OPTIONS méditerranéennes

Feeding Knowledge

Edited by:
D. Petruzzella, S. Sancassani

FEEDING KNOWLEDGE

OPTIONS
méditerranéennes

SERIES A: Mediterranean Seminars
2017 - Number 120

CIHEAM

Feeding Knowledge

CIHEAM

Feeding Knowledge

Scientific Editors: D. Petruzzella, S. Sancassani
Compilation: M. Giannelli, F. Concia

OPTIONS
méditerranéennes
Head of Publication: Cosimo Lacirignola

2017 | Series A: Mediterranean Seminars | Number 120

Centre International de Hautes Etudes Agronomiques Méditerranéennes
International Centre for Advanced Mediterranean Agronomic Studies

L'édition technique, la maquette et la mise en page de ce numéro d'Options Méditerranéennes ont été réalisées par l'Atelier d'Édition de l'IAM de Bari (CIHEAM)

Technical editing, layout and formatting of this edition of Options Méditerranéennes was performed by the Editorial Board of MAI Bari (CIHEAM)

Comment citer cette publication / *How to quote this document :*

D. Petruzzella, S. Sancassani. Feeding Knowledge - IAM Bari: CIHEAM (Centre International de Hautes Etudes Agronomiques Méditerranéennes), 2017 – 194 p. (Série A : Mediterranean Seminars, N° 120, Options Méditerranéennes).

Catalogue des numéros d'Options Méditerranéennes sur / *Catalogue of Options Méditerranéennes issues on* :

www.ciheam.org/publications

ISSN : 1016-121X – ISBN : : 2-85352-569-4

Contents

Foreword

In 1996, the World Food Summit formulated an important definition of the concept of food security, describing it as the condition of “access to safe and nutritious food, consistent with the right to adequate food and the fundamental right of everyone to be free from hunger”.

Since then, a great deal of energy and effort has been made on different occasions and in all areas of the world to translate this concept into a real reduction of the disparity in access to food and into promotion of a healthy and sustainable diet.

Twenty years after 1996, food security remains a distant goal, and a challenge that many industrialised countries also find they are forced - perhaps unexpectedly - to tackle.

In this context, the campaign to reduce food waste is often talked about as one of the possible solutions, but the issue of waste of resources is not only about material products; the campaign for food security is actually impeded by another form of waste, which threatens to do even worse damage: waste of knowledge.

To use economic terminology, waste of knowledge can be defined as the failure of the “demand”, i.e. the needs of the various territories, to meet with the “offer”, i.e. the vast range of knowledge belonging to the field of research.

Knowledge is wasted when it is not shared, when the outcomes of scientific research are not available to all and are not translated into solutions for real problems. Waste of knowledge, is also a waste of precious time, of human and financial resource. If something is working somewhere else, why are we still reinventing the wheel?

One solution for waste is to establish direct connections between the actors: a short knowledge system is one where the appropriate tools enable understanding, dialogue and exchange,where researchers forge a direct link with a diversity of stakeholders (citizens, businesses, associations, institutions) and “create” with them the necessary knowledge.

This is why 2012 saw the launch of the “Feeding Knowledge” Programme, Expo Milano 2015’s strategic initiative that has been jointly developed and operated by CIHEAM Bari and the Politecnico of Milan – METID.

This volume presents the outcomes and activities of Feeding Knowledge, whose aim was to establish the idea that sharing and joint creation of knowledge are effective and sustainable tools for putting an end to the problem of food insecurity in an extraordinarily rich and diverse geographical area like the “Mediterranean laboratory”,

Our objective was certainly ambitious. “Feeding Knowledge” has helped to create the permanent legacy of Expo Milano 2015, and we hope that it can constitute a “good practice” for applying the principles mentioned here, and that it can show the importance of knowledge enhancement for improving the quality of life in the present and in the future.

Cosimo Lacirignola
Secretary General of CIHEAM

Graziano Dragoni
Direttore generale Politecnico di Milano

Presentation

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 in 2012 to launch an ambitious international Programme for supporting cooperation on research and innovation in the field of food security: “**Feeding Knowledge**”. Developed, co-funded and implemented jointly by CIHEAM-IAMB and Politecnico di Milano, this initiative run until the end of the Universal Exhibition (October 2015) and contributed to building up Expo Milano 2015 legacy. Feeding Knowledge is the result of a long term reflection on one of the major challenges for sustainable development: guaranteeing safe, accessible, nutritious and sufficient food to everyone on the planet (according to the definition of food security given by the World Food Summit in 1996). In this context, Feeding Knowledge represents a good practice on the creation of a sound knowledge system for food security in the Mediterranean region: a unique laboratory to test the effectiveness of innovative solutions for sustainable development. This book collects several papers developed within the Programme, giving an overview on “Feeding Knowledge” philosophy, methodology, activities, achievements and future perspectives. The aim of this publication is to give value and to acknowledge the work of more than 50 people who contributed to the success of “Feeding Knowledge” Programme and to share with a larger public the main message and results of the Programme on the importance of fighting knowledge waste to ensure food security.

Damiano Petruzzella
CIHEAM Bari

Susanna Sancassani
POLIMI

Part One

Rooting Knowledge for feeding the planet

Abstract. Feeding Knowledge is a strategic initiative of Expo Milano 2015, the Universal Exhibition hosted by Italy from May through October 2015, whose claim was "Feeding the Planet. Energy for Life". The Programme has been developed, co-funded and implemented between 2012 and 2015 by CIHEAM (Centre International de Hautes Etudes Agronomiques Mediterranéennes – Bari Institute) and Politecnico of Milano - METID (Metodi e Tecnologie Innovative per la Didattica). The Programme, which contributed to building up Expo Milano legacy, dealt with the importance of cooperation on research and innovation for food security in the Mediterranean. "Feeding Knowledge" constitutes an interesting model for testing innovative knowledge sharing and co-creation methods through the involvement of all the stakeholders of the food security "innovation chain", from farmers to extension services, to academia and decision makers. Thanks to the support of the on-line ecosystem www.feedingknowledge.net, the Programme has developed a mechanism for sharing needs, problems, knowledge and best practices aimed at enabling research to provide concrete solutions to local problems. This paper presents "Feeding Knowledge" concept, philosophy and main results, which largely contributed to the creation of an effective knowledge system in the Mediterranean.

Keywords. Knowledge sharing – Food security – Research and innovation – Expo Milano 2015.

Enraciner la connaissance pour nourrir la planète

Résumé. *Feeding Knowledge est une initiative stratégique lancée par Expo Milano 2015, l'exposition universelle qui s'est tenue à Milan, de mai à octobre 2015, autour du thème " Nourrir la Planète. Energie pour la Vie ". Le programme, mis au point, cofinancé et réalisé entre 2012 et 2015 par le CIHEAM (Centre International de Hautes Etudes Agronomiques Méditerranéennes – Institut de Bari) et le Politecnico di Milano - METID (Metodi e Tecnologie Innovative per la Didattica), a contribué à jeter les bases de l'héritage permanent de l'exposition.*

L'objectif était de démontrer l'importance de la coopération pour la recherche et l'innovation en matière de sécurité alimentaire dans la région méditerranéenne. Feeding Knowledge représente donc un modèle intéressant pour tester les méthodes de partage et co-création de la connaissance innovante et ce, à travers la participation de tous les acteurs de la "chaîne de l'innovation" de la sécurité alimentaire, depuis les exploitants aux services de vulgarisation, en passant par le milieu académique et les décideurs. Grâce au soutien de l'écosystème en ligne www.feedingknowledge.net, le programme a développé un mécanisme de partage des besoins, des problèmes, de la connaissance et des meilleures pratiques pour permettre à la recherche d'identifier des solutions concrètes aux problèmes locaux. Dans cet article, nous allons parcourir le concept, la philosophie et les résultats les plus importants de Feeding Knowledge qui ont largement contribué à la création d'un système de connaissances efficace au niveau de la région méditerranéenne.

Mots-clés. *Partage de la connaissance – Sécurité alimentaire – Recherche et innovation – Expo Milano 2015.*

Rooting Knowledge for feeding the planet

Damiano Petruzzella[1], Susanna Sancassani[2],
Francesca Concia[2], Marinella Giannelli[1]

[1] CIHEAM Bari, Italy
[2] Polimi

I – Feeding Knowledge Programme

Feeding Knowledge is the strategic programme on food security promoted by Expo Milano 2015 which is part of the legacy of the Universal Exposition. This initiative, launched in 2012, is attuned to Expo's theme "*Feeding the Planet. Energy for Life*" which is a claim for sustainable development to the whole world.

WHY FOOD SECURITY

Choosing food security as the main theme of the "Feeding Knowledge" Programme is motivated by several reasons many of which are linked to the efforts made by the international community to fight hunger. Despite the commitments of the last decade, these efforts have not allowed to guarantee food security, which is one of the main priorities for the international cooperation notably in the light of the projected increase in the world population.

According to the latest FAO estimates, some 795 million people are undernourished in the world that is one in nine people on earth. The majority of these people live in developing countries where 12.9% of the population is undernourished. These facts are not encouraging especially if account is given to the goal set on the occasion of the World Food Summit in 1996 (400 million undernourished people in 2015).

Moreover, the Final Declaration of the World Food Summit on Food Security in 2009 pledged the importance and the central role of food security within international cooperation. The Declaration identified some goals and principles for food security, some of them in tune with the "Feeding Knowledge" Programme:

- *Investments in development plans elaborated by developing countries.*
- *Role of research and access to knowledge at national, regional and international level to guarantee food security for all.*
- *Produce statistics, studies and forecasts on food security whose results serve as robust bases for national agricultural policies and food strategies.*
- *Assign a strong role to the multilateral system that shall operate through greater efficiency, promptness, coordination and efficacy of global institutions.*
- *Ensure a substantial commitment by the States in order to increase investments in agriculture, food security and nutrition, allocating resources for multiannual plans.*

Feeding Knowledge Programme was worked out, co-funded and run by **CIHEAM Bari** (Centre International de Hautes Etudes Agronomiques Méditerranéennes – Mediterranean Agronomic Institute of Bari) and by Politecnico di Milano - **METID** (Metodi e Tecnologie Innovative per la Didattica). Its task is to disseminate data and information that may help combat hunger in the world, to share the best practices which have had a positive impact on food security, to create networks and promote collaboration at international level across the main players of the knowledge chain (policy makers, scientists, businesses, civil society, etc.). The main aim is to share and develop knowledge based on the needs of territories avoiding the "waste of knowledge", to communicate using innovative methodologies and technologies, to build the capacity of human resources and reduce food insecurity in the world.

The philosophy of Feeding Knowledge is based on the setting up of a virtuous knowledge chain that takes into account the needs of areas and communities, identifies effective research solutions and provides innovative methods to be transferred to the final beneficiaries.

The activities of Feeding Knowledge cover **five research thematic priorities**:

- Sustainable management of natural resources
- Qualitative and quantitative enhancement of crop products
- Socio-economic dynamics and global markets
- Sustainable development of small rural communities in marginal areas
- Food consumption patterns: diet, environment, society, economy and health.

The **target area** of the Programme includes **10 Mediterranean Countries**: Italy, Albania, Algeria, Palestinian Authority, Jordan, Lebanon, Macedonia, Morocco, Tunisia, and Turkey.

Countries involved in the Feeding Knowledge Programme

The choice of this geographical area is not only linked to "food priority" but also to political and scientific considerations since the Mediterranean area hosts about 37 million undernourished people:

a) The priority interest of the EU policies in the area and the relevant investment programmes;

b) The high socio-economic vulnerability of the area, as shown by the sudden rise in the price of food commodities between 2007 and 2010;

c) Availability of a qualified research system and awareness of competent political institutions;

d) A consolidated network of institutional relations and the strong will of countries towards international collaboration and cooperation with the EU supported by the European Neighbourhood Policy;

e) A community of high-level young researchers who may participate in international research networks and mobility programmes.

During its three years of activities, the project has pursued the following results:

- Setting up of the **Feeding Knowledge Network** with more than **3000** members among researchers, experts, research organizations and bodies, which share the results of their own research and experience with special attention to innovation and transfer of technologies.
- Setting up of an **International Technological Platform** (www.feedingknowledge.net) in support of all the activities of the Programme and Network with an open and collaborative database of about **1000** research works and with more than **900** sources on food security.
- Scientific coordination and scheduling of **two cycles of on-line seminars** delivered by international experts to the benefit of the Network members.
- Participatory elaboration of **5 White Papers** which provide the state of the art of research and innovation in the field of food security in the Mediterranean area and recommendations on future research avenues.
- Identification of 10 national **"Local Points"** at the Ministries of Agriculture of the countries involved; their role is to back up the Programme activities at local level, to collect the needs of the local operators and identify methods and strategies for the transfer of knowledge, in collaboration with Agricultural Extension Services.
- Organization of **training and knowledge-sharing** activities to train facilitators at the service of Local Points and to strengthen Extension Services in Agriculture through innovative methods and tools.
- Support to Expo Milano 2015 International Call on **Best Sustainable Development Practices for Food Security** and collection of **786 applications**, available in the "Best Practices" section of the Platform.
- Drawing up of a **Policy Paper** on the creation of a knowledge system for food security in the Mediterranean area, through a participatory path of more than two years with the involvement of experts and representatives of more than 30 institutions working in the field of cooperation, research and food security.

II – Methodology and philosophy of the Programme

The success of Feeding Knowledge results from a methodological model developed by CIHEAM and Politecnico–METID, elaborated and optimized based on the feedback from all the users.

The methodological model is grounded onto three pillars, which have allowed to achieve the objectives of Feeding Knowledge: the "**principles"** which inspired all actions; the "**channels"**,

that is the pathways along which the project itself was carried out; the "**activities"** carried out in the four years of the Programme.

The principles upon which Feeding Knowledge activities are based describe its "philosophy":

1. LOCAL NEEDS DRIVEN

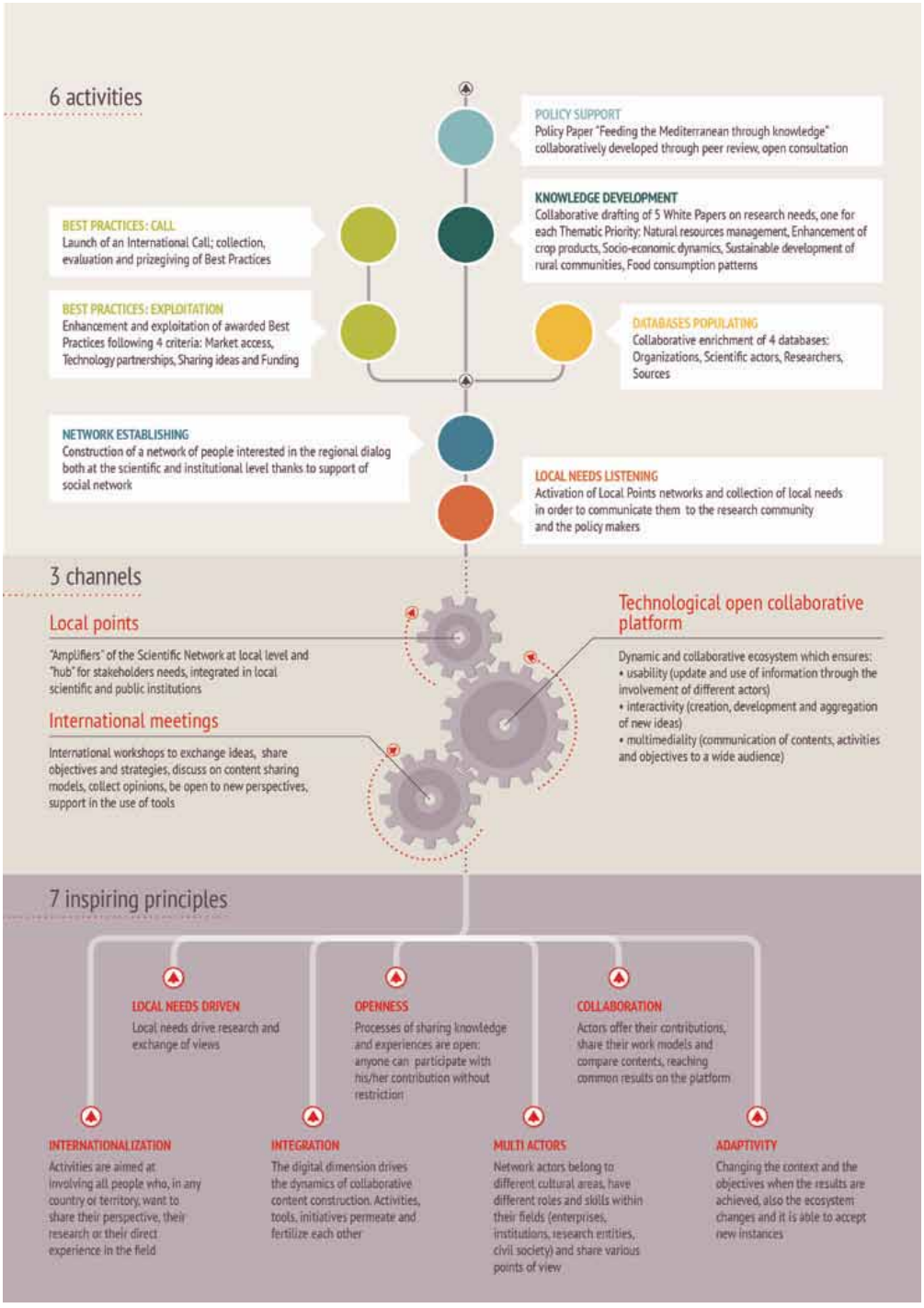
The needs of specific geographical areas were the starting point for further thinking and planning: they are the engine of scientific research that must provide answers to needs, and of the interaction among the network's stakeholders who look for applicable solutions. Problems may be solved by investigating their root causes: an in-depth survey of the farmers 'need scan not result from superficial interactions but rather from the identification of the ample range of needs of agricultural areas.

2. OPENNESS

There are no limits to participation: anyone can register in the feedingknowledge.net platform, participate in the periodical *open consultation*, and share the experience through communication tools. Databases are open along with the sharing of knowledge and experience: anyone is free to participate and contribute without any access restriction to all that is published by others and discussed in the forums. The technical board controls only the thematic relevance of the users inputs before they are made available. *Openness* guarantees the sustainability of *knowledge sharing* processes and of represented approaches so that the knowledge made available by Feeding knowledge might ignite the development of new knowledge.

3. COLLABORATION

Key results have been achieved thanks to the collaboration of participants through the three channels offered by the project (Technological Ecosystem, Local Points, and Meeting). Collaboration has been one of the most crucial levers to motivate and involve network's members; they have been more aware of their role and contribution and more active towards mediation and thinking. The users of the system offer their contribution in terms of scientific publications, report critical situations, share their direct experience and discuss working arrangements, compare contents and achieve results all together.



Feeding Knowledge model

4. INTERNATIONALIZATION

In the organization of all the processes and activities, special attention is paid to the involvement of representatives from the target countries and to the international context; this allows to guarantee a constant exchange and the development of networks that may recognize and enhance the capacities in each context.

5. INTEGRATION

The three channels of participation offered by the programme (Technological Ecosystem, Local Points, and Meetings) have not been developed separately but constantly integrated and enhanced. The technological ecosystem is the core of activities of collection, creation and dissemination of knowledge; it has been propelled by the dynamics of knowledge creation activated by the Local Points and developed on the occasion of international meetings promoted by the programme.

6. MULTI ACTORS

The stakeholders involved in the Programme's activities belong to different cultural areas, have different roles in their relevant company, institution, research body or society and provide for different skills and viewpoints.

The Policy Paper is the result of recommendations suggested by international organizations and by Europe; they have been compared with those provided by the international scientific community, the text has been submitted for review to the whole Feeding Knowledge network through an *open consultation*. Several stakeholders, of different origin, culture, language and skills have contributed to the creation of the Policy Paper.

7. ADAPTIVITY

The ecosystem is modified in order to respond to the changing needs of the socio-political scenario. It thus enables to respond to the new requirements, optimize crucial processes and support the achievement of new goals.

Interaction channels, through which activities have been carried out, are both virtual and physical. The technological ecosystems, the network of the ten Local Points and the international meetings have constantly been integrated. The three channels have backed up and made the actions of the Programme possible through their successful integration.

The open and collaborative technological ecosystem (made up of the dedicated platform and of its social media) is the technological component of the programme that has climbed up over time thanks to the development of its numerous sections; it has prompted the participation of users belonging to different areas, institutions and cultures.

Map of Local Points

The Mediterranean institutional network made up of ten national Local Points, integrated into the local institutions such as Ministries of Agriculture, National Research Councils, universities, has provided support to the Programme's activities at local level, listened to the needs of local operators and identified methods and strategies for the transfer of knowledge in collaboration with Extension Services.

International Workshops and conferences, with the participation of international experts, representatives of Mediterranean countries, have provided opportunities of effective debate, design and planning, sharing of ideas and collaboration.

The Programme's activities have been carried out through the three channels on the basis of the principles of Feeding Knowledge. They may be ascribed to six main types:

1. *Listening to the local needs:*
   The starting point for each activity, based on the ability to listen to and understand problems, going beyond the mere transfer of solutions and top-down approaches. Stakeholders' needs have been collected by means of *an online survey* on the platform co-designed by the representatives of the Local Points.

2. *Creation of the Network:*
   Setting up of a network of people sharing the same interest in the regional dialogue on research, innovation at scientific and institutional level, who have contributed to the identification of common and specific issues and shared their knowledge through the platform.

3. *Population of Databases:*
   With the publication of research by their authors and the reporting of authoritative sources and organizations working in the field of food security. The 5 databases are loaded on the Feeding Knowledge platform by the users: each user may load his/her scientific research or refer to it if the *pdf* file may not be loaded for copyright reasons; his/her profile and that of his/her organization; report the most authoritative sources and participate in the International Call for Best Practices with his/her projects.

4. *Knowledge development:*
   Through a deeper learning about the 5 thematic priorities and writing of the 5 White Papers. Knowledge development has been based on a collaborative bottom-up approach through the identification of the real needs of target countries strengthened by the study of the requirements of the research and political system.

5. *Collection and dissemination of the Best Practices:*
   Of significant sustainable development initiatives carried out in the last 10 years. The steps of this two-year activity are reported here below:

   a) Writing of the Call

   b) Creation of the form

   c) Launch of the Call

   d) Support to users and collection of applications

   e) End of the call and evaluation of applications in three steps

   f) Enhancement of the winning Best Practices

6. *Support to the Policy*
   Through the writing of a paper reporting the recommendations of experts addressed to decision makers. The Policy Paper writing started in February 2014 when the representatives of Local Points, ministries, international institutions and organizations of Mediterranean countries met to discuss and share ideas about a preliminary draft based on the recommendations provided in the 5 White Papers by the scientific network of the programme and on the results of an online survey on the food security needs made involving 200 *stakeholders* across the Mediterranean region.

III – Knowledge: co-creation and transfer

Starting from the philosophy and the model described above, which are at the basis of the Programme activities, Feeding Knowledge has tested the setting up of a chain based on the co-creation and transfer of knowledge.

To this end, an experts' Network was set up; its tasks are as follows:

- Identification of research priorities on food security and on key topics for which cooperation among researchers and knowledge sharing may contribute to reducing food insecurity in the world.
- Identification of the main institutional and scientific players at national, regional (Mediterranean) and international level who respond to the priorities on food security.
- Creation and development of an international network of experts, and availability of the necessary tools for remote collaboration and sharing of ideas, opinions and knowledge.
- Definition of technological and functional characteristics of the Technological Platform www.feedingknowledge.net: a*hub*of meetings, collaboration, sharing and knowledge.
- Transfer of knowledge to the National Advisory Services and *stakeholders'* associations, in order to promote direct development and bring together the "*demand*" and "*supply*" of knowledge.

The five **White Papers** produced by the Network provide an overall view of the state of the art of specific issues. They also suggest interesting prospects for the development of research and identify innovative solutions to reduce food insecurity. The key messages of the papers are reported hereinafter:

Priority 1: Sustainable management of natural resources

- ✓ Improvement of land and water use efficiency in agriculture
- ✓ Development of new crops that may adapt to climate change and protect bio-diversity

Priority 2: Qualitative and quantitative enhancement of crop production

- ✓ Attention paid to the efficiency of Integrated Pest Management and organic farming systems following an eco-functional approach
- ✓ Pre- and post-harvest control of mycotoxin contamination

Priority 3: Socio-economic dynamics and global markets

- ✓ Enhancement of the availability of quantitative and qualitative information as precondition for appropriate analysis policy
- ✓ Strengthen the capacity to analyse the impact of alternative policies at national level

Priority 4: Sustainable development of small rural communities in marginal areas

- ✓ Research on the value chain and on the development of the "non-farm" sector with added value for the rural communities
- ✓ Research on systems and technologies of small land owners. Research is designed to provide guidance on the basis of the specific characteristics of small land owners, of their needs and opportunities through a long-term agro-ecological approach

Priority 5: Food consumption patterns: diet, environment, society, economy and health

- ✓ Assessment of the sustainability of the current food patterns and diets from the environmental, economic, social, cultural and health point of view
- ✓ Discuss and tackle the causes, extent and economic and environmental impact of food waste in the Mediterranean region

After the elaboration of contents and the collaborative creation of knowledge, the Programme has focused its attention on the transfer of knowledge through National Extension Services, which play a pivotal role in the Euro-Mediterranean area by applying the solutions identified by research works.

The main activity allowed launching a dialogue among the extension services to focus on the working methods, problems and needs of operators. The extension officers of ten countries in the target area of the programme took part in a **workshop** in which **they** identified innovative models, methods and instruments of technological transfer. The Orientation Paper came up with some noteworthy recommendations such as the importance of promoting international cooperation initiatives in support of national extension services, the need to develop national extension strategies on food security, the potential offered by ICT to make the work of extension officers more efficient and to involve the youth in agriculture more actively.

The ten **Local Points** have played an outstanding role in the Network development and support to the National Extension Services. The **Local Points** are constituted by the local offices at the

Ministries of Agriculture of the countries involved in the Programme; two officers run them; they are the “brokers” of knowledge whose task is to involve all the players at national level namely farmers, civil society, scientific world and academia, national and local institutions. Local Points coordinate all the activities of public consultation with the local stakeholders on the local needs, which are then shared with the members of the scientific network so as to identify relevant research and innovation solutions.

Thanks to these activities, the Programme has initiated a **knowledge chain** on food security in the Euro-Mediterranean area dealing with the identification of local needs, dialogue among researchers, identification of solutions and tools for their application.

IV – Technological Ecosystem

The technological dimension of Feeding Knowledge is represented by the environments which have contributed to the creation of an “ecosystem” made up of the platform and of the integrated tools. It links the key processes going from the identification of needs to their transformation into themes that might stimulate the world of research and institutions; from solutions to their enhancement; from knowledge sharing to the creation of new knowledge. This also explains the integration of the main social networks into the platform (Facebook, Twitter, and YouTube) that have amplified the project message and extended the primary target.

The platform, with new sections and instruments, has been the virtual place of exchange and comparison, a group work area and the tool to disseminate results.

Sections of the Platform.

The platform is subdivided into **six sections**, which are the six cornerstones of the programme:

– E-Collaboration is the area of exchange and elaboration of contents through iterative processes between participants having different cultural backgrounds and objectives. E-Collaboration strategies have enabled to reach individuals independently of their geographical location: they have been crucial in the setting up of the network and in the publication of the five White Papers and of the Policy Paper.

e-Collaboration.

– DATABASES are the archive of the shared knowledge. They include scientific paper, sources, food security organization and scientific players: they are online, open and collaborative.

Database.

– The Best Practices section is designed to promote the International Call, the collection of applications through the online form, their assessment and enhancement in terms of market exploitation. Initiatives, brochures and information are available in this section.

Best Practices.

– Events section brings together the events promoted by the Programme, national and international organizations and partners in order to encourage exchange and meetings.

Events .

– Local Points refer to the activities of local development in the Programme. For these activities, e-Collaboration tools have been used at various levels: from the old forum to the latest tools to design and manage questionnaires online, to surveys within the social networks.

Local Points.

The integration of **Social Networks** (in particular Facebook, Twitter and You Tube) has boosted the communication potential, enabling to carry essential contents and the most important concepts with an informal language and to set up new links between stakeholders and the project.

The communication strategy is based on weekly editorial plans, which have kept the interest of users high: 60% of contents regard the programme (live events, news, video, and info graphs, contents from the Policy Paper or the White Papers, Best Practices). Other publications report news and events on food security promoted by other organizations. Although these themes are highly specialized and target experts, many users have been involved:1000 followers on Twitter, 2000 fans on Facebook. Twitter followers are mainly institutions.

The analysis of data on the use of the portal by the users provided interesting results. The number of users active on the platform increased with the activity of collaborative writing of the five White Papers (March 2013) and with the organization of the webinars on the priorities of research for food security (January – July 2013). The year 2014 was characterized by the promotion of the call for the Best Practices and collection of applications: the highest numbers of users were achieved during the closing of the call (October 2014) and of the publication of results. June and July 2015

were characterized by events on the Best Practices; during the last phase, users were involved in the activities of Market Exploitation and in the open consultation on the Policy Paper.

The platform has been consulted everywhere in the world. As regards the number of accesses, the first 25 countries after Italy are:

- United States
- France
- Tunisia
- Morocco
- Turkey
- Algeria
- United Kingdom
- Germany
- India
- Belgium
- Lebanon
- Russia
- Jordan
- Spain
- Egypt
- Mexico
- Brazil
- Switzerland
- Palestine
- Albania
- Portugal
- The Netherlands
- Japan
- Canada

V – Best practices

In the framework of the Programme, a very important activity was developed for the Universal Exposition of Milan: the launch, collection, evaluation and enhancement of the "*Best Sustainable Development Practices on Food Security*" in the **International Call of Expo Milano 2015**.

The Call was launched in November 2013 until October 2014. It was designed to identify projects, policies, technologies, processes, products and know-how on food security which could provide improvements in this field following the five thematic areas of the programme: sustainable management of natural resources; qualitative and quantitative enhancement of crop production; socio-economic dynamics and global markets; sustainable development of the small rural communities in the marginal areas; food consumption patterns: diet, environment, society, economy and health.

The response to the call was surprising: 786 applications concerning initiatives carried out all over the world were submitted through an innovative on-line form available in the Platform. The initiative was narrated including texts, photos, videos and links. The form becomes a story of ideas, people and experiences in 10 steps: the story is a simple and effective tool to share experiences, concepts and ethical values and to fill cultural gaps.

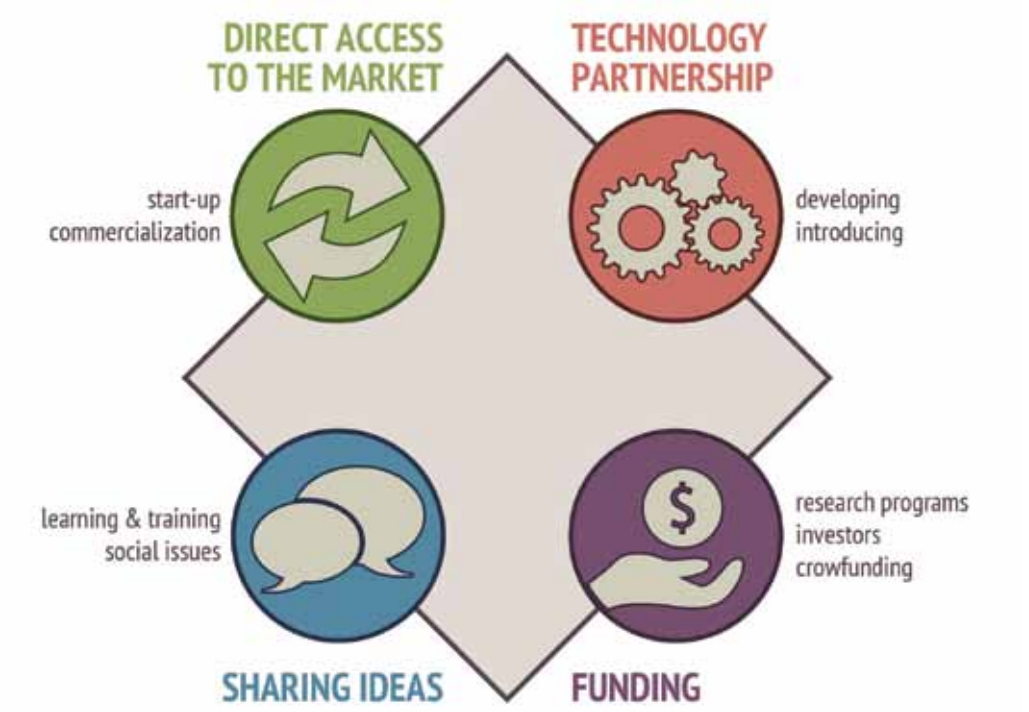
The online form was designed to include the general data of the candidate project (title, abstract, area of execution, budget, and partnership) in the first part and the project description in the second part with special reference to items such as sustainability, environmental and social impact, human resources and their interaction with the beneficiaries of the project.

Out of all the applications, 749 were eligible for evaluation. They were divided in the five thematic areas as follows: 203 (27%) for the first priority, 164 (22%) for the second, 47 (6%) for the third, 172 (23%) for the fourth, 164 (22%) for the fifth.

During the phase of evaluation, carried out by an *International Selection Committee* chaired by H.S.H. Prince Albert II of Monaco, nine criteria were taken into account to select initiatives of higher impact and with a high potential of sustainability: innovation, social impact, environmental impact, concreteness, transferability and replicability, openness, attractiveness.

Eighteen initiatives were selected. The prize awarded by Expo Milano 2015 and the Feeding Knowledge Programme was not money but visibility and support to future development. As regards visibility, dedicated events were organized for the winning initiatives during the period of the exposition: the prize-awarding ceremony in the *Padiglione Italia* on 6 July 2015, with the participation of Italian and foreign representatives of institutions; thematic workshops organized inside the site of the exposition and two exhibitions of photo and video stories – one at Pavilion 0 for the whole duration of the universal exhibition and one at the Urban Centre in Galleria Emanuele II of Milan in the month of June.

As to the enhancement of the 18 winning Best Practices, Feeding Knowledge developed "**Market Exploitation Support**", activities designed to identify possibilities of improvement, stabilization, evolution of the initiatives in accordance with four "pillars": access to the market, models of technological transfer, fund raising, sharing if ideas.



The four pillars of the Market Exploitation Support model.

The first pillar, "**access to market**", includes actions that guarantee an income to small landowners. This is achieved through the marketing of the local products via an integrated international supply chain, which ensures the compliance with given standards. The marketing is channelled through an association that organizes production or guarantees an equitable income.

The **transfer of technologies** can occur following a vertical model when companies offer technological tools to farmers or through a cross integration within a partnership.

Funding may be obtained through several strategies and instruments: ethical credit institutions, non-traditional lenders (i.e. a supplier), crowd funding.

Sharing of ideas is the last pillar of the model. It implies the transfer of knowledge, setting up of networks with the institutions, promotion of sustainable tourism.

The activities in the programme pertaining to the Best Practices went beyond. Since the applications submitted represent a valuable resource of knowledge and experience and may contribute to the fight against food insecurity, a dedicated section was developed on the Feeding Knowledge platform. Furthermore, a digital catalogue was also produced; it contains the candidate Best Practices (749) and the data sheets for each initiative alongside the analysis of the context of origin and of the innovative solutions developed and applied in the field.

The Programme's team carried out a "***cluster analysis***" identifying seven sectors in which the 749 initiatives have been subdivided according to the characteristics of the context, the activities carried out or the processes and products developed and the achievements:

1. Networking, Cooperation & Institutional aspects
2. Natural resources management
3. Economy & Market
4. Sustainable Development
5. Food Chain
6. Research, Development, Knowledge & Awareness
7. Climate & Environment

The cluster "Research, Development, Knowledge & Awareness", including not only research and development but also training activities, development and sharing of knowledge, is one of the most recurrent in the analysis (24%), followed by "Sustainable Development" (19%), "Food Chain" (18%), "Natural resources management" (16%), "Networking, Cooperation and Institutional Aspects" (11%), "Economy and Market" (7%), and "Climate and Environment" (5%).

The result of this analysis shows how the activities, technologies and know-how linked with knowledge and research are the key to solving problems of food security, in line with the philosophy of Feeding Knowledge.

The Best Practices carried out in the Euro-Mediterranean region were also analysed. Thanks to the effort made by the experts in the scientific network and the contribution of the Local Points in disseminating the Call and supporting the applicants, the Best Practices in the Mediterranean countries were 478 (61%). An excellent result made possible also by the active involvement of the Italian **Ministry of Foreign Affairs** and **International Cooperation** (MAECI) and of the Italian **Ministry of Agriculture, Food and Forestry Policies** (MiPAAF).

Also for the Best Practices coming from the Mediterranean region, a "*cluster analysis*" was conducted using the same thematic clusters. Once again, the cluster "Research, Development, Knowledge & Awareness" is the most recurrent (26%), followed by "Food Chain" (19%), "Natural resources management" (18%), "Sustainable Development" (15%), "Networking, Cooperation and Institutional Aspects" (10%), "Economy and Market" (7%) and "Climate and Environment" (5%). It shall be underlined that from the qualitative analysis of the Mediterranean Best Practices, the solutions pertaining to the cluster "Research, Development, Knowledge & Awareness" had

been applied even when the main problem of the context of origin regarded another of the seven clusters identified.

These elements show that a virtuous system of knowledge in the Mediterranean might provide appropriate solutions to reduce food insecurity.

VI – Future prospects

Feeding Knowledge ended in October 2015. On the background of its achievements in five years of activity, the Programme has become part of Expo Milano 2015 legacy and has contributed to the Milan Charter, a global commitment on the right to food which is the intangible heritage of the universal exposition. Feeding Knowledge was not only a programme; it is the start of a process, the bench test of a true "knowledge ecosystem" in a laboratory – the Mediterranean – which enshrines many of the peculiarities of other regions of the world. For this reason, the promoting and implementing agencies of the programme intend to carry on the work so far carried out in order to apply the main strategic approach of Feeding Knowledge: sharing and co-creation of knowledge to meet real needs with special reference to food security. The idea is to create an open and collaborative technological Ecosystem, an environment for the sharing of knowledge based on networking and access to useful information to satisfy the needs of the innovation chain stakeholders for a sustainable agriculture and rural development. Through an interactive approach, the Ecosystem can help create virtuous channels of communication and exchange of needs, knowledge and solutions among players: institutions, civil society, researchers, operators, private sector. They would contribute to innovation for food security in a pro-active, collaborative and sustainable manner.

VII –Human resources

Feeding Knowledge results from a five-year collaboration between **CIHEAM** (Centre International de Hautes Etudes Agronomiques Méditerranéenes – Bari Institute) and **Politecnico di Milano** - **METID** (Metodi e Tecnologie Innovative per la Didattica) with **Expo S.p.A.** interested in the project for its innovative approach.

Expo S.p.A. is the company entrusted by *Bureau International des Exposition* to organize and manage the international exposition in Milan on "*Feeding the Planet. Energy for Life*".

CIHEAM (Centre International de Hautes Etudes Agronomiques Méditerranéenes) is an **intergovernment al organization** founded in 1962 and including 13 Euro-Mediterranean countries. It is a centre for **post-graduate training, applied scientific research and design/ implementation of international cooperation projects**. The Mediterranean Agronomic Institute of Bari **(CIHEAM Bari**) works in four thematic areas: "Land and water resources management", "Integrated protection of Mediterranean fruit and vegetable crops", "Mediterranean organic agriculture" and "Sustainable agriculture, food and rural development". CIHEAM Bari capitalizes on the synergy between training/education, applied scientific research and cooperation **to provide tangible solutions to current issues such as food security and quality of agriculture**. Thanks to constant attention paid to the dialogue among institutions in the Mediterranean basin, CIHEAM Bari is involved in numerous activities ranging from international, European and national strategic programmes to local initiatives. Actions are carried out in the respect of natural resources and biodiversity for the promotion of sustainable agriculture and to meet the challenges of globalization. Its **national and international networks** make CIHEAM a platform for institutions and organizations which wish to cooperate in the Mediterranean basin and in other regions of the world.

As to the “Feeding Knowledge” Programme, CIHEAM has dealt with the technical scientific aspects linked to the design of the platform, the drawing up of the five White Papers and of the Policy Paper, a support to the National Extension Services, a survey on the needs linked to food security, the call for the Best Sustainable Development Practices of Expo Milano 2015, promotion of the successful Best Practices. Furthermore, thanks to the institutional networks to which it belongs, CIHEAM could facilitate the creation of 10 Local Points of the Programme and identify and train local facilitators.

Fifteen members of CIHEAM staff were involved in the implementation of “Feeding Knowledge” Programme: project managers, scientific experts and researchers, communication manager, project secretary.

Politecnico di Milano is one of the top universities in Europe in the field of science and technology. It trains engineers, architects and industrial designers. The University has always focused on the quality and innovation of its teaching and research, developing a fruitful relationship with business and productive world by means of experimental research and technological transfer. Research has always been linked to education and is a priority commitment which has allowed Politecnico di Milano to achieve high quality results at international level as to join the university to the business world. Politecnico takes part in several research and training projects collaborating with the most qualified European universities. Politecnico’s contribution is increasingly being extended to other countries: from North America to Southeast Asia to Eastern Europe. Today the drive to internationalization sees Politecnico di Milano take part in the European and world network of leading technical universities and offers several exchange and double-degree programmes beside many programmes which are entirely taught in English.

METIDis the Politecnico’s body which deals with**e-Collaboration, e-Learning, Social Media for research;** it designs and tests strategies, instruments and methodologies for an innovative and efficient use of the Network in **national and international** contexts.

Within the framework of Feeding Knowledge, the **Managing Director of METID** was also responsible for its coordination suggesting development avenues, defining roles and objectives and ensuring public relations. The **Process manager** was the coordinator of production and implementation activities. The **project managers** were in charge of the project management. The **Administration** was in charge of the management of contracts, expenditure and reporting. The Process staff implemented the activities dealing with:

- **Analysis and monitoring** of the innovative uses of the network in the field of communication, collaboration and learning.
- Development of a **feasibility study.**
- Implementation of prototypes**.**
- **Design** of e-collaboration activities.
- **Implementation and customization** open source and web 2.0 systems.
- **Multimedia editing**.
- **Visual design**: interaction design, video editing and photography, development of graphic interfaces, digital and editorial graphic.
- **Development of communication strategies.**
- **Implementation of community.**
- **Technical and methodological training.**
- **Technical help** and support to users.

For CIHEAM

Cosimo Lacirignola - CIHEAM Secretary General and CIHEAM Bari Director

Maurizio Raeli –CIHEAM Bari Deputy Director

Biagio Di Terlizzi - Head of International Cooperation Office CIHEAM Bari

Damiano Petruzzella - Project Manager FKNetwork component

Antonio Prisciantelli - Administrative Officer

Marinella Giannelli - Project Officer

Jocelyne Jawhar - Project Officer

Silvana Campanale - Project Secretariat

Laura Scivetti - Communication & Social Media Officer

Ivana Pekez - Assistant Project Officer

Amine Hmid - Assistant Project Officer

CIHEAM team.

For Politecnico

Graziano Dragoni –Director General Politecnico di Milano

Susanna Sancassani – METID Managing Director – Project manager FK Best Practices component

Daniele Albricci - Visual Designer

Daniela Casiraghi – Interaction Designer

Francesca Concia–Project Officer – Content Manager

Paola Corti – Project Officer

Sara De Donno - Information and Web Designer

Sara Maraschin - Visual Designer

Paolo Marenghi – Technical Supervisor

Lia Navarotto - Community Manager

Marco Re - Senior Software Engineer

The Politecnico team.

Part Two

White papers

Abstract. Within “Feeding Knoweldge” programme, a strategic initiative of Expo Milano 2015 jointly planed, co-funded and implemented by CIHEAM Bari and Politecnico of Milano – METID, an International scientific network of more than 3000 members has been created to share ideas and knowledge regarding five priority areas linked to food security, namely: sustainable natural resources management; qualitative and quantitative enhancement of crop products; socio-economic dynamics and global markets; sustainable development of small rural communities in marginal areas; food consumption patterns – diet, environment, society, economy and health. Using e-collaboration tools and methods provided by the international platform www.feedingknoweldge.net, the international network has developed five “white papers”, one per each priority area, identifying the state of the art of research and giving recommendations for future knowledge development to identify innovative solutions. This article collects the five “white papers” developed by the international network, which were drafted under the scientific coordination of CIHEAM Bari.

Keywords. Natural resources management – Food production – Socio-economic aspects – Rural development – Mediterranean diet.

Livres blancs

Résumé. *Dans le cadre du programme Feeding Knoweldge, une initiative stratégique voulue par Expo Milano 2015, développée, financée et réalisée par le CIHEAM Bari de concert avec le Politecnico di Milano – METID, un réseau scientifique international a été mis en place mobilisant plus de 3000 membres pour favoriser le partage d’ idées et connaissances autour de cinq priorités thématiques en matière de sécurité alimentaire, à savoir : la gestion durable des ressources naturelles ; la valorisation des produits des cultures sur le plan qualitatif et quantitatif ; les dynamiques socio-économiques et les marchés globaux ; le développement durable des petites communautés rurales dans les zones marginales ; les modèles de consommation alimentaire – régime alimentaire, environnement, société, économie et santé. En s’appuyant sur des instruments et des méthodes de collaboration en ligne, à travers la plateforme internationale www.feedingknoweldge.net, le réseau international a élaboré cinq “ livres blancs ”, chacun consacré à une priorité thématique. Les livres blancs ont permis de faire l’état des lieux de la recherche et de formuler des recommandations en direction du développement futur de la connaissance pour identifier des solutions innovantes. Cet article réunit les cinq “livres blancs” élaborés par le réseau international et rédigés sous la direction scientifique du CIHEAM Bari.*

Mots-clés. *Gestion des ressources naturelles – Production alimentaire – Aspects socio-économiques – Développement rural – Diète méditerranéenne.*

Priority 1:
Sustainable management of natural resources

Pandi Zdruli, Nicola Lamaddalena, Mladen Todorovic, Alessandra Scardigno, Jenny Calabrese, Gaetano Ladisa, Vincenzo Verrastro

Ciheam Bari, Italy

Contributing authors
Luis Santos Pereira[1], Antonio Coppola[2], Mario Marino[3]

[1] University of Lisbon
[2] University of Basilicata
[3] FAO

"Human beings are all interlocked with plants, animals, soils and waters, in one humming community of cooperation and competition: one biota! They are related and bound into a seamless fabric"

(A. Leopold, 1949)

I – Abstract (including aim and sub-priorities)

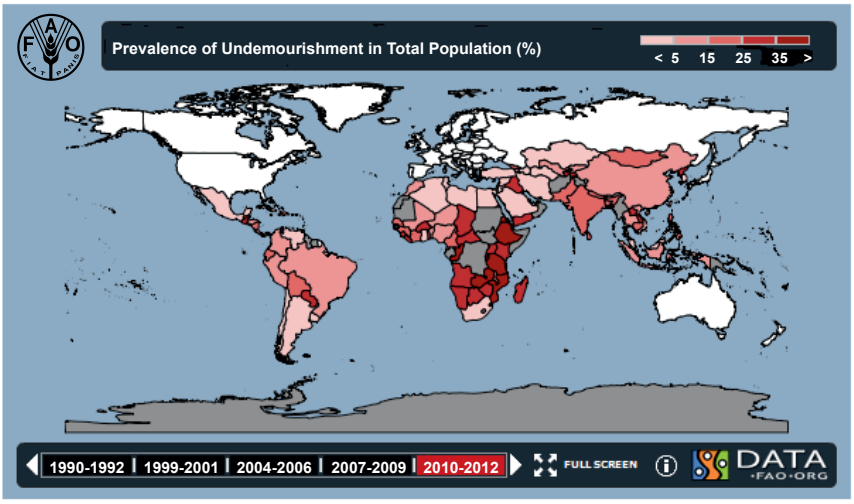
The Mediterranean region is undergoing tremendous political, economic, social and environmental changes and many challenges lie ahead. Within the endless myriad of problems, fears are that food security[1] may be the next major "trouble" for a region that historically has left behind many of such worries. The Arab Spring is turning into a "hot summer" and its impacts on natural resources management and food security are yet to be seen, but there are reasons for concern. The Mediterranean is unique for its geographical position where Europe, Africa and Asia meet and for the distinct differences between the Southern and Northern countries of the region. There are considerable economic disparities between Mediterranean EU countries with an average Gross Domestic Product, or GDP per capita in the range of €16,000 while in North Africa the average GDP per capita is only €1,600 reflected with a significant migration flow from the poorer south to the richer north. Consequently, issues related to food should be dealt differently: food safety and waste of food for the North and food security for the South. We focus in our analyses mostly on the South.

The region is best described for its limited natural resources especially land and water, its rich biodiversity and by high population growth rates in the Middle East North Africa (MENA) region[2]. Paradoxically, shortages of suitable land for crop production and water for irrigation or urban use are much severe in the MENA. Climate change effects are already taking their toll as the region is becoming drier and hotter imposing considerable negative consequences on crop production, biodiversity loss, reduction of ecosystems services and overall compromised environmental sustainability. On the other side, the MENA region posses considerable fossil fuel reserves (Egypt only has proven oil reserves of 4.4 billion barrels and proven natural gas reserves of 78 trillion cubic feet) and large potential for renewable energy production such as solar, even though this last source is yet in the early stages of development and it is not clear what impact could have on food security.

In 2004, the overall ecological footprint in the Mediterranean Basin countries reached 1.3 billion global hectares (gha), almost 10 percent of the worldwide footprint, while the Mediterranean population represent less than 7 percent of the world's population. The ecological footprint of 3 gha/inhabitant is higher than the world's average ecological footprint of 2.2 gha/inhabitant and the region's ecological deficit (*i.e.* 1.7 gha/inhabitant) is more than four times greater than the world's ecological deficit of 0.4 gha/inhabitant indicating that current economic development trends in the Mediterranean are not sustainable.

One thing is sure however: the MENA countries, even by the most optimistic scenarios, not only today, but also on the medium and long term periods can't meet the goal of being food self sufficient via their own agricultural production and hence food-safe. They will continue to rely on food imports compensated largely from their fossil fuel sources and tourism revenues as long as these sources would be available. This conclusion conforms predictions of international research institutions and UN organisations and fits well with the new concept that *food security is not necessarily equal to self-sufficiency* in food production. However, it is closely related to political and social stability of a country and hikes in global food prices could provoke "food scarcity shocks" and social unrest as it happened in Egypt and Algeria in 2008. Widespread land degradation and desertification but especially the inefficient and inequitable use of water, lie at the roots of many problems the region is facing, and yet, effective solutions remain elusive.

This first priority of the Feeding Knowledge project describes the links between natural resources status and management and their inter-linkages with food security by analysing five important components that include land, water, climate change, biodiversity, and energy. Natural resource degradation is not a fate but often receive a "back seat" position in the Governmental agendas. It can be reversed however, if it is caught up early and there is a political will to stop it. Research results show that there are many options available for its recovery through sustainable land and water management, biodiversity conservation, efficient use of energy sources and mitigation/ adaptation actions to climate change.



Map 1. Prevalence of undernourishment in the World

This interacti ve map developed by the FAO to show the level of undernourishment in the World for the period 1990-2012 indicates that the situation in the MENA region has either remained stable or improved with Algeria moving at the same level as all other countries and only Morocco remaining at the lower level.

Source: http://www.fao.org/hunger/en/

Sub-priorities at the glimpse

Land	Water	Climate change	Biodiversity	Energy
Globally, the Mediterranean land area covers 6.3 per cent of the Earth's land mass, 3.7 per cent of natural pastures and rangelands, 1.9 per cent of forests and woodlands, 8.6 per cent of areas with limited biomass potential or sealed by urbanisation and only 7.9 per cent of total agriculture lands. Region-wide, agricultural land cover 14 per cent (in MENA 5), natural pastures 15 per cent, forest and woodlans 8 and the remaining 63 per cent represent areas sealed by urbanisation or with limited biomass production capacity. Soil sealing is a big issue all over the Mediterranean and data show that 40 per cent of the Mediterranean cost is already urbanised and by 2050 that area will be as high as 50 per cent. Still, 41 per cent of the population in the MENA lives in rural areas and these people rely heavily on their local natural resources for their very survival. Major land degradation processes include water and wind erosion, salinisation, organic matter and soil fertility decline, landslides, flooding, overgrazing, and wild fires. Salinisation and alkalinisation alone cover about 10 million ha. Desertification affects more than 40 per cent of the region's territory and 31 per cent of the population, but such process is particularly widespread in the MENA region. If present rates of land degradation and urbanisation will remain unchanged, the region will lose an additional 8,3 million ha by 2020. Still 60 per cent of the local food production comes from the reinfed agriculture. These figures reinforce the need for immediate action in endorsing and implementing sustainable land management techniques and soil conservation practices.	The region is home to 6.3 percent of world's population but has access to a measly 1.4 percent of the world's renewable fresh water. The average water availability per person in other geographical regions is about 7,000 m^3/year, whereas water availability is merely 1,200 m^3/person/year in the MENA region. The region has the highest per capita rates of freshwater extraction in the world (804 m^3/year) and currently exploits over 75 per cent of its renewable water resources. Due to burgeoning population and rapid economic growth, the per capita water availability is expected to reduce to alarming proportions in the coming decades. By the year 2050, two-thirds of MENA countries could have less than 200 m^3 of renewable water resources per capita per year. Around 85 per cent of the water in the MENA region is used for irrigation. MENA's average water use efficiency in irrigation is only 50 to 60 percent, compared to best-practice examples of above 80 percent efficiency under similar climate conditions in Australia and southwest US. Similarly, physical water losses in municipal and industrial supplies in the region are way above world averages, around 30 to 50 percent in some cities, compared to global best practice of approximately 10 percent. In general, MENA countries are beginning to recognize the importance of an integrated approach to water management. The demand for water will continue to rise across the region, due to population increase and economic growth.	Climate, water and land management are intrinsically linked and shaped the characteristics of natural and agricultural systems. The vulnerability of the systems strongly relies on the actual state of availability and exploitation of resources and capability to response to variability and changes of climate over various time spans. Certainly, many areas in the Mediterranean might be a particularly vulnerable due to the scarcity of resources and pronounced degradation of both water, land and environment. In particular, climate changes implications on agriculture and food security could be relevant with interrelated effects on the biophysical factors (physiological effects on crops, pasture, forests and livestock; changes in water, land and soil availability; increased weed and pest challenges) and socio-economic impacts (changes in yields and food production; fluctuations in world market prices; increased number of people at risk of water and food insecurity; human health, products distribution channels, market flows, etc.) (FAO, 2007). Focusing primarily on the agricultural sector, the climate change implications could be twofold: 1) causing permanent structural changes of cropping pattern and agricultural vocation of an area due to expected trend of main climate factors (precipitation, temperature and CO_2 concentration), and 2) increasing vulnerability to transitory extreme events as prolonged hot spells, droughts and floods difficult to predict . The adaptation/mitigation measures should consider the capacity of each specific area/country and could have greater success in the Northern than in the Southern Mediterranean countries.	The importance of biodiversity in the frame of food security and global sustainability is optimally shown in the report about the state of environment of the Millennium Ecosystem Assessment that describes the relationship between biodiversity and eco-system services (MEA, 2005). Food provisioning is the first typology of service delivered by ecosystems and in terms of importance it is closely followed by all the services related to ecosystem's ability in supporting life on Earth. Key functions of the ecosystems are linked to biodiversity for provision of basic materials for life (adequate livelihood and sufficient nutritious food) or for health (strength, feeling well, access to clean air and water). There are even many other important ecosystem services deriving from it that are more related to environmental aspects such as regulating ability (climate, flood, disease regulation and water purification) that relate to public security (i.e. security from disasters), or to health, and to good social relations.	Energy is needed in all steps along the agrifood chain: in the production of crops, fish, livestock and forestry products; in post-harvest operations; in food storage and processing; in food transport and distribution; and in food preparation. Historical trends indicate an evident link between food prices and energy prices and the higher fuel costs increased the cost of producing and transporting agricultural commodities. Energy is one of the key drivers that cause food prices to surge to their highest levels in nearly 50 years. Moreover the higher food prices affects food access, which drove millions of people into food insecurity. In Mediterranean countries for rural development, the access to energy is fundamental for the provision of goods and services that can improve agricultural productivity and bring new opportunities for generating income. Increasing the energy services in Mediterranean rural areas could have the potential to spur agricultural development by increasing productivity, for example through irrigation, and improving crop processing and storage. It could also strengthen the development of non-farm commercial activities, including micro-enterprises, and create opportunities for other livelihood activities beyond daylight hours. Renewable energies such as bio energy, solar, wind, hydro and geothermal could be used in Mediterranean countries in agrifood systems as a substitute for fossil fuels to generate heat or electricity for use on farms or in agriculture-related operations. If excess energy is produced, it can be exported off the property to earn additional revenue for the owners. Such activities can bring benefits for farmers, landowners, small industries and rural communities.

II – State of the art

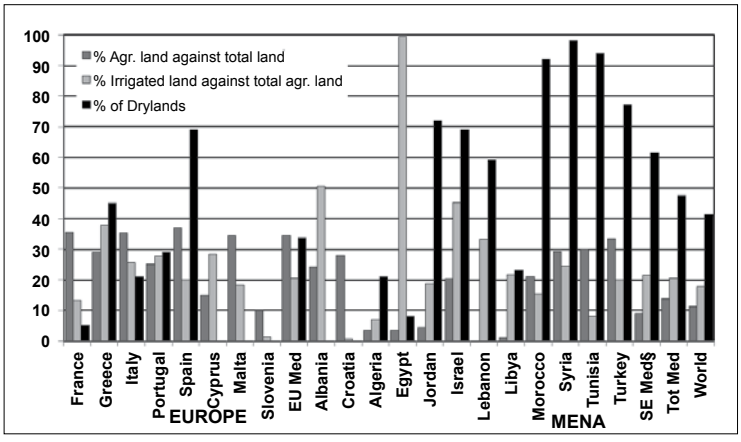
1. The Land issue

How much land is available for crop production? Is it of good quality? What is the role of agriculture in overall economic development and food supply?

The Mediterranean region posses about 854 million ha of total land resources but only 118 million ha of them (or 14 per cent) are suitable for agricultural production while the MENA countries cultivate on average only 5 per cent of their total area. The most land constraint countries are Libya (less that 2 per cent), Egypt and Algeria with less than 4 per cent and Jordan with less than 5 per cent of its land fit for agriculture production. Region wide land cover patterns include also natural pastures and rangelands (15 per cent), forests and woodlands (8 per cent) and the remaining 63 per cent (or about 538 million ha) represent areas with very limited or no biomass production capacity while coastal wetlands cover about 1 million ha throughout the region. Contrary to tropical countries, options for agricultural expansion are extremely limited and if land is reclaimed for agriculture, costs are high and the newly reclaimed soils often result in poor quality needing further investments to keep (or increase) their productivity level. If water would be available, options for growing crops could be largely increased, but one must consider however that irrigation necessitates additional energy sources and investments that in addition to water, may be shortcoming.

Drylands (as described by the United Nations Convention to Combat Desertification UNCCD)[3] are spread over 33.8 per cent of the Northern Mediterranean countries while in the MENA they reach as much as 61.3 per cent (Graph 1). Desertification affects 30 per cent of the semi-arid drylands (Rubio and Recatala, 2006) and 31 per cent of the region's population (Safriel, 2009). Compounding the many natural disadvantages and the rugged topography are the long periods of soil exploitation and mismanagement, overgrazing, deforestation and wild forest fires (Zdruli, 2012). Land degradation in the form of salinisation, water and wind erosion, sand encroachment, compaction, organic matter decline, sealing, and coastal littoralisation are severe in many countries.

Desertification is also a man-made water scarcity regime, which requires appropriate water conservation and saving, and relates to great social challenges (Pereira, 2005; Pereira *et al.*, 2006; 2009).



Graph 1. Comparison between agriculture land, total land area, irrigated land and distribution of drylands in Mediterranean Europe and MENA. *(Source: Zdruli, 2012)*

A GIS-based approach for desertification risk assessment in Apulia region, SE Italy

An assessment of the desertification risk was carried out for Apulia region (south-eastern Italy), a typical example of many Mediterranean areas affected by land degradation. The presented approach represents a modification of the ESAs model (Environmental Sensitive Areas to Desertification; Kosmas *et al.* 1999), applied in the MEDALUS (Mediterranean Desertification and Land Use) project funded by the European Commission. A set of new indicators was developed to account for the regional-specific environmental features as well as for the socio-economic parameters relevant to land use planning and control measures. GIS analysis was done including the whole set of indices (the Soil Quality Index, the Climate Quality Index, the Vegetation Quality Index, the Land Use and Management Quality Index and the Human Pressure Index), at both regional and administrative scales that constitute the principal territorial units for natural resources management and for the implementation of mitigation policies. The sensitivity of the areas to desertification risk was determined using (i) only bio-physical factors of the territory by means of soil, climate and vegetation quality indices, and (ii) both biophysical and human-induced factors, i.e. including also land use and management practices and human pressure. The estimation of desertification risk by means of bio-physical factors (soil, climate, vegetation) shows that more than half of the territory (51.7 per cent) could be classified as critical, 27.7 per cent as fragile, 8 per cent as potentially affected by desertification processes, 7.3 per cent as non-affected land, while 5.3 per cent represents urban and industrial areas and water bodies. The inclusion of human-induced factors (land use and management, human pressure) significantly changes the situation about desertification risk in Apulia region by describing 80 per cent of the territory as critical, 12.9 per cent as fragile, 1.2 per cent as potentially affected and 0.5 per cent as non-affected land (5.3 per cent represents artificial areas and water surfaces). The results of this study have shown how the effect (not in all cases negative) of human activities and pressures can trigger factors that move sensitive areas from a marginal steady state to an actively unstable state. The results showed good performance of the proposed approach that permits not only to identify and refine different degrees of vulnerability to land degradation, but also to analyse specific factors affecting desertification as well as their evaluation in terms of spatial and temporal distribution. The presented method can be easily implemented at different spatial scales (from watershed to regional level) and might represent a benchmark methodology to identify priority measures for mitigation of desertification risk in semi-arid Mediterranean environments.

Ladisa, et al,. 2012

Soil salinisation and alkalization are regarded as major causes of desertification and are serious forms of soil degradation in the Mediterranean (Zdruli *et al.*, 2007). Human-induced salinisation has expanded mostly due to poor quality irrigation water and irrigation management, especially along the coasts where seawater intrusion into the fresh water aquifers is a common problem. Almost all the saline soils of Egypt (1 million ha) for instance are human-induced (Gomaa, 2005) and in Algeria in 2011 the area of secondary salinisation was estimated to cover 15 per cent of all irrigated lands. A decade ago, estimates of the economic costs of environmental degradation in Egypt ranged between €2.7 billion to €5.1 billion per year (or 3.2-6.4 per cent of GDP), €1.5 billion per year (or 3.6 per cent of GDP) in Algeria and €1.2 billion per year (or 3.7 per cent of GDP) in Morocco (Montanarella, 2007). No one expects that the situation has improved since these data were published.

> *What now remains of the formerly rich land is like the skeleton of a sick man. . . . Formerly, many of the mountains were arable. The plains that were full of rich soil are now marshes. Hills that were once covered with forests and produced abundant pasture now produce only food for bees. Once the land was enriched by yearly rains, which were not lost, as they are now, by flowing from the bare land into the sea. The soil was deep, it absorbed and kept the water in loamy soil, and the water that soaked into the hills fed springs and running streams everywhere. Now the abandoned shrines at spots where formerly there were springs attest that our description of the land is true.*
>
> **Plato (427-347 BC)**

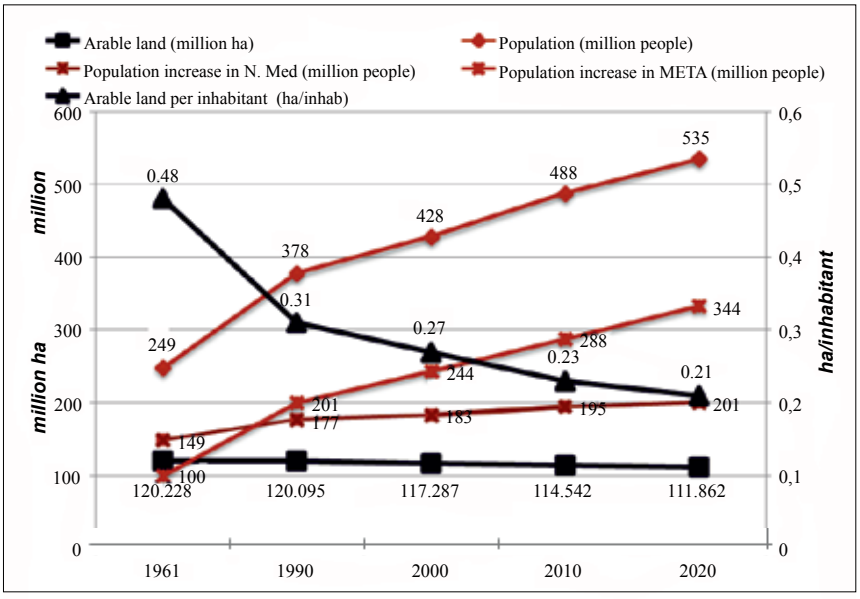
Land degradation in the Mediterranean is as old as its history. There is ample evidence for instance showing that ancient Greeks (Runnels, 1995) cut their forests to expand cultivation on the sloping lands causing thus extreme erosion and leaving behind abandoned badlands. In the area of Aleppo, in Syria called “hundred dead seas” archaeological surveys demonstrate that 1-2 metres of soil was washed away during the first century AD following invasion of several armies and massive deforestation. The same is true for eastern Turkey, Jordan and Lebanon showing evidence of forest clearing since Roman times. Lebanese cedars reached not only the Egyptian Pharaohs but they were used even in the Balkans for building deluxe homes.

Figure 1. Natural erosion in sedimentary claystone/siltstone/sandstone/ formations in Calabria, Italy, locally known as *calanchi.* *(Photo credit: Zdruli, 2012)*

Forest fires in Spain and gully erosion due to land abandonment in Albania

Figure 2. Man made land degradation. *(Photo credit: Cerda and Zdruli)*

While analysing the status of land resources, particular attention is given to agriculture land and not only to the total land area a country has. In the Mediterranean EU countries the average agricultural land per capita is 0.30 ha and the agricultural land per agricultural worker is 11.4 ha, while in the MENA countries (including Turkey) the first value is 0.25 ha and the second is only 1.9 ha, indicating that land available for agriculture is much less and still larger portions of the population (on average 41 per cent) live in rural areas. Other indicators link population increase with availability of agricultural land and predictions show that Mediterranean population by 2020 could reach as much as 535 million people and the largest increase will be in the MENA over passing 300 million people. Contrary, agricultural land area may further shrink by losing 8.3 million ha (or 7 per cent) if the actual rates of urbanisation and land degradation will remain the same (Zdruli, 2012). Consequently the agricultural land (ha/capita) region wide would drop from 0,48 ha in 1961 to 0,21 ha in 2020 (Graph 2). Unless these rates are reversed, the situation in the MENA region could become particularly critical.



Graph 2. Relationships between availability of land resources and population trends. *(Zdruli, 2012)*

Agriculture remains an important economical sector for the MENA economies and its share on the national GDP varies from country to country. In Egypt for example the sector provides 13.4 per cent the country's GDP and must be noted that Egypt is one of world's largest producers of rice and cotton and in 2011 produced about 5.67 million tons of rice and 635,000 tons of cotton. On the other side Egypt is the world's largest wheat importer!!

Despite the fact that MENA is one of the most land and water scarce and dry region in the world, many of these countries, especially those around the Mediterranean Sea, are highly dependent on agriculture. For example, the Oum Er Rbia River basin contains half of Morocco's public irrigated agriculture but produces 60 per cent of its sugar beets, 40 per cent of its olives, and 40 per cent of its milk.

Agricultural output is central also to the Tunisian economy. Major crops are cereals and olive groves, with almost half of all the cultivated land sown with cereals. Tunisia is one of the world's biggest producers and exporters of olive oil, and it exports dates and citrus fruits that are grown mostly in the northern parts of the country. Agriculture in Lebanon is the third most important sector in the country after the tertiary and industrial sectors. It contributes nearly 7 per cent to the GDP and employs around 15 per cent of the active population. Main crops include cereals (mainly wheat and barley), fruits and vegetables, olives, grapes, and tobacco, along with sheep and goat herding. These figures indicate the importance of the agriculture sector in the overall economical activities of the MENA countries and the impact the sector has in partially fulfilling the population's food needs.

Figure 3. Extensive olive groves in Tunisia, world's largest olive oil producer and exporter

2. The Water issue

Water and food security are highly interconnected. Many of the over 800 million people in the world who still go hungry live in water scarce regions (FAO, 2008a): a limited and insecure access to water resources is often one of the main factors threatening food production (UNDP, 2007). Since water is a key factor for agricultural development, water scarcity can endanger food production and food security (Pereira *et al.*, 2009).

According to the World Bank, water withdrawals in the MENA region represent 67 per cent of renewable water resources and 85 per cent of the water used in the region is for irrigation. As expected, the demand on water for irrigation is considerable, especially because of climate features: a long dry summer, relatively low rainfall and very high evapotranspiration rates. In addition, irrigation systems and practices are often less appropriate to minimise non-beneficial water uses (Pereira *et al.*, 2012).

Besides water scarcity, problems of poor water quality and water pollution are also expected as a result of increasing salinity due to over-abstraction and inadequate irrigation management, pollution from agricultural run-off and uncontrolled discharges of wastewater and effluents. The latter take a great importance as causing public health problems. A point that cannot be ignored is for example the damage coming from fertilisers contaminated water runoff into lakes, rivers and the sea. Egypt is now the largest user of fertilisers in the region that, in addition to less efficient agronomic practices, also relate with the construction of the Aswan High Dam and the consequent Nile floods termination (along with their fertilising silt).

In some cases the irrigated agriculture has changed the dynamics of discharge and recharge to groundwater. The current water conveyance and distribution system leads to recycling of surface water through the aquifer, thus increasing salt concentration in the groundwater used for irrigation. Salt loads of drainage water flowing back to the rivers or groundwater can considerably exceed those projected to occur from irrigation alone. Such waters obviously are an economic burden to those downward in the basin who have to use waters into which such exceeding salt loads have been disposed (note for example the case of the Euphrates river in Syria) (Coppola, 2010). In other cases, degradation of water quality for irrigation may be related to the specific transboundary characteristics of the water resources. For example, in the Syrian area at the Turkish-Syrian boundary the water table has fallen due to the over-pumping and less water flows of the Euphrates river into Syria. It seems plausible that such a dropping is especially due to the strong water abstraction policy actuated by the Syrian government in order to supply water to the dams near the boundary, as well as directly to the El Khabour River and its affluents. This induces farmers to deepen their pumps thus frequently pumping more saline water from gypsiferous porous formations (Coppola, 2007). For more on water quality issue and its relation with land salinization and pollution see also sub-priority 1: the land nexus.

The Mediterranean receives on average only 3 per cent of global freshwater resources. In some countries, these mainly come from transboundary water resources: 97 per cent in Egypt (Nile), 55 per cent in Israel (Jordan River and Mountain Aquifer) and 43 per cent in Syria (Euphrates) (UNEP/MAP-Plan Bleu, 2009). Transboundary water issues (surface and groundwater) are cause for political disputes among the Mediterranean countries and with the impacts of climate change, most likely they will further deepen.

Half of the “water poor” world population (i.e. less than 1,000 m^3 per capita per annum) is concentrated in the Southern Mediterranean region (Mediterra, 2008) and it has been estimated that by 2025 potentially 180 million people will be affected by water problems, 60 million of whom will suffer water shortage of less than 500 m^3 per capita per annum (UNEP/MAP-Plan Bleu, 2009). Demographic pressures together with the economic development of non-agricultural sectors will further deteriorate the water balance in many Mediterranean countries where the water exploitation index is already a matter for serious concern. Pressures will become more severe

for the agriculture sector that consumes the largest volume of all water users since it accounted for 64 per cent of overall demand in the period 2005-2010 (49 per cent in the North, 74 and 81 per cent in the South and East), (Blinda, Plan Bleu, 2011). The irrigated area in Mediterranean countries has more than doubled over the last 40 years, totalling 24,200,000 ha in 2009 (17,8 million in the Mediterranean Europe and 6,4 million in Northern Africa). Irrigated land accounts for 20 per cent of all arable land and produces 40 per cent of food production while rain-fed agriculture and pastoralism still occupy an essential place in Mediterranean countries producing around 60 per cent of all the food needs (Molden *et al.*, 2007). In arid and semi-arid Mediterranean countries, irrigation contributed to boost agricultural yields and outputs, stabilized food production and prices and improved farmers' income and economic welfare of rural population (Hanjra *et al.*, 2010; Rosegrant and Cline, 2003).

Nevertheless, the effects of global climate change on the water cycle- rainfall, evaporation, run-off- are expected to deplete water resources (see sub-priority 3: the climate change nexus). Some countries have already revised their resources estimates downwards (Algeria by 20 per cent and Morocco by 25 per cent).

3. The Climate Change issue

Climate Change (CC) refers to any change in climate over time which, triggered (and triggering) with other expected and plausible changes (e.g. population growth and migrations, social, economic and technological development, political, financial and cultural setup, consumption and living habits, dietary preferences), will create new scenarios that will affect the availability and quality of water and land resources used in agricultural production and the biodiversity of ecosystems, thus creating new challenges in water resources management and use (Pereira *et al.*, 2009; 2012). In turn, it could likely affect the availability and spatial distribution of food over the planet and cause concatenated effects throughout the water, land, energy and food security nexus (Fig. 4).

The observations of climate in the past together with the future projections (Bates *et al.*, 2008; IPCC, 2007; Jones and Moberg, 2003) provide a quantitative basis for estimating the likelihoods for many aspects of future CC: continuous warming and increase in mean air temperature of 1–3°C by the middle of 21st Century (Nakićenović and Swart, 2000; Giannakopoulos *et al.*, 2005) are expected to occur whereas, by the end of the Century, the increase of temperature could reach between 2.1 and 5.2°C (IPCC, 2007). It appears that these global projections match in a remarkable agreement with the Mediterranean region, perhaps better than with many other areas. However, warming in the Mediterranean is expected to be higher than the global average, precipitation much reduced in southern areas (Map 2) and frequency and intensity of extreme events and inter-annual variability to increase notably (Giorgi, 2006; Norrant and Douguédroit, 2006; Giorgi and Lionello, 2008; Giannakopoulos *et al.*, 2009; Ferara *et al.*, 2010).

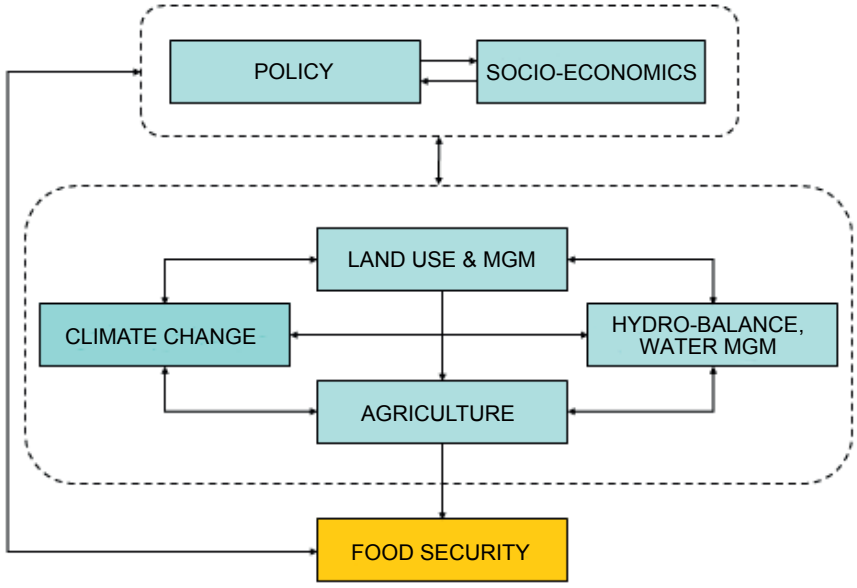
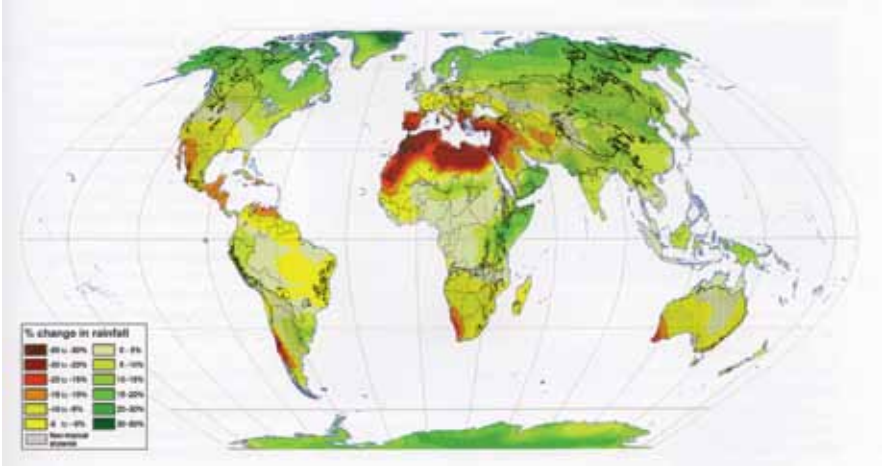


Figure 4. Climate change and its interactions within a larger context of land and water management, agricultural production and food security

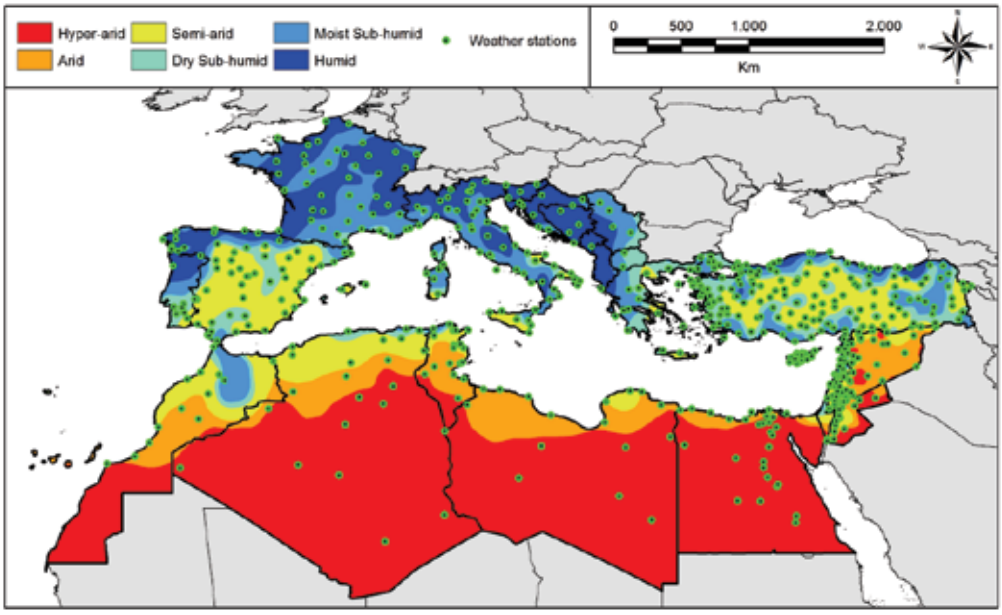


Map 2. Projections of precipitation change (in %) for the period 1989-2099 (SRES, A1B) (IPCC, 2007)

Many drylands may be severely affected by climate change. The Scenario A1B of the IPCC predicts an increase in average temperature between 2-4° C for the period between 1980/89 and 2080/99, and especially vulnerable are the regions of non-tropical drylands characterized by higher temperatures and lower rainfall. The WANA (West Asia and North Africa) region is already adversely affected by severe drought stress in cropland with strong repercussions to global food security. Other regions (i.e., Southern Europe, parts of western US and Central America, Northern and Western Latin America and parts of South Western Africa and Australia) are also projected to experience reduced rainfall by as much as 20-50 per cent.

Source: Scenario A1B, IPCC, 2007

The most typical part of the Mediterranean region, i.e. its coastal zone, is characterized with a specific “Mediterranean” type of climate indicating dry and hot summer season and mild and rainy winters which coincides mainly with semi-arid conditions. However, considering the continental areas neighbouring the coastal zone and intrinsically linked with it, the Mediterranean presents a transition area between the arid climate of North Africa and the temperate and rainy climate of central Europe (Map. 3). Hence, due to its specific geographical location, the Mediterranean region is affected by interactions between mid-latitude and tropical processes which makes the region potentially highly vulnerable to climatic changes as it has shown large climate shifts in the past (Luterbacher *et al.*, 2006) and has been emphasized in recent climate change projections (Giorgi, 2006; IPCC, 2007).



Map. 3. Climatic zones in the Mediterranean Region according to the global aridity index (UNEP, 1997) on the basis of the ratio between precipitation and reference evapotranspiration. *(Todorovic et al., 2013)*

The recent analyses, based on A1B scenario and carried out within the WASSERMed project[4] ave shown that, in the Mediterranean region, annual mean temperature over the period of 50 years (2000-2050) would increase in average from 0.8°C in Spain to 2.3°C in Morocco. The overall raise of air temperature would be the greatest in some areas of Northern Africa and the Middle East, and in Southern Turkey. Seasonal patterns indicated that, in winter, the continental interior of South-eastern Europe and Eastern Mediterranean would warm more rapidly than elsewhere. Differently, in summer, the western Mediterranean would warm more than the other parts (Todorovic *et al.*, 2012).

For the same time span (2000-2050), the average annual precipitation could have a decreasing trend of around 6 per cent for the whole region, while the expected range of variation at country level would be between -21 per cent (for Cyprus) and +1 per cent (for France and Slovenia). The spatial pattern of annual precipitation indicates an increase over most of France and Alps, while a decrease is observed in almost all the other regions. There is a marked contrast between

winter and summer patterns of precipitation change. Most of Europe could get wetter in the winter season with the exception of Greece, Southern Italy and Turkey. In summer, an overall decrease of precipitation could be expected in Europe, while an increase is foreseen in some areas of Northern Africa and the Middle East (Tanasijevic, 2011; Saadi, 2012; Todorovic *et al.*, 2012).

Therefore, the Mediterranean might be a particularly vulnerable region to CC and especially in the areas already characterized by water scarcity and land degradation. In fact, the warming trend and changes in precipitation pattern might further affect the water balance and composition and functioning of natural and managed ecosystems. In particular, CC impacts on agriculture could be relevant with interrelated effects on the biophysical factors (physiological effects on crops, pasture, forests and livestock; changes in land, soil and water resources; increased weed and pest challenges; etc.) and socio-economic impacts (changes in yields and food production; fluctuations in world market prices; increased number of people at risk of food insecurity; human health, distribution channels, market flows, etc. (FAO, 2007). Moreover, besides the changes in food availability, the collateral effects of CC could be expected over the whole chain of food system stability, accessibility and utilization, including the water and energy used in food processing, storage and transport, as well as the consideration of environmental services (FAO, 2008b). Certainly, these effects will be redistributed in a different way at the global level, with economically advanced regions more capable to adapt to changes opposed to areas penalized because of the scarcity of economical and natural resources, as they are the Southern parts of the Mediterranean.

4. The Biodiversity issue

Biodiversity is not just the direct expression and the term of evaluation of the state of conservation of an environmental system, but it means, even and overall, that it expresses system's productivity, stability and the ability of being self-supporting and self-perpetuating in the long run. Biodiversity loss with consequent reduction of delivery of ecosystem services, has very high economic and social costs not only in terms of environmental sustainability but also to reduce poverty, hunger and diseases all over the world. That's why stopping or reducing biodiversity loss was and still is one of the main Millennium Development Goals (the 7b) replaced by Sustainable Development Goals after Rio+20 and in this regard the Mediterranean region is particularly sensitive.

Due to its location placed in the middle of two major terrestrial land masses (Eurasia and Africa), its climatic characteristics, differences in altitude level (ranking from below sea level - with the Dead Sea 420 meters b.s.l.- to the 4,165 meters of the Atlas in Morocco) and to the variations in rainfall (going from 100 to 3,000 millimetres), the Mediterranean Basin is a real biodiversity hotspot. This is well represented by the high level of endemic species (10 per cent of the world's endemic plants located in only 1.6 per cent of the world's surface). Above all, the region scores third in biodiversity richness at world level (CEPF, 2010) as it hosts 60 per cent of all unique flora species, 30 per cent of endemic fauna and about 7 to 8 per cent of the known marine species. However, nearly 19 per cent of the hosted species are considered as threatened by extinction.

Much of the original vegetation cover of the Mediterranean hotspot has been altered by millenary human induced activities and many of them include conversion of forests and scrubs into agriculture use reducing thus existing natural cover to just about 5 per cent, which is the lowest in respect to any other hotspot in the world. Less than half of this area is actually under protection but the high increasing population trend in the MENA is continuously threatening the remaining biodiversity wealth and its habitats.

In the Apulia region in southern Italy agriculture cover 81 per cent of the territory and only limited patches of shrubs, natural pastures and forests remain untouched

Figure 5. Typical Mediterranean landscapes of Mediterranean Europe showing cereal cultivation surrounded by natural vegetation. *(Photo credit P. Zdruli)*

According to the International Union for Conservation of Nature (IUCN) Red List there are 555 threatened species in the terrestrial area of the Mediterranean hotspot, 336 of these are endemic and 100 are plants. In total 1,110 key biodiversity areas have been identified for the Mediterranean hotspot (CEPF, 2010). Of these key areas, 79 are totally irreplaceable because they contain the entire range of globally threatened species. The Mediterranean Basin is crucially important also for the migratory birds, because it lays along the major migratory bird flyways and it harbours even many critical wetland sites of international importance as described by the Ramsar Convention[5].

Figure 6. Wetlands in the Marine Protected Area of Torre Guaceto in the Province of Brindisi in Italy. *(Photo credit P. Zdruli)*

The Mediterranean sea represents 0.8 per cent of the global ocean surface area, 0.3 per cent of the global water volume but as biodiversity hotpot, on average, it is home to 7 – 8 per cent of all the known marine species accounting with more than 12,000 described species. Its geo-morphological and geological history and the position of the biomes from temperate to tropical, enable it to accommodate both species affinities hot and cold (Pergent Martini, 2009) and to host a strong proportion of all endemic species (over 25 per cent), existing only in the Mediterranean. A higher diversity is observed in the western part of the basin, where almost 90 per cent of the known plant benthiques and more than 75 per cent of fish species are found in the shallow waters (0 to 50 m) although they represent only 5 per cent of the Mediterranean waters.

Apart from the coastal habitats, available knowledge is extremely fragmentary and vary from one sector to the other. At regional level, the latest edition of the IUCN red lists shows that among the Mediterranean marine species the most endangered taxonomic groups are the monk seal (*Monachus monachus* with only 350 - 450 individuals left) and cartilaginous fish (chimaera, rays and sharks; almost 42 per cent of the Mediterranean shark species are at risk of extinction, as opposed to only 17 per cent at global level). Other species of concern at risk of extinction are: the Atlantic blue-fin tuna (*Thunnus thynnus*, because of over fishing) and two turtles species *Caretta caretta* and *Chelonia mydas* (CEPF 2010). According to Annex II of the Protocol concerning Specially Protected Areas and Biodiversity (SPA/BD), the situation is extremely worrying at least for three fish and one mammal species. For the other groups of species, it is difficult to provide a clear diagnosis in the absence of any up-to-date assessment at regional level or as a baseline concerning the state of these species now and in the past.

The straits of Sicily divides the Mediterranean Basin into two main sub-basins, the Western one with a strong influence from the Atlantic ocean, and the eastern one that is characterized by higher productivity and mostly concentrated over the continental shelf. Many other species contribute to ecological functions from which agriculture depends, including soil services and the water cycle.

Biodiversity is the origin of plants and animals that form the basis of agriculture and the immense variety within each crop and livestock. Biodiversity has enabled farming systems to evolve since agriculture was invented about 10,000 years ago in many parts of the world, including the Mediterranean, the birthplace of European agriculture. Presently, all around the world a great diversity of agricultural systems with many different crops and diets are available.

Of the approximately 15,000 species of mammals and birds, only 30 to 40 were domesticated for food production and fewer than 14 species-including cattle, goats, sheep and chicken provide 90 per cent of global trade in livestock production at present (FAO, 2010). According to FAO, about 7,000 species of plants have been cultivated since man began farming, but today, only 30 crops provide 90 per cent of dietary needs of the world's population, with wheat, rice and corn providing about half of the food globally consumed (FAO, 2010). In recent decades, there has been an alarming genetic erosion of these species. Loss of genetic diversity can occur through poorly planned replacement of local varieties of crops. Genetic erosion can also result from intruding invasive alien species, pests, weeds and diseases, land use changes and environmental degradation.

Since agricultural biodiversity is both the result of natural and human selection its conservation and sustainable use is essential for the future of agriculture production and humanity well being.

5. The Energy issue

Energy inputs are essential to create employment in many productive sectors such as industry, transportation, commerce and agriculture. Water management and use for agriculture is closely related to reliable access to energy. Water resource management, irrigation, urban and industrial water supply, and water and wastewater treatment all place demand for energy to be able to operate on the local level[6].

The type of energy we use in the agrifood chain and how we use it will in large part determine whether our food systems will be able to meet future food security goals and support broader development objectives in an environmentally sustainable manner. As shown in Figure 7, agrifood systems not only require energy, they can also produce energy.

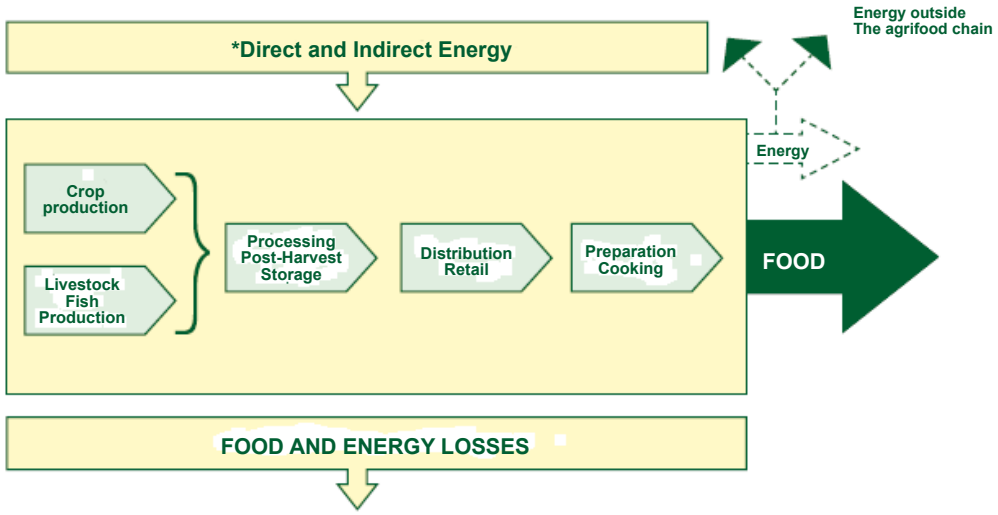


Figure 7. Energy for and from the agrifood chain

Population growth rates (the fertility levels in the MENA are significantly higher than in the wealthy, fully-industrialised nations of the northern Mediterranean) are expected to have an obvious impact on energy consumption in the region. Such a condition is very relevant with regards to energy infrastructure, which requires large investments and long-term planning. The present situation implies that much more energy will be needed especially in the MENA nations, to maintain or increase the present level of per capita energy consumption, notwithstanding the relatively large population growth.

According to projections by the Mediterranean Energy Observatory, primary energy demand of the MENA countries will increase from 33 per cent of the total demand in 2010 to 40 per cent in 2020 and 42 per cent in 2030. In this analysis, it has also been considered that the economies of the MENA countries are at a different stage of maturity compared to those of the European Mediterranean edge. While the EU countries have shifted much of their economies from production to the less energy-intensive service sector, the MENA regions currently tend to developing of a classical manufacturing production.

Energy security is associated with social security, economic security (besides military security), but also refers to food security. Traditional agriculture simply converts solar energy into food for humans and livestock. Nevertheless, as argued by Weissenbacher (2012), societies evolution has turned agriculture, their first great source of energy, into an energy sink. It is expected that the agriculture development in the Mediterranean to fulfil population growth will require much larger inputs of technical energy into food production. The enormous energy inputs for fertilizer production are a major factor in this system. Natural fossil fuels prices have a strong influence on fertilizers and thus on food prices. On the other side, the energy-water nexus is very much interlocked as both components of the equation rely heavily on each other.

Boosting irrigation for enhancing food production also tends to increase the energy demand. In various South-Eastern Mediterranean countries, the demand for energy for irrigated agriculture is expected to increase considerably (see sub-priority 2: the water nexus) because of the increasing water pumping that is necessary to run irrigation schemes. This situation is expected to worsen where desalination plants need to be implemented.

As a consequence, feeding the world in the coming decades will require the gradual decoupling of agricultural intensification from its dependency on fossil fuels, in order to make inputs affordable – hence contribute to both climate and food security. This requires more **energy-smart food systems**, which means:

- increasing the efficiency of direct and indirect energy use in agro-food systems, without lowering productivity (Lamaddalena and Khila, 2012);
- using more renewable energy as a substitute for fossil fuels in the agro-food chain and irrigation;
- improving access to modern energy services (FAO, 2012).

III – Problem analyses

1. Land and Food Security Nexus

The Mediterranean region covers 6.3 per cent of the global land area, contains 7.9 per cent of the agricultural land, 3.7 per cent of natural pastures and rangelands, but only 1.9 percent of forests and woodlands. Noteworthy however, is that urban settlements, deserts and areas with minimal photosynthetic potential cover about 8.6 per cent of world's land area. It is significant that only this last figure ranks higher in a region of land scarcity!

Competing interests for land in the region identify agriculture as the major looser. Built-up areas now cover nearly 40 per cent of the Mediterranean coastline and by 2050, provided the present sealing (urbanization and land take) rates will remain similar, it will reach at 50 per cent spurred also by the tourism industry that brings into the region about 300 million tourists each year. Urban expansion has often happened at the expense of prime soil and major cities like Alexandria, Cairo, Tripoli, Beirut, Casablanca, Istanbul, Barcelona, Marseilles, Athens and many others have been established where the best soils are. Data from Italy show that during the period of 2000-2010 more than 300,000 hectares of agricultural land were lost to urbanization. This is translated with the loss of 1,500,000 tons of wheat per year. Similar "disturbing" data are available also for Spain (Barbero-Sierra, *et al.*, 2013).

Fertile soils could not be converted to non-agricultural uses either for installation of solar panels or windmills mushrooming in many European Mediterranean countries. Good soils and the rural agricultural landscapes should not be threatened by ill-implemented renewable energy initiatives camouflaged with environmental concerns. Soil sealing is one of the major soil degradation problems in the EU that losses as much as 275 ha day^{-1} of agricultural land (JRC-EEA, 2012) or for every 3 seconds an area equal to one football field size. This is a very significant figure since for every hectare of fertile arable land lost in Europe it would be necessary to bring into production elsewhere outside the continent an area up to ten times larger (Gardi *et al.*, 2011), accelerating thus the process of land grabbing in Africa or other world regions.

Figure 8. Solar panels replacing olive groves in the Apulia Region, Southern Italy
Source: Salviamo il paesaggio difendiamo i territori. Italian Forum Movement for Land and Landscape
www.salviamoilpaesaggio.it

The Southern Mediterranean experience similar problems. In Egypt, Morocco, Tunisia, and Syria thousands of hectares of valuable agricultural land were lost to urbanization especially during the period 1975-1985. A typical example is Egypt where even 110 km² of desert lands were urbanised between 1995 and 2007 (UN HABITAT 2012). Prior annual land transformations (1960-1990) in Egypt, the most populated Mediterranean country have been 10,000 ha $year^{-1}$, increasing to 12,600 ha $year^{-1}$ after 1990 (Plan Blue, 2003) but the land take rates for the surroundings of Cairo were much larger (Chaline, 2001). In 2012 the Greater Cairo area accounting for about 20 million people, 65 per cent of them living in the so-called informal areas, was ten times bigger than in 1950. It is also for these reasons that Egypt, a country expected to have 101 million by 2020 and 150 million by 2050 is making land acquisitions in the nearby Sudan or expanding irrigated crop production in the arid areas as it is happening between Cairo and Alexandria crossed by the famous Desert Road. Similarly, in the region of Algiers in Algeria about 140,000 ha of fertile lands have been affected by urban sprawl and other forms of land take (Chaline, 2001) and in Lebanon 30,800 ha of productive lands have been lost to urbanization for the period 2000-2010. Data for Turkey show that this country too lost to sealing 827,000 ha only for the period 2001-2010.

Outside the arable lands, there are the categories of natural pastures and rangelands that along with rainfed agriculture and pastoral activities produce the largest share of the food supply in the Mediterranean. In the MENA region, pastures and rangelands cover 95,275,000 ha or 13.8 per cent of the whole area, which is almost triple the surface area covered by this type of land cover in the Northern Mediterranean countries. This land use category is important also for the preservation of biodiversity and global life support and ecosystem services, especially as potential pools for carbon sequestration and mitigation of climate change, hence deserves protection. Forests and woodlands cover only a small portion in the region and are best preserved in the Mediterranean EU countries, where almost one third of the land is under forest or woodland. The MENA countries have only 2.9 per cent of their territory covered by forests and shrubs many of which have either been damaged by wild fires, exploited for fuel wood, overgrazed, converted to cropland or consumed by urbanization. It is concluded that despite land scarcity is evident throughout, actions to prevent or restore degraded lands are only marginal.

2. Water and Food Security Nexus

Water scarcity and associated water quality degradation are expected to become the main environmental and social problems for all the countries in the Mediterranean region, particularly those in the MENA region. Due mainly to the increasing population, demand for water has increased as well and many countries are currently facing water shortages and forecasting future water resource scarcity. This is a problem not only for countries located in the arid areas, but also for those outside such areas which are over using and deteriorating their water resources. A number of Mediterranean countries regularly experience severe water supplies and demand imbalances, particularly in the summer months. Water shortages are also frequently affecting regions less used to such events, where dry spells are becoming more frequent and long lasting. Due to resource scarcity, agricultural activities are especially penalized, while higher priority demands for urban and industrial uses are satisfied. Notice should be taken that agriculture in MENA is responsible for more than 50 per cent of total groundwater abstraction, reaching values superior to the natural recharge, thus leading to the mining of groundwater resources.

Water scarcity and water quality degradation in most of the MENA countries are aggravated by relatively low beneficial water uses as a fraction of total uses, as well as water over-abstraction. According to UNEP/MAP - Plan Bleu (2009), in the Mediterranean region, total (for all uses) losses, leaks and wastage sum up to about 40 per cent of the total water demand. Such losses come partly from dilapidated water distribution networks and limited funds for network maintenance, but also results from high levels of wastage due to less efficient irrigation systems.

On the other side, the growing demand for water to meet agricultural needs is largely met by an increasing over-exploitation of both the renewable and fossil groundwater. Over-exploitation of groundwater, in addition to mining, leads to degradation of the resource (Pereira *et al.*, 2009). UNEP/MAP - Plan Bleu (2009) estimated that this way 16 km^3/year of so-called «non sustainable» water is produced, two thirds of which comes from the abstraction of fossil water and the remainder from the over-use of renewable resources or the re-use of drainage water. In some cases (e.g., Egypt) abstractions exceed the primary renewable resources.

It is clear that water quality and water scarcity are strictly related, as water degradation in the region mainly results from high salinity due to over-abstraction and contamination. Thus, since water in the Mediterranean serves largely for producing food needed to feed its population, the combined effects of shortage and degradation of water resources may lead to reduce agriculture's capability to maintain its per capita agricultural output and to contribute towards achieving food security objectives.

3. Climate Change and Food Security Nexus

Precipitation pattern (spatial intensity and variation), air temperature increase and higher atmospheric CO_2 concentration are three major interconnected CC parameters that will influence agricultural production in the future. Most plant processes related to growth and yield are highly temperature dependent and a shifting of agro-ecological zones (from lowland to upper altitudes and from Southern to Northern areas) is expected. Certainly, this will create new conditions related to land and water availability for agricultural production and modification of agro-ecosystems. On one side, higher temperature will decrease the growing cycle of plant species; on the other, it will extend the overall period suitable for cultivation and allow, in some areas, for more than one cropping in the same year. Nevertheless, the duration of optimum temperature range for obtaining maximum yield could be compromised in many regions. Moreover, it should be recognized that the effects of elevated CO_2 on crop yields could be strongly different among crop type and location. Recent studies confirmed that the effect of elevated CO_2 on plant growth and yield depend on photosynthetic pathway, species, growth stage and management regime (Pereira and

de Melo-Abreu, 2009). Furthermore, the increase of CO_2 concentration would affect also the level of stomata opening and transpiration process.

Therefore, in the future, crop yields affected by climate change are expected to be different in various areas: in some areas crop yields will increase, and for other areas it will decrease depending on the latitude, soil characteristics and water availability for irrigation. In general, crop yield is more sensitive to precipitation than temperature. If water availability is reduced, the soils of high water holding capacity would attenuate better the impact of drought. In general, with the increase of temperature and overall water demand, it is likely that water availability and crop production could decrease in the future. However, the results of investigations are contradictory due to use of different scenarios, various scales of study, difficulties to interact with many correlated parameters, etc. (ISMEA-IAMB, 2009).

In the Mediterranean, the impact of CC on agricultural production could be negative for most areas with a large variability and reduction of crop production (Olesen and Bindi 2002; Ewert *et al.*, 2005; Olesen *et al.*, 2007). No changes or slight increase in yield are expected for autumn and winter crops while, for summer crops, a remarkable decrease of yield is predicted due to a lengthier drought period during this season (Giannakopoulos *et al.*, 2009). The possible increase in water shortage and in frequency and intensity of extreme weather events may cause lower harvestable yields, higher yield variability and a reduction in suitable areas for traditional crops (Maracchi *et al.*, 2005; Todorovic *et al.*, 2012).

As a consequence of air temperature increase and the shortening of the growing season, the average crop water requirements over the whole Mediterranean region are expected to decrease by 4 to 8 per cent (Tanasijevic, 2011, Saadi, 2012). Hence, the average net irrigation requirements (NIR) would decrease or remain stable. This could be explained by an overall reduction of crop evapotranspiration (ET) as well as the spatial and temporal variability of the precipitation change. Therefore, the air temperature increase could have a dominant role on the shortening of the growing season rather than on the increase of crop water requirements (CWR). The impact of precipitation decrease would be limited only to the perennial and winter crops because most of spring-summer agricultural production in the Mediterranean is already characterized by very low rainfall (Tanasijevic, 2011; Saadi, 2012; Todorovic *et al.*, 2012).

However, conditions for rainfed crop systems are likely to be negatively affected by the lack of water availability resulting from CC. Further concerns relate to future agricultural water requirements with respect to water availability under the combined effects of CC, growing population demands, and competition from other economic sectors under future socio-economic development (FAO, 2003; Rosenzweig *et al.*, 2004; Schmidhuber and Tubiello, 2007; Tubiello and Rosenzweig, 2008). in addition, it is important to emphasize the uncertainties related to the combined effects of air temperature and CO_2 concentration increase, future advances of plant breeding and genetics, irrigation and crop production technologies and agronomic management practices. Overall, CC could likely intensify the problems of water scarcity and sustainable agricultural production in the Euro-Mediterranean region

The effects of CC on the coastal areas of the Mediterranean have also to be carefully considered. Coastal erosion caused by natural conditions and human activities and sea level rise, will cause a loss of the productive land and the disappearance of many wetlands. Egypt for instance could pay dire consequences and may lose considerable highly productive lands along its coast compromising food security in the country. In addition, the sea level rise could provoke the intrusion of salty water in the coastal lagoons which provide about one-third of the Egyptian fish production. In fact, the expected increase of air and water temperature would affect the biodiversity of aquatic ecosystems (river and marine) with tremendous consequences on fish production and food security at the regional and global scale (Fig. 9).

The impact of CC on global and regional water resources has been investigated by various authors. The overall results indicated that CC is likely to increase water scarcity around the globe, prevalently in regions that already suffer under present conditions and are exposed to extreme weather events. Warmer, drier conditions will lead to more frequent and prolonged droughts, and the river-basin areas affected by severe water shortage will increase (EEA, 2005; Lehner *et al.*, 2006). However, on the other side, a more frequent and severe flooding could be expected too. As a whole, CC could likely intensify the problems of water scarcity and sustainable agricultural production in the Euro-Mediterranean region (IPCC, 2007) where irrigated agriculture is a major water user accounting for more than 60 per cent of total abstractions.

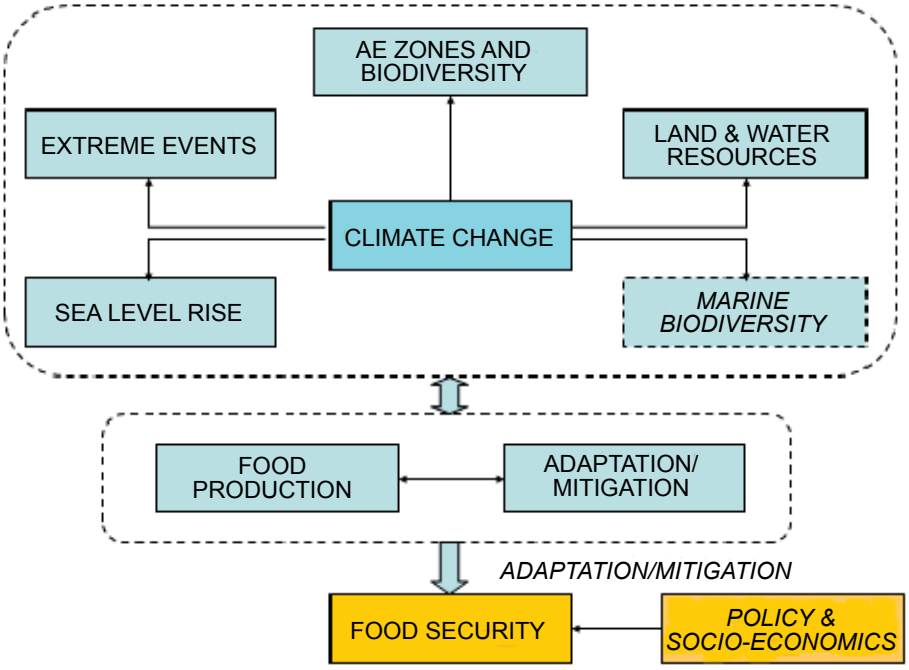


Figure 9. Climate change implications and interlinks with food security

4. Biodiversity and Food Security Nexus

All populations, but in a stronger way the populations of poorer regions in the Mediterranean area, greatly depended on biodiversity richness. For instance, many rural households depend on rainfed farming, local varieties and endemic species as well as fishing and hunting to meet their basic food need. Consequently the loss of biodiversity limit the food options of such populations and undermine the potential for economic growth. For instance, many rural households depend on rainfed farming as well as fishing and hunting to meet their food need. Consequently the loss of biodiversity undermine the potential for economic growth and limit the food options of such populations. The conversion to standardized ecosystems or agro-ecosystem (e.g., monoculture following deforestation) destroys the habitat of diverse species that preceded these areas prior to conversion. At regional level, 149 different threats have been identified by the Mediterranean

countries (CEPF 2010), attaining to degradation and fragmentation of habitats, by-catches, overexploitation, pollution and introduction of invasive species (Cuttlelod, 2008).

The first main cause of reduction of biodiversity is the habitat loss or reduction (fragmentation). Factors contributing to habitat loss are: land use competition, overpopulation, deforestation, pollution (air, water, soil) and global warming due to climate change. Many Mediterranean lagoons and deltas are disappearing because of the growth in artificial surfaces that disturb the equilibrium in sediment balance, especially in heavily populated areas with little or no protection from natural sedimentation process. For surface coastal ecosystems, the most serious threat is posed by the construction of facilities and coastal artificialization. Such typology of "urbanization" lead to the loss of ecosystems with a high level of biodiversity (coastal ponds and lagoons, Posidonia beds and surface bio-concretions), a loss which is virtually irreversible on the human scale (Pergent Martini, 2009).

The other main cause of biodiversity reduction and loss is the natural resources overexploitation. In the case of forests or pastures there is currently a huge disparity between the situations prevailing on the two banks of the Mediterranean (De Montgolfier, 2009). To the north, after a period of major overexploitation of natural areas occurred in 18th and 19th Centuries there is a steady regression and the forests are now making a more or less strong comeback in many areas, due to the abandonment of farming and grazing on soils with low productivity. However, biodiversity is at risk in other areas of extreme farm intensification and increasing urbanization. The nature of the pressure in the south of the Mediterranean region is different as there is still very strong over-exploitation of forests and shrubs for firewood.

The over-exploitation of the marine biodiversity currently appears to be one of the major threats to fish, in particular to the migratory ones and to some mollusc, sea urchin and shellfish species (Pergent Martini, 2009). In addition, there are about 200 large oil tankers navigating in the Mediterranean Sea daily posing another threat to marine life in many ways. Climate change appear to encourage the geographic spread of the species introduced through the Suez canal in particular, by providing them with more favourable environmental conditions than in the past, although it is not the only original cause of the introduction of exotic invasive species into the Mediterranean Sea. Little is known about the possible impact of climate change on many marine species, but as a consequence of it many aquatic permanent and ephemeral ecosystem might disappear (Pergent Martini, 2009).

Habitat size and numbers of species are systematically related. A 2007 study (Lankau and Strauss 2007). conducted by the National Science Foundation found that biodiversity and genetic diversity are co-dependent—that diversity among species requires diversity within a species, and vice versa.

Since biodiversity is closely linked to agriculture, even under the most optimistic scenarios, climate change will cause shifts in suitable areas for cultivation of a wide range of crops. Modelling indicates that rain-fed agriculture yields in some regions of Africa could be reduced by up to 50 percent by 2020 (IPCC, 2007). Climate change may increase temperature of between 2–6 degrees Celsius in the MENA and changes in rainfall regimes anticipate both an increase and decrease in precipitation, and an increased frequency of dry spells and floods (IPCC, 2007). These changes will impact both rainfed and irrigated agriculture, making adaptation necessary. Climate change will have an impact on agricultural biodiversity too by increasing the genetic erosion of landraces and threatening wild species including crop wild relatives (Jarvis *et al.* 2008). Severe pest outbreaks may increase with climate change, profoundly affecting agro-ecosystems and global food availability (Tubiello *et al.* 2008). Food production and access to appropriate varieties in many African countries will be severely compromised, exacerbating food security problems and malnutrition (IPCC, 2007).

Relationships of biodiversity and food security could be better described by the fact that agriculture, arguably the most important ecosystem for human health and wellbeing, have been put under severe stress to meet the demands of a growing population. If the world's nutritional demands have to be met, greater attention must be devoted to the limits of ecosystems and the services they provide (Chappell et al, 2011).

5. Energy and Food Security Nexus

In the MENA countries, the availability of reasonably priced energy is a major factor in resolving the interconnected issues of population, food security and environmental sustainability. Many areas in the MENA region are dependent on groundwater for irrigation as well as for water supply. It is thus obvious that increasing need to pump groundwater for those purposes, which relate to the population growth, will bring with it a corresponding increase of the cost of production and will reduce the productivity of the agriculture in the area. Climate change is likely to exacerbate the problem (see sub-priority 3: the climate change nexus), as it will amplify demand for reliable energy supply. This will affect the development of the rural areas in the region and have implications on food security and sustainable livelihoods. As a consequence, it is expected that the energy balance in the area will be affected by the extent to which water management (see sub-priority 2: the water nexus) may be improved to reduce total energy consumption and by the capability in the area to increase supply through renewable energy sources.

The issue of food security linked with energy is very complex; indeed, the problem has been out of for several years as it sits uncomfortably with notions of regional free trade areas and interdependence. However, the combination of sudden global commodity price rises and the continuing inhibitions to free trade in foodstuffs and agricultural products within the Mediterranean region has made it, once again, a subject of acute concern to regional governments. In addition, an examination of the actual trade figures of the Med-10 countries demonstrates that the majority of them are food deficit countries.

Energy efficiency measures, behind-the farm gate and beyond-the farm gate, have been promoted in the MENA countries with varying degrees of success. Historically, energy costs have been a small component of the total operating costs for many food businesses and, for this reason, incentives to reduce energy demands have not been strongly promoted.

Energy is strictly interrelated to water and food security in a number of ways. Food production, especially large-scale agriculture, depends both on energy and water as essential inputs. Water pumping, treatment and redistribution need energy; and energy production needs water. Energy inputs via fertilizers, tillage, harvest, transport, and irrigation and processing have their influence on food prices. Environmental pressures and climatic changes, as well as growing economies and populations, both intensify the existent relations between the three systems. In regions with limited water resources and growing population (such as MENA), those linkages are even tighter and more challenging. In these countries, the population growth and the increasing demand for food is changing (worsening) the rainfall and weather patterns. More of the freshwater available is demanded by energy, industrial and urban systems. Farmers are induced to pump from aquifers faster than they can be replenished (especially in cases where electricity is subsidised) and, as water levels drop, energy for pumping continually increases. In this context, desalination become an option but it is very energy-intensive, can increase CO_2 emissions if fossil fuels are used and is associated with environmental concerns such as brine disposal.

Given these strong connections, each sector (energy, water and food) has the potential to drastically affect the others. Droughts, besides reducing crops and contributing to high food prices, may also impact energy supplies (when water withdrawals are for cooling power plants). Subsidies for food, energy, or water, for example, often have unintended consequences for the other two sectors. The popularity of biofuels as an alternative fuel, for instance, has brought

unintended consequences for food and water. Biofuels consume water; additionally, by competing for cropland, they have increased cereal prices on world markets and are not a viable option for the Mediterranean, especially the MENA region.

If food security is to be achieved, strategies, policies, and investments need to consider all the related areas of energy, water and food production, distribution, and use, especially in developing countries. And yet, due to the width of the individual sectors, there is little work focusing on how to support decision-making at the nexus. When it is done, it normally focus on two areas only, and few approaches have comprehensively addressed the broader interdependencies (Bazilian *et al.*, 2011). Thus, the need for understanding the energy-water-food nexus and the impact on it of climate change is obvious and demands for systematic, coordinated planning approach.

The energy-water link in irrigation schemes: results from a case study in Vigia Irrigation District, Alentejo, Portugal

This study analysed the energy efficiency of sprinkler irrigated sunflower, wheat and maize crops during the summer season of 2008. It was applied to selected farms where pressurised water distribution systems are used. Impacts of the crops' energy balance when full and deficit irrigated, as well as relative to upgrading irrigation systems performance were assessed. Centre-pivot and solid set sprinkler systems were used. Energy efficiency (EE) was computed as the ratio between the energy output represented by the crop production and the total energy input; EE hence indicates the amount of energy produced by a crop per unit of consumed energy. Results have shown that maize was the most efficient in producing energy and wheat was the least for all the scenarios considered. Results for maize have shown that adopting a centre pivot system and a full irrigation schedule EE varied between 2.06 and 2.23, while for the solid set sprinkler system EE ranged from 1.89 to 2.18. For wheat, EE averaged 1.32 for centre-pivot and 1.23 for set systems. Results for full irrigation presented higher EE than deficit irrigation because EE greatly depends on the yields achieved. Results have shown also that improving the irrigation system performance leads to increased EE but related impacts are small. Only weak relationships were found when relating EE and water productivity (WP). Results are influenced by the share of irrigation energy input in the total energy input. This share may be greater than 50 per cent for sunflower, is close to 42 per cent for maize, and less than 40 per cent for wheat. The greatest share corresponds to solid set systems when compared to centre pivot systems. Thus centre-pivot irrigation favours attaining higher EE. The low EE values referred above do not favour the use of irrigation for bio-fuel production. Results also indicate that there is a risk when converting surface irrigation to pressurized irrigation which relates to the high share of energy used for irrigation when it is pressurized.

Rodrigues et al., 2010.

However, today as energy costs have increased and more businesses set targets to reduce their carbon footprints, there is renewed interest in improving energy efficiency. In addition, as new energy demand from expanding food sectors in MENA countries are increasing, efforts are being made to minimize their energy intensities. Opportunities to reduce the energy intensity can come from modifying at no or little cost existing farming and food processing practices. These modifications would also require changes in the behaviour of farmers, managers and operators. Introduction of new modern efficient equipment is another option. However, this may require significant capital investment. Producers in MENA countries may be faced with financial constraints to adopt improved energy efficient technologies, such as precision farming, irrigation monitoring, and transport logistics. Options need to consider the balance between efficiency measures, projected energy costs and the need of improving energy access and affordability.

This problem not only affects water-scarce arid countries globally, but also those where intensive agriculture is already practiced, and where water productivity has to be increased and/or diffuse pollution impacts need to be reduced. Despite the strategic interest of this topic, and the technical developments achieved in recent years in reducing water use and energy consumption in water distribution systems, there exists still major opportunities to introduce more effective (and necessary) innovations both in technology and management approaches. In fact, the interest of the water-energy-nexus has led to substantial technical developments to reduce water use and energy consumption in water distribution systems. Responding to the above challenges, it is important to support and boost the necessary innovations, to help overcome the identified barriers, and to develop appropriate conditions for new market opportunities, mainly on: i) Remote control, electro-mechanical components and technologies in water distribution systems, ii) Modelling and development of decision support systems (DSS) in relation to optimum design and management of water distribution systems and pumping stations (Khadra and Lamaddalena, 2010), iii) Pressure and water requirement reduction by means of new on-farm devices and precision irrigation (i.e. on-farm technologies and management, demands forecast, etc.); iv) Electricity tariff policies and energy market negotiation.

We emphasise again that bio-fuels are not an option for the Mediterranean due to its limited land and water resources. On the contrary the region must invest in renewable energy sources (solar and wind) and use its land for producing food and feedstock. Recent data point out that even globally, if the arable land would be used to grow bio-fuels such production would be able to meet by 2050 only 4-6 per cent or the world's energy needs while using 85 per cent of the world's fresh water resources (HLPE, 2013).

IV – Future research needs

Investing in research pays back!

> "In the United States over the past half century, every dollar invested in public agricultural R&D returned benefits valued at between 20 to 30 dollars. Changes in US corn production illustrate how investments in research and development have paid off in productivity gains. US corn production grew from 67.9 million metric tons in 1900 to 312 million tons in 2011, or 36 per cent of the entire world's output, while over the same period the amount of land under corn production decreased. A sizeable share of the growth derived from use of technological innovations (notably, new hybrid varieties of corn) resulting from investments in research"
>
> *(The Chicago Council on Global Affairs. 2013)*

1. Land

To forget how to tender the land is to forget about ourselves.
Mahatma Gandi

To describe better future research needs it is necessary to make a distinction between the concepts of "soil" and "land". Soil is the most upper layer of the Earth's crest (called also Earth's skin) that is more closely related to farming and by pedological agreement ends up to 2 m deep, even though often soils are much deeper. Land on the other side is a delineable area of the Earth's surface, encompassing all attributes of the biosphere immediately above or below this surface, including those near the surface, the climate, *the soil* and the terrain forms, the surface hydrology (including shallow lakes, rivers, marshes, and swamps), the surface sedimentary layers and the associated groundwater reserves, the animal populations, the human settlement pattern and the physical results of past and present human activity such as terracing, water storage or drainage structures, roads and buildings, etc. (FAO 1998). We deal primary in this chapter with land resources.

Despite covering a very limited part of the Earth, soils produce more than 99 percent of global food needs. Fibber, fodder and recently bio-fuels, are other soil by-products. Additional soil-beneficial environmental functions have been recognised by the EU Strategy for Soil Protection (EC COM (2006) 231) such as water filtering, buffering, storing, and cleaning of pollutants, carbon sequestration, source of raw materials, preservation of biodiversity and of archaeological heritage. To this end, implementation of *sustainable land management* (SLM) technologies is hence the best approach for mitigation, remediation and sustained agricultural development. Healthy soils produce healthy food!

However, further studies are needed to show the potential of SLM to increase yields, soil organic content and carbon sequestration capacity, and how best to improve the interaction between the soil-plant-water system and increase land productivity while protecting the environment. Research should also deepen to the practical assessment and application in Mediterranean conditions of technologies such as conservation agriculture, no till or reduced tillage, agro forestry, mulching, cover crops, controlled grazing, integrating crop and livestock production, and well designed terracing to control soil erosion, as well as halophyte cultivation in saline areas. The traditional benefits of crop rotations, nitrogen fixing legumes and trees and the combination of no-till with cover crops needs to be experimented further in a holistic approach (including relative to water) and the *win win* benefits of conservation agriculture in improving soil fertility and increasing crop productivity must be better explored (Bisaro *et al.*, 2013).

Photo credit: F. Turkelboom

Photo credit: R. Bouabid

Figure 10. Well designed terraces in Syria and Morocco

Additional studies are needed to endorse *productive farming systems* that mostly promote reduced fertiliser use, water conservation, backing of organic farming, conversion of arable land to grassland, cover crops and strips preventing erosion and fires, preserving areas of special biodiversity, maintenance of existing conservation systems, and preserving farmed and rural landscapes. Social aspects and issues in relation to land use and particularly with combating desertification are also priority areas.

2. Water

In order to tackle these challenges, Mediterranean countries will need to promote more efficient measures for managing scarce water and agricultural land in a sustainable manner. Managing supply, increasing water use efficiency and re-allocation of irrigation water, protecting water quality and re-using non-conventional water resources for irrigation are the main key issues for further research (CIHEAM, 2004; FAO, 2012).

In order to tackle these challenges scientific research and policy actions should be focussing on several strategies (Breisinger et al, 2010; CIHEAM, 2004; FAO –ICID, 2011; FAO, 2012; Molden, *et al.*, 2010; Pereira *et al.*, 2009) as below:

- Upgrading rainfed agriculture: rainfed systems dominate world food production and they cover most of the world's cropland area (80 per cent). However the remaining 20 per cent (or the irrigated area) produce 60 per cent of cereals globally. Upgrading rainfed agriculture could generate social, economic, and environmental paybacks, particularly in poverty reduction and economic development. Estimates suggest that about 75 per cent of the increased water requirements needed to attain the 2015 hunger reduction target of the Millennium Development Goal will have to come from water investments in rainfed agriculture, i.e., in water conservation or, in other words, in making better use of the green water. Introducing and/or improving water harvesting techniques may be strategic for rainfed agriculture in the area but other approaches to improve infiltration, soil water storage and decrease evaporation are definitely required (Pereira *et al.*, 2009);
- Increasing production in irrigated areas and consequently improving water use at different scales from crop to irrigation system: in regions that rely heavily on agriculture, irrigation is likely to be even more important in food security strategies; in addition, the increasing competition for water will be an incentive for irrigation to perform better;
- Increasing water resources availability through modernized collection and distribution infrastructures, taking into account economic, social and environmental sustainability criteria, and particularly by improving irrigation water service performances (Lamaddalena and Pereira, 2007; Zaccaria *et al.*, 2010);
- Reducing water losses and wastage, particularly by restoring and modernizing networks in a state of disrepair or having low service performance, and providing for increased performance of irrigation systems, thus for more efficient, sustainable water use;
- Increasing water resources availability through non–conventional water resources such as the re-use and recycling of wastewater and the use of saline water as well as desalinated water. Undoubtedly, water scarcity is a major incentive to finding alternative water supplies. Water conservation is an answer to the problem and certainly wastewater reuse is an important component in water conservation strategies. Wastewater use for irrigation may have the largest field of application because it offers attractive environmental and socio-economic benefits, mainly due to the reduction in effluent disposal in receiving water bodies, nutrient recovery as fertilizers, and improvements in crop production during the dry season; however research is needed to control impacts on soils, on crops and on human health (Coppola *et al.*, 2003; Coppola *et al.*, 2004);
- Supporting diversification in agricultural production in order to re-orient trade flows of food by reducing the production of low-value water-intensive crops. Appropriate economic related research is therefore needed;
- Enhancing water multiple-use systems since the largest gains in water productivity can be achieved by using water for many productive and non -productive purposes such as fisheries, livestock, domestic and environmental;
- Institutions and policies for a new and democratic water governance as essential elements to implement options and strategies for a more sustainable water management.

There is also an urgent need for investment in scientific research and policy changes that will allow water -dependent countries to become more resilient by improving their agricultural productivity, reducing water losses through water conservation measures and water harvesting (Suweis *et al.*, 2013).

3. The Climate Change

As mentioned, CC will affect the agro-ecosystems in heterogeneous ways, with either benefits or drawbacks dominating in different agricultural regions. The shifting of agro-ecological zones will be one of the primary impacts which will interacts with the land and water availability and agricultural productivity under new conditions (CIAGR, 2012). These impacts will lead to the new scenarios and various implications in different areas of the Mediterranean that could have a relevant impact on the overall development of the entire region. In the coastal areas, it should include the sea level rise and loss of agricultural land and biodiversity. The concept of integrated coastal zones management (ICZM) strategy has been formally introduced with the adoption of the UE Recommendation 2002/413/CE by the European Council and Parliament and remain a crucial priority for the Mediterranean.

The relationship between CC, natural resources, agricultural production and food security is very complex and needs a consideration of both bio-physical, social, economic, technical, political and anthropogenic (management) factors and their interactions at different scales and directions (from local to global level and vice versa). Unquestionably, a particular attention should be given to the water-energy-food security nexus which represents one of the kernels of the Green Economy concept and pursues the sustainability development goals[7]. Hence, the eco-efficiency of agricultural water systems and agricultural production could be one of the main topics for further investigations. The efforts should focus on the adaptation measures and the interrelations of innovative technology uptake in agricultural water systems, and their economic and environmental impacts. Research should address the selection of appropriate indicators for assessing system-wide eco-efficiency improvements, the integration of existing tools and assessment methods in a coherent modelling environment, and the analysis and characterisation of existing structures and policies. Then after, the eco-efficiency approach should be extended also to the whole chain of food production, conservation, transport and consumption.

The above mentioned studies should consider a large range of proposed mitigation and adaptation measures to climate change and especially those focusing on conservation and more efficient use of natural resources in agriculture and other sectors (Porter *et al.*, 2010). Particular attention should be reserved for the combined effects of temperature increase, rainfall variability, CO_2 increase and genetic and technological improvements (CGIAR, 2012). Hence, water and carbon balance of modern agro-ecological systems should be among the priorities for research. Equally so, the adaptation to extreme weather events and various abiotic stresses are of primary importance for agricultural production and food security. In fact, for arid and semi-arid Mediterranean lands it is essential to select management practices and exploit varieties able to respond to adverse environmental conditions and to increase yields and water productivity and, in the future, triggering specific combinations of abiotic stresses (e.g., water, heat and salinity) and greater pressure on water resources.

Unquestionably, the translation of research findings into policy making and on-ground implementation in the region are of paramount importance. In fact, the aim should be to promote appropriate and efficient farming systems able to adapt to climate change while reducing pollution and impacts on the environment and getting the benefits of CC (Ewert, 2012). This will be possible through an appropriate institutional setting and further funding of the initiatives that focus on the demonstration units and on-farm implementation activities that include the application of modern monitoring and decision-making technologies (FAO, 2008a). Surely, it could permit the identification and adoption of the locally tailored best management practices that can optimize the use of resources in agricultural production. In addition, it will require on-farm training, field days campaign and increase of awareness on the relevance of the topic for the whole society. The promotion of alternative educational approaches as distance learning courses could be of large interest.

4. The Biodiversity

Although indicators of the state of biodiversity are already able to show declines, there are considerable gaps in their geographic, taxonomic and temporal coverage (CEPF, 2010; Pergent Martini, 2009). Biodiversity loss is a global phenomenon but its impact may be greatest in areas were indicators and data coverage are the least available complete. Particular gaps in knowledge for state indicators include: grassland and wetland extent, habitat condition, primary productivity, genetic diversity of wild species, freshwater and terrestrial trophic integrity, ecosystem functioning and ocean acidification (GEO 5, 2012). Pressure indicators lack data on pollution, exploitation in terrestrial and freshwater ecosystems, wildlife disease incidence and freshwater extraction (GEO 5, 2012).

The principal gaps in response indicators include sustainable management of agriculture and freshwater fisheries and management of invasive alien species, relationship between landscape asset and species (GEO 5, 2012).

Minimizing the adverse impacts of climate change on biodiversity is dependent on the efforts to mitigate climate change itself and on the measures to ensure that the activities and the societal adaptation efforts do not themselves have adverse impacts on biodiversity. Many approaches to adaptation are dependent on the conservation and sustainable use of healthy ecosystems and offer opportunities for synergies in terms of climate change mitigation and maintenance of biodiversity. Further analysis and research are needed on the effective impacts of application of best practices in conserving and restoring biodiversity facing climatic change. This concerns intact forests and wetlands, but also natural and semi-natural grasslands and agricultural ecosystems. For example, some agricultural approaches, such as conservation tillage and agro-forestry, can result in the maintenance and enhancement of terrestrial carbon stocks and also contribute to the conservation and sustainable use of biodiversity (CBD 2009). In this frame studies aimed to prevent the introduction and spread of plant pests and to promote appropriate measures for their control are needed too.

Integration of protected areas into broader landscapes and seascapes through ecological networks, ecological corridors and/or buffer zones to maintain ecological processes and take into account the needs of migratory species are urgent. The research could help to identify priority marine ecosystems and limit use in these areas, through, inter alia, designation of protected areas. Sustainable use of the components of biological diversity foresees investigations to support remedial action where biological diversity has been reduced.

The need for adapted germplasm will require characterization, evaluation, and availability of materials coming from hotspot areas and/or stored in the gene banks all over the world. The amount or identity of plant genetic resources that may be useful to adapt agriculture to climate change cannot be precisely known a priori. Assessments of necessary traits and the conservation and characterization of the broadest range of genetic resources available are needed.

Conservation of genetic resources will become a key issue and in depth analysis are needed to focus on benefits and threats that might arise time by time from the *in situ* and the *ex situ* modalities of conservation to better enable choices (GEO 5, 2012). Some of the more important traits to be found in varieties and genotypes for responding to climate change include: drought tolerance, extreme events tolerance, resistance to very hot and humid conditions, pest and disease resistance, and separation from certain climate sensitive pollinators or symbionts. Most of these traits may be present in traditional cultivars or wild species, but additional studies and further engagement are needed to stop the genetic erosion they are subject too.

Maintaining knowledge of indigenous communities relevant for the conservation and sustainable use of biological diversity, to promote their wider application must be encouraged and the resulting benefits must be widely disseminated. Studies and analysis on collaborative approaches to

achieve sustainable use of biological diversity and fair and equitable sharing of benefits arising from the use of genetic resources should remain primary research goals for the future biodiversity conservation in the Mediterranean.

5. Energy

Traditional sources of energy are getting scarcer. As the impact of climate change becomes evident and efforts are made to minimize greenhouse effects, the nature of energy production will fundamentally change. The overall result is definitely increased energy costs. Thus, innovative energy conservation programmes are required.

Renewable energy can be used throughout the food sector either directly to provide energy on-site or indirectly by integrating this energy into the existing conventional energy supply system. Renewable energy sources tend to be widely dispersed throughout rural areas. The availability of a reliable and affordable energy supply can become an essential component for sustainable development.

Reducing the dependence of food systems on fossil fuels by using renewable energy is feasible for farm and aquaculture production. Renewable energy can also be used for transporting raw food feedstock, processing food, distributing finished products and cooking. In MENA countries, renewable energy also presents opportunities to provide much needed basic energy services. Adequate supply of energy in the immediate post-harvest stages is important for reducing food losses. Because of this, significant attention has been given to the possibility of using renewable energy in these countries. For instance, solar energy and biomass have been successfully used for both dry and cold storage.

In locations where good renewable energy sources exist, farmers, fishermen and food processing businesses have also opportunities to generate wind power, solar power, micro-hydro-power. Solar thermal, biomass and geothermal resources generated from decentralized facilities can be used for both heating and cooling.

Animal waste, crop and forest residues, by-products from food processing, food waste from retailers, households and restaurants are examples of biomass originating from different stages of the food supply chain. These biomass resources are flexible energy resources. They can be:

- used on-site if and when needed to provide direct energy inputs;
- processed on-site into energy carriers for sale elsewhere;
- sold off-site for collection and use at community heating or anaerobic digestion CHP plants; and
- sold off-site and collected on a wider scale and in greater volumes to supply larger commercial liquid bio-fuel production plants.

As more knowledge and experience is gained, the costs for renewable energy technologies are likely to continue to decline. In many specific situations, renewable energy is already economically competitive. For example, in remote rural areas without access to the electricity grid, autonomous renewable energy systems are competitive as they allow users to avoid the high expenses involved in connecting to the grid.

V – Policy outcomes

Natural resources management requires the endorsement of an ecosystem-based integrated approach that pays particular attention to both human and environmental components (Conway, 2012). Land, water, biodiversity, climate change and energy are interlinked to each other and the disruption of one of them will definitely impact the others. The Mediterranean region is particularly sensitive to these relationships due to its natural, social, economic and political context.

> ***"Mediterranean syndrome"*** *is characterized by structural deficiencies common to most Mediterranean countries, such as corruption, the lack of comprehensive plans or programmes to combat environmental problems and poor cooperation between the various administrative sectors that hold competence in issues such as desertification*
>
> *(Wilson and Juntti, 2005).*

Therefore, developing and proposing policy outcomes requires first a thorough review of existing Euro-Mediterranean regulatory frameworks and policies and the impacts they have on natural resources at local, national and regional scale. Further on, the role of participatory and scientific context in policy development, guidelines and policies and the wide range of boundary conditions including national and regional dimensions, the institutional framework and its influence in policy development are paramount preconditions to be considered first.

Guidelines and indicators for the establishment of incentives for land-users to enhance sustainable natural resources management and conservation, development of economically sustainable measures that match with environmental quality, establishing the role and responsibilities of rural communities, scientists, researchers, policy and decision-makers in natural resources management and biodiversity conservation requires the adaptation of policies and regulations that follow carefully local conditions and differences between North and South as well as South-South.

One thing is sure however: there is not such as an "*absolute perfect policy"* universally suitable for every place. Last but not least, even the best policies and guidelines would have no impact on the ground if they are not implemented. On the contrary they could have the opposite effect meaning further destruction and degradation. The complex policy, economic and socio-cultural structures that operate at the local, regional and national levels in areas of Mediterranean EU countries and MENA region provide a unique background to explore and analyse how these could hinder, or promote, the implementation of policies aimed at alleviating the threats deriving from natural resources degradation and climate change.

The Mediterranean is one of the most prominent birthplaces of civilization. It is rich in biodiversity, and all kinds of energy sources (non and renewable) and in best management indigenous (and ingenious) practices in land and water management. Still-productive ancient terraces in Italy, Turkey, Syria, Morocco etc, ingenious irrigation systems including the Sahara oasis, and sustainable land use patterns spread throughout the region could easily prove this. However, the region is faced also with a number of degradation processes that are seriously threatening its future and its people especially food security. They include water and wind erosion, salinisation, overgrazing, deforestation, forest fires, vegetation cover destruction, desertification and drought, climate change, water scarcity, soil impoverishment, floods, groundwater degradation and contamination, etc. These processes often are accelerated by human mismanagement that has brought in many cases to irreversible damages. In this case, the impacts of these degradation processes become heavier with the weakness or lack of societal commitment and/or governmental responses.

Many crucial policy and governance questions remain still open and some of them are listed below as a framework for discussion and debate:

- Haven't we witnessed cases of wrong policies?
- Is the wrong or weak implementation of adequate legislation and appropriate policies a common practice in the Mediterranean?
- Is it enough only to document a problem, orient research towards problem solving and then do little to apply it?
- Did the existing links between the research bodies, governmental institutions (policy and decision makers), civil stakeholders and end users reveals to be effective?
- What about the impacts of partnerships between the governmental bodies, private sector and NGOs in reversing resource base degradation and to which extent?
- Who is responsible for natural resources degradation and who must pay for it?
- How can we promote the bottom up approach to strengthen the democratic and creative basis of legislation and policies related to combating natural resources degradation without undermining the coherence and implementation of relevant laws and decisions?
- What is the role of the farmers and other local stakeholders in the elaboration of guidelines to support policy making?

Natural resources management policies and institutional frameworks related to biodiversity conservation, land and water management, climate change adaptation and mitigation and increased energy efficiency have a strong impact on the economical development and environmental quality of every country. They require the development and adoption of legislation and regulatory aspects as well as the elaboration policies and guidelines addressing country specific conditions.

In particular the Mediterranean countries need to pay special attention to the below mentioned issues:

- ***Coordination gaps*** and lacks in decision making at national, regional or local level;
- International donors and development agencies including the EU, should consider themselves as ***stakeholders*** and fully responsible for the foreign aid invested in the MENA region and not as outsiders or simply financing entities;
- ***Disparities in legislation framework*** between the Mediterranean EU nations and those in the MENA are evident; not withstanding this, results on the ground show that both regions face similar problems in natural resources management;
- ***Competing forms of land use*** and issues like food security, food safety, trade and market strongly influence the status and quality of natural resources and the overall social and political stability especially of the MENA countries;
- ***Agricultural productivity and environmental quality*** are very much linked to each other; legislation should consider them both in an ecosystem-based context;
- ***Interference*** between different aspects of legislation makes difficult to establish the roles and responsibilities of governmental structures at all levels therefore legislation needs to be renewed and updated continuously;
- ***Decentralisation*** of power and local involvement in decision making ***policies*** through a bottom-up approach could increase chances of success in sustainable natural resources management, public awareness and active participation. However experience shows that societies that switch from ***centrally-controlled*** forms of governance to more democratic systems tend to accelerate degradation of the natural resources as the rule of law implementation is weakened due to the diminishing role of governmental institutions and the mistrust on them by the local people; knowing this, it is required to use public participation to prevent such negative issues;

- ***Policy and politics*** are two different things; being a politician does not necessarily mean being a good policy-maker. Following this, the support of the scientific community in policy development is essential and should be strengthened;
- ***Corruption*** could have devastating repercussions on natural resources. It should be combated with the same strength as the naturally occurring degradation processes;
- ***Good governance*** should be based on sound institutions, prudent policies, transparent processes, open access to information, and equitable public and democratic participation in decision making.

Further attention should be paid at ways in which the multi-functionality of agriculture can be enhanced and some of its negative outputs, especially in the context of climate change, can be minimized. But, considering future developments and most importantly population increase in the MENA, the agricultural sector will continue to play a dominant role both in the rural areas of Europe and most importantly in North Africa and the Middle East. This would require that the agriculture development policies and natural resources management advance harmonically and not at the expense of each other.

VI – Final remarks

Meeting the region's food needs will be one of the most important challenges and a package of solutions including sustainable land management, efficient use of water, conservation agriculture, high yielding cultivars best suited to climate change, and better use of fertilizers is needed rather than promotion of a single strategy. Still the region will continue to rely on food imports to meet its basic nutritious needs. Biodiversity conservation and mitigation/adaptation actions to climate change will remain important priorities for a region that is particularly vulnerable to these threats. Unfortunately, natural environmental endowments do not offer easy solutions to these problems. The critical conditions for land and water management and stewardship call for a complete reassessment of roles and potentials of agriculture and overall natural resources management strategies. These might include retrenchment of agriculture into the most favoured areas, supported by comprehensive, enabling policies, good governance and programmes and set aside areas that are at environmental risks. Furthermore, closer links with ecotourism and re-renewable energy production (solar and wind) should be explored but not at the expense of fertile soils that must be conserved for food production.

Despite the technical developments achieved in recent years in reducing water use and energy consumption in water distribution systems, there are still many opportunities to introduce more effective (and necessary) innovations both in technology and management approaches to reduce energy consumption in water distribution systems.

Finally research results must find the way towards implementation. Addressing sustainability concerns in natural resources management requires the adaptation of an ecosystem based management approach that considers both natural conditions and socio-economic factors. This approach should be ecologically sound, economically viable, socially just, culturally appropriate, humane and based on a scientific holistic approach. Consequently, sustainable natural resources use and management in the region is not a choice but a prerequisite to secure prosperity and improve the livelihoods of its people by establishing societal responsibilities and priorities in this crucial process.

References

Barbero-Sierra C., Marques MJ., Ruíz-Pérez M. 2013. The case of urban sprawl in Spain as an active and irreversible driving force of desertification. Journal of Arid Environments Vol. 30:95-102.

Bates B.C., Kundzewicz Z.W., Wu S., Palutikof J.P., Eds. 2008. Climate Change and Water. IPCC, Geneva. Technical Paper VI of the Intergovernmental Panel on Climate Change.

Bazilian M., Rogner H., Howells M., Hermann S., Arent D., Gielen D., Steduto P., Mueller A., Komor P., Tol R. J., Yumkella K. K., 2011. Considering the energy, water and food nexus: Towards an integrated modelling approach. Energy Policy, doi:10.1016/j.enpol.2011.09.039.

Bisaro A., Kirk M., Zdruli P., Zimmermann W. 2013. Global drivers setting desertification research priorities: insights from a stakeholder consultation forum. Land Degradation & Development DOI:10.1002/ldr.2220. Wiley

Breisinger C., van Rheenen T., Ringler C., Pratt A.N., Minot N., Aragon C., Yu B., Ecker O., Zhu T., 2010. Food Security and Economic Development in the Middle East and North Africa. Current State and Future Perspective. IFPRI Discussion Paper 00985, May 2010.

CEPF, 2010. Ecosystem profile – Mediterranean Basin biodiversity hotspot. Critical Ecosystem Partnership Fund, Arlington, USA

Chaline C. 2001. Urbanisation and town management in the Mediterranean countries. Evaluation and Perspective for Sustainable urban development, Plan Bleu. [online] URL: http://www.planbleu.org/publications/chaline_eng.pdf [last accessed 8 November 2012].

Chappell M.J., LaValle L.A. 2011. Food security and biodiversity: can we have both? An agroecological analysis. *Agriculture and Human Values.* 28: 3-26

CGIAR, 2012. Impacts of climate change on agricultural and aquatic ecosystems and natural resources under the CIGR's mandate. Working document N°23. 201pp.

CIHEAM, 2004. Food Security under Water Scarcity in the Middle East: Problems and Solutions (Ed. Hamdy A. and Monti R.), CIHEAM Options Méditerranéennes, Série A, N. 65.

Conway G. 2012. One billion hungry: Can we feed the world ? Cornell University Press.

Coppola A., Santini A., Botti P., Vacca S., 2003. Urban wastewater effects on water flow and solute transport in soils. Journal of Environmental Science and Health. Part A-Toxic/Hazardous Substances and Environmental Engineering Vol.A 38, 8: 1479-1488.

Coppola A., Santini A., Botti P., Vacca S., Comegna V., Severino G., 2004. Methodological approach to evaluating the response of soil hydrological behavior to irrigation with treated municipal wastewater. Journal of Hydrology 292 (2004) 114–134.

Coppola A., 2007. Report on Analysis and Options for Controlling Salt Balance. CIHEAM/IAMBari and "Cooperazione Italiana", Italian Government PROJECT "Rationalisation of Ras El Ain irrigation system: - Sustainability of irrigated agriculture in the Ras El Ain area, Syria

Coppola A., 2010. Report on Analysis and options for monitoring water and salts in soils of Al Hassakeh and Al Raqqua governorates. CIHEAM/IAMBari and "Cooperazione Italiana", Italian Government Project "Rational Use of Natural Resources to Improve Agricultural Productions"

Cuttelod A., García N., Abdul Malak D., Temple H., Katariya V., 2008. The Mediterranean: a biodiversity hotspot under threat. In: J.-C. Vié, C. Hilton-Taylor and S.N. Stuart (eds). *The 2008 Review of The IUCN Red List of Threatened Species*. IUCN Gland, Switzerland.

De Montgolfier Jean, 2009. *Natural terrestrial eco system*in UNEP/MAP-Plan Bleu: State of the Environment and Development in the Mediterranean, UNEP/MAP-Plan Bleu, Athens, pp. 61 - 65. ISBN : 978-92-807-3061-6

EEA, EUROPEAN ENVIRONMENTAL AGENCY, 2005. The European Environment. State and outlook.

EEA, EUROPEAN ENVIRONMENTAL AGENCY, 2008. Impacts of Europe's changing climate — 2008 indicator-based assessment, EEA-JRC-WHO report, EEA Report No 4/2008, JRC Reference Report No JRC47756.

Eilers E. J., Kremen C., Smith Greenleaf S., Garber A. K., Klein, A-M., 2011. Contribution of Pollinator-Mediated Crops to Nutrients in the Human Food Supply. *PLoS ONE.* 6 (6) e21363. This study is free to view at: www.plosone.org/article/info:doi/10.1371/journal.pone.0021363

Ewert F., Rounsevell M.D.A., Reginster I., Metzger M., Leemans R., 2005. Futures scenarios of European agricultural land use. I: Estimating changes in crop productivity. *Agriculture, Ecosystems and Environment* 107, 101-116.

Ewert F., 2012. Adaptation: Opportunities in climate change? *Nature Climate Change* 2, 153-154.

FAO, 1998. Terminology for integrated resources planning and management. Choudhury, K. and Jansen L.J.M. (eds). FAO, Rome.

FAO & ICID, 2011. Forum on "Contribute to food security by optimal use of water" for the 6th World Water Forum, www.worldwaterforum6.com

FAO, 2003. World Agriculture Towards 2015-2030. FAO, Rome
FAO, 2008a. Food outlook: Global Market Analysis, FAO, Rome.
FAO, 2008b. Climate change and food security: a framework document, FAO, Rome, 107pp.
FAO, 2009. Declaration of the World Food Summit on Food Security, November 16–18, 2009, Rome.
FAO, 2010. Biodiversity and nutrition. A common path. FAO, Rome. http://www.fao.org/fileadmin/templates/food_composition/documents/upload/Interodocumento.pdf
FAO, 2012. Coping with water scarcity. An action framework for agriculture and food security, FAO Water reports 38.
Ferrara R. M., Trevisiol P., Acutis M., Rana G., Richter G. M., Baggaley N., 2010. Topographic impacts on wheat yields under climate change: two contrasted case studies in Europe. *Theoretical and applied climatology.* 99 (1-2): 53-65.
Gardi C., Panagos P., Bosco C., de Brogniez D. 2011. Soil Sealing, Land Take and Food Security: Impact assessment of land take in the production of the agricultural sector in Europe. European Commission, Joint Research Centre, Ispra, Italy
GEO5. Global Environment Outlook: The future we want - Chapter 5 – Biodiversity. UNEP ISBN: 978-91-807-3177-4.
Giannakopoulos C., Bindi M., Moriondo M., Le Sager P., Tin T. 2005. Climate change impacts in the Mediterranean resulting from a 2°C global temperature rise. Report for WWF, 1 July 2005.
Giannakopoulos C., Bindi M., Moriondo M., LeSager P., Tin T., 2009. Climate Changes and associated Impacts in the Mediterranean Resulting from a 2°C Global warming. *Global and Planetary Change*, n. 68: 209-224.
Giorgi F., 2006. Climate change Hot-spots. Geophys. Res. Lett. 33, L08707
Giorgi F., Lionello P., 2008. Climate change projections for the Mediterranean region. *Global and planetary change*. 63(2-3): 90-104.
Gomaa M., 2005. Participatory management of salt-affected soils in Egypt: role of Executive Authority for Land Improvement Projects –EALIP. In *Promoting participatory management of the land system to enhance soil conservation,* Zdruli P, Trisorio Liuzzi G. (eds). Workshop proceedings, Alexandria, Egypt. MEDCOASTLAND publication **3**: 101-118, IAM Bari
Hamdy A., Monti R. (Eds), 2005. Food Security under Water Scarcity in the Middle East: Problems and Solutions, Options Méditerranéennes A65.
Hanjra M. A., Qureshi M. E., 2010. Global water crisis and future food security in an era of climate change, *Food Policy*, 35, 365-377
HLPE, 2013. Biofuels and food security. A zero-draft consultation paper. High Level Panel of Experts on Food Security and Nutrition. http://typo3.fao.org/fileadmin/user_upload/hlpe/hlpe_documents/_Biofuels/HLPE_V0_draft_report_Biofuels_and_Food_Security-09-Jan-2013.pdf [last accessed 18 January 2013]
IPCC (International Panel on Climate Change), 2007. Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA
I**SMEA-IAMB, 2009.** "Cambiamenti Climatici e Risorse Idriche nella Regione Mediterranea: le nuove sfide per l'agricoltura", (Lamaddalena N. and G. Trisorio Liuzzi, eds.). Rapporto scientifico ISMEA – IAMB, pp. 141.
Jarvis A., Lane A., R.J. Hijmans., 2008. The effect of climate change on crop wild relatives. Agriculture. Ecosystem and Environment 126: 13–23
Jones P. D., Moberg A., 2003. Hemispheric and large scale surface air temperature variations: an extensive revision and an update to 2001. *J. Clim*., n. 16: 206-223.
Khadra R. Lamaddalena N., 2010. Development of a Decision Support System for Irrigation Systems Analysis. Journal of Water Resources Management. Volume: 24 Issue: 12 Pages: 3279-3297
Lamaddalena N., Pereira L. S., 2007. Assessing the impact of flow regulators with a pressure-driven performance analysis model. *Agric. Water Manag*. 90(1): 28-35
Lamaddalena N, Khila S., 2013. Efficiency-driven pumping station regulation in on-demand irrigation systems; Journal of Irrigation Science; DOI: 10.1007/s00271-011-0314-0
Lankau R. A., Strauss S. Y., 2007. Mutual feedbacks maintain both genetic and species diversity in a plant community. *Science*, 317 (5844): 1561-1563. DOI: 10.1126/science
Lehner B., Döll P., Alcamo J, Henrichs, T., Kaspar F., 2006. Estimating the impact of global change on flood and drought risks in Europe: A continental integrated analysis. Climatic Change 75: 273–299
Luterbacher, J., *et al*., 2006. Mediterranean climate variability over the last centuries. A review. In: Lionello, P., Malanotte-Rizzoli, P., Boscolo, R. (Eds.), Mediterranean Climate Variability. Elsevier, Amsterdam, pp. 27–148

Maracchi G., Sirotenko O., Bindi M., 2005. Impacts of present and future climate variability on agriculture and forestry in the temperate regions: Europe. *Climatic Change*, n. 70: 117-135

MEA-Millennium Ecosystem Assessment, 2005. Ecosystems and human well-being: Desertification Synthesis, Island Press, Washington DC, USA

Mediterra, 2008. Il futuro dell'agricoltura e dell'alimentazione nel Mediterraneo, International Centre for Advanced Mediterranean Agronomic Studies and Blue Plan, Hervieu B. (ed.), Editori Laterza, Bari, 2008

Mediterra, 2009. Rethinking Rural Development in the Mediterranean, International Advanced Mediterranean Agronomic Studies and Blue Plan, Hervieu B. and Thibault H. (eds.), Presses de Sciences Po, Paris, 2009.

Molden D, Oweis T.Y., Steduto P., Kijne J.W., Hanjra M.A., Bindraban .PS., Bouman B.A.M., Cook S., Erenstein O., Farahani H., Hachum A., Hoogeveen J., Mahoo H., Nangia V., Peden D., Sikka A., Silva P., Turral H., Upadhyaya A., Zwart S., 2007. Pathways for increasing agricultural water productivity. In *Comprehensive Assessment of Water Management in Agriculture, Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture* Molden, D. (eds.), International Water Management Institute, London Earthscan, Colombo.

Molden D. (Ed.), 2010. Water for food, Water for life. Comprehensive Assessment of Water Management in Agriculture, Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. International Water Management Institute, London: Earthscan, Colombo.

Montanarella L., 2007. The EU Thematic Strategy for Soil Protection and its implications in the Mediterranean. In *Status of Mediterranean soil resources: Actions needed to support their sustainable use* Zdruli P. Trisorio Liuzzi G. (eds). Mediterranean conference, Tunis, Tunisia, 26-31 May 2007. MEDCOASTLAND publications **6**. Bari

Norrant C., Douguédroit A., 2006. Monthly and daily precipitation trends in the Mediterranean. *Theor. Appl. Climatol*., n. 83: 89-106.

Olesen J. E., Carter T. R., Diaz-Ambrona C. H., Fronzek S., Heidmann T., Hickler T., Holt T., Minguez M. I., Morales P., Palutikof J. P., Quemada M., Ruiz-Ramos M., Rubaek G. H., Sau F., Smith B. and Sykes M. T., 2007. Uncertainties in projected impacts of climate change on European agriculture and terrestrial ecosystems based on scenarios from regional climate models. *Climatic change.* 81(S1): 123—143.

Olesen J. E., Bindi M., 2002. Consequences of climate change for European agricultural productivity, land use and policy. *European journal of agronomy.* 16(4): 239—262.

Olesen J. E., Bindi M., 2004. Agricultural impacts and adaptations to climate change in Europe. *Farming policy journal*. 1(3): 36-46.

Pereira L. S., 2005. Combating desertification: water conservation and water saving issues. *New Medit* IV(1): 4-13.

Pereira L. S., Louro V., Rosário L., Almeida A., 2006. Desertification, territory and people, a holistic approach in the Portuguese context. In: W. G. Kepner, J. L. Rubio, D. A. Mouat and F. Pedrazzini (Eds.) *Desertification in the Mediterranean Region: a Security Issue*. NATO Sc.Com., AK/Nato Publishing Unit, Springer-Verlag, Dordrecht, pp. 269-289.

Pereira L.S., Cordery I., Iacovides I., 2009. Coping with water scarcity, addressing the challenges. Springer Science+Bussiness Media B.V. 2009

Pereira L. S., de Melo-Abreu J. P., 2009. Vulnerability of rainfed and irrigated agriculture to climate change. In: Eulisse E.and Ceccato L. (eds.)*Climate Changes and Natural Resources: Impact and Water Challenge* (Marie Curie Action on European Sustainable Water Goals, Sept. 2008). Universitá Ca'Foscari di Veneziaand Civilitá dell'Aqua,Venice, Italy, pp. 39-64.

Pereira L.S., Cordery I., Iacovides I., 2012. Improved indicators of water use performance and productivity for sustainable water conservation and saving. *Agric. Water Manage.,* 108, 39–51.

Pergent Martini Christine, 2009. *Marine ecosystem* in UNEP/MAP-Plan Bleu: State of the Environment and Development in the Mediterranean, UNEP/MAP-Plan Bleu, Athens, pp. 53 - 59. ISBN : 978-92-807-3061-6

Plan Blue, 2003. Les menaces sur les sols dons les pays méditerranéens. Etude bibliographique. *Les Cahiers du Plan Blue 2*. Sophia Antipolis

Porter J. R., Challinor A., Ewert F., Falloon P., Fischer T., Gregory P., van Ittersum M. K., Olesen J. E., Moore K.J., Rosenzweig C., Smith P., 2010. Food Security: Focus on Agriculture. *Science* 328, 172-173.

Rosegrant M. W., Cline, S. A., 2003. Global food security: challenges and policies. Science 302 (5652), 1917–1919.

Rosenzweig C., Strzepek K. M., Major D. C., Iglesias A., Yates D. N., McCluskey A., Hillel D., 2004. Water resources for agriculture in a changing climate: international case studies. *Global Envir. Change*, n. 14: 345–360.

Rubio J. L., Recatalà L., 2006. The relevance and consequences of Mediterranean desertification including security aspects. In *Desertification in the Mediterranean: A Security Issue.* Kepner W. Rubio JL. Mouat D. Pedrazzini F. (eds). Springer. Dordrecht; 113-165

Runnels, C., 1995. Environmental degradation in ancient Greece. Scientific American, Vol 272 (3) pp. 96-99, March 1995.

Saadi S., 2012. Assessing the impact of climate change on water productivity in the Mediterranean agriculture, Master of Science theses n.650, CIHEAM – Mediterranean Agronomic Institute of Bari, 134pp.

Safriel U.N., 2009. Status of desertification in the Mediterranean region. In: *Water Scarcity, Land Degradation and Desertification in the Mediterranean Region*. Rubio JL, Safriel UN, Daussa R, Blum WEH, Pedrazzini F. (eds). NATO Science for Peace and Security Series C: Environmental Security, Springer Science+Bussines Media B.V. 33-73

Schmidhuber J., Tubiello F.N., 2007. Global food security under climate change, Proc Natl Acad Sci U S A. 2007 December 11; 104(50): 19703–19708

Suweis S., Rinaldo A., Maritan A., D'Odorico, P., 2013. Water-controlled wealth of nations. PNAS. DOI: 10.1073/pnas. 1222452110

Tanasijevic L., 2011. Assessing impacts of climate change on crop water and irrigation requirements in the Mediterranean, Master of Science theses n.615, CIHEAM – Mediterranean Agronomic Institute of Bari, 107pp.

Todorovic M., Assimacopuolos D., Lionello P., Chabaane Z. L., Shatanawi M., Spano D., Fahmi A., 2012. Impact of climate change on agriculture in the Mediterranean region, WASSERMed Final Report, FP7-ENV, Grant Agreement n° 244255, in press.

Tubiello F. N., Rosenzweig C., 2008. Developing climate change impact metrics for agriculture, The Integrated Assessment Journal, Bridging Science and Policy, Vol. 8, Iss. 1 (2008), Pp. 165–184

UN HABITAT, 2012. The state of Arab cities: 2012: Challenges of urban transition. [last accessed 8 November 2012] http://www.preventionweb.net/files/27581_stateofarabcitiesreport.pdf

UNDP, 2007. Human Development Report 2006 – Beyond Scarcity: Power, Poverty and the Global Water Crisis. United Nations Development Programme, New York.

UNEP/MAP-Plan Bleu, 2009. State of the Environment and Development in the Mediterranean, UNEP/MAP-Plan Bleu, Athens, 2009.

Weissenbacher M., 2012. Energy Security in the Euro-Mediterranean Region. In Change and Opportunities in the Emerging Mediterranean, Ed. Stephen Calleya and Monika Wohlfeld, 23:452-469.

Wilson G., Juntti M., 2005. Unraveling desertification: Policies and actor networks in Southern Europe. Wageningen Academic Publishers.

Zaccaria D., Oueslati I., Neale C.M.U., Lamaddalena N., Vurro M., Pereira L.S., 2010. Flexible delivery schedules to improve farm irrigation and reduce pressure on groundwater: A case study in Southern Italy. *Irrigation Science* 28:257–270

Zdruli P., 2012. Land resources of the Mediterranean: status, pressures, trends and impacts on regional future development. *Land Degradation & Development*. Wiley. DOI: 10.1002/ldr.2150

Zdruli P., Lacirignola C., Lamaddalena N., Trisorio Liuzzi, G., 2007. The EU-funded MEDCOASTLAND Thematic Network and its Findings in Combating Land Degradation in the Mediterranean region. In: Climate and Land Degradation. (Eds. M.V.K. Sivakumar and N. Ndiang'ui). Springer Berlin Heidelberg New York.

Additional materials

EcoMENA

Powering Sustainable Development in MENA

EcoMENA's primary mission is to create mass awareness on renewable energy, sustainability, waste management, environment protection and resource conservation in the Middle East and North Africa (MENA) region.

http://www.ecomena.org/

Video presentations

"Introducing two degrees up" prepared by the CGIAR, 2012

http://www.youtube.com/watch?v=oaEY3hhjLDs&list=PL5924FD982CBEA3FD

"Climate-smart agriculture: helping the world produce more food". World Bank Institute, Washington, DC.

http://lnkd.in/9JcyfC

Notes

[1] A person is considered food insecure, or hungry if food availability or access to food fails below FAO's recommended average calorie intake level of approximately 2,100 calorie per day, depending on the region. As of 2012, none of the MENA countries is below that level.

[2] MENA region in this study include: Syria, Lebanon, Jordan, Israel, Palestinian Authority, Egypt, Libya, Tunisia, Algeria, and Morocco.

[3] Drylands include arid, semi-arid and dry sub-humid zones based on values of aridity index. Aridity index is calculated as the ratio between mean annual precipitation (PPT) to mean annual potential evapotranspiration (PET). Drylands of concern to the UNCCD include those lands with an aridity index between 0,05 to 0,65 (excluding polar and sub-polar regions).

[4] www.wassermed.eu

[5] www.ramsar.org

[6] http://www.rtcc.org/rethinking-water-and-energy-links-in-middle-east/

[7] http://www.water-energy-food.org/

Priority 2: Qualitative and quantitative enhancement of crop products

Thaer Yaseen[1], Alessandra Ricelli[2], Francesco G. Ceglie[1], Franco Santoro[1], Maurizio De Santis[1], Richard Strange[3], Luca Colombo[4], Anna Maria D'Onghia[1]

[1] CIHEAM Bari, Italy
[2] Istituto di Biologia e Patologia Molecolari-CNR
[3] University of London
[4] FIRAB

Abstract

The world's human population will reach rather over 9 billion by 2050, placing considerable strains on agricultural production, which depends largely on smallholder farmers. Although food production in aggregate is enough to feed the current population of about 7.1 billion, the existence of around 870 million people who are undernourished demonstrates that, on its own, it is not sufficient to ensure food security for all. Two reasons for this are that about one third of food is wasted and one third is fed to livestock (Tscharntke et al., 2012). Other drivers of food insecurity are lack of entitlement and poor access to markets. However, in this paper we will focus on constraints to quantitative and qualitative enhancement of crop production. Quantitative constraints include pests, diseases and inappropriate farm management practices: qualitative constraints include contamination of food, for example, by mycotoxins. The paper concludes with suggestions for the safe and sustainable use of resources for the increased production of high quality food.

I – Introduction

Food producers and their family members represent 75% of the global food insecure. Ensuring adequate productive capacity in short and medium term, safeguarding the surrounding environment and guaranteeing suitable markets and remunerable prices, are three fundamental prerequisites to concur to their livelihood. Food security is primarily achieved through the improvement of food vulnerable people living conditions as well as their empowerment vis-à-vis their socioeconomic context. Improving quantitative and qualitative farm production is thus strategic to achieve such farmers' livelihood renaissance, further enabling the flow of sufficient amount of food in consumption circuits.

The farming sector and farmers themselves are facing current and emerging threats: widespread economic recession and pauperisation, rural-urban disconnections, increasing resource scarcity and competition, price volatility, input market oligopolies and cartels. Peak of oil cost, climate crisis and pest vagaries pose additional pressure on productive systems and urge to restore or build resilient farming conditions.

Threats and constantly evolving socioeconomic and environmental circumstances demand new adaptative knowledge and a transition path to a more socially fair and environmental sustainable primary sector. Part of the needed knowledge is already available at scientific and community level and requires to be disseminated, accessed and adjusted to specific local contexts. Additional new knowledge is further vital: research centres and farm innovative practices concur to its provision generating innovation and new combinations of existing one.

As indicated by IAASTD and a recent EU SCAR report, a fundamental change in research policies and priorities is needed for a shift toward sustainable food systems. These prerequisites are aimed at:

- Restoring and strengthening of extension services to assist and qualify farm activities;
- Assessing, with participatory approaches, research and innovation needs, further to identifying suitable existing knowledge and know-how;
- Providing an enabling environment for sustainable food provision, through both the adoption of agroecological practices and approaches and the fulfilment of multifunctional scopes for the primary activity capable to adapt to local agroecosystem constraints and potentials;
- Enhancing ecosystem services through diversification at all levels (intra and extra- specific; spatial and sequential crop rotation; mixed farming with the reconnection of crop and livestock production at farm or territorial scale; creation, maintenance and organisation of functional biodiversity; closure of biomass and energy cycles):
- Rebuilding circular metabolisms mimicking nature cycles (i.e. for water, N, C, residues) that can help to minimize waste and to value it as functionally recycled biomass;
- Recovering soil fertility as a milestone for sustainable food production, further reducing dependence from off-farm inputs (as well as connected risk and costs) and minimizing pollution;
- Reshaping farming systems in order to adapt to and mitigate climate change, progressively emancipating food production from fossil energy;
- Adapting to local conditions and local farmers' skills while intensifying local and scientific knowledge;
- Fostering crucial resilience of agroecosystems.

Most of these far-reaching changes can occur simultaneously and be mutually supportive.

Food security is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO 1996). However, increasing population and consumption are placing extraordinary demands on agriculture and natural resources. The State of Food Insecurity in the World 2012 (SOFI), jointly published by the Food and Agriculture Organization (FAO) of the United Nations, the International Fund for Agricultural Development (IFAD) and the World Food Programme (WFP), reveals that almost 870 million people, or nearly one in eight, are suffering from chronic malnutrition. The report used innovative methodology which assessed some parameters such as food supply, food losses and dietary energy requirements more accurately than those used previously. In spite of this, it is not yet possible to assess precisely the short-term effects of food price surges and other economic shocks. Also, additional sets of indicators are needed to better capture dietary quality and other dimensions of food security. It is evident therefore that an effective response to the demand for food by all people at all times has not yet been found and that meeting the challenges of 'Food security' and 'Food safety' beyond the paradigm of crop production (which, being strictly oriented on yield, may increase food security problems), is necessary (Giovannucci *et al.*, 2012). Meanwhile our capacity to feed the world's increasing population is being thwarted by land degradation, diminishing water supplies, decreasing biodiversity and climate change.

Integrated crop management (ICM), integrated pest management (IPM), Organic farming entails the use of sustainable practices of productions that may act together to bridge the gap between

ecology and agronomy, allowing the development of an ecosystem approach which will enhance yield, quality, sustainability and equity (FAO, 2010). The pillars of sustainable production are the maintainance or the enhancement of productivity and services, the reduction of the level of production risk, the protection of natural resources ant of their potential, the economical viability and social acceptability. Within this context, production of healthy food must be ensured 'always and absolutely' with regard to nutrition and organoleptic properties, and to meeting consumers' needs and expectations. Such improvements imply the responsible management of both natural resources e.g. maintenance of the long-term fertility of the soil (Powlson *et al.*, 2011), and human resources. The latter includes such social responsibilities as attention to the living conditions of workers, the needs of rural communities, consumer health and safety and the creation of new market opportunities for farmers and exporters in developing countries.

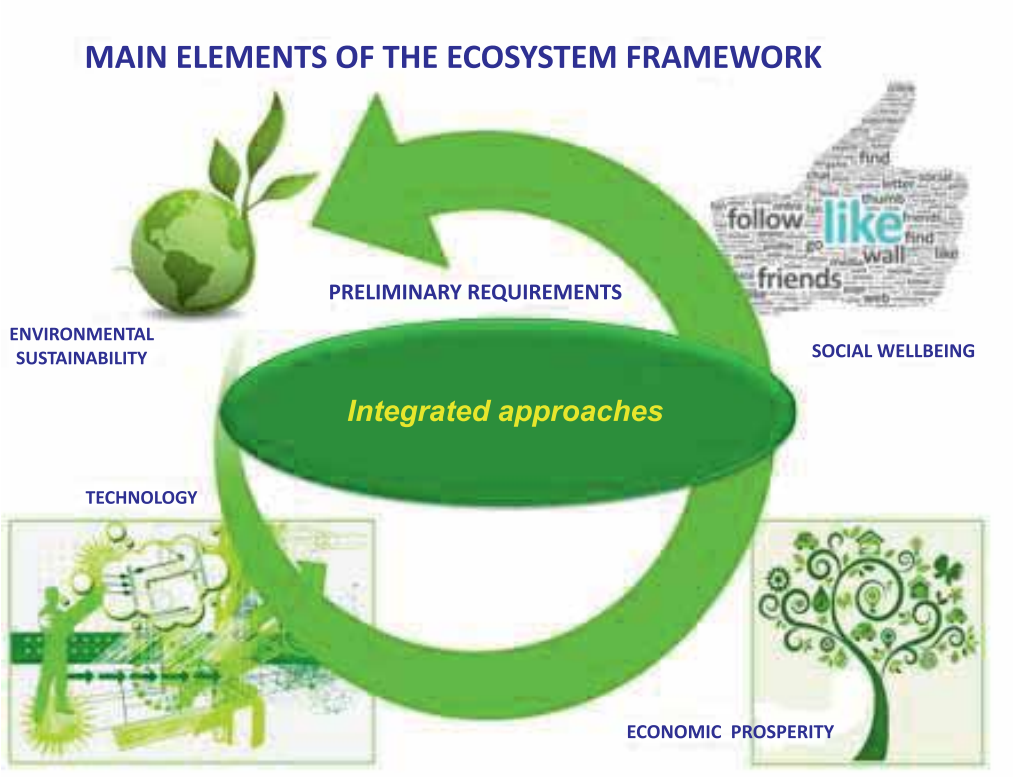


Figure 1. Graphic description of the main elements of the ecosystem framework.

II – State of the art

Increasing food availability is the first, but not the only, step towards achieving food security as, although the current global food production would seem, in aggregate, sufficient to meet energy and protein requirements of the entire population of the planet (ICROFS, 2009), about 870 million inhabitants (most of them in Africa and Asia) still suffer from hunger. Food availability, adequate access to the resources needed to produce or obtain food, a balanced diet consisting of safe food and the stability of such conditions over time, are the four key points of food security. Many studies confirm that the hunger crisis is linked to problems in food

distribution (Boucher *et al.*, 1999). The current situation of yield and quality of crop grown products varies considerably depending on intrinsic factors (temperature, humidity, type of crop) and logistical factors (management, technological facilities, performance of the economy). One of the first studies addressing the problem of food losses in an analytical way was that made by the FAO in 1977 (Special Action Program for the Prevention of Food Losses) in response to a UN request. Reliable assessments of the nature and quantity of the loss of food are still rather scarce. This is due to the difficulty in collecting comparable data in different areas of the planet. Moreover, losses are usually valued for staple food grains, whereas, for an accurate assessment of food losses, those for more perishable foods, such as fruit and vegetables, should be also taken into account.

In developing countries, losses range from 5 to 50% and occur mainly in production, harvesting, storage and processing, whereas in industrialized countries losses range from 2 to 20% and are concentrated mainly in retail and final consumption (Prusky, 2011). Most of the food losses in developed countries is due to two factors: the existence of strict quality control and the demand for perfect looking food, causing the discard of perfectly edible foodstuffs.

Improvement of availability and access to food must be sustainable in economic and ethical terms. To date, increases in productivity have been through selection and breeding of high yielding cultivars such as the short-strawed wheats of the Green Revolution. Besides their favourable harvest index, a critical property of these cultivars was their resistance to stem rust. Disease and pest resistance are important properties for new cultivars but often these have to be supplemented by pesticide application. One reason for this is that pathogens and pests evolve to overcome the resistance of plants. Post-harvest, the management of temperature and humidity represents a very effective mean for the protection of food quality. Unfortunately it is very expensive to manage these two parameters in a suitable manner to ensure an effective control of foodstuffs contamination because large amounts of energy and high levels of infrastructure are required. They are therefore often not feasible in developing countries where the ambient conditions of both temperature and humidity may be high.

In addition to the problems of the evolution of resistance among pests and pathogens to pesticides, there are concerns that these products can be toxic to sector operators and their residues can accumulate in crops. This has led to special attention being paid to Organic Farming (EC 834/07, 889/08) which is aimed at minimizing the input of synthetic chemicals by the use of biological control as well as reducing overall off-farm inputs, creating microhabitats for agro-biodiversity and optimizing ecological niches for beneficial organisms that compete with harmful ones. This strategy promotes conservation and sustainability in a way that is claimed to be equitable for rural communities and small holders.

Unfortunately, when transferred to commercial reality, exclusive dependence on biological control has not been as successful as hoped. However, combining antagonistic microorganisms with pesticides has shown more promise. With regard to post-harvest storage, physical means, such as the use of modified atmospheres, have been successful as they inhibit the growth of strictly aerobic spoilage bacteria and moulds, although they have limited efficacy in the control of microaerophilic fungi.

From these observations it is evident that the use of a single technology often does not achieve the objective of efficient control of plant disease, whereas an integrated approach, combining several different methods, offers greater possibilities (Thomas, 1999). Furthermore it is clear that the preservation of the quality of foodstuffs from contamination should be carried out specifically for each category of product under the environmental conditions in which it must be preserved. In these scenarios it is evident that knowledge of the most appropriate strategies is of fundamental importance. The current lack of dissemination of knowledge of these strategies is therefore a significant obstacle to the realization of effective policies for safeguarding the quantity and quality of crop grown products.

III – Regulatory framework

In the EU the quality of agricultural products is regulated by several Directives: EC N. 2000/29/EC for preventing the introduction of pests not present on the territory of the European Community; EC N. 2003/2003 for the use of fertilizers; EC N. 396/2005 with the amending EC N. 839/2008 for the maximum residue levels of pesticides; EC N. 1881/2006 and EC N. 1333/2008 for the maximum levels of certain contaminants in foodstuffs; EC N. 834/2007 and EC N. 889/2008 governing organic production methods and the national guidelines for integrated production; EC N. 1107/2009 for placing plant protection products on the market; and EC N. 128/2009/EC on the sustainable use of plant protection products. This last directive, which regulates the mandatory use of IPM in agricultural production by 2014, will change the agriculture scenario in Europe because the use of chemicals will have to be reduced or adjusted to needs-based pesticide doses and alternative methods, where practicable, will have to be used instead.

IV – Problem Analysis in Mediterranean Region: from constraints to solutions

The demand for food is not only driven by a growing population but also by diet choice, lifestyle and food safety regulations, the last three often encouraged by media and social networks (Spiertz, 2012). To ensure the availability of food in areas where people still suffer from hunger, it is necessary to provide an increase in production specifically in those areas or as close as possible to them.

There is considerable potential for doing this by employing appropriate techniques both at the pre-harvest and the post-harvest stages, but this must be done taking into account the different socio-economic conditions prevailing in the different localities of the world. Also, it is imperative that it is done while maintaining or even increasing the fertility of the soil (Powlson *et al.*, 2011).

Pre-harvest, crop production must be enhanced while reducing the inefficient use of land, water, nutrients and living resources. To this end, the ecological intensification pattern, as represented diagrammatically in Figure 2, could be investigated as a way of increasing productivity, preserving yield and using natural resource more efficiently. Here, global food security goals are represented by the green areas. Conventional intensification is envisaged as moving the current situation (2a) towards greater environmental impacts, which are likely to be negative, while still not fulfilling global needs (2c). In contrast, ecological intensification is envisaged as moving the current situation to the left and upwards into the green safe area where the environmental impact is reduced and global needs are satisfied (2b) (Bommarco *et al.*, 2012).

A further factor is the necessity of slowing the rate of increase of the agricultural environmental footprint (Foley *et al.*, 2011). All this implies sustainable integrated management, which is a knowledge-based approach, requiring good understanding of agro-ecological processes. Access to knowledge is the major bottleneck when moving to sustainable management. Inexperience and lack of adequate extension and training for knowledge-intensive management systems and location-specific science require long-term investments in capacity building (Scialabba, 2007). Sustainable management, particularly when programmed on a large scale, cannot be conducted through the use of a single technology but should be based on the integrated use of different actions both pre- and post-harvest.

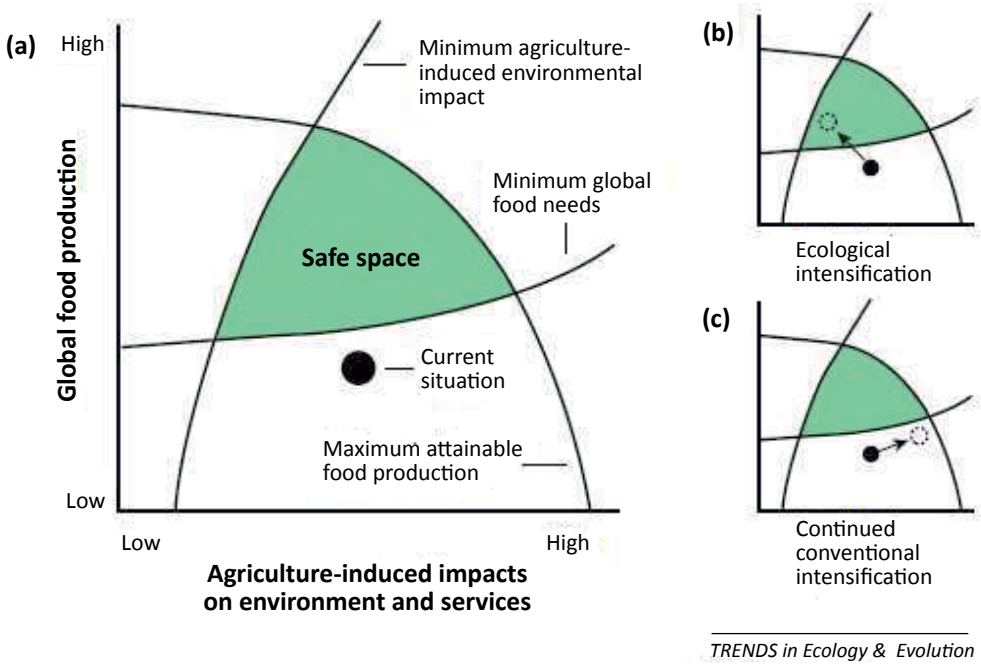


Figure 2. Ecological intensification paradigm should be considered as alternative to the yield paradigm (Bommarco *et al.*, 2012).

1. Pre-harvest

Yield increases per unit of land imply the introduction of high-yielding cultivars, well adapted to local environmental condition and resistant to pests and diseases. They should be farmed using the best practices which, in some cases, will mean the establishment of efficient irrigation technology. The main biotic and abiotic factors implicated in yield decline of crops grown in short rotation or monoculture are reported in figure 3. Detrimental effects are caused by the repeated planting of the same crop, with recurring use of the same management practices, resulting in poor plant growth and development, delayed crop production and reduced yields And also in increased contaminations (bacteria, pests, fungi) that, in turn, can lead to toxic metabolites production. Although one factor may be responsible for yield decline, it is more likely that combinations of factors interact to cause the effect (Bennett *et al.*, 2012).

2. Post-harvest

The quality of produce achieved at harvest time should be maintained from field to table. This implies storage under conditions in which neither abiotic nor biotic factors cause deterioration. Inappropriate temperature and humidity play major roles in causing quantitative and qualitative losses, while, among the biotic factors, contamination by pests and microorganisms represent the main problem. Moreover, if the contaminant produces toxic metabolites, the problem is not only the visible alteration of the commodity, but also the invisible presence of these noxious metabolites. For example, it is claimed that mycotoxins contaminate 25% of food with major negative consequences for human health (Kolosova and Stroka, 2012). Stringent quality criteria should always be applied to products in order to protect consumers in all countries. The production of high quality products, in fact, constitutes an objective which cannot be separated from obtaining good yields.

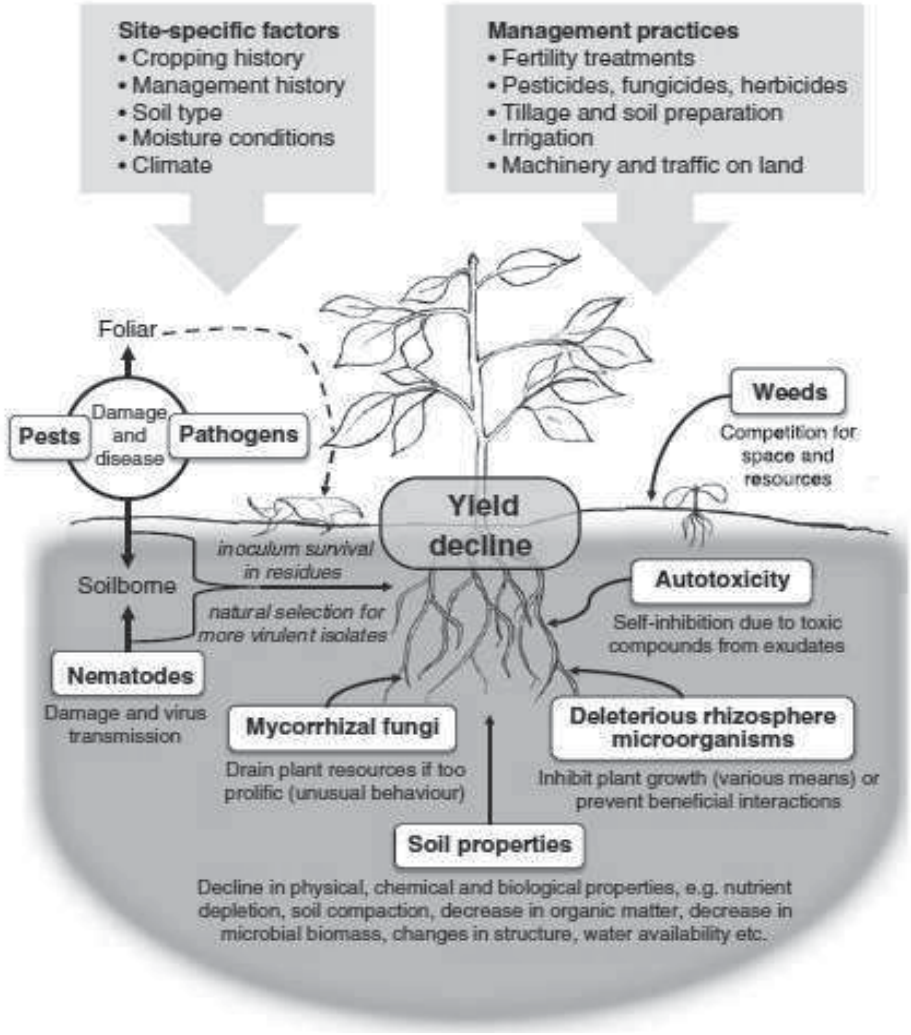


Figure 3. Representation of biotic and abiotic factors implicated in yield decline of crops (Bennett *et al.*,2012).

V – Key actions (Pre/Post-harvest)

1. Innovative Integrated Crop Management (ICM) including Integrated Pest Management (IPM) and organic practices to increase quantity and quality of production

To date, the main approaches for the control of disease are: chemical and biological control, host-plant resistance and cultural practices. Each of them has its own strengths and weaknesses. Chemical control has been practiced for many decades, using non- systemic fungicides and pesticides based on copper and sulphur compounds. These have been replaced since the early 1960s with systemic pesticides which are more specific and effective, although the older generation of pesticides is still used in developing countries because of their lower cost.

However, the risk of selection of resistant pathogens together with the growing concern about the toxicity of these products and their impact on the environment have led to the development of international standards that require the use of products with low toxicity and low environmental impact. Biological control has been extensively studied for more than 25 years and can be used successfully in certain situations. However, several limitations have become apparent when used exclusively on a commercial scale such as lack of reliability of disease control and the need for optimum environmental conditions for a satisfactory outcome. Plant breeding for disease resistance is a very important tool in disease management programs, and some plant varieties resistant to particular diseases have proved to be very effective. In some cases the resistance has proved to be remarkably durable but more often it is overcome by variants of the pathogen. Marker assisted selection (MAS) can aid the process of breeding effective genes into crops and, of course, the GM approach has high potential for maintaining the resistance of our crops to disease. Cultural practices such as crop rotation, pruning and the planting of barrier crops are probably the oldest instruments of control and have significant effects in reducing inoculums and encouraging antagonists in the soil. However, crop loss often remains too high despite the application of these methods, which therefore need to be complemented by other strategies.

2. Resource use efficiency

Organic farming practices should be oriented towards the efficient use of water, nutrient and energy use by the following strategies: preservation of soil fertility by recycling on- farm residues through composting, planning long rotations cycles among different plant species, introducing cover crop mixes with specific functions (green manure, bio- fumigation, soil structure enhancement), improving crop diversification. Biofumigation is based on the incorporation of fresh plant mass into the soil, which will release several substances able to suppress soil-borne pests. It reduces weed competition and soil-borne pathogens and is a suitable tool for soil disinfection. So far, Integrated Pest Management practices have increased ecosystem efficiency by reducing the overuse of insecticides and encouraging natural predation. Protecting the environment of production by the use of glasshouses or unheated plastic tunnels and using recycled rainwater could improve yield per unit area of land and per unit of water. However, such techniques require practitioners to be versed in them and their appropriate use to suit specific environments, which implies knowledge transfer.

3. Early diagnosis of the causal agents of the main diseases through innovative techniques

The early and rapid monitoring of disease in the field is essential in order to be able to take action to limit losses and to maintain the high quality of the harvested product. Until now this was achieved by frequent sampling, but this practice is not always possible as it is time consuming and requires well trained staff. Remote sensing systems use fewer personnel, facilitate the monitoring of large areas and can give more reliable results. However, laboratory tests would usually be required to identify the causal organisms of the diseases.

Recent developments in molecular, serological and electronic sensor technologies have led to a broadening of the capacity to detect pests and diseases and could improve application of crop protection practices. These alerts or sensors can be space-borne (satellite), air-borne (airplane, unmanned aerial vehicle) or ground-based (handheld, vehicle-mounted). Since 2001, research on these systems has been ongoing in order to create efficient intervention tools for the identification of pests and pathogens which are highly variable in space and time (Nutter, 2001; Nutter, 2004; Nutter *et al.*, 2006). As a result, crop protection activities may be tailored to achieve effective control when and where needed. Such innovative technologies should be established in the Mediterranean region. The data generated may then be used by scientists to monitor and analyze online the spread of pests and diseases in order to take steps to prevent them. For

example, in combination with application of an agricultural decision support systems (DSS: see below), a decision may be reached as to whether pesticide use is necessary or not.

4. The application of agricultural Decision Support Systems (DSS).

The early diagnosis of the main pests and pathogens through innovative techniques on a small or large scale is fundamental to the application of (DSS). Identification is mainly based on biological, serological and molecular techniques which are constantly evolving to reach a larger-scale and higher sensitivity. Among these, molecular diagnosis by different methods such as biosensors and LAMP PCR are the most efficient owing to their high specificity and sensitivity. DSS is a computer-based information system that supports economic decision-making activities consisting of three basic components: i). DATABASE, containing large amounts of organized and retrievable data. ii). MODEL, a representation of an object, a concept or a system. iii). USER, a system that allows interaction between machine and user. Current techniques are not sufficiently advanced to manage large numbers of samples and to detect all relevant pests and pathogens but recent developments in molecular, serological and electronic technologies as well as in proximal and remote methods have led to improvements. The integration of DSS and IPM is the rational way to reduce pesticide use and consequently significantly reduce pesticide residues. Together they should allow the early detection of pests and pathogens in the Mediterranean region while numbers are still low and allow speedy and cost effective intervention. This platform of information should create a high level of collaboration among governmental agencies, farmers, growers and agribusiness societies.

5. Accurate and rapid monitoring of food contaminants and pesticide residues

The analysis of the presence of microorganisms has been performed for a long time using serological and microbiological methods. However, these are time consuming and are not compatible with current trade requirements or with the need to take action for control promptly. For these reasons, molecular techniques of detection and quantification have been developed in recent years. These enable accurate diagnosis of infection or infestation at early stages, giving control measures greater chances of success. On the other hand, as these methods require the use of specific expertise and are rather expensive, they must be used in a targeted and informed way. Furthermore, technical problems inherent in the complexity of the food matrices to be tested are still unsolved. In order to tackle this problem, the scientific community is making great efforts to decrease time and cost of analyses and to develop easy-to-use protocols with the aim of applying them.

6. The use of innovative technology and eco-compatible methods to reduce post-harvest losses and to control crop contaminants

During post-harvest, the development of ‘storage fungi’ represents a real threat as they are able to grow and synthesize mycotoxins when moisture content is relatively low (between 0.71 and 0.90 aw). Species of Aspergillus and Penicillium, producing aflatoxins and ochratoxins, respectively, belong to this group. In the Mediterranean basin, aflatoxins contaminate dried fruits and nuts, while ochratoxin A is often present in grapes and raisins. The severity of contamination is worst during drought years when plants are stressed and their resistance consequently low. Moreover, insect attack opens the way to infection even by fungi that are weak pathogens. Physical, chemical and biological control methods have all been used with varying degrees of success.

Physical control: Reducing the water content of the material to be stored, where appropriate e.g. grain, is an effective means of preservation and can be applied also to some non-grain crops e.g. tomatoes (Nonclerq *et al.*, 2009). Refrigeration is effective but expensive as is maintenance of low humidity. Recently, the use of modified atmospheres has given good results, in particular ozone

treatment, which requires little investment, is easy to manage, sustainable and eco-friendly. Chemical control: Although control of food contaminants with compounds such as sodium nitrite and benzoic acid has a long history, concerns about the safety of their use has prompted the development of Biological control. Here the use of various peptides and chitosan, among other natural products, has shown promising results.

VI – Suggested research needs

Food security for the world's increasing population demands attention to the quality and quantity of crop production.

Food security, sustainability and ecosystem services at regional and global scale should be achieved in a cost-effective way. However, the nutritional value of food should be assessed because it varies according to the crop's genotype, to the environmental conditions and to the methods of production. The qualitative level achieved at harvesting time should be maintained from the field to the table during post harvest. There is a lack of research in determining production systems able to yield nutritious food with long storage potential. The identification of innovative best practices for an integrated and sustainable management and control of biotic and abiotic factors (both during pre-harvest and post-harvest stages) is fundamental to enhancing quantity and quality of the products. To this aim, research should focus on the efficiency of IPM and organic production systems under an eco-functional intensification approach, which can be pursued through the following 10 point plan, involving all actors in the food chain from farmers through researchers to retailers. This requires political will, scientific expertiseand financial support. Providing these are forthcoming, the security of access to nutritious and safe food for all should be attainable.

1. Development of early pest and pathogen detection;
2. Development of early pest/pathogen alert systems on a large scale through innovative agricultural decision support systems (DSS);
3. Adaptation of cropping systems to climate change and to biotic and abiotic stresses by genetic improvement of crops and increasing agro-diversity;
4. Improvement of water and nutrient efficiency of agriculture without reducing food production by targeting particular 'hotspots' of low efficiency;
5. Development of the quality of nursery production by innovative eco-compatible methods;
6. Enhancement of protected cropping system for meeting local fresh food needs;
7. Setting up of innovative rapid and accurate tools for detection of toxins, pesticide residues and other food contaminants on large and small scales;
8. Application of post-harvest innovative practices using environmental friendly technologies such as Ozone and Electrolyzed water;
9. Increasing the natural resources use efficiency for food production and improving the widespread availability of food in the poorest areas;
10. Integration of traditional knowledge and innovative agronomic practices;
11. Harmonization of innovative technical protocols in the production systems.

References

Bennett A. J., Bending G. D., Chandler D., Hilton S. and Mills P., 2012. Meeting the demand for crop production: the challenge of yield decline in crops grown in short rotations. *Biol Rev Camb Philos Soc*, 87(1): 52-71.

De Schutter, 2011. Agroecology and the Right to Food, Report presented at the 16th Session of the United Nations Human Rights Council [A/HRC/16/49]

FAO 2010. Sustainable crop production intensification through an ecosystem approach and an enabling environment: capturing efficiency through ecosystem services and management Rome, FAO. COAG/2010/3.

Foley A. J., Ramankutty N., Brauman A. K., Cassidy S. E., Gerber J. S., Johnston M., Mueller D. N., O'Connell C., Ray K. D., West P. C., Balzer C., Bennett E. M., Carpenter S. R., Hill J., Monfreda C., Polasky S., Rockström J., Sheehan J., Siebert S., Tilman D., Zaks D. P. M. 2011. Solutions for a cultivated planet. Nature, 478: 337-342.

Giovannucci D., Scherr S., Nierenberg D., Hebebrand C., Shapiro J., Milder J. and Wheeler K., 2012. Food and Agriculture: the future of sustainability. A strategic input to the Sustainable Development in the 21st Century (SD21) project. New York, United Nations. Department of Economic and Social Affairs.

Godfray H. C. J., Beddington J. R., Crute I. R., Haddad L., Lawrence D., Muir J. F., Pretty J., Robinson S., Thomas S. M., Toulmin C., 2010. Food Security: The Challenge of Feeding 9 Billion People. Science, 327(5967): 812-818.

IAASTD, 2009. Agriculture at a crossroad: synthesis report.

ICROFS, 2009. Results from research in organic food systems. fact sheet International Centre for Research in Organic Food systems. No. 2.

Nutter F., 2001. Disease assessment. In: Malloy O. and Murray T. (ed). Encyclopedia of plant pathology. John Wiley and Sons, Inc, New York.

Nutter F. W., 2004. Developing forensic protocols for the post-introduction attribution of threatening plant pathogens. Phytopathology, 94(6): S77-S77.

Nutter F. W., Esker P. D., Netto R. A. C., 2006. Disease assessment concepts and the advancements made in improving the accuracy and precision of plant disease data. European Journal of Plant Pathology, 115(1): 95-103.

Powlson D. S., Gregory P. J., Whalley W. R., Quinton J. N., Hopkins D. W., Whitmore A. P., Hirsch P. R., Goulding K. W. T., 2011. Soil management in relation to sustainable agriculture and ecosystem services. Food Policy, 36: S72-S87.

Prusky D., 2011. Reduction of the incidence of postharvest quality losses, and future prospects. Food Security, 3(4): 463-474.

SCAR, 2011. Sustainable food consumption and production in a resource-constrained world

Scialabba N., 2007. International conference on Organic agriculture and food security. Rome, Food and Agriculture Organization of the United Nations.

Spiertz H., 2012. Avenues to meet food security. The role of agronomy on solving complexity in food production and resource use. European Journal of Agronomy, 43: 1-8.

Thomas M. B., 1999. Ecological approaches and the development of "truly integrated" pest management. In: (eds). Proc. Natl. Acad. Sci., USA 96, 5944-5951

Tscharntke T., Clough Y., Wanger T. C., Jackson L., Motzke I., Perfecto I., Vandermeer J., Whitbread A., 2012. Global food security, biodiversity conservation and the future of agricultural intensification. Biological Conservation, 151(1): 53-59.

Priority 3:
Socio-economic dynamics and global markets

Roberta Callieris[1], Felice Adinolfi[2], Fabian Capitanio[3], Fabio Gaetano Santeramo[3]

[1] CIHEAM Bari, Italy
[2] UNIBO
[3] UNINA

I – Rationale

We have experienced a period of great agricultural capacity almost on a global scale, called “the Green Revolution”. This is a term used to refer to the remarkable increase in world agricultural production between the early 1960s and the end of the 1980s. The technological progress experienced in the more developed economies and its transfer to other regions, especially Asia and Latin America, led at that moment to the doubling of yields for some cereal crops which are basic for the human diet, like rice, wheat and maize, besides the productivity of other plant species and livestock.

This real production boom has been able to meet rising food demand in the past 30 years and has also ensured a certain stability to food prices. A historical phase in which giant steps taken in developing pesticides and fertilizers, combined with an improvement in production techniques and plant breeding, allowed a rapid growth in farmland yields. Certainly, not everywhere: in Asia, yield increases were obtained practically without increases in cultivated areas, while in Africa yields were stationary despite the bringing into cultivation of new lands.

However, we are talking of a quarter-century of sustained yield increases, coinciding with a marked rise in public investment in agricultural research, both in more developed and in developing countries. The result was a mean annual global increase in cereal production of 2%, with the highest rises in Asia (+2.5%). The Green Revolution seemed universally to be the death knell of the Malthusian theory of growth.

What has changed? How can we account for an alarming situation that today goes well beyond the ever-neglected issue of hunger in the world’s poor areas? What has compromised the reaching of internationally-agreed goals regarding the war against malnutrition?

The international markets for agricultural commodities are the stage on which the new scarcity is shown in all its clarity. The roller-coaster ride of commodity prices fully expresses the tensions between demand and supply which are responsible for price rises.

It would be clear now that, referring at market instability, one of the main drivers is the headlong growth in food consumption, associated with population growth, but especially with the higher purchasing power among increasingly broad ranges of the population in emerging countries. As early as the mid 1990s, major increases were being witnessed in the demand for some strategic agricultural commodities, such as wheat, whose prices had long been in constant decline. Demand began to rise at an average rate of 2% per annum, especially thanks to China, India and Brazil, able on their own to account for at least one-third of increases in world requirements at that time. There has been a transition from a period of abundance, albeit characterized by problems of unfair distribution of available resources, to one of structural scarcity manifested in a progressive widening of the scissors between food availability and demand against a trend, at first timid and

then more marked, of price rises. For many years the change was not perceived or was at the very least underestimated.

II – Extended summary

This work is concerned with the issue of food security, placing special emphasis on the current situation of South Mediterranean countries.

The events of 2007/2008 and those of 2010/2011, has been unfortunately more than an alarm-bell. The most recent spike in food prices alone has shifted almost 45 million people below the poverty line, synonymous with leading an existence on less than 1.25 USD a day, which is already experienced by more than 1.2 billion people around the world. The tensions between supply and demand suggest this is a structural imbalance that will grow in the years to come. The failure to meet the first of the millennium development goals, a reduction in hunger in the world, ought to restore a sense of urgency and determination in order to conceive and design renewed policies at the international level, to build a new overview of global food security. Given the scale of the problem, this need cannot be relegated solely to its traditional place on the agenda on just how to support agricultural development and food self-sufficiency in late-developing areas, but should be tackled with decisions that necessarily involve agriculture world-wide. It is a problem that affects us all and not just a question of how to help "others".

After decades in the wilderness it is no coincidence that the issue of food security is once again part of the lexicon of American and European policy makers, just at the moment when the USA and EU are preparing to reform their own agricultural policies, the longest established and also the most criticized.

By a brief introduction of the main conceptual aspects of food security, this work point out the shift from a former focus on food energy availability to a more comprehensive appraisal of this phenomenon in recent times. The most likely causes of recent rises in food prices are also described. Food security issues are analyzed in connection with rural poverty issues and with the failure to achieve successful agricultural development in some developing countries, which sometimes have to overcome strong restrictions concerning the availability of land and water resources for food production. The paper points to the convenience of using multivariate statistical tools to summarize a wealth of food security-related indicators, and a practical example of the use of Principal Components Analysis (PCA) for data concerning SEMC countries is provided, with a dataset originally comprising 11 variables. The PCA methodology is described in a non-mathematical fashion, also showing the basic steps in its application to this case. Two basic composite indicators, or 'principal components' are selected, one in connection with 'human development' and the other with 'being at risk of hunger', and countries in the sample are ranked according to their situation with regards to these dimensions.

III – Key messages

Food volatility: 1) Structural characteristic of the food market; 2) Food Security question in South Mediterranean Countries since these countries are the largest net importers of cereal calories in the world.

Agricultural Policy in SEMC countries: 1) lack of adequate infrastructures, and efficient markets challenge; 2) policy aimed to support value chain efficiency and risk management tools; 3) strengthen credit, transport and storage capability in these countries; 4) marketing and producers organization.

1. The Background: A new era in the global agriculture commodity market

From the early fifties there was a long period of stagnating and declining prices on agricultural markets, interrupted only by some spurt in concomitance with extraordinary events (like the "oil shock" in the 1970s). The scenario changes in the mid 1990s where an inverse trend begins, with sharp peaks in farm commodity prices in 2007/2008 and 2010/2011. The most recent forecasts indicate a sizeable rise in prices for the coming years.

Several causes are driving the increase in agricultural commodity prices. One of the main is the headlong growth in food consumption, associated with population growth, but especially with the higher purchasing power among increasingly broad ranges of the population in emerging countries. According to FAO, world population will exceed nine billion in 2050. This represents an increase of about one third against the current population of 6.9 billion. An increase that will be lower than in the past. In fact, the population increase of over 30% predicted by the FAO for the next 40 years is well below the relative growth in the past four decades, during which the population more than doubled.

The largest increases will take place in developing countries, while the population in high-income economies will remain almost stable and in some areas, especially in some regions of Europe, there may even be population declines. By contrast, in Africa the population is expected to double, growing from one to two million by 2050. In emerging areas growth will continue to be sustained especially in India, while China's growth should slow down; absolute increases will remain appreciable. In these two countries, which now make up over one-third of the world's population, the number of inhabitants is expected to rise from the current 2.5 billion to 3.2 by the year 2050.

The global effects of population increases will be strictly linked to migration intensity between countryside and town. Around 50% of the world's population is now distributed in urban areas, the other half in rural areas. In 1950 only 28% of the population lived in large urban agglomerations; in 2050 this percentage is destined to reach 70%. Compared with today, there will be 19 more cities with over ten million inhabitants and five of these will be in Asia where the trend toward metropolitan concentration will be particularly marked. FAO estimates the population reduction active in agriculture in the next 40 years at around 30%. However, it will also contribute to orienting consumer choices for much of the world's population towards products with larger contents of services (starting from processing) and thus bring them closer to the food styles in the planet's wealthier areas.

The most important contribution to the global convergence of diets will be made by the expansion of the middle classes in emerging areas. Individual income in countries like India, Brazil and China rose at sustained rates in recent years, only to slow down, but not stop, during this long phase of world economic recession. The cases that stand out most are those of China and India which have recorded annual growth rates close to the double figures in the years immediately prior to the recession and which are forecast, according to the International Monetary Fund, to continue their trend at least for the next 20 years. This means on one hand that expenditure on food consumption grow fast, on the other that food habits change radically (the so called "substitution effect" explained by Engel's Law).

As populations gradually become richer, in their diets the unprocessed starch products (like rice and flour) are replaced by products with a higher protein content (such as meat, milk and other dairy products) and by processed products with greater value added, promoting a process of dietary convergence worldwide along the models of richer populations. This trend is involving several billion people in emerging countries and the demand of livestock product is forecast to increase very fast in the coming years with the consequence of a multiplying effect on the demand for some agricultural raw materials, like soya and wheat, which are at the basis of animal feed[1].

Competition in land use is not restricted to the process of urbanization but now includes also the rise of the areas covered by biofuels production. The bioethanol production for the next ten years is projected to reach about 60 million litres, with the US, Brazil and EU-27 soaking up much of the expected increase. As regards biodiesel, an increase is expected of over 25 million litres. The raw materials used will largely be ad hoc crops. In 2020 13% of global maize production, 15% of vegetable oils and 30% of sugar cane will be used for the production of biofuels. Crops for biofuels have taken up about 20-22 million hectares in the last few years and could, due to further development, reach over 35-40 million hectares in 2020.

The policies supporting biofuel production are affecting the food market in two main ways: the change in land use from food to energy production, and the quantity of foodstuffs progressively removed from market trading. To what extent this has actually supported the upward trend in prices remains uncertain, yet it is undeniable that biofuel represents an additional source of agriculture commodity demand for a market, already short, of strategic commodities like sugar and cereals.

In general terms, the objective of increasing the amount of foodstuffs available on the markets cannot pass through the expanding of world agricultural areas. This option can today play a marginal role. Of the land remaining, the more fertile areas are already farmed and thus possible expansion can only rely on marginal and scarcely productive lands or on reduction, not at all desirable, of the current surface area given over to forests.

The per capita farmed area decreased by over 50% between 1963 and 2008. The used agricultural area (UAA) increased at an average rate of 0.30% per year in the last 40 years while increases close to zero are forecast for the near future (+ 0.1% per year).

Subjected to growing competition between the various uses, also water has become a critical factor not because its overall availability worldwide is not sufficient to cover demand, but because it is not distributed on the basis of the various regional needs: 15% of the world's fresh water is concentrated in the Amazon forest inhabited by only 1% of the world's population. By contrast in China, which accounts for 20% of the population, only 7% of water is available. This makes the water problem geographically specific.

Critical situations concerning water consumption may arise from overexploitation, climatic stress and pollution, in the case in which water courses receive more waste than they can assimilate. In the course of time, some such situations have been alleviated in many parts of the world thanks to technological progress, which has allowed an increase of about 700% in the storage capacity of fluvial systems in the past 50 years, promoting economic development, especially agriculture.

By contrast, problems have become more serious in other areas, for example where economic and urban expansion have required large quantities of water, exchanged for ever greater doses of pollution. There are also cases where erosion has led to a reduction in water availability in many large areas of Africa, including some SEMC. This is a clear constraint to possible expansion in the agriculture sector, which becomes even more serious if we view the growing negative implications accompanying the relationship between water and agriculture starting with the Green Revolution: agriculture is indirectly responsible for about 40% of pollution of surface water, stemming from the increase in use of chemicals, as fertilizers and pesticides, whose use seems to intensify when areas are devoted to biofuel production.

In past years the adjustment of supply to demand was guaranteed by technical progress. The agriculture sector has experienced a period of great agricultural capacity almost on a global scale, called "the Green Revolution" that has seen a remarkable increase in world agricultural production between the early 1960s and the end of the 1980s. The technological progress experienced in the more developed economies and its transfer to other regions, especially led to the doubling of yields for some cereal crops which are basic for the human diet, like rice, wheat and maize, besides the productivity of other plant species and livestock. The sustained yield increases was

lead by a marked rise in public investment in agricultural research, both in more developed and in developing countries.

Now we are faced with two types of limits: on the one hand the need for more sustainable agriculture, hence based on less use of chemical inputs, one of the main protagonists of the Green Revolution; on the other, the concern at having reached a technological barrier such as to be able to achieve only marginal short-term increases.

The OECD and FAO recently estimated that for the coming years the annual growth in production will continue to be slower than in the past, falling from an annual average of 2.4% for the previous decade to 1.7% for the coming years. According to many analysts, these data indicate unequivocally the end of the season of the Green Revolution and the reaching of a level of efficiency that will be hard to beat in the short-medium term (Brown, 2012).

This concern is reinforced by the decline in public expenditure devoted to research and development in the farm sector, which has stagnated in poorer countries, while in more developed countries it is growing at decidedly lower rates than in previous decades. Only in some emerging countries the investments in R&D are growing and many voices have pointed out the close relationship between the trend in public expenditure in research and the decline in growth rates for farm productivity. We are dealing with a sector in which, more than in others, public investments are fundamental.

The particular fragmentation affected the farming system limits private R&D activity. Even where firms reach a significant size, such as in the seed or agro-chemicals sectors, they are characterized by a short-medium term view and are calibrated on production scales such as to maximize the rate of return on investments as rapidly as possible. Instead, public research allows investment in long-term solutions, taking due account of the diversity of contexts in which the research is to be applied as well as the social and environmental sustainability of the technical improvement.

What gives cause for concern is not only long-term structural factors. Also those of a contingent nature have far more impact than in the past, since the greater integration of the economy favors a more rapid transfer of signals (and shocks) from one market to another (De Castro et. al. 2012). Such integration is also partly responsible for another aspect of the current scenario: market volatility.

This term is used when the frequency and range of price variations recorded in a given time span are greater than the historical average. Between 2007 and 2008 the farm price index used by the International Monetary Fund (IMF) rose by 50%, to then drop sharply (without return to its pre-boom levels) and rise to even higher levels at the beginning of 2011, representing a rise of 130% against 2002 levels.

This phenomenon, depending on several causes, exacerbates the natural instability of agricultural markets linked to the seasonal cycles. One cause arise from the small-scale market, characterized by low volumes and a restricted number of exporters. Only 12% of maize and 18% of wheat are traded on international markets; the remaining part stays within producer countries.

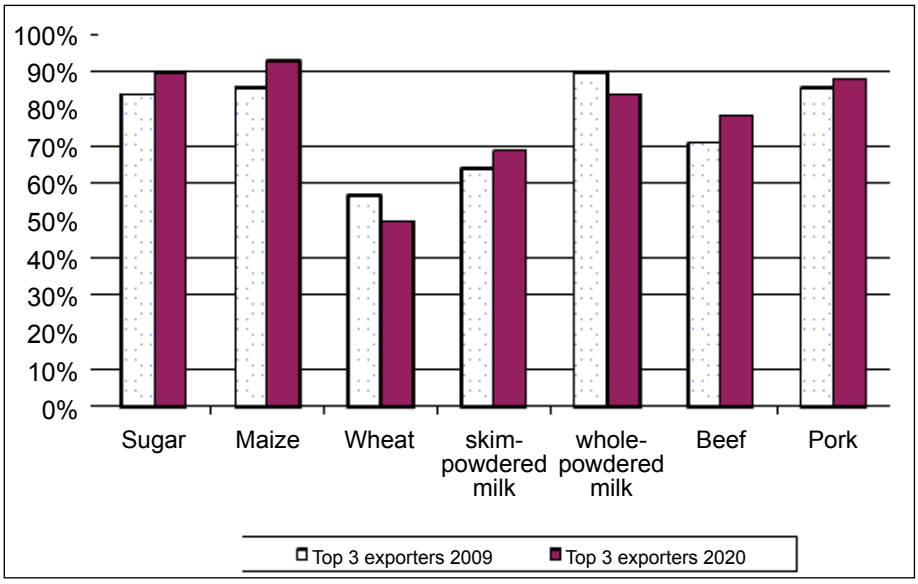


Figure 1. Market share of the world's first three exporters
Source: Our elaboration from FAPRI data

This means that also in the case of modest shocks, repercussions on prices may be significant and the return to equilibrium may take a long time. This is what has happened with increasing frequency of extreme meteorological events linked to the broader phenomenon of climate change.

Often reactions to these events have led to restrictions of trade. In 2010 we experienced a new cycle of measures which were completely uncoordinated at the international level. In summer 2010, following huge wildfires which hit Russia and caused damage to crops, Moscow banned grain exports, triggering price increases. The Russian example was followed by Ukraine, while in parallel many governments began to subsidize imports or reduce their taxation. The announcement of the ban was enough for many concerned importers to begin to negotiate higher volumes than in the past, fearing subsequent price rises. According to the FAO, world wheat prices increased by between 60 and 80% between July and September 2010 after the export ban decided by Russia.

Government reactions to price booms have aimed to stabilize domestic supply as rapidly as possible by adopting protective measures (such as bans on exports or incentives for imports), to alleviate the impact of increases upon its citizens. Yet these initiatives have had the sole result of exporting instability (and inflation), taking it from national to international markets (Tangermann 2011), amplifying price oscillations and triggering a vicious circle which made the markets even more precarious.

The scenario is further complicated by the state of reserves of strategic agricultural products. Today, the level of food reserves is much lower than in the past. In 2007 cereal reserves reached their historical minimum. This actually made the agricultural supply even more inelastic than it is naturally, further restricting the capacity to respond to price increases.

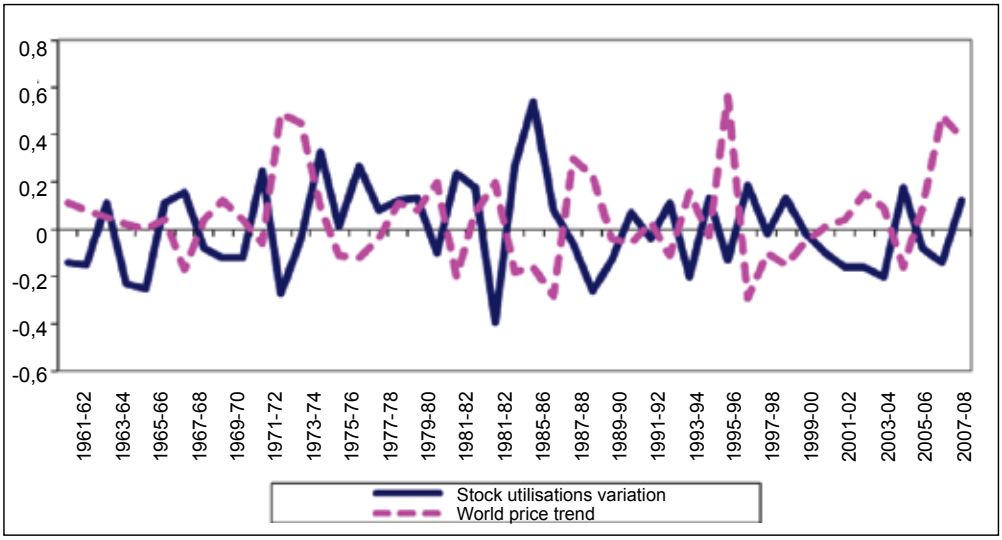


Figure 2. Wheat stocks are negatively correlated with wheat prices
Source: Our elaboration from USDA data

Also the role played by the financial markets during the price rises is more hotly debated. Some governments, but also several analysts and representatives of international institutions have pointed the finger at financial speculation, it being identified as one of the main drivers behind recent booms in farm prices.

In its broader, more authoritative strands the economics literature is rather skeptical regarding the nexus of direct causality which is thought by many to connect speculation and price rises. The trend in futures quotations is theoretically tied to expectations on demand-supply relations and thus tends to converge on the real market value of the traded commodity as the contract expiry date approaches.

By contrast, financial operations conducted outside commodity exchange circuits are different, such as in the so-called "over the counter" (OTC) market, where it is large institutional intermediaries which trade commodities through non-standardized contracts and without solvency guarantees made available by stock exchanges. This generates large risks, like those which became reality during the financial bubble in 2007, in which the contractual reneging of many players who had taken on excessive risks led to real market failure.

2. Aim and scope

A. Foundation: Measuring food security in South Mediterranean Countries. Towards a more comprehensive approach.

The development in analyzing the field of food security reflect the shift from a former focus on food energy availability to a more comprehensive appraisal of this phenomenon developed in recent years.

In September 2000 189 nations approved the "United Nations Millennium Declaration " (UNMD), calls for halving by the year 2015, the number of people who live on less than one dollar a day. The Millennium Development Goals pointed out by the UNMD include eight priorities: Eradicate

extreme poverty and hunger, Achieve universal primary education, Promote gender equality and empower women, Reduce child mortality, Improve maternal health, Combat HIV/AIDS, malaria and other diseases, Ensure environmental sustainability and Develop a global partnership for development. The level of this goals are measured each year using more than 60 indicators[2].

What emerge applying the upgraded $1.25-a-day poverty line, which is used to measure progress toward the first Millennium Development Goal (MDG), is that official poverty rates in most south Mediterranean countries are lower than in many other low- and middle-income countries (LMICs). Extreme poverty affects less than 3% of the population. But going depth in the analysis of non – income MDG indicators the situation change and the difference between south Mediterranean countries (and in general all Arab countries) and other LMICs appears less pronounced (IFPRI 2012, World Bank 2011).

On this field, is interesting the results come out from a study conducted by International Food Policy Institute (IFPRI) in 2012[3], pointing out how poverty and income inequality in the SEMC context are likely higher than official numbers have long suggested. In this study a new indicator of food insecurity risk is developed, merging a macro-level and a micro-level measure of food insecurity. The first one is defined as the share of food imports divided by total exports plus net remittance inflows[4], while the prevalence of child under nutrition is used for representing the micro micro-level measure of food insecurity. The result is a classification of SEMC countries into five risk groups, based on this composed indicator.

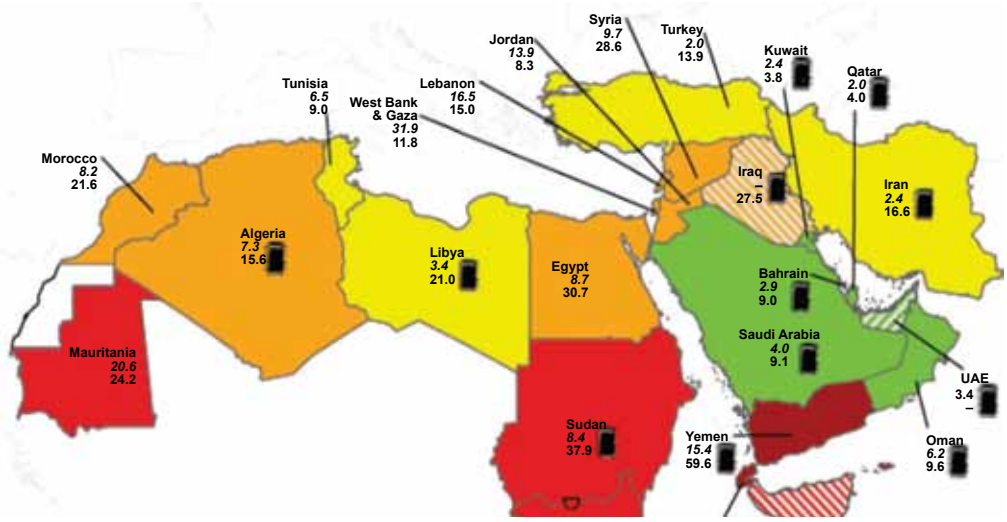


Figure 3. The SEMC food insecurity.
Source: IFPRI 2011

This approach goes beyond the traditional micro aspects put at the basis of the Global Hunger Index (GHI)[5], calculated each year by the International Food Policy Research Institute (IFPRI). The GHI provide a multidimensional overview of the hunger, combining three equally weighted indicators.

The proportion of undernourished as a percentage of the population, which reflects the share of the population with insufficient dietary energy intake.

The prevalence of underweight children under the age of five, which indicates the proportion of children suffering from low weight with regards to the adequate weight for their age.

The mortality rate of children under the age of five, reflecting the interaction between an inadequate energy intake and an unhealthy environment.

The scores for some selected North Africa and Middle East countries, in comparison with the six countries at the bottom of the world list in 2010, show that the situation of South Mediterranean countries is relatively good and widely differs from the situation of those African countries that suffer the most from food insecurity. All the selected countries are classed, in 2010, in the category of countries with low hunger levels, with the exception of Morocco and Syria, which appear with moderate hunger levels. The best scores among the SEMC correspond to Tunisia, and the worst to Morocco, where the prevalence of underweight children under five years of age has increased between the average of 1988-92 and the average of 2003-08, to 9,9%.

A factor becomes more and more crucial in measuring the multiple dimension of the concept of food security is the exposure to food import. The South Mediterranean Region has as one of the most food import-dependent area in the world, with net food imports accounting for 25-50 % of national consumption. This result is a consequence of a very rapidly demographic growth in the last few decades combined with the change in consumption patterns linked to the increasing average income. A direct consequence of this development has been the rising external food trade deficits, that if in general it should not mean self-sufficiency deficit[6], in the cases of some South Mediterranean countries the figure gives rise some concerns, related to the high ratio of food imports over total exports. In particular in those countries characterized for an high dependence of export earnings from oil, the exposure to food security risks is directly related with the oil price fluctuations. The quota of total exports used to pay for imports is in the SMC higher than the world average. The food dependence is more pronounced for Palestinian Territories, Lebanon, Jordan and Egypt than in the other countries included in the region.

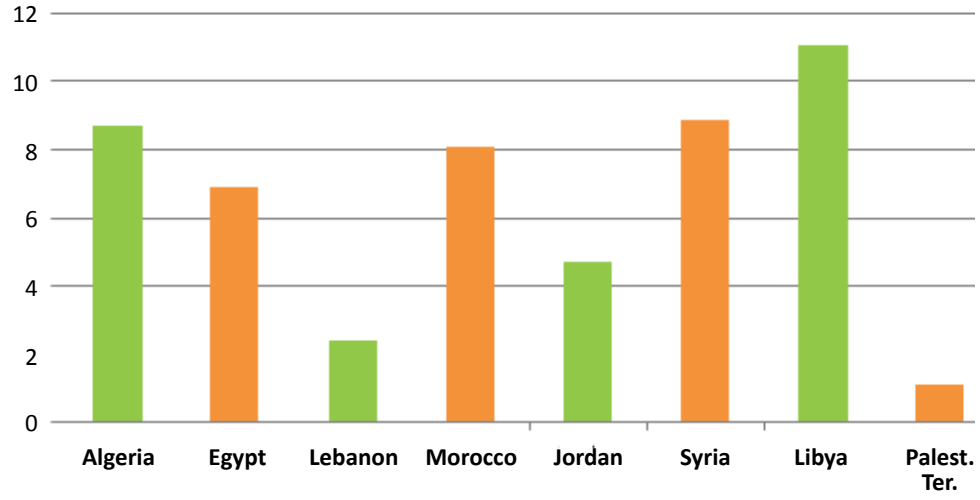


Figure 4. Total exports / Food imports in SEMC (2010)
Source: Breisinger et al. (2010)

Combining the number of times that total exports cover food imports with the food production per capita, the GHI, and Gross National Income per capita, on the basic distinction grounded on the mineral resources endowment of each country, Breisinger and other authors have proposed a

food security countries classification in which all the South Mediterranean countries considered are included in the category countries facing a food security challenge (Breisinger *et al.*, 2010).

A most recent multidimensional food security indicator is the Global Food Security Index (GFSI) developed by The Economist Intelligence Unit, that consider the core issues of affordability, availability, quality and safety across a set of 105 countries. The index is a dynamic quantitative and qualitative benchmarking model, constructed from 25 unique indicators, that measures these drivers of food security across both developing and developed countries, providing a rank of countries in function of their food vulnerability. The 2012 GFSI for the South Mediterranean countries covered by the survey provide the following result.

Table 1. Global Food Security Index in some SEMC (2012).

	Overall Score	Affordability	Availability	Quality and Safety	GFS Rank
Algeria	40.1	38,2	39,1	47,6	72
Egypt	50,4	38,1	59,8	55,3	52
Morocco	49,1	49,5	47,5	52,6	57
Tunisia	52,2	52	48,6	66	49
Turkey	62,2	55,6	66,6	66,2	33
Jordan	49,8	51,8	49	47,1	49
Syria	40,9	33,6	44,9	47,9	70

Source: "The Economist" Intelligence Unit

3. Objectives of the White Paper

The situation of the SEMC countries in terms of food security is not particularly bad when compared with other regions of the developing world, but they still face a host of problems: scarce endowments of agricultural land and water, excessive food-import dependence, and the presence of some poverty-stricken rural zones. A World Bank typology, which classifies developing economies according to their stage of agricultural development, has placed most SEMC countries in the middle-of-the-way category of transforming countries. A specific issue for this type of countries is the great divide between the rural and urban conditions concerning incomes and poverty, as nonagricultural sectors now account for most of their economic growth. The SEMC have experienced substantial progress, with regards to GHI, between 1990 and 2010. All of them are classed in 2010 in the category of countries with low hunger levels, with the exception of Morocco and Syria which appear with moderate hunger levels. Among them, Tunisia registers the best scores, and Morocco the worst.

As we seen, many factor influence what we call food insecurity. It is a complex phenomenon, encompassing elements related to standards of living, health, income distribution, import dependency and other aspects, and where is fundamental to consider the connection linking the various key factor influencing the state of a Country in terms of food security.

In this context, the priority is contributing to develop a multidimensional approach in measuring food security, aimed to better explore the country – specific factor which affect the state of food security and the exposure to price shock in the international food market. In this scenario, a multivariate analysis is proposed in order to summarize in a small number of composite indicators an array of data concerned with specific social and economic aspects related to food insecurity. It would be clear that, in parallel, the output of the model should help analyst and policy maker to better understand the specific need of each country in order to improve their food security state and coping with risks associated to prolonged price shock on international commodity market.

The second priority is strictly linked to the previous, aiming at analyzing the specific country -performance in managing the domestic effects of international food price volatility. Many factors can contribute to isolate households from price volatility and food inflation. One of this, as we seen, is the set of public measures implemented by Governments in order to mitigate the effects of prolonged price peak on the poorest population. Other are factors are at the basis of the asymmetric price transmission that characterized the SEMC area. The analysis of the causes leading asymmetric transmission of price is often complex and associated with several factors (Meyer and Cramon-Taubadel, 2004), which largely represents traditional concerns in SEMC countries. In fact, the level of transports and distribution cost, domestic market distortion, the ability and cost in managing reserves, including food subsides, are in overall factor which affect price transmission from international to domestic market.

If we aims to improve the state of food security in SEMC countries needs a set of action, where some of them are strictly related to the global scenario, implying choices in terms of global food security. In this concerns, since the "G8 Leaders Statement on Global Food Security" delivered in Hokkaido in 2008, the food security issue has entered the agenda of the meetings of the leaders of the most relevant economies in the world. In the 2009 G8-Summit held in L'Aquila, the leaders issued a stronger declaration prioritising the need of an increase of the agricultural productivity and of agricultural investments. For the first time in G8 history, a meeting of agricultural ministers preceded the Summit. After that, the G8 leaders committed to raise 22 billion dollars in 3 years for agricultural investments and launched the "L'Aquila Food Security Initiative" (AFSI), endorsed by 26 Nations and 14 international organizations. This was based on a "comprehensive approach", including: "increased agriculture productivity, stimulus to pre and post-harvest interventions, emphasis on private sector growth, smallholders, women and families, preservation of the natural resource base, expansion of employment and decent work opportunities, knowledge and training, increased trade flows, and support for good governance and policy reform". Since 2009, the AFSI has met on a regular basis, in a roadmap that ideally is accomplished in 2012, with the declaration of Camp David launching the New Alliance for Food Security and Nutrition. Recognized to be the "next phase" of the G8 "shared commitment to achieving global food security", the priorities of the New Alliance are: mobilizing "private capital for food security"; taking "innovation to scale"; reducing and managing the risk; improving nutritional outcomes and reducing child stunting. A report on the implementation of the New Alliance is expected to be presented at the 2013 G-8 Summit, to be held next summer in Northern Ireland under the UK Presidency. In last January, food security, nutrition and hunger have been announced being among the central issues of the Summit. In his most recent speeches, though, UK Prime Minister David Cameron's references to food security appear to fade out.

Regarding G20, whose leaders has been meeting officially only since 2008, food security is one of the nine key pillars of the "Seoul Development Consensus for Shared Growth", a set of principles endorsed by G20 leaders at the Seoul Summit, in 2010. The G8-G20 French Presidency of 2011 promoted the "Action Plan on Food Price Volatility and Agriculture", adopted by the G20 Agriculture ministers in June 2011 and endorsed by the G20 leaders the following November, in the Cannes declaration. In spite of disappointment and criticism, it is – so far – the most ambitious attempt to approach some aspects related to food security, such as the volatility of markets, on a global and comprehensive perspective. The plan objectives are: "improving agricultural production and productivity, (ii) increasing market information and transparency, (iii) reducing the effects of price volatility for the most vulnerable, (iv) strengthening international policy coordination and (v) improving the functioning of agricultural commodity derivatives' markets". Among the other initiatives, the 2011 G20 launched the AMIS (Agricultural Markets Information System) to improve transparency of the markets; supported the "International Research Initiative for Wheat Improvement" to foster public funded studies on the wheat genome; constituted the "Rapid Response Forum" to enhance the international community's capacity to coordinate policies and develop common responses in time of market crises. Others initiatives, such as agreement to

"remove food export restrictions or extraordinary taxes for food purchased for non-commercial humanitarian purposes by the World Food Program and agree not to impose them in the future" were not implemented at Wto level. The Mexican presidency of G20 (2012) continued along the ambitious French program, without any further relevant achievement. Meeting in Los Cabos the deputy-ministers of Agriculture of G20 nations launched the "AgResults Initiative, aimed at improving food security for the poor and vulnerable by encouraging private sector innovation of new agricultural products and systems constrained by market failures in agriculture". Food security is mentioned among the Russian's presidency priorities, but only as one of the sub-headings of a more general approach to "Development to all". The next meeting of G20 leaders will take place in Saint Petersburg on December 1, 2013.

In this global perspective the paper provide a set of suggestion based on the general figures used in the first part of the work, in order to better priorities for an agenda for the global food security.

On the other hand there are specific country-condition influencing food security that need of other specific suggestion that the paper organize in the following sub priorities.

Addressing weakness factor in enhancing domestic food supply.

Integration in the global food market and reduce food price pass-through negative effects improving market infrastructure.

Better performing safety nets measures to dampen the effects of food-price shocks.

4. *Assessment Indicators, Scientific approach and conceptual framework*

As well known in literature, the implementation of the multivariate analysis is based on a set of variable capable to reflect the basic determinants of food consumption. Since the seminal work conducted by Reig (2010), we add in our analysis the contribution provide by the "import dependency" dimension.

In addition to the traditional measures related to the concept of food security the work take into account also specific variables representing this dimension, enriching the framework proposed by Reig, organized on three pillar (availability, access and utilization) that are inherently hierarchical (Barrett, 2010).

The Caloric intake is a variable representing the supply side (availability) of the food security problem, while Gross National Income per capita is a basic determinant of access. Access is also conditioned by the degree of inequality in the distribution of income, which can be measured by the Income Gini Coefficient. A concern for utilization has led to the inclusion of several variables related to human health, like life expectancy at birth, and with the health conditions of children, a particularly vulnerable group, using underweight and early mortality as indicators. The influence of a healthy/unhealthy environment is reflected in the inclusion of two variables that measure the access to fresh water and basic sanitation facilities. Also, the intake of basic nutrients has been represented by the daily intake of iron in the diet.

Three variables are intended to measure net food security outcomes: the proportion of the undernourished in the total population and the intensity of food deprivation (food deficit of the undernourished population).

Finally, a group of two variables aims to measure the dependence on the external market: the share of food imports on total exports and the food dependency ratio (Net Imports as a Share of Consumption).

Therefore, the following variables are included in measuring the level of food security in the considered countries:

- Gross National Income per capita
- Dietary Energy Consumption (calories/person/day)
- Proportion of undernourished in total population
- Life expectancy at birth
- Under-five children mortality rate
- Improved sanitation facilities (% of population with access)
- Improved water source (% of population with access)
- Female participation rate in the labour force (%)
- Income Gini Coefficient, 2000-2010
- Total exports/ total food imports
- Net imports as a share of consumption

Principal Components Analysis has been recognized as one of the main methods currently available for analysts concerned with the construction of composite indicators (Nardo *et al.* 2008). Principal Components Analysis (PCA) is a statistical technique, belonging to the field of multivariate analysis, which is particularly suitable in summarizing the impact of a set of interconnected variables, as occur in the problem at hand.

The objective of the analysis is to select the minimum number of factors needed to account for the maximum portion of the total variance represented in the original set of variables, and then being able to assign a reasonable practical meaning to each factor. After doing that, and taking into account the specific influence of each original variable on each factor ('factor loadings') it is possible to ascertain the 'factor scores' corresponding to each observation.

Observations are countries in our case, and we are constrained to take into account that their number must be kept in proportion with the number of the original variables included in the analysis.

The interest of using PCA is double. First, we gain insight into the structure of the food security problem, by discovering a reduced set of underlying factors strongly connected to a collection of partial indicators or variables that we are able to observe. Second, we are able to substitute these factors for a larger number of variables and summarize the performance of each country according to each factor. Doing this, it is possible to simplify the analysis of the information at hand, allowing for a ranking reflecting the relative position of each country in a scale that depicts the seriousness of the problem.

IV – Findings

In the analysis carried out, the usefulness of a multivariate technique, Principal Components Analysis, is expounded and illustrated with an exercise comprising all SEMC countries and a set of 11 variables, addressing different facets of food security. The main aim of adopting this methodology (Nardo *et al.*, 2008) in this case is to summarize the information contained in the data in a small number of dimensions, or 'principal components'. The computation process has been carried out involving the deletion of some food security-related variables from the original set.

Following Reig, we found two components, so called "human development" and "risk of suffering from hunger", that have been finally retained and given an interpretation.

It has been found that the following variables have strong links ('loads') with the first component: Gross National Income per capita, life expectancy at birth, under five years child mortality rate, access to adequate sanitation facilities, access to drinkable and safe water supplies. The relationship is positive with those variables for which an increase implies a rise in wellbeing, and negative with those for which higher levels of the variable are associated with a situation of low social and economic development and the presence of deprivation.

Another group of variables mainly exert their influence on shaping the second component: dietary energy consumption, proportion of undernourished people, and net import. All of them are clearly linked to the intake of energy contained in food. The association is positive with variables measuring undernourishment and food deficit, and negative with caloric intake.

Countries in the sample have been ranked according to the aforementioned two components. All SEMC countries scored the higher value concerning the 'human development' indicator – a sub-indicator of food security - with Tunisia, which occupies the third position, as the best positioned country among the SEMC. The second sub-indicator, which measures the 'risk of hunger', gives rise to a more blurred ranking. Now some countries with a relatively high standard of living – within the African context – appear not as well-off as expected.

The main findings which we found carrying out our analysis is there exists the need for deeply investigation aimed to understand the reason and the solution for the food security problem in this region.

We emphasized that with less than two hectares per capita, small farmers account for almost all economic activity and enterprise, supply and demand, production and consumption in these regions. In some cases small-scale agriculture amounts to more than 80% of the food production in some developing regions. These people are therefore major actors in triggering the processes leading to economic growth. As a result these local actors should also be decisive for investments in agriculture in developing countries. The technical and organizational growth of agricultural systems falls by necessity on their shoulders and can best be configured only with the coherence of their initiatives.

To do this we must raise their knowledge and skills level, improve the quality of services and their ability to access them, calibrating the research and transfer of innovation on the specific aspects of the environmental and production conditions in the areas in which they live.

Improving human capital is a prerequisite. Keeping pace with these markets means having to interpret these multiple phenomena and translate this interpretation into management initiatives that tend to become increasingly complex, requiring continuous updating to take into account both technical and organizational innovations. This objective implies a greater incisiveness of gender policies: women make up over half of small farmers around the world and enhancing their role can be of great significance in terms of the stability of food supplies.

Raising the sum of human capital is one condition. Equally important is the contribution they can make to the development of the services and infrastructure starting with irrigation systems. The FAO estimates that about 1.2 billion people live in regions with marked problems of water scarcity and the situation could worsen in the short term, coming to affect another 600 million people by 2025. The advantages gained through the establishment of new and efficient irrigation infrastructure could be immense, particularly in Africa. The productivity differential is approximately 130% between irrigated and non-irrigated areas, and in places where water is not only a problem of distribution but also with regard to the volumes available, updated irrigation techniques can help to achieve major results. The transport and storage infrastructure should also be supported and fostered. Farmers in the poorest areas of the world sell their product at harvest when the price is at its lowest, having to buy it back when the cost is higher, contributing, paradoxically, to a general increase in prices. This is due to a lack of appropriate technology and facilities for handling,

storage and processing, which would extend the shelf-life of the product and raise its value in the market place. Finally, there is the need to strengthen the credit system and, more generally, risk management. The poverty in which farm families live represents a barrier to investment that becomes insurmountable in the face of the slightest adversity, such as falls in production, lower prices or increased energy costs. Unfavorable years often affect the continuity of farming, making it impossible to maintain operating costs at normal levels and in such a situation the ability to borrow or have access to tools for income stabilization is essential in the short term, to ensure that farms are economically viable and are able to respond more consistently to market signals.

Another important question is the specificity of all single country in SEMC region; even if there are common problem which affect the agricultural sector efficiency in this region, among countries we observed specific characteristics and linked problem for each country. In this context, due to the lack of reliable data, to investigate more deeply the topic for better understanding and proposing probable solutions to different type of risk in these countries, e.g. food security question, we performing in three countries (Syria, Turkey and Tunisia) a "Delphi Method" which is a methodology built on interviewing number of experts (bankers, traders, wholesalers, insurers, policy makers, consumers, etc.) and farmers (farmers, farmers' leaders, farmer association members and farmer union members) as well.

For example, in Syria our analysis underlines that one of a major problem of Syrian agriculture is the lack of facilities for marketing. In particular, as stressed by expert's opinions, farmers face severe difficulties during the marketing operations, especially for perishable products. The lack of adequate infrastructures, and efficient markets challenge the crossing of supply and demand sides. In Turkey, unexpected price fluctuations and apriori price uncertainty during marketing heavily affects farmers income. The shift in agricultural policy which moved away from coupled agricultural policies towards decoupled payments negatively affected this aspect. In Tunisia, the production/yield risk revealed to the main type of risk faced by farmers, followed by market risk and financial risk. This is explainable by the fact that there is a strong market intervention aimed at administratively fixing prices thereby protecting both farmers and consumers from market risk. The risk of policy change and personal risk are therefore less perceived by farmers as possible sources of risk as a result. Another significant source of risk is the increasingly limited availability of labor.

In conclusion, as well known, SEMC are experiencing a substantial phase of instability and policy changes. Besides the vulnerability implied by those changes, they might represent a rather unique opportunity to rethink the policy, and precisely the leading instruments to revitalize the agricultural sector. But, it would be important to emphasize that the target of the agricultural policy of each country should be set on the single specificity of the agricultural sector.

1. *Structural factors affecting food security in South Est. Mediterranean Countries*

The population growth rate of SEMC countries has averaged 2.1 percent in the last seven years compared to a world rate of 1.2 %. In the southern and eastern Mediterranean countries, high population growth rates have been recorded over the past three decades with natural growth peaks of 3% and more. Profiles vary widely, however. Population growth in the Maghreb countries is controlled as the result of a steep decline in fertility rate: this is the case in Tunisia, whose population has grown from 5 million in 1970 to 10 million at the present time but should not exceed 15 million by 2050. Population growth is still buoyant in most of the countries in the Near East. In Syria, Jordan, Egypt and the Palestinian Territories the annual growth rate is still around 2%. Egypt, for example, which had a population of 35 million in 1970, now has some 75 million inhabitants, and the figure could rise to almost 120 million by 2050. In the Near East, population trends are very correlated to socio-economic disparities: the demographic and socio-economic profile of Lebanon, for instance, is far removed from that of Syria.

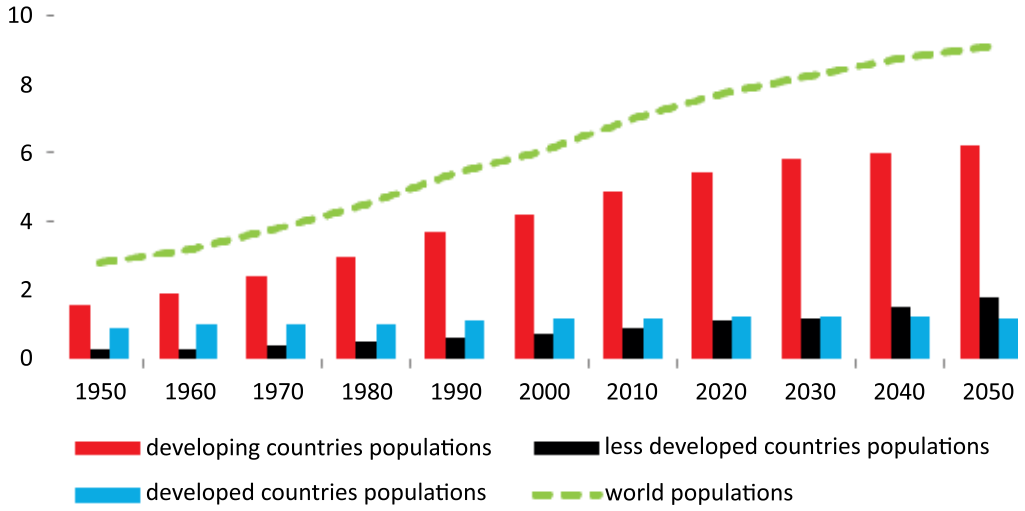


Figure 5. Total population growth and projections
Source: FAO

This trend has been accompanied by a rapid urban growth in the SEMC, where the number of city dwellers will have doubled by 2020 compared to the figure for 1990. Yet rural areas, on the whole, are not becoming depopulated. There has been a steep decline in the rural population in most SEMC in general terms, but the relative share of the rural population is decreasing in absolute terms as a necessary corollary of galloping urbanization, rural areas have never been so populated, particularly in the countries of the Near East and in Egypt, where the rural population is still larger than the urban population and farming still remain the primary activity in large part of this region (World Bank, 2011).

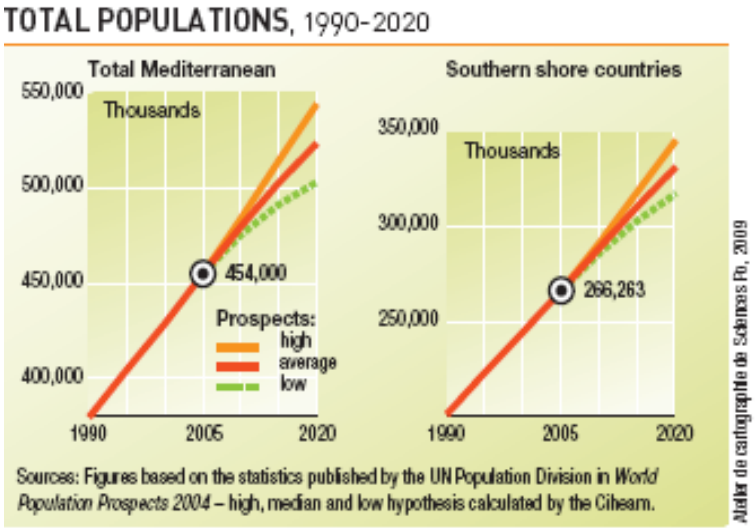


Figure 6. Rural population trend (total and annual %)

At the same time the average income growth rate has been roughly 3.0 % in the last decade, compared to the world average of 1.1 %, redrawing, hand in hand with the increasing urbanization, the consumption patterns of the entire region and leading, as previously recalled, toward a progressive exposure in terms of food trade deficits.

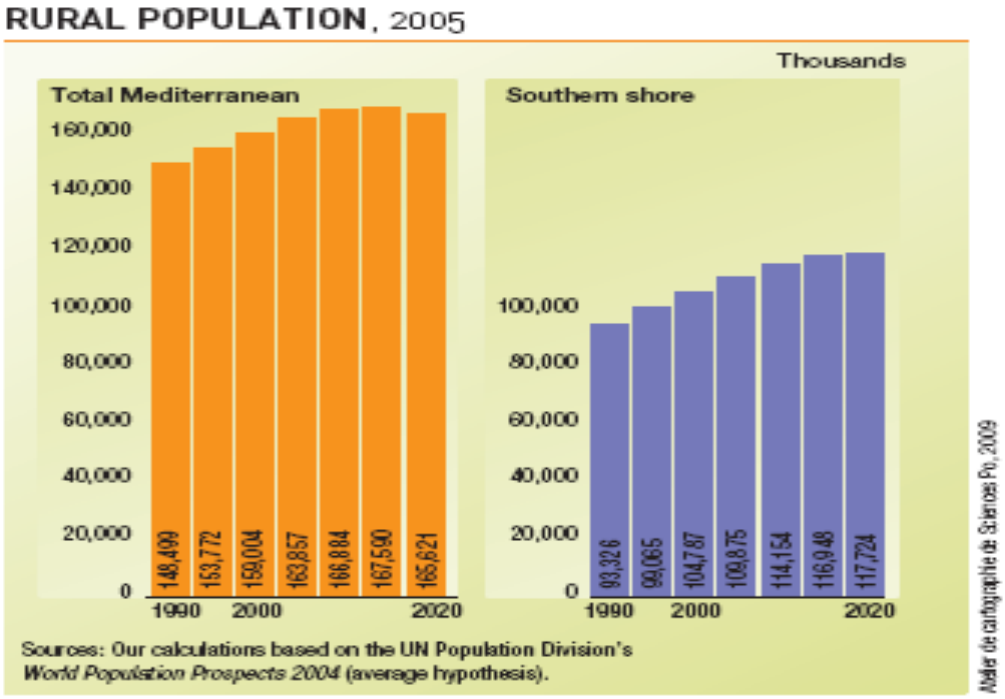


Figure 7. GDP per capita (US$)

The competition in covering soil has seen an increasing role of the urban area, often at the expense of fertile areas. In a region characterized by a strictly limited resources of arable land and water this means limiting option available for contributing to cover the increasing food demand. In Algeria, Jordan, Libya and Egypt, for example, the acreage of arable land accounts for less than 5% of the total area of the country. In many of the SEMC the arable land per capita is below the global average and its decline has been rapid.

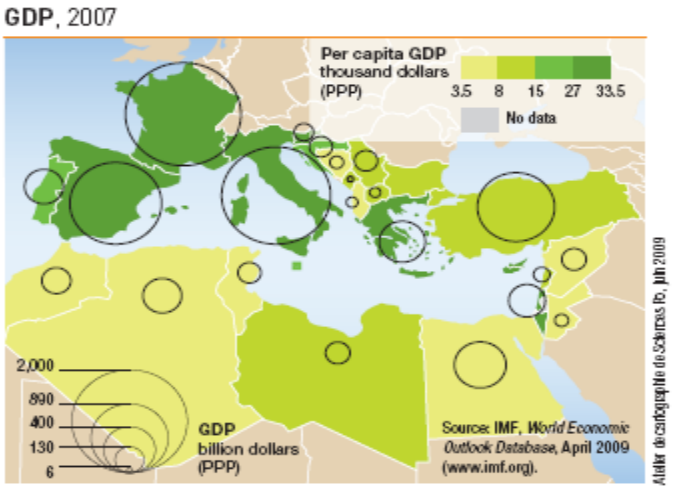


Figure 8. Arable land (Ha per person)

In order to get around water scarcity, the people of the SEMC developed efficient systems of water engineering, which they used mainly for watering their crops (CIHEAM 2012). In Egypt, where crops cannot grow without irrigation, numerous techniques have been used for thousands of years to exploit Nile spates. But it was in the 20th century that irrigation was developed most, at least in terms of areas covered.

Irrigation is no doubt reaching its limit after years of rapid development, particularly in SEMCs, which are amongst the least endowed in the world in terms of available water resources: half of the world's "water-poor" (less than 1000 cubic meters per capita) live in the region. The natural resources exploitation index (the ratio between the volumes abstracted and the renewable water resources available) gives a worrying indication of the pressure that now weighs on water resources. Most of the SEMCs have an exploitation index of over 50%, for instance, but it is the situation in the east of the basin that is reason for the greatest concern. With the exception of Lebanon and Turkey, both of which have water resources, the indexes are already very high (over 75%) and, to judge by trend scenarios, are liable to rise further. These quantitative limits are compounded by signs of deterioration in water quality.

As seen previously, SMC are particularly concerned about food security because they are highly dependent on international commodity markets. The level of exposure is directly related both to the ratio of food imports to total exports and the fiscal balances.

SEMC countries are the largest net importers of cereal calories in the world, importing roughly 56 percent of the cereal calories they consume. This dependence on foreign market concerns all countries of the south Mediterranean region, which are the world largest net importers of cereal calories buying on the international market more than 50% of the cereal consumed calories. Wheat represents a significant part of the SMC diet, reaching in the case of Tunisia roughly 50% of the total consumed calories.

The exposure of SEMC countries to world food price volatility is firstly linked to their high dependence on the external market. The World Bank (2012) has calculated the ratios of net imports to domestic consumption, as indicative of the dependency on foreign imports to satisfy domestic food demand[7]. The results show that dependence on food imports in general is high across SEMC countries.

Table 1. Food Dependency Ratios, Import, and Consumption Share for 2010.

Country / Food Item	Net Imports as a Share of Consumption	Commodity Import Shares	Commodity Consumption Shares
Algeria			
Grains	68%	52%	52%
Oils	88%	22%	18%
Meat	33%	7%	15%
Sugar	89%	19%	15%
Food	69%	100%	100%
Bahrain			
Grains	100%	28%	25%
Oils	n/a	n/a	n/a
Meat	88%	62%	65%
Sugar	100%	10%	9%
Food	92%	100%	100%
Egypt			
Grains	39%	54%	62%
Oils	78%	27%	14%
Meat	37%	10%	13%
Sugar	37%	9%	11%
Food	44%	100%	100%
Iran			
Grains	19%	32%	46%
Oils	80%	28%	11%
Meat	23%	24%	34%
Sugar	61%	17%	9%
Food	31%	100%	100%
Iraq			
Grains	71%	56%	58%
Oils	100%	9%	7%
Meat	62%	20%	25%
Sugar	104%	15%	11%
Food	75%	100%	100%
Jordan			
Grains	97%	42%	35%
Oils	68%	17%	20%
Meat	25%	27%	34%
Sugar	98%	14%	11%
Food	67%	100%	100%
Kuwait			
Grains	101%	25%	26%
Oils	100%	3%	3%
Meat	86%	67%	66%
Sugar	100%	6%	6%
Food	91%	100%	100%
Yemen			
Grains	84%	54%	55%
Oils	100%	8%	7%
Meat	43%	10%	20%
Sugar	104%	27%	18%
Food	81%	100%	100%
Lebanon			
Grains	87%	39%	32%
Oils	38%	7%	8%
Meat	56%	38%	49%
Sugar	100%	16%	11%
Food	70%	100%	100%
Morocco			
Grains	51%	57%	61%
Oils	59%	24%	21%
Meat	n/a	n/a	n/a
Sugar	57%	19%	18%
Food	54%	100%	100%
Oman			
Grains	91%	26%	24%
Oils	93%	27%	18%
Meat	88%	37%	45%
Sugar	85%	10%	12%
Food	89%	100%	100%
Saudi Arabia			
Grains	85%	35%	34%
Oils	95%	12%	10%
Meat	57%	33%	46%
Sugar	151%	20%	11%
Food	80%	100%	100%
Syria			
Grains	51%	53%	62%
Oils	6%	7%	19%
Meat	n/a	n/a	n/a
Sugar	126%	40%	19%
Food	56%	100%	100%
Tunisia			
Grains	68%	58%	63%
Oils	-73%	15%	22%
Meat	n/a	n/a	n/a
Sugar	104%	27%	16%
Food	43%	100%	100%
United Arab Emirates			
Grains	100%	18%	22%
Oils	82%	19%	19%
Meat	87%	24%	51%
Sugar	82%	40%	8%
Food	89%	100%	100%

Source: Calculations using USDA data collected by Cristina Savescu.

This situation shall produce, in case of price shock, dramatic consequences in terms of food inflation. The SEMC region is the largest wheat importer in the world, and wheat prices increased by 70 percent in the second half of the 2000s. The incidence of food consumption in the basket household expenditures in SEMC countries is, in fact, still account between 30 and 50% and consequently food inflation often represent the most important component of the overall inflation.

It is well known, that the effects on the field of food security are strictly correlated with the income distribution among the population. The question of the high concentration of household living near the poverty line that characterized the SEMC area, would represent in case of prolonged price shock a threat in increasing the severity of poverty levels (IFPRI 2012). About half of the populations of the SEMC countries live in rural areas, and within this category agricultural sector plays a key role in, Syria, Egypt, Tunisia, Morocco and Jordan. Therefore, we need to emphasize that rural poverty is at the core of food security problems in the region, and recent rises in food prices have contributed to an increase in the incidence, depth and severity of poverty. Some preliminary analysis carried out during last years have stressed the link between increase in food price and increase in poverty in these countries; these results suggested that about a 30 percent increase in food prices in Egypt would result in a 12 percentage point increase in poverty, and a 14 percent increase in food prices in Morocco would result in a 4 percentage point increase in poverty (World Bank, 2011).

Furthermore, the tight of supply available on the food commodity market for certain strategic products, like cereals, increase the risk of disruptions in procurement and shortfalls in food availability in countries with high food dependency ratios (World Bank and FAO 2012). A further point which should be emphasized is the similarity often misleading of the concept of food security compared at self-sufficiency; indeed, food trade deficits may be an acceptable way of guaranteeing the availability of food supplies, but only under the condition that deficit-prone countries are able to generate enough foreign currency to pay for their imports. In practice it means being able to keep a relatively low ratio of food imports over total exports. In this context, SEMC countries are currently using 11.5% of their total exports to pay for their food imports. As underlined by the joint World Bank/IFAD/FAO report on improving food security in SEMC countries (World Bank 2009), food security in the region is determined by resource endowments which affect the level of food import requirements and also by fiscal balance which influences a country's ability to afford food imports.

This means that vulnerability to food price shock is basically influenced by the import dependence, but also by the fiscal position of the considered country. High import dependence associated with a sound fiscal position is not of concern, excepted in case of quantity shock such as export bans (African Development Bank 2012).

Global price movements in some strategic agricultural products markets is one important source in conditioning domestic price levels, accompanied by others linked to country-specific factors, including public policy measures.

Governments of SEMC countries use many policy instruments in order to mitigate the effects on consumers rising from fluctuations in global agriculture commodity price. Those measures has helped SEMC countries in isolating households from price volatility and food inflation. As observed by Ortiz *et al.* (2011) different policy interventions (especially an extensive use of price subsides, but also measures aimed at managing and regulating food consumption, production and trade) are used by SEMC countries in this field.

The latest peaks in international price has consequently complicated the macroeconomic scenario, leading toward an extensive use of resource devoted to price subsides measures and others instruments, including production subsidies, import protection cuts, and build-up of food reserves, taking away fiscal resources that can be used to finance growth-enhancing investments (World Bank 2012). The effects of food price transmission is linked to both the level and the typology of policy instrument used to mitigate the transmission into the domestic market. In case

of prolonged period of increasing food price fiscal, the amount of resources for covering the cost of those measures increase, generating a heavy fiscal drain on government budget and compromising the sustainability of these kind of response.

Inevitably fiscal and inflationary pressure has grown in many SEMC countries that are experimenting a fast growing domestic food demand and spending a relevant share of their GDP on food subsides. Some SEMC countries with high food import dependence and large fiscal deficit, such as Libya, Jordan, Lebanon, Egypt, Algeria, and Tunisia, appears most vulnerable to a sustained food price shock (IFPRI 2012, World Bank 2009).

In countries with limited fiscal budget and high import food dependency the space for price subsides in order to keep domestic prices stable decrease hand in hand with the increase in food price. In the last years public policy expenditures in some countries, like Egypt, Tunisia, Morocco, Algeria, has seen an increase arising from extending food and fuel subsidies. In parallel the fiscal deficit has grown.

Albers and Peeters (2011) analyzing the fiscal implications of increased expenditure on subsidies argue that the impact on public finances of the commodity price increases has been large by comparison with other. For Egypt, Algeria and Tunisia food subsidies as a percentage of GDP increased during 2007 and 2008 food price peak,. The weight of the combination of food and fuel subsidies on total government expenditure increased dramatically in Egypt where they reached 30.9% of current government expenditure in 2008, but also in Morocco and Tunisia where they reached 19.9% and 17.7% in 2008.

In this regard, by and large, observers have identified amongst the causes of the “Arab Spring” a set of common factors including social inequality, high levels of youth unemployment, a desire for greater individual freedoms together with a widespread sense of dissatisfaction in the population, stressing that at the root of the protests were significant “factors unrelated to income”[8] This having been said, one cannot underestimate the impact, especially in some countries, of the increased weight of food expenditure on family incomes brought about by the volatility in prices of agricultural commodities since 2007.

In December 2010, following the spike in prices of agricultural commodities, the global prices of sugar and cereals had increased by 77 and 40% over the previous year. This was a decisive event for the stability of many SEMC countries, where the availability of the two commodities, which provide 61% of per capita calorie intake in these regions, is largely dependent on imports (De Castro *et al.* 2012).

Table 2. Percentage of income spent on Food and Non-alcoholic beverage in 2008.

USA	**6.8**
UAE	**9.0**
Qatar	**12.8**
Kuwait	**14.6**
Israel	**17.8**
Saudi Arabia	**23.7**
Iran	**26.3**
Tunisia	**35.8**
Egypt	**38.3**
Morocco	**40.3**
Jordan	**40.8**
Algeria	**43.8**

Source: US Department of Agriculture

Given that much of the food imported into North Africa consists of bulky cereals, a large part of the final cost is due to international and domestic transport, warehousing and storage costs. Economic and Social Commission for Western Asia (ESCWA, 2010) argues that countries in the region, (which includes Egypt as the only North African country) tend to perform worse than other Middle Income Countries in terms of trade development indicators such as the World Bank's Logistics Performance Index. This is partly due to lack of integration of border services and inspections, lack of simplified procedures for transit freight, the poor state of railways and roads, inefficient and lengthy border clearance procedures, and lack of ability to trace and track consignments.

The Logistics Performance Index (LPI) for the four North African countries included in the World Bank's sample. As evident in the Table, there is considerable scope for all four countries to improve their trade logistics. This is particularly true for Algeria and Libya who rank 130th and 132nd out of 155 countries and have a LPI below the average for the SEMC region as a whole as well as below the average for Lower Middle Income countries (when they are Upper Middle Income) and below the East Asia Pacific region. There is a positive relationship between the LPI and food security with the latter measured by the Global Hunger Index (ESCWA 2010). Hence, reforms to improve trade logistics in North Africa may well have a beneficial impact in terms of food security. Furthermore countries need to tailor their stockpiling strategies to their specific needs. Food stocks serve multiple purposes: as rapid emergency food aid in times of crisis, as working stocks for regular distribution, and as buffer stocks to stabilize domestic prices (Dorosh, 2008).

Each country must assess how useful each of these purposes is for their needs.

Key factors in making this assessment are national consumption, variability of domestic production (increasing with climate change), storage costs, size of the country relative to the international market, risks of production shortfalls and high prices to the poor, and thinness of international markets.

Although wheat reserve offer no protection against structural, long-term price increases, they effectively serve as an insurance policy with costs and benefits that must be carefully considered. In fact, many SEMC countries are considering expanding their strategic reserves to be able to hold six months' to one year's worth of wheat stocks.

Despite being the largest wheat-importing region, in 2010 SEMC countries held only 10 percent of the world's wheat stocks. Egypt is the only SEMC country among the top-ten wheat stock holding countries. The majority of global wheat stocks are held in wheat producing countries such as China, the United States, and India, which may indicate that it is more cost effective to hold stocks close to production. As food security concerns have grown, many SEMC governments have revisited the idea of strategic reserves and are planning to increase their level of wheat stocks. Overall storage capacity in the region is on average six months of consumption, and estimated ending stocks are four and one-half months.

The relative size of the subsidy in SEMC countries can be estimated by comparing their storage costs with the cost of storage in the Netherlands, South Korea, and the United States. In all three benchmark countries, the private sector manages the WISC in markets characterized by high competition.

Assuming the long-term marginal cost of storage is approximately US$2 per metric ton per month, in 2009, four SEMC countries fell below this international rate, suggesting either lower land, labor or capital costs or the presence of direct or indirect subsidies.

On the other hand SEMC governments are responding to the recent price shock with a combination of trade policies, wage increases, and safety-net programs that will be difficult to scale back. Trade - and tax - policy changes have been a common initial response, aimed at increasing food security and controlling consumer prices. Public-sector wages have been increased in several

countries, including Jordan, Egypt, Syria, although these increases are largely intended as compensation for both higher energy and food prices. Some countries have used cash transfers to increase the purchasing power of the poor. Food subsidies are popular, but have substantial drawbacks. Many countries in the region rely heavily on food subsidies as the primary safety net, including Egypt, Jordan, Syria, and Morocco, among others. In-kind food subsidies are particularly popular and many countries have expanded these subsidies in response to the recent price shock. food subsidies absorb up to 2% of GDP in some cases.

Table 3. Food Subsidies as % GDP 2002-2010 in Four North African Economies.

	Algeria	Egypt	Morocco	Tunisia
2002	0.0	1.2	n/a	0.6
2003	0.0	1.2	0.4	0.5
2004	0.0	1.7	0.4	0.6
2005	0.0	2.1	0.7	0.6
2006	0.0	1.5	1.0	0.7
2007	1.8	1.3	-1.2	1.2
2008	1.5	1.8	0.8	2.1
2009	1.8	2.0	0.1	1.6
2010	n/a	1.4*	0.6*	1.4*

Notes: *= estimates

Source: Albers and Peeters, 2011, Boxes 3 and 4.

Subsidies have several disadvantages. First, they divert significant resources from alternative, more productive uses. Second, when they are not targeted, they are unnecessarily expensive, because most benefits are captured by the non poor. And third, in-kind food distribution systems entail heavy administrative overhead and substantial wastes due to storage losses, and they encourage corruption, waste, and leakage of food to non-human uses. Existing safety nets do not reach those most in need.

Programs need to be targeted to the poor because they are most affected by price shocks, spending proportionately more on staple foods. Most cash-transfer programs in the region are small, amounting to less than 1% of GDP in most cases. Most programs use categorical targeting approaches. Households and individuals are entitled to benefits if they fall into eligible categories, such as single mother, widow, unemployed, elderly, or disabled. These categories are not limited to the poor, and do not necessarily cover the poorest sectors of the population.

V – Policy Outcomes

Strategic wheat reserves require sound management in order to mitigate import supply and price risks effectively.

Mismanagement of strategic reserves may outweigh the benefits of maintaining wheat stocks, ultimately weakening a country's food security (Murphy 2009). To ensure a well managed reserve, each country must establish a set of guiding principles regarding when to draw down stocks and when to replenish, assuming the first-in-first-out (FIFO) principle. These guidelines must be clear and must be designed with the objective of mitigating supply and price risks, and the purchasing and selling of the wheat reserves must be done in a competitive and transparent market. In

addition, to ensure that wheat is accessible when needed it is important to make sure that all stakeholders are well informed about the guidelines and that staff located both at the site of the reserves and in back offices are properly trained. Lastly, the management of wheat reserves must be adequately financed (Murphy 2009).

Three factors must be considered in establishing the guidelines for the reserves: the threshold domestic price that will trigger the drawdown of wheat reserves, the target reserve level, and the rate of reserves replenishment. A recent analysis argues (Larson *et al.* 2011) that selecting a higher threshold domestic price turns the reserve into more of a safety net to be used in emergency situations rather than as a tool for price stabilization; with a high threshold price, strategic reserves may not have much of an impact on domestic price volatility as long as prices remain below the threshold. The larger the targeted size of the reserve, the more costly it will be to maintain, but the more food-security coverage the reserve will provide. Lastly, a more aggressive rate of building up and replenishing the reserves is more likely to smooth domestic price volatility, as there is less chance of there being insufficient reserves. However, replenishing reserves increases demand from international markets, which may aggravate international price volatility.

The appropriate management structure of the reserve is specific to each country and should be designed to minimize costs, ensure food safety, and reduce distortive impacts of stock policies on grain markets (Rashid and Lemma 2011). Once the strategic reserve policy is established, there may be opportunities to create public-private-partnerships (PPPs) for management.

The government could pay private operators to manage logistics and storage operations for strategic stocks or could play a more limited role, getting involved only during severe price and supply shocks.

Improve the design of safety nets to dampen the effects of food-price shocks and prevent them from doing permanent harm.

Strengthen program coordination and enhance payment mechanisms to improve resource efficiency. At the policy level, program coordination needs to be improved to reduce overlapping beneficiaries and mandates that waste resources. Implement safety nets that are flexible enough to be scaled up when shocks strike and scaled down when they recede.

This is important because scalability enables relief for the vulnerable when prices are high and a reduction in the fiscal burden when prices are low. If possible, existing targeted cash-transfer programs should be the prime candidates to be scaled up. These include poverty-focused social assistance, as well as social pensions, unemployment assistance, and disability pensions. Where public workfare is already part of the safety net, it may be useful to expand program reach. The next most desirable candidate would be food stamps or other near-cash assistance that could be targeted and scaled up or down. Direct subsidies and food distribution would be the least desirable option, only advisable when food markets are functioning poorly or when subsidies are the only available safety net.

Agricultural markets in SEMC appears nowadays still organizationally and structurally weak: the role of the policy maker is therefore one of a great responsibility.

International coordination of measures is required to prevent unilateral actions (such as export bans) aimed at promoting food security within particular areas that end up destabilizing the global food supply and increasing the size of those populations at risk from hunger and malnutrition. As recently pointed by leading scholars in agricultural economics, trade policy initiatives aimed at reducing the impacts of price increases have been a major stimulus to the increases that immediately followed. In particular, the adoption of restrictive measures exacerbated the price increase trend.

A further important topic to be taken into account is the management of risks. The large exposure of agricultural sector to risks related to natural events and the instability of the market still require a significant public intervention. As pointed by our field research, SEMC Poverty, Food Security and Risk Management in SEMC lack of a solid structure to help farmers in managing risks. This in turn exposes MPCs to risks of disasters, reduction in productive potential, vulnerability and food insecurity.

An appropriate intervention strategy would be to ensure a fair functioning of markets. The incentives must drive the adoption of practices and technologies to increase yields and have less impact, as well as compensating farmers for the environmental benefits they produce. In other words, support policies should be directed towards the stabilization of incomes rather than the market, using intelligent, flexible measures. Among them a special role needs to be played by the tools of risk management. Access to the opportunities offered by traditional devices for risk transfer to third parties, such as insurance, should also play their part.

1. Econometric assessment of Food Security: autologistic regression

Information available on measurements of variables such as food security, hunger and poverty use absolute, alternative and subjective approach methods. These methods use single indicators such as income, headcount ratios, nutritional variables or household expenditures as proxies (Booth, 1996). Using a single indicator or a few of them as proxies do not capture the real situation of the individual households. There are approximately 200 definitions and more than 450 indicators or explanatory variables of food security (Hoddinot, 1999).

As introduced above, in this study we adopted the most commonly used definition of food security which states “food security is widely defined as access by all people at all times to enough food for active healthy life.” It is a condition in which a population has physical, social and economic access to sufficient safe and nutritious food secure population can meet its consumption needs during the given consumption period by using strategies that do not compromise future food security. Food security is therefore a very complex multidimensional phenomenon, which varies through a continuum ofexcessive stages as the conditions change. Food security is therefore a very complex multidimensional namely, vulnerability access sufficiency and sustainability. Therefore, food security status of a given population is very complex product in a farming system characterized by interdependency and interactions at 1 varying levels between agents such as public sector entities markets NGOs and the community among many others. These interactions result into non-linear effects - population.

The difficulty in documenting an econometric model analyzing food security stems from the fact that 450 variables are really just too many for a model.

Whereas food insecurity intervention is multi-criteria in decision making, econometric estimation of parameters in such a model may be impossible because of errors in variables, heteroscedasticity, multicollinearity and autocorrelation. Further, the situation becomes even much more complicated because these relationships arise from the larger systems of food security status. This tasks often difficult and the interaction of the pieces is uncertain and complexity with respect to food security, there is no limitations of uncertainty and complexity with respect to food security and there is no consensus to date among social scientists in how food security should be econometrically documented.

In this context, this study introduce a spatial analysis which could represents a way to determine those variables that affect household poverty and to estimate the number of poor people in the target areas. This type of analysis is based on the assumption that measured geographic variables often exhibit properties of spatial dependency (the tendency of the same variables measured in locations in close proximity to be related) and spatial heterogeneity (non-stationarity of most geographic processes, meaning that global parameters do not well reflect processes occurring at

a particular location). While traditional statistical techniques have treated these two last features as nuisances, spatial statistics considers them explicitly.

As a special case, generalized spatial linear models include spatial linear regression and analysis of variance models, spatial logit and probit models for binary responses, loglinear models and multinomial response models for counts.

Let c_i denote the level of consumption per household, *z* denote the poverty line, and $s_i = c_i/z$ be the normalized welfare indicator per household. The household *z*poverty indicator is determined by the normalized welfare function as follows:

$y_i = 1$ if $\ln s_i < 0$

$y_i = 0$ if $\ln s_i \geq 0$

The households are observed in n sites that form a subset S of the space. Each point (household) i has a binary response y_i and a vector $k \times 1$ of covariates x_i. The responses constitute a map $Y = (y_i)_{i=1}^{n}$

The regression model is called autologistic and states the conditional probability p_i that y_i is equal to 1, given all other site values $y_i = (j \neq i)$:

$$p_i = Pr(y_i = 1 | y_i, j \neq i) = Pr\left(y_i = 1 | y_j, j \in N(i)\right) = \Phi\left(\beta_0 + \beta^H x_i^H + \beta^C x_i^C + \gamma y_i^*\right) \quad (1)$$

where N(i) is the neighbor set of site *i* according to a neighborhood structure, β^H and β^C are the vectors of regression coefficients and y_i^* is the sum of the values of the dependent variable of the neighbours of the site i, that is:

$$y_i^* = \sum_{j=1}^{n} y_j I(i \cong j) = \sum_{j:i \cong j} y_j \qquad (2)$$

where $i \cong j$ denotes denotes that the households i and j are neighbors.

This kind of model takes into account the spatial distribution of the welfare indicator, incorporating the neighborhood structure in the model as another parameter to estimate.

In the model, X^H is the vector of explanatory variables that describe the household characteristics, X^C is the vector of explanatory variables describing the characteristics of the area in which the households reside, and Φ is a cumulative distribution function that is standard normal in the case of probit regression.

For a given poverty line and a given set of observation on X^H and X^C, the estimates of β^H, β^C and γ can be obtained by the maximum pseudo-likelihood method.

Besag (1975) has demonstrated that the pseudo-likelihood method produces consistent parameter estimates under regular conditions.

Given the above generalized linear model, a maximum pseudo-likelihood estimator (MPE) for the unknown parameter vector $\Theta = \{\beta_0, \beta^H, \beta^C, \gamma\}$ will be defined as the vector $\hat{\Theta}$ that maximizes the pseudo-likelihood function:

$$\prod_{i=1}^{n} Pr(y_i = 1 | y_i, j \neq i) = \prod_{i=1}^{n} p_i^{y_i} (1 - p_i)^{y_i} \quad (3)$$

As a result, the function in Equation 3 is not a full likelihood. An analytical form of the full likelihood is intractable for this problem because there is generally an unknown normalizing function (Besag, 1974). Note that the logit expressions in equation 3 are not independent across households because each household's variable y_i is related to the y_i variables of all the other households. Consequently, from the standpoint of the maximum likelihood estimation theory, we should not

multiply the *n* logit likelihoods generated by equation 3 together to compute the overall likelihood function. Nevertheless, it can be shown that maximizing the function obtained by multiplying together the logit likelihoods represented by equation 3, yields consistent estimates of model parameters. This procedure, known as maximum pseudo-likelihood estimation (MPLE) (Cressie, 1993), provides consistent estimates of model parameters.

For the autologistic model, this approach is computationally simple since it amounts to using standard logit software to estimate the model parameters - ignoring the fact that the response variables are actually interdependent.

Therefore, the pseudo-likelihood estimation procedure proposed is an intuitively plausible method that avoids the technical difficulties of the full maximum likelihood approach. A drawback of the method is that its sampling properties have not been studied as extensively as those of the full maximum likelihood estimators.

Besag (1977) discusses the consistency and efficiency of pseudo-likelihood estimation for simple spatial Gaussian schemes. Strauss and Ikeda (1990) have shown that, for a logit model, maximization of Equation 3 is equivalent to a maximum likelihood fit for a logit regression model with independent observations y_i. Consequently, estimates can be obtained by using an iteratively reweighted least squares procedure. Therefore, any standard logistic regression routine can be used to obtain MPEs of the parameters. However, the standard errors of the estimated parameters calculated by the standard programs are not directly applicable because they are based on the assumption of independence of the observations.

The next step is the estimation of the incidence of poverty in all counties. These estimates are made on the basis of the relationship between the area characteristics and the probability that households residing in these areas are poor. The probability that households in a given county are poor is estimated only on the basis of the area characteristics:

$$\pi_C = \Phi(X^C\beta^H + X^C\beta^C) \qquad (4)$$

where $\overline{X}^c$ is a vector of variables describing the household characteristics calculated at area level, β^H and β^C are the coefficients from Equation 1 and π_c is the probability that a household drawn from a certain county is poor. The parameter estimates from the regression are applied to the census data in order to obtain an imputed value for π_c, the percentage of poor households in a county. In this way, the poor households in all the counties are estimated. Finally, using the information on household size, the probability of a household being poor can be extended to the probability of an individual being poor. At this stage, by implement and carry out an empirical application for SEMC's, would be necessary to collect survey data for each country, on all dimensions of household well-being and socio-economic characteristics including highly disaggregated data on household consumption expenditures. The survey design incorporated both clustering and stratification on the basis of the country's three main agroclimatic zones and rural-urban breakdown.

References

Abbot P., 2009. "Development Dimensions of High Food Prices" OECD Food, Agriculture and Fisheries Working Papers, No.18, OECD Publishing, doi: 10.1787/222521043712.

Albers R., Peeters M. 2011. "Food and Energy prices, Government Subsidies and Fiscal Balances in Mediterranean Countries, European Commission, European Economy, Brussels.

Barrett Ch. B., 2010. "Measuring Food Insecurity", Science, n. 327, pp.825-828.

Besag J. E., 1974. Spatial interaction and the statistical analysis of lattice systems (with discussion). Journal of the Royal Statistical Society, Series B, 35, 192-236.

Besag J. E., 1977. Efficiency of pseudo-likelihood estimation for simple Gaussian fields. Biometrika, 64, 616-618.

Binswanger-Mkhize H. P., 2009. "Challenges and opportunities for African agriculture and food security: high food prices, climate change, population growth, and HIV and AIDS" Expert Meeting on How to feed the World in 2050. Food and Agriculture Organization of the United Nations. Economic and Social Development Department, 24-26 June 2009.

Booth C., 1996. Life and labor of people in London. A.M. Kelly, New York.

Breisinger C., van Rheenen T., Ringler C., Nin A., Minot N., Aragon C., Bingxin Y., Ecker O., Tingju Z., 2010. "Food Security and Economic Development in the Middle East and North Africa. Current State and Future Perspectives" IFPRI Discussion Paper 00985. May 2010. International Food Policy Research Institute.

Bruinsma J. 2009. "The resource outlook to 2050. By how much do land, water and crop yields need to increase by 2050?" Paper presented at the FAO Expert Meeting , 24-26 June 2009, Rome, on "How to Feed the World in 2050".

Cressie N., 1993. Statistics for Spatial Data. New York: John Wiley & Sons.

De Castro P., Adinolfi F., Capitanio F., Di Falco S., Di Mambro A., 2012. "The Politics of Land and Food Scarcity", Book Edited by Routledge – Earthscan, Taylor & Francis Group Ltd, Oxford (Uk).

FAO, 2010b. "Impacts of the financial crisis on agricultural commodity markets", Committee on Commodity Problems, Sixty-eight Session, Rome 14-16 June 2010.

FAO, 2010c. "Management of wide international commodity price movements. National and international experiences and policy responses", Committee on Commodity Problems, Sixty-eight Session, Rome 14-16 June 2010.

Hoddinot J., 1999. Operationalizing Household Food security in Development Projects: An Introduction. International Food Policy Research Institute [IFPRI]. Washington DC, 20006, 1999.

International Food Policy Research Institute, 2010. Global Hunger Index. The Challenge of Hunger: Focus on the Crisis of Child Undernutrition. IFPRI (Washington DC, USA).

Meyer J., Cramon-Taubadel S., 2004. "Asymmetric Price Transmission: A Survey", Journal of Agricultural Economics, Wiley Blackwell, vol. 55(3), pages 581-611.

Nardo M., Saisana M., Saltelli A., Tarantola S., Hoffman A., Giovannini E., 2008. Handbook on Constructing Composite Indicators: Methodology and User Guide. Joint Research Center, OECD, Paris.

Ndulu B., Chakraborti L., Lijane L., Ramachandran V., Wolgin J., 2007. Challenges of African Growth. Opportunities, Constraints and Strategic Directions.The World Bank.Washington D.C. (USA).

OECD, 2008b. Biofuel Support Policies: An Economic assessment. Organisation for Economic Cooperation and Development.

Plucknett D. L., 1995. "Prospects of meeting future needs through new technology" en N.Islam (Editor) Population and Food in the Early Twenty-First Century : Meeting Future Food Demand of an Increasing Population. International Food Policy Research Institute.

Reig E., 2012. "Food security in African and Arab countries: a review of the topic and some suggestions for building composite indicators with Principal Component Analisys", working paper in Applied Economics, WPAE 2012-10, Universitat de València, Spain.

Strauss D., Ikeda M. 1990. Pseudo-likelihood estimation for social networks. Journal Am. Stat. Ass., 85, 204-212.

Tangermann S., 2011. "Policy Solutions to Agricultural Market Volatility", Ictsd issue paper, n. 33, 2011.

World Bank, 2009. Improving Food Security in SEMC Countries.The World Bank (Washington DC.).

Notes

[1] To globally satisfy a diet which will be increasingly enriched in calories and change in its composition, annual cereals production will have to reach around three billion tons, about one third higher than today, that of soya will have to increase by 140% and that of meat will have to reach 470 million tons, 200 million more than current production (FAO 2010).

[2] The official list is available on http://mdgs.un.org/unsd/mdg/Host.aspx?Content=Indicators/OfficialList.htm

[3] *Beyond the SEMC Awakening: Policies and Investments for Poverty Reduction and Food Security* (IFPRI 2012)

[4] Food imports / [total exports + net remittance inflows]

[5] The GHI ranks countries on a 100-point scale. Values less than 5.0 reflect low levels of hunger, values between 5.0 and 9.9 reflect moderate hunger, values between 10.0 and 19,9 indicates the presence of a serious problem of hunger, values between 20.0 and 29.9 are alarming, and values of 30.0 or higher are considered as extremely alarming.

[6] Food trade deficits may be an acceptable way of guaranteeing the availability of food supplies, but only under the condition that deficit-prone countries are able to generate enough foreign currency to pay for their imports.

[7] Dependency ratios is calculated as: $D_i = \frac{M_i}{C_i}$ where M_i is net imports of food product I, C_i is the domestic consumption with I corresponding to grains, edible oils, meat, and sugar.

[8] Breisinger C., Ecker O., Al-Riffai P., *Economics of the SEMC awakening: from revolution to transformation and food security*. IFPRI Policy Brief 18, May 2011. http://www.ifpri.org/publication/economics-SEMC-awakening

Priority 4:
Sustainable development of rural communities in Mediterranean Region

Lamberto Lamberti[1], Virginia Belsanti[1], Graham Woodgate[2]

[1]Ciheam Bari, Italy
[2]University College London

Contributing authors:

Omar Bessaoud (CIHEAM-IAMM)

I – Key messages

The growth of agro-industrial practices, global climate vulnerability and policies that favour the dominant global food regime all threaten regional food security. Smallholders can make an important contribution to ameliorating food insecurity and achieving food sovereignty, i.e. local control over food production and supplies.

Rural development has a multi-dimensional nature that encompasses economic, social, political and environmental sustainability. Smallholders need empowerment to take action and participate in all development processes. Such action can be fostered by appropriate institutional arrangements, including opportunities to engage in political activity and the design and implementation of relevant public policy.

Agroecology has emerged in response to the negative impacts of the first Green Revolution and has matured in response to proposals for a new Green Revolution. Agroecology offers an alternative agenda for addressing poverty and hunger through food sovereignty.

A socially just solution needs a careful combination of public and private investment to assist smallholders to lift themselves out of poverty, improve incomes and secure their access to good-quality, culturally and ecological relevant food. Furthermore, such support is also important in terms of allowing certain sectors of rural communities to diversify into non-farm activities and enhance their livelihood security.

Rural communities are confronted with multifaceted challenges and vulnerabilities – demographic, economic, social, environmental (climate change and natural resource degradation and depletion). A more context specific and participatory research is needed and a more targeted set of policies must be designed and implemented under sound governance regimes, involving innovative institutional arrangements and decentralisation.

II – Extended summary

Recent trends and strategies for sustainable rural development recognise the central role of smallholders in development dynamics and their crucial contribution in achieving food security. This paper embraces that stance stressing the multi-dimensional and cross-sectoral character of sustainable rural development and the idea that development strategies should not rely solely on increasing agricultural productivity through technical innovation but matching production as closely as possible to agroecological potential. Moreover, the latter should be framed within the hierarchy of social, cultural and political structures that provide the context for development activities.

The present document begins by outlining the current situation of rural smallholders in the Southern and Eastern Mediterranean Countries (SEMC), highlighting their importance in the rural landscape of this region, where agriculture still counts as the main economic activity but is threatened by land fragmentation, water scarcity, limited rural services, and climate vulnerability. At the same time the region is experiencing a population increase that brings along problems such as youth unemployment, heavy influx of rural migrants to urban centres and widespread rural poverty.

The outline provides a classification of the major farming systems of the area, categorised according to socio-economic and institutional contexts, as they reflect the complexity of rural livelihoods, the interdependence between on- and off-farm activities and rural-urban linkages and the need to adjust livelihood systems to limited resources. According to the specific contexts some main strategies for increasing income and generating growth - intensification and diversification of production, development of off-farm activities and, eventually for some, exit from agriculture- are identified.

The document, in the following sections, sets out a number of key development challenges: demographic trends, off-farm economic activities, climate change and natural resource degradation, poor services, gender inequalities and inadequate decentralisation.

It is particularly stressed the importance of the state in facilitating sustainable development by providing public goods like rural infrastructure, extension services, credit, education and access to markets. At the same time it is acknowledged the limits of state action in targeting and responding to the needs of rural communities because of the lack of administrative coordination, conflicting priorities and restricted budgets. In this context local stakeholder organisation and action take on increasing importance. Through participation in decision-making and development processes, community organisation and collective action, and the mobilisation of under-utilised local resources smallholders and rural communities can better respond to development priorities articulated at the local level. Decentralisation has played a major role in empowering local stakeholders but the process remains incomplete. There is still a need for policy to: support the emergence of innovative institutional forms; promote the role of both formal and informal groups and networks; and, above all, to foster the expansion of capabilities and development of critical innovation and learning competences among the full range of rural development stakeholders.

In order to provide appropriate guidance to policy makers, the paper concludes by assessing immediate policy needs and identifying priority issues for research: creating and systematising knowledge on sustainable agricultural practice and natural resource management, understanding smallholder farming systems and appropriate technologies, identifying key development actors and institutions, assessing the potential for capabilities expansion through the development of critical innovation and learning competences among the inhabitants of rural communities and the employees of relevant state, private and third sector institutions.

III – Introduction

Food security, as defined by the World Food Summit (1996)[1], requires people to have physical and economic access to food at all times. Despite a significant reduction in the proportion of people living in extreme poverty since 1990, according to the FAO (2012), almost 870 million people remained food insecure and chronically undernourished in 2010–12, the vast majority living in developing countries. Rural communities, who account for 48% of the total global population (2004), and include 70% of the world's 1.4 billion poor, are among the most severely impacted by food insecurity (World Bank and IFAD, 2011).

Rural people's vulnerability to food insecurity depends on several factors, characterised by interrelated complexities and linked to specific local contexts. These may include: scarce and environmentally-fragile resource base, extreme and unpredictable weather events, population growth, and weak local economies. Public policy shortfalls resulting in insufficient or locally inappropriate provision of services (access to market, credit, education, extension), rural infrastructure (roads, electricity, information and communication technologies), regulatory frameworks (land rights) and protection for the most vulnerable groups (women, youth, displaced), have also contributed to the political, economic and social marginalization of rural communities (IFPRI, 2011). Nonetheless, rural communities and small-scale farmers remain very important actors in terms of producing food and contributing to the feeding of more than 50% of the global population (IFAD, 2009), and, at the aggregate level, they manage vast land areas and natural resources, determining their maintenance or degradation.

Important research efforts conducted in more than 50 poor countries over millions of hectares, demonstrate the extent to which poor, small-scale producers are able to apply resource conserving, low external input technologies, maintaining or enhancing natural resources, while improving food security and incomes (Pretty *et al*., 2006; WOCAT, 2007; IAASTD, 2009). Literature also reports greater land use efficiency and productivity for smallholders compared to larger producers (Hazell, 2011; Conway, 2011; *Eastwood et al.,* 2009; De Schutter, 2011) the validity of their conservation technologies, polycultural and integrated farming systems; their ability to adapt to stress and changing conditions, invent and innovate technologies, preserve and use fragile landscapes, and maintain bio-cultural heritage (Altieri, 2008; Barthel et al., 2013; Critchley, 1999; FAO, 2002; Pretty, 2006).

Success stories often emerge from new patterns of working between external and local institutions, especially the shift from top-down to bottom-up approaches. Key elements for success are the recognition of the agroecosystem/territorial specificities and the active participation of rural communities in technology development and dissemination, innovating productive activities, policy and decision making, building informal knowledge systems, territorial planning, market processes, and resource management (FAO, 2012; Critchley, 1999; Lamberti *et al*., 2011).
Almost without exception, an appropriate institutional framework is a key element in the success of smallholder agriculture, giving power and authority to rural communities in vital sectors related to their livelihoods development (OECD,2012; FAO, 2012).

Numerous international agencies and fora emphasize the importance of investing in rural communities to facilitate sustainable development and inclusive growth as a viable path towards food security and sovereignty[2] and poverty eradication. The FAO proclaimed 2012 the International Year of Cooperatives and 2014 the International year of family farming, thus highlighting the crucial role of local institutions and small scale producers
Investments by governmental institutions are needed to target a set of key elements for supporting livelihood strategies, which include intensification and diversification of smallholders' agricultural activities; production of more and cheaper food while protecting natural resources and human health; development of non-farm rural economies, linked to agricultural activities or as an alternative where agriculture cannot be intensified, to generate alternative employment and raise

incomes; development of institutions to improve market and services access and development planning; public goods supply, addressing the urban bias in development policy, protection from unpredictable and unstable economic and political events at the national and regional levels, as well as the more obvious secure access to adequate land and natural resources. The empowerment of marginalised groups, such as women, is also identified as a key goal for increasing the productivity of rural communities (FAO, 2012; IFAD 2011).

The role of the rural poor in generating food sovereignty and security continues to be threatened, besides the aforementioned multidimensional challenges by the increasing expansion of a global agro-food system pushing towards a new Green Revolution[3] (Box 1), In the wake of last years' more people-centred and resource conserving approaches aiming at local and sustainable rural communities development agroecology[4], for its transdisciplinary, participatory, and action-oriented approach to the development of sustainable food regimes (Altieri, 1995, 2009; De Schutter, 2011; Gliessman, 1997, 2000, 2007; Mendez, Bacon and Cohen, 2013), appears as a promising approach for addressing the "interrelated global problems of hunger, rural poverty, and sustainable development" and is identified as a discipline whose principles should guide the design of sustainable strategies and policies (IAASTD, 2009).

Box 1

By the middle of this century the global human population is estimated to grow to around 9 billion, leading to calls for an increase of 70% in global food production by 2050 (Conforti, 2010). Numerous reports have claimed that the most effective way to achieve this increase in production is through significant investment in biotechnology (World Bank, 2007; Bertini and Glickman, 2008; Baulecombe *et al.*, 2009; Beddington 2011) to accelerate and disseminate what Conway (1997) has referred to as the 'Doubly Green Revolution'. It has been estimated that a new Green Revolution of this type would theoretically allow the world's food requirements to be produced on roughly 50,000 large-scale industrial agricultural units (Amin, 2011). However, as Holt-Giménez and Altieri (2013: 94) enquire, if this were to happen "how would 2.5 billion displaced smallholders be able to buy this food"?

The further global expansion of industrial agriculture through a reinvigorated Green Revolution represents a significant threat to the ability of smallholders to continue farming. The further consolidation of what McMichael (2009) has called the 'corporate food regime' would involve transnational corporations in land-grabbing campaigns, the assertion of intellectual property rights over crop genetic materials and the establishment of oligopolies in both inputs and food markets. In the process smallholder livelihoods will be destroyed, agro-biodiversity will be reduced and ecosystem services and resilience will be weakened – developments that will "increase global hunger and limit our ability to mitigate and cope with climate change" Holt-Giménez and Altieri (2013: 97). Emerging in response to the negative ecological and social impacts of the first Green Revolution and maturing in response to proposals for a new Green Revolution (Gliessman, 2013), new development approaches, like agroecology, putting rural people and small farmers at the centre of development and offering an alternative proposal for addressing poverty and hunger.

Development institutions should also investigate success stories and best practices in order to learn lessons and feed them into policy processes. Significant changes are needed to establish and strengthen more appropriate institutional attitudes and capacities. Development approaches need to be adapted to the specificities of the bio-physical and socio-economic environments where rural communities live, while agencies must learn to work with rural communities rather than trying to manage them. In fact, best practice in relation to community empowerment, based on decentralization and participation, natural resource conservation, and cross-sectoral approaches,

often remain confined to specific projects, while they deserve to be included in higher level policy and institutional strategies, which further demands an upgrading of institutional capacities (Pretty, 1995).

Success and sustainability depend on expanding people's capabilities and empowering rural communities to secure their own access to natural resources, information and markets, and guarantee their rights to participate in policy making and governance processes (OECD, 2012; FAO, 2012; ESCAP, UNDP and ADB, 2007, Via Campesina).

1. Aim and Scope

The present document identifies rural communities as crucial actors in the struggle to end food insecurity and poverty, and contribute to the sustainable development of rural areas. It provides an overview of the situation in the Southern and Eastern Mediterranean Countries (SEMC), for which current conditions and regional trends are assessed and key areas requiring research are identified by drawing on a range of international reports, on the tenets of agroecology and the goals of food sovereignty. The aim of the research agenda is to generate better understanding of the roles of rural people and communities in achieving food sovereignty and sustainable development and the institutional arrangements required to facilitate their efforts.

The specific objectives of the paper are briefly to outline the situation of smallholders and rural communities in the SEMC in terms of their geographical and social contexts, their agroecological resources and food systems, their livelihood strategies, political and institutional contexts, and the environmental, social and economic challenges they face. Having described their situation we identify which aspects would additional research to provide a more targeted and specific set of policies to address development deficits and allow them to tackle food insecurity and achieve food sovereignty.

IV – Concepts and definitions

The present paper reports and discusses issues related to the following concepts and definitions:

Rural communities: conventionally understood as human populations clustered together in hamlets, villages and small towns located in rural territories (ISTAT, 2010). They share similar socio-economic and agroecological conditions that influence the livelihood systems of their inhabitants and have long-established cultural norms and institutions for dealing with community problems and resolving disputes. Especially within pastoral and semi-pastoral traditional communities, activities are governed by customary rules and land ownership is characterised by tight linkages between ecological conditions and social structures. Families (nuclear and extended) are the main social unit in rural communities.

Small scale producers: these are the backbone of rural communities. They include: "women and men, farmers, fishers, livestock producers, and forest users who produce on a small scale for both auto-consumption and the market … [They] are relatively vulnerable to food insecurity due to limited resource endowments ... Scale refers to farm size for farmers or to the scale of production for fishers and forest users" (FAO and IFAD, 2012).

Rural livelihood systems: sets of activities that are carried out to secure the necessary means for living. Livelihood systems can be defined at the level of the individual, the household or the community. They are characterised by a number of factors: agroecological resources, human and physical capital, and access to infrastructure and services. Rural livelihoods are based largely on natural resource management. Small scale producers manage resources including cultivable lands, forests, rivers, rangeland, etc., to which they have a mixture of access rights: private property, state property with management rights, common property and open access resources.

Livelihood strategies: in order to satisfy different human needs and to cope with risk, seasonality and other vulnerability factors, rural communities are engaged in a wide range of interlinked activities that can include agriculture, forestry, fishing, processing, trading, etc. Different activities can be categorised according to what they involve and where they occur. They may be undertaken on-farm or off-farm and might include farming, herding, hunting, gathering, handicrafts (e.g. weaving, carving), processing, petty trading or wage labour, etc. Depending on the location and size of rural communities, other non-farm activities are conducted such as masonry, carpentry, tourism, hospitality and transport services.
Smallholder agricultural practices, based on techniques developed from local knowledge and experience, are generally characterized by low external inputs, diversification in time and space, significant crop and wild species genetic variation, integration of crops and livestock, and water harvesting techniques (De Schutter, 2010; IAASTD, 2009). In the context of policies and efforts towards market integration, commercial/industrial resource use practices may also be incorporated within rural livelihoods. These, in contrast, are more likely to involve external knowledge and inputs, specialised monocultures of hybrid or genetically engineered crops and modern, capital intensive irrigation systems.

Local groups and organisations: these refer to associations of farmers, pastoralists, fishers, forest users, food processors or craft workers that are established to optimise their members' responses to agroecological conditions, market opportunities and public policy signals. In addition, we can also talk about communities developed in the context of NGO activity seeking to enhance local capacity for managing the social and financial resources required for fostering sustainable development processes. Examples of such groups are identified in Box 2.
Local groups are particularly important for providing a framework for consensus building, collecting, analysing and evaluating information and taking collective action such as co-ordinated management activities. Local groups and institutions can also provide the basis for the type of learning and innovation systems that enable small scale producers to identify solutions collectively and build strategies to cope with change (FAO, 2012). Other institutions may play a bridging role between various local groups and between local groups and higher level organisations. The success of agricultural innovation and technology adoption depends on institutional arrangements including political power.

Box 2 Institutions for sustainable rural development and food sovereignty

Community campaigning groups: to gain political recognition, fight for agrarian reform and win inclusion in policy-making fora and develop political capital.
Community co-operatives: allow people to benefit from economies of scale by bringing together their resources and experiences in production, processing or distribution.
Credit unions or rotating loan groups: community banks that can provide farmers with small loans to undertake investments in sustainable agriculture.
Farmer research groups: can facilitate community development by allowing smallholders to set the research agenda and providing an institutional setting to allow scientists to work within the complex dynamics of existing agroecosystems.
Farmer-to-farmer groups: spread knowledge and understanding of productivity enhancing and resource-conserving methods between local farmers.
Local consumer organisations: can stimulate the market for local agricultural products, allowing farmers to retain more income and consumers to buy their food more cheaply, by excluding intermediaries.
Local resource-management organisations: basis for community-led action in such areas as reforestation, irrigation management or soil and water conservation schemes.
Machinery circles: sharing the costs of owning machinery
Multi-stakeholder innovation platforms: promote learning and innovation competencies

Drawing on: (FAO, 2012, Woodgate, 2012)

Power and empowerment: There are many definitions of power and types of power. Rowlands (1997) distinguishes among: 'power over' – the type of coercive power that results in win-lose situations; 'power with' – associated with the mutual support and solidarity required to build political alliances and promote community interests; 'power to' – the agency we all possess, which allows us the make a difference in the world; and 'power within' – our own self-belief that allows us to hope for and believe in a better world for ourselves and our families. Empowerment is about building power 'within', 'with' and 'to', so that small-scale producers and rural communities can engage in political action and participate in state institutions in order to influence the design of public policies that create a favorable institutional framework for the development of sustainable agroecosystems and food sovereignty.

V – Rural communities in Southern and Eastern Mediterranean Countries

A significant number of the SEM countries have, in recent years, experienced and continue to experience significant economic and social change.

Over the last decades structural adjustment policies have sought to reduce public spending and promote market liberalization and integration, but while these policies resulted in significant economic growth, this was not proportional to the population growth rate and did not improve average living standards (OECD, 2011), generating further inequality. With the onset of the 2007-2008 banking crisis, compounded by the sovereign debt and the euro-zone crises in 2010 and 2011, and subsequent economic recession in the European Union and the USA, booming commodities markets began to slow and the dependence of regional growth to global economic

conditions was laid bare, resulting in a significant slowdown of the economic development rate in the SEMCs.

Under these circumstances numerous countries in the region have experienced political upheavals, leading to the "Arab Spring", that have had and continue to have significant implications for their citizens, including the inhabitants of rural communities. Thus any characterization of rural communities and livelihoods must be treated with caution and accepted as being subject to rapid change.

1 Population and poverty

The Region has an overall population of 361 million people that has increased by more than 120 million in the last two decades (IFAD, 2010). About 161 million (45%) live in rural areas. Rural populations are still growing and according to a study reported in Mediterra (2009) they will continue to grow until 2020 by which time a further two million people will have been added to the total. However, the rate of growth is slower if compared to the growth of urban populations, although it should be noted that the overall demographic trend is influenced by the weight of populations in particular countries. Egypt, for example, with more than 81 million people of whom some 47 million live in rural areas, masks a more diffuse trend of rural depopulation.

Box 3

Incidence of rural poverty
(percentage of rural people living on <US$2/day)
1988 – 32.7
1998 – 30.7
2008 – 11.7

Incidence of extreme rural poverty
(percentage of rural people living on <US$1.25/day)
1988 – 9.5
1998 – 6.6
2008 – 3.6

Number of rural people in poverty
(<US$2/day)
1988 – 41 million
1998 – 44 million
2008 – 19 million

Numbers of rural people in extreme poverty *(<US$1.25/day)*
1988 – 12 million
1998 – 10 million
2008 – 6 million

Rural people as percentage of those living in extreme poverty
(<US$1.25/day)
1988 – 99.0
1998 – 61.3
2008 – 40.1

Aggregate data show a decline in the number of poor and food insecure people in rural areas in recent decades. According to IFAD (2010 – see Box 3) the Region has seen a reduction in rural poverty from 32% in 1988 to 11.7% in 2008. In 2008 there were, however, still 6 million people living in extreme poverty (subsisting on less than US$ 1.25/ day) in the rural areas, which represent 40% of the total regional population experiencing this level of deprivation.

In some of the Region's countries poverty increased during the 1990s: especially Algeria, Egypt, Morocco and Tunisia. A decline in Algeria's industrial sector also led to an increase in social inequality.

The geographic distribution of poverty is characterized by significant variations depending on natural resource endowments, the presence or absence of social services, employment opportunities in accessible urban centres and, of course, the security situation. For example, 12% of the Region's rural population live in the highlands and mountains, which are isolated and characterized by low levels of economic development (Mediterra, 2009). On the other hand, urban poverty is increasing and has now overtaken rural poverty rates. This is related to the massive migration phenomenon pushing poor rural people towards urban centres in the search for employment opportunities.

The global economic and financial crises, of the last ten years, influenced significantly economic and political stability in the region. The Region's international trade decreased by 9% in 2009, the most important decline during the last 60 years (Benhammouda, 2010), while foreign direct investment has decreased by 50% and remittances and income from tourism have fallen between 5 and 8% since the crises set in (Hugon, 2010). The impacts in a number of the SEM countries are particularly notable (see Box 4).

Despite a significant improvement in food security in the SEM countries in recent decades, food insecurity still affects vulnerable groups, such as nomadic pastoralist communities and marginalized rural populations more generally. This situation is, of course, exacerbated during moments of political upheaval. During 2008 and 2009 there was an increase in the number of hungry people as a consequence of the food price hikes but also as a consequence of declining farming population, scarcity and deterioration of natural resources, and neglect of government policies (IFAD, 2010).

The"Arab Spring", calling for social and political reforms, has increased the level of uncertainty and instability in the most affected countries, downsizing projections of economic growth (OECD, 2011).

Box 4 Impacts of the economic crisis of 2007-2008 in the Maghreb countries

- Tunisia: of the loss of 40,000 jobs in the manufacturing sector in 2008. The unemployment rate during 2007-2008 stabilized at 15% and recorded a small increase in 2009, mainly affecting those with a university degree (whose unemployment rate was 30%). The tourist sector was also affected and only improved in 2009-2010 due to the influx of Algerian tourists (1.5 million out of a total of 4 million). All these economic indicators explain the fall in Tunisia's GDP growth rate, from 6.3% in 2007 to 4.6% in 2008 and 3.5% in 2009.
- Morocco: The economic growth rate dropped to 3.5% in 2010 as a consequence of the decline in the market value of phosphates, slow development of tourist revenues, weakened flows of remittances and a decrease in foreign direct investment. In the same year there was a deficit of 5.2% in the balance of payments. Morocco's trade deficit has doubled over the last 20 years due to the explosion of its food and energy bills, whose prices have dramatically increased since 2007-2008. The worldwide economic and financial crisis has restrained the scope of public spending intervention in relation to the investment needed to implement different sectors' plans (Green Plan, Industrial emergency, etc.). The National Pact for the industrial emergency, whose ambition was the creation of 400,000 jobs by 2015, has been reviewed and the target cut by almost 50% to 210,000.
- Algeria: the transition from the import substitution economic model promoted in the 1970s to one based on exports is taking place in a global economic situation characterised, in the year 2000, by relatively stable prices for hydrocarbons. This is why, even though the Algerian economy is not very diverse (hydrocarbons represent 90% of exports, with oil taxes amounting to 40% of State revenues) and there is a remarkable level of unemployment (10%), this country has been less affected by the financial crisis. Those effects have been ameliorated by public expenditure implemented within the framework of various plans under the general rubric of "economic revival". The increases in the price of oil prices in the global market have been crucial for the country's economic revival and have provided the basis for the redistribution function of the State in the years since 2000.

Source: Bessaoud, 2013

2. Rural community groups

Rural communities in the SEM countries are composed of numerous different groups and categories, and IFAD suggests distinguishing the major groups by livelihood systems as follows: small farmers, nomads and pastoralists, artisanal fishers, the landless and waged labourers(see Box 5). In addition, a number of important categories are also identified by personal characteristics such as women headed households, unemployed youth and displaced persons.

Box 5

Major groups defined by livelihood system

Small farmers

Tenants and smallholders practicing rain-fed agriculture on small farm plots are generally the poorest and most vulnerable groups of farmers. While there is insufficient data to aggregate their numbers across the region, they probably constitute the majority of farmers. In Morocco, for example, roughly 85 per cent of arable land lacks irrigation. Aside from rain-fed farmers, a considerable number of small farmers on irrigated land are also poor, due to their weak asset base. Most vulnerable of all, however, are farmers with insecure land tenure: those who farm as tenants or sharecroppers. The livelihoods of small farmers generally depend on a variety of resources including: rain-fed tree crops, cereals grown for household consumption (such as wheat) or animal feed (such as barley), and small livestock that enhance household nutrition and supplement crop income. In Egypt, for example, smallholder households typically have access to less than 1.5 ha of land and keep an average of one large and three small ruminants. They have to supplement their incomes from wage labour and internal migration, as their agricultural work provides, at best, only half of their staples.

Nomads and pastoralists

These groups depend on natural rangelands and are most prevalent in Algeria, Jordan, Morocco, Somalia, Djibouti, Sudan, Syria, Turkey and Yemen. Pastoralists in these countries typically keep a few camels and some small ruminants (sheep and goats) and reside/move in very arid zones. These include: (i) settled pastoralists who on average own around 50 animals; (ii) semi-nomads travelling limited distances with about 120 animals; and (iii) nomads with 200 or more animals who are part of extensive transhumance systems. Small Bedouin herders in Syria, for example, own a small ruminant herd of 50 to 100 sheep and/or goats as their major source of income. Some may derive additional income from other sources, such as working abroad or within the Badia rangelands for larger stock owners, or being involved in trade.

Artisanal fishers

Artisanal fishers can be broadly defined as the traditional fishers who exploit small-scale fisheries extending some 4 to 12 km from the shore. They operate with 5 to 10 metre boats, typically shared by small groups of four to seven members. The boats are usually open and single-deck, powered by small outboard engines. Artisanal fishers reside in small fishing communities located along more than 7,000 km of coastline in Yemen, Syria, Lebanon, Sudan, Egypt, Tunisia, Algeria and Morocco. These communities receive practically no social services and many live in destitution.

Landless and wage labourers

This group includes a growing number of agricultural and non-agricultural workers. Many are members of farm households with insufficient land or water resources to support all family members. Others have no land at all. In some areas there is a strong predominance of landless wage labourers over farmers, who make their living working for daily wages off-farm or on the farms of larger landowners. In Egypt, for example, the landless are usually engaged in daily wage labour in agriculture or construction, internal migration to urban areas, and petty trading. On average, they find work for about 10 days a month. They have insignificant numbers of livestock, usually only domestic fowl, which are used for home consumption but more frequently are sold when the need for cash is particularly acute. Rural households headed by wage earners tend to dominate the lowest expenditure groups. In Morocco, for example, the rural poor — landowning or not — rely more on wage income than the fruits of cultivating their own land. In Jordan, most small farm households rely on wage labour income to survive. In rural Egypt, labouring typically accounts for 85 per cent of household income among the poor.

Major groups defined by personal characteristics

Women-headed households

The number of households headed by women in the SEMC is increasing because of extensive male migration, the increased number of disabled males (due to conflict), widowhood and divorce. On average, these households tend to be considerably poorer and more vulnerable than households headed by men. In Turkey, for example, poverty rates are higher among households headed by women (32 per cent) than those headed by men (26.6 per cent). In the mid-1990s, woman-headed households constituted 5 to 20 per cent of all rural households in the Region. The percentage of woman-headed households was highest in Sudan, at 23.8 per cent, while in Egypt and Morocco it was 17 per cent. According to a recent study of the socio-economic characteristics of woman-headed households in Egypt, 62 per cent of women who head families are widows. The illiteracy rate for woman-headed families (73 per cent) is higher than the rate for the entire population of rural women (63.3 per cent). About 80.5 per cent of woman-headed households in rural Egypt are landless and it should be noted more generally that liberalization of the land-rental relationship has pushed some woman-headed tenants out of their agricultural landholdings.

Rural unemployed youth

As mentioned earlier, in a region with a very young population (58 per cent under age 25) estimates of youth unemployment are very high. Economic growth in recent years has not kept pace with the high population growth rates throughout most of the Region. The resulting rise in unemployment has particularly affected the young new entrants to the job market, especially in the rural areas. Unemployment figures for young women appear to be even higher. This segment of the population often has inadequate education and skills. In 2003, youth illiteracy was 17 per cent, 80% of whom were girls. According to the ILO, the youth unemployment rate in the Region stands at 25.6 per cent, which is the highest regional rate in the world. According to the same report, labour force participation rates for young people at just 39.7 per cent are lowest in the Middle East and North Africa compared with sub-Saharan Africa (65.4 per cent) and East Asia (73.2 per cent).

Displaced persons

Significant numbers of poor people have been displaced or live in post-conflict situations. The largest number of refugees in the Region today originates from Gaza and the West Bank, Somalia and Sudan. In addition, the region includes Yemeni returnee migrant workers, recent Iraqi refugees in Jordan, and Lebanese farmers whose farms were destroyed during the latest war with Israel. Most recently the Syrian civil war has resulted in more than two million people fleeing the country and more than 4 million becoming internally displaced, bringing the total to more than 30% of the national population. An estimated 19 per cent of the world's refugees and displaced persons emanate from the Middle East and North Africa. These people are probably among the poorest and most vulnerable population groups and constitute a significant proportion of the rural poor in the SEMC. The percentage of women and children in these groups is relatively higher than in more settled communities.

Source: Adapted from IFAD 2007

It is clear from the data presented in Box 5 that one group which requires particular mention across the Region is women, whose exclusion from the economic, political, civil and social life of rural communities is still marked. Women rarely benefit as much as men in terms of training, information, credit and extension services, and a significantly higher percentage is illiterate (in Morocco 62% of women against 39% of men). It has been estimated that if women received the same education as men, farm yields would rise by between 7-22% (J. Berdeguè, 2005; J.Dixon

et al., 2001; Roseboom, 2007b). Women suffer from limited access to and control over land, with some reports suggesting that women account for just 5% of total landholders in Egypt (where 80.5% of women-headed households are landless) and Syria.

Women, in some areas are only expected to interact with female extension agents the number of whom is very limited. However, the trend is reversing thanks to the emergence of women graduates returning to their villages in countries such as Algeria, Egypt, Jordan, Morocco and Tunisia (IFAD, 2007).

3. Territories and livelihoods

In general, agriculture is practiced on small, frequently marginal and/or fragmented parcels of land (see Table 1 for the most recent data).

Groups are located in a variety of landscapes and with different population densities. While there is a concentration of communities along the coastlines and major urban centres, other communities are located in desert oases, mountains and steppe areas. This implies marked differences in the availability of resources, services, presence/lack of institutions and infrastructures, urban employment opportunities, and security, all of which influence the possibilities and pace of development of their livelihoods.

Table 1 – Farm structure in Mediterranean countries

Morocco (1996)	2 million agricultural entrepreneurs, 70% with land holdings below 5 ha
Tunisia (2004-2005)	516,000 enterprises, 53% with access to less than 5 ha
Algeria (2001)	1.2 million enterprises with average farm size of 4,7 ha
Egypt (2000)	3.7 millions farms mostly under 2 ha
Turkey (2000)	3 millions farms 25% less than 5 ha
Albania (1996)	450,000 farms with an average size of 1,7 ha

Source: Mediterra 2009

Dixon and Gulliver (2001) identified eight main farming systems in the region, according to the specificities of regional territories, such as natural resources or the availability of infrastructure and services:

- irrigated: small-scale irrigation sub-systems represent a crucial factor in the livelihoods of smallholders in arid and remote mountain areas;
- *highland mixed:* where most of the rural communities are located but occupying only 7% of the total land available, hence with high poverty levels, distant markets, poor infrastructures and significant natural resource degradation;
- *rain-fed mixed*, characterized by high population density (living on only 2% of the available land) and lower poverty rates thanks to off-farm income generating activities derived from seasonal labour and migration;
- *dryland mixed*, with larger sized farms but higher risks of drought and high food insecurity, where poverty is widespread among smallholders;
- *pastoral*, with mainly sheep and goats but also some cattle and camels, carried out over large areas of semiarid steppe, characterised by low population densities, with more densely populated areas around irrigated settlements. These are linked to other farming systems through movement and sale of animals. Poverty is widespread;

- *coastal artisanal fishing*, artisanal fishers living along the coasts combining income from the sale of fish with small-scale crop and livestock production, accounting for about 1 million people living on an area of around 11 million ha;
- *sparse (Arid),* covering more than 60 percent of the region and including vast desert zones, where poverty is low and population pressure limited. It includes about 4 million people concentrated in oases and irrigation schemes (Tunisia, Algeria, Morocco and Libya) who produce dates, fodder and vegetables and have about 2.7 million cattle. Sparse agriculture and herding coexist with boundaries set by climatic conditions;
- *urban-based,* a small population of urban residents engaging in small-scale production of horticultural and livestock products.

Table 2 indicates the weight of different systems in terms of area and population, and indicates the predominant livelihood activities and the incidence of poverty.

Table 2 - Major Farming Systems in the Middle East and North Africa

Farming Systems	Land Area (% of region)	Agric. Popn. (% of region)	Principal Livelihoods	Prevalence of Poverty
Irrigated	2	17	Fruits, vegetables, cash crops	Moderate
Highland Mixed	7	30	Cereals, legumes, sheep, off-farm work	Extensive
Rainfed Mixed	2	18	Tree crops, cereals, legumes, off-farm work	Moderate (for small farmers)
Dryland Mixed	4	14	Cereals, sheep, off-farm work	Extensive (for small farmers)
Pastoral	23	9	Sheep, goats, barley, off-farm work	Extensive (for small herders)
Sparse (Arid)	62	5	Camels, sheep, off-farm work	Limited
Coastal Artisanal Fishing	1	1	Fishing, off-farm work	Moderate
Urban Based	<1	6	Horticulture, poultry, off-farm work	Limited

Source: FAO data and expert knowledge.
Note: Prevalence of poverty refers to number in poverty, not depth of poverty, and is a relative assessment for this region.

Source: Dixon and Gulliver (2001)

VI – Problems analysis

Small rural communities account for a significant proportion of the population of the Southern and Eastern Mediterranean countries, and they are spread over a vast area. Their productivity, economies and social wellbeing are important in terms of maintaining vibrant communities that, through food production and economic diversification, can counterbalance the attraction of rural-urban migration, which is seen to result in the shift of poverty from rural to urban areas. However,

a range of environmental, social and political issues related to the geography, history and ecology of the region, affect smallholders' productive capacity and wellbeing in critical ways.

1. Bio-physical and socio-economic challenges

Bio-physical and socio-economic constraints represent big challenges for the productive activities of these communities. Their livelihoods are strongly reliant on access to natural resources like agricultural land, pastures, forests, water bodies and flows, but the entire region has always suffered from resource scarcity, especially water and land (see Box 6). The Region has insufficient land for cultivating the staple crops required to meet the increasing demand of a growing population (Breisinger *et al.*, 2010). The current situation, involving natural resources degradation and climate change, with their unpredictable and irregular paths, is posing additional challenges. Production risks are increased for rural communities, frequently based in more remote territories, such as mountain and pastoral areas, and more exposed to phenomena such as droughts or floods.

Box 6

The entire region is characterized by scarcity of cultivable land (accounting for just 9% of the total, compared to 12% globally). Scarcity is exacerbated by land degradation due to deforestation, over-cultivation urbanisation and fragmentation. *FAOSTAT, Near East & North Africa (NENA), 2003.*

Water is also a very scarce resource and in vast areas the rainfall is below 300mm per year or is unpredictable and irregular. Water shortages can quickly become droughts, leading to increased fire risks, desertification, and changes in tourism patterns (IPCC, 2007).

The hotter and drier conditions brought on by global warming are likely to impact areas not usually at risk from erosion, salinisation, fire hazards and, ultimately, desertification, especially where inappropriate management practices and production systems are employed (IPPC, 2007).

Farming activities are also affected by farm sizes. According to World Bank data the availability of arable land (hectares per person) in the Region declined from 0.45 ha in 1961 to 0.14 ha in 2009, due to population growth, sub-divisions linked to inheritance, from unclear laws that reflect the overlapping of ex-colonial laws, land nationalization processes and tribal regimes, which have determined the multiplicity and complexity of land rights (AUC-ECA-AfDB, 2010) and urban encroachment and land grabbing. Rural communities have often lost rights to manage forests, pastures, and common lands, or their ownership is not officially recognized, discouraging investments that could increase their productivity and favour natural resource conservation practices (Devex, 2013).

Although indicators highlight that poverty in rural areas has decreased in recent decades, a general weakness in terms of infrastructure and services is reported in all SEM countries, preventing the creation and reinforcement of livelihood opportunities. The poor quality of roads, communication technologies, education, access to credit, agricultural research, extension services, storage facilities, etc., has hampered smallholders' access to markets, posing threats to incentive, to people's capacity to innovate and hindering their competitiveness (De Schutter, 2011). The enhancement of information and human capital are increasingly needed due to the emerging need to conserve limited resources and fragile agroecosystems, to create skills in non-farm sectors, and to adjust to market requirements shaped by local and regional demand, thus implying modified practices and patterns of production (IFAD, 2007).

Public investments in agriculture and rural areas have decreased since the disengagement of the state following structural adjustment in the 90s and this gap has not been filled by the private sector because of the marginalised status of rural areas and the perception of higher risk (Mediterra, 2009). Supporting services are very limited and often inadequate. For instance, agricultural extension processes, where still present, are mainly controlled by governments and operate under budgetary constraints and lack of adequate skills, with a consequent deterioration in their quality. They struggle to reach rural communities scattered in vast areas and they are often based on top-down processes (IFAD, 2007) that leave no room for developing local learning and innovation competences and are insensitive to local specificities and sustainability needs.

2. Rural livelihood opportunities

Rural economies are characterised by low levels of diversification: agriculture, tourism, remittances and income generated by foreign companies delocalised and based on low-skill labour, with low salaries and low technological input, are the main sources of economic wealth (Mediterra, 2009).

The population growth rate has not been accompanied by an equivalent economic growth. A high percentage of youngsters is ready to enter the job market (in the year 2010 alone there were between 300 and 400 thousand newly economically active people on the labour market in Morocco and between 30 and 40 thousand in Tunisia), more than 50% of whom are under the age of 25 (IFAD, 2010). Poverty, exclusion from development, and migration flows have been the most striking indicators of the crisis experienced by local economies, which have been unable to provide employment and income to support the livelihoods of the growing numbers of the potentially economically active young population, leading to significant migration flows towards urban areas (see Box 7). The massive exodus from rural areas causes further impoverishment of rural communities (lower services provision, less infrastructure investment, and economic decline). However, in some contexts, especially in countries like Algeria and Morocco, urban unemployment is determining a phenomenon of "counter urbanization", with the return of young people to their communities of origin, and the formation of new or the growth of existing settlements in rural areas (Mediterra, 2009).

Box 7

The unemployment rate in the SEMCs, in 2011, has been calculated, by the International Labour Organisation, close to 10%. It particularly affected young people with a diploma, whose unemployment rate has reached 23.6% in Algeria, 20% in Tunisia (800,000 unemployed) and 30% in Morocco (World Bank, 2012). Rural unemployment in the Region, however, is likely to have been underestimated for two reasons: first, what is called "disguised unemployment or underemployment" either as a consequence of family and especially women's labour on small farms invariably being unpaid or, a as result of involvement in the informal sector where unskilled labour is very poorly rewarded. The second reason is the mass migration of the rural poor towards the urban centres, thus inflating urban unemployment rates: what IFAD has called the "transfer of poverty from rural to urban areas" (2007).

Migration towards urban centres is massive, as young people looking for jobs try to escape the lack of opportunity and hardship of rural lives, but what they find is mainly very precarious livelihood conditions with very limited job and income opportunities. Most urban centres are unprepared to receive this influx leading to informal settlements and uncontrolled urban expansion onto agricultural land, environmental pollution, higher crime rates, unemployment, inadequate infrastructure and a subsequent fuelling of tensions (Mediterra, 2008).

Agriculture, though, is still the main activity on which rural communities base their livelihoods. In well served, sub-urban and irrigated areas, agriculture is still providing good opportunities to small farmers.
Strong support is needed from research and extension services for promoting crop diversification as well as sustainable intensification of cultivation, such as in horticulture, incentivising smallholder farmers, to invest their land and labour power and generate good incomes. At the same time, governments should invest in developing the commercial cultivation of under-utilised or minor species and crops, strongly linked to the territories and knowledge of small rural actors (e.g. medicinal and culinary herbs).
However, large communities' needs and expectations, in particular of those based in rain-fed and pastoral areas, are not currently satisfied by agriculture. This is confirmed by trends showing a decrease in agricultural workers in many countries such as Lebanon, Libya, Israel, Turkey, Morocco, Palestine, and Jordan (Mediterra 2009). This situation is clearly portrayed in Table 3, which takes the case of Turkey.

Table 3 Agricultural and non-agricultural employment in Turkey 1990-2006

Year %	Turkey			Rural areas*		
	Agriculture	Non-agriculture	Total	Agriculture	Non-agriculture	Total
2003	7165	13982	21147	6687	3173	9860
%	33.88	66.12	100	67.82	32.18	100
2000	7769	13811	21580	7349	3128	10477
%	36.00	64.00	100	70.14	29,86	100
1995	9080	11506	20586	8635	2559	11194
%	44.11	55.89	100	77.14	22.86	100
1990	8691	9848	18539	8308	2515	10823
%	46.88	53.12	100	76.76	23.24	100

** Villages of less than 20,000 inhabitants are considered rural.*
Source: SIS, Household and employment survey (2003) and Elci (2008).

Source: Mediterra, 2009

The increasing of unemployment records in rural areas indicates a general difficulty of the non-farm economy to provide incomes and jobs (see Fig.1). The construction sector, especially in Egypt and Algeria, has been a major source of attraction to urban centers, although the situation has deteriorated as the global economic slowdown as continued (Mediterra, 2009). Other sectors such as manufacturing and tourisms, considered important for the diversification and strengthening of rural economies for their linkages to agriculture and local territories, still lag behind and need to be supported.

The lack of job opportunities, consequently, implies people migration towards urban centers or abroad. This, in addition of creating potential discomforts in urban areas, can have negative impacts on the vitality of local communities, determining loss of human and social capital necessary to foster rural development.

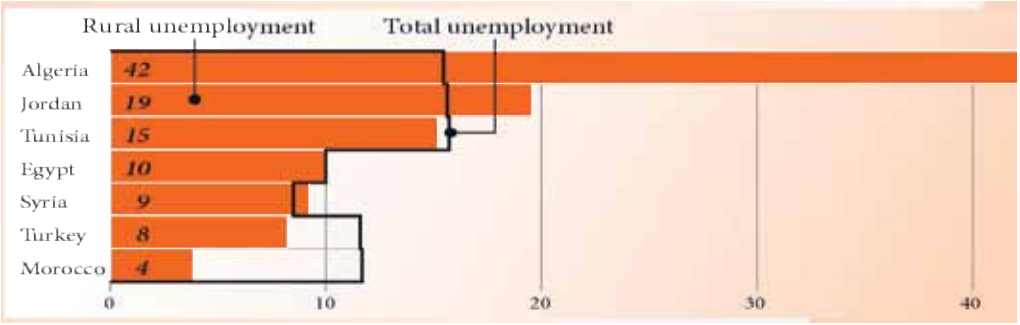


Figure 1. Rural and total unemployment rates in the Mediterranean. As % of the rural and total economically active population

Source: Adapted from Radwan (2007) according to national surveys in Mediterra 2009

3. Communities' social assets

The presence of local networks, community based organizations and institutions is the key for empowering rural communities. These are important structures that can bridge and link these communities with external environments, providing important economic and social services, and filling, at least in part, the existing gap with urban areas.

Producer organizations, such as associations and cooperatives, have an important presence in the region and data show that in some countries figures are increasing. Morocco, in 2006, registered 250 producers' associations and groups, and 6,000 cooperatives. Algeria had 1,300 professional associations and over 800 service cooperatives. Egypt had 5,717 cooperatives in 2002 (Mediterra, 2008). The majority deal with issues related to agricultural production and water management for irrigation purposes. Their role is very important in terms of ensuring food security and sustaining local economies. For example, in Tunisia cooperatives significantly influence the cereal crop market, with their annual business turn-over standing at 190m dinars (around 146m US$) (ESMED Network, 2011). However, these organizations frequently appear to depend on governmental authorities in terms of technical and managerial capacities, and have often acted as implementers of government policy, rather than conforming the vital two-way link between farmers and the private sector or government (World Bank, 2014).

New forms of rural organizations have also appeared in the last years, pushed by different factors. Within the context of decentralization and local development processes in the Maghreb countries, for instance, citizens have started to mobilize and organized themselves around common interests or needs, to produce, deliver services, and protect ecological and cultural values, etc. Organizations cover specific territories and communities. In Algeria cooperatives have been set up within a governmental program to facilitate distribution of food and provision of veterinarian and training services to pastoral people in steppe zones. In Morocco and Tunisia, communities have been organized in networks for promoting participatory management of territories to reduce natural resource degradation or promote local development strategies. The presence of new elites in rural areas, represented by those attending training programmes, young people looking for jobs and retired experts (e.g. extension officers and researchers), has favoured the establishment of new organizations promoting traditional products, organic farming, tourist activities, agro-processing plants, etc. (Bessaoud, 2008, 2009).

Governments are also taking important steps towards decentralizing their functions and facilitating local development processes. In Egypt's Fayoum Governorate Farmer Field Schools were adapted to local agro-ecosystems and operated as community networks, proving much more successful in building local human capital in agriculture. Now, after a decade of experience,

the government has decided to extend the program to other areas as part of its long-term Strategy of Sustainable Agriculture Development applied by the Ministry of Agriculture & Land Reclamation (MALR). In Morocco more than 40,000 local development agencies (most of them in rural areas and the outskirts of the largest cities) have been established to promote literacy campaigns, schooling projects for girls, programmes to bring water and electricity to villages, and more generally to promote connections and fight social exclusion by means of fostering income generation activities (ESMED Network, 2011). Similar agencies have been set up in Algeria and Tunisia, where important programmes have also been implemented in mountain areas prone to land degradation and poverty (Bessaoud and Petit, 2009).

However, in most cases a number of problems prevent the efficient functioning of these new rural organizations: while well intentioned, they are often dictated by official programmes and projects that lack the necessary human, financial and material capacities; while incomplete and immature decentralization processes limit their functions. (Bessaoud, 2008). Self-organised communities have found it hard to promote endogenous development due to the high level of bureaucracy and centralisation that continue to characterise this region's governments. At the same time the quality of governance is low, due to the lack of participation, rule of law (especially in land tenure issues), transparency, equity, consensus orientation, inclusiveness, and accountability (IAASTD, 2009). IFAD (2007) also highlights the fact that women are often underrepresented in the boards of rural associations and cooperatives. Nonetheless, there is an encouraging trend showing an increasing number of women's groups and associations at different levels (national and local), which contribute to spreading awareness and information concerning several aspects of interest to them (rights, technology, environment, education, etc.).

Some examples of rural organizations for delivering rural finance services to small communities come from IFAD experience and denote a variety of approaches and challenges. IFAD have promoted partnership arrangements with specific bodies, charitable foundations, small NGOs and rural institutions in countries like Morocco, Egypt, Syria and Yemen, succeeding in providing access to credit for very poor communities. Significant results have been achieved, sustaining the establishment of local women's savings and credit associations in West Bank and Gaza, Syria and Sudan. Nevertheless, the lessons learned from these experiences highlight a number of challenges threatening these processes. These include: widely dispersed populations; absence of credit culture; lack of managerial capacity at all levels; limited availability of performance data for practitioners, lenders and supervisory agencies; governmental preference for integrated rather than stand-alone rural finance programmes; and limited availability of wholesale credit funding (IFAD, 2006).

VII –Policy needs

Perhaps the most important issues identified by this paper is the importance of political and governance environments conducive to the establishment and development of rural community institutions, together with appropriate policies to enable stakeholders to take actions leading to sound development and investment choices. Existing policies have often failed to address: context specific problems; smallholders' specific needs; and inclusiveness and equity in the access to property, resources, and credit. This is clearly the case for land and water, where traditional rights can be unclear and differentiated across countries, communities and social groups. Limited access to information prevents smallholders from taking advantage of the market like other stronger players (commercial farmers, multi-nationals, etc.). Well intentioned policies to address low agricultural productivity and poor marketing, have often favoured large-scale producers operating in more favourable areas. Moreover, policies providing public goods and services, such as healthcare, education and infrastructure, are usually more favourable to urban people, leaving smallholder communities behind, restricting food sovereignty and failing to address food security

for the most marginalised. There is still the need for better designed policies in guaranteeing smallholders a full role in debate and decision-making, allowing them better representation in political bodies at different levels.

There is also a need for policies capable of addressing impending challenges like climate change, natural resource scarcity, and the loss of important agrobiodiversity. Policies need to target vulnerable groups and support rural community organizations, such as producer and consumer associations, cooperatives, and other formal and informal groups, which are essential tools for rural communities' development, especially in building effective "smallholder-oriented value chains" (IFPRI, 2011).

In the light of the trends and deficiencies mentioned above, the SEM Region has witnessed the emergence of rural development policies targeting improvements in living conditions, focusing on infrastructure; linkages between farming and non-farming activities; diversification of activities to support agricultural employment; protection of natural resources; strengthening the role of rural organizations that can successfully claim rights, establish responsibilities, reduce transaction costs, and facilitate the circulation of knowledge and information (Bessaoud et al, 2009). Such policies, and a better coordination among them, are crucial for smallholders' capacity and opportunities for development and also to support and encourage innovation and learning competence that can contribute to greater food sovereignty and reduce food insecurity.

VIII - Research needs

In the SEM countries the general situation of research presents broad margins for improvement: in terms of GNP only 0.2% is invested in rather than the recommended 2% (IAASTD, 2009). Moreover, there is a significant mismatch between the orientation of national and international research agendas and the types of research that would be most helpful to small farmers. This gap needs to be filled immediately as agricultural research has the greatest impact on poverty and agricultural productivity (De Schutter, 2010). Research should be more focused on the real needs of rural communities and of their small producers, more sensitive to their local ecological conditions and "receptive to local/traditional knowledge" (IFAD, 2009) aiming at developing more appropriate agroecological practices. More should be done to increase smallholders' resilience and productivity and to incorporate their indigenous/traditional knowledge into development processes. The existing trends towards decentralization require important investigation into the local and national institutional arrangements needed for supporting the establishment of ecologically and culturally appropriate local development processes.

After the political leadership was overthrown in Tunisia in January 2011, Arabic and Maghrebi civil societies have increased their expectations concerning the activities of the political decision-makers to solve problems such as unemployment, purchasing power, social equity and better governance of public affairs. Current political upheavals ("Arab spring") are the result of processes linked to profound changes experienced by the Arabic and Maghrebi societies, both political and social. Rural and farming communities in these countries have witnessed an unprecedented demographic expansion with migration towards urban centres causing the "urban sprawl", lack of growth in the rural areas and difficulties in the creation of economic activities for income generation and favouring employment, insufficient rural services that have hampered well-being and cultural progress. The sudden appearance of the civil society, not heralded by research, in the public domain poses question to the academic research. It is requesting to strengthen research programmes linked to increase knowledge of rural communities, of factors and causes at the basis of their evolution and profound changes. Those programmes, underpinned by considering the results obtained in the domain of social and cultural anthropology of the rural and farming communities of the Mediterranean region should, on one side, question the relevance

of agricultural and rural public policies, and on the other side, recognize an increased level of interest to the impacts of the those policies on the communities.

1. Creating Knowledge on Sustainable Agroecosystems (SA) and Natural Resource Management (NRM) experiences.

Sustainable Agroecosystems and Natural Resource Management are priorities in the SEM countries. These practices can ensure the conservation and protection of fragile rural environments and communities who often suffer from the externalities of economic development in the urban centres and so-called core nations. Experience generated over many years of the Sustainable Agriculture programme at the IAMB has already catalogued several positive experiences in the SEM countries (Lamberti, op.cit). Elsewhere, research has contributed to the development of technical measures for land management, soil and water conservation, soil fertility management, pest and disease management, etc. Frequently, programmes have been established to promote Integrated Pest Management (IPM), watershed management, and the conservation of critical natural capital. It is important to investigate how these technologies have been adopted and adapted to the benefit of small-scale producers in order to identify and understand both bottlenecks and catalytic factors in sustainable development processes.

2. Researching smallholder agroecosystems and technologies

Research has to orient investigations in the light of smallholder agroecosystem specificities and local needs or opportunities, while maintaining an agroecological approach that is consistent with long-term local potential (Gliessman, 2000; De Schutter, 2010). This includes the improvement of key technologies and practices, to increase agroecosystem productivity and resilience; the use of ecological processes, minimizing the use of external inputs and non-renewable energy. The study of small/medium scale post-harvest agro-processing technologies, with low operating costs, locally developed bio-pesticides and cultural practices will be essential.

3. Investigating local knowledge and institutions

Research should strengthen understanding of local knowledge and institutions, the product of a constant adaptation of local communities to specific agro-ecosystem conditions. Different studies and experiences worldwide (FAO, 2012; Pretty, 2003; Critchley, 1999), and in SEM countries too (Lamberti, op.cit; Lamberti *et al.*, 2010) show the important role that local communities have in innovation processes and development, designing sustainable practices and establishing local groups that facilitate sustainable management of natural resources and agroecosystem productivity. Traditional practices, institutions and knowledge have also been neglected and frequently lost to inappropriate and unsustainable modernization processes, yet they frequently can represent important cultural and social assets for securing livelihoods, building food sovereignty and maintaining the sustainable management of fragile environments. An example is the Agdal, a traditional institution for forest management in the High Atlas of Morocco that for a long time has contributed to the protection of sustainable patterns of forest resource use by village communities, by strengthening social-ecological system resilience and adaptability (Auclair *et al.*, 2011).

4. Research on value chains and non-farm sector development with added value for Rural Communities (RCs)

Research should be also be oriented towards sectors where market opportunities exist, not only in farming, but also at other levels in the value chain, looking for linkages among rural communities' actors and appropriate external players (De Schutter, 2011). Sectors like fruit crops and vegetables offer good opportunities in irrigated areas, where smallholder productivity is

higher and a lot of labour is required. In particular, locally valued species and varieties, often neglected by commercially oriented research should be identified and developed in the context of integrated production systems. In more marginal areas, spices, Mediterranean herb crops (such as rosemary, saffron and argan (Argania spinosa L.) and ecological and cultural tourism offer real opportunities for added value (Mediterra, 2009). The role and potential of smallholders should be analyzed at each level of the value chain: as suppliers of inputs, processors of products, or providers of other services, such as certification, marketing and training. Research into how more equitable linkages (embedded services, contracts, etc.) can be established between small-scale producers and more powerful actors along the value chain also needs attention.

5. Studies for supporting service decentralization processes and rural communities' empowerment

Research has to contribute to identifying and analyzing solutions for strengthening local institutions and organizations in consideration of a set of structural and organizational limits, such as marginalization, poor infrastructure, weak services, imperfect and unstable markets, natural resources access and control, which restrain the livelihood opportunities of rural communities and smallholders. The trend towards decentralization should drive research activities through the analysis of the most appropriate institutional arrangements for facilitating communities' participation and empowerment. Examples include: studying local governance systems for services innovation and development (research, technical assistance, credit, natural resources management, etc.) based on the decentralization of responsibilities and active participation of local actors; studying small rural producers' land tenure systems and looking for opportunities to extend their rights over the management of important resources such as water; studying positive externalities linked to the maintenance of rural communities as custodians of the environment and biodiversity.

IX – Final remarks

This work has highlighted the highly heterogeneous peculiarities of the Southern and Eastern Mediterranean Countries, a characteristic that is precious from the cultural and ecological point of view (Barthel *et al.,* 2013) but also the source of many vulnerabilities from the point of view of designing integrated regional rural development policies. And this has led to marked social and economic disparities.

About 48% of the population of the SEMCs lives in rural areas, where poverty is still concentrated despite a growing urbanization (especially along the coasts). Agriculture continues to be the main activity but is not the sole contributor to livelihood sustainability, rising incomes or food security. As data provided by IFAD in 2007 show, considering the percentage of economically active people engaged in agriculture in the region (37.8%) and the contribution of agriculture to regional GDP (12.6%) it can be seen that labour productivity is still low. One of the reasons is the reduction of public investment in rural areas that has not been compensated for by a stronger engagement of the private sector. The latter is hampered by several obstacles, among which the most important are poor rural infrastructure, poor access to credit, limited rural services like extension, education, and training to enhance smallholders' capabilities, and imperfect market mechanisms. Engagement in non-farm activities would offer smallholders more opportunities and reduce households' vulnerability to shocks and crises. At the same time, however, we have also pointed out that increasing labour productivity requires capital investments and associated energy costs that may not be sustainable in the long run.

The SEM countries are faced with major challenges, among which scarcity and depletion of natural resources are critical. Access to and use of water and land are at risk, as a consequence of demographic pressure, marginalisation, and gaps in policy frameworks, and will be aggravated

by climate change. They need access to technology and markets, and their role and potentialities should be analyzed at each level of the value chain. Small rural communities need to take action in the management of natural resources to guarantee their sustainable use. And in this they need to be assisted by better targeted policies defining clear and equitable sets of rules.

Empowering rural people and institutions is also important for holding local governments and government agencies to account with respect to the performance of policy measures and transparency of policy processes. The process of smallholder and rural community empowerment implies a set of pre-conditions such as political space for institutional development and the facilitation of constructive interaction among different interests (OECD, 2012).

All these issues affecting smallholders' productivity and posing obstacles to rural development have highlighted the importance of agroecology as an important approach to generating sustainable, long-term solutions. As stressed by UNCTAD (2013),this approach has proved its efficiency in increasing agricultural productivity by promoting cultivation practices that conserve the ecosystem: low external input techniques, where biodiversity is carefully managed favouring the distribution of more resilient crops (IFAD, 2013), labour intensive practices where diversification of land uses helps to cope with climate changes, where smallholders' livelihoods are improved. This improvement is synonymous with increased incomes that can drive smallholder communities out of food insecurity and towards greater food sovereignty, and out of poverty. In fact, more income is usually spent in the local markets, contributing to create demand for non-agricultural products and conferring dynamism and non-farm employment opportunities in their rural areas (UNCTAD, 2013; Wiggins *et al*., 2013; De Schutter, 2010) helping to slow down population migration to urban centres and with it poverty.

According to Gonzalez de Molina (2013), while agroecology is increasingly accepted as an important approach to dealing with food insecurity and promoting sustainable development, very few studies have paid significant attention to the politics of food sovereignty. The majority of practical agroecological experiences do not move beyond the local sphere; they are generally based on farms or occasionally in rural communities, where participatory research, design and action for sustainable rural development are developed. At this level, however, there is no significant challenge to the hegemony of the corporate food regime and its 'global food security' discourse. In order to mount a sustained challenge, and realise their counter-hegemonic potential, agroecological experiences and the goal of food sovereignty require appropriate institutional arrangements in terms of political power and appropriate public policies.

BIBLIOGRAPHY

Alcadi R., Mathur S, Rémy P., 2009. Research and Innovation for smallholder farmers in the context of climate change. Discussion paper for Round Table 3. IFAD, Rome, Italy.

Altieri M. A., 2009. "Agroecology, Small Farms, and Food Sovereignty". Monthly Review, Volume 61, Issue 03 (July-August).

Altieri M. A., 2008. "Small farmers as a Planetary Ecological Asset: Five Key Reasons Why We Should Support the Revitalisation of Small Farms in the Global South". Third World Network, Penang, Malaysia.

Altieri M. A., 1995. Agroecology: The Science Of Sustainable Agriculture. Westview Press.

Alvarez-Coque J. M. G., 2012. Agriculture in North Africa: A Chance for Development. Policy Brief, pp.1-7. The German Marshall Fund of the United States, Washington DC.

Aklilu P., 2009. Quelles réponses au mal-développement agricole ? Analyse des politiques agricoles et rurales passées et présentes. Options méditerranéennes B 64: pp.51-86

Amin S., 2011. Food sovereignty: A struggle for convergence in diversity. In Food movements unite! Strategies to transform our food systems, ed. E. Holt-Giménez, xi–xviii. Oakland, CA: Food First Books.

Auclair L., Baudot P., Genin D., Romagny B., Simenel R., 2011. Patrimony for Resilience: Evidence from the Forest Agdal in the Moroccan High Atlas Mountains, Ecology and Society 16 (4): 24 http://dx.doi.org/10.5751/ES-04429-160424

Gale J., Jones J., Pretty W., Sutherland, *et al*., 2009. Reaping the benefits: Science and the sustainable intensification of global agriculture. RS Policy document. London: The Royal Society.

Barthel S., Crumley C., Svedin U., 2013. 'Bio-cultural refugia—Safeguarding diversity of practices for food security and biodiversity', *Global Environmental Change* **23** 1142–1152
Beddington J., 2011. Foresight. The future of food and farming. Final Project Report. London: The Government Office for Science.
Berdegué J. A., 2005. Pro-poor innovation systems. International Fund for Agricultural Development (IFAD), Rome.
Bertini C., Glickman D., 2008. Renewing American leadership in the fight against global hunger and poverty. The Chicago Initiative on Global Agricultural Development. Chicago Council on Global Affairs. http://www.thechicagocouncil.org /UserFiles/File/GlobalAgDevelopment/Report/gadp_final_report.pdf.
Bessaoud O., 2013. « Aux origines paysannes et rurales des bouleversements politiques en Afrique Du Nord: l'exception Algérienne », in Maghreb-Machrek, N. 215, 2013.
Bessaoud O., Petit M., 2009. « Mediterranean Rural Territories », New Medit n.3/2009, CIHEAM-IAMB, 2009, Bari, pp.4-11.
Bessaoud O., 2008. Les organisations rurales au Maghreb -0 Leur role dans le development : un esai d'evaluation, Economie Rurale 303-304-305 Janvier-May 2008
Bessaoud O. 2006. "La gouvernance rurale en Méditerranée: tendances et nouveaux défis", Les notes d'analyse du Ciheam, 14, July 2006.
Bird K., Hulme D., Moore K., Shepherd A., 2002. Chronic Poverty and Remote Rural Areas. CPRC Working Paper No 13. Chronic Poverty Research Centre, UK.
Blue Plan, 2008. The Blue Plan's sustainable development outlook for the Mediterranean. Blue Plan, Sophia Antipolis, France.
Chambers, R., 2010. "Paradigms, Poverty and Adaptive Pluralism", IDS Working Paper 344, Brighton, UK.
Chambers R., Conway G.R., 1991. Sustainable Rural Livelihoods: Practical Concepts for the 21st Century. Institute of Development Studies DP 296.
Conforti P., 2010. Looking ahead in world food and agriculture. Food and Agriculture Organization. http://www.fao.org/docrep/014/i2280e/i2280e00.htm
Conway G., 2011. "*On Being A Smallholder",* Conference on New Directions for Smallholder Agriculture, 24-25 January, 2011, Rome, IFAD.
Conway G., 1997. The Doubly Green Revolution. Oxford, UK: Penguin Books.
Conyers D., 2003. Guidelines on social analysis for rural area development planning, FAO, Rome http://www.fao.org/docrep/T1660E/T1660E00.htm
Critchley W., 2006. Working With Farmer Innovators- a practical guide. CTA, Aj Wageningen.
Crtitchley W., 1999. Promoting farmer innovation – Harnessing local environmental knowledge in East Africa, UNDP-SIDA
De Schutter O., 2011. "Agroecology and the right to food". Report presented at the 16th Session of the United Nations Human Rights Council [A/HRC/16/49]. March 8.
Dixon J., Gulliver A., Gibbon D., 2001. Farming Systems and Poverty: Improving Farmer Livelihoods in a Changing World. Food and Agriculture Organization/World Bank, Washington DC.
Eastwood R., Lipton M., Newell A., 2009. "Farm size" in Handbook of Agricultural Economics, Volume 4. Elsevier, Amsterdam
Ellis F., 2000. Rural Livelihoods, Diversity and Poverty Reduction Policies: Uganda, Tanzania, Malawi and Kenya, ICRISAT.
Ellis F., 1993. Peasant Economics: farm households and agrarian development. 2nd edition, Cambridge University Press, Cambridge.
ESMED Network, 2011. The Social Economy in the Mediterranean. CEPES, Madrid.
European Economic and Social Committee, 2011. Rural Development and Employment in the Euro-Mediterranean Region. Brussels.
FAO, 2012. Good Practices in Building Innovative Rural Institutions to Increase Food Security, FAO, Rome.
FAO, 2011. The state of food insecurity in the world: How does international price volatility affect domestic economies and food security? http://www.fao.org/docrep/014/i2330e/i2330e.pdf
FAO, 2010. Characterization of small farmers in Asia and the pacific. APCAS/10/28. FAO, Rome.
FAO, 2008. Climate Change and Food Security: A Framework Document. FAO, Rome.
FAO, 2006. The Role of Agriculture and Rural Development in Revitalizing Abandoned/ Depopulated Areas. FAO, Rome.
FAO, 2002. "Land and Agriculture". FAO, Rome.
Forum for Food Sovereignty, 2007. Declaration of Nyéléni. Nyéléni Village, Sélingué, Mali, 27 February, 2007. Available at: http://www.nyeleni.org/spip.php?article290, accessed 29/05/13).
Gliessman S.R., 2007. Agroecology : the ecology of sustainable food systems. 2nd edition. CRC Press, Boca Raton.

Gliessman S.R., 2000. Agroecology. Ecological Processes in Sustainable Agriculture. CRC Press, Boca Raton, Florida.

Gliessman S.R., 1997. Sustainable agriculture : an agroecological perspective. In: International Short Course on Agroecology: reader : Berkeley, California, June 16-25, 1997 - Berkeley : University of California, Center for Biological Control, pp.45-57.

Halpern D., 2005. *Social Capital*, Cambridge Polity.

Hazell P., 2011. "*Five Big Questions about Five Hundred Million Small Farms*", Conference on New Directions for Smallholder Agriculture, 24-25 January, 2011, Rome, IFAD.

Hazell P., Poulton C., Wiggins S., Dorward A., 2007. The future of small farms for poverty reduction and growth, Policy Brief 75, IFPRI, Washington.

Herren R.H., 2011. Innovations in Understanding Complex Systems. in *State of the World 2011: Innovations that Nourish the Planet*, Worldwatch Institute Report on Progress Toward a Sustainable Society, W.W. Norton & Company; New York & London, first edition, pp.166-168.

Holt-Giménez E., Altieri M.A., 2013. Agroecology, Food Sovereignty, and the New Green Revolution, Agroecology and Sustainable Food Systems, 37:1, 90-102

IAASTD, 2009. (International Assessment of Agricultural Knowledge, Science and Technology for Development) . Agriculture at a crossroads.Washington, DC: Island Press.

IFAD, 2013. Smallholders, food security, and the environment, IFAD.

IFAD, 2011. Proceedings of the Conference on New Directions for Smallholder Agriculture, Rome.

IFAD, 2010. Rural Poverty Report 2011. IFAD, Rome.

IFAD, 2007. The status of rural poverty in the Near East and North Africa, IFAD, Rome.

IFAD, 2006. Rural FDinance in the Near East and North Africa, IFAD, Rome.

IFPRI, 2011. Policies, Institutions and Market to strengthen Food Security and Incomes for the Rural Poor, CGIAR Research Program 2. IFPRI.

IPCC, 2007a. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribute of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Martin Parry, O.F. Canziani, J.P. Palutikof., P.J. van der Linden and C.E.

ISTAT, 2010. Statistics on Rural Development and Agriculture Household Income. ISTAT, Rome.

Lamberti L., El Bilali H., Belsanti V., 2011. "Contribution of small-scale farmer innovations to sustainable agriculture". In: Fifth International Consumer Sciences Research Conference - Consumer 2011- "Consumer behaviour for a sustainable future", July 18th - 20th, 2011 - University of Bonn, Germany.

Lamberti L., El Bilali H., Belsanti V., (eds) 2010. Smallholders and Sustainable Agriculture – Workshop proceedings, CIHEAM-Bari & Italian Ministry for Foreign Affairs - Coopearazione Italiana allo Sviluppo.

McMichael P., 2009. A food regime genealogy. Journal of Peasant Studies 36:139–169.

Mediterra, 2009. Rethinking rural development in the Mediterranean. International Centre for Advanced Mediterranean Agronomic Studies. – Paris: Presses de Sciences Po, 2009.

Mediterra, 2008. The Future of Agriculture and Food in Mediterranean Countries International Centre for Advanced Mediterranean Agronomic Studies. – Paris: Presses de Sciences Po, 2008, pp 275-298.

Montaigne E., Bessaoud O., 2009. Quelles réponses au mal-développement agricole ? Analyse des politiques agricoles et rurales passées et présentes. Options méditerranéennes B 64: pp.51-86

Murphy S., 2010. Changing perspectives: Small-scale farmers, markets and globalization. working paper, Hivos Knowledge Programme, The Hague, The Netherlands, pp 6-46.

OECD, 2012. Empowerment of poor rural people through initiatives in agriculture and natural resource management, Paris, 2012.

OECD, 2011. Opportunities and challenges in the Mena Region, Paris, 2011.

OECD, 2006. The new rural paradigm. Policies and governance, Paris, 2006.

Pretty J., 2008. Agricultural sustainability: concepts, principles and evidence. *Phil. Trans. Royal Society of London B*, 363 (1491), 447-466.

Pretty J., Noble A. D., Bossio D., Dixon J., 2006. "Resource-Conserving Agriculture Increases Yields in Developing Countries", Environmental Science and Technology, 40:4, 2006, pp.1114-1119.

Pretty J., 2008. "Social Capital and the Collective Management of Resources" in Science 302, 1912-1915, American Association for the Advancement of Science, Washington DC.

Pretty, J. N., 1995. "Regenerating Agriculture. Policies and Practice for Sustainability and Self-Reliance". Joseph Henry Press, Washington DC.

Putnam Robert D., 1993. Making democracy work. Civic traditions in modern Italy. Princeton.

Reardon T., Delgado C., Matlon P., 1992. "Determinants and effects of income diversification amongst farm households in Burkina Faso," Journal of Development Studies, 28 (January 1992), pp. 264-296.

Roseboom J., 2012. Creating an Enabling Environment for Agricultural Innovation, Module 6, in *Agricultural Innovation Systems- An Investment Sourcebook,* The World Bank; Washington, D.C.

Rosset P., 1999. The Multiple Functions and Benefits of Small Farm Agriculture in the Context of Global Trade Negotiations. Institute for Food and Development Policy, CA, USA.
Rowlands J. 1997. Questioning Empowerment: Working with Women in Honduras. Oxfam: Oxford.
Sevilla Guzmán E., Woodgate G., 2013. Agroecology: Foundations in Agrarian Social Thought and Sociological Theory, Agroecology and Sustainable Food Systems, 37:1, 32-44.
Sevilla Guzmán E., Woodgate G., 1997. Sustainable rural development: From industrial agriculture to agroecolgy. In The international handbook of environmental sociology, eds. M. Redclift and G. Woodgate, 93–94. Cheltenham, UK: Edward Elgar.
Scoones I., Thompson J., 2009. Farmer First Revisited – Innovation for Agricultural Research and Development. Practical Action Publishing, London.
South African Government, 2000. The Integrated Sustainable Rural Development Strategy (ISRDS).
The Montpellier Panel, 2013. Sustainable Intensification: A New Paradigm for African Agriculture, London.
UNCTAD, 2013. Wake up before it is too late, United Nations, New York, 2013.
UNESCAP/UNDP/ADB, 2007. Access to Basic Services for the Poor: The Importance of Good Governance. Asia-Pacific MDG Study Series, Bangkok, 2007.
United Nations, 2007. Rural Households'Livelihood and Well-Being. United Nations, New York and Geneva, 2007.
Wiggins S., Keats S., 2013. Smallholder agriculture's contribution to better nutrition, ODI, London.
WOCAT, 2007. "Where the land is greener – case studies and analysis of soil and water conservation initiatives worldwide", edited by Hanspeter Liniger and William Critchley, Bern, 2007.
Woodgate G., 2012. Governance and Institutions for Sustainable Rural Development. Lessons held in the distance course "Sustainable agriculture innovation systems for small-scale farmers", academic year 2012, organised by CIHEAM-MAIB.
World Bank, 2014. Sector Brief – Agricultural and rural development in Mena. World Bank, Washington DC.
World Bank, 2012. Adaptation to a changing climate in the Arab countries. The World Bank, Washington DC.
World Bank, 2010. Poor Places, Thriving People: How the Middle East and North Africa Can Rise Above Spatial Disparities. MENA Development Report, World Bank, Washington DC.
World Bank, 2009. Improving Food Security in Arab Countries. World Bank, Washington DC.
World Bank, 2007. World Development Report (WDR) 2008. Agriculture for Development. The International Bank for Reconstruction and Development / The World Bank, Washington, DC.
World Bank, 2006. Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems. The International Bank for Reconstruction and Development (IBRD) / The World Bank (WB); Washington, DC.

Notes

1 World Food Summit definition of food security (1996): *"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."*

2 Via Campesina, the largest and most influential global peasant and small-farmer organization, has introduced food sovregnity as an alternative to the concept of global food security. It is "the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems, putting the aspirations and needs of those who produce, distribute and consume food at the heart of food systems and policies rather than the demands of markets and corporations" (Forum for Food Sovereignty, 2007).

3 Over the last decades approaches to research and development have promoted the transfer of standardised/ universal knowledge and inputs, fixed technology packages with "pre-set" goals, and where local people where considered beneficiaries rather than actors (Chambers, 2010) contributing to phenomena like the Green revolution-transfer of research and technology packages to promote development through increased production- benefiting farmers having access to them and in favourable areas, disregarding biodiversity, with intensive use of fertilizers and pesticides having a negative impact on the environment.

4 Agroecology "promotes the ecological management of biological systems through collective forms of social action, [employing] systemic strategies [focused on] local endogenous potential encoded within knowledge systems ... that demonstrate and promote both ecological and cultural diversity" (Sevilla, Guzmán and Woodgate 1997, 93–94).

Priority 5:
Mediterranean food consumption patterns: diet, environment, society, economy and health

Authors

Reference persons: Cosimo Lacirignola & Roberto Capone, CIHEAM-Bari
Senior expert: Hamid El Bilali, CIHEAM-Bari
Contributing authors: Philipp Debs, Gianluigi Cardone and Noureddin Driouech, CIHEAM-Bari
Reference scientists: Sandro Dernini, FAO/Forum on Mediterranean Food Cultures (FMFC); Barbara Burlingame, FAO; Vincent Gitz, FAO; Alexandre Meybeck, FAO

International experts
Rekia Belahsen, Chouaib Doukkali University, Morocco;
Elliot Berry, WHO Collaborating Centre for Capacity Building in Public Health, Hebrew University Israel;
Denis Lairon, Université Aix-Marseille, France;
F. Xavier Medina, Universitat Oberta de Catalunya, Spain;
Youssef Aboussaleh, Ibn Tofail University, Morocco;
Gulden Pekcan, Hacettepe University, Turkey;
Antonia Trichopoulou, Hellenic Health Foundation (HHF), WHO Collaborating Centre for Food and Nutrition Policies, Medical School, University of Athens, Greece;
Lluìs Serra-Majem, University of Las Palmas de Gran Canaria/CIISCAM, Spain.

This white paper is an outcome of the collaborative effort with the FAO/UNEP Sustainable Food Systems Program, FAO.

FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS
INTERNATIONAL CENTRE FOR ADVANCED MEDITERRANEAN AGRONOMIC STUDIES

Recommended citation
CIHEAM &FAO. 2015. *Mediterranean food consumption patterns: diet, environment, society, economy and health*. **A White Paper of Priority 5 of Feeding Knowledge Programme, ExpoMilan 2015. CIHEAM-IAMB, Bari/FAO, Rome.**

ISBN 978-92-5-108705-3 (FAO)

ISBN-2-85352-542-2 (CIHEAM-Bari)

Acknowledgements

This white paper is the outcome of a collaborative effort with the Sustainable Food Systems Program, Department of Agriculture and Consumer Protection, FAO, Rome.

We would like to thank all those that contributed to the preparation of this white paper with their valuable comments and insights.

The following experts are acknowledged for their significant contribution towards the development of the section regarding the indicators for assessing the sustainability of Mediterranean diets:

- Massimo Iannetta, ENEA, for the development of an Integrated Product Index for the Sustainability of Mediterranean Diets (IPI-SMeD)" and for the identification of environmental indicators;
- Angela Polito, Aida Turrini, Federica Intorre, Giuseppe Maiani, Ex INRAN/CRA; Lorenzo M. Donini, Alessandro Pinto, Annamaria Giusti and Valeria del Balzo, CIISCAM/Sapienza University of Rome, for the identification of nutrition and health indicators;
- Eva Alessi; WWF-Italy, for the identification of environmental indicators;
- Giulio Malorgio, University of Bologna, for the identification of the economic indicators;
- Mauro Gamboni and Silvana Moscatelli, CNR, for the identification of the socio-cultural indicators.

Also, following experts are acknowledged for their contribution to the brainstorming process that has accompanied the development of indicators: Denis Lairon, University Aix-Marseille, France, and FENS representative; Pasquale Steduto, FAO, Rome; Rekia Belahsen, Chouaib Doukkali University, Morocco; Elliot Berry, Hebrew University-Hadassah Medical School, Jerusalem, Israel; Lluís Serra-Majem, University of Las Palmas de Gran Canaria/CIISCAM/MDF, Spain; F. Xavier Medina; Universitat Oberta de Catalunya (UOC) & International Commission on the Anthropology of Food and Nutrition (ICAF)-Europe, Barcelona, Spain; Antonia Trichopoulou, Hellenic Health Foundation & WHO Collaborating Centre for Nutrition, Department of Hygiene and Epidemiology, University of Athens, Greece; Federico Mattei, Bioversity International.

The Forum on Mediterranean Food Cultures (FMFC) has significantly contributed in the organisation of the international workshop "Guidelines for the Sustainability of the Mediterranean Diet", held on 28-29 November 2011 at the CIHEAM- MAI Bari, towards the establishment of the Mediterranean Diets Working Group (MDWG) for evaluating the sustainability of Mediterranean Diets. A milestone of this collaboration was in 2005 with "the Rome Call for a Common Action on Food in the Mediterranean" (CIISCAM, 2005), that allowed to further re-activate the process of the development of a network for the advancement of Mediterranean Food Cultures started in 2002 by the FMFC and CIHEAM MAI-Bari and other Mediterranean institutions.

A special thanks to Suzanne Redfern, Sustainable Food Systems Programme, FAO, for the editing and layout of this document.

ACRONYMS AND ABBREVIATIONS LIST

CBD	Convention on Biological Diversity
CDO	Controlled Designation of Origin
CFS	Committee on World Food Security
CIHEAM	Centre International de Hautes Etudes Agronomiques Méditerranéennes
CIISCAM	International Interuniversity Study Centre on Mediterranean Food Cultures
CNR	Italian National Research Council, Italy
COLI	Cost of Living Index
COST	European Cooperation in Science and Technology
CRA	Agricultural Research Council, Italy
DEFRA	Department for Environment, Food and Rural Development, UK
EC	European Commission
EEA	European Environment Agency
ENEA	National Agency for New Technologies, Energy and Sustainable Economic Development, Italy
ESF	European Science Foundation
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FCPI	Food Consumer Price Index
FDM	Fundación Dieta Mediterránea, Spain
FENS	Federation of European Nutrition Societies
FMFC	Forum on Mediterranean Food Cultures, Italy
GFCM	General Fisheries Commission for the Mediterranean
GHG	Greenhouse gas
GMO	Genetically Modified Organism
HHF	Hellenic Health Foundation
HLPE	High Level Panel of Experts on food security and nutrition
ICAF	International Commission on the Anthropology of Food and Nutrition
IISD	International Institute for Sustainable Development
INFOODS	International Network of Food Data Systems
INRAN	National Institute for Research on Food and Nutrition, Italy
IOTF	International Obesity Task Force
IPCC	Intergovernmental Panel on Climate Change
ITFPCHD	International Task Force for Prevention of Coronary Heart Disease
LCA	Life Cycle Assessment/ Analysis

MAI-Bari	Mediterranean Agronomic Institute of Bari, Italy
MAP	Mediterranean Action Plan
MD	Mediterranean diet
MDF	Mediterranean Diet Foundation
MDP	Mediterranean Diet Pattern
MENA	Middle East and North Africa
NCDs	Non-Communicable Diseases
NGOs	Non-Governmental Organizations
OECD	Organization for Economic Cooperation and Development
PDO	Protected Designation of Origin
PREDIMED	Prevention with Mediterranean Diet
SCP	Sustainable Consumption and Production
SD	Sustainable Development
SDC	Sustainable Development Commission, UK
SDI	Sustainable Development Indicators
SEMC	Southern and Eastern Mediterranean Countries
SME	Small and Medium Enterprises
ULPGC	University of Las Palmas de Gran Canaria
UK	United Kingdom
UNCSD	United Nations Commission on Sustainable Development
UNDESA	United Nations Department of Economic and Social Affairs
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN-HLTF	United Nations System High Level Task Force on Global Food Security
UOC	Universitat Oberta de Catalunya, Spain
WFP	World Food Programme
WHO	World Health Organization
WWF	World Wildlife Fund for Nature

Key messages

- Food and nutrition security is still a problem in many Mediterranean countries, especially southern and eastern ones, while obesity and overweight are also becoming a new challenge.
- Today, the main concern for the Mediterranean food and agricultural sector is to provide simultaneously enough food, in quantity and quality, to meet the nutritional needs of a growing population and to conserve natural resources for future generations.
- Changes towards optimizing both food consumption and food production are important to ensure more sustainable food systems and to achieve food and nutrition security in the Mediterranean region.
- To satisfy the increasing food demand - due mainly to changing food consumption patterns and population growth - food production has to become more efficient with a decrease in food losses and waste and an increase in diet sustainability.
- The Mediterranean diet is widely considered as a healthy dietary pattern and a greater adherence to the Mediterranean diet has been associated with significant improvements in health and nutritional status. It has also been recognized as a sustainable diet because of its lower environmental impact.
- However, current data show a decline in adherence to the Mediterranean dietary pattern in northern as well as southern and eastern Mediterranean countries that is critically eroding the Mediterranean diet heritage, recognized in 2010 by UNESCO as an intangible cultural heritage of humanity.
- The abandonment of traditional habits and the emergence of new lifestyles associated with socioeconomic changes pose important threats to the preservation and transmission of the Mediterranean Diet to future generations.
- It is urgent to preserve the cultural heritage of the Mediterranean diet as an outstanding resource for sustainable development as it contributes to promoting local production and consumption, encouraging sustainable agriculture and safeguarding landscapes.
- The promotion and the enhancement of the Mediterranean diet is a critical issue for sustainable development to counteract food insecurity and malnutrition in the Mediterranean region.
- All main stakeholders in the agro-food sector in the Mediterranean region should cooperate towards increasing the sustainability of food consumption and production patterns to achieve food and nutrition security.
- Biodiversity also emerges as a crucial component between sustainability and public health that should be taken into consideration.

Summary

Today, the principal challenge for the food and agricultural sector is to provide simultaneously enough food, in quantity and quality, to meet nutritional needs and to conserve natural resources for present and future generations. FAO estimates thatto satisfy the needs of a growing and richer population with an increased demand for animal products, food production will have to increase by60 percent towards 2050 (FAO, 2012b). This figure can be reduced by improving production efficiency, changing diets and decreasing food losses and waste.

Food consumption and production trends and patterns are among the most important drivers of environmental pressures. Agro-food systems need to grow within the context of a finite and sometimes shrinking resource base, and must use natural resources in a sustainable manner to preserve the ecosystems on which they relay. Such growth needs to be inclusive and target broader objectives than just primary production; it must include efficiencies along the whole food chain to promote sustainable practices and diets, inside a coherent cultural and social framework. This can be achieved through sustainable food consumption and production driven by to the promotion of more sustainable dietary models. Recently, FAO has started to study the concept of sustainable diets in order to design methods and indicators for their assessment in different agro-ecological zones.

In 2010,FAO and Bioversity International organized an international scientific symposium on "biodiversity and sustainable diets". One of the major outcomes of the symposium was a consensus position on the following definition of "sustainable diets": *"Sustainable diets are those diets with low environmental impacts which contribute to food and nutrition security and to 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 and human resources"* (FAO/ Bioversity, 2010).

The Mediterranean diet has been well characterized scientifically. It is also recognized as a healthier dietary pattern. It is now being analysed in many surveys and is appreciated for its lower environmental impact. For these characteristics and, because it involves a large number of countries, the Mediterranean diet - recognized by UNESCO as an intangible cultural heritage - has been selected by FAO and CIHEAM for the assessment of diet sustainability models.

However, despite the well-documented health and environmental benefits of the Mediterranean diet, current data show a *decline* in adherence to the Mediterranean diet pattern in the Mediterranean area.

The Mediterranean region is passing through a "nutritional transition" in which problems of under-nutrition coexist with overweight, obesity and food-related chronic diseases. This nutrition transition is alarming as it has negative impacts on health systems. The key nutrition challenges facing the eastern and southern Mediterranean region are protein–energy malnutrition, micronutrient deficiencies, obesity and nutrition-related chronic diseases.

Drivers of consumption patterns and lifestyles are economic, technological, cultural, social and political. Global consumption levels and patterns are affected, among others, by population growth, urbanisation and the rise in affluence and living standards.

Fundamental and radical changes in the whole food systems are indispensable for achieving sustainable food and nutrition security in the Mediterranean region.

Improving sustainable food consumption patterns in the Mediterranean region requires sustainable supply chains, minimizing pressure on natural resources and externalities over the life-cycle - including the reduction of water consumption, and of food losses and waste - and promoting sustainable diets.

Given the importance of food consumption patterns as drivers of human well-being as well as environmental degradation, urgent steps must be taken to assess current food consumption patterns and promote the Mediterranean diet as a sustainable dietary pattern through the development of methods, indicators and policy guidelines.

Transition towards sustainable food systems in the Mediterranean region will require developing a set of comprehensive, coherent, integrated and holistic policies that deal with different spheres and areas of agriculture, environment (land, water and biodiversity), nutrition, health, economy, lifestyle, society, trade and culture.

Coordinated actions are needed at local, national and regional levels, in the Mediterranean countries, with the support of the private sector and the civil society, to strengthen the sustainability of the food systems.

The objective of this paper is to stimulate a multidisciplinary networking dialogue among the Mediterranean scientific community's members on the sustainability of the current food consumption and production patterns in the Mediterranean region.

I – Objectives of the white paper

This white paper aims at contributing to the overall development of the Feeding Knowledge Programme, and of its Euro-Mediterranean Network on Research and Innovation for Food Security. In particular, it is addressed to the priority 5 "Mediterranean food consumption patterns: diet, environment, society, economy and health" to facilitate an interdisciplinary dialogue and exchange among members of the scientific community on the need to improve the sustainability of food consumption patterns and diets in the Mediterranean area and to achieve the goal of food and nutrition security.

The objective of this document is to highlight the role that the current food consumption patterns play in food and nutrition security, public health, environment protection and socio-economic development in the Mediterranean region. The ultimate aim is to stimulate a multidisciplinary dialogue among the Euro-Mediterranean scientific community on the sustainability of current food consumption and production patterns in the Mediterranean region and beyond, to identify the research activities and policy actions needed to move towards more sustainable Mediterranean food systems.

The paper addresses several interdisciplinary and interdependent issues related to food consumption patterns; sustainable diets; health implications of the current food consumption patterns; food environmental footprints; food production systems; food economics; food cultures and sociology; food losses and waste; food system governance and policies.

II – Rationale

Food security, as defined by the World Food Summit in 1996 (FAO, 1996) and revised then in the World Summit on Food Security in 2009(FAO, 2009), depends on four pillars: (i) Food availability: sufficient quantities of food available on a consistent basis; (ii) Food access: physical and economic access toappropriate foods for a nutritious diet; and (iii) Food use: appropriate use based on appropriate means andknowledge of basic nutrition and care; (iv) Stability in food availability, access and utilization.

Food security is a complex sustainable development issue, linked to health through malnutrition, but also to economic development, environment, and trade. Food insecurity hassignificant

consequences for individuals as well as for society, including malnutrition, obesity, disease, and poverty.

The cost of malnutrition is both direct and indirect, because overnutrition, like undernutrition, not only has an immediate deficit impact on public health systems, but also an indirect impact on the gradual deterioration of human capital and the inevitable loss of productivity (Hassan-Wassef, 2012). The extent and severity of the health problems linked to food, which affect development, social activity and human beings' creative and productive capacity, have moved the food security issue higher up in the range of global concerns (Hassan-Wassef, 2012).

Unsustainable food consumption and production patterns are increasing food insecurity and putting more stress on ecosystems, the supply of resources, goods and services, and human social systems and well-being. Food consumption and production patterns are among the most important drivers of environmental pressures: land degradation, declining soil fertility, unsustainable water use, over fishing, and marine environment degradation. The social and economic costs of diet-related illnesses are straining individuals, families and national healthcare budgets. Consumption trends, through their direct impact on food accessibility, are adversely affecting food and nutrition security especially of the poor in developing countries.

The challenge of feeding the growing world population, which is expected to reach 9 billion people in 2050, requires new strategies and new multicultural and multisectorial rethinking capable of generating new forms of dialogue, at different levels, towards a more sustainable use of the available natural and human resources, to ensure food and nutrition security (Godfray *et al*, 2010). Eating patterns, which are important drivers for building sustainable agricultural and food systems, are often neglected in the research and policy areas (Guyomard *et al,* 2011).

In the early 1980s, the notion of "sustainable diets" started to be explored to recommend diets which would be healthier for the environment as well as for consumers (Gussow and Clancy, 1986). But, with food globalization and the increased industrialization of agricultural systems, with no attention to the sustainability of agro-food ecosystems, the sustainable diet concept was abandoned for many years.

In the late 1990's the Convention on Biological Diversity (CBD) and its governing body, the Conference of the Parties (COP), began to recognize the importance of biodiversity for ensuring food security. By 2004, the COP formally acknowledged the linkage between biodiversity, food and nutrition, and the need to enhance sustainable use of biodiversity to combat hunger and malnutrition. Two years later, the COP adopted the framework for a cross-cutting initiative on biodiversity for food and nutrition (Toledo and Burlingame, 2006), and by 2010, this initiative has merged with the work on sustainable diets (FAO/Bioversity, 2012).

Recently, the interest in sustainable diets has again been raised by international scientific societies and UN agencies (American Dietetic Association, American Nurse Association, American Planning Association and American Health Association, 2010; American Public Health Association, 2007; DEFRA, 2009, 2011; FAO/Bioversity, 2012; FAO, 2010, 2012b; UNEP, 2012a, 2012b; UNSCN, 2012). A growing body of evidence of the non-sustainability of current dietary trends published in technical reports (EC/JRC, 2009; SDC, 2009, 2011; WWF, 2011; Esnouf *et al*, 2013; Pluimers and Blonk, 2011; Guyomard *et al*, 2011) has further highlighted sustainable diets as an important element for a shift towards sustainable food consumption and production.

Food consumption is variably affected by a whole range of factors including food availability, food accessibility and food choices, which in turn may be influenced by geography, demography, disposable income, socio-economic status, urbanization, globalization, religion, culture, marketing, and consumer attitude (Kearney, 2010). A recent study (Kastner *et al*, 2012) indicates an inverse relationship between the two main drivers for increased land requirements for food production: with socioeconomic development, population growth decreases and, at the same time, diets

become richer in energy density. In many regions, dietary change may override population growth as the major driver behind land requirements for food in the near future.

There is growing evidence ofthe cost of diets for the environment, society and public health nutrition (Haines *et al*, 2009; Holdsworth, 2010; Hawkesworth *et al*, 2010; Lock *et al*, 2010; O'Kane, 2012; Delaney Burke, 2012; Clonan and Holdsworth, 2012). A growing body of research is showing that the achievement of substantial reductions in food-related GHG emissions to mitigate climate change must be addressed, not only by how we produce and distribute our food but also by what we eat (Marlow *et al*, 2009; Garnet, 2011; Macdiarmid *et al*, 2012; Vieux *et al*, 2012). Recommendations for lowering energy inputs and greenhouse gas emissions from household food consumption include diets with less meat and dairy products, more in-season vegetables and more locally produced and fresh foods (Carlsson-Kanayma, 1998, 2009; Carlsson-Kanayma *et al*, 2003; Trichopoulou, 2012).

A European Commission study (EC/JRC, 2009), which analysed the impact on the European environment caused by changes in the European diets, showed that current food consumption accounts for 27% of all environmental impacts in the EU-27, and highlighted a prominent role of meat production on environmental impacts generated along the food chain. Also, the European study pointed out that suggested dietary alterations imply changes in the structure of agricultural and food production sectors but that the impact on existing production structures would be limited, while more environmental benefits from a change in diet in the EU-27 will occur at a global level (EC/JRC, 2009).

According to studies on of "food miles", transport represents only a small part of overall food chain emissions and, therefore, "food miles" are a poor indicator of food impacts (Garnet, 2011; Edwards-Jones *et al*, 2008; Weber and Matthews, 2008; AEA Technology Environment, 2005), even if it does vary considerably, depending on country of origin and cultivation or production systems (Sim *et al,* 2007). It is important to acknowledge that 'food miles' should not be used as a main indicator for the environmental impacts of food products. The assumption that locally grown food is better for the environment is not always true, as some regions of the world employ more resource- efficient practices than others for the same production (Kissinger, 2012).

Sustainability, water, food security and diets are intimately connected. With rising incomes and urbanisation, dietary patterns with pronounced regional and cultural differences are shifting towards consumption patterns higher in animal products, which increase water demand (Renault and Wallender, 2000; Lundqvist *et al*, 2008). Dietary patterns with high meat consumption require more energy, water and land resources (Pimentel and Pimentel, 2003; Gerbens-Leenes and Nonhebel, 2005).

The Mediterranean diet, acknowledged by UNESCO as an intangible cultural heritage, has been well scientifically characterized also as a healthier dietary pattern, and is a recommended plant-based dietary pattern (Bach-Faig *et al*, 2011). It is now being analysed in many surveys and appreciated for its lower environmental impact (Gussow, 1995; Duchin, 2005; Baroni *et al*, 2007; EC/JRC, 2009; CIISCAM, 2009; Barilla Center for Food and Nutrition, 2010; Burlingame and Dernini, 2011; FAO/CIHEAM, 2012; Dernini *et al*, 2013; Sáez Almendros *et al*, 2013[1]).

For these characteristics and, because it concerns a large number of countries, the Mediterranean diet has been jointly identified by FAO and CIHEAM as a case study for its assessment as a sustainable diet model. The Mediterranean diet has nutritional, economic, environmental and socio-cultural characteristics that make it particularly relevant for such a case study for the characterization of sustainable diets in different agro-ecological zones.

The case study of the Mediterranean diet as a sustainable diet model may clarify what is required for an environmentally sustainable food system and for more eco-friendly food based dietary guidelines. It should lead to innovative intersectoral efforts to counteract the degradation of

ecosystems, loss of biodiversity and simplification of diets through the improvement of sustainable dietary patterns culturally accepted in the Mediterranean region.

The improvement of the sustainability of the food consumption patterns, with particular attention to enhancement of the sustainability of the Mediterranean diet, as a country-based sustainable diet model, and to the reduction of food waste and losses, is a critical priority for the food and nutrition security in the entire Mediterranean region in general, and southern and eastern Mediterranean countries in particular.

In the final declaration of their 9th meeting - held in Malta on September 27, 2012 - the Mediterranean Agriculture ministers underlined *"…the role of the Mediterranean diet as a driver of sustainable food systems within the strategies of regional development and on that of traditional local products, since quantitative food security must also be complemented by qualitative approaches*" (CIHEAM, 2012).

Recent events in the Middle East and North Africa (MENA) region have put more attention and pressure on food security. Therefore, it appears necessary to engage even more in strengthening and furthering research and political actions in sustainable food consumption and production in the Mediterranean region (Hassan-Wassef, 2012).

The sustainability of the Mediterranean food systems is under a pressing threat as it was forecasted in the 2005 Mediterranean Strategy on Sustainable Development: *"Mediterranean agricultural and rural models, which are at the origins of Mediterranean identity, are under increasing threat from the predominance of imported consumption patterns. This trend is illustrated in particular by the decline of the Mediterranean dietary model despite the recognized positive effects on health. The prospective scenario for the expected impacts of trade liberalization, climate change and the lack of efficient rural policies offers a gloomy picture in some southern and eastern Mediterranean countries, with the prospect of aggravated regional imbalances, deeper ecological degradation and persistent or accrued social instability."* (UNEP/MAP, 2005).

One of the most important challenges faced especially by southern and eastern Mediterranean countries is food and nutrition security (FAO, 2011a). The Mediterranean area in general and SEMC in particular are passing through a "nutrition transition" in which malnutrition problems (protein–energy under-nutrition and micronutrient deficiencies) coexist with over-nutrition problems (overweight, obesity), and food-related chronic non-communicable diseases. This nutrition transition is alarming as it has negative impacts not only on health systems but also dramatic economic, social and environmental implications. These interdisciplinary issues are interdependent or related, directly or indirectly, to the sustainability of Mediterranean food consumption patterns especially the decrease of adherence to the traditional Mediterranean diet (WHO, 2010).

Many developing countries are undergoing diet transitions bringing them closer to the diets prevalent in the western countries, i.e. with more energy-dense foods. There follows an increase in the incidence of diet-related non-communicable diseases, which are superimposed on the health problems related to undernutrition that still afflict them. Wider adoption of food consumption patterns akin to those of the Mediterranean diet hold promise of contributing to mitigate adverse effects of diet transitions (Alexandratos, 2006).

Across the Mediterranean region, there is "*unequalitarian drift*" in the current relation between northern Mediterranean countries and southern and eastern ones, where many difficulties are encountered due to the existing economic and social disparities. In fact, the macroeconomic indicators of the Mediterranean region emphasise the marked heterogeneity among the countries and a growing gap between the advanced economies in the northern shores and less developed ones in the southern/eastern ones. Moreover, other social and economic features make a contribution to the considerable development differences between the two Mediterranean shores

(Hervieu and Thibault, 2009): the demographic divide; the densely populated rural areas; the natural resources (soil and water) scarcity; the erosion of the Mediterranean diet model; and the climate change and the loss of biodiversity.

In many Mediterranean countries eating habits are changing following the introduction of Western style dietary patterns. The urbanisation of society, the integration of women into the labour market and retail development are modifying considerably dietary behaviour. Such changes are disrupting the long-established ecological, social and economic equilibriums of the area (Boulier, 2012). The loss of agricultural diversity occurring around the Mediterranean basin is having negative repercussions on the food security and livelihood of populations living in the region. An exacerbation of the genetic erosion of agro-biodiversity due to globalization trends and climate change is reducing the sustainability of local production systems, along with the capacity to safeguard the Mediterranean Diet heritage, based on indigenous food species and varieties (FMFC, 2010).

The Mediterranean agrarian landscape, in its ecological, cultural, social and economic dimensions, is mostly a food-based landscape inextricably linked to the Mediterranean diet. The symbolic value of food and its identification and differentiation has led to the creation of strong links between local food and local heritage and identity, the construction of *cuisines de terroir(s)* and, according to economic values, to local-food production knowledge and skills through the establishment, for example, of systems modelled on geographical indication of provenance (FAO, 2004; 2009). These products of origin-linked quality are strongly connected to the sustainability of the Mediterranean area by contributing to rural development and the preservation of biodiversity (Vasilopoulou *et al*, 2013).

The Mediterranean diet concept has nutritional, economic, environmental and socio-cultural characteristics that make it particularly relevant as a case study for the characterization of sustainable diets in different agro-ecological zones.

In 2010, the inscription of the Mediterranean diet on the UNESCO Representative List of the Intangible Cultural Heritage of Humanity was approved with the following description:

The Mediterranean diet constitutes a set of skills, knowledge, practices and traditions ranging from the landscape to the table, including the crops, harvesting, fishing, conservation, processing, preparation and, particularly, consumption of food. The Mediterranean diet is characterized by a nutritional model that has remained constant over time and space, consisting mainly of olive oil, cereals, fresh or dried fruit and vegetables, a moderate amount of fish, dairy and meat, and many condiments and spices, all accompanied by wine or infusions, always respecting beliefs of each community. However, the Mediterranean diet (from the Greek ***diaita,*** *or way of life) encompasses more than just food. It promotes social interaction, since communal meals are the cornerstone of social customs and festive events* (UNESCO, 2010).

The Mediterranean diet is the alive and evolving result of the millennial history of the Mediterranean (Berry *et al.*, 2011). The Mediterranean diet is transmitted from generation to generation, and it is constantly recreated by communities and groups in response to the change of their environment and their history.

The general term "*Mediterranean diet*" implies a common dietary pattern in Mediterranean countries; however, there are differences in the dietary patterns of the Mediterranean populations (Keys, 1970; Kromhout *et al*, 1989; Trichopoulou and Lagiou, 1997). The Mediterranean diet is characterized by its links to the various food cultures and traditions of the different countries of the Mediterranean area. Mediterranean diets are far from homogeneous; they involve a wealth of typical products and are extremely varied. This "*dietary polymorphism*" partially reflects religious and cultural differences (Manios *et al*, 2006; Berry *et al*, 2011). The most important factors that contributed to this huge diversity of foods and diets in the Mediterranean are:

extremely varied geographical and ecological environments; succession of different dominant peoples (Hebrews, Phoenicians, Greeks, Carthaginians, Romans, Arabs, Byzantines, Ottomans, Spanish, Portuguese, etc.) that introduced and/or diffused different crops and foods throughout the Mediterranean basin.

There is a contrast in food intake patterns between the Northern Mediterranean countries, Balkan countries and Southern Mediterranean countries. Diets in Southern Mediterranean countries are mainly vegetarian as only a small proportion of calories is of animal origin; cereals are the basic ingredient and pulses the main protein source. In Northern Mediterranean countries, food intake has higher animal produce content. Balkan countries have an intermediate diet and intake structure; their diet is richer in animal products than in Southern Mediterranean countries but contains more cereals and pulses than in Northern Mediterranean countries (Padilla, 2008). It is noteworthy that significant dietary differences can be observed even within the same country. In Italy, for instance, the consumption of cereals, fruit and vegetables is higher in the southern part of the country (Lupo, 1997).

The importance of the Mediterranean diet as an example of a sustainable diet lies, not only in its specific foods and nutrients, but also in the methods used to characterize and analyse it and the philosophy of sustainability that is at its core (Burlingame and Dernini, 2011).

The Mediterranean diet has been widely scientifically reported to be a model of healthy eating and a greater adherence to the Mediterranean diet is associated with significant nutrition and health benefits (Willett *et al,* 1995; Nestle, 1995; ITFPCHD, 2000; Serra-Majem *et al*, 2006; Sofi *et al*, 2008; Maillot *et al*, 2011).The health benefits of the Mediterranean Diet and its prophylactic effects against chronic diseases has been well established by the scientific community, since the pioneer *Seven Countries Study*, conducted by Ancel Keys established the association of a traditional Mediterranean dietary pattern with a markedly reduced incidence of coronary heart disease mortality (Keys, 1970, 1980; Keys and Keys, 1975). On the basis of this initial knowledge, scientists constructed dietary scores of adherence to the traditional Mediterranean Diet by indexing positively those beneficial foods which are mostly consumed in traditional Mediterranean diets, and negatively the foods less consumed and more typical of the western industrialized world (Trichopoulou *et al*, 1995; Menotti *et al*, 1999; Sánchez-Villegas *et al*, 2003; Fidanza *et al*, 2004; Serra-Majem *et al*, 2004, 2006; Bach *et al*, 2006; Gerber, 2006; Issa *et al*, 2011). Indeed, numerous more recent studies confirmed that better adherence to the traditional Mediterranean Diet is systematically associated with a markedly reduced risk of cardio-vascular events and mortality (Trichopoulou *et al*, 2003, 2005, 2009; Martínez-González *et al*, 2002, 2009; Estruch *et al*, 2013, 2006; Buckland *et al*, 2008, 2009; de Lorgeril *et al*, 1994; Mendez *et al*, 2006; Panagiotakos *et al*, 2006; Sánchez-Villegas *et al*, 2006; Zazpe *et al*, 2011); with a lower incidence of the metabolic syndrome (Tortosa *et al*, 2007; Babio *et al*, 2009; Kastorini *et al*, 2011;Kesse-Guyot *et al*, 2012) and of type 2 diabetes (Martínez-González *et al*, 2008). The data from a series of case-control studies showed, in general, that high intakes of foods typical of the traditional Mediterranean dietary pattern – i.e. fruit, vegetables, whole grains, olive oil and fish – were associated with a reduced risk of developing various types of cancers (La Vecchia, 2004; Bosetti *et al*, 2009; Vernele *et al*, 2010).

In 2005, “the Rome Call for a Common Action on Food in the Mediterranean” (FMFC, 2005), further re-activated the process of interdisciplinary dialogue started in 2002 by the Forum on Mediterranean Food Cultures, CIHEAM MAI-Bari, Mediterranean Diet Foundation and Sapienza University of Rome, among the international Mediterranean diet scientific community for a consensus position on a redefinition of the Mediterranean diet (Serra-Majem *et al*, 2004a). This process continued in 2009, at the 3rd International CIISCAM Conference, held in Parma, Italy, where a consensus position was reached on a new revised, updated and unpatented Mediterranean diet pyramid as well as on the Mediterranean diet as an example of a sustainable diet (CIISCAM, 2009). In 2010, this new Mediterranean diet pyramid was further developed at the

8th International Congress on the Mediterranean diet, held in Barcelona, Spain (Bach-Faig *et al*, 2011; Dernini *et al,* 2012).

The new revised Mediterranean Diet pyramid was conceived as a simplified main frame in order to be adapted to the different country specific variations related to the various geographical, socio-economic and cultural contexts of the contemporary Mediterranean lifestyle. To counteract the current dramatic decline of the healthy traditional Mediterranean diet pattern all around the Mediterranean area, it was aimed at better popularizing its applicability for present daily lifestyle, without leaving out the different cultural and religious traditions and different national identities present in the Mediterranean area. The concept of frugality and moderation was emphasized because of the major public health challenge of obesity.

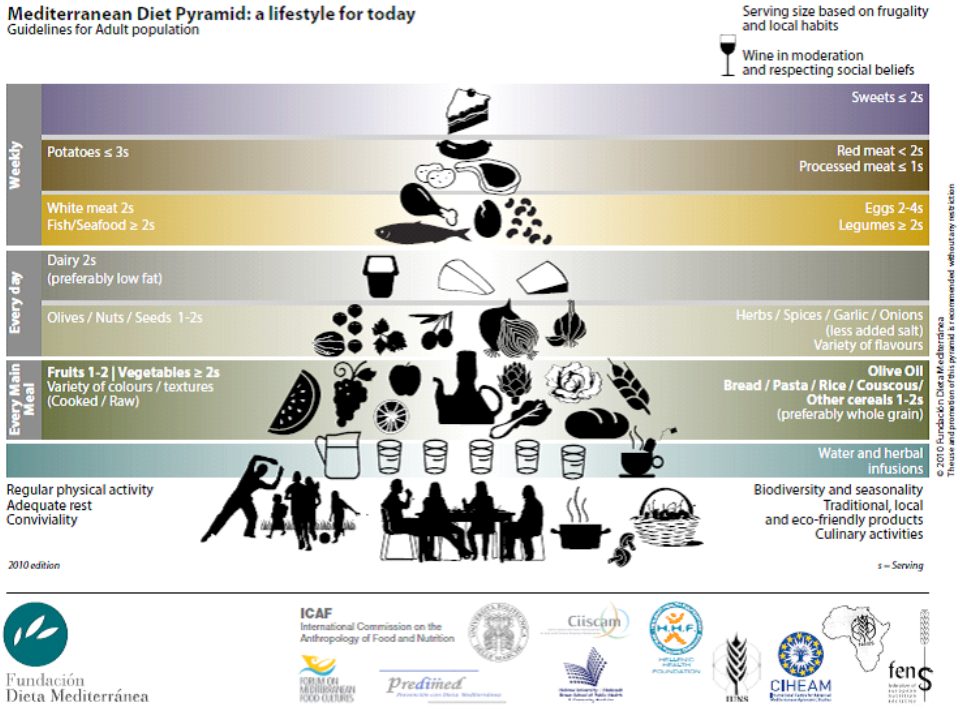


Figure 1. The new Mediterranean diet pyramid (Source: Bach-Faig *et al*, 2011).

This new revised Mediterranean diet was presented as an example of a sustainable diet, in which nutrition, local food productions, biodiversity, culture and sustainability are strongly connected together, with a lower impact on the environment. The concepts of seasonality, fresh and locally grown products, culinary activities, biodiversity, traditional, local and eco-friendly products, of variety of colours for fruits and vegetables were introduced together with main meals, conviviality and physical activity. Main foods included in the common food basket are: an abundance of olive oil and olives, fruits, vegetables, cereals (mostly unrefined), legumes, nuts and fish, moderate amounts of dairy products (preferably cheese and yoghurt) and low quantities of meat and meat products. Wine in moderation was considered acceptable when it was not contradictory to religious or social norms.

The Mediterranean diet, through its new revised pyramidal representation (Bach-Faig *et al,* 2011), shows that it not only offers considerable health benefits but also respects the environment. In fact, the various represented food groups in the pyramid can also be evaluated in terms of their environmental impact.

But despite the well-documented health and environmental benefits of the Mediterranean diet, current data show a decline in adherence in Northern, Southern and Eastern Mediterranean countries (IOTF, 2005; Garcia-Closas *et al*, 2006; Belahsen and Rguibi, 2006; da Silva *et al*, 2009; Vareiro *et al*, 2009; León-Muñoz *et al*, 2012). The evolution of food consumption in the Mediterranean countries is not encouraging, as these countries have followed the trend towards higher proportions of energy-dense foods (Alexandratos, 2006).

Paradoxically, just as the Mediterranean diet is becoming more popular in the world and increasingly recognised by the international scientific community, the Mediterranean populations are moving further and further away from this dietary model (Lacirignola and Capone, 2009).

III – Analysis of problems and assessment indicators

The main health, nutrition, economic, cultural, social, environmental issues related, directly or indirectly, to the ongoing nutrition transition and decrease in adherence to the Mediterranean dietary patterns – two parallel processes that are undermining the very bases of food and nutrition security - in Mediterranean countries in general, and SEMC in particular, are briefly discussed hereafter. A preliminary list of indicators for assessing the sustainability of the current Mediterranean food consumption patterns and transition towards more sustainable food systems is also proposed as a basis for further discussion.

1. Problem analysis

Recent trends and projections in the Mediterranean area (UNEP/MAP/Plan Bleu, 2011, 2010, 2008, 2006; Plan Bleu, 2012; FAO, 2012a; UNEP/MAP, 2005) were analysed to identify priority challenges to be addressed for improving the sustainability of the diets and food consumption patterns in the Mediterranean area.

A. Nutrition and health: malnutrition and decline of the adherence to the Mediterranean diet pattern

The Mediterranean area could be described as passing through a “nutritional transition” in which problems of under-nutrition coexist with overweight, obesity and food-related chronic diseases. Comparative regional data are shown in the Global Nutritional Index (Rosenbloom *et al*, 2008).

Under-nutrition is still significant in the South of the Mediterranean: 9.2 million people in 2001-03, 3.9% of the population of the zone, compared with 7.3 million people in 1990-92, 3.8% of the population (CIHEAM, 2008). Data referring to 2008 show that the rates of stunting amongst children under five years of age is also very high in many Southern and Eastern Mediterranean countries: 26.3% in Albania, 14.9% in Algeria, 10.5% in Bosnia and Herzegovina, 1.0% in Croatia, 28.9% in Egypt, 12.0% in Jordan, 10.8% in Lebanon, 20.7% in Libya, 22.5% in Morocco, 10.2% in Palestine, 0.5% in Serbia, 27.7% in Syria, 6.2% in Tunisia (UNICEF, 2012), and 10.3% in Turkey (Hacettepe University, 2009; UNICEF, 2012).

According to WHO, overweight and obesity rates in Mediterranean countries continue to rise. Currently reported rates for overweight and obesity are as follows: 54.4 and 21.3% in Albania; 45.5 and 16.0% in Algeria; 67.9 and 33.1% in Egypt; 50.7 and 18.2% in France; 53.7 and 20.1% in Greece; 54.1 and 19.8% in Italy; 61.8 and 27.4% in Lebanon; 64.3 and 28.8% in Malta; 46.8

and 16.4% in Morocco; 59.1 and 24.0% in Portugal; 62.0 and 26.6% in Spain; 53.7 and 22.3% in Tunisia; and 61.9 and 27.8% in Turkey (WHO, 2011).

Recent surveys are pointing out that many countries in the Mediterranean area are drifting away from the Mediterranean diet healthy patternandcurrent Mediterranean food consumption patterns show a decline in their adherence to the traditional Mediterranean diet (IOTF, 2005; Garcia-Closas *et al*, 2006; Belahsen and Rguibi, 2006; da Silva *et al*, 2009; Vareiro *et al*, 2009; León-Muñoz *et al*, 2012). In the decline of the adherence to the MD, there are two major concerns: an increase in the consumption of saturated lipids (*e.g.* meat, dairy products, etc.) and sugar, and a decrease in the consumption of complex carbohydrates (e.g. cereals and legumes). A recent study clearly showed that the easiest way to reach all nutrient recommendations was to select more Mediterranean-type food (Maillot *et al,* 2011).

In the Southern Mediterranean countries, populations are suffering from under-nutrition as well as chronic nutrition-related diseases, which are increasingly leading to disabilities and death. The data reported on this region show that there is a shift in dietary habits from a traditional Mediterranean Diet to industrial food, which could explain, in part, the nutritional and metabolic disorders reported in the region's population. Unhealthy eating practices in the Southern Mediterranean countries include high consumption of saturated fats and refined carbohydrates, low consumption of fibre, and sedentary behaviours (Belahsen and Rguibi, 2006).

In the Northern Mediterranean countries, there is a growing trend of obesity and over-weight with increased chronic nutrition-related diseases. There are three trends which can be identified here: 1)a tremendous increase in the consumption of lipids, which is explained by the higher consumption of animal fats (dairy products and meat consumption increasing as income rise), but even more by the consumption of vegetable oils used for cooking and seasoning or included in various industrial foodstuffs; 2)an increase in the consumption of simple carbohydrates, connected in particular with the consumption of beverages and foodstuffs with a high carbohydrate content, and a simultaneous decrease in the consumption of starches (bread consumption has dropped by half in the last 50 years in France, and potato consumption has dropped by two-thirds over the same period); and 3) a change in the total protein content, where the share of animal proteins is increasing to the detriment of vegetable proteins (Padilla, 2008).

The Mediterranean diet is inextricably linked to biodiversity. Indeed, biodiversity plays a key role in ensuring dietary diversity as nutrient composition between foods and among varieties/cultivars/breeds of the *same* food can differ dramatically. In order to guarantee that local Mediterranean diets are healthy, and that the average levels of nutrient intake is adequate, it is important that the biodiversity level is kept high. Mediterranean local food biodiversity has received relatively little attention concerning its nutritional value in the scientific literature, especially on nutraceuticals from plant species, with potential health benefit effects, traditionally used in rural communities (Heinrich *et al*, 2006).

B. Economy: population growth, urbanization, food prices, food waste

Population growth in the Mediterranean Basin is marked by a widening gap between the northern and southern shores: in the North, the growth rate is levelling off and the population is ageing, whereas the population in the South is increasing rapidly and steadily. Between 1990 and 2010, the Mediterranean population has grown at an average annual rate of 1.16 %, from 374 million to 473 million inhabitants. Today, 25% of the Mediterranean population is under 15 years of age and 25% of the 15 to 24-year olds are unemployed. As demonstrated in the recent events of the Arab spring, the construction of a sustainable future for the Mediterranean's young population is one of tomorrow's major challenges (Plan Bleu, 2012).

For the Mediterranean area, the globalisation of the economic field is introducing changes in the distribution and availability of food products (imports, commercial innovation, and transformation

of retail sales). At the same time changes in lifestyles and food habits are being introduced as a result of this transition from tradition to modernity (Florensa and Aragall, 2012).

The urbanization of society, the integration of women into the labour market and retail development are deeply modifying Mediterranean dietary and lifestyle patterns. New forms of distribution and sales are increasing the availability of certain food products leading to a loss of the Mediterranean food structure in northern countries and notable food imbalances in southern countries (Florensa and Aragall, 2012).

Within the globalization process, the pressure from the agro-food market has changed the production methods, i.e. forced the abandonment of some crops, long established livestock farming techniques and traditional crafts. It has imposed new networks and sales systems, and modified consumption habits. This impact entails loss in the knowledge and practices that have contributed historically to the identity of the Mediterranean peoples, and have built a rich and complex food universe in the Mediterranean area (González Turmo, 2012). Recently, the overall perspective of this "most vibrant theatre of human interaction in history" has been well described by Abulafia (2012).

Ancient vineyards, orchards and olive groves have been uprooted to make way for large scale fruit or olive plantations and mixed rotational farming has been replaced by intensive monocultures. This has not only caused the loss of wildlife-rich habitats but has also had a major socio-economic impact on large parts of the region as many small-scale farmers have been forced to abandon their land to go and search for jobs elsewhere (Padilla *et al*, 2012).

Price volatility has a strong impact on the poor and on food importing countries, especially where diets are less diversified. It also risks modifying diets, especially of the poorest as they tend to shift to cheaper, less preferred, and often poorer quality foods (HLPE, 2011).

The distribution of food losses and waste along the food chain vary between regions. Relatively speaking, losses in the first part of the food chain, which are due to poor harvesting techniques, lack of transport and poor storage in combination with climate conditions, are more important in developing countries (Lundqvist *et al*, 2008), where 40% of food losses occur at the post-harvest and processing level while in industrialised countries more than 40% of the losses occur at the retail and consumer level, i.e.food is wasted (FAO, 2011b). A study carried out in 2005 to estimate household food waste - using a sample of 500 households in Ankara (Turkey) - showed that waste accounted, on average, for 9.8% of the daily energy intake per person i.e. 215.7 kcal/person (Pekcan *et al*, 2006).

Reducing in the entire Mediterranean area the amount of food lost or wasted throughout the food chain (i.e. from farm to fork) would help improve food security and nutrition. Furthermore, reducing food losses and waste will also ease pressure on water scarcity. To do so, it is crucial to address losses all along the food chain and alert consumers to the environmental impacts of their diets and the negative effects of wasting food.

C. Environment: water scarcity, climate change and biodiversity loss

Water scarcity is the most critical development problem in the Mediterranean area and the single most important factor in limiting agricultural growth. Water availability in the region has been declining steadily since the late 1950s. Water resources in the Mediterranean region, according to Plan Bleu, are limited, fragile and unevenly distributed (UNEP/MAP/ Plan Bleu, 2008).

The most critical situation is recorded in the Middle East and North Africa (MENA). Water demand has doubled during the second half of the 20th century to reach 280 billion m3 per year for all riparian countries in 2005. Agriculture is the main water-consuming sector and accounts for 64% of total water demand: 45% in the North and 82% in South and East. According to the projections of the Blue Plan baseline scenario, *water demand is increasingly met by an unsustainable water*

production (UNEP/MAP/ Plan Bleu, 2008). Thus, improving the water demand management, water saving, rational water use, and, in some cases, reuse of waste water, even desalination projects to increase water availability especially for agriculture, is of paramount importance for sustainability in the Mediterranean area.

According to the 4th IPCC report (IPCC, 2007), the Mediterranean is one of the major regions of the world where global warming will threaten environment and human activities (UNEP/MAP/ Plan Bleu, 2008).Climate change is likely to affect agriculture and food security in the Region primarily through changes in temperature, precipitation, extreme climatic events and sea level rise (Skuras and Psaltopoulos, 2012). Climate change may result in such adverse effects as further deterioration of water scarcity, land degradation, crop failures, loss of rangeland and other vegetation covers, livestock deaths, and fisheries production and quality decline. Desertification is also a major threat to productivity in the South-Eastern Mediterranean countries. People in the dry areas mainly depend on agriculture and exploitation of natural resources for their livelihood and are hard hit by desertification. Of the 243 million hectares of agricultural land resources in the Mediterranean region 63% are located on the southern shores but only 39% are deemed to be arable land. This acreage is decreasing under the pressure of urbanisation and the rapid development of tourism, and soil quality is deteriorating due to the erosion from wind and rainfall, and the intensive use of irrigation (risks of salinization).

The Mediterranean basin is a major centre of plant diversity (Heywood, 1998), one of the eight centres of cultivated plant origin and diversity, with over 80 crops listed (Vavilov, 1951). The Mediterranean basin Biodiversity Hotspot is the second largest hotspot in the world. The rich biodiversity of the Mediterranean terrestrial and marine flora and fauna, including many endemic species, is currently threatened by standardization of cultivation practices, monoculture, chemicals contamination, over exploitation of natural resources, mechanization, and changes in life styles that are affecting traditional production systems across the Mediterranean area and have reduced the spectrum of the biodiversity, particularly relevant in preparing healthy and nutritious food recipes at the foundation of the Mediterranean diet heritage.

Changes in the landscape and ecosystems have increased in recent decades, especially in the Mediterranean. The main pressure on these ecosystems and their biodiversity come from tourism, urban development in coastal areas, over fishing, intensive farming and irrigation, and the abandonment of traditional agricultural practices (Numa and Troya, 2011).

Furthermore, indigenous knowledge on how to recognize, cultivate and use these local crops is also being lost at unprecedented rate. The genetic diversity of food crops and animal breeds is diminishing rapidly. In fact, at the beginning of the 21stcentury it is estimated that only 10% of the variety of crops that have been cultivated in the past are still being farmed, many local varieties being replaced by a small number of improved non-native varieties (Millstone and Lang, 2008).

The disappearance of ecological corridors and the homogenization of the natural mosaics are also threatening the survival and the reproduction of numerous wild species, many of direct economic importance (Zurayk, 2012). Environmental pressure is rising, particularly as a result of tourism, urban concentration in coastal areas, the development of intensive agriculture, the overexploitation of natural resources, overgrazing and the abandonment of traditional agricultural practices. Some effects of these pressures, such as changes in vegetation cover and habitat loss, can be estimated, but others are very difficult to quantify. About 18 percent of Mediterranean species are threatened with extinction, and it is estimated that only 5 percent of the original vegetation remains relatively intact in the Mediterranean region (FAO, 2013). The loss of agricultural diversity occurring around the Mediterranean area could threaten the food security and livelihood of populations living in the region.

Many scientific assessments have sounded the alert about the negative impacts of a thirty-year-old trend of the generalised exploitation of demersal stock that generated a gradual decline of

fish resources and catches in the Mediterranean (Plan Bleu, 2012). For instance, there is over fishing of ground fish some 50% of which are being exploited beyond the limits of biological safety leading to dire consequences for stock survival. According to the latest evaluations carried out by the General Fisheries Commission for the Mediterranean (GFCM), while exploitation is moderate in the case of small pelagic species, large pelagic, and in particular the blue-fin tuna, are in a critical situation. The stock of blue-fin tuna spawning adults is facing a serious risk of depletion. Swordfish are also threatened because of over capture of their young (Plan Bleu, 2012).

D. Society and culture: homogenization of lifestyles and erosion of the Mediterranean diet cultural heritage

Food plays a central role in social and cultural life in the Mediterranean area.Itis deeply influenced by the evolution of traditional values towards post-modern values as well as by the globalised production system.

Changes in intergenerational relations and gender relations, the role of women in society and interrelations with the rest of the world (tourism and migrations) are having importanteffects on Mediterranean lifestyles,including westernization of food consumption patterns in the Mediterranean area.These changes are influenced to a large extent by: urbanization, organization of working time, growing participation of women in economic life, fewer household members, fewer generations living together, desocialization, collective environment (Padilla, 2008, Berry and De Geest 2012). With the spread of compulsory schooling the collective environment is gradually replacing the traditional family group, and this is happening at an increasingly early stage in people's lives. Young people's tastes are now formed to a large extent outside the family, in places where food is simplified and industrialized and rarely reflects Mediterranean traditions.

The population in the South is mainly young. By 2020, 36% of the population in the South will be under 20 years of age compared to 20% in the North. Young people who are going through the phase of a break between generations ("adolescent revolt") are more open to media influences and fashion trends, and cultivate a certain degree of ambiguity between modern food which has a social identity appeal and traditional food (Padilla, 2008).

For all these reasons, the Mediterranean diet pattern is presently in decline among consumers because of standardization of lifestyles, loss of awareness and appreciation, particularly among younger generations, about their own cultural food heritage.

Despite its increasing popularity worldwide, the Mediterranean diet, inscribed by UNESCO, in 2010, in the Representative List of Intangible Cultural Heritage of Humanity, is today endangered in all countries of the Mediterranean area. The abandonment of traditional healthy habits and the emergence of new lifestyles associated with socioeconomic changes pose important threats to the preservation and transmission of the Mediterranean diet to future generations (Dernini, 2011). The inscription of the Mediterranean Diet in the Intangible Cultural Heritage List of UNESCO has put on the sustainability agenda, as a safeguarding measure, the utmost critical need of the inventory of this "intangible heritage".This inventory is both a complex process and indispensable tool in order to evaluate and decide what, and how, the intangible cultural heritage of the Mediterranean diet should be protected and transmitted (Reguant-Aleix and Sensat, 2012). However, there is at the present moment, three years later of the Declaration, a big deficit, especially in the government and public policies level, to act practically in relation to safeguarding the Mediterranean Diet. A real work of this nature is still urgent (González Turmo & Medina, 2012).

2. Assessment indicators

In the context of sustainable consumption and production (SCP), indicators can also show whether a society's consumption and production patterns lead to more socially equitable and environmentally sustainable development. In that regard, indicators of SCP are inextricably linked

to broader sets of indicators on environment and sustainable development, including poverty reduction (UNEP, 2008).

A number of international organisations and some governments have developed sets of indicators for SCP, mostly as part of wider ranging indicator sets for sustainable development (SD) but also as part, or in support of, dedicated SCP strategies (Watson *et al*, 2010). International organisations involved in the development of SCP Indicators and Indicator sets include the UNCSD, its Secretariat in UNDESA and the OECD. More recently UNEP has been involved in providing guidance for developing countries in developing SCP action plans including a model SCP indicator framework for use by these countries (UNEP, 2008). The EU Sustainable Development Strategy required Eurostat to develop a set of Sustainable Development Indicators (SDI) and review and update this every two years.

According to the International Institute for Sustainable Development "*an indicator quantifies and simplifies phenomena and helps us understand complex realities* (IISD, 1997). According to theOrganization for Economic Cooperation and Development**,** an indicator is "*a parameter, or a value derived from parameters, which points to, provides information about, or describes the state of a phenomenon/environment/area, with a significance extending beyond that directly associated with its value*" (OECD, 2003).

According to FAO, *an indicator is not only the data on which it is based; it generally comprises elements (a cut-off value, a frame of reference, a mode of expression, etc.) which allow a relatively universal appreciation of the information it supplies and also facilitate comparison in time and space* (FAO, 2005)**.**

A. Criteria for selecting indicators

To select the most effective indicators, the following criteria were considered (Watson *et al,* 2010):

1. *Relevant to the question being asked.* The indicator should be the best indicator currently available to answer the question;
2. *Understandablei.e.* clear, simple and unambiguous;
3. *Graphically representable;*
4. *Readily interpretablei.e.* clear which direction the indicator should develop to lead to greater sustainability;
5. *Relevant* in most EEA Member and collaborating countries *i.e.* not restricted to an issue which is limited to a few member countries;
6. *Monitorablei.e.* based on data that is readily available in member and collaborating countries, or could be made available at reasonable cost-benefit ratio and with regularity within the time frame of a policy cycle (i.e. updated each year and with maximum four year time delay);
7. *Reliable and consistenti.e.* data collection and analysis methodologies should preferably be consistent from country to country and at the very least be consistent within a given country from year to year;
8. *Representativei.e.* can be taken to represent current SCP trends within a given sector, final consumption cluster etc.

From a literature review (Maclaren, 1996) on social, environmental, health and sustainability indicators, the following criteria, commonly used in the process of selecting indicators, were also considered:

– Scientifically valid;
– Representative of a broad range of conditions;
– Responsive to change;
– Relevant to the needs of potential users;
– Based on accurate accessible data;
– Based on data that are available over time;
– Understandable by potential users;
– Comparable with indicators developed in other jurisdictions;
– Cost-effective to collect;
– Attractive to the media; and
– Unambiguous.

In the identification process of the indicators considered relevant, as descriptive of the major issues related to the assessment of the Mediterranean diet's sustainability, the Bellagio sustainability assessment and measurement principles were also taken in consideration (IISD/ OECD, 2009). In the identification process of the MD sustainability indicators, was also taken into account the set of indicators provided by the UK department for environment, food and rural affairs for enabling and encouraging people to eat a healthy, sustainable diet (DEFRA, 2009). Were also taken in consideration the sustainable development indicators used to monitor the EU sustainable development strategy (Eurostat, 2011).

B. Potentialindicators

An initial set of indicators to assess the sustainability of the Mediterranean diets was identified at the CIHEAM International Workshop held in 2011 in Bari (table 1).

Table. 1. Potential indicators for assessing the sustainability of the Mediterranean diet, CIHEAM-Bari 2011.

	Pressure/ impact indicators	
Thematic areas	**Production**	**Consumption**
Environment and natural resources (including agro-biodiversity)	- Water footprint - Carbon footprint - Ecological footprint - Energy efficiency	
	- Rate of biodiversity erosion - Share of land under organic agriculture - Share of land under sustainable management - Use of agro-chemicals (pesticides, fertilizers) - Number of CDO, PDO, PGI (food quality labels) - Resilience capacity of production systems - Change in arable land area - Change in aquatic resources - Share of area dedicated to urban and periurban agriculture. - Organic matter content (soil fertility) - Level of food processing - Carrying capacity - Number and acreage (ha) of GMO varieties	- Share of organic and eco-friendly food consumption - Food biodiversity consumption
Economy	- Degree of self-sufficiency (trade balance) - Regional (sub-national) income - Employment - Availability of total supply (products from Mediterranean crops) - Volatility of prices and yields - Fair price /trade	
	- Land price - Economic impact of organic agriculture - Diversification of food production - Number/capacity of farm structures - Number of SME in agro-food	- Food expenditure/weekly or monthly income - Share of home food consumption on total consumption - Cost of obesity and non-communicable diseases (NCDs)

Society & Culture	- Number of traditional products still in use - Number of direct sale outlets and farmer markets - Social Life Cycle Analysis (LCA) index - Gender empowerment - Level of transmission of traditional knowledge to new generations - Number of socio-cultural events on Mediterranean food cultures - Number of training sessions related to Mediterranean food cultures - Number of gastronomic tourism itineraries	
	- Degree of multifunctionality of agriculture - Level of salary of farm workers	- Consumer perception and attitude towards MD - Number of consumer organizations - Level of active involvement of the young in MD promotion
Nutrition, health and lifestyle	- Share of diets that is locally produced - Household food security - Prevalence of obesity and non-communicable diseases - Level of physical activity - Burden of nutrition-related diseases	
	- Biodiversity and food composition. - Nutrient profile of foods - Food energy density - Level of food processing in the diet	- Mediterranean diet adherence scores and new Mediterranean diet pyramid - Number of young people adhering to the Mediterranean diet/ food consumption pattern- Level of consumption of traditional foods and dishes - Share of eco-friendly and organic food consumption - Biodiversity in food consumption - Dietary diversity score (food choice) - Ratio fresh/ processed foods - Nutrient adequacy scores - Diet energy density - Nutritional anthropometry - Biochemical measurements of nutritional status - Adequate diet affordability - Frugality - Time spent on food preparation - Time for rest/ sleep - Number of meals consumed with family (conviviality)

Then, through a series of meetings jointly conducted by CIHEAM MAI-Bari and FAO held from January to June 2012, and through an online brainstorming process, held from June to September 2012, a second set of MD sustainability indicators, still under discussion, was identified together with a first outline of a methodology:

A. Nutrition and health indicators

A1. Diet-related morbidity/mortality statistics
A2. Fruit and vegetable consumption/intakes
A3. Vegetable/animal protein consumption ratios
A4. Dietary energy supply/intakes
A5. Dietary diversity score
A6. Dietary energy density score
A7. Nutrient density/quality score
A8. Food biodiversity composition and consumption
A9. Nutritional Anthropometry
A10. Physical activity/Physical inactivity prevalence

B. Environmental indicators

B1. Water footprint
B2. Carbon footprint
B3. Nitrogen footprint
B4. Biodiversity (to be determined)

C. Economic indicators

C1. Food consumer price index (FCPI): cereals, fruit, vegetables, fish and meat
C2. Cost of living index (COLI) related to food expenditures: cereals, fruit, vegetables, fish and meat
C3. Distribution of household expenditure groups: Food
C4. Food self-sufficiency: cereals, fruit, vegetables
C5. Intermediate consumption in the agricultural sector: nitrogen fertilizers
C6. Food losses and waste (to be determined)

D. Socio-cultural indicators

D1. Collective participation, cohesion, conviviality and commensality: Proportion of meals consumed outside home.
D2. Involvement of consumer in the preparation of food: Proportion of already prepared meals.
D3. Traditional diets relevance: Consumption of traditional products (e.g. Proportion of product under PDO (Protected Designation of Origin) or similar recognized traditional food.
D4. Transmission of knowledge: Mass media activities and products dedicated to traditional food. Proportion of mass media initiatives dedicated to the knowledge of food background cultural value.

IV – Conceptual framework

In the FAO regional priority framework for the Near East it was pointed out that "*with limited and fragile natural resources, high population growth and an increasing demand for food, the Near East Region is structurally unable to feed itself. In addition, both the prevalence of high poverty rates in some countries and inadequate food consumption patterns are major causes of food insecurity and malnutrition. The Region has wealthy but food-deficient countries as well as poor countries with higher levels of food production, which make the food security challenges of this region somewhat unique. The key objectives of this priority area are to achieve a reduction in hunger and malnutrition in the Region in line with the targets of the World Food Summit (WFS) and the Millennium Development Goals (MDGs) through support of regional and national food security initiatives* (FAO, 2012d).

In some Southern and Eastern Mediterranean countries, the civil and political unrest or revolutions have shown the vulnerability of these countries in terms of food security andthe limits of sectoral approaches used in the past to manage interdependent issues connected to food security (Hassan-Wassef, 2012).

By taking in consideration the UN-HLTF comprehensive framework for action on food and nutrition security, an approach for tackling food and nutrition security in the Mediterranean area should require: (i) taking into account the interconnectedness and interactions between the food and nutrition security dimensions – availability, access, utilization and stability; (ii) addressing the full spectrum of food and nutrition security, including food production, procurement and distribution of food, and safety-net strengthening;; (iii) integrating cross-cutting issues - such as gender equity, ecosystems and natural resources management, and climate change mitigation and adaptation - into law, policy andprogramme design;; and (iv) ensuring multi-sectoral engagement and coordination on agriculture, social security, trade and market, employment, health, education, nutrition, and humanitarian assistanceInpractice, adopting a comprehensive approach calls for maximum synergy and coordination among allcomponents of food and nutrition security and the sectors which influence them(UN-HLTF, 2011).

Achieving food and nutrition security involves (a) ensuring consistent availability and accessibility of sustainably-produced, nutritious and safe food; and (b) reducing and/or eliminating losses and waste in food production, processing and consumption. Food production and availability should be increased in ways that are environmentally, socially and economically sustainable (UN-HLTF, 2012).

Considering that in the Mediterranean region (i) present food production and processing, food supply and distribution, and food consumption systems are not sustainable due to biodiversity loss, natural resources degradation, climate change, high energy input for food production and consumption as well as poverty; (ii) present vulnerability of many Mediterranean rural communities, and particularly (iii), Mediterranean diet erosion and increasing consumer behaviours towards over consumption. For all these reasons, urgent measures are needed in Mediterranean countries to promote sustainable food consumption patterns and to enhance better adherence to the Mediterranean diet as a sustainable diet model.

Increased adherence to the Mediterranean dietary pattern among the Mediterranean populations, together with a reduction of food losses and waste, can contribute to the improvement of food security and nutrition in the Mediterranean region in general, and SEMC in particular, by improving the sustainability of Mediterranean food consumption and local production patterns, Moreover, the promotion of seasonality and local products would also reduce food miles with a reduction of emissions due to distribution and transportation.

This increased adherence to the Mediterranean diet will improve dietary diversity and plant-based foods consumption, with lower greenhouse gas emissions. It will contribute to reducing

biodiversity loss and consumption of animal-based food (meat, dairy products) and the use of natural resources, especially water, thus increasing food production, and effectively contributing to climate change mitigation. It is particularly important to take into consideration the fact that water resources are becoming very scarce in the Mediterranean region.

V – Research needs

The challenge of feeding the growing world population requires strategies and multicultural and multisectorial rethinking capable of generating new forms of dialogue, at different specialist levels, such as the ecological public health nutrition's approach (Rayner and Lang, 2012), towards a more sustainable use of the available natural and human resources, to ensure food and nutrition security as well as the sustainability of the food systems. In addition to highlighting the importance of access to food, the more holistic concept that recent definitions of food security leads to identify a wide range of research challenges, from food production to food consumption, spanning the humanities and social and economic sciences (Pálsson *et al*, 2011), as well as nutritional and environmental sciences.

In the Mediterranean region, research has historically concentrated on agronomy and its associated sciences asmost of food comes from crops, although livestock and fisheries also received considerable attention. However, research which considers multiple aspects of food security and food systems is needed. While research on producing food has allowed remarkable gains to be made, the dominance of these research fields has overshadowed many other important aspects of research related to the entire food system.

Food systems, and analyses of food security they underpin, provide a rich ground for research. While there is a long list of research questions in agricultural science, there is a major need to extend the research agenda in non-agricultural aspects. Technical fixes alone will not address the food security challenges, and adapting to future demands and stresses requires an integrated food system approach, not just a focus on agricultural practices (Ingram, 2011). According to Goodman (1997), "*Food systems represent all processes involved in feeding a population, and include the input required and output generated at each step. A food system operates within, and is influenced by, the social, political, economic and environmental context*".

Globalization, industrial development, population increase and urbanization have changed food production and consumption in ways that profoundly affect ecosystems and human diets. The trends are alarming, highlighting the inadequacy of the present food supply and dietary patterns. Considering that (i) present food production and processing, food supply and distribution, and food consumption systems are not sustainable due to biodiversity loss, natural resources degradation, climate change, high energy input as well as poverty; (ii) present vulnerability of many Mediterranean rural communities, and particularly (iii), Mediterranean diet erosion and an increasing consumer behaviour towards of overconsumption; urgent measures are needed to promote adherence to the Mediterranean diet as a sustainable dietary pattern in Mediterranean countries.

Many people in the Mediterranean region are still food insecure, despite world-wide production currently being, in aggregate terms, sufficient for all.

Research which considers multiple aspects of food security and food systems is needed, with particular regard also to assessing the environmental, economic, social, cultural, health and nutritional sustainability of the current food consumption patterns and diets as drivers of food production.

Cross-sectorial and interdisciplinary research on food consumption in the Mediterranean region should lead also to innovative intersectoral efforts to reverse the degradation of ecosystems,

prevent further loss of biodiversity and redress the excesses and imbalances of diets through the improvement of sustainable dietary patterns culturally accepted in the Mediterranean region.

The improvement of the sustainability of the food consumption patterns requires attention to food loss and waste as a critical priority for food and nutrition security in the entire Mediterranean region. It is assumed that an increased adherence to the Mediterranean dietary pattern, including a reduction of food losses and waste, can contribute to the improvement of food and nutrition security in the Mediterranean region in general and southern and eastern Mediterranean countries (SEMC) in particular, by improving the sustainability of Mediterranean food consumption and production patterns.

All in all, the main priority research themes regard: diet-related health implications, food- and agricultural production-related environmental footprints, food cultures and sociology, and foodlosses and waste.

1. Nutrition and health implications of the current food system

One of the most important challenges faced especially by southern and eastern Mediterranean countries is food and nutrition security (FAO, 2011a). The Mediterranean area in general and SEMC in particular are passing through a "nutrition transition" in which malnutrition problems (protein–energy, under-nutrition and micronutrient deficiencies) coexist with over-nutrition problems (overweight, obesity), and diet-related chronic diseases. This nutrition transition is alarming as it has negative impacts not only on health systems but also dramatic economic, social and environmental implications. Theseissues are interdependent or related, directly or indirectly, to the sustainability of Mediterranean food consumption patterns especially the decrease of adherence to the traditional Mediterranean diet (WHO, 2010). Therefore, multidisciplinary research is urgently needed to help understand andcounteract this "nutrition transition".

Nutrition transition occurs in conjunction with epidemiological transition towards non communicable diseasesand has serious implications in terms of public health, economic growth and nutrition policy. Nutrition transition is malnutrition ensuing not from a need for food, but the need for high quality nourishment. Foods rich in vitamins, minerals and micronutrients, such as fruit, vegetables and whole grains, have been substituted by foods heavy in added sugar, saturated fat and sodium (WHO, 2010). Food systems that promote increased food intake and non-healthful foods, together with physical inactivity, lead to "*obesogenic societies*" (Kickbusch, 2010). In fact, the nutrition transition is associated with an increase in overnutrition and obesity. It also appears to bear a causal relationship to the disease burden and mortality transition referred to as the "epidemiological transition" (Omran, 1971; FAO, WFP and IFAD; 2012).

The prevalence of overweight and obesity has reached alarming rates in the region (Hossain *et al.*, 2007; Sibai *et al.*, 2003; Jabre *et al.*, 2005; Chakar and Salameh, 2006). According to WHO (2011), overweight and obesity rates in Mediterranean countries are high and continue to rise.

The inadequate dietary intake is the immediate factor causing undernutrition that is increasing in many countries of the Eastern Mediterranean region (including North Africa and the Near East) Therefore, undernutrition remains a major health problem in the Eastern and Southern Mediterranean with consequences that are too grave to be ignored (WHO, 2010).

The development of guidelines for the study of the Mediterranean diet as a sustainable diet model can contribute to enhance more adherences to the Mediterranean diet and clarify what is required for an environmentally sustainable food system and for more eco-friendly food based dietary guidelines.

An increased adherence to the Mediterranean dietary pattern among the Mediterranean population can contribute to improve food and nutrition security in terms of food availability, food access and food utilisation. Increased adherence to the Mediterranean diet, characterised by a high

consumption of plant-based foods (cereals, fruit, vegetables) and lower consumption of animal-based food (meat, dairy products), can increase the efficiency of the use of natural resources especially water thus increasing food production.

Taking into consideration the above-mentioned the research topics regarding this theme include the following:

- Relationship between Mediterranean diets and non-communicable diseases (*e.g.* obesity/ overweight).
- Nutrition transition and related health problems (*e.g.* obesity, malnutrition).
- Role of nutrition, food safety and lifestyle factors in non-communicable diseases development and prevention.
- Beneficial health and nutrition benefits of typical and local Mediterranean products.
- Characterization of functional and nutritional properties of Mediterranean food products.
- Characterizing the current food consumption patterns in the Mediterranean countries.
- Mediterranean eating patterns and diets diversity.
- Observation, analysis and understanding of the evolution of food behaviours and their determinants.
- Development of interdisciplinary studies on ecological public health and nutrition

2. Economics of the Mediterranean food system

For most people a key factor determining access to food is its affordability. This is dependent not only on food cost but also on the disposable income that can be spent on food. Access is also determined by the way society allocates food to its members and food preferences (Ingram, 2011).

The problem of hunger has been accentuated by high food prices and their volatility. In low income countries, food consumption expenditures typically account for 50% or more of households' budgets. In lower middle income countries the figure is about 40%. The principal cause of food insecurity remains poverty and inadequate incomes (OECD, 2013).

For many Mediterranean consumers, income is a major barrier to freedom of nutritious and sustainable food choice (Kickbusch, 2010). Price volatility has a strong impact on the poor and on food importing countries. It also risks modifying diets, especially of the poorest as they tend to shift to cheaper, less preferred, and poorer quality foods (HLPE, 2011). Pressures on food prices are exacerbated by volatile market dynamics and inadequate global coordination (Giovannucci *et al*., 2012; Headey and Shenggen, 2010).

Economic analyses have shown that diets with a lower energy density - *i.e.* calories provided by whole grains and fresh produce - tend to be associated with higher food costs than calories from refined grains, added sugars, and added fats (Rolls *et al*., 2005).

Some knowledge gaps regarding the economics of the Mediterranean food consumption patterns are reported hereafter:

- Impact of a higher adherence to the Mediterranean diet on the consumer prices of the typical Mediterranean food products and on the cost of living especially food expenditures.
- Adherence to the Mediterranean diets and health public spending.
- Access to and affordability of high quality Mediterranean food products for different socio-economic groups.
- Food price volatility and food access especially by the poor.

– Impacts of incentives and subsidies on the sustainability of the food system.
– Valorisation of typical and traditional Mediterranean food products.

3. Food-related environmental footprints

Diets are a significant factor in a number of critical sustainability issues such as climate change; public health; social inequalities; biodiversity; energy, land and water use; etc. (Reddy *et al*., 2009).

Environmental degradation - whose primary driving forces are population, consumption and technology - has reached in the Mediterranean proportions that require immediate action (UNEP, 2010).

The type, composition and quantity of food that is produced and consumed affects CO_2 emissions (carbon footprint) (Lam *et al*., 2010), land use (ecological footprint) (Wackernagel and Rees, 1996) and water resources demand (water footprint) (Mekonnen and Hoekstra, 2010).

The environmental effects of different dietary patterns depend on many factors, including the proportion of animal and plant foods (Smil, 2000; Carlsson-Kanyama *et al*., 2003; Carlsson-Kanyama and Gonzalez, 2009).

The world is becoming increasingly concerned about the high dependence of the global food system on fossil fuels (FAO, 2011c). Under globalised food systems, produce is often transported long distances, requiring high consumption rates of non-renewable resources (Mundler and Rumpus, 2012). Heinberg and Bomford (2009) showed the interface between the energy crisis and the food crisis. The dependency on fossil fuels of the present food system presents a major risk to food security (Heinberg and Bomford, 2009; Kickbusch, 2010).

Many Mediterranean indigenous species are important ingredients in the preparation of century-old traditional food recipes. Owing to their peculiar nutritional value and taste, these resources contribute to making local food preparations diverse, attractive and healthy at the same time. Unfortunately, globalization of agricultural markets and changes in lifestyles are having a profound impact on the conservation and use of these resources leading to their irreplaceable loss (FMFC, 2010).

Given the fact that nutrient contents of foods can differ significantly based on growing conditions (*e.g.*, trace elements) and the local species and varieties of foods (*e.g.*, vitamin contents), research attention needs to be given to analysing the nutrient content of local food biodiversity. It is only possible to ensure sustainable diets and bridge nutrient gaps when data on the nutrient contents of foods in the food supply are known (Burlingame *et al*, 2009). The activities of FAO/INFOODS rely on additional data generation through on-going research programmes and analytical laboratories. Similarly, research on dietary intakes and food consumption patterns is needed in order to assess the contribution of food biodiversity to achieving positive nutritional outcomes (FAO/INFOODS/ Bioversity, 2010).

The main identified research topics regarding environmental footprints related to food consumption and production include:

– Water, carbon, ecological, energy and nitrogen footprints of food consumption and production.
– Resource efficiency, design of resource circulation and recycling systems, and integrated waste management in the modern food supply chains.
– Developing scenarios regarding the impact of the current food consumption patterns on natural resources in the Mediterranean.
– Environmental impacts of new technologies for food processing/packaging, storage, logistics and distribution.

– Standardisation and harmonisation of metrics to assess environmental impacts of the food chain.
– Contribution of the Mediterranean diets to biodiversity conservation and promotion.
– Local food and sustainability.

4. Food cultures in the Mediterranean region

Changes in intergenerational and gender relations, the role of women in society and interrelations with the rest of the world (tourism and migrations) are having main effects on Mediterranean lifestyles and food consumption patterns (Padilla, 2008). Urban design and sedentary activities contribute to the many health and nutrition challenges (WHO, 2010).

A plenty of other, often related, causes can explain nutrition transition in general and the erosion of the traditional Mediterranean dietary pattern in particular. These include the income increase (Smil, 2002; Speedy, 2003); the adoption of culturally driven dietary patterns; the deployment of long food chains and of global food players (Finardi *et al*., 2010).

The Mediterranean diet is currently under an increasing erosion process for the effects of globalization, the homogenization of lifestyles, the loss of awareness and appreciation, and the lack of interest among younger generations about their own cultural food heritage. A silent cultural erosion resulting from new lifestyles is affecting the diversity of food cultures that makes Mediterranean foods so diverse and traceable to local territories and traditions. Such a phenomenon is undermining also the identity of millions of people living in this area whose traditions are so intimately linked to food cultures (Dernini, 2011).

Research on socio-cultural factors on food consumption among the different Mediterranean populations and cultures should be developed.

Some research topics dealing with cultural and social aspects of Mediterranean food consumption patterns with a particular focus on the erosion of the Mediterranean food-related cultural heritage should be particularly further developed:

– Diet, commensality, conviviality, rituality, and sociality.
– Food and Mediterranean cultural identity.
– Influence of age, gender, race, social class and ethnicity on food selection and consumption.
– Relationship between the Mediterranean Diet and traditional knowledge of Mediterranean rural communities.
– Factors influencing consumer attitudes, preferences, perception, acceptance.
– Influence of food cultures on food consumption patterns sustainability.
– Transmission of food knowledge to the young generations.
– Traditional foods in the current diets.
– Possible pathways and mechanisms for generating a shift towards sustainable consumption patterns and lifestyles.
– Consumer decision systems and sustainable consumption.
– Social innovations to promote sustainable production and consumption.

5. Food waste and losses

Reducing in the entire Mediterranean area the amount of food lost or wasted throughout the food chain (i.e. from farm to fork) would help improve food security and nutrition. Furthermore, reducing food losses and waste will also ease pressure on water scarcity. To do so, it is crucial to

address losses all along the food chain and alert consumers to the environmental impacts of their diets and the negative effects of wasting food.

Research activities are needed to address the causes, extent, quantification, as well as economic and environmental implications of food loss and food waste in the Mediterranean region.

VI – Policy needs

Previous policies and actions fell short from addressing holistically the problem of food and nutrition security in the Mediterranean in general and SEMC in particular. In fact, most of the previous strategies focused on food availability,adopting a quantitative approach aiming at increasing agricultural production while little attention, and consequently limited research activities and policy instruments, has been devoted to the other components of food and nutrition security that's to say food accessibility and food utilisation.

Therefore, any strategy to address food and nutrition security in the Mediterranean region should encompass both quantitative and qualitative issues and should also consider interactions that exist between them and with other sectors such as nutrition, health, etc. The focus on sustainable diets integrated in a wider food system is original in this sense and allows grasping the different facets and dimensions of food and nutrition insecurity in SEMC.

In the final declaration of the 9th meeting of the Ministers of Food, Agriculture and Fisheries of the Member Countries of CIHEAM - held in Malta on September 27, 2012 and dedicated to "Food security and food price volatility within the countries of the Mediterranean" - the Ministers and the Heads of Delegation considered that all forms of sustainable agriculture are necessary to meet the challenge of global food security, without overlooking the contributions of the aquaculture and forestry sectors. They stated as well that the requirements of food security in the Mediterranean must be seen in a context of multiple challenges (geographical constraints including water and land scarcity, demographic growth and urbanisation, climatic changes and environmental threats) and calls for more multilateral cooperation and regional solidarity among Mediterranean countries to face these challenges (CIHEAM, 2012).

Enabling food policies address constraints to achieving food and nutrition security and that support more efficient functioning of the global and national food, nutrition, and agriculture systems. They aim also at enhancing the functioning of supply chains from producers to consumers and supporting the sustainable management of natural resources (IFPRI, 2007). Future food policies must consider both agricultural and health sectors, thereby enabling the development of coherent and sustainable policies that will ultimately benefit agriculture, human health and the environment (Kearney, 2010).

One of the most important pointsis the development of one intensive and extensive plan and strategy of preservation, including necessary measures to ensure the safeguarding of the diversity of the Mediterranean food cultures heritage as a critical base for the safeguarding of the Mediterranean diet, understood as a cultural system. This preservation strategy should strengthen education initiatives, awareness-raising and capacity-building projects and training in the management of the intangible cultural heritage, in order to effectively preserve and to advance the transmission of Mediterranean diet heritage (Medina, 2009).

Food distribution and catering in many Mediterranean countries is concentrated in the hands of a few operators, who influence product supply, safety and price. The media, advertising and retail sectors and the food industry have a powerful influence on dietary choices, sometimes opposing those recommended by public health specialists (WHO, 2010).

In the southern Mediterranean countries, policies to enhance Mediterranean typical and traditional food products should be implemented, by giving also more relevance to their nutritionalbenefits and lower environmental impacts, within the different Mediterranean dietary patterns.

Possible policy responses to the diet transition problems include measures to raise awareness of the benefits of healthier diets and/or to change relative food prices in favour of such diets (by taxing fattening foods) or, at the extreme, making individuals who follow 'bad' diets, and thus are prone to associated diseases, bear a higher part of the consequent costs borne by the public health systems (Alexandratos, 2006).

Promoting healthy diets and lifestyles requires a multi-sectoral approach involving the various relevant sectors in societies. The agriculture and food sector figures prominently in this enterprise and must be given due importance in any consideration of the promotion of healthy diets. Food strategies must not merely be directed at ensuring food security for all, but must also achieve the consumption of adequate quantities of safe and good quality foods (WHO and FAO, 2003).

Policies aiming at achieving food and nutrition security in the region should also address the issue of food losses and waste. According to FAO (2012c), strategies for reducing food losses and waste include: (1) application of current knowledge to improve the food handling systems and assure food quality and safety; (2) removing the socioeconomic constraints, (3) more education to all stakeholders of the chain, including farmers and consumers, (4) better and adequate infrastructure, including storage facilities and marketing systems, (5) improved research and development capacity; and (6) special attention to overcoming the limitations of small-scale producers.

Good food system governance is crucial. Increasingly, decisions regarding who produces food, what food is produced, when, where and how that food is produced, and who gets to eat it, are being made by those managing a small number of dominant food firms. Public policy decisions that impact the food system and often facilitate structural change continue to be made at local, regional, national, and international levels of government. Meanwhile, farmers, consumers, policymakers, communities are trying to cope with the impacts that the increasing consolidation and concentration is having throughout the food system.

The governance of the Mediterranean food system is hindered by many problems and constraints including the lack of a common and shared Mediterranean strategy, from food production to food consumption, towards the development of a sustainable agriculture as well as ofsustainable food systems in the Mediterranean region. Therefore,the impacts of the policies and actions for improving the sustainability of the current Mediterranean food consumption patterns – as well as their contribution to achieving food and nutrition security in the Mediterranean area - should be also monitored and evaluated through appropriate indicators.These indicators should be used to formulate measures to safeguard and promote the Mediterranean diet as joint heritage as well as to make recommendations for multi-sectoral policy instruments to enhance the sustainability of the Mediterranean agro-food systems and food consumption patterns.

All these actions are necessary to improve the food and nutritional security in the Mediterranean in general and SEMC in particular.

VII –Food for Thought

An action program should envisage the implementation in the member countries of CIHEAM of a three year pilot project to develop "*Guidelines for improving the sustainability of diets in the Mediterranean area*".

The Mediterranean diet, in its various national forms, should be used as a model to describe, understand and improve the sustainability of current Mediterranean food consumption patterns.

In order to measure the sustainability of food consumption some potential indicators have been identified in this paper with the aim of formulating recommendations for cross-sectoral policy instruments allowing the improvement of the sustainability of the diets and food systems in the Mediterranean area.

The «Mediterranean Diet», recognized by UNESCO as an intangible heritage of humanity in 2010, could be considered as a model of sustainable diets in the Mediterranean basin, and able to contribute to the sustainability of the agro-food systems around the Mediterranean and to the valorisation of quality products.

Given the importance of diets for health and as drivers of environmental pressure, steps must be taken as a matter of urgency to monitor and measure sustainable diets through analysis of information, development of methods and indicators, and development /promotion of policy guidelines. The assessment and development of sustainable diet models will foster a consensus for action in the Mediterranean region towards nutrition-sensitive agriculture and sustainable development by raising awareness among consumers and governments that agriculture, food, nutrition, health, culture, education, economy, environment and sustainability are strongly interdependent.

Actions to be undertaken in order to change this situation in the Mediterranean region are urgent and represent a timely opportunity to start new strategies for food security.

The development of a methodological approach might be useful for designing policies in order not only to conserve and preserve the Mediterranean diet, as a common cultural heritage and lifestyle, but also to enhance its sustainability. That requires developing a set of comprehensive, coherent, integrated and holistic policies that deal with different spheres and arenas of nutrition, health, lifestyle, society, culture, education, economy, environment, and agro-biodiversity.

A shared methodological approach development will facilitate dialogues among members of the scientific community concerning the sustainability of dietsin the Mediterranean area, and towards the development of a feeding knowledge network which could be considered as a “Euro-Med pilot sustainability laboratory”. Such an initiative might provide solutions to counteract the increasing pressure on its fragile natural resources exacerbated by the changes of Mediterranean food consumption patterns, in order, not only to conserve and preserve the Mediterranean diet as a common cultural heritage, but also to promote sustainable food systems for the benefit of all the peoples living in the Mediterranean area.

FAO and UNEP have formed in 2011 a joint Sustainable Food Systems Programme, within the 10 Year Framework of Programmes of the SCP, to improve the efficiency of resource management and reduce the intensity of pollution in food systems from production to consumption, while at the same time addressing issues of food and nutrition security. CIHEAM, in collaboration with the FAO/UNEP Sustainable Food Systems Programme, could play a lead role in identifying and catalysing partnerships with other intergovernmental organizations, national governments, UN and EU agencies, private sectors and NGOs, to enhance the transition of the Mediterranean food systems towards a more efficient sustainable consumption and production pattern.

References

Abulafia D., 2012. The great sea: a human history of the Mediterranean. Allen Lane, UK.

AEA Technology Environment, 2005. The validity of food miles as an indicator of sustainable development. Final report for DEFRA, UK. http://archive.defra.gov.uk/evidence/economics/foodfarm/reports/documents/foodmile.pdf

Alexandratos N., 2006. The Mediterranean diet in a world context. Public Health Nutrition: 9(1A), 111–117.

American Dietetic Association, American Nurse Association, American Planning Association and American Health Association, 2010. Principles of a healthy, sustainable food system. www.planning.org/nationalcenters/health/pdf/HealthySustainableFoodSystemsPrinciples.pdf

American Public Health Association, 2007. Toward a healthy, sustainable food system. Policy statement. www.apha.org/advocacy/policy/policysearch/default.htm?id=1361

Babio N., Bullo M., Basora J., Martinez-Gonzalez M. A., Fernandez-Ballart J., Marquez-Sandoval F., *et al.*, 2009. Adherence to the Mediterranean diet and risk of metabolic syndrome and its components. NutrMetabCardiovasc Dis; 19(8):563-570.

Bach A., Serra-Majem L., Carrasco J.L., Roman B., Ngo J., Bertomeu I., Obrador B.. 2006. The use of index evaluating the adherence to the Mediterranean diet in epidemiological studies: a review. Public Health Nutrition; 9(1A): 132-146.

Bach-Faig A., Berry E.M., Lairon D., Reguant J., Trichopoulou A., Dernini S., Medina F.X., Battino M., Miranda G., Serra-Majem L., 2011. Mediterranean Diet Pyramid Today. Science and Cultural Updates. Public Health Nutrition; 14(12A): 2274–2284.

Barilla Center for Food and Nutrition, 2010. Double Pyramid: Healthy food for people, sustainable food for the planet. Parma.

Baroni L., Cenci L., Tettamanti M., Berati M., 2007. Evaluating the environmental impact of various dietary patterns combined with different food production systems. Eur J ClinNutr; 61(2):279-86.

Belahsen R., Rguibi M., 2006. Population health and Mediterranean diet in southern Mediterranean countries. Public Health Nutrition; 9(8A):1130-5.

Berry E.M., De Geest S.,2012. Tell me what you eat and I will tell you yoursociotype: coping with diabesity. RMMJ ; 3(2):e0010.

Berry E.M., Arnoni Y, Aviram M., 2011. The Middle Eastern & Biblical origins of the Mediterranean diet. Public Health Nutrition; 14 (12A): 2288-2295,

Bosetti C., Pelucchi C., La Vecchia C., 2009. Diet and cancer in Mediterranean countries: carbohydrates and fats. Public Health Nutrition; 12(9A):1595-600.

Boulier F., 2012. Food security in the Mediterranean in 2030: From foresight to research priorities. The Futures of Agriculture. Brief No. 11 - English. Rome: Global Forum on Agricultural Research (GFAR).

Buckland G., Bach A., Serra-Majem L., 2008. Obesity and the Mediterranean diet: a systematic review of observational and intervention studies. Obes. Rev; 9:582-593.

Buckland G., González C.A., Agudo A., *et al.*, 2009. Adherence to the Mediterranean diet and risk of coronary heart disease in the Spanish EPIC cohort study. Am. J. Epidemiol; 170(12):1518-29.

Burlingame B, and Dernini S. (2011). Sustainable diets: the Mediterranean diet example. Public Health Nutrition; 14(12A): 2285–2287.

Burlingame, B., Charrondiere, U.R., Mouille, B., 2009. Food composition is fundamental to the cross-cutting initiative on biodiversity for food and nutrition. Journal of Food Composition and Analysis; 22, 5: 361-365.

Carlsson-Kanyama A., Gonzalez A., 2009. Potential contributions of food consumption patterns to climate change. American Journal of Clinical Nutrition; 89 (5): 1704S-9S.

Carlsson-Kanyama A., Pipping Ekstrom M., Shanahan H., 2003. Food and life cycle energy inputs: consequences of diet and ways to increase efficiency. Ecological Economics; 44: 293-307.

Cash D. W., Adger W. N., Berkes F., Garden P., Lebel L., Olsson P., *et al.*, 2006. Scale and cross-scale dynamics: Governance and Information in a Multilevel World. Ecology and Society; 11(2): 8.

CFS, 2012. Coming To Terms With Terminology: Food Security, Nutrition Security, Food Security and Nutrition, Food and Nutrition Security. Committee on World Food Security (CFS), Thirty-ninth Session, 15-20 October 2012, Rome.

Chakar H., Salameh P. R., 2006. Adolescent obesity in Lebanese private schools. Eur J Public Health; 16:648-651.

CIHEAM, 2012. Final declaration. 9th meeting of the Ministers of Food, Agriculture and Fisheries of the Member Countries of CIHEAM; Valletta, 27 September 2012. International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM).

CIHEAM, 2008. MediTerra 2008. The future of agriculture and food in Mediterranean countries. CIHEAM–SciencesPo Les Presses, Paris.

CIISCAM, 2009. The Mediterranean diet: a model of sustainable diet. 3rd CIISCAM International Conference, Parma. www.ciiscam.org/203/28/products/3rd_ciiscam_international_conference.html

Clonan A, Holdsworth M., 2012. The challenge of eating a healthy and sustainable diet. Am J ClinNutr; 96/3: 459-460.

Da Silva R., Bach-Faig A., Raido Quintana B., Buckland G., Vaz de Almeida M.D., Serra-Majem L., 2009. World variation of adherence to the Mediterranean diet, in 1961-1965 and 2000-2003.Public Health Nutrition; 12(9A):1676-1684.

de Lorgeril M., Renaud S., Mamelle N., *et al.*, 1994. Mediterranean alpha-linolenic acid-rich diet in secondary prevention of coronary heart disease. (Erratum Lancet 1995; 345: 738). Lancet; 343: 1454–1459.

DEFRA, 2009. Indicators for a Sustainable Food System. Report UK. www.defra.gov.uk/statistics/files/defra-stats-foodsystemindicators.pdf

DEFRA, 2011. Sustainable, secure and healthy food supply evidence plan 2011/12.www.defra.gov.uk/publications/files/pb13515-ep-food-supply.pdf

Delaney Burke J., 2012. Bridging the sustainability gap. Nutrition today; 47(4): 155-159.

Dernini S., Berry E.M,, Bach-Faig A., Belahsen R., Donini L.M., Lairon D., Serra-Majem L., Cannella C.. 2012. Scientists reassess a dietary model: the Mediterranean diet. In, Mediterra 2012. CIHEAM–SciencesPo Les Presses, Paris; 71-88.Dernini S. (2011). The erosion and the renaissance of the Mediterranean diet: A sustainable cultural resource. Quaderns de la Mediterrania, IEMED, Barcelona; 16:75-82.

Dernini S., Meybeck A.,Burlingame B., Gitz V., Lacirignola C., Debs P., Capone R., El Bilali H., 2013. Developing a methodological approach for assessing the sustainability of diets: The Mediterranean diet as a case study. New Medit; 3:28-36.

Dernini S., 2011. The erosion and the renaissance of the Mediterranean diet: A sustainable cultural resource. Quaderns de la Mediterrania, IEMED, Barcelona; 16: 75-82.

Duchin F., 2005. Sustainable consumption of food: A framework for analyzing scenarios about changes in diets. Journal of Industrial Ecology; 9(1-2):99-114.

EC/JRC, 2009. Environmental impacts of diet changes in the EU. Technical Report, European Commission (EC), Joint Research Centre (DG JRC), Institute for Prospective Technological Studies (IPTS).

Edwards-Jones G., Mila` i Canals L., Hounsome N., Truninger M., Koerber G., Hounsome B., Cross P., York EH., Hospido A., Plassmann K., Harris I.M., Edwards R.T., Day GAS A., Tomos D., Cowell S.J., Jones D.L., 2008. Testing the assertion that 'local food is best': the challenges of an evidence-based approach. Trends in Food Science & Technology; 19: 265-274.

ESF, 2009. European food systems in a changing world. Strasbourg: ESF-COST Forward Look Report. www.esf.org/fileadmin/Public_documents/Publications/food.pdf

Esnouf C., Russel M., Bricas N., (eds), 2013. Food Systems Sustainability: Insights from duALIne. Cambridge University Press, Cambridge.

Estruch R., Martínez-González M.A., Corella D., Salas-Salvado J., Ruiz-Gutierrez V., Covas M.I., Fiol M., Gomez-Gracia E., Lopez-Sabater M.C., Vinyoles E., Aros F., Conde M., Lahoz C., Lapetra J., Saez G., Ros E., Premided Study Investigators, 2006. Effects of a Mediterranean-style Diet on Cardiovascular Risk Factors: A Randomized Trial. Annals of Internal Medicine; 45: 1-11.

Estruch R., Ros E., Salas-Salvadó J., Covas M.-I., Corella D., Arós F., Gómez-Gracia E., Ruiz-Gutiérrez V., Fiol M., Lapetra J., Lamuela-Raventos R. M., Serra-Majem Ll., Pintó X., Basora J., Angel Muñoz M., Sorlí J. V., Alfredo Martínez J., Martínez-González M. A., 2013. Primary Prevention of Cardiovascular Disease with a Mediterranean Diet. N Engl J Med 2013; 368 (14): 1279-1290.

Eurostat, 2011. Sustainable development indicators. Theme 2: Sustainable Consumption and Production. http://epp.eurostat.ec.europa.eu/portal/page/portal/sdi/indicators/theme2.

FAO, 2004. 24th Regional Conference for Europe. Item Six – Food safety and quality in Europe: Aspects concerning in particular quality, nutritional balance, the importance of agricultural land and cultural heritage ("Terroirs"). Montpellier. FAO, Rome.

FAO, 2005. Nutrition indicators for development. FAO, Rome.

FAO, 2009. Linking people, places and products. A guide for promoting quality linked to geographical origin and sustainable Geographical Indications. FAO/SINER-GI, FAO, Rome.

FAO, 2010. Report of the technical workshop on Biodiversity in Sustainable Diets. FAO, Rome.

FAO 2011b. Global food losses and food waste. Extent, causes and prevention. FAO, Rome.

FAO, 2011c. "Energy-smart food" for people and climate. FAO, Rome.

FAO 2012a. 31st Regional Conference for the Near East. Report. www.fao.org/docrep/meeting/025/md988e.pdf

FAO 2012b. Greening the economy with agriculture. Working paper 4: utilization. Improving food systems for sustainable diets in a green economy. FAO, Rome.

FAO, 2012c. Food loss prevention for improving food security in the Near East. FAO Regional Conference for the Near East (RCNE), Thirty-first Session, Rome, 14-18 May 2012; NERC/12/4. FAO, Rome.

FAO, 2012d. Regional Priority Framework for the Near East. FAO Regional Office for the Near East, Cairo.

FAO, 2013. The State of Mediterranean Forests 2013. FAO, Rome.

FAO, WFP, IFAD, 2012. The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. Rome, FAO.

FAO/Bioversity, 2010. Report of the international symposium on Biodiversity and Sustainable Diets. Rome. www.fao.org/ag/humannutrition/28506-0efe4aed57af34e2dbb8dc578d465df8b.pdf

FAO/Bioversity, 2012. Sustainable Diets and Bioversity. Directions and Solutions for Policy, Research and Action. Rome. www.fao.org/docrep/016/i3004e/i3004e00.htm

FAO/CIHEAM, 2012. Towards the development of guidelines for improving the sustainability of diets and food consumption patterns: the Mediterranean diet as a pilot study. Rome. www.fao.org/docrep/016/ap101e/ap101e.pdf

FAO/INFOODS/Bioversity International, 2010. Expert Consultation on Nutrition Indicators for Biodiversity 2. Food Consumption. FAO, Rome.

Fidanza F., Alberti A., Lanti M., Menotti A., 2004. Mediterranean Adequacy Index: correlation with 25-year mortality from coronary heart disease in the Seven Countries Study. Nut MetabCardiovasc Dis; 14: 254-258.

Finardi C., Arfini F., Turrini A., 2010. Dietary evolution over time in Europe, between Cyclops and Phaecians: an outlook on the role of supply-side factors in driving changes in the food patterns. 1st Joint EAAE/AAEA Seminar "The Economics of Food, Food Choice and Health" Freising, Germany, September 15 – 17, 2010.

Florensa S., Aragall X., 2012. Mutations in Mediterranean societies. In Mediterra 2012. CIHEAM–SciencesPo Les Presses, Paris; 91-113.

FMFC, 2005. The 2005 Rome Call for a Common Action in the Year of the Mediterranean. 3° Euro-Mediterranean Forum; 30 September – 1 October 2005, Rome. www.plexusinternational.org/files/download/Allegati/2005_rome_call_for_action.pdf

FMFC, 2010. Biodiversity? Sustainable food for everybody. Mediterranean diet: an example of a sustainable diet. Mediterranean diet talk show; May 21, 2010, Rome. www.plexusinternational.org/files/download/Allegati/2010_parco_della_musica_talk_show_background_paper_inglese.pdf

Garcia-Closas R., Berenguer A., Carlos A., Gonzalez C., 2006. Changes in food supply in Mediterranean countries from 1961 to 2001. Public Health Nutrition; 9(1):53-60.

Garnet T., 2011. Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)? Food Policy; 36:s23-s32.

Gerbens-Leenes W., Nonhebel S., 2005. Food and land use. The influence of consumption patterns on the use of agricultural resources. Appetite; 45:24-31.

Gerber M., 2006. Qualitative methods to evaluate Mediterranean diet in adults. Public HealthNutr; 9(1A):147-51.

Giovannucci D., Scherr S., Nierenberg D., Hebebrand Ch., Shapiro J., Milder J., and Wheelern K., 2012. Food and Agriculture: the future of sustainability. A strategic input to the Sustainable Development in the 21st Century (SD21) project. UN-DESA, New York.

Godfray H.C.J., Beddington J.R., Crute I.R., Haddad L., Lawrence D., Muir J.F., Pretty J., Robinson S., Thomas S.M., Toulmin C., 2010. Food security: the challenge of feeding 9 billion people. Science; 327: 812-818.

González-Turmo I., 2012. The Mediterranean diet: consumption, cuisine and food habits. In Mediterra 2012. CIHEAM–SciencesPo Les Presses, Paris; 115-132.

González-Turmo I., Medina F. X., 2012. *Retos y responsabilidadestras la declaración de la Dietamediterráneacomopatrimonio cultural inmaterial de la Humanidad (UNESCO)*, in Cantarero, L. (ed.) La antropología de la alimentaciónenEspaña. Perspectivasactuales. UOC (UniversitatOberta de Catalunya), Barcelona.

Goodman D., 1997. World-scale processes and agro-food systems: critique and research needs. Review of International Political Economy; 4(4): 663-687.

Gussow J.D., Clancy K., 1986. Dietary guidelines for sustainability. Journal Nutrition Education; 18(1):1-5.

Gussow J.D., 1995. Mediterranean diets: are they environmentally responsible? Am J ClinNutr; 61(suppl):1383S-9S.

Guyomard H., Darcy-Vrillon B., Esnouf C., Marin M., Momot A., Russel M., Guillou M., 2011. Eating patterns and food systems: critical knowledge requirements for policy design and implementation. INRA. Document prepared for the Commission on Sustainable Agriculture and Climate Change. http://ccafs.cgiar.org/sites/default/files/assets/docs/guyomard_et_al_eating_patterns_and_food_systems.pdf

Hacettepe University, 2009. Turkey Demographic and Health Survey, 2008. Institute of Population Studies, Hacettepe University & General Directorate of Mother and Child health and Family Planning, Ministry of Health; T.R. Prime Ministry Undersecretary of State Planning Organization and TUBİTAK, Ankara.

Haines A., McMichael A., Smith K., Roberts J., Woodcock J., Markandya A., Armstrong B.G., Campbell-Lendrum D., Dangour A.D., Davies M., Bruce N., Tonne C., Barrett M., Wilkinson P., 2009. Public health benefits of strategies to reduce greenhouse-gas emissions: overview and implications for policy makers. The Lancet; 374(9707):2104-2114

Hassan-Wassef H., 2012. Food security in the Mediterranean: Public health concern. www.ipemed.coop/en/our-projects-r16/agriculture-and-rural-development-c86/-sc68/food-security-in-the-mediterranean-public-health-concern-a1485.html.

Hawkesworth S., Dangour A.D., Johnston D., Lock K., Poole N., Rushton J., Uauy R., Waage J., 2010. Feeding the world healthily: the challenge of measuring the effects of agriculture on health. Philosophical Transactions of the Royal Society, B- Biological Sciences; 365:3083-3097.

Headey D., Shenggen F., 2010. Reflections on the global food crisis : how did it happen? how has it hurt? and how can we prevent the next one? Research Monograph 165. International Food Policy Research Institute, Washington, D.C.

Heinberg R., Bomford M., 2009. The Food and Farming Transition: towards a post carbon food system. Post Carbon Institute. www.postcarbon.org/report/41306-the-food-andfarming-transition-toward.

Heinrich M., Müller W.E., Galli C., (eds.) 2006. Local Mediterranean food plants and nutraceuticals. Karger, Basle.

Hervieu B., Thibault H.-L., (eds.) 2009. Rethinking rural development in the Mediterranean. CIHEAM; Presses de Sciences Po, Paris.

Heywood V.H., 1998. The Mediterranean region. A major centre of plant diversity. In: Heywood VH, Skoula M (eds) "Wild food and non-food plants: information networking". Proceedings of the II MEDUSA Regional Workshop (1-3 may 1997, Port El-Kantaoui, Tunisia). Cahiers CIHEAM, *Options Méditerranéennes*; 38:5-15.

HLPE, 2011. Price volatility and food security. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.

Holdsworth M., 2010. Sustainability should be integral to nutrition and dietetics. J Hum Nutr Diet; Journal of Human Nutrition and Dietetics; 23 (5): 467–468.

Hossain P., Kawar B., El Nahas M., 2007. Obesity and diabetes in the developing world-a growing challenge. N Engl J Med; 356:213-215.

IFPRI, 2007. IFPRI's strategy: Toward food and nutrition security: Food policy research, capacity strengthening, and policy communications, updated. International Food Policy Research Institute (IFPRI), Washington, D.C.

IISD, 1997. Assessing Sustainable Development – Principles in Practice. International Institute for Sustainable Development, Winnipeg, Canada. www.nssd.net/pdf/bellagio.pdf

IISD/OECD, 2009. Bellagio STAMP: Sustainability assessment and measurement principles. The International Institute for Sustainable Development/The Organisation for Economic Co-operation and Development; Winnipeg, Manitoba.

Ingram J. S. I., 2011. From Food Production to Food Security: Developing interdisciplinary, regional-level research. PhD Thesis, Wageningen University.

IOTF, 2005. EU platform on diet, physical activity and health. Briefing paper. International Association for the Study of Obesity, London, UK. http://ec.europa.eu/health/ph_determinants/life_style/nutrition/documents/iotf_en.pdf

IPCC, 2007. Fourth Assessment Report. Climate change 2007: synthesis report. Inter-governmental Panel on Climate Change, Valencia.

Issa C., Darmon N., Salameh P., Maillot M., Batal M., Lairon D., 2011. A Mediterranean diet pattern with low consumption of liquid sweets and refined cereals is negatively associated with adiposity in adults from rural Lebanon. Int.J.Obes; 35(2):251-8.

ITFPCHD, 2000. Consensus statement: dietary fat, the Mediterranean diet and lifelong good health. International Task Force for Prevention of Coronary Heart Disease. London.

Jabre P., Sikias P., Khater-Menassa B., Baddoura R., Awada H., 2005. Overweight children in Beirut: prevalence estimates and characteristics. Child Care Health Dev; 31:159-165.

Kastner T., Rivas M.J.I., Koch W., Nonhebel S., 2012. Global changes in diets and the consequences for land requirements for food. Proceedings of the National Academy of Sciences; 109(18): 6868-6872.

Kastorini C.M., Milionis H.J., Esposito K., Giugliano D., Goudevenos J.A., Panagiotakos D.B., 2011. The effect of Mediterranean diet on metabolic syndrome and its components a meta-analysis of 50 studies and 534,906 individuals. J Am CollCardiol; 57(11):1299-1313.

Kearney J., 2010. Food consumption trends and drivers. Phil. Trans. R. Soc; 365:2793-2807.

Kesse-Guyot E., Fezeu L., Hercberg S., Ahluwalia N., Lairon D., 2012. Adherence to Mediterranean diet reduces the risk of metabolic syndrome: a prospective study. NutrMetabCardiovasc Dis;142(5):909-15.

Keys A.B., Keys M., (eds.) 1975. How to Eat Well and Stay Well the Mediterranean Way. Doubleday Publishing, New York.

Keys A.B., (eds.) 1970. Coronary heart disease in seven countries. Circulation(1 Suppl.): 51-52.

Keys A.B., (eds.) 1980. Seven countries: a multivariate analysis of death and coronary heart disease. Harvard University Press. Cambridge (MA).

Kickbusch I., 2010. The food system: a prism of present and future challenges for health promotion and sustainable development. Triggering the debate – white paper. Promotion Santé Suisse, Bern.

Kissinger M., 2012. International trade related food miles – The case of Canada. Food Policy; 37:171-178.

Kromhout D., Keys A., Aravanis C., Buzina R., Fidanza F., Giampaoli S., Jansen A., Menotti A., Nedeljkovic S., Pekkarinen M., *et al.*, 1989. Food consumption patterns in the 1960s in seven countries. Am J ClinNutr; 49(5): 889-94.

La Vecchia C., 2004. Mediterranean diet and cancer. Public Health Nutr; 7(7):965-8.

Lacirignola C., Capone R., 2010. Rethinking the Mediterranean diet for the 21st century. The CIHEAM Watch letter; 13:1-5.

Lacirignola C., Capone R., 2009. Mediterranean Diet: Territorial Identity and Food Safety. New Medit; 4 (8): 2-3.

Lam H.L., Varbanov P.. Klemeš J., 2010. Minimising carbon footprint of regional biomass supply chains. Resources, Conservation and Recycling; 54, 303-309.

León-Muñoz L.M., Guallar-Castillón P., Graciani A., López-García E., Mesas A.E., Aguilera M.T., Banegas J. R., Rodríguez-Artalejo F., 2012. Adherence to the Mediterranean diet pattern has declined in Spanish adults. Journal of Nutrition;142 (10): 1843-1850.

Lock K., Smith D.R., Dangour A.D., Keogh-Brown M., Pigatto G., Hawkes C., Fisberg R.M., Chalabi Z., 2010. Health, agricultural, and economic effects of adoption of healthy diet recommendations. The Lancet; (376):1699-1709.

Lundqvist J., de Fraiture C., Molden D., 2008. Saving Water: From Field to Fork – Curbing Losses and Wastage in the Food Chain. SIWI Policy Brief, Stockholm International Water Institute (SIWI), Stockholm.

Lupo A. (1997). Nutrition in general practice in Italy. Am J ClinNutr; 65(Suppl 6):1963S–1966S.

Macdiarmid J.I., Kyle J., Horgan G.W., Loe J., Fyfe C., Johnstone A., McNeil G., 2012. Sustainable diets for the future: can we contribute to reducing greenhouse gas emissions by eating a healthy diet? Am J ClinNutr; 96: 632–9.

Maclaren V.W., 1996. Developing Indicators of Urban Sustainability: A Focus on the Canadian Experience. ICURR Press, Toronto.

Maillot M., Issa C., Vieux F., Lairon D., Darmon N., 2011. The shortest way to reach nutritional goals is to adopt Mediterranean food choices. Evidence from computer-generated personalized diets. Am J ClinNutr; 94(4):1127-37.

Manios Y., Detopoulou V., Visioli F., Galli C., 2006. Mediterranean Diet as a Nutrition Education and Dietary Guide: Misconceptions and the Neglected Role of Locally Consumed Foods and Wild Green Plants. In M. Heinrich, W.E. Müller & C. Galli (eds.) Local Mediterranean food plants and nutraceuticals, Karger, Basle;154-170.

Marlow J.H., Hayes W.K., Soret S., Carter R.L., Schwab R.E., Sabate' J., 2009. Diet and the environment: does what you eat matter? Am J ClinNutr; 89(suppl):1699s-703.

Martínez-González M.A., Bes-Rastrollo M., Serra-Majem L., Lairon D., Estruch R., Trichopoulou A., 2009. Mediterranean food pattern and the primary prevention of chronic disease: recent developments. Nutr Rev; 67 Suppl 1:S111-6.

Martínez-González M.A., Fernandez-Jarne E., Serrano-Martinez M., *et al.*, 2002. Mediterranean diet and reduction in the risk of a first acute myocardial infarction. An operational healthy dietary score. Eur J Nutr; 41: 153–160.

Martínez-González M.A., Fuente-Arrillaga C., Nunez-Cordoba J.M., Basterra-Gortari F.J., Beunza J.J., Vazquez Z., *et al.*, 2008. Adherence to Mediterranean diet and risk of developing diabetes: prospective cohort study. BMJ; 336(7657):1348-1351.

Maxwell S., Slater R., 2003. Food policy old and new. Development Policy Review; 21(5–6): 531–553.

Medina F. X. (2009). Mediterranean diet, culture and heritage: challenges for a new conception. Public Health Nutrition; 12: 1618-1620.

Mekonnen M.M., Hoekstra A.Y., 2010. The green, blue and grey water footprint of farm animals and animal products, Value of Water Research Report Series No. 48, UNESCO-IHE, Delft, the Netherlands.

Mendez M.A., Popkin B.M., Jakszyn P., Berenguer A., Tormo M.J., Sanchez M.J., Quiros J.R., Pera G., Navarro C., Martinez C., Larranaga N., Dorronsoro M., Chirlaque M.D., Barricarte A., Ardanaz E., Amiano P., Agudo A., Gonzalez C.A., 2006. Adherence to a Mediterranean Diet is Associated with Reduced 3-year Incidence of Obesity. Journal of Nutrition; 136:2934-2938.

Menotti A., Kromhout D., Blackburn H., Fidanza F., Buzina R., Nissinen A., 1999. Food intake patterns and 25-year mortality from coronary heart disease: cross-cultural correlations in the Seven Countries Study. The Seven Countries Study Research Group. Eur J Epidemiol; 15(6):507-15.

Millstone E., Lang T., 2008. The Atlas of Food. Earthscan, second edition, London.
Mundler P., Rumpus L., 2012. The energy efficiency of local food systems: A comparison between different modes of distribution. Food Policy; 37: 609-615.
Nestle M., 1995. Mediterranean diets: historical and research overview. American Journal Clinical Nutrition; 61(suppl.):1313S-20S.
Numa C., Troya A., 2011. The challenge for biodiversity conservation in the Mediterranean. IEMED Mediterranean Year Book 2011; 255-260
O'Kane G., 2012. What is the real cost of our food? Implications for the environment, society and public health nutrition. Public Health Nutrition; 15(02):268-276.
OECD, 2013. Global food security: challenges for the food and agriculture system. Working Party on Agricultural Policies and Markets; Committee for Agriculture; Trade and Agriculture Directorate; Organisation for Economic Co-operation and Development (OECD), Paris.
OECD, 2003. Environmental Indicators – Development, Measurement and Use. Organisation for Economic Cooperation and Development Reference Paper.OECD, Paris.
Omran A., 1971. The epidemiologic transition: a theory of the epidemiology of population change. The Milbank Memorial Fund Quarterly; 49(4): 509–38.
Padilla M., Capone R., Palma G., 2012. Sustainability of the food chain from field to plate: case of the Mediterranean diet. In "Sustainable diets and biodiversity: United against hunger. FAO/Biodiversity International", Rome; 230-241.
Padilla M., 2008. Dietary patterns and trends in consumption. In, Mediterra 2008: The future of agriculture and food in Mediterranean countries. CIHEAM–Presses de Sciences Po. Paris;149- 170.
Pálsson G., Avril B., Crumley C., Hackmann H., Holm P., Ingram J., *et al.*, 2011. Challenges of the anthropocene: Contributions from Social Sciences and Humanities for the Changing Human Condition. ESF/COST RESCUE–Task Force on "Science Questions". Strasbourg: ESF.
Panagiotakos D.B., Chrysohoou C., Pitsavos C., Stefanadis C., 2006. Association between the Prevalence of Obesity and Adherence to the Mediterranean Diet: the ATTICA Study. Nutrition; 22:449-456.
Pekcan G., Köksal E., Küçükerdönmez Ö., Özel H., 2006. Household food waste in Turkey. Statistics Division, working Papers series N° ESS/ESSA/006e; FAO, Rome.
Pimentel D., Pimentel M., 2003. Sustainability of meat-based and plant-based diets and the environment. Am J ClinNutr; 78(3):660s-663s.
Plan Bleu, 2012. 20 Years of sustainable development in the Mediterranean: review and outlook. Blue Plan Notes; 22. www.planbleu.org/publications/8p22_20ans_dd_EN.pdf
Pluimers J., Blonk H., 2011. Methods for quantifying the environmental and health impacts of food consumption patterns. BlonkMilieuadvies, PJ Gouda, The Netherlands
Rayner G., Lang T., 2012. Public health and nutrition. Our vision: Where do we go? World Nutrition; 3(4): 92-118
Reddy Sh., Lang T., Dibb S., 2009. Setting the table - Advice to Government on priority elements of sustainable diets. Sustainable Development Commission, UK.
Reguant-Aleix J., Sensat F., 2012. The Mediterranean diet, intangible cultural heritage of humanity. In, Mediterra 2012. CIHEAM – Sciences Po Les Presses, Paris; 465-484.
Renault D., Wallender W.W., 2000. Nutritional water productivity and diets. Agricultural Water Management; 45: 275-296.
Rolls B.J., Drewnowski A., Ledikwe J.H., 2005. Changing the Energy Density of the Diet as a strategy for Weight Management. Journal of the American Dietetic Association; 105 (5): 98-103.
Rosenbloom J.I, Nitzan-Kaluski D., Berry E.M. 2008. A Global Nutrition Index. Food and Nutrition Bulletin; 29; 266-277.
Sáez Almendros S., Obrador B., Serra-Majem L., Bach-Faig A., 2013. Beyond the health benefits of the Mediterranean Diet: environmental sustainability. Environmental Health; 12 (118): 1-8.
Sánchez-Villegas A., Bes-Rastrollo M., Martínez-González M.A., Serra-Majem L., 2006. Adherence to a Mediterranean Dietary Pattern and Weight Gain in a Follow-up Study: the SUN Cohort. International Journal of Obesity; 30:350-358.
Sánchez-Villegas A., Delgado-Rodriguez M., Martínez-González M.A., De Irala-Estevez J., 2003. Gender, Age, Socio-demographic and Lifestyle Factors Associated with Major Dietary Patterns in the Spanish Project SUN. European Journal of Clinical Nutrition; 57:285-292.
SDC, 2009. Setting the table - Advice to Government on priority elements of sustainable diets. Sustainable Development Commission. UK. www.sd-commission.org.uk/data/files/publications/Setting_the_Table.pdf
SDC, 2011. Looking back, looking forward. Sustainability and UK food policy 2000-2011. Sustainable Development Commission. UK. www.sdcommission.org.uk/data/files/publications/FoodPolicy10_Report_final_w.pdf

Serra-Majem L., Ribas L, Ngo J., Mortega R., Garcıa A., Perez-Rodrigo C., Aranceta J., 2004. Food, youth and the Mediterranean diet in Spain. Development of KIDMED, Mediterranean Diet Quality Index in children and adolescents. Public Health Nutrition; 7(7): 931–935.

Serra-Majem L., Roman B., Estruch R., 2006. Scientific evidence of interventions using the Mediterranean diet: a systematic review. Nutrition Review; 64:S27-S47.

Serra-Majem L., Trichopoulou A., Ngo J., de la Cruz J., Cervera P., García Álvarez A., La Vecchia C., Lemtouni A., Trichopoulos D., 2004a. Does the definition of the Mediterranean Diet need to be updated?" Public Health Nutrition; 7:927-929.

Sibai A.M., Hwalla N., Adra N., Rahal B., 2003. Prevalence and covariates of obesity in Lebanon: findings from the first epidemiological study. Obes Res; 11:1353-1361.

Sim S., Barry M., Clift R., Cowell S., 2007. The relative importance of transport in determining an appropriate sustainability strategy for food sourcing. Int J LCA; 12(6): 422-431.

Skuras D., Psaltopoulos D., 2012. A broad overview of the main problems derived from climate change that will affect agricultural production in the Mediterranean area. FAO/OECD Workshop: Building Resilience for Adaptation to Climate Change in the Agriculture Sector, 23-24 April 2012, FAO, Rome.

Smil V., 2000. Phosphorus in the Environment: Natural Flows and Human Interferences. Annual review of energy and the environment; 25 (1): 53–88.

Smil V., 2002. Worldwide transformation of diets, burdens of meat production and opportunities for novel food proteins. Enzyme and Microbial Technology; 30 (2002): 305–311.

Sofi F., Cesari F., Abbate R., Gensini A., 2008. Adherence to Mediterranean diet and health. BMJ; 337:1136-1344.

Speedy A.W., 2003. Global production and consumption of animal source foods. J.Nutr; 133(11 Suppl 2), 4048S-4053S.

Termeer C. J. A. M., Dewulf A., van Lieshout M., 2010. Disentangling scale approaches in governance research: Comparing monocentric, multilevel, and adaptive governance. Ecology and Society; 15(4): 29. www.ecologyandsociety.org/vol15/iss4/art29

Toledo A., Burlingame B., 2006. Biodiversity and nutrition: A common path toward global food security and sustainable development. Journal of Food Composition and Analysis; 19, 6-7, 477-483.

Tortosa A., Bes-Rastrollo M., Sanchez-Villegas A., Basterra-Gortari F.J., Nunez-Cordoba J.M., Martinez-Gonzalez M.A., 2007. Mediterranean diet inversely associated with the incidence of metabolic syndrome: the SUN prospective cohort. Diabetes Care; 30(11):2957-2959.

Trichopoulou A., Lagiou P., 1997. Healthy traditional Mediterranean diet: an expression of culture, history, and lifestyle. Nutrition Reviews; (55): 383–389.

Trichopoulou A., Bamia C., Trichopoulos D., 2005. Mediterranean diet and survival among patients with coronary heart disease in Greece. Arch Intern Med; 25, 165(8):929-35.

Trichopoulou A., Bamia C., Trichopoulos D., 2009. Anatomy of health effects of Mediterranean diet: Greek EPIC prospective cohort study. BMJ; 338:b2337.

Trichopoulou A., Costacou T., Bamia C., Trichopoulos D., 2003. Adherence to a Mediterranean diet and survival in a Greek population. N Engl J Med; 348: 2599-2608.

Trichopoulou A., Kouris-Blazos A., Wahlqvist M.L., Gnardellis C., Lagiou P., Polychronopoulos E., Vassilakou T., Lipworth L., Trichopoulos D., 1995. Diet and overall survival in elderly people. BMJ; 311:1457-1460.

Trichopoulou A., 2012. Diversity v. globalization: traditional foods at the epicentre. Public Health Nutr;15(6):951-4.

UNEP, 2008. SCP Indicators for Developing Countries - A Guidance Framework www.unep.fr/scp/publications/details.asp?id=DTI/1085/PA Paris.

UNEP, 2010. HERE and NOW - Education for Sustainable Consumption: Recommendations and Guidelines. A publication from the United Nations Environment Programme (UNEP) and the Marrakech Task Force on Education for Sustainable Consumption.

UNEP, 2012a. The Critical role of global food consumption patterns in achieving sustainable food systems and food for all. Discussion paper. Paris.

UNEP, 2012b. Avoiding Future Famines: Strengthening the Ecological Foundation of Food Security through Sustainable FoodSystems. Synthesis report. www.unep.org/publications/ebooks/avoidingfamines/portals/19/Avoiding_Future_Famines.pdf

UNEP/MAP, 2005. Mediterranean Strategy For Sustainable Development: A Framework for Environmental Sustainability and Shared Prosperity. Tenth Meeting of the Mediterranean Commission on Sustainable Development (MCSD), Athens.

UNEP/MAP/Plan Bleu, 2006. A Sustainable Future for the Mediterranean. The Blue Plan's Environment and Development Outlook. Executive Summary. Sophia Antipolis, France.

UNEP/MAP/Plan Bleu, 2008. The Blue Plan's sustainable development outlook for the Mediterranean. Sophia Antipolis, France.
UNEP/MAP/Plan Bleu, 2010. Economic Evaluation of Water Demand Management in the Mediterranean. *Study report*. Sophia Antipolis, France.
UNEP/MAP/Plan Bleu, 2011. Mediterranean Strategy For Sustainable Development Follow Up: Main Indicators. Sophia Antipolis, France.
UNESCO, 2010. Representative List of the Intangible Cultural Heritage of Humanity.UNESCO, Paris.
UN-HLTF, 2011. Food and Nutrition Security: Comprehensive Framework for Action. Summary of the Updated Comprehensive Framework for Action (UCFA). United Nations System High Level Task Force on Global Food Security (HLTF); Rome/ Genève/ New York.
UN-HLTF, 2012. Food and nutrition security for all through sustainable agriculture and food systems. United Nations System High Level Task Force on Global Food Security (HLTF); Rome/ Genève/ New York.
UNICEF, 2012. Monitoring the Situation of Children and Women. Statistics by country – nutrition country profiles. www.childinfo.org/country_list.php.
UNSCN, 2012. Nutrition security of urban populations, Statement. www.unscn.org/files/Statements/August_31-_UNSCN_World_Urban_Forum_6-_Statement_final_3108_finalfinal.pdf
Vareiro D., Bach-Faig A., Raidó Quintana B., Bertomeu I., Buckland G., Vaz de Almeida M.D., Serra-Majem L., 2009. Availability of Mediterranean and non-Mediterranean foods during the last four decades: comparison of several geographical areas. Public Health Nutrition; 12 (9A):1667-75.
Vasilopoulou E., Dilis V., Trichopoulou A., 2013. Nutrition claims: a potentially important tool for the endorsement of Greek Mediterranean traditional foods. Mediterr J NutrMetab;6 (2): 105 – 111.
Vavilov N.J., 1951. Phytogeographic basis of plant breeding - The origin, variation, immunity and breeding of cultivated plants. Chronica Bot; 13: 1-366.
Vernele L., Bach-Faig A., Buckland G., Serra-Majem L., 2010. Association between the Mediterranean diet and cancer risk: a review of observational studies. Nutrition and Cancer; 62(7): 860–870.
Vieux F., Darmon N., Touazi D., Soler L.G., 2012. Greenhouse gas emissions of self-selected individual diets in France: changing the diet structure or consuming less? Ecological Economics; 75:91-101.
Wackernagel M., Rees W. E., 1996. Our ecological footprint: reducing human impact on the earth. New Society Publishers, Gabriola Island, British Columbia, Canada.
Watson D., Lorenz U., Hansen M.St., Szlezak J., Zoboli R., Kuhndt M., Wilson C., Mont O., Wittmer D., 2010. Towards a Set of Indicators on Sustainable Consumption and Production (SCP) for EEA reporting. European Topic Centre on Sustainable Consumption and Production (ETC/SCP), Copenhagen.
Weber C.L., Matthews S.H., 2008. Food-miles and the relative climate impacts of food choices in the United States. Environmental Science & Technology; 42(10):3508-3513.
WHO, 2006. Addressing the socioeconomic determinants of healthy eating habits and physical activity levels among adolescents. WHO/HBSC forum. www.euro.who.int/document/e89375.pdf
WHO, 2010. Regional strategy on nutrition 2010–2019. World Health Organisation (WHO); Regional Committee for the Eastern Mediterranean; Fifty-seventh Session, Technical paper EM/RC57/4.http://www.emro.who.int/docs/EM_RC57_4_en.pdf
WHO, 2011. Non communicable diseases country profiles 2011. Global report. www.who.int/nmh/publications/ncd_profiles2011/en/index.html
WHO, 2012. Food security. www.who.int/trade/glossary/story028/en
WHO and FAO, 2003. Diet, Nutrition and the Prevention of Chronic Diseases. WHO Technical Report Series 916. Report of a Joint WHO/FAO Expert Consultation. World Health Organization (WHO) & Food and Agriculture Organization of the United Nations (FAO).
Willett W.C., Sacks F., Trichopoulou A., Drescher G., Ferro-Luzzi A., Helsing E., Trichopoulou D., 1995. Mediterranean diet pyramid: a cultural model for healthy eating. Am J ClinNutr; 61 (suppl):1402S-1406S.
WWF. (2011). Livewell: a balance of healthy and sustainable food choices. UK.
Zazpe I., Bes-Rastrollo M., Ruiz-Canela M., Sánchez-Villegas A., Serrano-Martínez M., Angel Martínez-González M., 2011. A brief assessment of eating habits and weight gain in a Mediterranean cohort. Br J Nutr;105(5):765-75.
Zurayk R, 2012. Can sustainable consumption protect the Mediterranean landscape? In Mediterra 2012. CIHEAM–Sciences Po Les Presses, Paris; 155-193.

Notes

[1] In this Spanish case study, the adhesion of the Spanish population to the MDP would have a marked impact in all the considered environmental footprints. The MDP pattern in Spain would reduce greenhouse gas emissions (72%), land use (58%) and energy consumption (52%), and to a lower extent water consumption (33%). On the contrary, the adhesion to a western dietary pattern would imply an increase in all these descriptors of between 12% and 72%.

Annex 1. Conclusions of the CIHEAM International Seminar "*The Sustainability of Food Systems in the Mediterranean Area*".

Conclusions of the International Seminar
"The Sustainability of Food Systems in the Mediterranean Area"
25-26 September 2012
Malta

CIHEAM - Centre International de Hautes Etudes Agronomiques Méditerranéennes – with the technical cooperation of FAO (Nutrition and Consumer Protection Division) and in partnership with MOAN has organized the International Seminar on "The Sustainability of Food Systems in the Mediterranean Area", held in Malta, from 25 to 26 September 2012. This document summarizes the main issues and makes proposals for actions to be implemented in the Mediterranean basin and highlights concrete projects that can be funded in the coming years.

The main objective of this Seminar, beyond the intrinsic value of the exchanges that took place among the participants (about 70 Euro-Mediterranean experts, senior officials of ministries and international organizations, researchers, etc.), was to provide an innovative approach to reconcile food and nutrition security with sustainability including the use of resources while ensuring the protection of the environment, the adaptation of production systems to climate change, social enhancement and conservation of the Mediterranean diet cultural heritage.

To this end, the participants hope that the recommendations of the seminar will be brought to the attention of the Ministers of Agriculture of the 13 CIHEAM member countries, during their 9th meeting on 27 September 2012.

The participants have also emphasized the importance of the role played by CIHEAM, a privileged space for exchanges and analyses aimed at developing cooperation in the Mediterranean basin, a role that has been confirmed and strengthened in the year 2012 by the 50th anniversary of its establishment.

The participants focused their consultations in two separate sessions:

1. Food Systems and Sustainable Diets: the Mediterranean Diet as a pilot study;
2. Organic and quality schemes: Sustainability challenges and prospects in the Mediterranean Region

Context

The participants in the Seminar have made the following observations about the evolution of food systems in the Mediterranean countries:

Current food consumption and production patterns are not sustainable in the Mediterranean basin due to biodiversity loss, degradation of natural resources, pesticide contamination, climate change, high energy and water consumption, dietary patterns and eating habits changes and high dependency on imports as well as poverty and vulnerability of many rural and urban Mediterranean communities, and particularly the erosion of the Mediterranean diet;

Currently, in the Mediterranean basin, we have multiple burdens of malnutrition - undernourishment, micronutrient deficiencies, overweight and obesity - due to recent and dramatic shift in dietary patterns. The trends of diet-related diseases (*e.g.* overweight, obesity, cardiovascular disease, type 2 diabetes, metabolic syndrome, and certain cancers) are alarming, highlighting the inadequacy of the present food systems and dietary patterns. According to WHO (NCD Country Profiles, 2011), overweight and obesity rates in Mediterranean countries continue to rise;

The protective effect on health of a good adherence to a Mediterranean-type diet has been repeatedly evidenced by scientific and medical studies since the 1960's pioneer Seven countries study;

Consequently, urgent measures are needed to promote and disseminate the global concept of «sustainable diets[1]». For instance, recent scenarios built to model future sustainable agriculture and food consumption acknowledge the necessary changes towards integrated and agro-ecological systems of production as well as a change in the consumption pattern with a higher plant/animal food ratio;

In 2012 the European Commission has presented to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions, «Innovation for sustainable growth: a bioeconomy for Europe», which, among other things, envisages activities to spread information among consumers about food products adopting a scientific approach (highlighting the benefits of nutrition, methods of production and sustainability of the environment) and to promote a healthy and sustainable lifestyle;

In 2008, at the 26th FAO Regional Conference for Europe, it was recommended to promote local and traditional food products as an essential way for realizing food sovereignty and biodiverse and resilient food production. Several member nations urged FAO to direct more efforts towards market access and consumer awareness of high value traditional products, acknowledging that traditional agriculture practices are often the only farming methods possible in difficult agro-climatic areas. Several delegations agreed that "organic" was a quality designation important for consumers and significant for sustainable agriculture and environment, and countries needed FAO support in establishing a regulatory framework for implementing and protecting this designation. Many delegations highlighted the Mediterranean Diet being rich in biodiversity and nutritionally healthy. Indeed, the promotion of the Mediterranean Diet could play a beneficial role in the development of sustainable agriculture in the Mediterranean region.

The traditional and tradition-based innovative food products are a good way to give value to local biosystems, economies and communities and to improve sustainable development;

Sustainable rural development, organic agriculture and geographical indications were mentioned specifically in the First Conference of Ministers of Agriculture held in Venice in 2003 within the framework of the Euro-Mediterranean Partnership. Organic farming and geographical indications are also mentioned together in various international strategic documents concerning Mediterranean region. Furthermore, development agencies, national governments, private operators and NGOs, working on individual and institutional capacity building for the sustainability of agrofood system, are increasingly taking account the many potential synergies between food quality schemes and certification.

The participants also reflected that the «traditional Mediterranean Diet», recognized by UNESCO as an intangible heritage of humanity in 2010[2], should be considered as a model of sustainable diet in the Mediterranean basin, and able to contribute to the sustainability of the agro-food systems around the Mediterranean and to the valorisation of quality products.

As a result of these observations, the participants to the seminar felt that the attention of the Ministers of Agriculture of the 13 member countries of CIHEAM, who will meet on 27 September 2012, should be drawn particularly on the increasingly unsustainable situation of food systems around the Mediterranean affecting a large proportion of citizens who currently reside in the Southern and Northern Mediterranean, and on methods and strategies to be adopted to reverse this negative trend.

***

Proposals for an action program

The participants agreed that actions to be undertaken in order to change this situation are urgent and represent the conditions to permanently modify the observed processes and to develop and implement new strategies for achieving sustainable food systems in the Mediterranean. They relate in particular to:

The previous statements made by the CIHEAM's countries Ministers of agriculture in 2008 and 2010, summarized by their final declaration in (Istanbul, May 8, 2010), reporting that it is necessary to: "…*Work to promote a healthy and sustainable regional food production system following the standards of the Mediterranean diet that foster the spirit of conviviality and favour consumption of local and seasonal products, particularly by encouraging regional networks to support public decisions for the protection, promotion and marketing of Mediterranean products and the development of environmentally sound agricultural production systems*…".

The need to reconcile food and nutrition security and sustainable use of resources while ensuring the local food demand and the protection of the environment, and resilience of production systems to climate change and their contribution to its mitigation;

The sustainability of Mediterranean food systems, which represents an important area of thinking and action for governments and international organisations, should replace the short-term approaches. In this context, the use of certification and quality assurance measures (geographical indications, organic agriculture, PDO, etc.) is a very effective means of adding value to products in local and international markets.

***

Activities to be developed

Session I
Food Systems and Mediterranean Sustainable Diets:
The Mediterranean Diet as a pilot study
with technical collaboration of FAO

Activities must envisage the implementation, in the 13 member countries of CIHEAM and also member States of FAO, of a pilot project to develop **"Guidelines for improving the sustainability of diets and food consumption patterns in the Mediterranean area"**. The Mediterranean diet, in its various national forms, will be used as a model to describe, understand and improve the sustainability of current diets and food systems.

In order to assess this sustainability, specific indicators should be identified and further developed to be applied to the different 13 CIHEAM's member countries. These indicators will be used,

in a first step, to characterize the current production and consumption systems in the various Mediterranean countries and, in a second step, to identify the changes needed to achieve both production systems and consumption patterns with noticeably better sustainability and resilience. Measures to protect and improve the Mediterranean diet are expected. Scenarios will be constructed through modelling various options. This will form the basis to formulate recommendations for cross-sectoral policy instruments allowing the improvement of the sustainability of Mediterranean food systems and food consumption patterns.

A previous technical workshop and an international seminar gathered 51 experts in CIHEAM-MAI in Bari in 2011 to launch a first exchange on the necessary indicators to be implemented for that purpose. This Task Force already raised a first list of possible and relevant indicators in four domains, environment and natural resources; economy; society and culture; nutrition, health and lifestyle. An action plan was also proposed.

These indicators could also be used to assess the sustainability of diets in other parts of the world.

***

Session II
Organic and quality schemes: Sustainability challenges and prospects in the Mediterranean Region
in partnership with MOAN

Concerning quality schemes for agricultural products and foods it is suggested to:

foster cross-border exchange and public-private permanent dialogue through the strengthening of specific **Network initiatives** focussing on quality schemes and labels (*e.g.* organic agriculture and local identity products) with promising export potential and significant positive implications for the development of local communities and territories;

establish a cross-border, intergovernmental **Mediterranean Gateway** on quality schemes as well as enhancing bioeconomy through: i) facilitating continued access to up-to-date information on food quality rules, standards and practices changes; ii) providing technical assistance and capacity building to institutional and corporate actors; iii) supporting the design of adequate policies for the integration of Mediterranean small and medium producers and processors into global food quality supply chains; iv) promoting equivalence and local ownership of food quality standards and schemes; v) furthering synergies and complementarities between quality schemes; vi) linking research and enterprising (and clusters) to enhance innovation in agro-food.

Notes

[1] "*...Sustainable diets are those diets with low environmental impacts which contribute to food and nutrition security and to 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 and human resources*." FAO/Bioversity International (2010). Biodiversity and Sustainable Diets - United Against Hunger. Report of a scientific symposium; 3-5 November 2010, Rome.

[2] « … *derives from the Greek word "diaita" – way of living – it is a social practice based on "know-how, knowledge, and traditions ranging from the landscape to the table and that concern, in the Mediterranean basin, cultures, harvest, fishery, conservation, preparation, cooking and, in particular, the way of consuming*» (UNESCO, 2010).

Part Three

Policy paper

Abstract. One of the main outcomes of "Feeding Knowledge" Programme, a strategic initiative of Expo Milano 2015 jointly planed, co-funded and implemented by CIHEAM Bari and Politecnico of Milano – METID, is a policy paper giving some advice on suitable policy options for establishing a sound knowledge system for food security in the Mediterranean, based on the recommendations of the scientific experts gathered in the "Feeding Knowledge Network" and on the main needs of target countries collected by the Local Points of the Programme. The Paper is the result of a long participatory process, made up of several steps, namely: preliminary draft based on the main recommendations outlined in the five "white papers" and on the results of stakeholders interviews in target countries (200 stakeholders reached); open consultation on www.feedingknowledge.net (that reached 2000 members of FK network); discussion with policy makers, institutional actors and stakeholders from more than 15 Euro-Mediterranean countries on the occasion of an ad-hoc event held in January 2015 in Rome, hosted by the Italian Ministry of Foreign Affairs and International Cooperation. The key messages of the policy paper have been presented at Expo Milano 2015 during the Award Ceremony of the Best Sustainable Development Practices, on July 6th, 2015. This article presents the integral text of the policy paper.

Keywords. Knowledge system – Food security – Food policies – Euro-Mediterranean cooperation.

Document d'orientation

Résumé. *L'un des résultats les plus importants du programme Feeding Knowledge, une initiative stratégique d'Expo Milano 2015, développée, cofinancée et mise en œuvre par le CIHEAM Bari et le Politecnico di Milano – METID, a été l'élaboration d'un document d'orientation proposant des options politiques pour l'établissement d'un système de connaissances solide en matière de sécurité alimentaire dans la région méditerranéenne. Le document a été conçu à partir des recommandations formulées par les experts scientifiques réunis dans le réseau de Feeding Knowledge et en prenant en compte les principaux besoins des pays cibles recueillis par les Points locaux du programme. Ce document est le résultat d'un long processus participatif, articulé autour de différentes étapes : un avant-projet rédigé sur la base des recommandations contenues dans les "livres blancs" et des résultats des interviews des acteurs dans les pays cibles (au total, 200 acteurs) ; une consultation ouverte sur le site www.feedingknowleldge.net (qui a mobilisé 2000 membres du réseau FK) ; une discussion avec les décideurs politiques, les acteurs institutionnels et les parties prenantes, provenant de plus de 15 pays euro-méditerranéens – à l'occasion d'un évènement spécialement prévu et organisé à Rome, en janvier 2015,auprès du Ministère italien des Affaires étrangères et de la Coopération internationale. Les principaux messages du document d'orientation ont été présentés à Expo Milano 2015, lors de la cérémonie de remise des prix pour les Meilleures pratiques de développement durable, qui s'est tenue le 6 juillet 2015. Dans cet article, nous allons présenter le texte intégral du document d'orientation.*

Mots-clés : système de connaissances, sécurité alimentaire, politiques alimentaires, coopération euro-méditerranéenne

Feeding the Mediterranean through knowledge

Felice Adinolfi[1], Damiano Petruzzella[2], Marinella Giannelli[2]

[1] Università di Bologna,
[2] CIHEAM Bari

I – 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 this 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".

II – 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.

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.

III – A picture of knowledge and innovation transfer in the Mediterranean

In the last decades, the resources allocated to research and development in agriculture have 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.

IV – 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.

V – 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:

1. 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.

2. 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.

3. 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.

4. 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.

5. 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.

VI – 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.*

References

Birner R., Davis K., Pender J., Nkonya E., Anandajayasekeram P., Ekboir J., Mbabu A., Spielman D. J., Horna D., Benin S., Cohen M., 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., La Rocca G., Longordo S., 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., 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., Leeuwis C., 2008. "Matching demand and supply in the agricultural knowledge infrastructure: experiences with innovation intermediaries", *Food Policy* 33 (3): 260–276.

Klerkx L., Hall A. Leeuwis C., 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., Pinch T., 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., Wagemakers W. A .E., (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., 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., 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/9304887-1377201212378/9305896-1377544753431/1_AnnualReport2013_EN.pdf

Notes

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