon qualifie de « révolution technologique dans le secteur agricole » (Griffon, 2006). L'originalité de cette période réside tout autant dans le dispositif de politiques publiques – en l'occurrence la *Politique agricole commune* – qui a encadré la propagation du modèle, lequel s'est ensuite imposé majoritairement aux acteurs, faisant du secteur agricole l'un des maillons de la modernisation des structures économiques de l'économie nationale – et plus largement européenne – souhaitée par l'État.

C'est ce modèle productif qui, en dépit de ses succès, a engendré parfois des externalités négatives suffisamment préoccupantes pour lancer la réflexion sur la nécessité d'en changer. Déforestation, pollutions diverses (eaux, sols), pathologies animales, montée des risques pour la santé humaine… c'est bien ce paradigme antérieurement construit qui est aujourd'hui critiqué, voire même discrédité, alors qu'il était appréhendé comme allant de soi il n'y a pas encore très longtemps. L'orientation donnée désormais à la politique agricole européenne a accordé de ce fait une priorité à des pratiques plus soucieuses de l'environnement.

En tant que principe directeur d'une nouvelle organisation des économies et plus largement des sociétés, la transition écologique concerne l'ensemble des secteurs d'activité, et notamment l'agriculture. Il s'agit de tendre vers un paradigme productif plus efficace en termes d'utilisation d'intrants, moins polluant, et plus qualitatif pour les citoyens. Comme pour l'ensemble de l'économie, placer l'agriculture sur une trajectoire innovante, dans le but de promouvoir une croissance viable et soutenable, requiert des changements profonds non seulement dans l'organisation de la production elle-même, mais aussi, et surtout, en amont, dans les institutions sociales qui coordonnent ces mutations. L'épuisement du modèle de production agricole hérité de l'après-guerre ouvre donc la voie à une vague d'innovations radicales dont le socle est l'environnement, et va dans le sens d'une révision fondamentale de ce modèle. Il est probable que l'acte inaugural de ce cycle d'innovations se situe dans les déclarations du Club de Rome en 1972, relayé ensuite par celles du *Sommet de la Terre* à Rio en 1992.

Les sentiers escarpés menant à l'agroécologie

Au regard de la problématique de la compétitivité de l'agriculture française, des préoccupations environnementales et des attentes des consommateurs sur la qualité des produits qu'ils consomment, l'innovation constitue le cheval de bataille des pouvoirs publics et des agriculteurs eux-mêmes. Ce besoin d'innovation est mis en évidence par les nombreuses limites sur lesquelles butent le système agricole antérieur, et en particulier la baisse de la fertilité des sols et la diminution des disponibilités en eau, deux menaces fondamentales en matière de développement durable.

De plus, l'entrée dans la mondialisation s'est traduite par une montée des incertitudes, une remise en cause des valeurs et des normes qui structuraient le système agricole (Faure et *al.*, 2012). Ces innovations apparaissent multiples mais doivent converger pour faire système et former un *paradigme socio-économique* qui se substituerait à celui ayant couvert grossièrement la période 1950-1990, tout en répondant aux défis alimentaires du XXI^{ème} siècle. Réduction du travail du sol, progrès technique dans le domaine des variétés de semences – avec plusieurs finalités, dont l'augmentation en protéines pour le blé, la résistance aux aléas climatiques, aux parasites… –, diversification sur les rotations et les assolements, développement des cultures de légumineuses, diminution des apports chimiques au profit d'organismes naturels…

L'impulsion donnée par le gouvernement français, avec la *Loi d'Avenir de 2014*, et par la réforme de la PAC entrée en application en janvier 2015, va dans ce sens. Les expertises publiées récemment par le GIEC et par la FAO ont par ailleurs donné un caractère d'urgence à cette perspective d'innovation en agriculture (FAO, 2014).

On voit bien que dans cette ambition de transformer le système agricole mis en place à la fin des années 1950, l'innovation va jouer un rôle décisif, ne serait-ce qu'en raison de la complexité et de l'enchevêtrement des demandes qui sont adressées à l'agriculture. Mais sa particularité a trait au fait qu'elle doit nécessairement associer des acteurs diversifiés voire hétérogènes, privés ou publics. C'est pourquoi dans le processus visant à instaurer un système agroécologique, il est suggéré de parler de « système national d'innovation », ou, si l'on préfère, de « réseau d'acteurs » engagés dans l'innovation.

L'innovation en agriculture résulte alors d'un exercice d'emboîtements successifs des comportements innovants, qu'ils émanent des agriculteurs eux-mêmes ou de l'incitation à innover dont est porteuse une politique publique. Dit autrement, l'innovation en agriculture résulte d'un dispositif d'interaction entre les principaux acteurs des filières, les institutions agricoles privées et publiques et l'État. Les investissements indispensables qui permettront de garantir la transition paradigmatique doivent avoir un haut degré de complémentarité.

La transition d'un *paradigme socio-économique* à un autre est toutefois une opération compliquée, incertaine, pouvant s'étendre sur une période assez longue si l'option d'une transition « pas à pas » est retenue par une majorité d'acteurs, ou s'avérer brutale si le scénario de la rupture est privilégié. A l'échelle européenne, la coordination des acteurs est d'autant plus complexe qu'elle engage 28 pays membres aux modes de fonctionnement, aux objectifs et aux intérêts fortement divergents.

L'impératif de l'innovation ne répond toutefois pas à un processus naturel. C'est ce qui justifie le recours au concept de *paradigme socio-économique*. Puisqu'elle engage différents acteurs socio-économiques, l'innovation est aussi à l'origine de résistances. Dans le cas de l'agriculture, le projet agroécologique se heurte à un *paradigme socio-économique* élaboré il y a plus de cinquante ans, dont l'efficacité en termes de productivité et d'approvisionnement alimentaire a été saluée par de nombreux observateurs. De plus, les stratégies économiques déployées par tous les acteurs des filières furent somme toute assez cohérentes entre elles. La politique publique a constitué de son côté un puissant vecteur d'incitation à produire des biens alimentaires dans un premier temps, et à les exporter dans un second temps.

Globalement, ces résistances sont à l'origine de ce que les économistes appellent des « verrouillages technologiques » ou des processus de « dépendance au chemin » (Labarthe, 2010). Dans la problématique sur l'innovation en agriculture, se télescopent deux types de fonctions économiques, l'une tournée vers la fourniture de biens alimentaires, l'autre vers la production de biens environnementaux. La *Loi d'avenir* entend bien les articuler. Il n'en reste pas moins que la transition vers l'agroécologie renferme quelques contradictions, l'une d'entre elles ayant trait à la compétitivité qui nécessite en économie une spécialisation élevée et parfois une concentration des unités productives, laissant se déployer le clivage entre les rendements d'échelle et le souci de l'environnement. Ce qui compte en dernier ressort pour une exploitation agricole innovante a trait à la rentabilité de ses investissements.

Ajoutons que le cheminement vers l'agroécologie doit entrer en résonance avec les mutations du système économique global afin de déboucher sur un nouveau régime de croissance, au même titre que l'agriculture intensive se situait en phase avec le développement du fordisme (nom donné par l'école française de la régulation pour qualifier le régime de croissance d'après-guerre). Or l'innovation, le progrès technique, peuvent connaître un certain épuisement, bloquant du coup l'émergence d'un nouveau régime de croissance. Une telle perspective a été développée par l'économiste américain R. Gordon, qui voit dans l'épuisement actuel du progrès technique la cause du prolongement de la crise. Le secteur agricole pourrait ne pas être épargné par un tel phénomène.

La période qui s'ouvre est par conséquent hautement incertaine. En matière d'innovation, une voie possible pour sortir des contradictions consiste sans doute à hiérarchiser les objectifs et les ambitions, à apporter aux agriculteurs les outils de l'innovation et leur souligner les enjeux que leurs propres démarches innovantes renferment pour l'avenir de l'agriculture française, et à leur témoigner d'une certaine confiance pour conduire leurs propres innovations.

Mobiliser l'innovation multidimensionnelle en Méditerranée

Les dimensions générales de l'innovation qui viennent d'être rappelées avaient pour objectif d'apporter un éclairage sur les défis auxquels l'agriculture doit désormais répondre. En quoi cela concerne-t-il le monde agricole méditerranéen ?

Si l'on se limite à la zone Afrique du Nord et Proche-Orient, on doit avoir à l'esprit que le développement de ces économies et de leurs territoires ne saurait s'accomplir sans l'agriculture, dans la mesure où plus d'un tiers de la population vit en milieu rural. Outre l'inégale répartition des ressources hydriques, d'ailleurs déjà rares, l'insuffisance des terres cultivables, les pays d'Afrique du Nord et du Proche-Orient sont d'ores et déjà exposés aux risques du changement/réchauffement climatique.

Ces contraintes fortes exercent des répercussions sur les niveaux des productions agricoles, fragilisant l'approvisionnement alimentaire de populations de plus en plus nombreuses, et alourdissant les budgets publics du fait d'un recours massif aux importations de produits agricoles dont certains ont connu une flambée des prix depuis 2007. On sait en effet que cette région est l'un des grands importateurs mondiaux de céréales.

L'importance de l'innovation en agriculture apparaît manifestement décisive pour le futur de ces pays, l'objectif étant de concilier approvisionnement alimentaire et développement rural (Abis, Bergeret, 2014). Plusieurs pays ont pris la mesure des défis à venir et lancer des politiques publiques visant à y répondre. Le Maroc avec le Plan Vert, l'Algérie avec le déploiement d'une stratégie de développement rural et agricole centré notamment sur l'exploitation familiale, comme l'a rappelé la déclaration ministérielle d'Alger, du 6 février 2014 (l'exploitation familiale comme vecteur de la sécurité alimentaire et de la gestion durable des ressources).

L'innovation doit accompagner de telles politiques, non seulement sous l'angle technique et agronomique, mais tout autant, comme cela a été rappelé plus haut, sous celui de la mobilisation et l'implication des acteurs, privés ou publics, et des institutions socio-économiques. Des innovations dans l'organisation de filières prioritaires doivent également être entreprises (céréales, productions laitières, fruits et légumes) pour approvisionner les marchés et répondre à la demande des ménages, urbains et ruraux. Dit autrement, l'innovation multidimensionnelle doit être porteuse d'un desserrement de la contrainte extérieure, d'un rapprochement entre les capacités de production agricole d'un pays et les besoins de sa population (Kroll, 2002).

La proximité géographique de ces pays méditerranéens requiert *in fine* un profond réexamen de la politique de coopération agricole avec l'Union européenne. La mise en place depuis 2012 d'ENPARD (*European Neighbourhood Programme for Agriculture and Rural Development*) s'inscrit dans une telle perspective. La priorité pour l'Union européenne est d'accompagner la transition agricole dans ces pays, de faire émerger une « révolution » technique capable d'enclencher une dynamique de développement. Certains y voient de surcroît une opportunité pour leur ouvrir l'accès aux dispositifs publics contenus dans la PAC (Cheriet, 2014). C'est sans doute une voie à explorer dans une période de grands et menaçants défis géopolitiques et alimentaires qui concernent cette région.

Bibliography / More information

- Abis S., Bergeret P. (2014), *2014, année internationale de l'agriculture familiale. Enjeux globaux et défis méditerranéens »,* in S. Abis (sous la dir.), *Mobilisations rurales en Méditerranée,* éditions l'Harmattan,bibliothèque de l'iReMMO, p.13-26.

- Cheriet F. (2014), *Réforme de la PAC : enjeux alimentaires et géostratégiques pour l'Algérie,* in S. Abis (op.cité), p. 127-138.

- Dockès P. (1990), *Formation et transferts des paradigmes socio-techniques,* Revue française d'économie, numéros 4-5, p. 29-89.

- FAO (2014), *Emissions de gaz à effet de serre provenant de l'agriculture, de la foresterie et des autres utilisations des terres.*

- Faure G., Coudel E., Soulard C., Devautour H. (2012), *Repenser l'innovation pour le développement durable,* in E. Coudel et al. (sous dir.), *Apprendre à innover dans un monde incertain. Concevoir les futurs de l'agriculture et de l'alimentation,* éditions QUAE, p. 1-14.

- Griffon M. (2006), *Nourrir la planète,* éditions Odile Jacob.

- Griffon M. (2013), *Qu'est-ce que l'agriculture écologiquement intensive ?,* éditions QUAE.

- Kroll J.-C. (2002), *Nous allons à la famine. La première leçon de René Dumont, in* M. Dufumier (sous la dir.), *Un agronome dans son siècle. Actualité de René Dumont,* éditions Karthala, p. 69-79.

- Labarthe P. (2010), *Services immatériels et verrouillage technologique. Le cas du conseil technique aux agriculteurs,* Economies et Sociétés, série « Economie et gestion des services », numéro 11, p. 173-196.

- Mazoyer M., Roudart L. (1997), *Histoire des agricultures du monde, du néolithique à la crise contemporaine,* éditions du Seuil.

Microalgae for biofuels: the Portuguese experience

Luisa Gouveia
Researcher of Unit of Bioenergy, National Laboratory of Energy and Geology, Portugal

Alberto Reis
Researcher of Unit of Bioenergy, National Laboratory of Energy and Geology, Portugal

Patrícia Moura
Researcher of Unit of Bioenergy, National Laboratory of Energy and Geology, Portugal

Cristina Oliveira
Researcher of Unit of Bioenergy, National Laboratory of Energy and Geology, Portugal

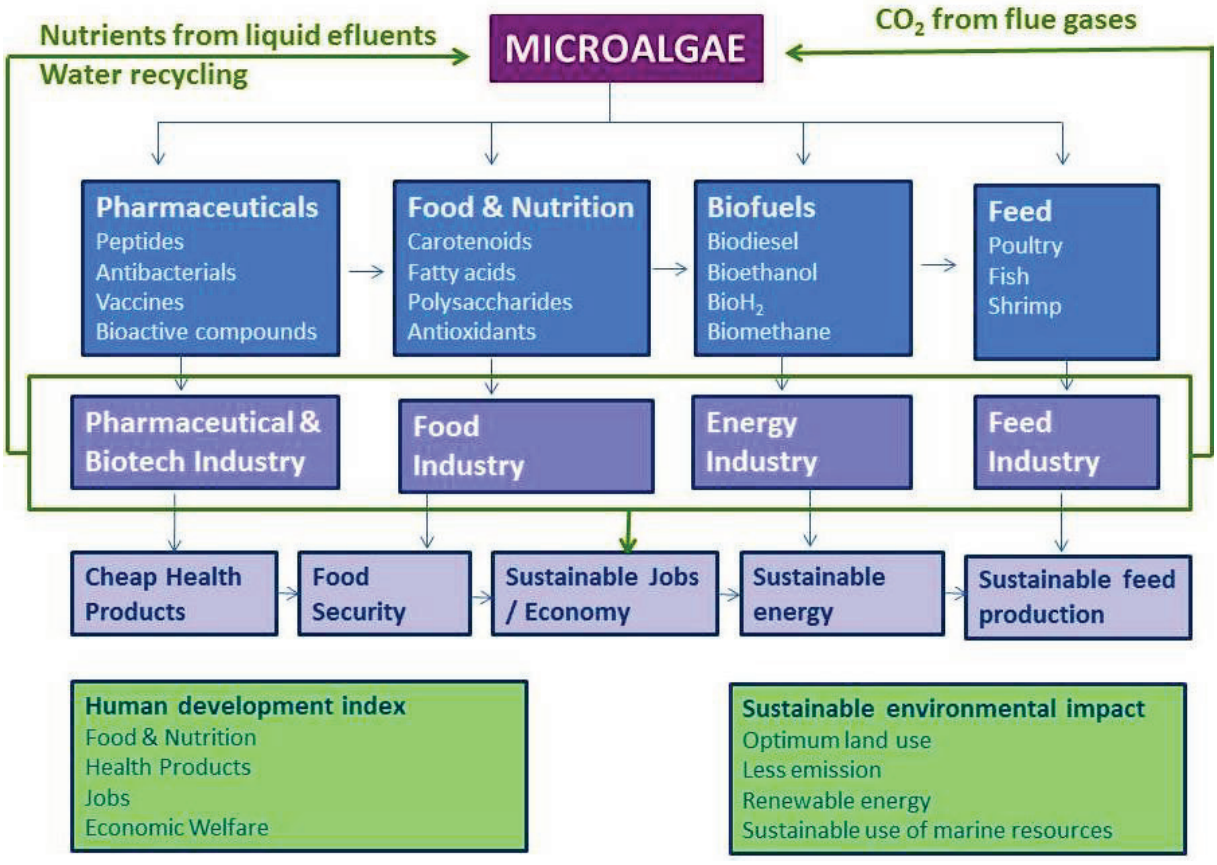
Francisco Gírio
Researcher and Head of Unit of Bioenergy, National Laboratory of Energy and Geology, Portugal

Autotrophic microalgae are photosynthetic organisms that undergo the conversion of light into chemical energy as a form of a wide range of organic compounds through its photosynthetic machinery. The cultivation of microalgae brings environmental advantages, bearing in mind the capability of nutrient recycling in wastewaters together with the fixation of greenhouse gases such as CO_2.

These micro-organisms have been widely recognized as having huge potential as feedstock for food, feed, pharmaceutical and cosmetic industries (carotenoids, antioxidants, polyunsaturated fatty acids, single-cell proteins (SCP), phycobiliproteins, polysaccharides, vitamins, phytosterols, minerals). Microalgae have also been proposed as a feedstock for bioplastics, agriculture biofertilizers and recently as an energetic vector towards the production of a wide range of biofuels. Microalgae exhibit clear advantages when compared with higher plants, such as higher photosynthetic efficiency, higher aerial biomass productivities, higher CO_2 biofixation rates (many polluting focus such as cement and thermoelectric plants can be used), higher O_2 production rates, non-competition for agricultural areas (marginal lands such as deserts, rocky areas and salt pans can be used), non-competition for drinking waters (saltwater, brackish water and wastewaters can be used), harvesting routines can be carried out daily with a better equipment and resources management trimming storage costs.
Several constraints should be overcome in order to achieve a cost-effective microalgal biofuel production, such as high energy inputs and still prohibitive production costs (currently around 5000 €/ton, far above the desired threshold target of 700 €/ton).

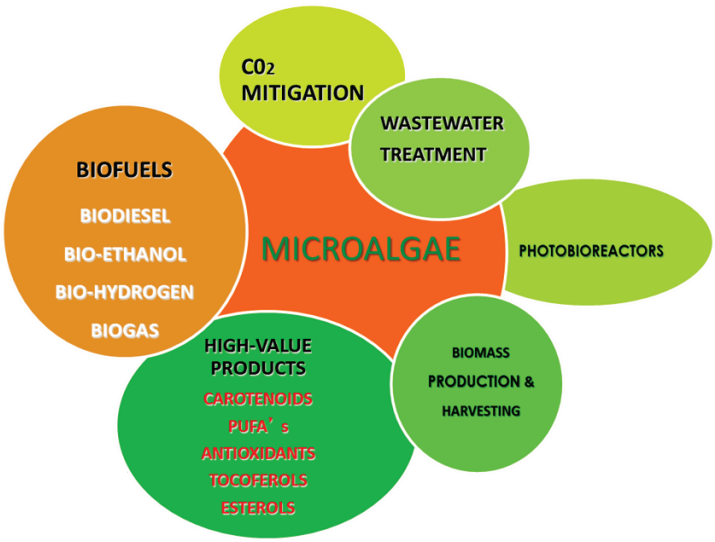
In order to become reality R&D investment should be preceded in the improvement of biomass productivity and harvesting together with cell wall breakage and adequate and efficient metabolite extraction. These topics have been widely covered by the Bioenergy Unit within the National laboratory for the Energy and Geology (LNEG) in Lisbon, Portugal (formerly the Renewable Energy Department within the INETI- Nacional Institute for The Engineering, Technology and Innovation). Its microalgal biotechnology research group has been the pioneering group in microalgal biotechnology in Portugal with more than 25 years of experience and a national and international well known reputation (Fig 1).

Figure 1
Microalgae biorefinery



Source: adapted from Subhadra (2010)

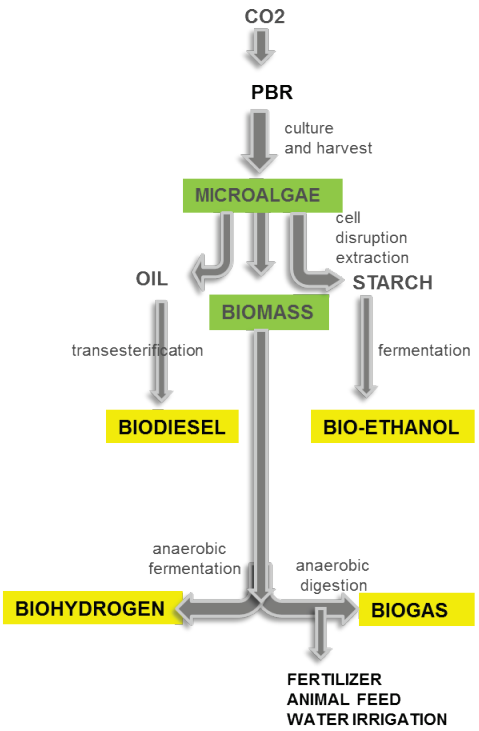
Figure 2
R&D areas at Bioenergy Unit – LNEG- National Laboratory of Energy and Geology (Portugal)



The Bioenergy Unit has been developed research in the above referred areas (Fig 2) through some emblematic National and International Projects, such as:

Microalgae as a sustainable raw material for biofuels production (Fig 3)

Figure 3
Microalgae as a sustainable raw material for biofuels production (biodiesel, bioethanol, bio-H_2 and biogas) (PTDC/ PTDC/AAC-AMB/100354/2008)



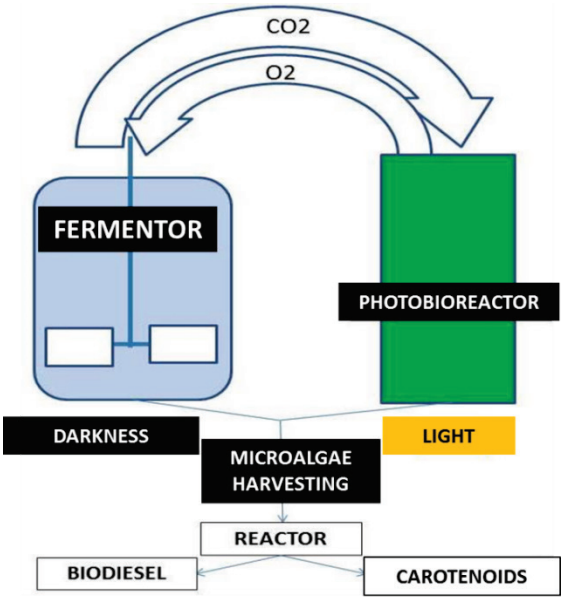
Source: http://www.lneg.pt/iedt/projectos/392/

The project addressed the optimization of some innovative technologies for harvesting, dewatering, cell disruption and extraction of valuable metabolites and conversion of the microalgal biomass into biofuels. The integrated valorization of the all energy vectors (biodiesel, bioethanol, biohydrogen and biogas), using the biorefinery concept, were highlighted on the project. Life Cycle inventory, technical and economical evaluation was also performed to a quite a few value chains. Several publications came out from this project. Some concerning the production of a single biofuel (e.g. biodiesel (Gouveia and Oliveira, 2009), bioethanol (Miranda et al., 2012), biohydrogen (Marques et al., 2011; Baptista et al, 2014) and other related biorefineries for the production of biodiesel, pigments and biohydrogen (e.g. Nobre et al., 2013).

Symbioalga- New symbiotic approach for a truly sustainable integrated microalgae production directed to a biorefinery platform (Fig 4)

The target of the project was to produce biodiesel from auto and heterotrophic microalgae using an innovative symbiotic approach. Two reactors were used, one photoautotrophic and other heterotrophic, connected by the gas phase. The outlet gas from the auto one (O_2 enriched) was used as the inlet gas for the heterotrophic. In parallel, the outlet gas from the hetero one (CO_2 enriched) was used for the autotrophic. This symbiotic approach increases biomass and oil productivities, greater than the sum of the productivities of the two bioreactors operating separately, thus diminishing operational production costs (Santos et al., 2011).

Figure 4
***SIMBIOALGA - New symbiotic approach for a truly sustainable integrated microalgae production directed to a biorefinery platform* (FCOMP-01-0124-FEDER-013935)**

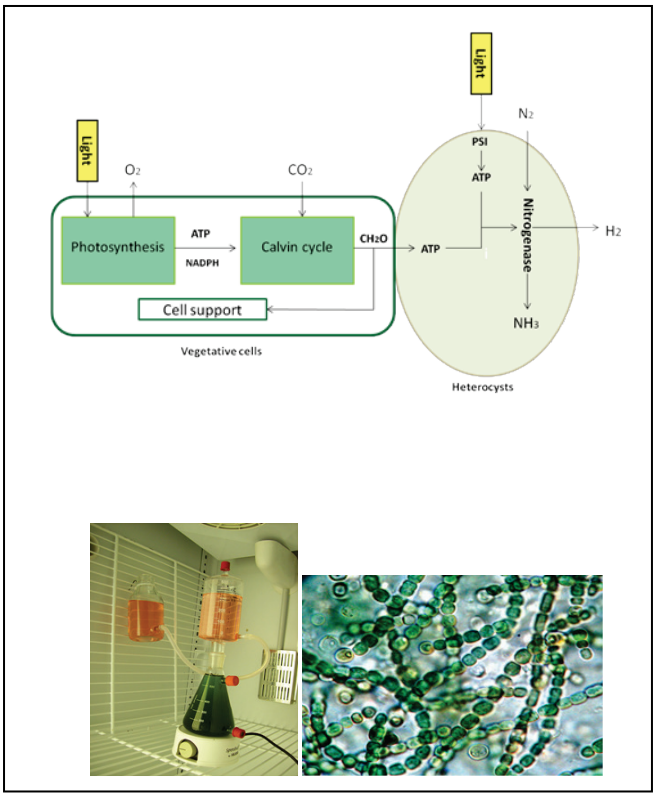


Source: http://www.lneg.pt/iedt/projectos/393/

Biohydrogen production from the cyanobacteria Anabaena sp. and its mutants (Fig 5 a, b, c)

In this project the production of H_2 was done by growing a nitrogen fixing cyanobacteria *Anabaena* PCC 7120 wt and its mutants (deficient in uptake and/or bidirectional hydrogenase enzymes), using mineral media under light and aerobic conditions. Evaluation of H_2 production was performed by testing and optimizing cultivation parameters. A separation and purification process of hydrogen-rich gases was developed using a hot Pd-based hydrogen gas separation system integrated in the bioreactor (Marques et al., 2011).

Figure 5
***Biohydrogen production from the cyanobacteria Anabaena sp. and its mutants.* PTDC/ENR/68457/2006**



Vegetative and heterocyst cells metabolism showing H_2 production *(Picture on the left)*

H_2 produced collection system *(Picture on the right)*

***Anabaena sp.* Strain** *(Picture on the left)*

ww-SIP - From Wastewater Treatment Plants to Biorefineries (Fig 6)

Figure 6
From Wastewater Treatment Plants to Biorefineries (LIFE+)

PHOTOBIOREACTOR
(microalgae + urban wastewater)

Microalgae biomass

Bioenergy production

Chemical production

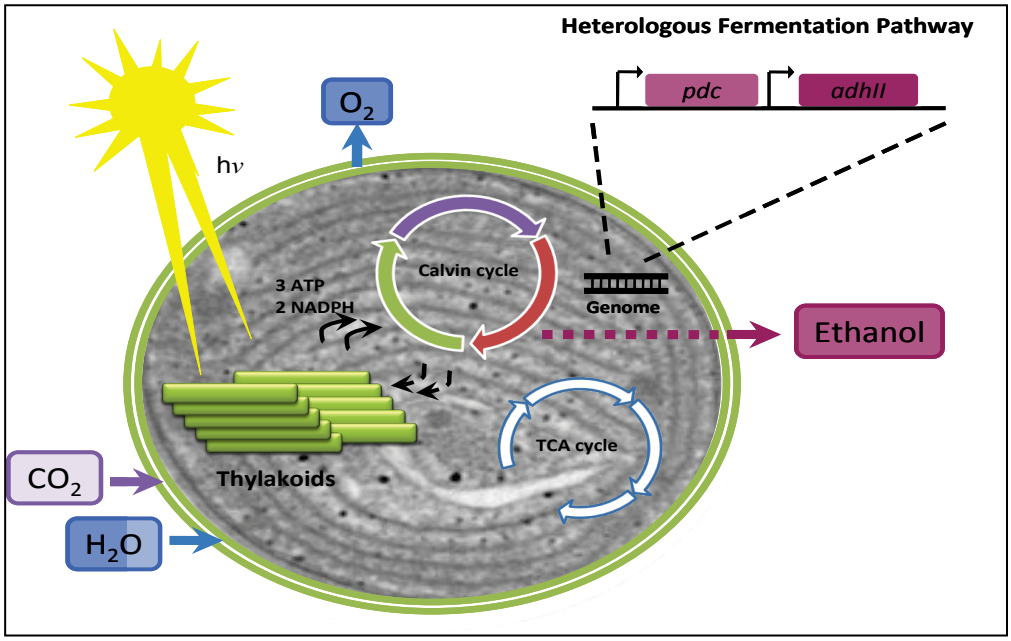
Treated water

Source: http://www.lifewwsip.it

This project aims the simultaneous treatment of urban wastewater using microalgae and the energetic valorization of the obtained biomass. The nutrient removals were quite high and the treated water fits the legislation (PT Dec-Lei 236/98) in what concerns the parameters analyzed (N, P, COD). The obtained biomass was converted into biohydrogen ($bioH_2$), a clean energy carrier, through dark fermentation by the bacteria *Enterobacter aerogenes* (Batista et al., 2015). This is an ongoing project.

DEMA - Direct Ethanol from microalgae (Fig 7)

Figure 7
DEMA- Direct Ethanol from microalgae(FP7). Cellular metabolism for ethanol drop-in production

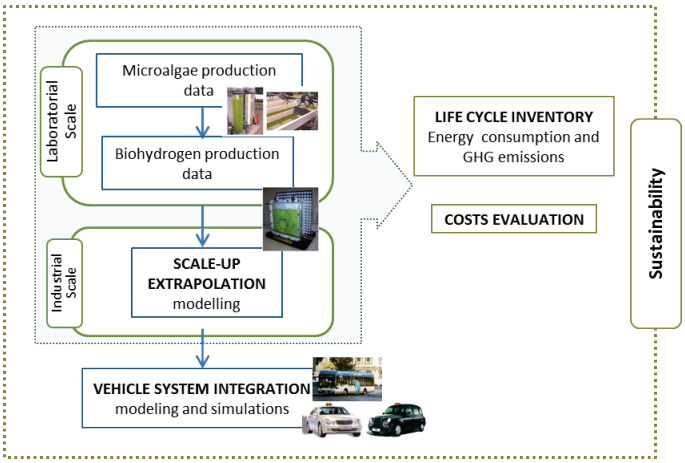


Source: http://www.dema-etoh.eu

The goal of the project is to develop, evidencing and licensing a complete and economically competitive technology for the direct production of bioethanol from microalgae, with low-cost scalable photobioreactors. The initial proof-of-concept results show via Life Cycle Assessments (LCA) and economic balance that using microalgae to produce bioethanol for less than € 0.40/L is feasible. The catalytic conversion of solar energy, H_2O and CO_2 into ethanol is been carried out by a metabolically engineered strain of the cyanobacterium, *Synechocystis* sp. PCC 6803. This project still proceeds.

ESIBITS - Evaluation of the Sustainability of Industrial Biohydrogen production from microalgae, and Integration in taxi/bus Transport Systems (Fig 8)

Figure 8
ESIBITS – Evaluation of the Sustainability of Industrial Biohydrogen production from microalgae, and Integration in taxi/bus Transport Systems EXPL/EMS-ENE/1078/2012

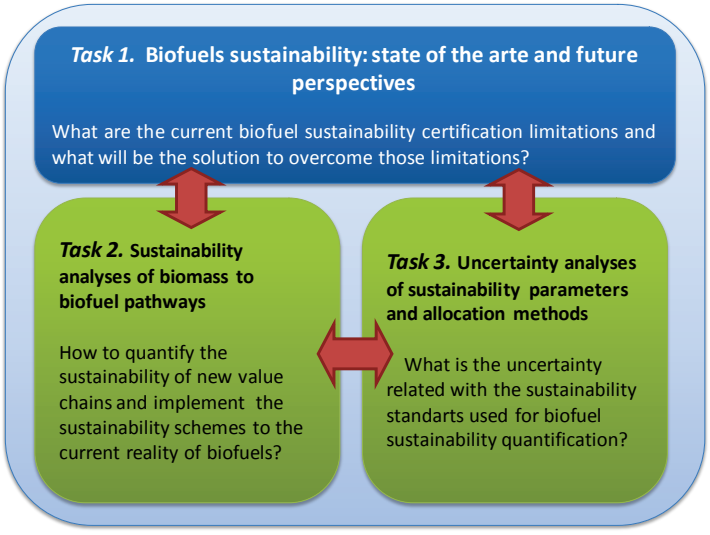


The present project aimed to the evaluation of the potential of biohydrogen production at industrial level, from microalgae, with a possible application to the road transport sector, namely taxi and bus fleets.

The whole process regarding the culture of microalgae and extraction of oil, pigments and biohydrogen was taken into account for energy and emission evaluation and life cycle co-product credits. Aiming a future implementation of biohydrogen for use in road transportation, the scale-up is highly relevant to determine the potential of competitiveness of the biohydrogen fuel comparatively to conventional fossil fuels when used in specific road vehicle fleets.
Present and future estimations for economic viability taking into account the hydrogen fueled vehicle penetration in the taxi/bus fleet market were considered (Ferreira et al., 2013).

BioSustain - Sustainable mobility: Perspectives for the future of biofuel production (Fig 9)

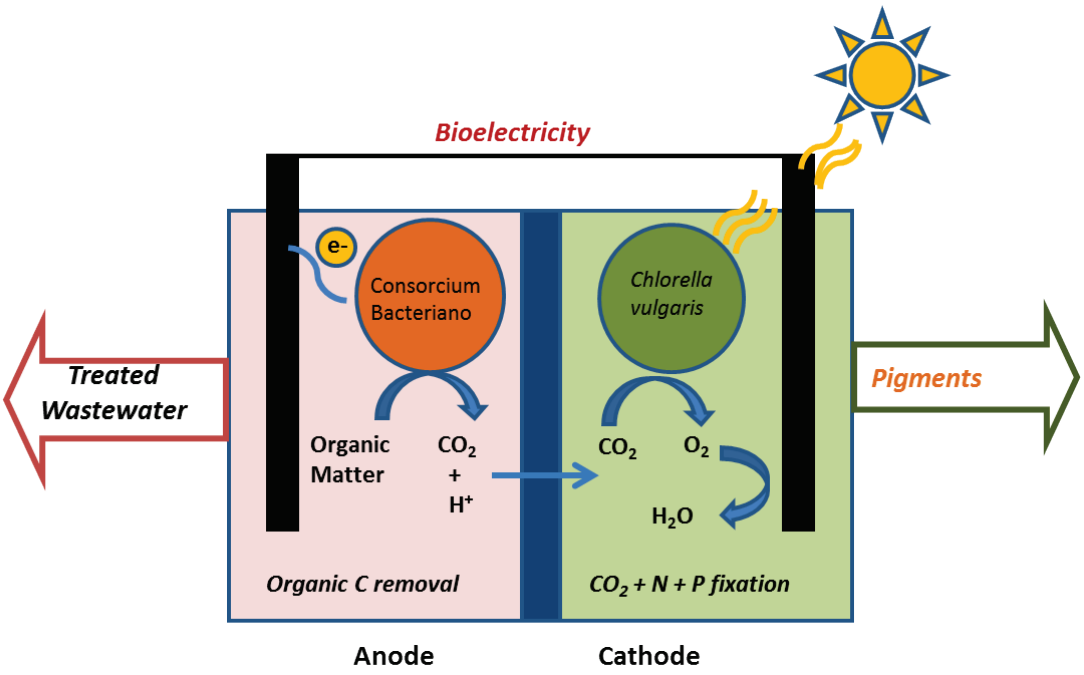
Figure 9
BioSustain - Sustainable mobility: Perspectives for the future of biofuel production. PTDC/EMS-ENE/1839/2012



The objective of this project is to develop comprehensive life-cycle models to characterize the environmental, energetic and economic performance of advanced biofuels value chains (in particular from microalgae and lignocellulosic materials). Furthermore, the project aims to create new perspectives for future biofuels, especially by: identifying the more sustainable technologies available and incorporating uncertainty in biofuel life-cycle sustainability assessment (LCA), in order to increase reliability of the results. This project is on road.

PMFC – Photosynthetic Microbial Fuel Cells (Fig 10)

Figure 10
Photosynthetic Microbial Fuel Cell (Chlorella vulgaris microalga in the cathode electrode)

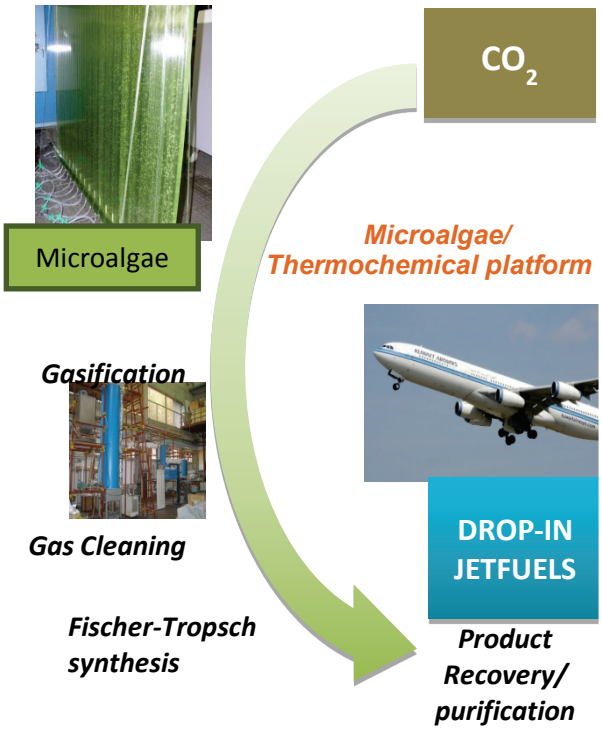


Source: adapted from Gouveia et al. (2014)

This study demonstrates the simultaneous production of bioelectricity and added-value pigments in a Photosynthetic Alga Microbial Fuel Cell (PAMFC), with a concomitant wastewater treatment and carbon fixation. A PAMFC was operated using *Chlorella vulgaris* in the cathode compartment and a bacterial consortium in the anode. In this compartment bacteria reduced the carbon source and produced protons and electrons that were transported to the cathode compartment, producing electricity. In the cathode the microalga in the presence of carbon dioxide/bicarbonate and light produced oxygen, reacts with the protons and electrons producing water. The results shown that increasing light intensity leads to an increase of about 6-folds in the power produced. Additionally, the light intensity and PAMFC operation potentiated the pigment carotenogenesis, produced in the cathode compartment (Gouveia et al., 2014).

Advanced fuels for Aviation using Thermochemical platform of Microalgae (Fig 11)

Figure 11
Advanced fuels for Aviation using Thermochemical platform of Microalgae



The evaluation of the potential of microalgae to jet fuel production is the target of the project. The thermochemical platform, trough gasification and Fischer-Tropsch will be envisaged.

Conclusion

Microalgae have been widely recognized as a key value chain for the bioeconomy. The European SET-PLAN (strategic energy technological plan) through the EBTP (European Biofuels Technological Platform), the EIBI (European Industrial Bioenergy Initiative) and the EERA Bioenergy (European Energy research Alliance) recognizes the strategic importance of micro- and macro-algae as a key value chain for advanced and other biomaterials production. Moreover, past and current set of R&D project Calls in the frame of the H2020 and COST Actions have also been evidencing the importance of microalgae in this context.

On the other hand, Portugal as a coastal European country with excellent edafoclimatic conditions, has a great potential for microalgae culturing in a sustainable way, helping in food/feed, wastewater and flue gas treatment, as well as in biofuel supply security. Besides fisheries and aquaculture, microalgae farms (similarly to agriculture farms) could contribute for the blue growth/blue economy and could have an especial importance on the development of the coastal communities. However, this activity it is not only restricted to the coast as fresh water and brackish water microalgae can be easily grown inland, providing economical and societal advantages in several depressed rural areas. These farms could be important source of nutrition, employment and income.

Portugal is also the second largest fish consumer per capita, thus a quality and quantity of microalgae biomass produced is also essential for fish farming, as microalgae is the basis of the food chain. Portugal has several spots with more than 3000h/year insolation hours, together with adequate temperature profile along the year, constitute some of the most remarkable competitive advantages.

Other nearby regions with similar edafoclimatic conditions, such as the Mediterranean basin, will strongly benefit from the Portuguese experience. The close cooperation between these countries under the frame of research programs and human mobility will be very welcome in the near future, and is imperative to accelerate this promising field of R&D.

Bibliography / More information

- Batista, A.P.; Moura, P.: Marques, P.A.S.S.; Ortigueira, J.; Alves, L.; Gouveia, L. (2014). *Scenedesmus obliquus as feedstock for biohydrogen production by Enterobacter aerogenes and Clostridium butyricum*. Fuel 117, pp. 537 – 543.

- Ferreira, A.F.; Marques, A.C.; Batista, A.P.; Marques, P.; Gouveia, L.; Silva, C. (2012). *Biological hydrogen production by Anabaena sp. – yield, energy and CO2 analysis including fermentative biomass recovery*. International Journal of Hydrogen Energy 37, 179-190.

- Ferreira, A.F.; Ortigueira, J.; Alves, L.; Gouveia, L.; Moura, P.; Silva, C.M. (2013). *Biohydrogen production from microalgal biomass: energy requirement, CO_2 emissions and scale-up scenarios*. Bioresource Technology 144, 156-164.

- Gouveia, L.; Oliveira, C. (2009). *Microalgae as a raw material for biofuels production*. Journal of Industrial Microbiology and Biotechnology 36, 269-274.

- Gouveia, L.; Neves, C.; Sebastião, D.; Nobre, B.P.; Matos C.T. (2014). *Effect of light on the production of bioelectricity and pigments by a Photosynthetic Alga Microbial Fuel Cell*. Bioresource Technology 154, 171-177.

- Marques, A.E.; Barbosa, T.A.; Jotta, J.; Tamagnini, P.; Gouveia, L. (2011*). Biohydrogen production by Anabaena sp. PCC 7120 wild-type and mutants under different conditions: Light, Nickel and CO2*. Journal of Biomass and Bioenergy 35, 4426-4434.

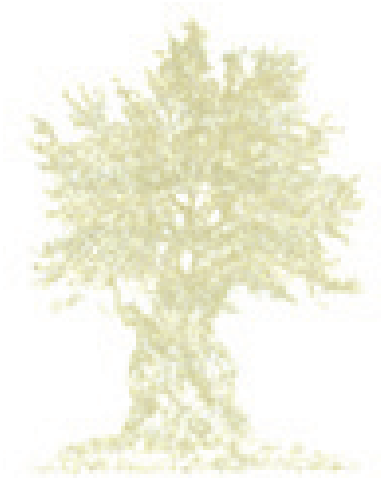
- Miranda J.R.; Passarinho P.C.; Gouveia L. (2012). *Bioethanol production from Scenedesmus obliquus sugars: the influence of photobioreactors and culture conditions on biomass production*. Applied Microbiology and Biotechnology 96, 555-564.

- Nobre, B.; Villalobos, F.; Barragán, B.E; Oliveira, A.C.; Batista, A.P.; Marques, P.A.S.S.; Sovotó, H.; Palavra, A.F.; Gouveia, L. (2013). *A biorefinery from Nannochloropsis sp. microalga – Extraction of oils and pigments. Production of biohydrogen from the leftover biomass*. Bioresource Technology Special Issue: Biorefinery 135, 128-136.

- Santos, C.A.; Ferreira, E.; Lopes da Silva, T.; Gouveia, L.; Novais, J.M.; Reis, A. (2011). *A symbiotic gas exchange between bioreactors enhances microalgal biomass and lipid productivities: taking advantage of complementary nutritional modes*. Journal of Industrial Microbiology and Biotechnology 38, 909-917.

- Santos, C.A.; Reis, A. (2014). *Microalgal symbiosis in biotechnology*. Applied Microbiology and Biotechnology 98(13): 5839-46.

- Subhadra, B.G. (2010) *Sustainability of algal biofuel production using integrated renewable energy park (IREP) and algal biorefinery approach*. Energy Policy 38: 5892–90.

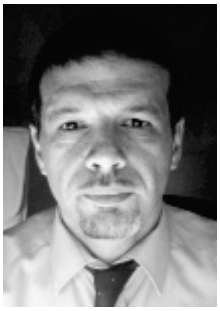


Crop monitoring and yield forecasting at global level
The GLOBCAST project from the European Commission

Raúl López-Lozano
European Commission,
Joint Research Centre (JRC), Institute for Environment and Sustainability (IES), Monitoring Agricultural Resources Unit (MARS), Ispra (Italy)

Bettina Baruth
European Commission,
Joint Research Centre (JRC), Institute for Environment and Sustainability (IES), Monitoring Agricultural Resources Unit (MARS), Ispra (Italy)

Mohamed El Aydam
European Commission,
Directorate-General for Agriculture and Rural Development (DG AGRICULTURE), Arable Crops Unit, Brussels (Belgium)



Eric Willems
European Commission,
Directorate-General for Agriculture and Rural Development (DG AGRICULTURE), Arable Crops Unit, Brussels (Belgium)

Tomás García Azcárate
European Commission,
Directorate-General for Agriculture and Rural Development (DG AGRICULTURE), Observatory of Agricultural Markets, Brussels (Belgium)

Acknowledgments

The GLOBCAST project phases 1 -3 (2008 – 2015) were funded by DG AGRICULTURE.

The useful inputs from Dr. Maurits van den Berg to the present manuscript are sincerely acknowledged.

Introduction

Recent trends in global agriculture prices have brought a new scenario for agricultural policies worldwide. Increased world demand for agricultural products combined with inter-annual fluctuations of global production mostly caused by climate variability have been an important cause for price volatility in agricultural markets, and social unrest in many parts of the world.

In this context, crop monitoring and yield forecasting play a major role in anticipating supply anomalies, thus allowing well-informed timely policy action and market adjustment, preventing food crises and market disruptions, reducing market speculation, and contributing to overall increased food security. This is the objective of international initiatives such as AMIS (Agricultural Market Information System) at global level established in 2011 after the request of G-20[1] or MED-Amin in the Mediterranean, launched in 2014 and coordinated by CIHEAM[2].

The European Commission (EC) DG AGRICULTURE launched and financed a three-phase project named GLOBCAST in 2011, an initiative to demonstrate the feasibility and operationalization of a project for crop monitoring and forecasting in the world's main grain producing areas. This project includes the set-up of two main systems. The first system, is dedicated to the estimation of crop areas through the integration of area sampling and remote sensing methods (Carfagna and Gallego, 2005). The second one, presented in this paper, is about forecasting yields. The global yield forecasting system represents an extension of the current European system (the MARS Crop Yield Forecasting System, or M-CYFS) to other world regions with a high relevance on agricultural market prices.

The main output of the current European system, run since 1992 by the Monitoring Agricultural Resources Unit (MARS) of the EC Joint Research Centre, is a monthly bulletin on crop monitoring and yield forecasting in Europe [3] with quantitative yield forecasts and country analysis reports on crop development.

This article presents the basic principles of this new global crop yield forecasting system: the conceptual design of the system, the regions of the world to be covered, and the specific technical solutions to be implemented.

Agricultural regions of interest

GLOBCAST is focused on seven large grain producing regions with a high relevance on agricultural market prices (see the figure 1)

The global system to be constructed considers these geographical areas as "windows" of the system, all of them sharing the same basic principles and data structure, but with some features (crop models, static information layers, etc.) implemented differently on each window depending on the region-specific requirements and data availability:

- *The EU and its neighbourhood*, including the EU-28 member states, plus neighbouring countries in the Mediterranean and Eastern Europe with a relevant influence on agricultural markets: Ukraine, Turkey, Belarus, Morocco, Algeria, Tunisia, Egypt and Libya. The analysis and crop yield forecasting for the EU-28 is focused on the following crops: soft wheat, durum wheat, winter barley, spring barley, rye, triticale, maize, rice, sunflower, potato, sugar beet, and rapeseed. In neighbouring countries, the focus is on the main winter and summer crops: soft wheat, durum wheat, barley, maize, and sugar beet. The EU-28 and some of the neighbouring countries are covered by the European window of the M-CYFS.

- *Russia and Kazakhstan*. In these countries the crops considered are winter wheat, winter barley, spring wheat, spring barley, rapeseed, and sugar beet.

- *China*, where the main crops of interest are: wheat, maize, and two seasons for rice (harvested in summer and harvested in autumn).

- *India*, where the monitoring and yield forecasting activities will include winter wheat, early season rice (so-called *rabi* rice), and late season (*kharif*) rice.

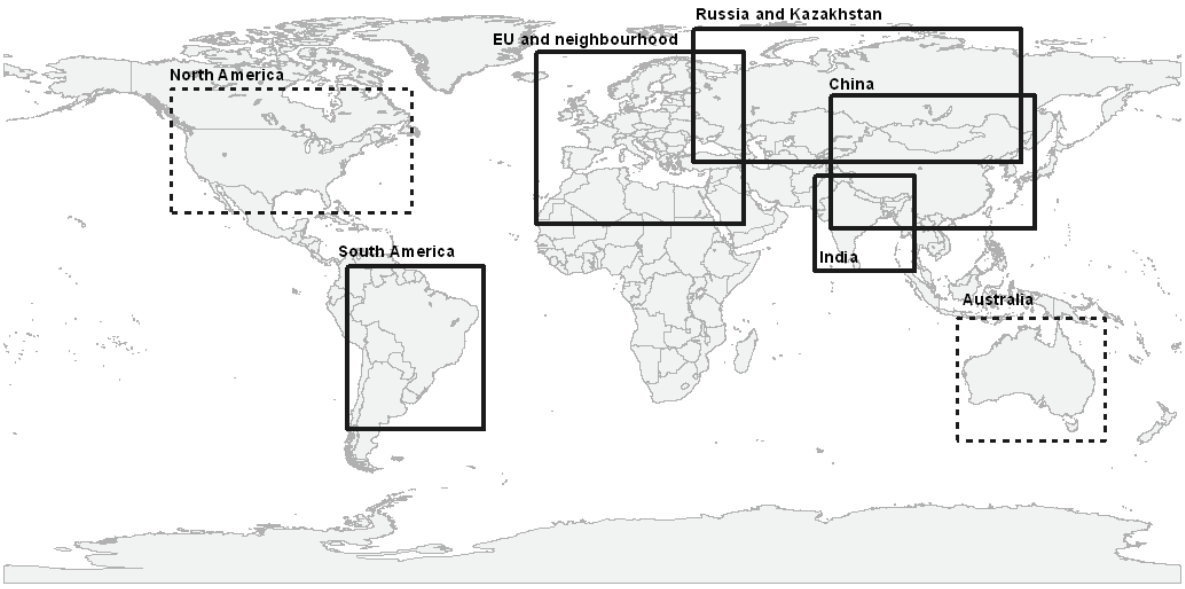
- *South America*. This geographical window includes Argentina and Brazil, where the main crops to be covered are wheat, barley, maize (cash crop), soybean and sugarcane.

- *North America*. This window englobes the United States and Canada for wheat, barley, rapeseed (canola), maize, soybean and sugar beet.

- *Australia*, where only wheat will be analysed.

[1] See http://www.amis-outlook.org/
[2] See https://med-amin.ciheam.org/en/
[3] http://mars.jrc.ec.europa.eu/mars/Bulletins-Publications

Figure 1
"Windows considered in GLOBCAST. Solid squares identify those windows considered as priority in the system set-up"



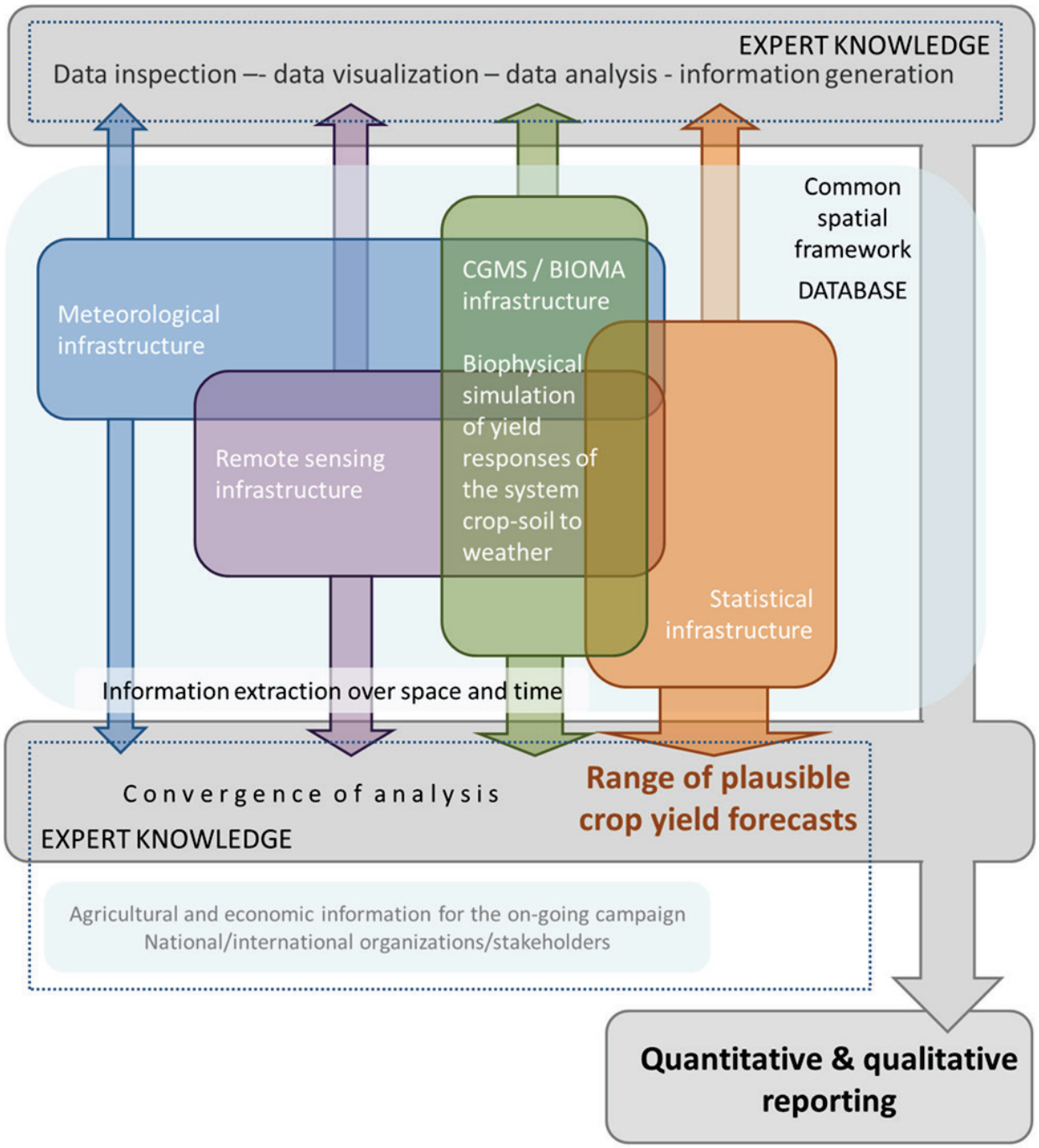
General principles for a global crop yield forecasting system: the M-CYFS concept

The crop yield forecasting system that is envisaged to be implemented is based on the principles of the current M-CYFS running at EU-28 level[4].

The M-CYFS is a system that makes use of several models and tools producing a large volume of information in near real time (NRT) on meteorological and crop indicators. Nevertheless, the system is driven by expert knowledge, in which a team of analysts play the central role in evaluating and interpreting numerous indicators, and selecting those that are determining crop yields to produce a reliable yield forecast. A conceptual design of the system is given in figure 2

[4] http://marswiki.jrc.ec.europa.eu/agri4castwiki/index.php/Main_Page

Figure 2
Conceptual design of the MARS Crop Yield Forecasting System (M-CYFS) with the five system components: meteorological data infrastructure, remote sensing data infrastructure, crop modelling infrastructure, statistical analysis infrastructure and the common spatial framework



Data production of the M-CYFS relies on five system components:

- *Meteorological data infrastructure.* This component accounts for the acquisition and processing of meteorological data in NRT (temperature, precipitation, incoming radiation, etc.) relevant for crop monitoring.

- *Crop modelling infrastructure.* This system component uses NRT meteorological data, soil information, and agronomic parameters (collected from field experiments, scientific literature, etc.) for the crops monitored to run crop models. The modelling platform BioMA[5], developed at MARS, constitutes the engine of this component. The outputs are a set of simulated crop indicators (total above-ground biomass, leaf area index, relative soil moisture, biomass in storage organs, crop development stage) describing –according to the crop model assumptions– the effects of weather conditions on crop growth and yield.

- *Remote sensing infrastructure.* This includes the acquisition and processing of satellite imagery at medium-low spatial resolution (about 1-km) to produce biophysical vegetation indicators, such as the normalized difference vegetation index (NDVI), the fraction of absorbed photosynthetically active radiation (fAPAR) or the leaf area index (LAI). These indicators are used to assess the actual green biomass formation and canopy vegetative status over arable land areas.

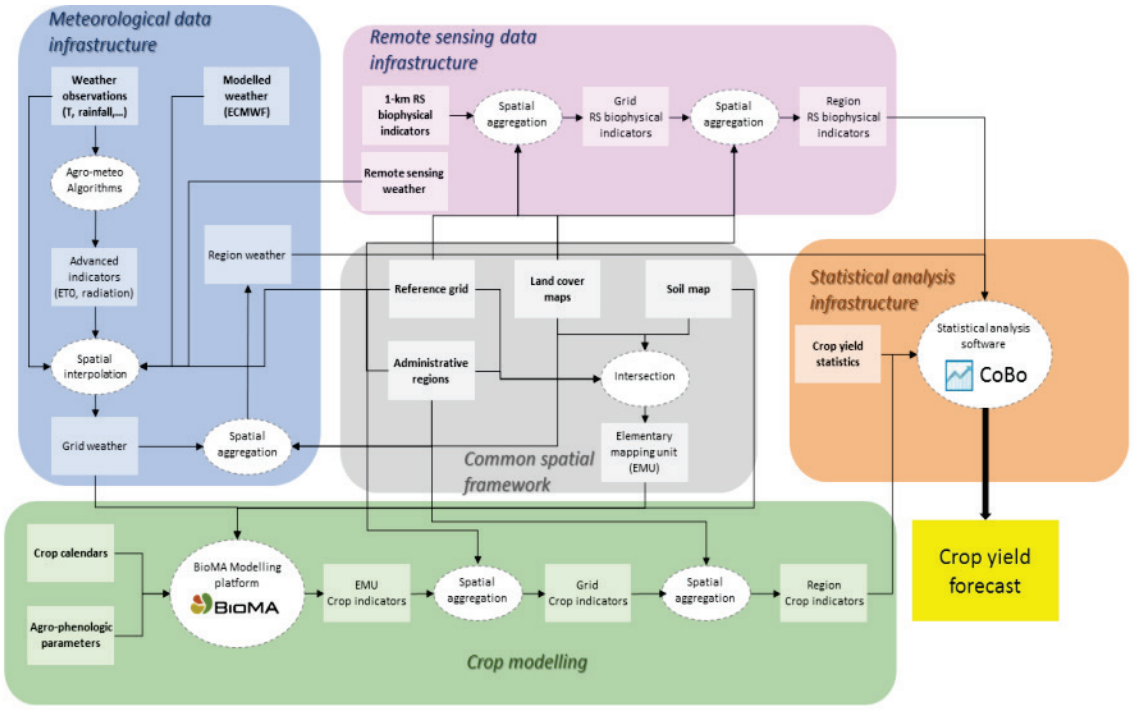
- *Statistical infrastructure.* This component encompasses the methodological framework to use the outputs from the previously mentioned system components to produce a yield forecast. The following statistical procedures are used: (i) analysis of yield trends, (ii) simple/multiple linear regression between indicators and official yield statistics, and (iii) similarity analysis to identify historical years that are similar to the forecast season in terms of sets of selected indicators (e.g. simulated leaf area and soil moisture behaviour over the season). A specific software application CoBo (acronym for Control Board) was developed in-house to accommodate these statistical tools, and to manage and store all the statistical processes executed by the analysts to produce their forecasts. This ensures a full traceability of the process and it permits to assess the overall quality of the system outputs.

- *Common spatial framework.* The M-CYFS is a spatialized system. The spatial framework permits an integrated analysis of all the information. It includes the datasets containing the system spatial units (reference grid, different levels of administrative units), their intersection, and the methods to aggregate spatially the indicators from their original resolution.

  The data workflow in the system is shown in figure 3. All the datasets produced by these five components are stored in a relational database (the M-CYFS DB), and can be accessed through viewing and mapping applications developed for that purpose.

[5] http://bioma.jrc.ec.europa.eu/

Figure 3
Data workflow among the M-CYFS system components to produce a final crop yield forecast
Datasets are identified with boxes, whereas data processing is identified with ellipses



Implementation of the M-CYFS in different regions of the world: technical solutions to set-up the system components

The set-up of the M-CYFS in the areas of the world mentioned in Section 0 is envisaged as an incremental process of improvement from a basic system to a technically advanced and more performing one. The adoption of a technical solution for a system component, e.g. the meteorological infrastructure depends on two main criteria:

- Cost-efficiency, defined as the expected contribution of that solution to the overall performance of the system compared with the costs of implementing it ;
- The availability of required data and methods necessary to implement such a solution.

After carrying out a viability assessment of the system composition and implementation in the regions of the world covered in GLOBCAST, three technical levels (basic, intermediate, and advanced), were identified as successive stages of implementation and improvement for the different system components. These solutions are summarized in table 1 *(see the Annex).*

Basic system components

Basic components are those constituting a system able to achieve an accuracy of the crop yield forecasts comparable to the average inter-annual variability at national level; valid predictions can be produced also at sub-national level, in those specific regions where strong variations happen.

The basic option for the meteorological component is the use of weather data produced by meteorological models. ECMWF (the European centre for medium-range weather forecasts) provides the products ERA (archive reanalysis) and HRES (deterministic 10-day forecasts), based on the assimilation of observed atmospheric data from different sources (meteorological satellites, radiosondes, weather stations, etc.) into a global circulation model to produce weather indicators [6] . Although the reliability of modelled weather in the different regions of the world depends strongly on the availability of observed data to assimilate into the model, it may constitute a valid option where NRT data from automatic weather stations is not available or accessible.

[6] http://www.ecmwf.int/en/forecasts/datasets

The crop modelling component relies on the BioMA platform with different crop models implemented: WOFOST (Van Diepen et al., 1989) and CropSyst (Stöckle et al., 2003) to simulate crop growth of most field crops; WARM (Confalonieri et al., 2009), a specific model for rice; and CANEGRO (Singels et al., 2008) for sugarcane. For all these models a basic parameter setting exists based on general agronomic studies and values reported in scientific literature. In the basic system configuration, this basic setting is used, which may present some limitations for specific crops and regions of the world.
The remote sensing infrastructure relies on 1km resolution vegetation indices such as the NDVI (Normalized Difference Vegetation Index) for these platforms: SPOT-VEGETATION, METOP-AVHRR and NOAA-AVHRR. A disadvantage of this approach is that these products are not directly comparable, which makes it difficult to maintain long-term records when the lifecycle of these platforms finish and are replaced by others. Finally, the statistical analysis is applied with the basic statistic tools implemented in the CoBo software: trend analysis, regression, similarity analysis performed at country level to produce yield forecasts.

Intermediate system components

It is the goal with the intermediate and advanced system components to obtain crop yield forecasts with an accuracy significantly better than the average inter-annual change at national level and with accuracy comparable to the average inter-annual change at sub-national level for the main production regions.

The intermediate level represents an incremental enhancement compared to the baseline level. In the meteorological component global datasets of weather stations are added to the system. The M-CYFS interpolates those observations from stations to produce spatially-continuous layers of meteorological indicators. The daily records of the WMO surface network stations constitute the most valid option, although in some of the countries the availability of stations is low. These data are freely accessible via the GHCN (Global Historical Climatological Network Dataset)[7] maintained by the US NOAA.

The crop modelling component is enhanced by improving the crop model calibration based on regional specific agro-climatic conditions, in partnership with local agricultural and research institutions. This implies the compilation of local agronomic data (phenological observations, biomass measurements, etc.), which permits a fine-tuning of the crop model outputs to the actual conditions in the field.

In the remote sensing component, the land vegetation biophysical products from the EC Copernicus Programme [8] represent an advancement against the basic system. Although the spatial resolution is still 1 km, the products have been conceived to be platform-independent, which permits to generate compatible long-term historical archives from different platforms: NOAA-AVHRR, SPOT-VEGETATION, PROBA-V and the future Sentinel mission. Long-term archives are crucial to understand the relationship between biomass dynamics observed by satellites and crop yields in large areas.

The statistical analysis will be performed at sub-national level, which allows the analyst to select specific methods to produce yield forecasts for regions within countries based on local agro-climatic conditions. This improvement depends, however, on the availability of reliable crop statistics at sub-national level for the different countries.

Advanced system components

In an advanced system, the meteorological component is further enhanced by including data from national networks of weather stations. The reliability of the meteorological indicators produced from weather stations is strongly determined by the spatial density of the latter, and determines as well the accuracy of crop model indicators, fed with NRT weather data. Global repositories of weather station data (like GHCN) contain only sparse data on some countries, and therefore alternative sources have to be considered to reach the required density.

The advanced crop modelling component includes the development of specific modules to simulate country or region specific abiotic stress that are locally determining yields, and that are not included in the general purpose crop models. This includes, for example, a frost-kill module to simulate effects of extreme low temperatures in Russia and Kazakhstan; or modules to simulate pests and diseases, etc. Moreover, additional agro-management information (irrigation, fertilizing, etc.) must be collected with local partners to further calibrate crop models on local conditions.

The remote sensing advanced component would incorporate high-resolution products. In many countries, the agricultural landscape is highly fragmented and 1-km images are not sufficient to isolate the response of the different crops. The forthcoming European Space Agency's (ESA) Sentinel-2 Mission would permit to exploit synergistically high and low spatial resolution data to retrieved continuous crop-specific time-series of biophysical products. In that scenario, advanced procedures assimilating remote sensing data into crop models (Dorigo et al., 2007, Guerif and Duke, 2000) could be envisaged to upgrade as well the statistical analysis component.

[7] http://www.ncdc.noaa.gov/climate-monitoring/

[8] http://land.copernicus.eu/global/?q=products

Outlook

In the EU the system is active, and has reached an important degree of maturity after more than 20 years, as well as in Turkey and Ukraine. The meteorological and crop monitoring components have reached an advanced technical level: the system processes every day weather data from more than 2200 weather stations, and the crop modelling component has been improved during different calibration exercises. Remote sensing and statistical analysis are already at an intermediate level, based on low resolution products (1-km SPOT-VEGETATION and PROBA-V products). The forthcoming ESA Sentinel-2 mission [9] will permit to improve the system component with high resolution data.

The system is active as well for Maghreb countries (Morocco, Algeria and Tunisia), Belarus, Russia and Kazakhstan, but with a lower technological level compared to the European one. Weather data for these regions rely heavily on modelled ECMWF data, with sparse observations from weather stations. The crop model calibration needs some improvements with specific datasets to implement realistic crop calendars and crop phenology parameters in many regions. The remote sensing and statistical analysis components are at the same as in Europe.

The implementation of a basic system for Argentina, Brazil, China, India, Egypt and Libya will occur during 2015 in the frame of the current GLOBCAST project. The system will rely mostly on global datasets: ECMWF weather data, a basic crop model calibration with basic data published in scientific literature, global soil and land cover maps, etc. The MARS Unit is currently working to identify local partners to exchange agronomic and meteorological information and experiences, including technology transfer and capacity building activities to these countries.

Bibliography / more information

- Carfagna, E., Gallego, F.J., 2005. *Using Remote Sensing for Agricultural Statistics*. Int. Stat. Rev. 73, 389–404. doi:10.1111/j.17515823.2005.tb00155.x
- Confalonieri, R., Rosenmund, A.S., Baruth, B., 2009. *An improved model to simulate rice yield*. Agron. Sustain. Dev. 29, 463–474.
- Dorigo, W.A., Zurita-Milla, R., de Wit, A.J.W., Brazile, J., Singh, R., Schaepman, M.E., 2007. *A review on reflective remote sensing and data assimilation techniques for enhanced agroecosystem modeling*. Int. J. Appl. Earth Obs. Geoinformation 9, 165–193
- Guerif, M., Duke, C.L., 2000. *Adjustment procedures of a crop model to the site specific characteristics of soil and crop using remote sensing data assimilation*. Agric. Ecosyst. Environ. 81, 57–69.
- Singels, A., Jones, M., van den Berg, M., 2008. DSSAT v4.5 - Canegro Sugarcane Plant Module.
- Stöckle, C.O., Donatelli, M., Nelson, R., 2003. *CropSyst, a cropping systems simulation model*. Eur. J. Agron. 18, 289–307.
- Van Diepen, C.A., Wolf, J., Van Keulen, H., Rappoldt, C., 1989. *WOFOST: a simulation model of crop production*. Soil Use Manag. 5,1

[9] https://earth.esa.int/web/guest/missions/esa-future-missions/sentinel-2

Table 1
Summary of the technical solutions (basic, intermediate, and advanced) foreseen to construct the GLOBCAST system component

	Basic solution		**Intermediate solution**		**Advanced solution**	
	description	**datasets/methods**	**description**	**datasets/methods**	**description**	**datasets/methods**
Meteorological data infrastructure	Modelled weather data	*ECMWF daily global datasets: ERA historical archive, HRES re-analysis, OPE deterministic forecast*	Observed weather from global repositories	*WMO – GHCND daily data*	Observed weather from local networks	*Acquisition and processing on NRT of weather stations from each country network*
Crop modelling	Crop models with a baseline calibration	*WOFOST, CropSyst, WARM, CANEGRO models implemented in BioMA* *Calibrated with data from scientific literature*	Crop models locally calibrated	*WOFOST, CropSyst, WARM and CANEGRO models implemented in BioMA* *Calibrated specifically for each region using local agronomic studies*	Region-specific crop model solutions with agro-management	*WOFOST, WARM, CropSyst and CANEGRO plus additional biotic and abiotic stress modules implemented in BioMA* *Calibrated specifically for each region using local agronomic studies and local agro-management data*
Remote sensing data infrastructre	Low resolution datasets	*NOAA-AVHRR NDVI 1-km data* *METOP-AVHRR NDVI 1-km data*	Low resolution long-term biophysical products	*Copernicus global land vegetation monitoring 1-km products:* *NDVI, LAI, fAPAR, fCOVER*	Synergy low resolution and high resolution biophysical products	*Copernicus high and 1-km biophysical products and 30-m imagery (future Sentinel-2 Mission) exploited to produce crop-specific information.*
Statistical analysis infrastructure	Country-level statistical forecasts	*Analysis performed at country level (GAUL0) with basic statistical procedures*	Sub-national statistical forecasts	*Analysis performed at sub-national level (GAUL1) with basic statistical procedures*	Data assimilation	*Remote sensing data assimilation techniques into crop models to exploit components synergy*

Assessing and Advancing Food Security in Lebanon: Innovative Initiatives at the American University of Beirut

Nahla Hwalla
Faculty of Agricultural and Food Sciences,
American University of Beirut
Member of CIHEAM Advisory Board

Rachel Bahn
Food Security Program, American University of Beirut

Background on food security in Lebanon

Achieving food security is a serious challenge for the countries of the Middle East and North Africa (MENA) region, including Lebanon. Lebanon is a small country of 10,452 square kilometers and approximately 4.5 million people subject to heightened demographic pressures, possessing limited arable land (20% of all land as of 2012, according to the World Bank (2014)) and renewable fresh water (approximately 1,000 m3 per capita, compared to a global average of 6,000 m3 (Sadik, 2014)), and highly reliant on food imports (for example, roughly 90% of all cereals are imported (FAO, 2014)). Climate change is contributing to irregular weather patterns, notably serious drought in the 2013-2014 hydrologic year that saw rainfall at only a fraction of its historic levels. Beyond food availability, food access remains problematic: Many individuals cannot access food in the face of poverty (approximately 28% of the population lives under $4.00 per day according to UNDP figures (2012)), unemployment (approximately 10% according to the Government of Lebanon (2014)) or exclusion from the formal workforce, and a lack of social safety nets.

While most Lebanese have access to improved water and sanitation systems, vulnerable demographic groups including refugees remain especially underserved, undermining their ability to utilize food properly. Lebanon is also experiencing a nutrition transition that has contributed to a double-burden of malnutrition, or the presence of under-nutrition and micronutrient deficiency at the same time as overweight and obesity: As the population increasingly shifts from traditional diets heavy in legumes and vegetables towards Western-style diets marked by higher fat, salt, and sugar consumption in the form of processed and fast foods, the prevalence of obesity among Lebanese adults increased from 17% to 28% from 1997 to 2009 (Nasreddine *et al.*, 2012). Food security in the country is a major concern of the Government of Lebanon, but efforts to tackle it are hampered by deficiencies in qualified human resources to lead such efforts.

To tackle the issue of food security in all its complexity, the Faculty of Agricultural and Food Sciences (FAFS) at the American University of Beirut (AUB) is undertaking capacity building through education and research. Efforts include development of culture-sensitive methods to measure and assess food security (Naja *et al.*, 2014 and Sayhoun *et al.*, 2014); research to examine the determinants of food security (Abou Zaki *et al.*, 2014); and educational programs to prepare future leaders, change agents, and policy-makers to address food security in Lebanon and throughout the region.

Assessing food security challenges

A serious hurdle in achieving food security in Lebanon – and many other countries – is the lack of data to assess the situation and inform sound, well-targeted policies and programs. Data collection, however, requires appropriate indicators and assessment tools that can be used to identify food security and its gaps and determinants. Properly structured, culturally-sensitive assessments can then be used to design and prioritize interventions, monitor their progress, and evaluate their results and impacts.

Food security data are typically collected at one of three levels. The first level is country- or region-level, with indicators including quality and reach of infrastructure that may be attributed to a wide population. The second level is household-level data that include indicators collected at the level of the household; examples include income and food expenditure data and direct or experiential measures of food security, usually in the form of questions about the accessibility of food (Tohmé Tawk *et al.*, 2014). Third, individual-level data are specific to the individual in question, and include anthropometric assessment to determine nutritional outcomes like underweight, wasting, and stunting. Food security indices may combine data from one or all of these levels, particularly for the purpose of cross-country comparison and assessment and to guide policy development.

There are several challenges in assessing food security, the first of which is the complexity of food security itself. The complex nature of food security makes its assessment more difficult. An accurate assessment should cover all of the relevant components, across all four dimensions (availability, access, utilization, and stability). Instead, assessments often over-simplify food security by relying on indicators for a single dimension. For example, in the MENA region, food security is often equated with food sovereignty and restricted food imports, which in many cases is not attainable at a country level. This narrow reliance on specific indicators can be useful, but does not always correlate with the ultimate indicator of food security – sound nutritional status. This is particularly the case when the selected indicators are averages that mask variation within populations or when they omit parts of the causal chain (*e.g.*, average calorie availability does not necessarily lead to evenly-distributed calorie intake).

A second challenge in assessing food security in countries like Lebanon is that many of the existing tools are developed internationally and hence not culturally-sensitive, and would not reflect an accurate measure of the Lebanese food security status. Assessment tools may have been developed for specific contexts (*e.g.*, conflict situations) or for use in areas that are substantially different from the MENA region. These assessment tools require significant modification before they can be effectively used. At the American University of Beirut, researchers have responded by undertaking two such efforts, leading to the production of two tools suitable for use in the region.

The Household Food Insecurity Access Scale

One such tool is the Household Food Insecurity Access Scale (HFIAS), which AUB researchers modified and used to assess food security in Lebanon. The HFIAS was previously developed as an English-language tool for use in other regions, to measure components of food access including food quantity and quality, hunger, and under-nutrition. The research team translated the tool from English to colloquial Arabic and modified it to suit the cultural context of rural Lebanon (see text box). The tool was then field-tested and validated in the heavily agricultural Beqaa Valley.

Demographic and anthropometric information on the study population were also collected. The HFIAS identified a positive correlation between gaps in food security and poverty indices, malnutrition, and poor dietary quality in the target populations. The researchers concluded that 48% of households surveyed were food secure, while the remaining households were classified as mildly food insecure (17.7%), moderately food insecure (12.9%), or severely food insecure (21.1%) (see Table 2); and recommended the HFIAS for use in other Arabic-speaking countries, following adjustment for linguistic and culture-specific modifications (Naja *et al.*, 2014).

Sample of Survey Questions within Selected Food Security Assessment Tools

Adjusted Household Food Insecurity Access Scale

- *In the past 4 weeks, did you worry that your home would not have enough food?*
- *In the past 4 weeks, were you or any family member living with you at home not able to eat the kinds of food you preferred because of a lack of available resources?*
- *In the past 4 weeks, did you or any family member living with you at home have to eat a limited variety of food due to a lack of available resources?*
- *In the past 4 weeks, did you or any family member living with you at home have to eat some foods that you really did not want to eat because of a lack of available resources to obtain other types of food?*
- *In the past 4 weeks, did you or any family member living with you at home have to eat a smaller meal than you felt you needed because there was not enough food available?*
- *In the past 4 weeks, did you or any family member living with you at home have to eat fewer meals in a day because there was not enough food available?*
- *In the past 4 weeks, was there ever no food to eat of any kind in your home because of a lack of available resources to get food?*
- *In the past 4 weeks, did you or any family member living with you at home go to sleep at night hungry because there was not enough food available?*
- *In the past 4 weeks, did you or any family member living with you at home go for 24 h without eating anything because there was not enough food available?*

Arab Family Food Security Scale

- *Concerned food would run out*
- *Inadequate quality food*
- *Food bought did not last*
- *Not enough of some foods*
- *Cut size of meal*
- *Skipped meal*
- *Did not eat whole day or went to bed hungry*

The Arab Family Food Security Scale

The second tool developed for measuring food security is the Arab Family Food Security Scale (AFFSS). The AFFSS survey tool was independently developed, validated, and tested with data on vulnerable populations in Lebanon, specifically residents from southern Lebanon (Tyre governorate) and Palestinian refugees living in camps within Lebanon. Survey questions used within the AFFSS are presented in the text box above. Using the AFFSS, the research team found a strong correlation between food security and both mean monthly income and educational attainment of the head of household. The team estimated that 42% of southern Lebanese and 62% of Palestinian refugee households are food insecure (see Table 1). (Sayhoun *et al.*, 2014).

Table 1
Food Security Prevalence among Lebanese Sub-Populations

	HFIAS (Beqaa Valley)	**AFFSS** (South Lebanon)	**AFFSS** (Palestinian Refugees)
Food Secure	48.3%	58%	38%
Mildly Food Insecure	17.7%	-	-
Moderately Food Insecure	12.9%	32%	42%
Severely Food Insecure	21.1%	10%	20%
Total	100%	100%	100%

Some operative conclusions

The process of developing and implementing these two assessment tools revealed specific and technical challenges, including the following:

Classification of food security

The classification of households as food secure or not, and degrees thereof (mild, moderate, severe), has proven difficult. As a result, Sayhoun *et al.* recommend re-calibrating the AFFSS tool in the future to more accurately report on degrees of food security (2014).

Replicability

The initial assessments conducted using the HFIAS and the AFFSS have not yet been replicated in the populations studied, and thus it is unclear if the results of ongoing food security monitoring will be replicated or otherwise consistent with the initial findings.

Modification of survey tools

No single survey tool is appropriate for use in all contexts. Instead, survey tools must be modified to each situation, within and across countries. To determine whether an existing tool may be used "off the shelf" or requires further modification, research teams must validate tools in the target communities before use. Modification requires a greater effort and higher costs, but will ultimately produce valid and comparable survey results across cultural and linguistic lines. Data that is directly comparable can then help inform decision-makers to better allocate resources for food security programs and policies.

Food security tools measure outcomes, not causes

The HFIAS and AFFSS assessment tools presented previously in this paper offer the benefit of being relatively brief, requiring limited time and budget to implement, and being tested on the specific populations of interest. The survey results also provide limited insight as to why certain households are food secure and others are insecure. This causal path must be determined through additional means and supported by other tools, in order to inform policy-makers and design better programs to improve food security.

Exploring the determinants of food security

To better understand the determinants of food insecurity, and specifically the role of urban agriculture in food security in the MENA region, AUB researchers administered a locally developed questionnaire based on the HFIAS[1] to low-income households in peri-urban areas around Tripoli, the second-largest city in Lebanon, and Amman, Jordan. Findings indicated that approximately 51% of households in the target areas were food insecure, that food producers were more food insecure than non-food producers, and that gaps in food security were most strongly associated with poverty (lack of purchasing power to buy food and the percentage of income spent on food) and with larger household sizes (four or more members).

These findings suggest that food production is "the urban poor's response to a lack of purchasing power and to inadequate, unreliable and irregular access to food." Distinct results for households in Jordan and Lebanon suggested that a local policy environment that is supportive of urban agriculture can improve food security of producer households (Tohmé Tawk *et al.*, 2014).

[1] The survey did not apply an identical version of the HFIAS as the one used by Naja *et al.*, since the survey was administered in August-October 2011, prior to the Naja *et al.* study.

In order to understand the impacts of recent global food-price shocks on food and nutrition security in Lebanon, AUB researchers studied nationally representative household expenditure micro-data and determined that household intake of critical nutrients decreased significantly in Lebanon following food price shocks in 2008. This is significant, given the country's high level of import dependence: Food comprised 17% of Lebanon's total goods imports in 2011, according to the World Bank, compared to 7% for all upper middle income countries.

Specifically, price increases were found to have a negative impact on intake of critical micronutrients including calcium, zinc, iron, and folate in central urban areas of the country. These results are alarming, given the relatively high rates of micronutrient deficiency even before the food price shocks (Abou Zaki *et al.*, 2014). This research indicates that, in the future, sharp increases in international food prices should be monitored and sound public policies should be used to limit their impacts on nutritionally adequate food consumption and so avoid longer-term, negative health outcomes.

Similar efforts will continue at the American University of Beirut, as an understanding of the determinants of food security must necessarily be ongoing so long as the MENA region is subject to shifting human, economic, and environmental developments.

Conclusion

The Faculty of Agricultural and Food Sciences at AUB is committed to advancing food security in the MENA region through its ambitious agenda of research, education, and practice. Future collaboration with critical partners like CIHEAM will be instrumental to our success, particularly in the areas of food security research.

By working to measure the scope of food security, identify its determinants, and provide evidence for focused intervention strategies, FAFS is making an essential contribution not only to improved methodological research approaches, but also to the substantive and long-term changes needed to tackle this critical challenge in the Eastern Mediterranean and beyond.

Advancing food security for the future

The AUB contribution

Assessing food security and identifying its determinants is only useful if the information is applied to inform programming and policies. At the American University of Beirut, a recently established the Food Security Program (FSP) was developed to promote food security through education, research, community action, and policy-oriented professional practice. The FSP prioritizes research around topics that can inform food security policies and programming, specifically in the MENA region. Research will also translate directly to the classroom through a suite of academic offerings under the FSP, which was established as part of a strategic response to the challenge of food security across the region and to provide intellectual leadership on the issue.

In fact, the FSP is the first graduate-level academic program in the MENA region to focus specifically on food security. This applied academic program is designed to educate a new generation of leaders, preparing graduates to address the issue of food security in a multi-disciplinary and hands-on fashion. The FSP is also leading efforts to translate research and education into action at the local level, by engaging the wider university community. Engagement in efforts like the cross-campus Presidents United to Solve Hunger (PUSH) Initiative will help raise awareness of hunger and food security gaps in and around the university community, working through the student body and in partnership with more than 40 other universities to achieve a wider impact over time.

Bibliography / More information

- Abou Zaki, S., Chaaban, J., Nasreddine, L., and Chalak, A. (2014). *The impact of food price increases on nutrient intake in Lebanon*. Agricultural and Food Economics 2(3). Available at http://www.agrifoodecon.com/content/2/1/3.

- Food and Agriculture Organization (FAO). (2014, November 17). *Food Security Indicators* [Data set]. Retrieved from http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/#.VNoh153LfYg.

- Government of Lebanon and Council for Development and Reconstruction. (2014). *Lebanon Millennium Development Goals Report 2013-2014*. Beirut, Lebanon: Author. Retrieved from http://bcs.bedfordstmartins.com/resdoc5e/RES5e_ch09_s1-0002.html#RES5e_ch09_p0158.

- Naja, F., Hwalla, N., Fossian, T., Zebian, D., and Nasreddine, L. (2014). *Validity and reliability of the Arabic version of the Household Food Insecurity Access Scale in rural Lebanon*. Public Health Nutrition 4: 1-8.

-

- Nasreddine, L., Naja, F., Chameih, M.C., Adra, N., Sibai, A., and Hwalla, N. (2012). *Trends in overweight and obesity in Lebanon: evidence from two national cross-sectional surveys (1997 and 2009)*. *BMC Public Health* 12: 798.

- Sadik, A. (2014). The State of Food Security and Agricultural Resources. In Sadik, A., El-Solh, M., and Saab, N. (Eds.), *Arab Environment 7: Food Security Challenges and Prospects* (pp12-43). Beirut, Lebanon: Arab Forum for Environment and Development.

- Sayhoun, N., Nord, M., Sassine, A., Seyfert, K., Hwalla, N., and Ghattas, H. (2014). Development and validation of an Arab Family Food Security Scale. *The Journal of Nutrition* 144(5): 751-757.

- Tohmé Tawk, S., Abi Said, M., and Hamadeh, S. (2014). Urban agriculture and food security in the Middle Eastern context: A case study from Lebanon and Jordan. In Z. Babar and S. Miragni (Eds.), *Food security in the Middle East* (pp. 159-184). London, UK: Hurst & Company.

- United Nations Development Program (UNDP). (2012). *Millennium Development Goals: Eradicate extreme hunger and poverty*. Retrieved from http://www.mx.undp.org/content/lebanon/en/home/mdgoverview/overview/mdg1/.

- World Bank. (2014). *World Development Indicators Database* [Data set].Retrieved from http://www.data.worldbank.org.

New Medit

Based in Italy, this journal is produced under the direction if the CIHEAM-Bari. Agro-food economy, rural systems and environmental issues are the main topics addressed.

Established in 1990, *New Medit* is a quarterly publication. This peer-reviewed journal is evaluated in the "Journal Citation Reports (JCR) Science Edition". The articles are referenced in the "Web of Science Core Collection".

Its peer recognition makes it even more attractive for researchers and scientists in the Mediterranean and elsewhere. Since 2014, the editorial board of *New Medit* has opted for the free access policy by making all articles available online.

Economics, agriculture, and environment are the key words of the subjects dealt with in the review.

You can find all the articles published in the review since 1990 on the official website

newmedit.iamb.it

Governance of food and nutrition security: Impact assessment and accountability within the Committee on World Food Security

Matthieu Brun
Doctorant à SciencesPo Bordeaux
(Laboratoire Les Afriques dans le Monde), ex-IDDRI

Arlène Alpha
Chercheuse, Centre de coopération International en Recherche Agronomique pour le Développement (CIRAD), UMR MOISA

Sébastien Treyer
Directeur des programmes à l'Institut du développement durable et des relations internationales (IDDRI)

Nicolas Bricas
Chercheur, CIRAD, UMR MOISA

Christine Ton Nu
Adjointe au Directeur, CIHEAM Montpellier

As food prices spiked on agricultural markets and political instability spread throughout the world in 2007-2008, food and nutrition security (FNS) has arisen again on the development agenda. It was through the issue of price volatility that food politics became a global issue and some countries and stakeholders pushed for the formalisation of a global governance of FNS. In this context, the Committee on world Food Security (CFS) set up in 1974 under FAO to review and monitor food security policies, was reformed in 2009. Its revitalization led to new institutional arrangements with the inclusion of a wide range of stakeholders and the creation of a mechanism producing scientific and professional expertise on controversial issues in order to inform policy makers, the High Level Panel of Experts on Food Security and Nutrition (HLPE). This article builds on the discussions held during an international workshop on global governance of FNS (July 2014), convened by IDDRI, CIHEAM-IAMM and CIRAD, gathering 30 experts from different backgrounds (international organizations, research, NGOs, private sector). It aims at making explicit what can be learnt from the CFS reform experience and contributing to the reflection on global FNS governance. One of its objectives is to provide supporting views on the CFS monitoring process. It will also address the specific issue of accountability within and outside the CFS framework, as one of the most critical issue for enhanced FNS governance. Concrete examples of links between global and local governance of FNS in the Mediterranean region will be discussed.

The CFS, a major governance revolution

Many stakeholders consider food and nutrition security as a global rather than only a national or local public good, and consider that food security for all on the planet cannot be achieved without international coordination. They particularly stress the issue of climate change mitigation and adaptation or price volatility on international commodity markets for which one country's policies can impact other countries' situation. However, FNS governance does not constitute a spontaneously coordinated whole and the reality on the ground is of a deep fragmentation and breakdown of agendas[1].

The CFS reform in that regard constitutes a new governance approach, as it seeks to extend the intergovernmental discussions to a variety of different stakeholders and broaden the problematic of food security to issues outside the realm of agricultural production in an inter-sectorial approach, relying particularly on the HLPE. While these intentions are considered very useful by many stakeholders, others consider that food security should be dealt with at other scales (mainly national, particularly for some governments, insisting on their sovereignty) or in other international instances. Other global steps have been made to address the issue of price volatility, like the AMIS system or the agreement on stocks in Bali at WTO in 2013. However, broadening the approach to other dimensions of food security appears difficult. The CFS discussions are still very focused on the relationships between agriculture and food security rather than food security itself[2].

Among the outputs of the reformed CFS that are put forward, the VGGT ("voluntary guidelines on the responsible governance of tenure of land, fisheries and forests in the context of national food security") is acknowledged as an important achievement. It is considered as an example of a constructive multi-stakeholders policy negotiation at the global scale that would have been inconceivable under the previous CFS functioning. If the VGGT achievement is to be considered as a major performance of the CFS, it is nevertheless important to stress that these guidelines are soft law and can only be implemented through the consent of the concerned actors, first of all the States themselves. To what extent can we consider that the CFS governance mechanics is thereby reinventing or shaping differently what is internationally binding, especially compared with other global governance mechanisms (e.g. WTO) where stringent compliance mechanisms exist? Answering this question is crucial in order to not only focus on the participatory nature of the process of production of such guidelines, but also to ensure that they can have an impact on public and private strategies at different scales. For instance, the endorsement of voluntary guidelines by States and their inscription in a rights-based approach could create obligations, and give the impetus for accountability processes at different scales.

However, many analysts remain sceptical about the effective ability of these guidelines to have any impact on the ground. Assessing the impacts of the reformed CFS and clarifying accountability processes are therefore two crucial issues for the future, raising many methodological and political challenges.

Assessing the impacts of the reformed CFS: What does it mean?

What can we expect from the reformed CFS and what criteria should be used for judging the successes or failures of such governance platform? Can it be measured by the extent to which it manages to reduce the number of people malnourished? The CFS evaluation should actually consider the Committee's actual primary role, which is global coordination and convergence of policies, and not the actual governance of global food systems or directly the capacity to reduce the number of food unsecured people.

This assumption acquires more force when we note that it might be too early to proceed to a proper evaluation of the CFS as it would be very difficult to document impacts. Considering the length of institutional and legal processes, more time is needed to have enough perspective on the integration and use of soft law: for instance, the Voluntary Guidelines to support the progressive realization of the right to adequate food have been approved in 2004 and we realize that ten years are not so much to assess their impact. A proper evaluation of the CFS would be of course necessary but in the mid-term future, so that the time could be used to reflect on a proper methodology which could allow assessing impacts from a global platform like the CFS to the situation of food insecurity and malnutrition on the ground.

[1] See Lerin, F., Louafi, S. (2014). "Addressing the fragmentation of discourses and governance for food and nutrition security", *IDDRI Working Papers* n°10/14, Paris, France; Margulis, M. (2011). "The evolving global governance of food security", *Research Paper – Global Governance,* DFAIT Policy Staff, Canada

[2] See Alpha, A., Bricas, N. (2014). "Opening he CFS to an inter-sectorial approach to food security: a difficult process", *CIRAD Working Paper*, Montpellier, France

When it comes to frame the impacts and effects expected from the CFS, inevitably, different groups within the Committee will have their own criteria for deciding whether the process is working adequately and deliver the expected outcomes. Indeed, different stakeholders consider their participation to the reformed CFS with different objectives: for instance, facilitating the establishment of national food security policies and making national governments accountable for them in front of the international community; or ensuring a balance in the mobilisation of different fields of expertise for the formulation of those policies. In any evaluation effort of what impacts the CFS produces, it is therefore useful to account for this diversity of objectives through a diversity of analytical perspectives.

Even if it is too early for a proper evaluation, monitoring CFS outcomes should however be launched quickly. It is needed in order to prepare the relevant material and data for the evaluation, but it is also directly needed in the short term by many members, participants and observers of the CFS so that they can assess, decide and justify their involvement in the CFS. For those who have limited resources, their further engagement is partly linked to their possibility to assess how the debates, guidelines or frameworks adopted in the CFS are enabling people to produce and access nutritious food in a sustainable way and how their action in the CFS can help them to have an impact locally. While monitoring the substance of CFS outcomes is one of the main critical issues at the agenda, it remains also pivotal to monitor the changes in processes growing out of the CFS reform.

Indeed, the CFS experience, compared to other multilateral and intergovernmental platforms of governance of public goods or environmental conventions, has created a particularly inclusive environment with the Civil Society Mechanism [3] (CSM), and the Private Sector Mechanism (PSM). Ideas can be expressed and controversies addressed properly thanks to the structure given to debates by the HLPE[4]. The new governance principles set up by the CFS reform are to be evaluated and monitored *per se*. They show the feasibility of institutional innovations like the CSM enabling Civil Society Organisations (CSO) and social movements' participation to an intergovernmental discussion that has little equivalent in other arenas –even if it remains a fragile equilibrium. The organisation of the different stakeholders engaged in the CFS is a long and complex process and it might be relevant to differentiate the organisational achievements and to assess the progress made in terms of transparency and legitimacy. The balance between monitoring outcomes/impacts and processes is rightly highlighted in the June 2014 document of the CFS Open-Ended Working Group on Monitoring.

Eventually, it has to be emphasised that no monitoring is neutral. It depends on the objectives that are set to the institution, the analytical perspective chosen, the types of impact pathways expected, which can be very diverse among the stakeholders. As a matter of fact, it is necessary to design the monitoring framework within the more general conceptual framework of evaluation, implying for instance the use of concepts such as the theory of change[5].

Revealing the different theories of change behind stakeholders' engagement in the CFS

Adopting a pluralistic approach that identifies different "theories of change" would eventually meet both the need to assess the Committee's effects on interim and long-term outcomes and the need for information on how the interventions produce those outcomes. The theory of change approach applies critical thinking on the design, implementation and evaluation of initiatives and programmes intended to support change in their own contexts. In the case of the CFS, it could help specifying its intended outcomes, the contextual factors that are likely to influence them, and the impact pathways through which these different influences can combine to produce an expected (or unexpected) outcome. It reinforces the idea that the impacts of a platform like the CFS are to be expected in the intermediate steps, that is to say how it helps national coordination and national policy design for FNS with a specific focus on the needs of those who have little or no access to the levers of power. When it comes to the matter of evaluation and assessment of impacts, we could refer to the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) for which the spill-over impacts have been tracked through case studies at various scales. It helped exemplifying the diversity of possible impact pathways and some lessons could be drawn for the CFS from this experience especially at a time when the CFS is trying to adapt its guidelines to national contexts.

The theory of change approach replaces the two principal and often independent types of evaluation reports with one that explicitly and deliberately covers both activities process and implementation. Inevitably, there are important methodological challenges associated to the design of such a monitoring or impact assessment framework incorporating the concepts of theory of change and impacts pathways. The first challenge is to make the link with the local, national and global scales. To cope with this challenge, lessons can be learnt from the IAASTD processes and the Guidelines on the progressive realisation of the Right to Food. A second issue which is an ongoing problem for any evaluator deals with the capacity to attribute changes to actions. The next set of difficulties relates to the ability to combine in the same framework a qualitative and a quantitative approach in order to have comprehensive and well-documented results. Eventually, one can add to the already long list of methodological challenges the fact that within the CFS, various stakeholders hold different views about what it will take to produce the long-term outcomes of the CFS. Indeed multiple theories of change may be operating simultaneously and must be articulated to produce an evaluation.

[3] See Barling, D., Duncan, J. (2012). "Renewal through Participation in Global Food Security Governance" *International Journal of Sociology of Agriculture and Food*, Volume 19, issue 2

[4] See Eklin, K. et al. (2014). "The Committee on World Food Security reform: impacts on global governance of food security", *IDDRI Working Paper*, n°03/14, Paris, France

[5] See Connell, J., Kubisch, A. (1998). "Applying a theory of change approach to the evaluation of comprehensive community initiatives: progress, prospects and problems", Theory, Measurement, and Analysis. Washington, DC

Novel ways of monitoring Multi-Stakeholders Platform

The 2009 CFS reform and its consequences in terms of new institutional arrangements for global governance of FNS is one of the foremost examples of the evolution in the action and the manner of governing global public goods. From intergovernmental governance led entirely by Member States working together, there is a trend toward more multi-stakeholder arrangements; the Scaling-up Nutrition movement and the Global Fund to Fight AIDS, Tuberculosis and Malaria are other evidences of such a governance shift. The development of these multi-stakeholders platforms questions the best way to ensure mutual accountability since the very tenets and framework of accountability are also evolving.

In the CFS, Member States accountability is critical as it is governmental bodies that have the power to decide and the only ones that can be bound by an international legal instrument. No one denies that States bear the primary responsibility for protecting the rights and interests of their people while international institutions responsibility is to hold States accountable for the treatment of their citizens. States accountability, not only for domestic policies but also for international cooperation, is therefore critical in global FNS governance. However it does not mean that States are the only ones impacting food security at the global and national scales. Non-State actors and more specifically transnational actors have indeed a responsibility because their actions have impact on Human Rights - more precisely the Right to food. They should therefore also be held accountable for their strategies, decisions and initiatives impacting FNS.

The accountability of private sector, civil society, private philanthropy but also international organisations and international initiatives[6] therefore appears to be critical; but how to address it? In the framework of the CFS – but not only there – this raises a crucial question: what do the different stakeholders consider to be an obligation? It seems relevant to approach this issue through the double lens of mutual accountability (different types of actors are accountable to one another) and differentiated responsibility (different types of stakeholders do not have the same roles and responsibilities). On the latter, see for instance the existence of different concepts depending on the type of stakeholders, such as government accountability, private sector's responsibility and civils society organisations' legitimacy. The accountability framework should also be differentiated depending on the stage in the process of the CFS where stakeholders are engaged specifically: elaboration of guidelines, negotiations, implementation and assessment.

State but also non-State actors' accountability is central to ensure that CFS outputs are translated into effective impacts and outcomes but it is also politically sensitive as it is the case in other fields like climate change, where negotiators have only recently been able to invent forms of international monitoring of mitigation efforts without being blocked by issues of sovereignty. Innovative accountability mechanisms should then be explored and can be designed to monitor stakeholders' responsibility in achieving the expected outcomes. Various methodologies such as peer review processes (like at the OECD) or case studies should be explored and assessed. Common principles for such an accountability framework like transparency and legitimacy are also key.

FNS Governance from a Mediterranean Perspective

Addressing the governance of FNS in the Mediterranean region is not an easy task: (i) because of a lack of recognition as a region in the UN system (data have to be gathered from Europe, Africa and the Middle East regions) and consequent gaps on statistics and compiled data; (ii) because of the political landscape that makes it difficult to manage multilateral initiatives (cf. The mixed success of the Barcelona process after 20 years and the many conflicts and instabilities throughout the region); (iii) because of underlying factors behind this political landscape (pressure on natural resources, conflicts for land and water access, demographic growth and migrations...) that put at stake food security in the region. The picture is not so pleasing: almost all the Mediterranean countries followed in the CIHEAM observatory have their Global food security index7 decreasing in the latest period, in particular in Southern Europe. However, no common regional initiative has been taken so far to govern FNS, such as in ASEAN or Latin American regions for example. Only isolated initiatives based on national programmes or private funds can be identified, as well as multilateral initiatives such as MED-Amin[8], linked to AMIS, addressing only one piece of the puzzle (information systems on agricultural markets).

Though, attempts of implementation of the CFS decisions can be observed in the region, notably the implementation of the VGGT on land tenure: regional and national awareness raising workshops on the Voluntary Guidelines were organized in Jordan, Morocco, Turkey, Albania, Italy and France, with representatives of governments, civil society, private sector, academia and regional organizations attending. A joint FAO and World Bank initiative tackled land issues in the Western Balkans (Albania, Bosnia and Herzegovina, Kosovo, FYR Macedonia, Montenegro and Serbia) and formed teams of land tenure, social and gender specialists, representing policy-makers, service providers and NGOs from May 2013. It has led to the formulation of reform proposals to make land administration services more accessible to vulnerable groups.

[6] Eg. the New Alliance for Food Security and Nutrition or the Alliance for a Green Revolution in Africa

[7] See Global Food Security Index of the Economist Intelligence Unit (http://foodsecurityindex.eiu.com/) and http://www.ciheam.org/index.php/en/observatory/indicators/60-observatoire/indicateurs/113-securite-alimentaire. See also Smulders Mark and al. (2013) "Food security and nutrition in the Southern and Eastern Rim of the Mediterranean Basin", FAO

[8] See https://med-amin.iamm.fr/ MED-Amin is a Mediterranean information network on agricultural markets. It was officially launched during the CIHEAM 10th ministerial meeting in Algiers on February 2014. It aims at enhancing the cooperation and information sharing between national information systems on agricultural markets of the 13 CIHEAM Mediterranean countries. It is dedicated initially to cereals (wheat, maize, barley, rice), strategic for the food security in the Mediterranean area.

It also streamlined the Voluntary Guidelines principles on gender equality into ongoing Land Administration projects. Reports for these six countries showed that although women and men have equal status in law in relation to property as well as equal access to information, local customs, cultural norms, and traditions prevail over laws in some places and amongst certain groups. In another important sector for region, the fishery, where regional governance can be more binding, a first regional symposium on sustainable small-scale fisheries has been organized by the General Fisheries Commission for the Mediterranean. This symposium, based on the VGGT, supported the implementation of co-managed fisheries and the creation and support, of one or more platforms of small-scale fishers and fishworkers following a participatory approach.

Of course, progress takes some time. Governance at the local scale is still precluded by the lack of capacities and resources of the civil society and smallholders, sometimes by failed transplant of new institutions on more traditional ones, and by lack of transparency, democracy or accountability[9]. But despite the findings of poor governance linked to the absence of civil and political freedom and institutional factors in some countries of the region [10], hopes exist for an enhanced FNS regional and national governance, based on the dynamic of constitution of farmers' organisations and farmers' unions [11], slow institutional changes including decentralisation, more inclusive and participatory policies, and on the growing awareness of the role of smallholders and trade to ensure food security, but also of the fracture between rural and most favoured areas. So demonstrated by the tenth CIHEAM ministerial meeting in 2014, when the Ministers discussed on the "Sustainable food security in the Mediterranean" requesting Mediterranean countries to "*promote – alongside regional strategies – a territorial approach to food security, given the interest of making such strategies operational and adapting them to local realities*" and CIHEAM to develop "*activities to promote food security at all levels (local, national and regional) with the involvement of all actors concerned (international organisations, governments, regional authorities and local players)*".

Research Questions

We have been witnessing a paradigm shift in global governance; from intergovernmental governance led by Member States toward multi-stakeholder arrangements and the FNS governance is not an exception. Analysis and research is therefore needed not only to support the development of the CFS but also to provide useful inputs for other global governance platforms and for governance at infra levels. An important stream of question is related to the evaluation and monitoring framework that has to be supported by a pluralistic approach accounting for the different theories of change of the diversity of stakeholders involved.

Concretely, they are producing transformation but the stakeholders have different objectives on the types of changes expected and the impact of these platforms is therefore at the heart of controversies. Another stream of questions deals with multi-stakeholder accountability frameworks. It is indeed necessary for the research community to analyse how monitoring frameworks could account for the diversity of "theories of change" within a multi-stakeholders platform and organize explicit discussions of long term transformation pathways.

Behind these two blocks lies a series of sub-questions and issues: what conceptual framework(s) should be used for assessing the CFS impacts and influence from global to local scales? To what extent the guidelines and principles agreed within the CFS are considered binding by the CFS stakeholders; and do they want to be held accountable for their implementation? Eventually, there is a remaining question related to the form of a desirable process of global governance: would such a monitoring and accountability framework be enough to ensure that the ideal and demanding governance principles of this very specific multi-stakeholder process are also taken on board by other multi-actors governance mechanisms that affect food security on the ground?

[9] See Elloumi Mohamed (2010). « Développement rural, participation et nouvelle gouvernance », in Développement rural, Environnement et Enjeux territoriaux, Cérès éditions

[10] See Ben Abdennaji Houda, Chkoundali Ridha (2012): « Développement humain et gouvernance : cas du monde arabe », New Medit 2

[11] See Öcal Ash (2014) « L'expérience d'une lutte pour la démocratisation du système alimentaire », in Mobilisations rurales en Méditerranée, l'Harmattan

Activities
in the 4 CIHEAM Institutes

News from CIHEAM Bari

Med Diet Expo 2015
"Does the Mediterranean Diet Still Exist?"

The International event "*Med Diet Expo 2015: Does the Mediterranean Diet Still Exist?; Health/Nutrition-Quality-Sustainability-Innovation-Evolution*" will be held at EXPO Centre, Milan on May 14, 2015. Over the past years, interest in sustainable diets and their assessment has increased. The Mediterranean diet (MD), scientifically well-characterized as a healthy dietary pattern, has begun to be also investigated for its lower environmental impact and its higher economic and socio-cultural value. However, the non-adherence of the current Mediterranean dietary patterns to the MD model is particularly alarming.

In line with the theme of EXPO 20015 Milan "*Feeding the Planet –Energy for life*", the focus of the full day event is to widespread a new perspective of the MD, focused not only on its health benefits but as a model of a sustainable contemporary diet and lifestyle. The aim of the event is to contribute to revitalize the Mediterranean Diet as a model for the development of sustainable diets in order to contribute to reduce the increasing unsustainable changes of diets in the world, particularly in the Mediterranean area. In the morning, will be organized an International Forum to launch "The Med Diet Expo 2015 - Call: Time to Act", by the Secretary-General of CIHEAM. The Italian Minister of Agricultural, Food and Forest Policies will close the Forum. The aim of the CALL is to foster a broader consensus on the need to develop new strategies, solutions and actions to revitalize the MD as a model of sustainable dietary pattern. In the afternoon, through three international conferences, research project results and updates of current activities and collaborations will be presented for discussion. New directions for enhancing the Med Diet sustainability in Mediterranean countries will be also explored.

The event is structured as follows:

- International Forum: *The Med Diet Expo 2015 Call for more Sustainable Food Consumption and Food Systems to Enhance Sustainable Food Security for all in The Mediterranean*.
- International Conference: *Mediterranean Diet: Health/Nutrition-Sustainability - Innovation and Evolution*.
- International Conference: *The Mediterranean Diet as a Case Study Project for Assessing Sustainable Dietary Patterns* (in collaboration with FAO/UNEP Sustainable Food Systems Program).
- International Conference: *Improvement of Food Productivity and Quality through the Enhancement of the Mediterranean Diet*.

The event is included in the Italian National Research Council (CNR) programme of events for Expo 2015. It organized by the Secretary General of CIHEAM, CNR-Disba, Italian Agricultural Research Council (CRA), the National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) and the Forum on Mediterranean Food Cultures (FMFC). Med Diet Expo 2015 is organized in collaboration with IFMeD - International Foundation of Mediterranean Diet, SapiExpo, CIISCAM and Mediterranean Diet Foundation of Ostuni (Italy). Sprim Italy, as a technical advisor and media partner in the initiative, coordinates the implementation during all phases of operation and outreach.

More information on www.meddietexpo2015.com

Gender Empowerment Initiatives

Launch of Ge.Mai.Sa. Project

The project entitled "Enhancing gender mainstreaming for sustainable rural development and food security" is financed by the Italian Ministry of Foreign Affairs and International Cooperation. It draws its origin from the path started by the Italian Cooperation (GDCD) for defining the sustainable development goals post 2015. Main needs addressed inclusion of Gender mainstreaming in policies related to rural development and food security, to promote women's empowerment in the three pilot countries. The action is focused on Mediterranean Countries (Egypt, Lebanon and Tunisia) with the cooperation of specialized institutions and Ministries (Agriculture, fishery etc.). The conceptual Drivers are horizontal/vertical dialogue both at institutional and civil society levels (i) and pilot experience in Tunisia to activate specific partnerships for women empowerment (ii).

Methodology of intervention of the project will be the following

- Collaboration with the Institutions of the 3 Partner Countries (Technical assistance and capacity building of the staff of the institutions involved, strengthening of the capacity for gender analysis).
- Establishment of mixed Interinstitutional Platforms for the valorization of women's role in natural resources and food security management and use of Gender related data, with particular focus on cooperation for development initiatives.
- Creating networks of gender experts.
- Analysis and dissemination/visibility of successful entrepreneurship experiences (Best Practices) carried out by women in the 3 Partner Countries.
- In particular for Tunisia Assess potential strategic partnerships to support women empowerment with related capacity building in the framework of the programme Italy-Tunisia.

Launch and implementation of WEE Project

The project entitled "Developing the handcrafts skills and enhancing the economic status of women in Upper Egypt)" is financed by the Italian Ministry of Foreign Affairs and International Cooperation in the framework of the debt swap programme. The overall objective is to contribute to poverty reduction in the rural areas of the country through the empowerment of women and the specific objective is to improve the social and economic status of women living in the reclaimed lands in different Governorates of Upper Egypt. The aim is also to better the local authorities' knowledge of gender issue and improve their capacity to provide services to rural women at local level.

The interventions aspire to have repercussions on the quality of life of women, children and families particularly with respect to: women awareness, community behaviors in relation to the women dignity and rights, education, health and hygienic conditions of children and other family members, financial revenues and family budget management.

More information : quagliariello@iamb.it

News from CIHEAM Chania

Collaboration with the Municipality of Kantanos-Selino

On Thursday, 5 March 2015, the delivery - on the part of the Municipality of Kandanos, Selino - and the receipt - by CIHEAM-Chania - of the soil analysis equipment was completed. This equipment had remained unused for more than seven years in the space it was intended to serve as the Regional Center for Rural Support in Plemeniana.

This equipment, which was purchased by the authorities of the then municipal authorities of Kandanos during 2007-2011, was awaiting activation for more than seven years for the execution of the soil analysis of crops in the region. Unfortunately the local government bodies were included in the greatest victims of the wider economic crisis in Greece. Simultaneously, given the fluid legal framework for managing municipalities, the decision to abolish the Regional Centres for Rural Development came, thus ingloriously ending any hope for the recovery of the equipment.

The only way now for this equipment to begin operation was its concession/collaboration with a body that has the appropriate expertise, staff and reliability. As a first option, the Soil Laboratory of the Agricultural Cooperative Union in Selino was chosen, with its headquarters in Paleochora, but this relationship did not bear fruit, since this equipment would not offer any substantial improvement in the already technologically modern and well equipped laboratory. The next choice was the proposal made by Mr Arisitidis Stamatakis, responsible for the Laboratory of Soil Analysis and Leaf Diagnostics at CIHEAM-Chania, which constitutes an internationally renowned research and academic center, with extensive experience in laboratory analysis and research related to the primary sector of our country.

The presence of qualified scientific personnel, the compatibility of the equipment with the Institute's existing equipment and the complete specialized services offered to farmers, were the main factors in this choice. Within this fruitful cooperation, CIHEAM-Chania has ensured proper operation, technical support for the equipment and a number of offsets to the residents of the municipality of Kandanos, Selino. Specifically, it has provided, for three years, free soil analysis and advice on appropriate fertilization, according to crop requirements for farmers in the municipality.

Furthermore, utilizing existing data from previous analyses and from the collection of new samples, in collaboration with the Department of Geoinformation in *Environmental* Management at CIHEAM-Chania, coordinated by Dr. Chariton Kalaitzides, a digital soil map of the surrounding area of Plemeniana and the plain of Kountoura will be drawn up. Using the map farmers will now be able to use the data and carry out targeted fertilization, optimizing production and reducing production costs. The completion and publication of digital soil maps will be implemented in about two years.

This initiative is considered as catalytic as it now opens a wider path towards cooperation by the Municipality of Kandanos and CIHEAM-Chania.

Cooperation between CIHEAM-Chania and the Forestry Directorate of Chania concerning the aromatic plants of Crete

A working meeting on the progress of the pilot program for the "Long-term monitoring of wild aromatic and medicinal plants in the prefecture of Chania and the evaluation of their natural populations" was held on Wednesday, March 18, 2015 at the premises of CIHEAM-Chania.

The meeting was attended by the Forestry Services Director, Mrs. P. Sklavaki and officers of the Forestry Directorate of Chania, while on behalf of CIHEAM-Chania, the Director Dr. G. Baourakis and researchers of the Institute also participated.

The program, funded by the Green Fund, was launched a few months ago and aims at both the evaluation and monitoring of the natural populations of four aromatic herbs of interest (oregano, sage, marjoram, ironwort), in order to provide a reliable scientific basis for the adoption of regulatory provisions for collecting herbs from the Forestry Directorate of Chania, as well as surveying the existing situation in terms of foraging/harvesting, cultivation and marketing of herbs, for the purposes of certifying them as a local product.

During the meeting CIHEAM-Chania researchers presented preparatory actions for the program, which relate primarily to the fields of cartographic mapping of natural populations of aromatic plants from already available sources, and the planning of subsequent recording and evaluating operations of the situation.

For the mapping of natural populations and cultivated areas of herbs in Chania the preliminary maps and databases that have been made so far were presented. The data included the cartographic depiction of natural populations and the licensing of the Forestry Directorate of Chania for harvesting and cultivation. A description was made of the monitoring system which will be developed, and basic technical details relating to how the system works, data content and improving the quality and accuracy were discussed, so that the application which will be developed will comprise a useful tool for the Forestry Directorate of Chania.

Regarding other activities of the program, secondary economic and census data of the most commercial herbs have been collected. Moreover, the main processing units in Greece and the classification of herbs as marketable goods according to trade procedures and international trade standards have also been noted. At the same time, efforts have been initiated to investigate the supply chain of aromatic herbs, and the design of a recognition and identification system for the local production, in order to empower and protect, as well as increase, its value, thereby providing additional income to our locality.

On the part of the Forestry Directorate of Chania, the availability of close cooperation to support the work of the program was verified, so that, alongside the sustainable management of herbs by the local community of Chania, the safeguarding of the long-term viability of natural populations of aromatic pants can be guaranteed.

News from CIHEAM Montpellier

ENPARD initiative

By launching ENPARD (European Neighborhood Partnership for Agriculture and Rural Development) in 2011, as a response to a delicate economic, social and political, the European Commission brought support to the EU's Neighborhood countries in their agriculture and rural development. As part of the larger European Neighborhood and Partnership Instrument, this initiative builds on EU best practices and experience gained in the past, particularly, with the Eastern European countries before their accession.

The objectives of the program are three-fold: to help the countries concerned increase their agriculture productivity, by improving the quality of products and the capacity to adapt to climate change; to improve livelihoods in rural areas, to develop institutional capacities and improve adherence to the principles of good governance.

The first phase of ENPARD (2012-2014) was operated by CIHEAM-Montpellier, as regards Southern neighbor countries. It was successfully concluded in December 2014. The initiative was re-funded by the European Commission late last year and will run for a period of two years and half. The new framework will provide for a more coherent and better coordinated action.

The overall aim of ENPARD II is to encourage partnership and transnational cooperation, based on European rules and standards, through a continuous dialogue and exchange of best practices with stakeholders in the Southern neighborhood countries (institutions, professionals, civil society…). In defining the new framework for phase II, the European Commission and CIHEAM-Montpellier have drawn on the experience gained with the first phase of ENPARD. This showed that the most interesting results were achieved when people from different countries faced by similar challenges met, shared their experiences, discussed and expressed themselves on agricultural and rural issues.

In the new design for ENPARD II, opportunities for partner countries to meet, discuss and work together are increased, made more coherent and better coordinated at three levels: national, sub-regional (Maghreb and Mashreq) and regional level (the Mediterranean region). The new format will focus on a range of topics likely to affect and be of interest to more than one country. All the topics will be gathered together under a single umbrella with the general heading "support policies for farmers". Examples of possible topics are: producers' organizations, the management of natural resources, the "territorialization" of the agricultural and rural economy, the development of an advisory system for farmers… …

Each country will define the themes on which it wishes to work with CIHEAM-Montpellier, according to its own needs, objectives, challenges and priorities. This choice of themes will be made during the first national consultation meeting, which will bring together a range of actors engaged, to different extents, in agricultural and rural development (institutional bodies, professionals, members of civil society).

Discussions that will follow at sub-regional level will help to identify common priorities issues and define a sub-regional program to be accomplished together. The goal is to encourage actions that can strengthen policies and measures in favor of farmers, following an integrated, territorial and participatory approach. Negotiations with the European Commission are still ongoing and it should soon be possible to launch the new process in the partner countries, under the assistance of CIHEAM-Montpellier

More information: www.enpard.iamm.fr/en/

Mediterranean Agricultural Markets Information System (MED-Amin)

Launched on January 22nd and 23rd 2014 in Paris, the MED-Amin initiative aims at enhancing cooperation and information sharing between national information systems on agricultural markets in the 13 Mediterranean countries members of CIHEAM. Coordinated by CIHEAM-Montpellier, this network collaborates with the Secretariat of the G20 AMIS initiative based in Rome, with FAO and the European Commission.

MED-Amin aims at developing trust between the members of the network as well as a stronger mutual understanding, through meetings, experience-sharing, and a common work on the monitoring of cereal markets in the Mediterranean area. Through its data collection process, the network targets the improvement of the information on cereal markets (production, utilization, stocks, prices, trade) within the region, while aiming at the preparation of forecast balance sheets.

Following the first MED-Amin meeting in Paris in 2014, a questionnaire was designed with the purpose of establishing a first state of the art on national market monitoring systems, focused on both soft and durum wheat. A second meeting of the network took place in Izmir in November 2014 and Turkey took over the Chair after France.

At the end of 2014 and in early in 2015, MED-Amin Secretariat developed and released, a number of information media (a dedicated website, newsfeed, newsletters, activity report on the first data collection, forum of discussion, resources bases) designed for policy makers and high-level national representatives taking part in the network's activities. Currently, MED-Amin is focusing on facilitating its second data collection of statistics from the member countries - this process addressing 5 commodities: soft and durum wheat, maize, rice and barley – as well as on preparing its 3rd meeting to be held in October 2015 in Italy, in the margins of the Universal Exposition, Expo Milano 2015.

The process of data collection itself is an opportunity to develop information and methodology sharing. The network may also in the future produce and disseminate analyses, in particular on short-term perspectives, as well as advocacy material for an enhanced communication towards media and policy-makers.

More information: www.med-amin.org

News from CIHEAM Zaragoza

Agreement with FAO benefiting students of the CIHEAM Zaragoza Master in Sustainable Fisheries Management

As from the forthcoming edition of the International Master in Sustainable Fisheries Management, commencing October 2015, students may benefit from internships in the FAO Fisheries and Aquaculture Department during the second year of the programme.

The Master is jointly organized by the University of Alicante (UA), the Spanish Ministry of Agriculture, Food and Environment (MAGRAMA), through the General Secretariat of Fisheries (SGP), and the CIHEAM, through the Mediterranean Agronomic Institute of Zaragoza (IAMZ), and it is an official Master of the Spanish university system within the framework of the European Space for Higher Education. These internships have been made possible through an agreement signed recently between FAO and the University of Alicante.

Agricultural Higher Education

The International Conference on "*Agricultural Higher Education in the 21st Century. A global challenge in knowledge transfer to meet world demands for food security and sustainability*" will be held in Zaragoza (Spain) on 15-17 June 2015, organized by the CIHEAM-Zaragoza the Centre for Agricultural Research of the Hungarian Academy of Sciences (MTA-ATK) the Union for the Mediterranean(UfM), the Association for European Life Science Universities (ICA) and the Global Confederation of Higher Education Associations for Agricultural and Life Sciences (GCHERA), with the support of the OECD Co-operative Research Programme on Biological Resource Management for Sustainable Agricultural Systems.

This Conference will convene top-level experts and hold a brainstorming discussion on the current challenges of the Agricultural and Life Sciences higher education systems. Highly trained human capital is key for facing the need to sustainably increase world food production, but, among others, Agricultural and Life Sciences studies have to regain their attractiveness for new generations of students, find a better way to adapt and transfer knowledge to the sector, and complement classical agricultural education with new and emerging techniques. The outcome of the conference will be recommendations for the future development of curricula in the agricultural and life sciences.

More information: www.iamz.ciheam.org/educagri2015

Network Meetings

The XVI GREMPA Meeting on Almonds and Pistachios will be held in Meknès (Morocco) from 12 to 14 May 2015, jointly organised by the National School of Agriculture of Meknès (ENAMeknès, Morocco) and the CIHEAM-Zaragoza, with the collaboration of the Ministry of Agriculture and Fisheries of Morocco.

More information: www.iamz.ciheam.org/grempa2015

The Joint Seminar on the Nutrition and Production Systems Sub-networks of the FAO-CIHEAM Network on Sheep and Goats will be organised in Montpellier (France) on 16-18 June 2015. This Seminar is organised by INRA France and CIHEAM's Institutes of Zaragoza and Montpellier, with the collaboration of the FAO, the International Center for Agricultural Research in the Dry Areas (ICARDA), Agropolis International, the Agrifood Research and Technology Centre of Aragón (CITA), the Spanish National Institute for Agriculture and Food Research and Technology (INIA) and the European Federation of Animal Science (EAAP) through the Mediterranean Working Group.

CIHEAM
International Centre for Advanced Mediterranean Agronomic Studies

Watch Letters published

2007

1. Water Resources and Agriculture
2. Identity and Quality of Mediterranean Products
3. Zoonoses and Emerging Diseases

2008

4. Aquaculture Sector
5. Sociopolitical Impacts of the Rising Food Prices
6. Forest Fires
7. Organic Farming

2009

8. Agro-Business
9. Drought Management and Desertification
10. Agricultural Policies Outlook
11. Agriculture and Fisheries in the Islands

2010

12. Climate Change and Agriculture
13. Food, Nutrition and Health
14. Women in Agriculture
15. Agricultural Trade and Liberalization

2011

16. Olive Growing
17. Financing Agricultural and Rural Development
18. Urban Agriculture
19. Labelling Mediterranean Products

2012

20. Agri-Food Chain and Logistics
21. Enhancing Research
22. Education and Training
23. Cereals Trade and Markets

2013

24. Rural Development
25. Mediterranean Forests
26. Farmer's Trade Union
27. EU CAP Reform and the Mediterranean

2014

28. Land Issues in the Mediterranean
29. Corporate Social Responsibility
30. Food Waste and losses
31. The Mediterranean Sea: Fisheries and Beyond

2015

32. Feeding Expo Milano with Mediterranean Perspectives

Next Issues

2015

33. Invasive species: emerging issues and risks
34. The Agenda post-2015 and Mediterranean Futures
35. Wholesale markets in the Mediterranean Countries

Access to the Watch Letter

All the issues are available on **www.ciheam.org**

- English and French Version from n°01 to n°20
- Arabic Version since n°12
- Bilingual Version (English/French) since n°21

Communication Policy

The Watch Letter is dispatched electronically to more than **20,000 recipients** in the Euro-Mediterranean World (decision makers, ministers, journalists, researchers, students, documentation and research centres, universities, etc.).

Constant efforts are made to ensure a wide variety of contributor profiles in both geographic and professional terms. In the 32 issues published so far, we have published **236 articles** involving **399 authors.**

Contributing to the Watch Letter

We invite persons who have relevant expertise in Agriculture, Food and Rural Development Areas (teachers, researchers, students, decision makers, etc.) and wish to contribute to the Watch Letter to contact us at the following email: abis@ciheam.org

ciheam.org