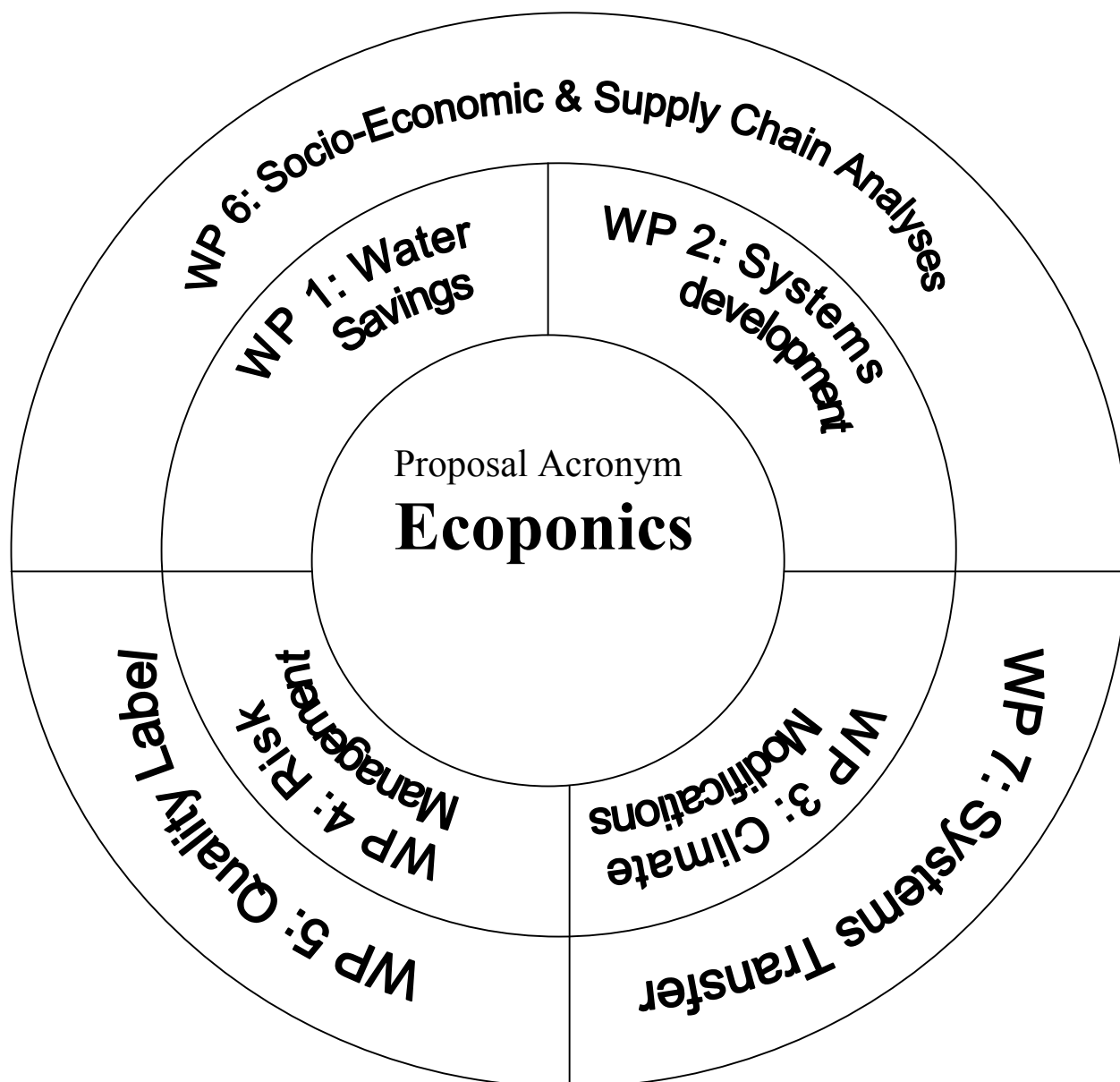


Proposal Title

Efficient water use through environmentally sound hydroponic production of high quality vegetables for domestic and export markets in Mediterranean countries.



Part B

Description of research work

INCO-MED: (Shared Cost Action)
Call identifier: ICFP502A3PR03

Section B2. Objectives

Vegetable production in Mediterranean partner countries (MPC) is of particular importance, due to very high per capita vegetable consumption rates in these countries. As a highly valued export crop to EU markets, vegetables play an important role for the foreign trade balance sheet of several MPC's national economies, particularly during winter season. However, vegetable production is increasingly associated with heavy environmental burden regarding water resource depletion and massive use of pesticides as well as high rates of fertilizer applications, often connected with low efficiency. Additionally, overexploited resources of high quality water, previously available for vegetable production, compete progressively more for human consumption, due to the strong population growth and increasing urbanization in the region.

General Research Objectives of ECOPONICS

The project aims to improve in an economically viable manner the efficiency in water use of the Mediterranean horticultural sector for major vegetable crops (tomato and cucumber) by means of

- research for new and simple, but highly water efficient hydroponic systems
- which are on one hand capable to produce vegetables of superior quality under different water quality conditions
- and on the other hand suitable to replace soil cultivation e. i. in case of soil contamination in (smallholder) vegetable production systems with restricted access to financial and knowledge resources.

The specific scientific and technological objectives

1. Improved hydroponic systems with best water use efficiency (WUE) for different water qualities to maximize unit marketable crop per unit water needed. This will be achieved through
 - the analysis and modeling of crop environment factors and their interactions influencing water use efficiency (climate, plant root system performance, water, drought and heat stress, poor water quality, pest infestations)
 - the development of new superior crop management methods ECOPONICS to maximized water use efficiency (measurable in terms of increased marketable crop unit per consumed water unit and monetary value produced), covering agronomic and environmental situations in INCO-Med countries.
2. Promotion of hydroponic cultivation to a larger group of growers to increase overall efficiency in water use by substitution of vegetable soil cultivation with ECOPONICS through,
 - the analysis and assessment of existing farming systems regarding their capacity to adopt hydroponics
 - the integration of newly developed crop management methods to differently tailored vegetable productions systems, appropriate for adoption in contrasted vegetable farming systems existing in INCO-Med countries (measurable in terms of higher farm profit per unit water used).
3. Assurance of economic sustainability of hydroponic vegetable production with high water use efficiency through the introduction of a new quality label ECOPONICS, based on
 - the analysis of quality perceptions and evaluation modes at different levels of the vegetable supply chains for domestic and export markets and
 - the validation of superior quality of vegetables produced in these water efficient systems.

Section B3. Contribution to the programme objectives**ECOPONICS contributions to the topics of the call for proposals**

The ECOPONICS project is highly coherent with the topics of the call identifier: ICFP502A3PR03 and contributes to the development of sustainable irrigation technologies, through the research for and the technology development of different simplified resource saving water by hydroponic systems. ECOPONICS combines the research for a bundle of different water saving approaches as for example climatic modification and management under protected cultivation for optimized water use efficiency, water efficient rootstocks and the reuse of drainage water as a key element of ECOPONICS by simplified recirculating and closed hydroponic systems.

Knowledge of plant physiology for crop management will significantly be improved and is a key element of scientific approach of this proposal. By research on poor water quality effects on water use efficiency of plants, the research for grafting of plants on water efficient rootstocks and its impacts on tolerance to low quality water use as well as the evaluation of new biocontrol strains and other agents for the rhizosphere enhancing tolerance against negative impacts of poor water qualities and improving plant growth. Research concerning plant physiologic responses to greenhouse climate modifications in order to increase water use efficiency is an integrative part of water use management in ECOPONICS.

Water saving through hydroponics versus soil grown vegetables will compare “modern” to “traditional” technologies, but also different “modern” technologies will be compared, when different hydroponics system are evaluated for technical simplification.

The research of ECOPONICS targets different kind of stakeholders as it will also improve existing hydroponic systems technologies of agro-industrial producers through climatic modification for increased water use efficiency and to combat negative impacts of pest and virus attacks and poor quality irrigation, but it will also develop simplified systems suitable for smallholders with restricted access to resources and low management knowledge.

The production chain and farming system research approach integrates participative elements which will guarantee together with the product quality management research the economic feasibility and sustainability of ECOPONICS under prevailing socioeconomic and institutional arrangements.

ECOPONICS contribution to the objectives of INCO2 and programme structure of INCO-Med

This project reinforces EU capacities in the field of science and technology and contributes, therefore, to the main objectives of INCO2. MPC institutions in this project consortium are covering 40 % of the Mediterranean countries eligible to participate in the INCO-MED work programme 2002 A3: This will ensure a broad impact of research results for the vegetable production all over the Mediterranean area and will also enhance the position and role of Community research in the international scientific and technology arena. The project will produce significant mutual benefits as it develops Mediterranean vegetable production for domestic and export markets in the Community, regarding their respective quality requirements. Therefore, research co-operation for ECOPONICS optimises the added value at the European level. ECOPONICS will considerably contribute to the long-range sustainable development in the Mediterranean area as it aims to develop horticultural technologies to be more efficient in the use of water, pesticides and fertilizers. Besides these environmental issues ECOPONICS research is oriented to the transboundary economic development of Mediterranean vegetable production. The creation of a new product quality label “ECOPONICS” for MPC’s domestic and export markets (mainly but not exclusively to the Community), will ensure a better market position for ECOPONICS products. To reach this target, ECOPONICS integrates also MPC and EU consumer perception concerning vegetable qualities in the research for new production technologies. In order to encourage a broad adoption of this new, environmentally friendly and consumer oriented vegetable production system “ECOPONICS” by farmers, the research packages of this project focuses consequently on technology simplification of what is usually

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ECOPONICS

called hydroponics. This feature of the project also allows poorer farmers, with restricted access to resources and low management and professional knowledge capacities to use ECOPONICS as an economic vegetable growing system adapted to regions with scarce and often poor quality water resources.

Section B4. Innovation**B4.1 State of the art**

Growing crops in hydroponics under protected cultivation can be considered as the most complex production system available today. Two basic technologies may be distinguished: The conventional open system supplies water and nutrient solution to the plants and surplus is allowed to run off; the other, environmentally more friendly technology recirculates water and nutrient solution in a closed system resulting in better water use efficiency (WUE). Basically, hydroponics can be considered water efficient because it needs only 10 – 20 % of water compared to field cultivation for the same yield (Bradly and Marulanda, 2000; UNDP, 1996). It is therefore considered as a technique of choice under arid conditions (Schwarz, 1995).

However in terms of farming systems, Ruthenberg (1980) classified hydroponic cultivation as a “high input – high output – high risk“ system and in fact, the to-date available techniques require considerable specialization with sophisticated management and know-how as well as high financial inputs to realize expected production potential (Schwarz, 1995), otherwise crop failures can be disastrous. To further increase WUE, experts considered until now additional heavy investment costs, although satisfactory recommendations to achieve this has not been brought forward yet. With other words, there is a definite need for new technologies to simplify hydroponic systems, suitable for different farming systems and environmental conditions. Some more simple and cost effective closed recirculating systems were already recently introduced (for anonymity literature cited in the Annex) but were developed for temperate climates with possible modification needed for Medit. environment. Another very simple system without circulation is suggested by Asian Vegetable Research and Development Center (AVRDC, Taiwan) for the humid tropics. This system does not require electricity nor other specialized equipment and is setup in a way for plant roots to perform different functions: one for oxygen and the other for nutrient and water uptake. The aerial roots will supply the plants with oxygen, thus overcoming the most serious constraints in hydroponics, which is aeration (Imai and Wu, 1997; Imai and Takasu, 1997; Wu and Imai, 1999). This system was actually developed empirically, the real plant physiological background is still unknown and has to be investigated in order to redesign this system for the drier Medit. climate.

Hydroponics under protected cultivation was designed to maximize yield per surface area (or greenhouse volume) because this is generally in horticulture the limiting factor to expand production as long as all other inputs, including water is in abundance. Most of the hydroponics systems today can be found in temperate climates for various reasons. While technical literature and recommendations of hydroponics for before mentioned situation is plentiful, research results and technology recommendations for hydroponics with emphasis to WUE can hardly be found (Schwarz et al., 1998). Without any doubt, there remains an enormous gap of knowledge concerning the methods for how to improve and how to manage WUE in hydroponics.

Similarly, the same can be said for the effect of different water qualities in hydroponics with regard to vegetable yield and quality. Shannon and Grieve (1999) concluded that, although there is abundant literature for various salt tolerance levels in field grown vegetable crops, much has still to be done for understanding the interactions of vegetables grown in soilless culture. Commercial production of tomatoes in rockwool cultivation is utilizing already higher EC-levels to improve taste and aroma (Peteresen et al., 1998), but negatively impacting yield (Maas and Hoffmann, 1977). Principally it has been found that higher dry matter contents is improving sugar, acids, total soluble solids, carotene and vitamin C (Cuartero and Fernandez-Munoz, 1999) but fruit shelf life (Mizrahi, 1982) and fruit firmness (Sharaf and Hobson, 1986) will be lower. These findings will, of course, be incorporated in the new technology system of ECOPONICS on the base of better understanding the plant physiological reactions to tailor this new system accordingly.

To craft cultivars on tolerant and resistance root stocks is an old technology and extensively used in soil cultivation to protect the plants against soil borne diseases (Morra et al., 2001). It has also been tried effectively in hydroponics against pathogens in the nutrient solution by Reist et al. (1999).

There are also some reports of root stocks to moderate abiotic stress, i.e. to low soil temperatures (Yu-Xian et al., 1997) and water logging (Kleinhenz, 1997). Some indications exist that crafting has also positive impacts on salinity tolerance (Romero et al., 1997).

Bio-control agents, like *Bacillus subtilis* have shown to enhance crop growth in hydroponics under unstressed growth conditions (Böhme, 1999) and to increase salinity tolerance of soil grown vegetables (for anonymity literature cited in the Annex).

Brandly and Marulanda (2000) summarize the present situation for hydroponics, that very few research results exist for nutritional value of crops grown in those systems with virtually no technology available for hydroponics systems in arid climates and, therefore no training material for growers is available for those places.

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B4. 2 Innovative aspects

ECOPONICS introduces several innovative approaches for WUE, water savings, reuse of drainage water, use of poor water quality and better knowledge of plant physiology in order to reduce water requirements for growing vegetables under protected cultivation in Medit. environments.

1st Innovation

A farming systems research approach for the design of a simplified water saving, recirculating or non circulating hydroponic production package utilizing locally available inert substrate materials or non at all, tailored to the professional knowledge, financial outlet and environmental conditions of smallholders and other horticultural enterprises to produce high valued vegetables under Medit. conditions (WP1, WP2).

2nd Innovation

Conditioning vegetable plants by measuring plant physiological responses to further reduce dependence of plants to quantity and quality of water in hydroponics. This will be done by:

2.1 Utilizing root stocks for crafting on compatible high quality tomato and cucumber cultivars in order to promote tolerance to poorer water quality, drought, heat and oxygen stress conditions as well as disease resistance (WP1).

2.2 Introduction of bio-agents such as various *Bacillus subtilis* strains, evaluated for their capacity to improve WUE and improved tolerance to poorer water quality. The presently available commercial strain is known for its microbial antagonism and as a growth enhancer, more strains will be screened to widen the efficiency (WP2).

3rd Innovation

Plants stressed by pest and virus infestations can not utilize water in the optimum. Threshold levels will be established and integrated pest and production measurements (IPP) will be introduced interacting with WUE and water savings procedures (WP4).

4th Innovation

A model will be developed in which climatic conditions will be interrelated with crop response to amount and quality of water for the production high quality tomato and cucumber fruits (WP3).

5th Innovation

With the help of analyzing consumer perception and production supply chain governance as well as establishing quality standards (external and internal) for tomato and cucumber fruits produced by ECOPONICS, a special quality label will be introduced (WP5, WP6).

Section B5. Work plan

a) Introduction

To achieve the objective of increased efficiency in water use through the development of the innovative vegetable production system ECOPONICS, the project is designed in a multidisciplinary approach and integrates scientists of different disciplines from natural and social science around the objective to create a technology following this description:

ECOPONICS is an innovative and new production technology for high quality vegetables in which hydroponics as recycling (reuse of drainage water) or non cycling systems are used together with other production methods as grafting, biocontrol and other agents in order to improve water use efficiency by drought resistance and poor water quality tolerance for different substrates in combination with environmental-climate control under protected cultivation including efficient IPM (integrated pest management) measures for healthy and highly efficient growing plants, assuring substantial pesticides savings and securing a fast and optimal plant development for the efficient use of growing factors (nutrient and water use efficiency). ECOPONICS is not only oriented to ECOlogical criteria but aims to be ECONomically sustainable and integrates therefore for its production technology design in participatory manner consumer (in EU and MPC) expectations about vegetable quality and economic and institutional conditions for the broad adoption of ECOPONICS by Mediterranean farmers (agro-industrial and smallholders). Special focus on governance issues at three different levels is done concerning: the farming system, the input supply chain and the product supply chain, both on domestic and export markets.

In order to plan rationally this ambitious research work the project is broken down in seven clearly delimited work package, each one with a responsible lead contractor experienced in the specific field of research of his workpackage. However, workpackages are not designed to isolated the different researcher in their task. A high degree of "Interworkpackage" cooperation is achieved through the contribution from different partners. The results of a task in workpackage is very often an inputs for a following task in another workpackage.

WP1, W2, WP3 and WP4 are in the center of technology development, whereas WP5,WP6 and WP7 are on strategic position to become the interface for dissemination of the ECOPONIC growing system.

ECOPONICS Research activities and structure of first year

Research for the development of water saving methods

WP1 is the center workpackage for the development of new methods to improve water use efficiency and the use of poor water qualities. This starts with the definition of water quality response curve under the climatic conditions occurring under protected cultivation in Mediterranean climate. This basic physiologic research will help to better understand the mechanisms involved in plant response and create adapted data for management recommendations. Simultaneously, the water use efficiency of hydroponics is evaluated against traditional soil or field cropping, in order to gather basic plant physiological data. During this time partners in WP2 will start to do first experiments about the design of new simplified hydroponic systems and P4 in WP3 will carry out the first model experiment concerning the climate modification approach for to increased water use efficiency. Simultaneously P5 is responsible to identify thresholds of plants to poor water quality regarding their sensitivity to pests. from poor quality water as well as for measures against higher pest infestation caused by greenhouse climate management reducing transpiration for higher water efficiency. P1 responsible for the vegetable quality analysis in this Project will start the analysis of first samples arriving from the partners. Partner 6 and 7 will start in the 7th project month to execute the first work consumer perception of quality in France and in Germany and subtasks relate to the supply

chain. At the end of the first year results and deliverables will be presented to all partners during the first annual project meeting and annual reports of research work will be send to the Commission and exchanged between partners.

ECOPONICS Research Activities and Structure of second year

Research for validation of water saving methods and system integration of water saving methods

P2 will start in the second year to investigate new innovative technologies for increased water use efficiency as grafting and bio control and other agents are evaluated and recommendation for their applications modes are developed. P2 will receive the Bacillus strains from P9 who will assist him for knowledge transfer. Partners in WP2 will validate their results concerning the design of water use efficient simplified hydroponic system and improve it further. Partner 4 in WP3 will start to validate the results of the climatic model experiment with an on farm experimentation of different climate modification methods. P5 in WP4 will validate the results of the first year an will start an comparative experiment of the newly developed methods to traditional pest management methods. Also experiments of cost effective methods for nutrient solution disinfection will start. During this time all samples from experiments of partners are analyzed by P1 for quality. Partner 6 and 7 start the socio-empirical work in Morocco and Turkey but will assist all partners in the second semester of the year for the microeconomic analysis of their experiments. At the End of the year results and deliverables will be presented to all partners during the first annual project meeting and annual reports of research work will be send to the Commission and exchanged. between partners.

ECOPONICS Research Activities and Structure of third year

Research for system validation and preparation of dissemination

At the beginning of the third year the first results (effective Bacillus subtilis strains from the first screening and effective rootstocks) of recommendations from WP1 will be given to partners of WP2 who will integrate these methods in their developed hydroponic system and test the compatibility of the approaches . Also recommendations from WP4 concerning pest management will be integrated.. With the beginning of the third year all partners will WP1 continue to screen other strain and rootstocks . WP3 will start to build up a computer model for climate management in greenhouses for dissemination after month 42 of the project. WP4 will continue the technology comparison between improved and traditional pest management systems. WP5 will continue to analyze vegetable qualities of the experiments of the other partners and will additionally analyze vegetable produced in MPC and purchased in MPC or EU market Partner 6 and 7 will analyze the institutional environment of the supply chain and help partners for the economic analysis of their data. All partner will start with beginning of the third year to contribute to FAO newsletters and homepages.

At the end of the third year results and deliverables will be presented to all partners during the first annual project meeting and the final report of the technical research work will be send to the Commission and exchanged between partners.

ECOPONICS Research Activities and Structure of the forth year

Dissemination of ECOPONICS and Creation of ECOPONIC quality label.

P1 and some EU as well MPC will collaborate together for the dissemination of results, through technical manuals and teaching courses. Demonstration sides for ECOPONICS will be installed in selected INCO-Med countries. P1, P6 and P7 will design the quality label ECOPONICS

b) Adequacy of chosen approach

Diversity of actions and research do not qualify ECOPONICS as a “container” proposal where every idea was put in without relation to the other one. But it reflects the pluridisciplinary of the consortium and its opinion, that only the integration of different research competencies, are capable to improve efficiency of water use in sustainability for Mediterranean countries.

Time table of activities in the project ECOPONICS

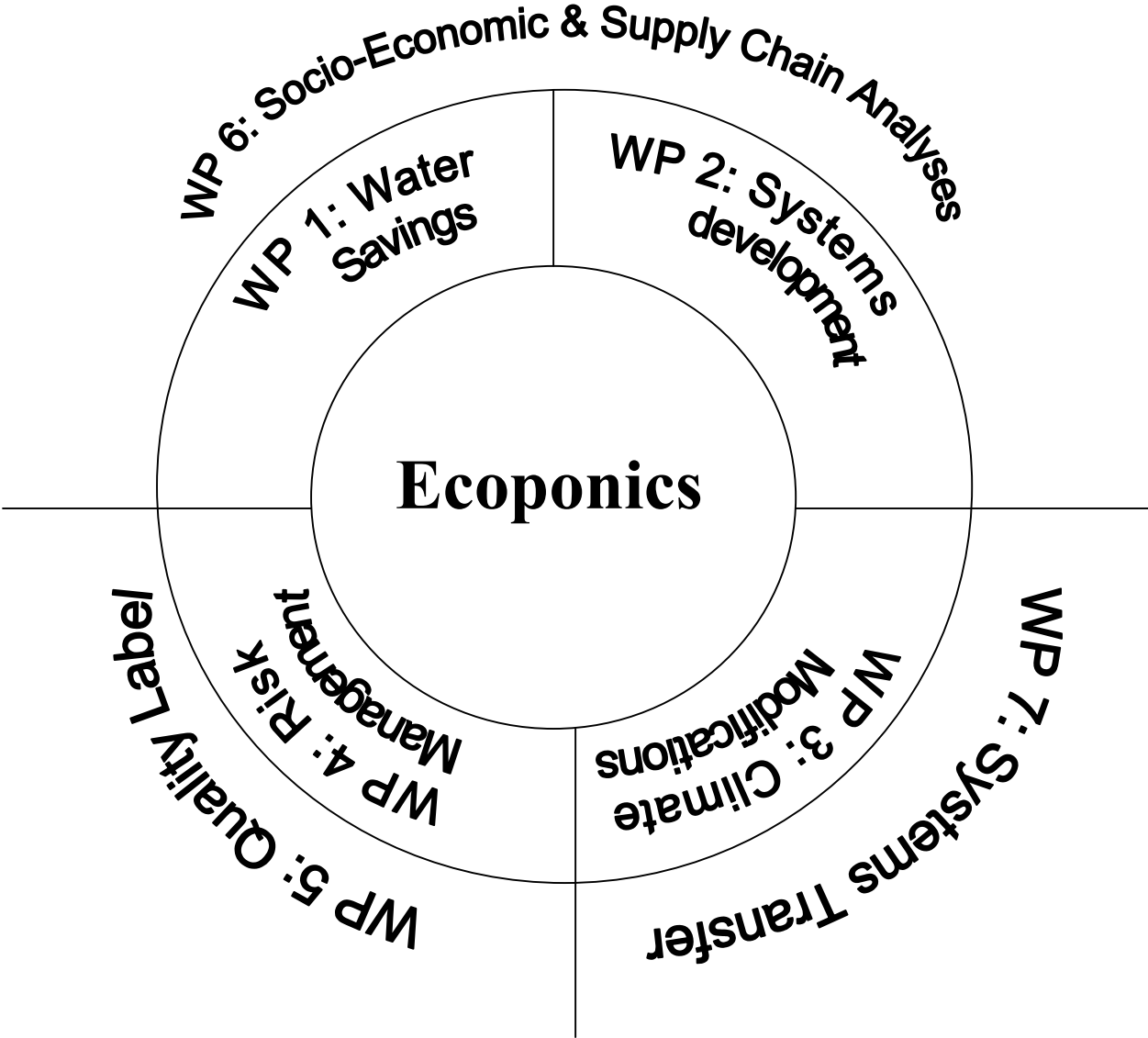
	Workpackages and Tasks	Partners	1 st Year		2 nd Year		3 rd Year		4 th Year	
			6	12	18	24	30	36	42	48
	Project month		6	12	18	24	30	36	42	48
WP0	Coordination	P1								
WP1	Development of methods for ECOPONICS to improve water use efficiency and use of poor water qualities for agro-industrial and smallholder fruit vegetable production	P2								
Task 1.1	Identification of water saving potential in hydroponics versus soil or field grown vegetables.	P8								
Task 1.2	Assessment of water use efficiency, fruit quality, plant growth and development as effected by poor water quality for nutrient solutions.	P2								
Task 1.3	Grafting of tomato plants as strategy to promote water use efficiency as well as tolerance against drought, salinity, heat and diseases.	P2, P3, P4								
Task 1.4	Promoting water use efficiency as well as tolerance against drought, salinity, heat and diseases with bio control and other agents	P2, P9								
Task 1.5	Microeconomic evaluation of different measures to improve water use efficiency	P1, P2, P3, P4, P6, P8								
WP2	Development of water saving simplified open, recirculating and non-circulating hydroponic systems for smallholders	P3								
Task 2.1	Development of simplified and water saving hydroponics systems for ECOPONICS also suitable to smallholder farmers.	P1, P3, P8								
Task 2.2	Developing and testing crop coefficient for simplified ECOPONICS	P1, P3, P8								
Task 2.3	Development of cost effective and water saving techniques for protected cultivation in ECOPONICS (plastic tunnel).	P4								
Task 2.4	Validation of developed simplified growing systems for ECOPONICS and integration of results from other workpackages to increase water use efficiency	P1, P3, P4, P5, P8								
Task 2.5	Economic evaluation of feasible ECOPONICS enterprise development	P1, P3, P4, P6, P8								
WP3	Utilization of climate modification in ECOPONICS for improving water use efficiency	P4								
Task 3.1	Creation and management of data base for climatic information and crop management experiences in ECOPONICS project.	P1, P2, P3, P4, P5, P8								
Task 3.2	Determine optimal microclimate management for high water use efficiency in ECOPONICS (Model experiment).	P4								
Task 3.3	On farm validation: Physiological response of plant to tested microclimate management systems (relationship between plant growth and shading, humidity, etc.)	P4								
Task 3.4	Computer based modeling for water use efficiency, crop growth, and yield in ECOPONICS	P4								

Time table of activities in the project ECOPONICS, continued

	Workpackages and Tasks	Partners	1 st Year		2 nd Year		3 rd Year		4 th Year	
			6	12	18	24	30	36	42	48
		Project month								
WP4	Improved production risk management in ECOPONICS vegetable production for overall reduction of water consumption	P5								
Task 4.1	Identify tolerance thresholds of plants to poor water quality with regards to their sensitivity to insect, mite and virus infestation.	P5								
Task 4.2	Combating negative impacts of microclimate control (high humidity, restricted ventilation etc.) for high water use efficiency in ECOPONICS on pest management (UV absorbing plastic films and nets, bio control agents, etc.).	P5								
Task 4.3	Modify IPM and IPP to water saving ECOPONICS for high quality products, more economically than in the conventional production system and with the least amount of pesticide	P1, P5, P7								
Task 4.4	Identify cost efficient and environmentally sound substrate disinfection methods for ECOPONICS	P4								
WP5	Assessment and identification of management options for product quality in ECOPONICS	P1								
Task 5.1	Creating and management of a data base for quality assessment and management recommendations based on the results of the tested technologies in the ECOPONICS project.	P1, P2, P3, P4, P5, P8								
Task 5.2	Determine and evaluate external quality, marketability and sensory quality of vegetables in response to different techniques tested and evaluated for ECOPONICS.	P1, P2, P3, P4, P5, P8								
Task 5.3	Determine the impacts of different growing practices in ECOPONICS including water quality impacts on the vegetable contents of vitamins, minerals and antioxidants.	P1, P2, P3, P4, P8								
Task 5.4	Evaluation of pesticide residues in ECOPONICS versus traditionally grown vegetables, with special emphasis on insecticides extensively used in conventional production.	P1, P5								
Task 5.5	Post harvest behavior and performances of vegetables produced with different methods evaluated for ECOPONICS including impacts from water stress and use of poor quality water.	P1, P2, P3, P4, P5, P8								
WP6	Analysis and assessment of economic and institutional conditions for the adoption of ECOPONICS	P6								
Task 6.1	Consumer perception of ECOPONICS products both on domestic and export markets	P1, P3, P5, P6, P7								
Task 6.2	Product supply chain governance issues both on domestic and export markets	P5, P6, P7, P8								
Task 6.3	Farming systems and conditions of adoption of ECOPONICS	P3, P5, P7								
Task 6.4	Input supply chain governance issues with special focus on water resources management	P3, P5, P7								

Time table of activities in the project ECOPONICS, continued

	Workpackages and Tasks	Partners	1 st Year		2 nd Year		3 rd Year		4 th Year	
			6	12	18	24	30	36	42	48
	Project month		6	12	18	24	30	36	42	48
WP7	Introduction of ECOPONICS technology system to farmers with quality label for ECOPONICS vegetables for consumer awareness	P1								
Task 7.1	Print of technical manuals and conducting training courses	P3, P5, P6, P7, P8								
Task 7.2	Utilizing FAO News letter and home pages	P1, P2, P3, P4, P5, P6, P7, P8, P9								
Task 7.3	Setting-up of demo-sites in selected INCO-Med partner countries	P3, P5, P8								
Task 7.4	Designing of a Quality label and selection of trading partners	P1, P6, P7								



B5.1 Work package list

Work package No.	Work package title	Lead contractor No.	Persons-months	Start month	End month	Deliverable No.
WP0	Coordination	P1	24	0	48	
WP1	Development of methods for ECOPONICS to improve water use efficiency and use of poor water quality for agro-industrial and smallholder fruit vegetable production	P2	122	0	36	D1.1, D1.2, D1.3, D1.4, D1.5, D1.6, D1.7
WP2	Development of water saving simplified open, recirculating and non-circulating hydroponic systems for smallholders	P3	111	0	36	D2.1, D2.2, D2.3, D2.4, D2.5, D2.6,
WP3	Utilization of climate modification in ECOPONICS for improving water use efficiency	P4	57	0	42	D3.1, D3.2, D3.3, D3.4, D3.5
WP4	Improved production risk management in ECOPONICS vegetable production for overall reduction of water consumption	P5	66	0	36	D4.1, D4.2, D4.3, D4.4,
WP5	Assessment and management for product quality in ECOPONICS	P1	123	0	36	D5.1, D5.2, D5.3, D5.4, D5.5, D5.6, D5.7
WP6	Analysis and assessment of economic and institutional conditions for the adoption of ECOPONICS	P6	142	6	36	D6.1, D6.2, D6.3, D6.4, D6.5, D6.6,
WP7	Introduction of ECOPONICS technology system to farmers with quality label for ECOPONICS vegetables for consumer awareness	P1	58	25	48	D7.1, D7.2, D7.3, D7.4, D7.5, D7.6, D7.7
	TOTAL		703			
	by EU Partner for research		336			
	by Med Partner for research		343			

- 1 Work package number: WP 1 – WP n.
- 2 Participant number of the leader of the work in this work package (as used in Part A).
- 3 The total number of person-months allocated to each work package.
- 4 Start date of work in the specific work package, month 0 being the start of the project and all other start dates being relative to this.
- 5 End date, months from start of project.
- 6 Deliverable number: Number for deliverable(s)/result(s) as mentioned in the work package description: D1 to Dn

B5.2 List of deliverables

No	Deliverable No. ¹	Deliverable title	Delivery date ²
1	D1.1	Knowledge about the relationship of water and salinity stress on water use efficiency in soilless cultivation of tomato and cucumber in spring and winter crops	Month 12
2	D1.2	Quantification of water saving potentials of hydroponic versus soil or field grown vegetables.	Month 24
3	D1.3	Screening results for effective strains of bio control agents, their optimal mode of application and performance of other agents for improved water use efficiency	Month 24
4	D1.4	Screening results of rootstocks capable to increase water use efficiency of different water qualities	Month 24
5	D1.5	Effectiveness of tested bio control and other agents for ECOPONICS to increase water use efficiency of different water qualities used for tomato and cucumber	Month 36
6	D1.6	Quantification of increased water use efficiency and salt tolerance from grafting high quality cultivars on selected rootstocks in ECOPONICS	Month 36
7	D1.7	Profit margins of tested methods to improve water use efficiency and salinity tolerance in agro-industrial and smallholder ECOPONICS	Month 36
8	D2.1	Reports on water and nutrient use efficiency as well as yield performances of simplified ECOPONICS based on open, recirculating and closed non-circulating systems.	Month 24
9	D2.2	Reports on crop coefficients (ratio of actual water consumption to ETp) for different simplified ECOPONICS systems.	Month 24
10	D2.3	Report on water saving potentials and economic as well as environmental evaluation of different plastic protection designs for water saving.	Month 24
11	D2.4	Validation of simplified systems in different environments and effects (compatibility) of integrated water saving methods introduced from WP1	Month 36
12	D2.5	Report on the economic feasibility of enterprise development with ECOPONICS technology for different types of vegetable producers in MPC.	Month 36
13	D2.6	Extension manuals for design and management of simplified ECOPONICS systems	Month 36
14	D3.1	Quantification of the relationship between micro climatic factors and plant response for water use efficiency in ECOPONICS	Month 12
15	D3.2	Validation report of on-farm results for water use efficiency and microclimate management techniques.	Month 24
16	D3.3	Extension guide for climate modification options in ECOPONICS.	Month 24
17	D3.4	A data base for the best management practices of microclimate control for ECOPONICS vegetable crops in the Mediterranean region.	Month 36
18	D3.5	A user friendly water and climate management software package for vegetable crops growing in different water saving systems of ECOPONICS.	Month 36
19	D4.1	Report on the impact of water stress and quality on the tolerance of tomato plants to some major pests (whiteflies, aphids, thrips and mites) and degree of virus outbreak .	Month 24
20	D4.2	Report on the impact of insect nets on whitefly and TYLCV management and its impact on greenhouse microclimate as well as its compatibility with the use of bumble bees for pollination and natural enemies for biological control of the major pests (whiteflies, aphids, thrips and mites) of tomato in greenhouse.	Month 24

B5.2 List of deliverables, continued

No	Deliverable No. ¹	Deliverable title	Delivery date ²
21	D4.3	Effectiveness of cost saving sand filter technology for nutrient solution disinfection and their management in ECOPONICS	Month 36
22	D4.4	Report on the economic feasibility of IPM and IPP in the ECOPONICS system as a environmentally friendly production system for healthy vegetable products	Month 36
23	D5.1	Impact of different water qualities on product quality criteria (outer, sensory, nutritional value and post harvest performance)	Month 12
24	D5.2	Product quality assessment (outer, sensory, etc.) of hydroponic vegetables versus soil grown.	Month 24
25	D5.3	Impact of different simplified hydroponic systems proposed for ECOPONICS on product quality criteria (outer, etc.)	Month 24
26	D5.4	Impacts of different microclimatic management techniques on the product quality of vegetables from ECOPONICS - results from modeling and validation.	Month 24
27	D5.5	Report on pesticides residues in vegetables from Mediterranean countries sold on EU and MPC domestic markets and product quality impacts of IPM and IPP measure in ECOPONICS	Month 36
28	D5.6	Report on product quality impacts of different tested methods to increase water use efficiency in ECOPONICS (grafting, bio control and other agents).	Month 36
29	D5.7	Report and disseminations papers about ECOPONICS product quality and its management opportunities in the final designed ECOPONICS system for farmers, actors in the market chain, consumers and NGO in EU and MPC as well as concerned decision makers in EU and MP countries.	Month 36
30	D6.1	Report on potential consumer market in France and Germany.	Month 12
31	D6.2	Report on consumer perception and attitudes in Morocco and Turkey	Month 18
32	D6.3	Report on produce supply chains in the different selected countries (Morocco, Turkey, Egypt, France and Germany).	Month 36
33	D6.4	Report on the institutional environment of the produce supply chain (Morocco and Turkey, France and Germany).	Month 36
34	D6.5	Report on farm strategies regarding the adoption of the ECOPONICS model (Morocco, Turkey).	Month 36
35	D6.6	Report on input supply chains and water resource management (Morocco, Turkey).	Month 36
36	D7.1	Training material, technical manuals and brochures in local languages (Arabic, Turkish, Berber and French).	Month 39
37	D7.2	Contacts with traders and trial shipments of ECOPONICS cucumbers and tomatoes to domestic and export markets.	Month 42
38	D7.3	Training courses conducted in partner countries.	Month 48
39	D7.4	Established links to FAO Hortivar homepage and regional FAO Newsletter.	Month 48
40	D7.5	Set up of at least one demo-site in Morocco, Turkey and Jordan.	Month 48
41	D7.6	Quality criteria and design of a ECOPONICS quality label.	Month 48

¹ Deliverable numbers in order of delivery dates: D1 – Dn

² Month in which the deliverables will be available. Month 0 being the start of the project and delivery dates being relative to this.

B5.3 Work package description							
Work package number : 1	Development of methods for ECOPONICS to improve water use efficiency and use of poor water quality for agro-industrial and smallholder fruit vegetable production						
Relative start month ¹ :	0						
Participant number ² :	P1	P2	P3	P4	P7	P8	P9
Person-months per participant:	3	54	12	12	3	30	8

¹ Month 0 being the start of the project. ² Participant number of Lead Contractor in bold letters.

Objectives

General: Improving water use efficiency of fresh and saline water. Validation of management options capable of setting up the growing system ECOPONICS with sustainable yields and product qualities in some fruit vegetables.

Specific :

Task 1.1 - Identification and quantification of water saving potential in hydroponics versus soil or field grown vegetables.

Task 1.2 – Assessment of water use efficiency, fruit quality, plant growth and development as effected by effects of poor water quality for nutrient solution .

Task 1.3 - Grafting of tomato plants as strategy to promote water use efficiency as well as tolerance against drought, salinity heat and diseases.

Task 1.4 - Promoting water use efficiency as well as tolerance against drought, salinity, heat and diseases with bio control and other agents (P2, P9)

Task 1.5 - Microeconomic evaluation of different measures to improve water use efficiency.

Description of work

Task 1.1 - Identification and quantification of water saving potential of hydroponics versus soil or field grown vegetables (P8).

Two experiments will be conducted in greenhouses in farmer fields. In each experiment, tomato and cucumber will be grown by using both hydroponics and soil culture methods under equal climate conditions. The water consumptions and water use efficiency as well as the economic return will be identified (P8) and fruit quality parameters (P1). (1-24 months)

Task 1.2 - Assessment of water use efficiency, fruit quality, plant growth and development as effected by effects of poor quality water for in nutrient solution. (P2)

Evaluate (months 1-12) salt sensitivity of the considered crops in ECOPONICS. Five levels of salinity conditions in nutrient solution will be tested. Both crops will be grown during two cultivation cycles (winter = low vapor pressure deficit and spring-summer = high vapor pressure deficit), effecting water consumptions under these contrasted environmental conditions (P2). Fruit quality will be evaluated (P1).

Task 1.3 - Grafting of tomato plants as strategy to promote water use efficiency as well as tolerance against drought, salinity heat and diseases. (P2, P3, P4)

Subtask 1.3.1. - (months 12-24): Two different available rootstocks at P3 will be used with non grafted F1 hybrid cultivar in order to test their tolerance to salinity and water stress. Different crop parameters measuring physiological responses will be used in order to reduce plant water consumption and increase water use efficiency (P3).

Subtask 1.3.2. - (months 13-24): A local tomato non-commercial cultivar with low fruit quality but salinity tolerance grown near salt marshes in one MPC was already identified as potential rootstock. Identification of other cultivars will follow during the project also in other regions. Additionally tomato cultivars from AVRDC, Taiwan with heat (improved set of fruit under hot conditions) and drought (water stress) tolerance as well as disease tolerance features will be evaluated as rootstock under Mediterranean climate conditions, differing from their humid tropical origin. At least this cultivar will be used as a root stock for commercial cultivars. The grafted plants will be grown in different growing media and salinity levels of the nutrient solution to be compared with non-grafted plants. All treatments will be subjected to water consumption monitoring as well as yield (P4) and

quality parameters (P1) of both grafted and non-grafted plants.

Subtask 1.3.3. - (months 25-36): Some (3-5) of inter and intraspecific hybrids more resistant/tolerant to soil born diseases will be evaluated as rootstocks for a non resistant commercial cultivar. During a spring summer cultivation cycle, the different tolerance level to salt stress will be evaluated; this response will be related to physiological indicators (Na or Cl accumulation, osmotic potential adjustments, etc.) in order to understand mechanisms involved in the response of grafted plants to salt stress (P2).

Task 1.4 - Promoting water use efficiency as well as tolerance against drought, salinity, heat and diseases with bio control and other agents (P2, P9)

Starting in the second year (months 13-36) the effectiveness of substances (i.e.: glycinebetaine) or plant strengthening organisms (i.e.: *Bacillus subtilis*) will be evaluated for tolerance against to salt stress (P2).

We will (month 13-24) start to screen under controlled conditions with vegetative grown plants to set up a protocol defining concentrations (i.e.: glycinebetaine) and different isolated strains (i.e.: *Bacillus subtilis*) from P9 to be adopted for a greenhouse experiment on tomato and cucumber production (month 25-36) (P2).

Task 1.5 - Microeconomic evaluation of different measures to improve water use efficiency. (P1, P2, P3, P4, P7, P8)

A microeconomic assessment for all experiments in this workpackage will be carried out based a general data gathering protocol defined at the beginning the project with all partners. Besides classical parameters of economic efficiency and profitability this protocol will allow also to express monetary water use efficiency in terms of product value per unit of water consumed and profit margin per unit of water consumed. This will also be done in terms of marginal returns for experiments with several salinity levels (month 13-36).

Deliverables

- D1.1 - Knowledge about the relationship of water stress and poor quality on water use efficiency in soilless protected cultivation of tomato and cucumber in spring-summer and winter croppings.
- D1.2 - Quantification of water saving potential of hydroponics versus soil or field grown vegetables
- D1.3 - Screening results for effective strains of bio control agents, their optimal mode of application and performance of other agents for improved water use efficiency
- D1.4 - Screening results of rootstocks capable to increase water use efficiency of different water qualities.
- D1.5 - Effectiveness of tested bio control and other agents for ECOPONICS to increase water use efficiency for different water qualities in tomato and cucumber production.
- D1.6 - Quantification of increased water use efficiency and tolerance to poor water quality from grafting high quality cultivars on selected rootstocks in ECOPONICS.
- D1.7 - Profit margins of tested methods to improve water use efficiency and tolerance to poor water quality in agro-industrial and smallholder ECOPONICS.

Milestones and expected results

- Month 12 - Definition of water quality plant response curves under Mediterranean climatic conditions
- Month 12 - Characterization of the relative water economy of ECOPONICS vs. soil or field growing vegetables
- Month 24 - Identification of rootstock capable to increase water use efficiency of different quality water
- Month 36 - Identification of mechanisms in rootstock grafting to increase water use efficiency under different water quality conditions.
- Month 36 - Validation of alternative treatment to reduce water needs per unit product.
- Month 36 - Increase fertilizer and water use efficiency for better environmental sound production
- Month 36 - Economic feasibility of methods to improved water use efficiency in ECOPONICS.

Work package number : 2	Development of water saving simplified open, recirculating and non-circulating hydroponic systems for smallholders					
Relative start month ¹ :	1					
Participant number ² :	P1	P3	P4	P7	P8	
Person-months per participant:	36	36	18	3	18	

¹ Month 0 being the start of the project. ² Participant number of Lead Contractor in bold letters.

Objectives

General: Promoting ECOPONICS as an innovative, integrated but simple technology system for a broad public focused on further water use efficiency for environmental sound vegetable production

Specific:

Task 2.1 - Development of simplified and water saving hydroponics systems for ECOPONICS also suitable to smallholder farmers.

Task 2.2. - Developing and testing crop coefficient for simplified ECOPONICS.

Task 2.3. - Validation of developed simplified growing systems for ECOPONICS and integration of results from other workpackages to increase water use efficiency

Task 2.4 - Development of cost effective and water saving techniques for protected cultivation in ECOPONICS (plastic tunnel).

Task 2.5 - Economic evaluation of feasible ECOPONICS enterprise development.

Description of work

Task 2.1 - Development of simplified and water saving hydroponic systems for ECOPONICS also suitable to smallholder farmers (P1, P3, P8)

Subtask 1 (month 1 – 24): Design of water use efficient simplified recirculating systems (P3)

Tomato and cucumber will be grown in short season in simple and cost effective recirculating systems. Plants will be grown in pots and/or beds filled with tuff and perlite. Subirrigated systems will be also tested. Irrigations during the day will be based on according to integrated indoor solar radiation levels of 1.0, 2.0, 3.0 and 4.0 MJ/m². Canopy development will be monitored using a canopy analyzer. Transpiration of crop will be measured by porometer in different growth stages of plant. Plant water consumptions will be determined by subtracting input and output of water amount in the systems. Waste water quantity and nutrient content will be recorded. Yields and nutrient efficiency (P3) as well as product quality characteristics (P1) of the different systems will be evaluated.

Subtask 2 (month 1 – 24): Design of water use efficient simplified open systems (P8)

A low cost simplified open system will be designed with different locally available substrates. Transpiration will also be measured by porometer in different growth stages. Drainage water will be collected and regularly analyzed for water quality (nutrient content and salinity) for the assessment of environmental impacts and water as well as nutrient efficiency of the system. Yields (P8) and product quality characteristics (P1) of the different systems will be evaluated and compared to common systems in P8 research station.

Subtask 3 (month 1 – 24): Design of water use efficient simplified closed systems (P1)

A closed non-recirculating hydroponics system, which does not require electricity, specialized equipment, substrates and special skills will be designed. The system is based on the fact that root system of plants easily adapt to their water environments and are capable to develop in the same plant with different functions; one for oxygen uptake and another for nutrient and water uptake. The aerial root in hydroponics plants can supply the crop with oxygen, thus overcoming the most serious constraints in hydroponics, which is aeration. To promote this feature of roots they are initially forced to grow inside a wide open area between the top cover and a net supporting the oxygen roots over the water surface. The design of this system will be optimized for tomato and cucumber, by investigating the special morphological and physiological characteristics of oxygen and water roots. Transpiration will be evaluated by porometer measurements and sap flow gauges at in different growth stages. Different nutrient solutions based on low cost and available compound and strait fertilizers will be tested and evaluated. Water use and nutrient efficiency as well as yield and quality characteristics will be evaluated and compared to common hydroponic systems used in P1 research station.

Task 2.2 - Developing and testing crop coefficient of simplified systems (P1, P3, P8).

Crop coefficients of the different experiments in Task 2.1 methods will be developed according to the

actual water consumption and potential evapotranspiration under different conditions in greenhouses. For this purpose, Class A pan evaporation, solar radiation and Penman methods will be used for potential evapotranspiration. The weekly ratio of actual water consumption (determined in Task 2.1) to potential evapotranspiration (ETp) will be obtained during the growing period. (month 01-24).

Task 2.3 - Validation of developed simplified ECOPONICS systems and integration of results from other workpackages for increasing water use efficiency (P1, P3, P4, P5, P8)

The optimized systems (open, recirculating and closed non-circulating) will be exchanged between partners and tested against each other. Results from WP1, WP3 and WP4 available at this moment will be integrated as well. The compatibility of the different components proposed in WP1 (rootstocks for grafting, plant strengthening organisms etc.) with the different simplified systems ECOPONICS will be of particular interest. Special emphasis will be given to the development of management recommendations for smallholders based on simple and cost-effective measurable key parameters (EC, pH), which could be executed by the farmer himself, members of farmer organizations or extension service agents. Yields and quality characteristics (P1) of these combined systems will be evaluated and compared to each other (month 24-36).

Task 2.4 - Development of cost effective and water saving techniques for protected cultivation in ECOPONICS (plastic tunnel) (P4).

A comparison between three different low cost protection techniques, namely: low plastic tunnels, walk-in tunnels, and high conventional tunnels, will be evaluated for water use efficiency of tomato and cucumber. The set-up of these structures in a coastal region will allow to assess their wind resistance and the generated plastic waste from cover renewing (month 01-24).

Task 2.5 – Economic evaluation of feasible enterprise development based on different ECOPONICS technologies (P1, P2, P3, P4, P7, P8).

A microeconomic assessment for all proposed technologies in the experiments in this workpackage will be carried out based on the same protocol than in Task 1.5 of WP1. However, besides classical parameters of economic efficiency and profitability the monetary water use efficiency in terms of product value per unit of water consumed and profit margin per unit of water consumed will be subject of evaluation. Based on farm models representing the different socio-economic realities of vegetable producers in the MP countries (identified in WP6), investment analysis will be performed in order to assess the feasibility of ECOPONICS-enterprise development based on the different proposed production systems and with special focus to smallholders (month 13-36).

Deliverables

- D2.1. – Reports on water and nutrient use efficiency as well as yield performances of simplified ECOPONICS based on open, recirculating and closed non-circulating systems.
- D2.2 – Reports on crop coefficients (ratio of actual water consumption to ETp) for different simplified ECOPONICS systems.
- D2.3 - Report on water saving potentials and economic as well as environmental evaluation of different plastic protection types for water saving.
- D2.4 – Validation of simplified systems and effects (compatibility) of integrated water saving methods from WP1
- D2.5 – Report on economic feasibility of enterprise development with ECOPONICS with technology for different types of vegetable producer in MPC.
- D2.6. - Extension manuals for design and management of simplified ECOPONICS systems

Milestones and expected results

- Month 24 Designed simplified but water use efficient hydroponic systems for ECOPONICS.
- Month 24 Cost effective methods of protected vegetable production for high water use efficiency.
- Month 36 Validated simplified systems with management recommendations tailored to smallholders including integrated WP1 methods to further increased water use efficiency.
- Month 36 Economic feasibility of ECOPONICS based vegetables enterprise development.

Work package number : 3	Utilization of climate modification in ECOPONICS for improving water use efficiency						
Relative start month ¹ :	1						
Participant number ² :	P1	P2	P3	P4	P5	P8	
Person-months per participant:	3	3	3	42	3	3	

¹ Month 0 being the start of the project. ² Participant number of Lead Contractor in bold letters.

Objectives

General: Improved water use efficiency through different climate modification techniques and their modeling for a dissemination decision support tool in ECOPONICS.

Specific :

- Task 3.1 - Creation and management of data base for climatic information and crop management experiences in ECOPONICS project.
- Task 3.2 - Determine optimal microclimate management for high water use efficiency in ECOPONICS (Model experiment).
- Task 3.3 - On farm validation: Physiological response of plant to tested microclimate management systems (relationship between plant growth and shading, humidity, etc.)
- Task 3.4 - Computer based modeling for water use efficiency, crop growth, and yield in ECOPONICS

Description of work

Climate modification has been used in other projects to study the impact of saline water on crop responses. The focus of this project will be expanded for improving water use efficiency in an hydroponic system such as ECOPONICS. Increasing relative humidity will be studied to decrease evapotranspiration together with other climate modification tools (e.g. shading, ventilation, mulches, adapted cultivars etc.). The results obtained from this work package will be integrated with the results from other work packages to produce a multi-lingual dissemination decision support toll to be utilized by extension services and/or growers in different countries in the region.

Task 3.1 Creating and management of data base for climatic information and crop management experiences in the ECOPONICS project (P1, P2, P3, P4, P5, P8).

Climatic data for different locations are available in P4 (30 automatic weather stations) and will serve with existing crop experiences for the initial data base. In order to exploit the knowledge gathered in the whole project, this data base will be updated and completed with climatic data and the related experimental results of project partners, based on a general data gathering protocol defined at the beginning the project (month 1-36).

Task 3.2 Determine optimal microclimate management for high water use efficiency in ECOPONICS (P4)

In the experiment, the effect of micro climate factors such as solar radiation, relative humidity and temperature, on the cucumber and tomato plants will be tested to water use efficiency in hydroponic. These parameters will be evaluated under site or top ventilation treatments in comparison with micro climate of slanted greenhouse (month 1-12).

Task 3.3 On farm validation: Physiological response of plant to tested microclimate management systems (relationship between plant growth and shading, humidity, etc.) (P4).

The experiment will be done for evaluating growth of tomato and cucumber plants grown under different climatic and cultivation conditions (different levels of shading and different percentage of relative humidity). The effect of these climatic factors will be determined by measuring yield, fruit quality and growth rate of plants in correlation with plant growth in the farm (12-24).

Task 3.4 Computer based modeling for water use efficiency, crop growth, and yield in ECOPONICS (P4).

P4 developed already a successful irrigation model for vegetables in open field production. The existing models for water use efficiency, crop growth and yield will be evaluated and validated for vegetable crops grown in ECOPONICS. Together with the data obtained in this work package and the data base created in Task 3.2 it will serve for the development of a multi-lingual decision support tool for dissemination in the different regions (month 24-36).

Deliverables

- D3.1 – Quantification of the relationship between micro climatic factors and plant response for water use efficiency in ECOPONICS.
- D3.2 – Validation report of on-farm results for water use efficiency and microclimate management techniques.
- D3.3 – Extension guide for climate modification options in ECOPONICS.
- D3.4 - A data base for the best management practices of microclimate control for ECOPONICS vegetable crops in the Mediterranean region.
- D3.5 - A user friendly water and climate management software package for vegetable crops in different growing in different water saving systems of ECOPONICS.

Milestones and expected results

The work package will produce a set of tools such as an extension guide and a software package that will improve water use efficiency and increasing yield and quality of vegetables under protected cultivation using the newly developed technology of ECOPONICS

Month 12 – Knowledge about the relationship between climatic factors and water use efficiency in greenhouses

Month 24 – Effective microclimate management techniques for water efficient production of vegetables in ECOPONICS.

Month 36 - The work package will produce a set of tools such as an extension guide and a software package that will improve water use efficiency and increasing as well as yield and quality.

Work package number : 4	Improved production risk management in ECOPONICS vegetable production for overall reduction of water consumption						
Relative start month ¹ :	1						
Participant number ² :	P1	P4	P5	P7			
Person-months per participant:	3	6	54	3			

¹ Month 0 being the start of the project. ² Participant number of Lead Contractor in bold letters.

Objectives

General: Water use efficiency of pest and disease infected plants is poor. Integrated production and pest management tailored to sustain high water efficiency in ECOPONICS will be developed.

Specific:

Task 4.1 - Identify tolerance threshold of the plant to the water quality with regards to their sensitivity to insect, mite and virus infestation.

Task 4.2 - Combating negative impacts of microclimate control (high humidity, restricted ventilation etc.) for high water use efficiency in ECOPONICS on pest management (UV absorbing plastic films and nets, bio control agents, etc.).

Task 4.3 – Modify IPM and IPP to water saving ECOPONICS for high quality products, more economically than in the conventional production system and with the least amount of pesticide.

Task 4.4 – Identify cost efficient and environmentally sound substrate disinfection methods for ECOPONICS

Description of work

Task 4.1 - Identify tolerance threshold of the plant to the water quality with regards to their sensitivity to insect, mite and virus infestation. (P5)

It is established that water quality and certain drought stress plays an important role in the integrity of the plant with regards to pests and diseases. It has also been established that some salinity levels are conducive to high infestation with certain pests. This work will focus on the evaluation of different water quality with different salinity content on the occurrence of insect (aphids, whiteflies and thrips) and mite pests on tomato in ECOPONICS. Caged plants within the greenhouse will be voluntarily infested with these pests and subsequent observations will determine whether such salinity regimes have any impact on the development of pest populations and virus (in particular TYLCV) infestation. These results will be compared to a control treatment within the same greenhouse using the same variety grown in ECOPONICS but using a control quality water for irrigation (month 1-24).

Task 4.2 – Combating negative impacts of microclimate control (high humidity, restricted ventilation etc.) for high water use efficiency in ECOPONICS on pest management (UV absorbing plastic films and nets, bio control agents, etc.) (P5).

Plants grown under stress (water, heat, salt, etc.) are more prone to insect damage. Given the threat of insect transmitted viruses in the Mediterranean region especially Tomato Leaf Curl Virus (TYLCV), greenhouse need to be equipped with insect net that exclude the vectors as a major component of an IPP package. Many types of insect nets and plastic films (regular and UV absorbing) with different mesh size and quality (regular and UV absorbing) are available on the market. There are no available norms for the use of these insect nets in the Mediterranean region. This work will focus on the evaluation of a regular insect net mesh size 10*20 or the 50 mesh as compared with the bionet which has in addition the UV absorbing quality. We will also evaluate the impact of these insect nets on the performance of introduced natural enemies; *Eretmocerus mundus*, *Aphidius colemani* and *Orius laevigatus* and *Phytoseiulus persimilis* for the biological control of whiteflies, aphids, thrips, and mites; respectively. We will use insect counts on bi-weekly sampled leaves (%infestation as well as % parasitism) as well as adult captures in yellow sticky traps (pests and natural enemies) to make our evaluations (month 1-24).

Task 4.3 – Microeconomic and product quality evaluation of different IPM and IPP measures in ECOPONICS versus conventional pesticide based systems (P1, P5, P7)

The ECOPONICS system will not be viable if it is not economical. This work will focus on the economic evaluation of the various IPP components (insect nets, biological control, climate management) as compared to a conventional system based on the use of chemicals, representing actual farmers practice in the region. The management of greenhouse climate as well as the use of insect traps to monitor the major insect pests are some of the tools that will be used and will allow to cut down on the number of pesticide treatments needed. Pesticides will be applied only when it is justified and on the basis of threshold levels according to crop response in ECOPONICS. More emphasis will be put on the management of greenhouse climate to combat foliar diseases and on biological and physical control (nets) for combat. Emphasis will also be on some cultural practices (leaf pruning and plant density) in the management of pests and diseases (P5). The microeconomic assessment of this and for all other experiments in this workpackage will be carried out based a general data gathering protocol defined at the beginning the project, which will also allow to express monetary water use efficiency in terms of product value per unit of water consumed and profit margin per unit of water consumed (P1, P7). Fruit samples of ECOPONICS and conventional pesticide based systems will be collected for pesticide residual analysis and assessment of other quality attributes (P1) (month 13-36).

Task 4.4 – Cost efficient and environmentally sound disinfection methods for nutrient solutions used in ECOPONICS (P4).

Locally produced sand filters will be evaluated for the disinfection of nutrient solutions in several hydroponic media for tomato and cucumber production. The initial effectiveness of this filter and its evolution over time will be evaluated by monitoring the level of an introduced non pathogenic Fusarium strain after passing the sand filter. Costs against common techniques will be assessed (month 12-36).

Deliverables

- D4.1 - Report on the impact of water stress and quality on the tolerance of tomato plants to some major pests (whiteflies, aphids, thrips and mites) and degree of virus outbreak .
- D4.2 - Report on the impact of insect nets on whitefly and TYLCV management and its impact on greenhouse microclimate as well as its compatibility with the use of bumble bees for pollination and natural enemies for biological control of the major pests (whiteflies, aphids, thrips and mites) of tomato under protected cultivation.
- D4.3 - Effectiveness and cost saving sand filter technology for nutrient solution disinfection and their management in ECOPONICS.
- D4.4 - Report on the economic feasibility of IPM and IPP in the ECOPONICS system as a environmentally friendly production system for healthy vegetable products.

Milestones and expected results

- Correlation of irrigation water quality (salinity regime), crop response and susceptibility, resistance/tolerance to insects and virus infestation in ECOPONICS.
- Impact of insect nets on the greenhouse microclimate and subsequently on the growth of the plants and water use efficiency in ECOPONICS.
- Impact of insect nets and UV absorbing films on the management of one of the major disease of tomato and pepper (TYLCV) in the Mediterranean region, for which there is no cure (60-100% yield reduction) at this point of time.
- Evaluation of the compatibility of the different components of the IPP package (insect nets, biological control, pollinators and low risk pesticides) in the management of crop health and the production of quality product.
- Production of quality products with virtually no or low residues of pesticides.
- Reduction of production costs by cutting down all unnecessary treatments that are generally applied on a calendar basis in a conventional production system.
- Alternative and economic nutrient solution disinfection method.

Work package number : 5	Assessment and identification of management options for product quality in ECOPONICS						
Relative start month ¹ :	1						
Participant number ² :	P1	P2	P3	P4	P5	P7	P8
Person-months per participant:	60	12	12	12	12	3	12

¹ Month 0 being the start of the project. ² Participant number of Lead Contractor in bold letters.

Objectives

General: Vegetables from ECOPONICS will produce a new standard of qualities in Mediterranean vegetable production, which need to be assessed.

Specific:

- Task 5.1 - Creating and management of a data base for quality assessment and management recommendations based on the results of the tested technologies in the ECOPONICS project.
- Task 5.2 - Determine and evaluate external quality, marketability and sensory quality of vegetables in response to different techniques tested and evaluated for ECOPONICS.
- Task 5.3 - Determine the impacts of different growing practices in ECOPONICS including water and salt stress on the vegetable contents of vitamins, minerals and antioxidants.
- Task 5.4 - Evaluation of pesticide residues in ECOPONICS versus traditionally grown vegetables, with special emphasis on insecticides extensively used in conventional production.
- Task 5.5 - Post harvest behavior and performances of vegetables produced with different methods evaluated for ECOPONICS including water and salt stress situations.

Description of work

Task 5.1 – Creating and management of a data base for quality assessment results of the tested technologies in the ECOPONICS project. (P1, P2, P3, P4, P5, P7, P8)

P1 as lead contractor of WP 5 will be responsible for the creation of a database for vegetable quality data gathered in the project. This database will regularly be updated with the quality results of P1 experiments and all other partners together with all other agronomic information of these trails. This will allow to evaluate (by PCA and PLS) the impacts of different tested methods and technologies on the different product quality criteria of ECOPONICS vegetables. This will be done also in consideration of the result of task 6.1 in WP6 in order to design the water saving features of the ECOPONICS system as close as possible for the different markets (domestic and export) and the production opportunities of Mediterranean farmers (month 1-36).

Task 5.2 - Determine and evaluate external quality, marketability and sensory quality of vegetables in response to different techniques tested and evaluated in ECOPONICS (P1, P2, P3, P4, P5, P8)

Based on a general data gathering protocol defined at project start with all partners, these parameters will be assessed in every experiment by every partner. External quality parameters are evaluated according to established EU quality norms and the respective norm of the partner country. Special attention will be given to blossom end rot, because this physiological disorder is closely related to water quality, cation interactions and the water status of plants (degree of water stress) as well as cultivar susceptibility. Additionally to these parameters, every partner will evaluate as well soluble solids (°Brix), electric conductivity and pH of fresh fruit. The sensory analyses are performed at the laboratory of each partner by trained panel members. For the assessment of sensory quality (odor, color, taste flavor and texture) procedures of sensory profiling accredited according to international standards (ISO 6564: 1985-E, ISO 8589: 1989 E and ASTM 1968) will be used. P1 will train panel members at site of each participating partner and monitor regularly the conduct of this task and process the data for the quality data base of ECOPONICS (month 6-36).

Task 5.3 - Determine the impacts of different growing practices in ECOPONICS including water quality impacts on the vegetable contents of vitamins, minerals and antioxidants (P1, P2, P3, P4, P8).

This task will focus on the identification and quantification of possible impacts from different methods tested for water use efficiently produced vegetables in ECOPONICS on substances determining the nutritional value. Representative sub samples from optimal harvest phase will be analyzed as deep frozen or lyophilised material from experiments in WP1 and WP2 sent by the partners. Samples from experiments in WP2 conducted by P1 will also be deep frozen before analysis. Contents and bioavailability of minerals will be determined using standard methods.

Ascorbic acid, flavonoids, carotinoides and phenols will be analyzed by HPLC using established methods. The antioxidative activity of fruit will be determined by chemiluminescent measurements done with the Photochem analyzer of the institute (month 6-36).

Task 5.4 - Evaluation of pesticide residues in ECOPONICS versus traditionally grown vegetables, with special emphasis on insecticides extensively used in conventional production (P1, P5).

This task aims to identify the potentials of ECOPONICS to reduce pesticide residues and perhaps to increase consumer acceptance of ECOPONICS products. Samples of all treatments of Task 4.3 in WP4 will be transferred to P1. All samples will be analyzed by partner P1 for pesticide residues according to EU standards and FAO recommendations. Additionally random samples of tomato and cucumber taken at different seasons of the year purchased in EU and originating from MPC countries as well as fruit samples from the domestic markets of MPC will be taken in order to quantify the pesticide saving effect of ECOPONICS in comparison to exiting qualities. Special emphasis will be given to insecticide residues regarding their extensive use in conventional Mediterranean horticulture (month 24-36).

Task 5.5 - Postharvest behavior and performances of vegetables produced with different methods evaluated for ECOPONICS including water stress situations and use of poor quality water (P1, P2, P3, P4, P5, P8).

Postharvest performance is an important physiological feature with will also influence the success of ECOPONICS vegetables in the supply chain. The post harvest physiological reactions of vegetable samples sent by partners from experiments in WP1 and WP2 and from P1's contribution to WP2 will be evaluated in the respiration measurement equipment of the institute for respiratory activity and water loss. This will be done under different temperature and humidity regimes, in order to simulate optimum cooled storage conditions and uncontrolled post harvest handling with high temperature and low relative humidity. In order to evaluate ex post the physiological age of samples at delivery to P1 due to different air shipment conditions from the different partners, small sensors for air temp. and rel. H₂O measurements with automated data registration will be added to the samples (month 6-36).

Deliverables

- D5.1 - Impact of different water qualities on product quality criteria (outer, sensory, nutritional value and post harvest performance)
- D5.2 - Product quality assessment (outer, sensory, etc.) of hydroponic vegetables versus soil grown.
- D5.3 - Impact of different simplified hydroponic systems on product quality criteria (outer, etc.)
- D5.4 - Impacts of different microclimatic management techniques on the product quality of vegetables from ECOPONICS, results from modelling and on farm validation.
- D5.5 - Report on pesticides residues in vegetables from Mediterranean countries sold on EU and MPC domestic markets and product quality impacts of IPM and IPP measure in ECOPONICS.
- D5.6 - Report on product quality impacts of different tested methods to increase water use efficiency in ECOPONICS (grafting, bio control and other agents).
- D5.7 - Report and disseminations papers about ECOPONICS product quality and its management opportunities in the final designed ECOPONICS system for farmers, actors in the market chain, consumers NGO in EU and MPC as well as concerned decision makers in EU and MP countries.

Milestones and expected results

- Identification of quality impacts from water stress and water quality factors on vegetable products.
- Knowledge about product quality effects from measures against water stress (grafting, microclimate control, bio control and other agents etc.).
- Identification of pesticide residues vegetables from MPC on EU and domestic markets.
- Characterization of post harvest behaviour of ECOPONICS products for efficient post harvest handling in the supply chain.
- Data base for the quality management of ECOPONICS related to consumers expectations (EU, MPC).

Work package number : 6	Analysis and assessment of economic and institutional conditions for the adoption of ECOPONICS						
Relative start month ¹ :	6						
Participant number ² :	P1	P3	P5	P6	P7		
Person-months per participant:	2	10	10	60	60		

¹ Month 0 being the start of the project. ² Participant number of Lead Contractor in bold letters.

Objectives

General : Study of the economic and institutional conditions of the adoption of ECOPONICS, with special focus on governance issues at three different levels: the farming system, the input supply chain and the product supply chain both on domestic and export markets.

Specific :

Task 6.1 - Consumer perception of ECOPONICS products both on domestic and export markets

Task 6.2 - Product supply chain governance issues both on domestic and export markets

Task 6.3 - Farming systems and conditions of adoption of ECOPONICS

Task 6.4 - Input supply chain governance issues with special focus on water resources management

Description of work

Task 6.1 Consumer perception of ECOPONICS products .

Subtask 1 (m06-m12): on EU export markets (Germany, France), a bibliographic survey will be conducted, using already existing consumer surveys dealing with products similar to ECOPONICS. It will be completed with interviews of retailers and fresh produce industry associations in both countries.

Subtask 2 (m13-m18): on domestic markets (Morocco, Turkey), semi-directive interviews will be conducted (50 per country) in order to bring out descriptive features of ECOPONICS produce and position them according to food representations classifying consumers. A content analysis will determine which major features to test.

Subtask 3 (m19-m30): the latter interviews will enable to test ECOPONICS produce features which consumers are aware of, as compared to those of conventional produce, along with the attitudes towards prices. To do so, a quantitative survey on a representative sample of the population will be carried out in an urban zone close to the production site (a 1000-individual sample for each country, stratified according to age, gender, education level, standard of living). An analysis by PCA statistical method will characterize customers.

Task 6.2 Product supply chain governance issues both on domestic and export markets

Subtask 1 (m06-m24): institutional environment for ECOPONICS produce qualification on domestic and export markets: characterization of ECOPONICS model attributes, study of ECOPONICS model insertion in existing qualification systems. Identification of private and public actors who may contribute to the qualitative positioning of the ECOPONICS model.

Subtask 2 (m13-m36): Supply chain governance issues on domestic markets with special focus on the role of supermarket chains in promoting safer and environmentally-friendly produce?

Characterization of retailing industry actors (general data on firm structures and strategies; specific data on the retailer fresh produce sourcing and marketing activities); analysis of retailer supply organization (internal organization, coordination mode with suppliers) and of its capacity to pass on the right incentives for ECOPONICS model adoption. Advantages/drawbacks of traditional supply chains for ECOPONICS valorization, role of wholesalers and retailers in the promotion of ECOPONICS.

Subtask 3 (m18-m36): Supply chain governance issues on export markets (France, Germany)

Which supermarkets or retailers are interested by the valorization of ECOPONICS produce? With what reference system? With what quality label for the consumer? Role of importers in the promotion of ECOPONICS. With which requirements? Which enforcement problems? Logistic and institutional (trade barriers) access condition to export markets. Governance issues on the whole chain.

Task 6.3 Farming systems and conditions of adoption of ECOPONICS

Subtask 1 (m06-m12): bibliographic survey and interviews with colleagues specialized in agronomy in order to characterize different technical growing sequences related to production of ECOPONICS produce (tomatoes, cucumbers), identification of elements which differ between ECOPONICS and conventional techniques (advantages/drawbacks).

Subtask 2 (m12- m18): Selection in two countries (Morocco, Turkey) of greenhouse crop zones for study (one zone per country), descriptive analysis of farm management in the chosen zones, characterization of the diversity of structures and management.

Subtask 3 (m19-m36): Analysis of farm capacity to adopt the ECOPONICS technical model : investments, labor organization and management, labor qualification, technical risks, economic risks. Identification of adverse factors and of technical-economic conditions for the adoption of the model by type of farm.

Subtask 4 (m37-m48): Dissemination of ECOPONICS technology and training of farm advisers and extension services (governmental and NGO).

Task 6.4 Input supply chain governance issues with special focus on water resources management

Subtask 1 (m06-m12): In the two selected countries (Morocco, Turkey) and for all input necessary for ECOPONICS production (seeds, bio auxiliaries, chemicals, substrates, greenhouses etc.) identification of the different suppliers.

Subtask 2 (m12-m18): Analysis at a national level of the input supply chain coordination devices. Identification of institutions in charge of advising farmers and of their role in the spreading of ECOPONICS.

Subtask 3 (m18-m36): At a local level (in the selected production zones), analysis i) of the input and technical advice coordination issues; ii) of the impact of the adoption of ECOPONICS on water management (quantitative and qualitative aspects of minimization of use of this resource : waste waters, etc.) and waste management (plastic wastes, etc.).

Deliverables

D6.1 Report on potential consumer market in France and Germany.

D6.2 Report on consumer perception and attitudes in Morocco and Turkey.

D6.3 Report on produce supply chains in the different selected countries (Morocco, Turkey, Egypt, France and Germany).

D6.4 Report on the institutional environment of the produce supply chain (Morocco and Turkey, France and Germany).

D6.5 Report on farm strategies regarding the adoption of the ECOPONICS model (Morocco, Turkey).

D6.6 Report on input supply chains and water resource management (Morocco, Turkey).

Milestones and expected results

Month 12 – Quantitative and qualitative demand evaluation in European countries (France and Germany)

Month 12 – Identification of actors and functions of the product supply chain

Month 18 – Protocol for the population survey

Month 18 – Characterization of the actors of the input supply chain in Turkey and Morocco, specific input supply conditions for producers.

Month 18 – Description of the technical and economic management of farms in two greenhouse crop regions in Morocco and Turkey.

Month 24 – Analysis of the institutional environment.

Month 30 – Data collection and handling of the population survey

Month 36 – Description of product supply chain coordination devices on the domestic and export markets.

Month 36 – Identification of farm strategies and of microeconomic factors which explain the adoption of the ECOPONICS model in two greenhouse crop regions in Morocco and Turkey.

Month 36 – Analysis of the role of collective water management and supplier organizations for the spreading of the technical model.

Work package number : 7	Introduction of ECOPONICS technology system to farmers with quality label for ECOPONICS vegetables for consumer awareness							
Relative start month ¹ :	26							
Participant number ² :	P1	P2	P3	P4	P5	P6	P7	P8
Person-months per participant:	8	2	12	2	12	5	5	12

¹ Month 0 being the start of the project. ² Participant number of Lead Contractor in bold letters.

Objectives

General: Dissemination of the ECOPONICS system for economical, environmentally sound and simplified protected vegetable cultivation in places with water constrains but high value tomato and cucumber productions (Protected glass and plastic houses areas in 2002: Morocco – 10550 ha, Egypt – 1350 ha, Turkey – 20.000 ha, Jordan – 2000 ha).

Specific :

Task 7.1 - Print of technical manuals and conducting training courses

Task 7.2 - Utilizing FAO News letter and home pages

Task 7.3 - Setting-up of demo-sites in selected INCO-Med partner countries

Task 7.4 - Designing of a Quality label and selection of trading partners

Description of work

Task 7.1 - Print of technical manuals and conducting training courses

Task 3 of WP 6 “Farming systems and conditions of adoption of ECOPONICS” will have generated a wealth of data and information during the first 3 years of the project for formulation of recommendations. The local INCO-Med. Partners will write-up in Arabic and Turkish (for Morocco if necessary also in French and Berber, respectively) with a manual with simple descriptions and drawings. For training courses a technical bulletin will be designed with full explanations of the new innovative features of ECOPONICS. Partner 4 has developed in WP 3 a model for growth and yield to become part of the technical information materials (month 37-42).

Task 7.2 - Utilizing FAO News letter and home page

The horticultural crops group of the Food and Agricultural Organisation (FAO) in Rome maintains a special and intensive program on greenhouse crop production in the Mediterranean region. Partners of ECOPONICS belong to this group which issues a regular FAO News letter (paid by FAO) for all INCO-Med countries. This newsletter will be used as a vehicle for ECOPONICS with the full consent of FAO. The Horticultural Crops Groups has also a special data base on its home page <http://www.fao.org/hortivar&fao.org> as an excellent platform to dissipate the results of ECOPONICS not only to INCO-Med but worldwide.

Task 7.3 - Setting-up of demonstration sites in selected INDO-Med partner countries

Partners 6 and 7 have gathered all necessary information under Task 3 “Farming systems and conditions of adaptation of ECOPONICS” and in Task 4 “Input supply chain governance issues with special focus on water resource management” to set up simple operations in farmers greenhouses for hand-on demonstration of ECOPONICS to convince farmers of this new growing system. It will also make tomato and cucumber fruits available to traders for quality judgement and trial shipments. A number of demonstration farms will be established with FAO’s involvement during the next years in several INCO-Med countries, which can be used for ECOPONICS show-case sites.

Task 7.4 - Design of a quality label and selection of trading partners

WP 6, Task 1 “Consumer perception of ECOPONICS products” and Task 2 “Product supply chain governance issues both on domestic and export markets” will provide excellent data-base and together with monitoring of quality performance by partner 1 will provide the needed information for this task. With existing quality standards issued by the EU commission special criteria will be formulated for tomato and cucumbers from ECOPONICS production. Although those fruits will not be covered by the EU-Bio-label, they should qualify for an environmentally friendly production recognizing considerable reduction in water and pesticide use. Many consumers in the INCO-Med countries have recognized the problems with vegetable production and consumption. The European Union has set regulations for

importation of vegetables which will favour ECOPONICS quality.

There is a large trade of 45.000 mto/annum cucumbers from Jordan and 10.000 mto/a from Turkey to other Arabic countries and in the average of 180.000 mto/a of tomatoes from Jordan, 215.000 mto/a from Morocco and 120.000 mto/a from Turkey for Arabic and European consumers. These well established trade channels will be tapped for the introduction of ECOPONICS produce.

Deliverables

D7.1. Training material, technical manuals and brochures in local languages (Arabic, Turkish, Berber and French).

D7.2. Training courses conducted in partner countries.

D7.3 Established links to FAO Hortivar homepage and regional FAO Newsletter.

D7.4 Set up of at least one demo-site in Morocco, Turkey and Jordan.

D7.5 Quality criteria and design of a ECOPONICS quality label.

D7.6 Contacts with traders and trial shipments of ECOPONICS cucumbers and tomatoes to domestic and export markets.

Milestones and expected results

Month 39 - Training material, technical manuals and brochures available

Month 48 - Training courses for extension officers, NGOs and other professionals have taken place

Month 48 - Relevant data were fed in Hortivar and articles written for Regional FAO-Newsletter and other technical and scientific journals

Month 48 - Demo-sites run in Morocco, Turkey and Jordan

Month 48 - A new quality label for ECOPONICS is designed with efforts for registration

Month 42 - ECOPONICS produce of tomatoes and cucumbers were introduced to various traders for trial shipments to diversified domestic and export markets