Regional action program on 'water resources management': an overview of actions towards better water use in Mediterranean agriculture

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REGIONAL ACTION PROGRAM ON "WATER RESOURCES MANAGEMENT": AN OVERVIEW OF ACTIONS TOWARDS BETTER WATER USE IN MEDITERRANEAN AGRICULTURE

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INTRODUCTION

The complex dimension of the Mediterranean freshwater resources, their fragility and scarcity have received considerable attention as a primary political, technical and scientific issue in many occasions during the last decade (Dublin, 1992; Rio, 1992; Barcelona, 1995; Stockholm, 1996 and 2001; Turin, 1999; the Hague, 2000) and also recently during the Johannesburg World Conference on Sustainable Development in August 2002 and the 3rd World Water Forum held in Kyoto in March 2003. All these Conferences and meetings have emphasized that the water perspectives in the Mediterranean region are concerned by two fundamental issues: the continuously growing water demand, on one hand, and the chronic water scarcity and expanding problems of pollution, on the other one. Both these issues are interrelated into the complex water functions and affected by unfavorable regional climatic conditions and other environmental and socio-economic factors having frequently triggering effects.

In fact, in the Mediterranean, water is the major factor limiting agricultural development under both “rainfed” and ”irrigated” conditions. In the most areas of the region, water resources development has reached near to maximum exploitation level and agriculture faces the challenges to produce more food for inexhaustible population growth, while maintaining almost unchanged land and water input. This challenge becomes exceptionally important for arid and semi-arid areas of the Mediterranean, where agricultural production is strictly related to irrigation and where, in many places, the maximum employment of resources has already achieved.

Nowadays, traditional solutions relying on the construction of dams, reservoirs and aqueducts to capture store, and move ever-larger fractions of freshwater runoff are questionable as most of the available water resources are already withdrawn and are under use. Moreover, this approach based on physical solutions is facing increasing opposition for environmental, economic and social reasons. Therefore, the resolution of the problem should be searched not in the increase of water supply for agricultural use but in "water demand management", i.e. in water saving and better employment of already existing resources. This requires considerable efforts in the modernization of irrigation systems and in the development of sustainable management activities which are compatible with the technical, financial and socio-economic capabilities of irrigation sector in Mediterranean environment.

Nevertheless, the lack of personnel with the appropriate technical and managerial skills for the use of advanced technological tools and implementation of modern management strategies are among the major constraints for achieving “more crop by drop”. Consequently, to achieve the goals of improved and more efficient agricultural production, it is needed to transform the concepts of water efficiency improvement and water saving in agriculture into implementation policies, programs and actions on the ground in the countries which are particularly affected by water shortage problems.

During the last decade, the Mediterranean Agronomic Institute of Bari (IAMB) has been developed several programs and research projects focussed on the water saving in irrigated agriculture in the Mediterranean region. Among them, a particular attention has been given to the Regional Action Program on "Water Resources Management" (RAP-WRM) carried out by the CIHEAM-Bari Institute within the frame of the EU DG I activities. This program, started in 1998 and lasted for almost 5 years, has involved , beside the Bari Institute, the most important scientific institutions and experts in irrigation sector from the Mediterranean region. This work aims to synthesize main considerations and objectives of the RAP-WRM program as well as to present the outputs and results achieved during its realization.

MAIN CONSIDERATIONS OF RAP-WRM

The Southern Mediterranean, comprehending the Northern African and Near East countries, is the poorest region in the world in terms of water resources, globally and per inhabitant. In many countries of the region, annual water withdrawal has reached or already exceeded total annual renewable water resources (e.g. Egypt, Libya, Palestine, Israel, Jordan, Syria, Malta, Tunisia) and further employment of resources is unrealistic from both technical and socio-economic point of view (Figure 1). In the region, population growth is among the greatest in the world (up to 2.5%) and agricultural production relies almost completely on irrigation: in the Northern African region, irrigated agriculture consumes in average about 85% of total annual water withdrawal (FAO, 1997), and, in some countries (e.g. Egypt, Morocco, Cyprus), water use for irrigation approaches even 90% as illustrated in Figure 2.

However, crop yield and efficiency of water use in agricultural sector are typically less than originally projected and less than reasonably achieved. As it is highlighted by the FAO (2000), average losses in irrigation projects is nearly 55% and only about 45% of water diverted or extracted for irrigation is effectively used by crops (Figure 3). The major causes of the low irrigation efficiencies are factors related to mismanagement of irrigation schemes causing deep percolation, waterlogging and evaporation, and the lack of adequate maintenance provoking deterioration of the irrigation systems, leakage and clogging problems, etc.

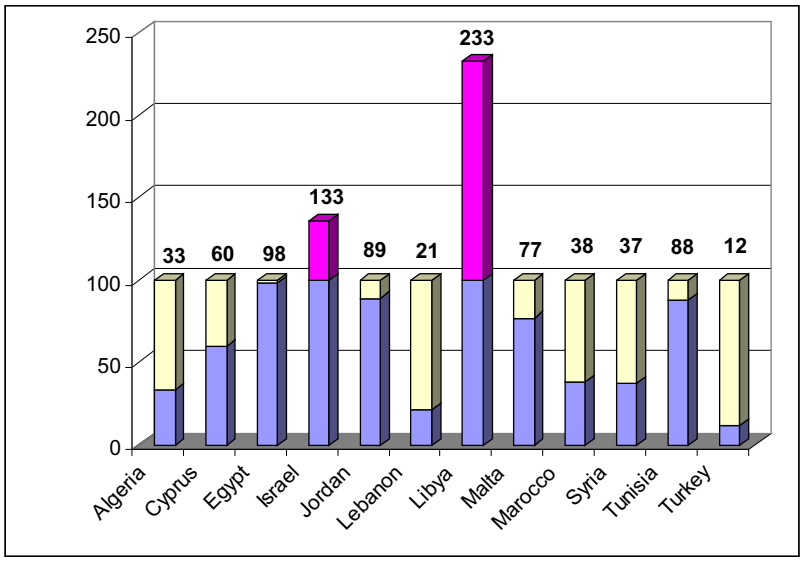

Fig. 1. Water withdrawal as percentage of internal renewable water resources (Sources: FAO, 1995, 1997; Hamdy and Lacirignola, 1999)

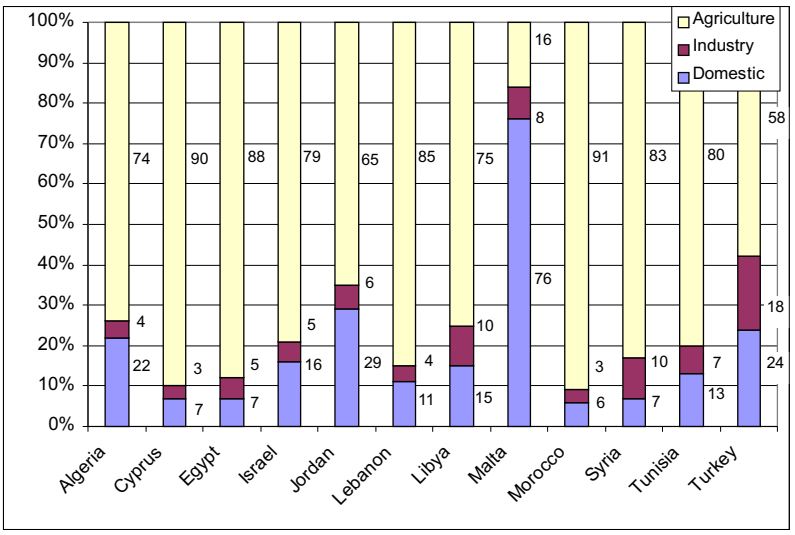

Fig. 2. Water consumption by sector in the Southern Mediterranean countries (Sources: FAO. 1995, 1997; Hamdy and Lacirignola, 1999)

The projections of food and water demand in the Mediterranean indicate, for the period 1990-2025, a population increase in the Southern Mediterranean countries of almost 100% with the corresponding increase of water demand of approximately 50% (United Nations 1994; World Bank, 1994). At present, the irrigated areas in the Mediterranean account for more than 16 million hectares with a growth rate stabilized, at the beginning of the nineties, to around 200,000 hectares per year. This requires an additional supply of water for agriculture by a rate of 2 km^3/year. However, regardless of these specific causes, existing situation is not amenable to cope with the spiraling increases in food and water demand due to water and land shortage in the region.

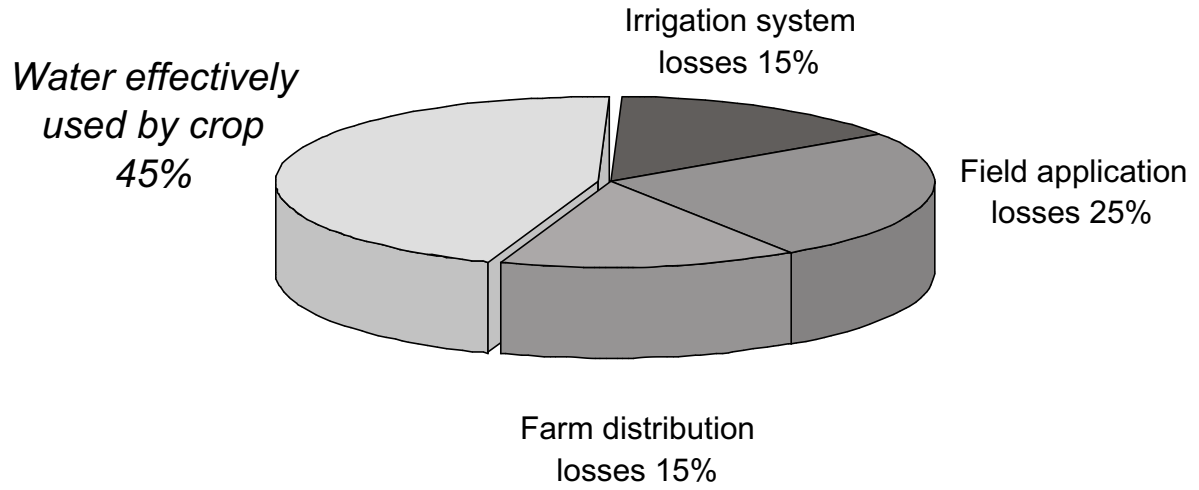

Fig. 3. Average losses of irrigation water (Source: FAO, 2000)

Therefore, most of the water savings would be made in the agricultural sector to meet the growing water demand for irrigation and other sectors. This is not only because irrigation takes the highest share of total water use, but also because it has considerable potential for efficiency improvement. In typical traditional irrigation schemes as little as 40 percent of applied water may be used for covering crop evapotranspiration, while modern schemes, and there are examples of this within the region, can achieve project efficiencies of about 65 percent. Assuming a typical situation where 80% of total water is used for agriculture, a 10 percent increase in the efficiency of irrigation would provide 40% more water for municipal and industrial use. This is a good illustration of the potential for water savings in agriculture and the need to press for it. The Regional Action Program on "Water Resources Management" (RAP-WRM) is based on the above considerations and aims at implementation policies, measures and actions for better management of water and land resources in irrigated agriculture.

RAP-WRM: OBJECTIVES, ACTIVITIES AND MANAGEMENT

The Regional Action Program on "Water Resources Management" (RAP-WRM) represents a part of a larger Program developed by CIHEAM and its four Institutes within the frame of EU DG I activities. The overall objectives of the whole program are human resources development, institutional capacity building and the improvement of regional cooperation in the agricultural sector through training, promotion of research and communication of scientific and technical information, with particular emphasis on sustainable agriculture and the transition to a more open and competitive market economy. The action programs are derived into 4 RAPs (each assigned to one of four CIHEAM Institutes) for training and for creation of research and information exchange networks based on the concept of "open centres" (centres without walls) in the following areas: water - irrigated agriculture (IAM-Bari), rainfed agriculture (IAM-Saragossa), food and agricultural policy including legislation aspects (IAM-Montpelier) and renewable natural resource preservation and utilization (IAM-Chania). The expected results of the whole program are: a better understanding of regional planning and its implementation, a more efficient regional cooperation and better information exchanges in the Mediterranean basin (South-South and North-South), an improved understanding and coordination of regional economies and compatible marketing policies necessary to facilitate economic transitions in the region.

The Regional Action Program on "Water Resources Management" (RAP-WRM), developed by MAI-Bari, aims to improve the institutional capacity building, human resources development and regional cooperation and exchange of experiences in the field of water resources and irrigation. The RAP-WRM is based on the concept of water demand management and it is oriented to the sustainable use of water resources in agricultural sector emphasizing technical, social and economic aspects through the following major issues (Figure 4):

Water use efficiency at farm scale;
Design, performance evaluation and management of collective irrigation systems;
Use of non-conventional water resources in agriculture;
Participatory Irrigation Management (PIM); and
Economic aspects of water mobilization and use.

The strengthening of regional co-operation and exchange of experiences between the Southern and Northern rim of the Mediterranean have been carried out through the following activities:

training (advanced short course and MSc mobility program),
promotion of research (networking and demonstration research projects),
workshops and courses for decision makers (in PIM, economic aspects of water mobilization and use and gender issues) and
logistic support - information technology development and transfer in Southern Mediterranean countries.

The program covers 10 Southern Mediterranean countries (Algeria, Cyprus, Egypt, Jordan, Lebanon, Malta, Morocco, Syria, Tunisia and Turkey) and is divided in two phases: the first, where it is coordinated exclusively by Bari Institute and the second, where a decentralization of activities towards Southern Mediterranean Institutions (National Water Research Center, Cairo, Egypt) has to be done.

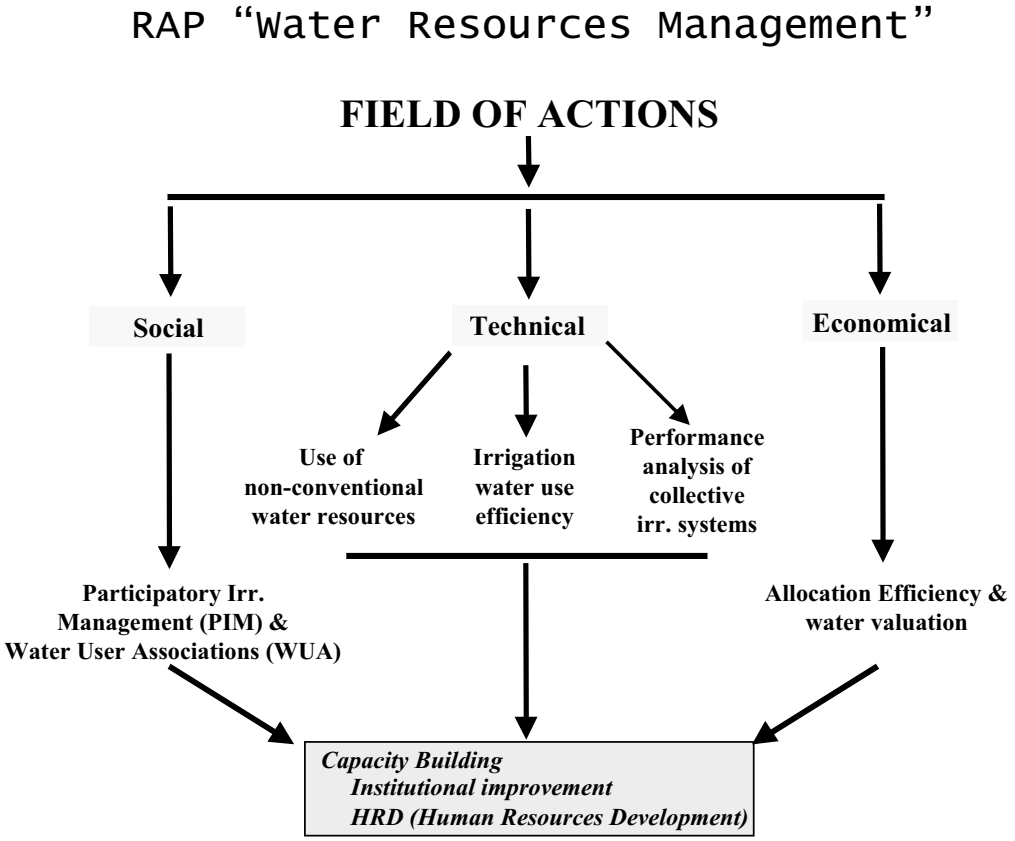

Fig. 4. Field of actions of RAP-WRM

The RAP is managed by two bodies, having complementary roles:

a) The Orientation and Management Committee (OMC)
b) The Thematic Work Group (TWG)

The OMC is composed of 13 members and activity is shared among the 4 RAPs. The role of OMC is to define:

the structure and modus operandi of the program
the basic outlines of the chosen themes
the nature and relative importance of proposed actions
the commitments of the main partners

The TWG is composed of 8 members and its role is:

to elaborate, on the base of the global framework proposed by the OMC, an operational structure for each RAP
to develop detailed actions programs as per directions laid down by the OMC
to define the structure and the mandate of the specialised ad hoc groups that will prepare each action
to specify the contribution and the role of each partner

The overall results and outputs of the activities carried out under the RAP-WRM Program are summarized here after:

RAP-WRM: OUTPUTS AND RESULTS

Training - Advanced Short Courses

In the period 1999-2002, twelve advanced short-term courses were carried out, three in each year, in eight different Southern Mediterranean countries (Algeria 1; Egypt 2; Jordan 1; Lebanon 1; Malta 1; Morocco 2; Tunisia 2; Turkey 2) beneficiaries of the RAP. The themes for each course were defined in accordance with the overall and specific objectives of the RAP-WRM and in cooperation and agreement with the regional partners taking into consideration:

the whole set of priority actions for water saving in the Mediterranean region as it has adopted in the logical framework - the course's themes were discussed recurrently and included the priority activities of national partners institutions,
specific interest of the countries hosting the course,
recommendations of Technical Working Group (TWG), and
thematic link among proposed topics and among them and collaborative research networks and overall RAP objectives.

The co-organising institutions are selected among the national partners of RAP-WRM able to provide adequate logistic support, dissemination of information and visibility of activities at both national and regional scale.

The course's topics endorsed the most important subjects for the implementation of water saving strategies in the Mediterranean agriculture (e.g. agricultural water demand management, use of non-conventional water resources in irrigation, water use efficiency and water productivity, etc.) while introducing new modeling tools and information technologies (e.g. Geographical Information Systems, crop growth modeling, water distribution modeling, etc.). The themes of the courses have evoked the multidisciplinary approaches and they were strongly linked to the network activities of RAP-WRM which has affirmed the networks themselves and reinforced and enlarged their impact in the Mediterranean region. The emphasis was given not only to the technical aspects, but equally so, to social, economical and environmental aspects, the major components of integrated water resources management approach. Particular attention has been given to the capacity to create arrangements for, and launch a process towards, integrated water resources management (IWRM) as a basis for competition resolution and capacity for dealing effectively and efficiently with the complex water challenges considering broad socio-economic, environmental and political contents. Moreover, the hosting country specific water resources problems have been elaborated through the presentation of case-studies, visits to water conservation and distribution systems, water treatment plants, irrigation systems and hydraulic structures and local units aiming at the use of modern technologies. Furthermore, the courses have offered a practical technical program at the experimental fields, laboratory work and computer exercises. The discussion sessions, round-tables, and workshops organized within the frame of the courses with the local water authorities highlighted clearly weak points (nodes) of local water management strategies and

helped to identify priority actions and programs for implementation. It is shown that the water resources problems in the Mediterranean region are similar elsewhere and that the strengthening cooperation and exchange of experiences could be one of the major forces in coping with water scarcity in the region.

The advanced short courses have generated high interest in the Mediterranean region. A total number of 709 candidates applied for admission to the courses which confirms the importance and attractiveness of proposed themes on water resources management. Among them, almost half (347) were selected to follow the courses. The participants in the courses belong to 15 Mediterranean countries and 3 other countries as illustrated in Figure 5. 318 participants (or 91.6%) belong to the beneficiary countries of the RAP which greatly exceeds the threshold of 240, posed in the RAP logical framework.

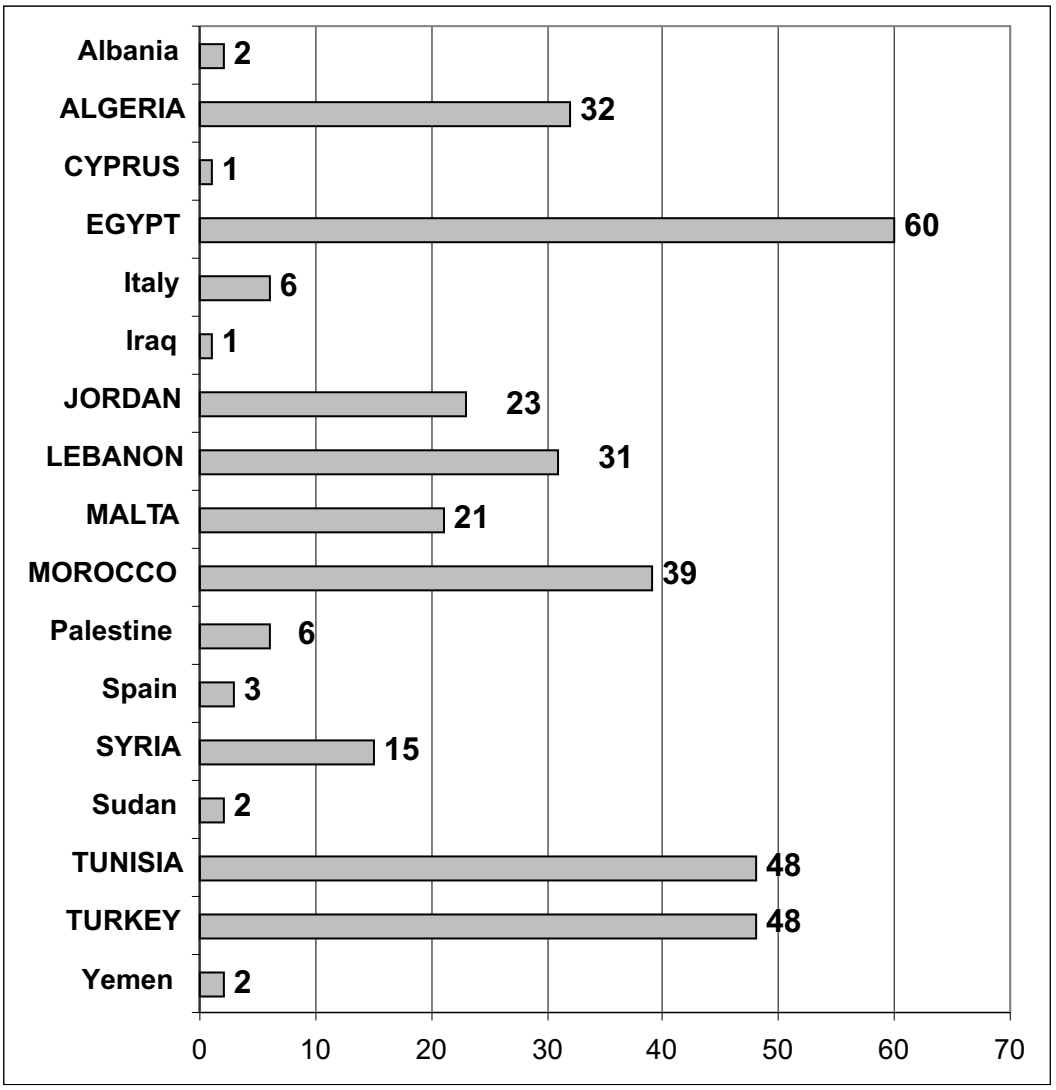

Fig. 5. RAP-WRM advanced short courses: participants per country (N.B. The countries beneficiaries of the program are written in capital letters)

The participation of the candidates from Italy, Spain and Portugal demonstrated the high interest for the course's topics in the Mediterranean region. Moreover, it has contributed to the exchange of experiences between participants from both Northern and Southern Mediterranean countries which, in turn, can reinforce the South-North cooperation in the Mediterranean region.

The profile of the course's participants ranges from researchers and university assistants to water and irrigation engineers, rural development managers and governmental officers, as well as the representatives of the private sector (Figure 6). Practically, the courses provide "training of trainers" of different profiles which should induce multiplier effects in the future.

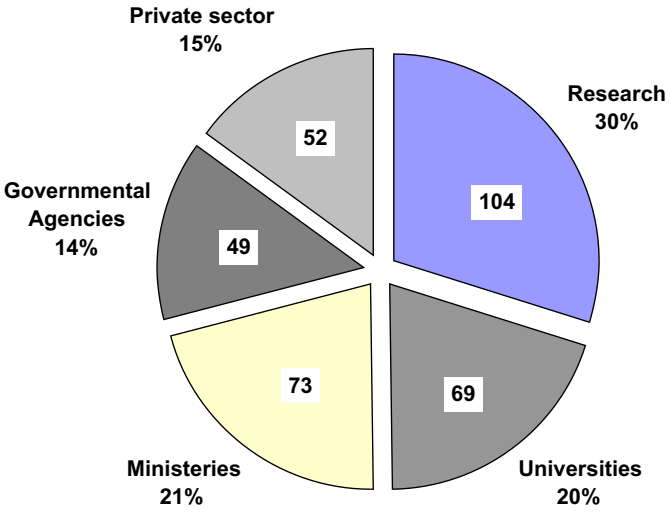

Fig. 6. RAP-WRM advanced short courses: professional profile of the participants

The lecturers were not only university professors but also high qualified specialist and researchers in irrigated agriculture, water development officers, irrigation managers and highly qualified personnel from the private sector. This allows for the elaboration of the problems from different points of view (i.e. an integrated approach) which has given an added value to the courses and has increased the interest to the courses.

The proceedings of the courses, prepared and distributed to the participants at the beginning of each course, consist of a complete documentation related to the course themes. High interest was expressed to the proceedings and they were distributed on request in more than 100 copies per course also to local scientific institutions and to some regional and international organizations (e.g. FAO, ICARDA, IFAD). Moreover, beside the participants, many lectures were followed informally by local scientists and managers. This additionally reinforced the impact of the courses and insured further dissemination of information related to the specific water management topics.

MSc Mobility Program

Mobility of trainees is a new strategy in training of water and irrigation professionals which should play an important role in the improvement of cooperation not only between Southern and Northern Mediterranean universities and scientific institutions but also among the Southern Mediterranean institutions themselves. The mobility scholarships had to enable trainees at Master level to undertake studies at institutions which will further strengthen their knowledge base and improve carrier prospects. This type of cooperation allows for exchange of researchers and, therefore, ideas which helps in development of better water management strategies and transfer and integration of local approaches into actions at the regional scale. Twelve eminent Mediterranean Institutions from Egypt (National Water Research Center - Cairo; Central Laboratory for Environmental Quality Monitoring - Kanater; Drainage Research Institute - Cairo), Italy (University of Catania; University of Trieste; National Research Center - CNR, Bari; Polytechnics of Bari), Lebanon (Saint-Esprit de Kaslik University, Beirut; ESIAM, Tamail), Morocco (IAV Hassan II, Agadir), Tunisia (INAT, Tunis) and Turkey (Cukurova University, Adana), are selected to host the fellows and assist them in conducting research programs. Research hosting institutions and research topics included in the mobility scholarship program were selected to fit into RAP research program and network activities and to improve the cooperation in the Mediterranean region.

The selection of mobility scholarships was done respecting the academic results of the DSPU course of the candidates, the coherence of the proposed thesis protocols with the objectives of RAP-WRM, the availability of necessary on-site equipment and the reference and scientific quality of the hosting centres. The emphasis is given to the cooperation between South-South scientific institutions, and thereby allowing the candidates to work under local conditions on some of concrete problems already existing in their countries of origin and highly related to the RAP program research activities.

The mobility program was fully completed with 19 trainees from 6 beneficiary countries (Algeria 1, Egypt 6, Lebanon 2, Morocco 4, Tunisia 3, Turkey 1) and Palestine (2), which is in agreement with the logical framework indicating a minimum of 16 Master thesis.

The research themes cover the most important subjects for the implementation of agricultural water demand management, improvement of irrigation efficiency and water saving in the region (e.g. use of saline water, treated waste water and recycled drainage water for irrigation) while introducing new information technologies and modern modeling tools (e.g. Geographical Information Systems, Decision Support Systems, expert systems, etc.). Moreover, the environmental (e.g. the case study of Aswan Dam in Egypt) and socio-economic aspects (e.g. the case study on Participatory Irrigation Management in Turkey) of water management in agricultural sector are treated within this program.

The mobility of trainees resulted in reinforcement of cooperation between Southern scientific institutions (e.g. IAV Hassan II, Morocco and INAT, Tunisia) and establishment of cooperation between Southern and Northern Institutions (e.g NWRC, Cairo, Egypt and University of Trieste and University of Catania). The mobility scholarships, particularly South-South mobilization, have created stronger linkages between scientific institutions and universities while giving the candidates better opportunity for working on concrete problems interesting the majority of developing countries in the region. Furthermore, it is expected that the mobility program contributes in the recognition of the MSc degree awarded by CIHEAM-IAMB in the majority of the Mediterranean countries and, also, in promoting the mutual recognition of diplomas obtained at different universities and scientific institutions throughout the Mediterranean region.

The mobility of trainees supports the "brain-drain" as some students continue their scientific carrier on the PhD programs in the EU universities. Finally, it is important to stress that the mobility program was opened also to the private organisations - however, there was no request from them to participate in it. The main reason for it could be the long duration of the mobility program which discourages the participation of the fellows from the private sector.

Cooperative Research Networks

The main objective of the "Water Resources Management" Collaborative Research Network is to provide scientific and technological know-how for investigated issues of water saving in the Mediterranean irrigated agriculture and, in such a way, contribute in improvement of human resources development and institutional capacity building in the region. Specific objectives are related to three Sub-networks of RAP-WRM (Figure 7)

Non-conventional Water Resources Management (NWRM);
Water Use Efficiency (WUE); and
Collective Irrigation Systems (CIS);

which, respectively, aims to promote:
sustainable use of non-conventional water resources, including brackish and treated wastewater and re-cycled drainage water;
increased crop water use efficiency and productivity in irrigation - more crop per drop;
improved water distribution management and performances of irrigation systems.

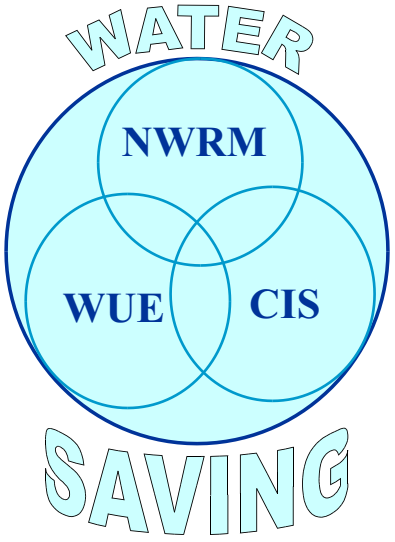

Fig. .7 "Water Resources Management" Collaborative Research Network: an integrated approach for water saving in irrigation agriculture

The research activities for each sub-network were planned in agreement to the specific objectives of each research theme and following the general and specific objectives of the Logical Framework of RAP on "Water Resources Management" and recommendations of the external Mid-term Evaluation Report (September, 2000). Four major lines of interventions are agreed with the network's members in order to alleviate some priority problems of Southern Mediterranean countries and to contribute strongly to the realization of the overall RAP objectives:

i development of human resources qualified and knowledgeable in understanding the basics of the network domains, using the data base information system and operating the information technology platform;
ii carrying out specific research works to fill in gaps in scientific information within the domains of interest;
iii realization of database information systems on each network domain;
iv implementation of an information technology platform for analysis, elaboration and interpretation of agricultural scenarios.

These Sub-Networks were already established before the RAP started and they represent the continuity with previous EU-CIHEAM programs, based on the priority issues of water management under scarcity conditions in the Southern Mediterranean countries, i.e. necessity for water saving in irrigated agriculture. During the Phase I of RAP (1998-2000), it is planned that the three sub-networks should act as three parallel research lines and in the second phase of RAP (2000-2002) they have to be integrated within one umbrella of research project WASIA to facilitate exchange of information and strengthen new strategies for water management in the region.

The rationale of the programd action-plan is in the recognition that fresh water resources are finite and limited, the potential for their further exploitation is marginal and the quality of water is continuously degrading. Furthermore, the management of collective irrigation systems requires revision and optimization of operation under dynamic changes of farming conditions and practices. Consequently, the NWRM-Net is engaged in water quality issues, the WUE-Net is engaged in water use efficiency issues and the CIS-Net is engaged in performance analysis of collective irrigation systems. They all integrated and exchange their approaches under the "Water Resources Management" Collaborative Network. The integration of Sub-Networks into an overall "Water Resources Management" Collaborative Network should denote the “soul” of RAP promoting, designing, generating, integrating, expanding and intensifying all other actions of RAP such as training and mobility, aid to decision making, workshops and seminars.

The overall results and outputs of the activities carried out within the all three sub-networks of the RAP-WRM in the period 1998-2002 can be summarized as:

the involvement of 32 scientific institutions from 15 countries (among them all 10 countries beneficiaries of the RAP) with the participation of 66 scientists;
experimental work has been carried out not only at the experimental fields, lysimeters and greenhouse of IAMB but also at the experimental sites in Morocco (IAV Hassan II, Agadir), Egypt (NWRC, Cairo), Syria (ICARDA, Aleppo), Tunisia (INAT, Tunis; IRESA, Bizerte), Turkey (Gaziantep Pistachio Research Institute), Italy (Faculty of Agriculture, Catania; Bonifica della Capitanata, Foggia), etc.;
a Crop Database containing information about 8 Mediterranean strategic crops was developed together with a crop growth and productivity model and an interface linking the crop growth and productivity model and the Geographical Information System (GIS);
a database on the performances of collective irrigation systems was developed together with a user friendly software package for the analysis of collective irrigation systems and demand hydrograph generation;
one Information Manual on the software package was published;
guidelines for the use of treated sewage water in agriculture has been prepared and published
68 MSc students from 9 countries (Algeria 4; Bosnia and Herzegovina 1; Egypt 15; Lebanon 12; Morocco 14; Palestine 5; Syria 1; Tunisia 11; Turkey 5) were completed their MSc work on the topics of the Network and under the supervision of the members of the Network
12 advanced short courses were organized with the participation of 347 trainees from 18 countries - more than 100 copies of proceedings are distributed in the occasion of each course
7 annual meetings of three Sub-Networks were held
23 bilateral meetings of the network partners were carried out
131 scientific papers were published in scientific journals and proceedings of conferences, workshops, advanced short courses, etc.
three books and 24 special publications are also published.

Research topics and activities, carried out under each of three sub-networks, have been tailored to the specific problems faced by the developing Mediterranean countries and aimed at satisfying the real needs of the region, for the benefits of development and cooperation, while maintaining the straight link with other activities within the RAP-WRM. Research activities have contributed for enhancement of cooperation not only with the national research institutes but also with some international organizations (FAO, ICARDA, IFAD) which have provided opportunities for expanding the action programs. For example, the NWRM-Network is one of the members of IPTRID (the International Program for Technology and Research in Irrigation and Drainage) Network - working actively with other IPTRID networking organizations and institutions (FAO, ICID, CEMAGREF, ILRI, HRW and IWMI). Also, the WUE-Network has established a concrete cooperation with the FAO in the field of water use efficiency and crop water requirements, through the exchange of information in this fields and the presence of Bari Institute, as observer, in the scientific meetings held by the FAO. Furthermore, the importance of the research results of CIS-Net have yielded in the joint publication of the FAO Irrigation and Drainage Paper N°59. The network activities are interconnected also with a series of other initiatives in the region including the Global Water Partnership - MED Network which has water saving in the Mediterranean countries as one of its primary objectives.

Whenever possible, the Research networks tried to mobilize the private sector to cope with certain problems which are of importance in water resources development and management. A successful example of this is the CIS-Net which, in cooperation with private companies, developed a new technology to improve irrigation management through automation system (AcquaCard), which is now introduced in several irrigation projects in Morocco and Tunisia.

The collaborative research networks will be continued on the base of voluntary participation of researchers and scientific institutions and universities. Several Research Projects were submitted and financed beyond the RAP to allow sustainability of network research activities. Among them, the project "BIOWATSYST - a system approach to wastewater biotreatment for the protection of Mediterranean coastal areas" is of particular importance since it was conducted within the frame of NWRM-Net with the participation of partners from six Mediterranean area (Spain, Italy, Greece, Jordan, Egypt, Morocco).

Research Project WASIA (Water Saving in Irrigated Agriculture)

The research project WASIA has been developed during the second phase of the RAP (2000-2002) when it was necessary to transfer some of research findings on the ground in Mediterranean environment. The main objective of the WASIA research project is to develop a conceptual framework for *water saving in irrigated agriculture* of the Mediterranean region through the *integration* of the activities which represent major topics of the three Collaborative "Water Resources Management" Research Networks and aim to:

Improve water use efficiency in irrigation practices (WUE_Net),
Improve performances of irrigation distribution systems (CIS_Net), and
Promote safe and sustainable use of non-conventional water resources (NWRM_Net),

Specific objectives of the project are addressed to the development of 8 (eight) research themes to be carried out at eight different locations in the Mediterranean Region:

1. Deficit Irrigation of orchards with low quality water, (Tunis, Tunisia)
2. Deficit Irrigation of pistachio with different fertigation practices (Southeast Anatolian Region, Turkey)
3. Hydraulics performances of irrigation systems under different irrigation practices (Ghezala-Teskraya, Tunisia)
4. Innovative approach for energy saving in irrigation systems (Souss Massa, Morocco)
5. Reuse of treated wastewater for irrigation of cereals, forage and vegetables by means of different irrigation methods (Agadir, Morocco)
6. Re-cycling of drainage water for sustainable irrigated agriculture (Nile Delta, Egypt)
7. Sustainable use of highly saline water for irrigation of crops under arid and semi-arid conditions: new strategies (Tarsus, Turkey)
8. Development of screening legumes and forage nursery for salinity tolerance (Aleppo, Syria)

The proposed research themes cover some of the most important aspect of water saving in the Mediterranean agriculture and represent the continuation of the collaborative research network activities carried out during the first phase of the RAP. Therefore, it is expected that the outputs of this project should provide a substantial contribution in tracing the way to achieving sustainable agricultural production and food security in the Mediterranean region.

A detailed presentation of the activities carried out under this project will be discussed during the meeting and are included in this volume.

Logistic Support/ICT Activities

The Logistic Support/Information and Communication Technology (ICT) actions aimed at the implementation of an Internet-based "Information System" to promote exchange and dissemination of scientific and technical information in the Mediterranean region. This system has to contribute to the establishment of a permanent co-operation network between Mediterranean institutions committed to develop training and research on "Water Resources Management". For such reasons, the financial resources have been allocated to upgrade scientific equipment, hardware and software in the countries beneficiaries of the program and, in such a way, to contribute in the improvement of human resources development and institutional capacity building in the Mediterranean irrigated agriculture.

In the first year of the project (1998-1999), the Logistic support funds were partially allocated to supply of some testing equipment and on-field instrumentation needed for the realization of research activities within the RAP-WRM. Starting from the second year, the Logistic Support actions were only focused on the upgrade of ICT especially in the centers which did not have adequate hardware and software for proper network collaboration and appeared in a clear disadvantage in respect to other partner Institutions. Accordingly, the following activities have been carried out:

Installation of a web server at the National Water Research Center (Cairo, Egypt);
Supply of 2 internet workstations to the IAV Hassan II Centre Horticole (Agadir, Morocco);
Supply of an info-network to Lebanese Agricultural Research Institute (LARI) (Bekaa valley, Lebanon).

According to priorities determined at TWG level and due to particular request of IRESA (Tunisia), specific training was carried out in Tunisia where 4 short courses on the use of new information technologies, multimedia and distance learning were organized. Training has been mainly focused on the people charged with the management of the ICT and documentation facilities in the collaborating institutions while only 25% of trainees belonged to research sector (Figure 8). Furthermore, a workshop on "Meta-information system for Mediterranean region" was organized in Bari in 2000 with the participation of the persons involved in other RAP sub-projects developed by other CIHEAM Institutes. Moreover, training and cooperation activities have included also the participation on several workshops organized by other Institutions.

The RAP-WRM web site has been developed in both English and French and it is available at URL: http://www.iamb.it/par/. The web-site's structure encompasses the main project's objectives and activities and it is consistent with the other CIHEAM RAP web-sites. On the home page of the RAP WRM web site, a search engine enables the searching on the site with keywords and an e-mail link allow the visitors to send questions or comments. The site contains also the link to all partners participating in the program and to the WASIA research project. The RAP-WRM web is the project's general container of all detailed information and documentation sources and its role is not only the exchange of data among the partners in the RAP but also dissemination of information among all stakeholders involved in water sector in the Mediterranean region. In fact, the web-site has a role of information gateway among the partners and it represents an important data bank (of bibliographic data and research results) for scientific users. The updating of web-site is ensured by the CIHEAM-IAMB webmaster through an efficient information retrieval system agreed by all project's partners and actors.

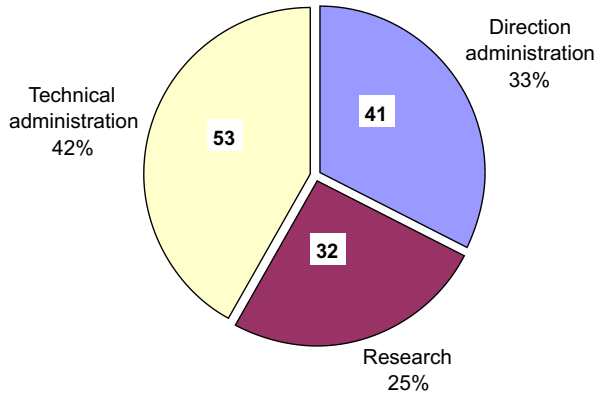

Fig. 8. Logistic Support/ICT training activities: professional profile of the participants

Aid to Decision Making

The aim of this action of the RAP-WRM is to give to decision makers guidelines and strategies for implementing new social and economic reforms in the irrigation sector via appropriate measures such as participatory irrigation management, water valuation and cost recovery, water allocation efficiency, etc. Consequently, two sub-programs have been developed:

Sub-Program I: Participatory Irrigation Management (PIM) and Water User Associations (WUAs)

Sub-Program II: Economic Aspects of Water Mobilization and Use

Participatory Irrigation Management (PIM) and Water User Associations (WUAs)

The overall objective of this program is to stimulate high level policy dialogue on Participatory Irrigation Management in the Mediterranean region leading to a policy commitment programming actions with the specific objectives to introduce policy-makers to the implementation of PIM, learn about best practices from other countries to select the most appropriate corresponding to the socio-economic situation of the majority of the developing countries in the region, and, as a pre-step, to formulate indicative action plan for enhancing participation in irrigation sector. These objectives had to be achieved through the exchange of experience and information during the training courses to be conducted annually at Bari Institute.

The promotion of training of high-ranking civil servants and exchange of information among them, decision-makers and senior managers should help politicians and decision-makers to set up the policies required for a proper PIM implementation at local level. Moreover, the courses organized at IAMB within the RAP-WRM should contribute in devising new training programs that respond to the prevailing socio-economic condition for each individual country parallel to the progressive process of the PIM reform implementation. In fact, on the *regional level*, many countries of the Mediterranean region (Egypt, Albania, Tunisia, Morocco, Turkey and, recently, Lebanon and Algeria) are on their way for PIM reforms and policies implementation with a gradual successful progress.

Three training of trainees (TOT) courses on "Capacity Building for Participatory Irrigation Management" were carried out at the IAMB in 1999, 2000 and 2001, in cooperation with the Economic Development Institute (EDI) of the World Bank, IFAD (International Fund for Agricultural Development) and INPIM (International Network on Participatory Irrigation Management). The World Bank is included in this program since it has a long experiences on the development of the PIM in different regions of the world. The CIHEAM/IAMB and the World Bank have started the cooperation on PIM in 1997 and the RAP-WRM courses on "Capacity building for Participatory Irrigation Management" have become a part of this cooperation since 1999.The program of the courses was composed of lectures, brain-storming workshops, discussion sessions and technical visits to the "Consorzio Bonifica Capitanata" offering to the participants a possibility to exchange the experiences with both technical and administrative staff of Consortia and farmers.

A total number of 209 candidates applied for the participation on three courses which confirms the importance of the subject for water saving and management especially in irrigated agriculture. 142 trainees (67.9%) from 20 countries not only from the Mediterranean region but also from some Asian and African countries are selected to followed the courses. Among them, 83 (or 58.4%) were from 7 Mediterranean countries beneficiaries of the RAP (Algeria 3; Egypt 27; Jordan 3; Morocco 8; Syria 4; Tunisia 21; Turkey 17). The greatest part of the participants from beneficiary countries came from the Ministry of Agriculture (the case of Tunisia and Syria), Ministry of Water Resources and Irrigation (the case of Egypt) and Ministry of Energy and Natural Resources (the case of Turkey). The rest of the participants from beneficiary countries work as coordinators or consultants of the irrigation projects and management units.

The proceedings of the courses, distributed to the participants and, on request, also to many governmental agencies and international organizations, contained five volumes of the complete PIM program including: Handbook on PIM, PIM Case Studies, Country overviews of PIM, PIM in the Mediterranean countries and The Experience of Consortia in Italy.

The courses, aiming at the training of trainers, have resulted in an increasing number of trained people on the national level, improving the local institutional capacity building and enhanced the irrigation management transfer process in many of the developing countries in the Mediterranean and other developing regions of the world. An analysis of the outputs and impacts of the activities on PIM realized in the period 1998-2002, indicated several important points:

a gradual increment, from year to year, in the number of candidatures and participants in the PIM coursesi s a strong indicator of the attractiveness and interest on the proposed program and its wide dissemination in the Mediterranean and other regions of the world (Figure 9);
high interest of the national governments of the developing countries in the running courses - it is the unique program where governments ask for the participation of additional number of candidates more than those officially accepted for the attendance of the course with full coverage of their expenses;
many participants came from the PIM Projects supported by the USAID in the region, as well as those supported by the International Organizations (FAO, World Bank, IFAD) with a complete coverage of the expenses of their participants;
on the request, within the frame of other programs developed by the World Bank, additional special training programs were organized for experts from Kirgyzstan and Uzbekistan in Italy;
the PIM Program of Bari Institute has been presented as a model for implementation in several African countries during the “National Conference on Irrigation” organized by FAO in cooperation with the Ministry of Agriculture and Food Security of Tanzania in 2001, where Bari Institute presented a keynote-paper titled: “Participatory Irrigation Management: Experiences, Gained Benefits and Arising Problems”;
IFAD, where the PIM represents one of priority issues to implement in the developing countries of the region, asked Bari Institute to be the implementation agency for PIM in Egypt, Morocco and Tunisia. This program has started at the beginning of 2002 and it will last for four years, with a total budget of US$ 1,680,000.

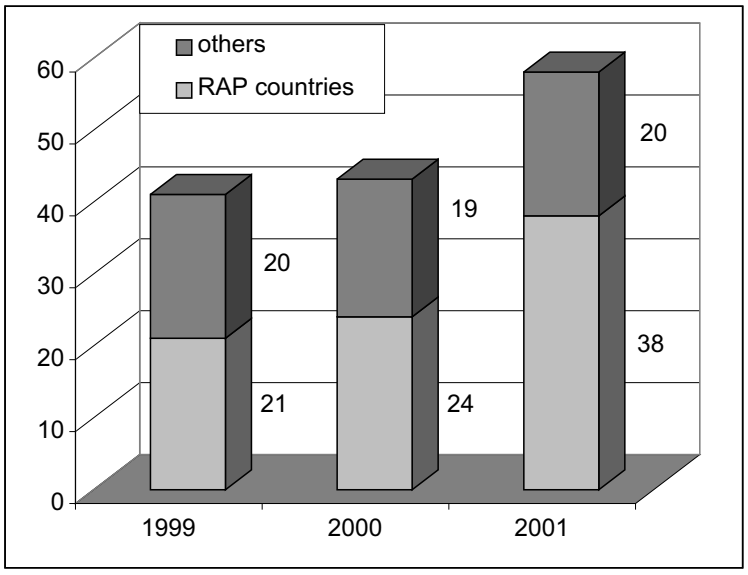

Fig. 9. Evaluation of the number of participants on the PIM courses 1999-2001

Economic Aspects of Water Mobilization and Use

The objective of this program was to give to decision-makers in the Mediterranean region, the opportunity to present, share and discuss various experiences relevant to the subject and to elaborate strategies and plans of actions for implementation of measures which could lead to a better valuation of irrigation water and appropriate cost recovery mechanisms. Furthermore, this program includes also the role of gender in the management of water resources in the Mediterranean and the involvement of women experts working in water sector. Accordingly, two Workshops have been organized:
a workshop on “Water valuation and cost recovery mechanisms in the developing countries of the Mediterranean region” , and
a workshop on "Gender and water resources management in the Mediterranean".

The workshop on “Water valuation and cost recovery mechanisms in the developing countries of the Mediterranean region”, was held in June 2002 in Agadir (Morocco), as a special session of the International conference on "Irrigation water policies micro and macro considerations”. The Conference was followed by more than 200 experts mainly from the Mediterranean region. Among them, 14 decision makers, engineers and economists from 8 beneficiary countries (Algeria 1, Cyprus 1, Egypt 1, Jordan 1, Malta 1, Morocco 3, Tunisia 1 and Turkey 1), Arab Organization for Agricultural Development (1) and

CIHEAM-IAMB (3) participated actively in the session. The session included the keynote presentation on water pricing, cost recovery and water valuation in the developing countries, the presentation of countries experiences and a round table discussion session tracing the guidelines and strategies for implementing new social and economic reforms in the irrigation sector with appropriate economic measures such as water valuation, cost recovery and water allocation efficiency. The decision makers from the Mediterranean countries underlined the importance of this session which gave them the opportunity to present, share and discuss various experiences relevant to the subject, and to elaborate strategies and plans of actions for the implementation of measures which could lead to a better valuation of irrigation water. Moreover, the participants of this session highly recommended the establishment of a network on "Water valuation and cost recovery mechanisms in the developing countries of the Mediterranean" as an appropriate approach to bring together the experiences in this field and to set viable strategies for implementation in the region.

The papers presented during the Special session on "Water Valuation and Cost Recovery Mechanisms in the Developing Countries of the Mediterranean Region" were included in the Proceedings of the Conference which was distributed to more than 200 participants of this important event. In addition, all contributions are published in a special volume of "Options méditerranéennes" (Hamdy *et al.*, 2002).

The recommendations from the Workshop on "Water valuation and cost recovery mechanisms" may be synthesized as the following:

Irrigation policies should play a regulatory role with regard to objectives of equity, natural resources protection and water market creation;

Tariffs will not be an effective tool for economizing on water as long as they do not relate available water volumes to irrigation water prices;

Irrigation water tariff and recovery policies should aim to guarantee irrigation infrastructure maintenance and replacement, and, simultaneously, ensure sound water services for agricultural uses;

Tariffs should have social, economic, political and environmental objectives and consequences;

The application of irrigation water tariffs and charge recovery policies should take into consideration the local, regional and/or national and socio-economic conditions, as well as the macro-economic orientations of irrigation development. Water prices should integrate the elements adapted to the specific context of irrigation projects, simultaneously ensuring agricultural development, risk aversion and water saving.

The workshop on "Gender and water resources management in the Mediterranean", was held on October 12-14, 2002, in Cairo (Egypt), as a special session of the First Regional Conference on "Perspectives of Arab Water Cooperation: Challenges, Constraints and Opportunities". The Workshop was attended by more than 100 participants covering most of developing Mediterranean countries and representatives from different Arab countries, national, regional and international institutions, NGOs and several women organizations. 17 experts from all the beneficiary countries of the RAP (Algeria 1; Cyprus 1; Egypt 2; Jordan 2; Lebanon 1; Malta 1; Morocco 1; Syria 2; Tunisia 2; Turkey 2) and Italy (2) have contributed in the Workshop. The contributions to the session are published as a special volume (El-Kady and Hamdy, 2002) which included an Introductory paper and a keynote paper on gender perspectives in water resources management and it is followed by the case studies related to the experiences on the gender issues from each of 10 beneficiary countries of the RAP.

The challenges for the future are identified to overcome the considerable gap between positive policy intention to concrete action as well as to improve the current knowledge on gender issues in irrigation management. Among them, the participation, information and consultation are basic elements for gender development and implementation. In the region, there is an urgent need for the establishment of a network to put together the local institutions, NGOs, stakeholders and water user associations working on gender issues to gather the scattered information in this field and to set and formulate policies, strategies and implementation methodologies in view of social, cultural as well as religion conditions on both national and regional level.

This workshop had a very high impact in the Mediterranean countries since it was organised as a special session of an important regional event with the participation of decision makers and experts from the whole region and with full involvement of local governments and institutions. The importance of the topic and the necessity for exchange of experiences from different Mediterranean countries was recognized by all participants. After detailed discussion and debate, the participants of the workshop on "Gender and water resources management in the Mediterranean region" came up with the following recommendation to be taken as an aid for decision makers:

In the Mediterranean region, there is an increasing recognition that irrigation is a crucial part of the broader movement of gender mainstreaming in agricultural and rural development, and, indeed, seriously considered by a wide array of people from grassroots women's organizations to international development and financing agencies.
Case studies and experiences presented in the workshop highlight that thanking to the changes in cultural trends, women labor forces are growing in number, yet, the accumulated knowledge from presented case studies and experiences achieved did not give the appropriate insight that could effectively guide the policy and interventions.
In the developing countries of the region, the slow conversion of gender policies into practice, in particular in water resources management and irrigation, are the resultant of the followings:

The lack of analytical tools and appropriate concepts;

The lack of generic conceptual framework and appropriate implementation methodologies, beside the absence of gender performance indicators and above all the vague and week roles of irrigation institutions and agencies.

Studies

Furthermore, a study on the *"Production and exchange of virus-free plant propagating material in the Mediterranean region"* has been carried out within the RAP-WRM Programme. The study was held during the first phase of the RAP (1998-2000) and covered all ten beneficiary countries and Albania. The overall objective of this study was to define and propose common phytosanitary rules regarding production, conservation and use of plant propagating material in order to facilitate the movement of this material throughout the Mediterranean seen as a free-trade area and to support the transition of developing Mediterranean countries towards more open and competitive economy.

The specific objectives of the study were:
to assess the current situation on factors (legislation, facilities, human resources, etc.) limiting implementation of an appropriate certification programs in participating countries;
to analyse fruit industry, in particular the nursery sector in the different Mediterranean countries and the level of their self-sufficiency;
to analyse the sanitary status of the main cultivated species with particular attention to the presence of quarantine and economic important diseases;
to promote certification as the unique tool which guarantees quality of nursery productions and a key point for the development of fruit tree industry;
to identify, for each country, the critical points which still obstruct the application of well-defined and internationally accepted rules related to the production of sanitarily improved plant propagating material.

Within the programme, a Round table Meeting was organised in Bari in 1999 with the participation of decision-makers appointed by Ministers of Agriculture of 11 Mediterranean countries and experts from international institutions (EPPO, IAMB and University of Bari). A country reports were prepared from all participants and a comparative analysis of the sector in the Mediterranean was accomplished. Finally, the study resulted in a phytosanitary project proposal for the Mediterranean seen as a free-trade area; covering a spectrum of topics: (i) phytosanitary situation of Mediterranean fruit tree industry; (ii) certification issues (legislation, facilities and human resources) in Mediterranean countries; (iii) legislation aspects and technical features of the certification service; (iv) proposal for the sanitary improvement of mediterranean fruit crops and actions to protect the health of typical productions. The results and outcomes of the study were published in a special number of *Option Méditerranéennes, Sér. B/n°35* Production and Exchange of virus-free Plant Propagating material in the Mediterranean Region (2001).

CONCLUSIONS

The Regional Action Program on "Water Resources Management" represents one of the biggest activities ever carried out by the Mediterranean Agronomic Institute of Bari. Thirty national institutions and Universities from 10 beneficiary countries, 7 Italian partners and 5 International organisations have been involved directly in the program (Figure 10) along with about 1105 persons from 31 countries around the world.

The orientation of the program towards the water problems in the Mediterranean irrigated agriculture has been confirmed by the fact that 1026 (or 92.9%) participants were from the Mediterranean region,

while 887 (or 80.3%) were from 10 Mediterranean countries, beneficiaries of the RAP. A non-significant number of participants belonged to Asia (5.5%), Africa (0.9%) and America (0.7%). The greatest number of the participants came from Tunisia (240) and Egypt (190) and it is in agreement with the severity of the water shortage problems and overall strategic importance of the countries in the region (Figure 11). The particularly high number of participants from Tunisia is due to request of Tunisian government to organize, within the logistic support program, four training courses on new information technologies and internet communications for 109 Tunisian technicians and administration staff.

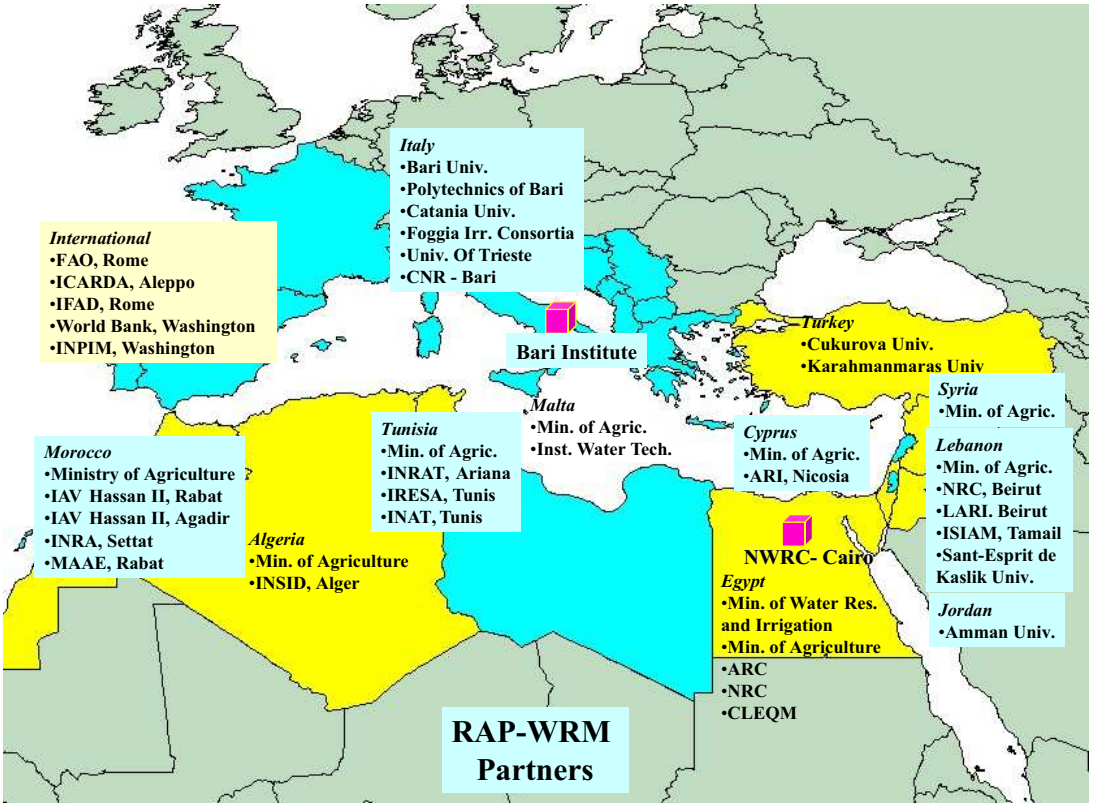

Fig. 10. The RAP-WRM Partners from 10 beneficiary countries and Italy

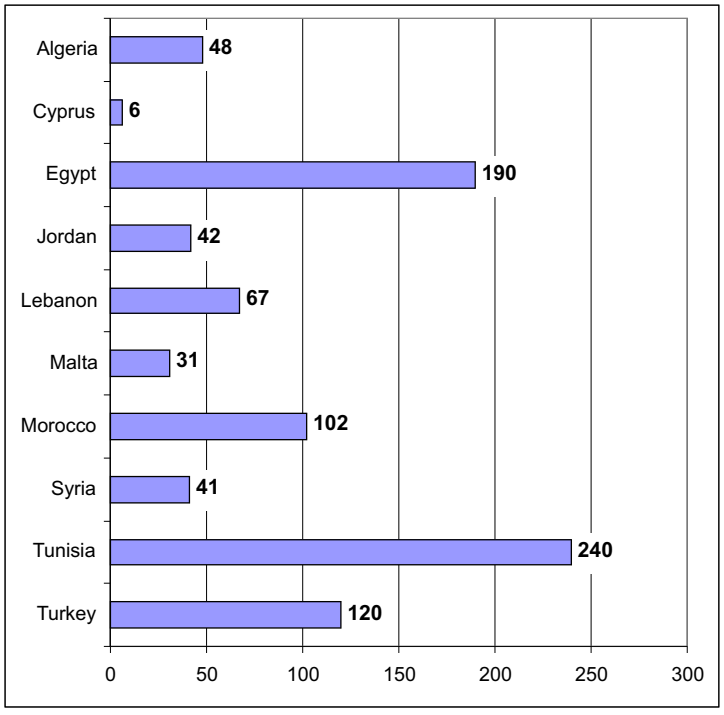

Figure 11 - The RAP-WRM distribution of participants from 10 beneficiary countries

The activities within the RAP-WRM have produced 19 short-term courses, tens of experimental works and 68 MSc theses, 19 mobility MSc programs, research works at seven pilot locations in the Mediterranean, two important workshops, numerous meetings and reports, 131 scientific papers, several research manuals, guidelines and databases, 24 special publications, 3 books, etc. These activities, following the recommendations of TWG and OMC, have been developed in agreement with other RAP programs and activities of other CIHEAM Institutes. The adoption of such approach gave the possibility to manage the activities within different RAP themes in a complementary way respecting the major necessities of each beneficiary country in the water resources management and agricultural sector. Certainly, this methodology, considering different aspects of water management in Mediterranean agriculture, has supported substantially the institutional capacity building process and human resources development in the beneficiary countries of the RAP. This is confirmed through the valuation of the progress reports and evaluation sheets of the training program of RAP-WRM which has underlined the following:

a) There is an overall appreciation of the topics and training approach implemented by the Bari Institute;
b) The majority of the trainees agrees that the knowledge acquired during the training is of great importance for efficient water use in irrigated agriculture and for practical implementation in their professional work;
c) The greatest number of participants work already at important positions at academic and governmental level and the latest know-how acquired during the training along with an international dimension of the courses should have a strong impact on the carrier of the trainees in the future and their ability to implement and transfer the knowledge;
d) Most of the RAP trainees represents the driving forces for the establishment and operation of the national networks on the major topics treated by the courses, regional network research project and other activities through the dissemination of information and bilateral research programs.

A particular emphasis have been given to the Aid for Decision Making Program which involved several international organisations and participants from other regions of the world. The sub-program on Participatory Irrigation Management is a realistic example of the international cooperation in the field of water resources management as it is fundamentally based on joint activities using the experiences in the field of CIHEAM-IAMB, the EDI (Economic Development Institute) of the World Bank, the INPIM and IFAD. The participation of trainees from different regions has created very fertile atmosphere for a worldwide exchange of experiences, transfer of knowledge and information and personal contacts.

Equally so, the International conference on "Irrigation water policies micro and macro considerations" was organised and sponsored by several institutions as: Ministry of Agriculture and Rural Development - Kingdom of Morocco; the International Center for Advanced Mediterranean Agronomic Studies (CIHEAM)/IAM-Bari Italy; the Moroccan Association of Agricultural Economists (MAAE), an organisation of 200 members from academia and government; the International Water and Natural Resource Economics Consortium (IWREC) representing about 50 water economists from more than 20 countries around the world; the Agricultural Policy Center, University of Minnesota, Saint Paul; the International Food Policy Research Institute (IFPRI), Washington, DC; and the World Bank. The involvement of such important institutions in the organization of the Conference and the participation of more than 150 experts have contributed that the Workshop on "Water valuation and cost recovery mechanisms in the developing countries of the Mediterranean region" had a very high impact in the region.

Finally, it should be highlighted that the Regional Action Program on "Water Resources Management" is not confined to itself but it should be seen as an opportunity to add durable values to the overall training, research and co-operation that CIHEAM is promoting within the Mediterranean Region, considering it as an Euro-Mediterranean space open for partnership and development. In fact, the activities carried out within the frame of the Water Resources Management Network have contributed in the generation of new programs and activities as it is the establishment of an additional *Network* on *Euro-Mediterranean Soils* addressing the problems of desertification and erosion in the Mediterranean Basin. During the last year of the RAP, the research network on "Water Resources Management" has presented for INCO-MED EU Program the project proposals for the establishment of two new thematic networks (on land management - MEDCOASTLAND and on water management - WASAMED). Both proposals, which should integrate the activities on "Land and Water Management" in the Mediterranean region, have been approved by the EU. The activities of the MEDCOASTLAND Thematic Network have started in October 2002, while the WASAMED Thematic Network has initiated at the beginning of 2003. The WASAMED (Water Saving in Mediterranean Agriculture) project comprehends 42 partners from 16 Mediterranean countries and has the 4-years budget of 1.5 million Euro, while the MEDCOASTLAND (Mediterranean Co-ordination of Land Conservation Management to Combat Land Degradation for the Sustainable Use of Natural Resources in the Mediterranean Coastal Zone) project involves 36 partners from 13 Mediterranean