(Water FARMING)

Improvement of water and Nutrient Retention and Use Efficiency in Arable Farming Systems from Field to Catchment Scale in Europe and North Africa Measurements

Abd-Alla Gad Abd-Alla Gad

National Authority for Remote Sensing and Space Sciences (NARSS)

Facts behind WaterFARMING (related to water availability Challenges).

- Agriculture consumes about 70% of the planet's accessible fresh water, thus sustainable management of water resources is one of the greatest global challenges.
- Depletion of water bodies and the necessity for water resource protection, has led to transnational and national resolutions such as the Water Framework Directive (WFD) in Europe and Water codes in Egypt and Tunisia to ensure the sustainable use of water
- Problems of low and fluctuating water supply are most serious in South Europe and N. Africa where climate change is predicted to result in 30% reductions and increased uncertainty in rainfall by 2050.

Cont. Facts behind WaterFARMING

- Overexploitation of ground water for irrigation has caused salinization leading to soil degradation and loss of fertility, particularly in N. Africa.
- Extreme rain events have resulted in severe erosion, landslides and flooding.
- Excessive and inappropriate timing of fertilizers and manure application in agriculture are causing
- considerable nutrient flows into the ground water or in the surrounding water bodies, thus affecting water quality.
- **WaterWORKS** calls for a coordinated and versatile strategy
- WaterFARMING was proposed to retain the available water at source and optimize water and nutrient use across
- agricultural sectors in Europe and N. Africa.

Objectives

1- Enhance water and nutrient retention capacity and improve use efficiency in diverse arable production systems across Europe and N. Africa

2- Reduce soil and water pollution

3- Identify and use environmental, economic and social indicators to evaluate the production systems

4- Design innovative practices and sustainable water and nutrient use production systems

5- Develop a web-based decision support tool for informIing decision making by farmers, advisory services and policy-makers

Challenges of Egyptian Sustainability

1. Limited and scarcity of water resources in Egypt are the main challenge for agricultural horizontal expanding policies and strategies.
2. Over population is rapid increase versus decrease of agricultural land, thus quantities and qualities of food gape.
3. Facing production challenges, in Egypt, needs an adopted policies of horizontal and vertical agriculture expansion, following activities should be considered;
    - ❖ Saving irrigation water to cultivate another area.
    - ❖ Estimating crop water requirements accurately.
    - ❖ Improving irrigation efficiencies by practicing efficient methods and irrigation scheduling.
    - ❖ Cultivate crop species, tolerated crops to drought.

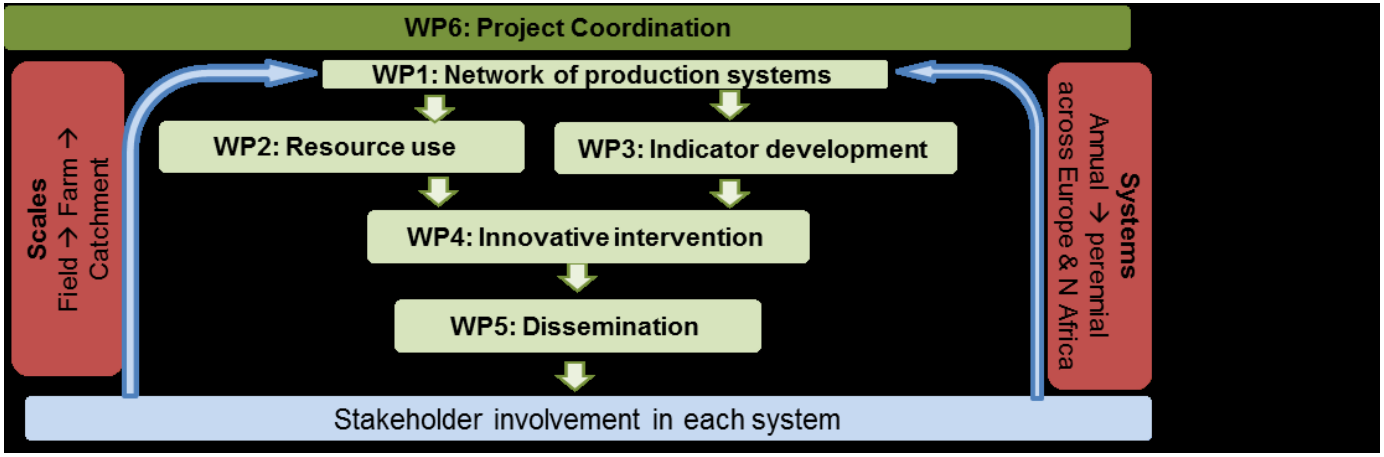
Expected Impacts

- The expected impacts are ways to mitigate farm nutrient and water losses, reduce
- economical costs to farmers and address contamination of water bodies' downstream. Farmers' involvement in the project is crucial for successful adoption and dissemination of innovative production systems. On-farm trials will therefore be used as a dissemination platform.

Alignment of call text with the WaterFARMING tasks

Call text	WaterFARMING tasks
Challenge-1: Development of water-conserving agriculture practices as a way to improve the management of water and to improve soil properties related to water; i) Increasing the resilience of agriculture and landscape management in a context of variable water availability.	Network of production systems in Europe and N. Africa (WP1) will be subjected to water and nutrient productivity assessments (WP2) in order to develop soil, water and nutrient conserving practices from farm to catchment scale (WP4), whilst enhancing the system resilience to climate change and weather extremes.
Challenge-2a: Optimizing fertilizer application to reduce over fertilization while avoiding nitrogen and phosphorus losses to surface water and groundwater.	Nutrient leakages to water sources will be assessed (WP2) by preparation of water and nutrient budgets at the farm to the catchment scale to identify the pollution sources due to farming.
Challenge-2 b: Assessment and development of monitoring schemes and indicators, for agricultural catchments to identify, quantify and minimize pollution sources and to reduce impacts on water quality.	Crop models will be linked to performance proxies in local monitoring systems to increase their predictive power (WP2). Indicators for productivity, environmental and economic performance will be developed to assess the production system performance (WP3).
Challenge-2 c: Modelling and assessing the nitrate and phosphorus loads from agriculture, forestry and sectors to avoid risks of eutrophication of rivers and lakes, and propose management approaches for reducing impacts on ecosystem biodiversity.	With models (such as HYPE) and ArcGIS, the nutrient and water loads will be mapped from farm to catchment scale and a combination of management practices and green infrastructures will be suggested for integrated soil and water management (WP4).
Challenge 3: Developing participatory 'approaches and assessing barriers (social, cultural, psychological and economic barriers) at catchment level for better implementation of policies.	Beneficiaries are actively involved for co-generation of knowledge. The methods and tools will be packaged into a decision support tool (WP5) and policy briefs will be disseminated to the EIPs and stakeholder platforms.

Overall coherence and effectiveness of the work plan



WaterFARMING

A 3-year project consisting of six interconnected work packages

Wp1: will define and analyze the network of production systems.

WP2: will assess the "network production system" for quantification of water nutrient use efficiency gaps by using mix of crop models and Kaya-Porter Identity.

Wp3: Environmental, economic and social SMART indicators will be developed to assess the performance of the production systems from farm to catchment scale.

Wp4: Innovative interventions, relevant to the local production systems will be identified

Wp5: The outputs from WPs 1 – 4 will be communicated through stakeholder-oriented dissemination materials and communication strategies that will be developed.

WP 1, Network of production systems and stakeholder platforms in Europe and North Africa

Country	Production systems	Research issues
Denmark	combined food and energy production	Water use, nutrient inputs and soil fertility
Germany	Barley-rye-rapeseed-Maize	nitrogen and phosphorus fertilizer management
Netherlands	potato-winter wheat-onion rotation	optimal water management, spring and summer droughts
Portugal	maize- potato/peas/ryegrass (irrigated)	Water and nutrient use efficiency and drought
Italy	olive trees intercropped with wheat	drought, soil erosion, landslides, flooding events
Egypt	cotton/maize – wheat/vegetables/beans	drought, water logging, salinity, evapotranspiration
Tunisia	wheat - fodder(cereal/legume mixture)	drought, salinity, soil fertility, groundwater depletion

The Production network includes Groups in a diverse production systems :

a) Permanent arable systems (e.g., wheat/rapeseed rotation)
b) Mixed farming rotations of cereals with grass .
c) Agroforestry systems.
d) Production systems embedded within catchments like Nile valley in Egypt.
e) Systems represents a gradient of increasing water limitation and supply uncertainty from Europe to N. Africa.

This network covers a wide range of catchments including grain and biomass yields of different crop, trees and grass components within rotation cycle, management practices (e.g., nutrient management, irrigation scheduling, and timing of planting) and socio-economic data.

Local stakeholder groups will be formed within each study site.

WP 1,

Network of production systems and stakeholder platforms in Europe and North Africa

Objectives

1. Description of a network of production systems and catchments,
2. Formation of local stakeholder platforms associated with each study site,
3. Development of a working protocol for stakeholder involvement.

Tasks, deliverable and milestone of Wp1

Task	Name	Lead	participants	S	E	Deliverable	Milestone
				Month			
T 1.1	Description of network of production systems and catchments A common template will be provide for descriptions of the identified production systems	CNR	UCPH, UFZ, NARSS, WU, FFCUL, CERTE	1	12	D1.1:D1.1: Description of network of production systems and catchments (Month 12)	M1.1: M1.1: Template developed to describe the network of production systems and catchments (Month 6)
T 1.2	Identification of stakeholders and formation of Stakeholder platforms Partners will identify relevant stakeholders in order to set up local platforms for each catchment.	CNR	UCPH, UFZ, NARSS, WU, FFCUL, CERTE	1	12	D1.2: D1.2: Report on stakeholder identification and formation stakeholder platforms . (Month 12)	M1.2: Identification of stakeholders for inclusion in stakeholder platforms completed (Month 6)
T 1.3	Working protocol development for stakeholder involvement in different WPs working protocols will be developed aiming to provide inputs to WPs 2, 3, 4 and 5.	CNR	UCPH, UFZ, NARSS, WU, FFCUL, CERTE	6	15	D1.3: D1.3: Protocol developed for stakeholder involvement in the network of production systems (Month	

Wp2 Assessment of water and nutrient use efficiency from field to catchment scale

Objectives

1. Develop and validate a crop model approach for our network of production systems,
2. Determine water and nutrient use efficiencies, gaps therein and leakages of the production systems,
3. Develop and validate a hybrid model approach that links field to catchment scale.

Wp2 Assessment of water and nutrient use efficiency from field to catchment scale

Description of work

1. The limited availability and pollution of water sources necessitate closing up the gaps in water and fertilizer use efficiencies, thus there is a need for quantitative analyses of the magnitude and causes of these gaps and the extent to which these patterns differ across Europe and N. Africa.
2. This needs a complex task, as including different processes and efficiencies act on different spatial and temporal scales.
   - Agricultural yield and resource use efficiency gaps are assessed at the field scale using crop growth models,
   - Decisions regarding management and resource use are made at the farm level.
   - Thus, field level efficiencies need to be viewed in the spatial and temporal context of the farm.
   - water and nutrient dynamics in a given area are strongly driven by (geo-morphological) characteristics at the catchment scale (Units of water management).
   - Processes at field and farm level need to be integrated with processes acting at the catchment scale.

Tasks, deliverable and milestone of Wp2

T	Name	Lead	participants	S (Month)	E (Month)	Deliverable	Milestone
T 2.1	Database and calibration and validation of model-based approach. A database will be developed (based in literature, past/ ongoing experiments and lab analyses) including e.g. field-level crop biomass production and yields, irrigation and fertilizer-use, soil data.	WU	UCPH, UFZ, NARSS, CNR, FFCUL, CERTE	1	12	D2.1 Report on chosen field-level model approach (Month 12)	M2.1M2.1: Crop models validated in our network of production systems (Month 12).
T 2.2	Assessment of water and nutrient use efficiencies and gaps in the network of systems Using the model-based approach.	WU	UCPH, UFZ, NARSS, CNR, FFCUL, CERTE	10	24	D2.2: Report on water and fertilizer use efficiencies and gaps therein and nutrient leakages for different study sites. (Month 24)	M2.2: Water and fertilizer use efficiencies and gaps therein determined (Month 24)
T 2.3	Assessment of water and nutrient budgets and soil loss at field and farm scale. The chosen crop model (T2.1) will be linked to a hydrological model. Remote-sensing data on land-use and proxies of crop production Will be used as model input for baseline simulations.	WU	UCPH, UFZ, NARSS, CNR, FFCUL, CERTE	1	30	D2.3: Catchment maps of land- and water- and nutrient use efficiency (Month 30).	

Wp3 Development of indicators for productivity, environmental and economic performance

Objectives

1. Development of a comprehensive list of productivity, environmental and economic indicators,
2. Identification of SMART indicators for the assessment of the network of production systems performance,
3. Mapping of the production systems efficiencies at catchment scale based on WaterFARMING indicators.

Wp3 Development of indicators for productivity, environmental and economic performance

Description of work

1. Simplifying the scientific and technical output of WP2 and make it understandable to stakeholders, by identification of indicators (SMART indicators that reflect in an easy and comprehensive way the current agricultural practice and the best scenarios for improvement).
2. The aim is to help the farmer and agricultural associations better understand resource management and improve the production system efficiency by increasing incomes and reducing environmental impact.
3. The indicators developed in WaterFARMING could be used at **EU level to evaluate/design current/new policies.**

Tasks, deliverable and milestone of Wp3

T	Name	Lead	participants	S	E	Deliverable	Milestone
				Month			
T 3. 1	**Task 3.1: Literature review on database of productivity, environmental and economic indicators** A comprehensive list of agronomic, environmental, and social indicators will be gathered through a structured review of available literature.	**CERTE**	**UCPH, NARSS, UFZ, FFCUL,CNR , WU**	**1**	**12**	D3.1: A comprehensive environmental, economic and social indicator database developed **(Month 12).**	M3.1: **Synthesis of the indicators and corresponding reports completed (Month 12)**
T 3. 2	**Task 3.2: Identification of SMART indicators with stakeholders for agronomic and environmental performance evaluation of the network of production systems.** SMART indicators that help to assess the resource use gaps in the production systems will be identified in consultation with the stakeholders.	**CERTE**	WU, UCPH, NARSS, UFZ, FFCUL, CNR	**18**	**30**	D3.2: Report on identified SMART indicators for agronomic and environmental performance evaluation of network of production systems **(Month 30)**	M3.2: **Indicators and metadata files and catalogue completed (Month 24)).**
T 3. 3	**Task 3.3: Implementation of the indicators for mapping ecosystem services in the network of the production** A GIS based multi-criteria analysis will be used to upscale the use of indicators to catchment scale.	**CERTE**	**WU, UCPH, NARSS, UFZ**	**24**	**30**	D3.3: Report on implementation of the SMART indicators for mapping of ecosystem services **(Month 30).**	
T 3. 4	**Task 3.4: Synthesis of a database on best practices for water and soil conservation** The SMART indicators will be used to identify best practices for soil and water conservation in the partnering countries.	**CERTE**	**WU, UCPH, NARSS, UFZ**	**24**	**34**	D3.4: **Synthesis of a database on best practices for water and soil conservation (Month 34).**	

WP4: Design of innovative water and nutrient efficient production systems

Objectives

1. Simulation of management measures by application of field-to-catchment scale indicators developed in WP3 and use of the map developed in WP2,
2. Analysis and short listing of different measures, in consultation with the stakeholder platforms,
3. Carry out on-farm trials for improvement water, nutrient and soil conserving practices in the network of production systems,
4. Assessment of on-farm trials with the stakeholder platforms for gaps and improvements.

Wp4 Design of innovative water and nutrient efficient production systems

Description of work

1. WP4 will test a variety of practices and improvements to increase water and nutrient use efficiency such as the adoption of multiple cropping systems, buffer strips, improved crop rotations, and reduced tillage.
2. WP4 will identify a number of measures to be implemented through on-farm trial followed by socio-economic analysis to assess the acceptability of the measures.
   - ❖ Agro-forestry improves pest control and increase nutrient and water use efficiency.
   - ❖ Cover crops or reduced tillage can reduce nutrient leaching and mitigate eutrophication problem.
   - ❖ Nutrient use efficiency is increased by appropriate timing and dosage of fertilizers. Applying fertilizers during periods of highest crop uptake, at or near the point of uptake (roots and leaves), as well as in smaller and more frequent applications may reduce losses, improving crop yield quantity and quality.

Tasks, deliverable and milestone of Wp4

T	Name	Lead	participants	S	E	Deliverable	Milestone
				Month			
T 4. 1	**Task 4.1: Simulation of management measures for the network of production systems by application of the field-catchment scale SMART indicators.** A number of management measures will be listed for each of the production systems in the network (WP1) and the task will be carried out in close consultation with the stakeholders.	**UFZ**	UCPH, NARSS, CNR, WU, FFCUL	**1**	**12**	**D4.1:** Report on simulation of management scenarios for the network of production systems (**Month 12**)	**M4.1:** Management scenarios for the network of production systems drafted **(Month 6).**
T 4. 2	**Task 4.2: Analysis and short listing of different measures in consultation with the stakeholder platforms, for improvement of the network of production systems .** The different measures developed in Task 4.1 will be analyzed for productivity, environmental and economic Performance.	**UFZ**	UCPH, NARSS, CNR, WU, FFCUL, CERTE	**01**	**18**	**D4.2:** Report on analysis and short listing of different scenarios with the stakeholder platforms **(Month 18)**	**M4.2:** Analysis and short listing of different scenarios reported **(Month 12)**
T 4. 3	**Task 4.3: Implementation of on-farm trials for improvement of water, nutrient and soil conserving practices.** Information will be obtained from the Task 3.2, where SMART indicators, will be tested.	**UFZ**	UCPH, NARSS, CNR, WU, FFCUL, CERTE	**24**	**32**	**D4.3:** Report on on-farm trials on water, nutrient and soil conserving practices **(Month 32)**	**M4.3:** On-farm trials protocol prepared **(Month 24).**
T 4. 4	**Task 4.4: Socio-economic assessment of the suggested management measures under current and future climate and land use conditions.** On-farm tested measures will be subjected to socio-economic analysis in order to assess their viability and attractiveness.	**CNR**	**UCPH, NARSS, CNR, WU, FFCUL, CERTE**	**24**	**36**	**D4.4:** Socio-economic assessment of on-farm trials with the stakeholder platforms **(Month 36)**	

WP 5: Dissemination of outputs and communication to stakeholders

Description

- Devise communication pathways and dissemination materials to share the results of the project with the stakeholder platforms and the wider farming and end-user community.
- Dissemination Mechanism and Platforms: Awareness creation, publications, workshops and online tools for hierarchy of stakeholders
- Developing a decision support system to synthesize the innovative tools

WP5

Dissemination and communication work

Objectives

1. Coordinate the communication of the project outputs from the work packages 1-4.
2. Invent dissemination tools to facilitate knowledge exchange, based on the scientific and practical agronomic knowledge (Either generated in the project or extracted from various stakeholder groups need).
3. Ensure the efficient delivery of disseminated information to the land-users, policy-makers, administration, extension services, and higher education institutions.
4. Assisting the adoption of soil, water and nutrient conserving practices in Europe and N. Africa.

Tasks, deliverable and milestone of Wp5

Task	Name	Lead	participants	S (Month)	E (Month)	Deliverable	Milestone
T 5. 1	**Development of Knowledge Exchange Plans and a common visual identity for the project**	NARSS	WU, UCPH, UFZ, CERTE, FFCUL, CNR	3	6	D5.1: Roadmap for Knowledge exchange, Communication and Impact Maximization Plan.	M5.1: Knowledge exchange, Communication and Impact Maximization plan drafted (Month 3)
T 5. 2	**Project website and exposure to social media and related research projects.**	NARSS	WU, UCPH, UFZ, CERTE, FFCUL, CNR	5	30	D5.2: Launching of the project website with links to social media like Facebook, Twitter, YouTube (M 8)	M5.2: Draft prepared for the Project web site (Month 4)
T 5. 3	**Communications with the scientific community, stakeholder and preparation of dissemination materials.**	NARSS	WU, UCPH, UFZ, CERTE, FFCUL, CNR	6	36	D5.3: Technical guidelines for farmers, stakeholders and preparation of policy briefs (M 36)	
T 5. 4	**Development of decision Support Tools (DST) for informed decision-making by stakeholders.**	NARSS	WU, UCPH, UFZ, CERTE, FFCUL, CNR	8	36	D5.4: Report on the DST and e-learning module made available on-line (M 36)	M5.3: Stakeholder events (field demonstrations and workshops) planned with stakeholders (Months 24)

WP 6: Project Co-ordination

Objectives:

1. Facilitate communication among all parties and actors involved in the project,
2. Ensure high scientific quality of the deliverables,
3. Effective kick-off and project coordination meetings,
4. Formation of advisory board to provide feedback and future direction on project activities.

WP 6: Project Co-ordination

Description

Coordinator responsibility includes the following

1. Submitting deliverables within the allocated time-frame and budget,
2. Carrying out the organizational and scientific management of the project,
3. Facilitate communication, coordination and data sharing among partners and stakeholder groups and
4. Ensure scientific quality of the deliverables.

An advisory board

- Consists of 3-4 experts will be formed within the first three months, of leading scientists in policy, research and extension services.
- Board members will be invited to annual coordination meetings to provide feedback on the activities carried out and suggestions for future research activities in the project.

Tasks, deliverable and milestone of Wp6

	Name	Lead	participants	S	E	Deliverable	Milestone
				Month			
T 6.1	**Overall project management Tasks include administrative, financial and contractual management, preparation of the Consortium Agreement among the participants.**	UCPH	WU, UCPH, UFZ, NARSS, CERTE, FFCUL, CNR	01	36	D6.1: D6.1: Consortium Agreement (Month 1)	M6.1: Knowledge exchange, Communication and Impact Maximization plan drafted (Month 3)
T 6.2	**Scientific management and quality control. Development of shared concepts and methodologies in the project will be shared. M**onitor progress of the milestones and deliverables throughout the project cycle.	UCPH	WU, UCPH, UFZ, NARSS, ERTE, FFCUL, CNR	01	36	D6.2: 1st, 2nd and 3rd periodic report to the national funding agency and Water JPI (Month 12, 24 and 36).	M6.2: Draft prepared for the Project web site (Month 1st, 2nd and 3rd periodic draft reports completed (Month 10, 22 and 34).
T 6.3	**Participation in Water JPI common kick-off, mid-term and final meeting and annual project coordination meetings**	UCPH	WU, UCPH, UFZ, CERTE, FFCUL, CNR	01	36	D6.3: Documentation of kick-off, annual coordination and WP leader meetings (Month 1, 12, 24 and 36).	

- D6.1: Consortium Agreement (Month 1)
- D6.2: 1st, 2nd and 3rd periodic report to the national funding agency and Water JPI (Month 12, 24 and 36)
- D6.3: Documentation of kick-off, annual coordination and WP leader meetings (Month 1, 12, 24 and 36).

WP 5

Dissemination of outputs and communication to stakeholders

Abd-Alla Gad Abd-Alla Gad

National Authority for Remote Sensing and Space Sciences (NARSS)