WASTEREUSE

Best practices for Agricultural Wastes (AW) treatment and reuse in the Mediterranean countries

WASTEREUSE aims to bridge the gap between research and application in field, and focus on the sustainable treatment and reuse of organic agricultural wastes

www.wastereuse.eu

LIFE10 ENV/GR/594

Project co-funded by EC LIFE+ Environment Policy & Governance

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Project Objectives

Evaluation of innovative as well as, traditional technologies for Agricultural Wastes (AW) treatment regarding their suitability for crop cultivation (irrigation and fertilization).

Development of Alternative Cultivation Practices for the most widely cultivated and water demanded crops (e.g. vegetables, cereals) in Mediterranean by recycling nutrients and water from AW via identification and development of Best Management Practices for waste application to main market crops aiming at maximizing yields and minimizing offsite environmental impacts.

Protection of soil quality from the disposal of treated and untreated AW by developing and using cultivation practices which are suitable for representative, including degraded and vulnerable, Mediterranean soil types.

Reduction of carbon footprint by recycling AW and minimizing the use of fertilizers.

Conservation of natural resources (e.g. soil, water, phosphoric deposits) from excessive use and uncontrolled wastes disposal.

Increasing competiveness of Mediterranean agricultural products and profits via the reduction of external inputs (irrigation water and fertilizers).

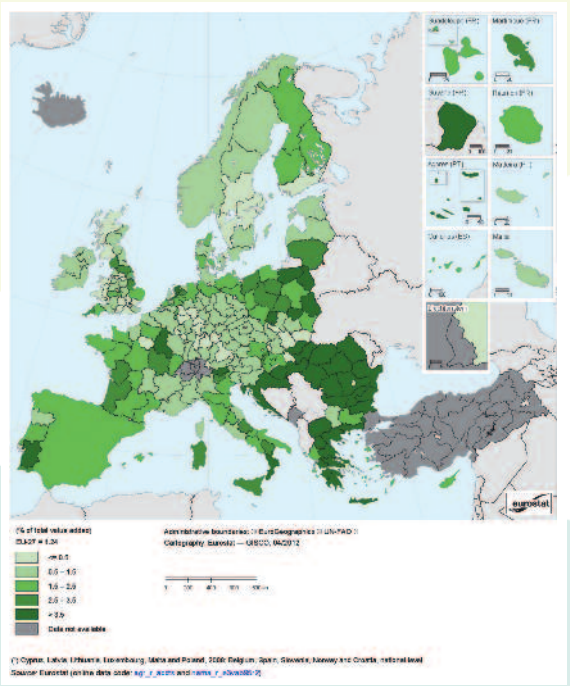
WASTEREUSE is an ambitious project funded by the European Commission for the period 01/09/2011 - 31/08/2015.

Four European Member States are the Beneficiaries, Greece, Spain, Italy and Belgium

Total Budget:	**1.384.799 €**
EC contribution:	**679.399 €**
Beneficiaries contribution:	**705.400 €**

WASTEREUSE will benefit

Farmers, by introducing alternative cultivation practices with the use of treated wastes that will offer increased yield, environment protection, soil protection and financial benefit.Industrial sector, by offering evaluation of the traditional technologies for waste reuse as well as new methods that can be introduced into markets. Policy makers, by providing evaluated data to enhance decision making on waste recycling in agriculture. Consultants, by providing alternative evaluated tools that will guarantee benefits for their clients in agricultural sector.



A map of the importance of Agriculture in the Economy

Farming is an activity whose significance goes beyond simple food production. Throughout the production chain processes occur that can have an impact on the natural environment. For example, heavy use of pesticides and fertilizers, incorrect drainage or irrigation practices, a high level of mechanization or unsuitable land use can produce environmental degradation. However, abandonment of farming activities can also endanger the EU's environmental heritage through loss of semi-natural habitats and the biodiversity and landscape associated with them. The Common Agricultural Policy (CAP) tries to take these factors into account. Integration of environmental goals into agricultural policy began in the 1980s. Since then the CAP has been increasingly adapted to serve sustainability purposes better. The CAP's objectives include helping agriculture to fulfill its multifunctional role in society: producing safe and healthy food, contributing to sustainable development of rural areas, and protecting and enhancing the status of the farmed environment and its biodiversity. The European Commission's 1999 communication 'Directions towards sustainable agriculture' underlined the importance of integrating environmental concerns into the CAP. The 2003 CAP reform is the latest step in this direction.

Targeted Problem

The project focuses on **two significant environmental problems:**

- the uncontrolled disposal of agricultural wastes (olive mill wastes (OMW), wastes from winery industry, etc), as well as, their uncontrolled use for crops / land fertilization.
- the excessive use of nutrients and natural sources (water, phosphoric minerals used for fertilizers) and the potential to increase recycling of nutrients and water with sustainable use of treated (or potentially untreated) agricultural wastes

and aims:

- to increase recycling of nutrients and water with sustainable use of treated (or potentially untreated) AW, and
- to combine the up to now developed technologies in integrated methodologies for the sustainable recycling of wastes' nutrients and water in agriculture, considering:
  - the input needs of main water - consuming crops cultivated in Mediterranean countries
  - the soil quality parameters that allow the use of this kind of wastes, and
  - the up to now accumulated knowledge regarding the sustainable use of AW in crop production across Europe and worldwide.

The production of safe and high quality agricultural products as well as environmental protection are nowadays the focal points of public interest.

Agricultural Wastes

In developed countries there is a great necessity for increasing the product quality, rather than quantity, due to the necessity of saving water and reducing the food surplus, the increasing demand for strong respect and conservation of the environment and to the fact that the vegetable market is no longer subject to needs of consumers but to their preferences.

In a strict sense the concept of agricultural waste refers to crops and pruning remains. These materials are characterized by high variability in water content (depending on crop development and harvest season), high organic matter content, changeable mineral fraction and high C/N ratio, depending on the residue nature and composition. The biodegradability of such residues will depend on their relative content of easily biodegradable compounds (sugars, cellulose and hemicellulose) and more recalcitrant compounds such as lignin and polyphenols. Agricultural wastes may present phytosanitary issues as a result of the incidence of pests and diseases in the original crop, which should be taken into account when considering their treatment and management. Agricultural wastes are characterized by the seasonality of their production and the need of rapid withdrawal from the field for both, avoiding interferences with other agricultural managements, and preventing diseases or fire propagation.

In a more broad sense, the by-products of vegetal origin generated in food industries such as olive oil production, dry fruits elaboration, wine industry, etc. as well as particular residues such as composts from mushroom cultivation, or substrates already utilized in greenhouse cultivations can be considered as agricultural wastes. Agricultural wastes comprise also slurry and manure. Wastewaters generated during washing, peeling or whitening processes can contain dissolved organic matter and suspended solids. Contamination by remaining pesticides can also occur.

Agricultural industry generates mainly liquid and solid residues with a high load of organic matter. The seasonal character of this type of industry means that high amounts of residues are generated in a short period of time. The amount of wastes generated as well as their characteristics depend on the type of crop.

Vegetables, cereals and ornamentals production in Europe

Agriculture remains an important economic sector in the Mediterranean region. Total production of fruits and vegetables in the 15-UE is of about 115 million tons, which places it in the third place at world level after Asia and Latin- America and Caribbean.

Within Europe, the main fruit producer is Spain (32.3 %) followed by Italy (30.4 %), France (13.3 %) and Greece (9.7%).

As regards vegetables the main producer is Italy (23.9 %) followed by Spain (20.9) and France (14.6).

Regarding cereals, Spain and Italy belong to the 5 most productive European countries (France, Germany, United Kingdom, Spain and Italy).

Moreover, the EU is the largest ornamentals and flowers producer worldwide (44% of the world production) while Italy holds the second place (15% of the total EU production) after Netherlands (32%).

Re-use and Recycle in Agriculture

Large quantities of AW are produced in Mediterranean region annually. For example, it is estimated that cereal cultivation produces about 5.5-11.0 ton dry matter of residues per ha; residues from woody tree pruning constitute about 1.3-3.0 ton dry matter per ha, while the average total production of OMW ranges between $10x10^6$ and $12x10^6$ m^3 and occurs over a short period of the year (November-March).

These examples give an idea of the huge amount of residues generated and the necessity of developing sustainable management plans, which will include recycling and re-use. The environmental impact of this kind of residues is considered significant and sustainable management plan is required to avoid environmental degradation. Their inappropriate disposal causes soil and aquifers contamination as well as, emission of gases such as methane, ammonium, and carbon dioxide to the atmosphere.

The presence in surface or ground waters of the organic matter contained in these residues can cause reduction of dissolved oxygen, fish death, production and emission of biogas and formation of a film of floating material and also eutrophication. When solid concentration in wastewaters is high, sediments can be formed in the bottom of the receiving waters where anaerobic degradation can take place with the consequent production of bad odors. Water can also be contaminated by residual of pesticides and other agrochemicals contained in wastewaters. In soils, wastes may cause increase in nitrogen content which, further undergoes slow mineralization; only part of this nitrogen is used by crops and the rest is lixiviated, contaminating groundwater as nitrates, which degrade aquatic environment and become harmful for human health.

Wastewater reuse in agriculture

Water resources shortage and environmental concerns have already led to wastewater reuse for irrigation. Due to the rapid development of irrigation and increased demand for domestic water supplies, conventional water resources have been seriously depleted. As a result, wastewater treatment and reuse is increasingly being integrated in the planning and development of water resources in the Mediterranean region, particularly for irrigation.

The development of guidelines is necessary for the planning and safe implementation of wastewater reuse for irrigation. Guidelines must also clearly promote the development of best practices. These do not need to be defined in great detail but must take into account important specific local conditions, such as the quality of treated wastewater, the type of soil, the climate, the relevant crops and the local agricultural practices.

However, the need for development of standards for wastewater treatment and reuse standards on both sides of the Mediterranean is obvious. The sustainable utilisation of rain water, the re-use of dirty water will become an issue soon also for South Europe as it is already for North African and Middle East countries.

Water, soil and air quality protection requires proper management of organic wastes from agricultural activities. Recycling of AW by land application for plant uptake and crop production is a traditional and proven waste utilization technique. Properly done, is an environmentally sound method of waste management producing also economical benefits due to the reduction of commercial fertilizers use. Since agricultural wastes are rich in inorganic nutrients (micro- and macro- elements) and organic matter, the recycling of this type of wastes in agriculture would contribute to:

- significant reduction of the volume of hazardous wastes disposed in the environment
- recycling of elements and water in agriculture which in turn, will reduce production cost and contribute to the increase in European products competiveness and profits
- protection of renewable and non-renewable sources (soil, aquatic bodies, phosphatic deposits) by the disposal and also via elements recycling.

However

if land distribution is planned (e.g. for irrigation) the organic load and the toxic substances (e.g. polyphenols) of treated or untreated wastes should not be the only issues of concern. Specific care should be taken also for inorganic constituents and especially for K, Cl^-, NO^3, SO^{42-}, P, Mg, Fe, Zn and others, since the very high concentrations disposed on soil may adversely affect its quality, while the concentrations of the inorganic soil constituents (especially K, P, Fe, Cu, SO^{2-}) and the electrical conductivity remain high even after many years from the last disposal. Previous studies and projects dedicated to the development of AW treatment technologies focused mainly on the reduction of the wastes organic load (COD, BOD) and on the reduction or the recovery of valuable substances, such as polyphenols from OMW, which are indeed harmful for the environment, and succeeded to develop suitable technologies and methods. However, by introducing inorganic nutrients in the picture, the puzzle of what may cause soil degradation at AW disposal areas, could be completed, and it is now possible to evaluate the up to now developed technologies for AW treatment regarding the quality characteristics of treated wastes and thus, their suitability to be used in agriculture. Although some of the up to now developed technologies for AW treatment have studied the effects of treated wastes on growth and yield parameters of a few crops, it should be noticed that in order AW to be used safely in agriculture, specific cultivation practices should be developed after detailed study of:

- the effect of AW on plant growth and yield quality characteristics
- water and nutrients demand of the specific crops
- the effect of AW on soil properties
- the soil-climatic conditions
- the environmental conditions

and this is exactly what WASTEREUSE proposes:

Development of new, alternative agricultural practices with the use of treated (or potentially untreated) Agricultural Wastes by considering all factors that affect, apart from the production itself, the quality of soil, water, and air.

WASTEREUSE will develop…

Alternative Cultivation Practices (ACP)

These will be **specific** cultivation practices with the use of AW for each one of the crops that are going to be cultivated during the life of the project.

So far, general guidelines have been developed (e.g. by FAO in "Guidelines on application of wastewater for irrigation") for the use of treated wastes in agriculture however, different crops and different soils under different climatic conditions require specific nutrients dosage and water for irrigation and this is exactly what will be considered for the development of the ACP: **what the crop needs under the specific growing conditions.**

This is crucial for the appropriate and sustainable use of waste in agriculture and necessary in order to avoid excessive application of nutrients. **Such an approach has been never followed before.**

Since EC has funded several projects in the past to develop waste treatment technologies, it's time to go a step further and **test the appropriateness of these treated wastes** for agricultural use and define the specific terms and conditions for the application on different Med crops.

Moreover WASTEREUSE will provide guidelines on the most feasible way to **test the appropriateness of each waste** prior to use in agriculture and the development of specific agricultural practices for different crops (what to consider, test, measure and evaluate).

WASTEREUSE updates its web site continuously with data derived from the activities of the partners.
Visit our site regularly and contact us for direct communication and knowledge exchange.

http://www.wastereuse.eu

Demonstration Actions

Treated and untreated wastes will be used for crop cultivation:

Spain

Open field cultivations (2,500 m^2).

Cultivation of cereals (barley or wheat and maize).

Protected cultivations at greenhouses (200 m^2).

Cultivation of vegetables (lettuce and melon or tomato) will be cultivated.

Italy

Open field cultivations (2,500 m^2).

Cultivation of lettuce and cabbage.

Protected cultivations in greenhouses (200 m^2).

Cultivation of basil and ornamentals.

The demonstration actions will lead to concrete and practical results, providing the ability to implement the developed agricultural practices elsewhere, covering the needs of the implementation areas; of other regions; or even of the Mediterranean countries, after the evaluation of its economic and technical viability, Life Cycle Analysis and Risk Analysis carried out during the project.

Specific guidelines and recommendations will be developed in order to:

- promote recycling of wastes in production systems that respect the environment, are economically viable, and sustain the multiple functions of agriculture, namely its social, cultural and recreational aspects
- preserve and enhance soil fertility
- minimize pollution of soil, water and air
- secure a sustainable production of healthy, high quality crops
- minimize effects on human and animal health from waste management practices
- promote conservation of natural resources
- promote and maintain high biological diversity in the agro-ecosystems concerned and in surrounding areas

Agricultural wastes could be indeed recycled in agricultural sector, but before this, an integrated approach is needed in order to establish guidelines, terms and conditions, which will consider soil, cultivated crops, environment and farmers as a system whose components are interrelated and affect each other.

Actions and Means

- Development of an inventory of the technologies related with AW treatment and applicability for crop production, developed so far through EC funding and other sources at European, national and regional level as well as, worldwide, based on development level (lab, pilot scale, full scale).
- Evaluation of the treated wastes derived from the above-mentioned technologies regarding their suitability for irrigation and fertilization of the widely cultivated and water demanded crops in Med countries.
- Collection of treated and untreated AW produced in Spain and Italy and identification of their physicochemical characteristics. Preliminary evaluation of their suitability to improve crop yield.
- Evaluation of application practices of the treated wastes (wastewater and composts) on crops after considering the crop input needs.
- Potential modification of wastes physicochemical properties in order to conform with input demands of field and protected crops through laboratory studies.
- Assessment of the impact of waste use and application on soil quality through experimentations using different soil types.
- Development of new/alternative cultivation practices for the main water consuming and market crops with the use of treated (and potentially untreated) wastes as source of water and nutrients.
- Two demonstration actions, which include four pilot areas, will be conducted in Spain and Italy, in order to implement the developed agricultural practices in greenhouses and in open field.
- Cultivation of the most widely cultivated and water demanded crops (vegetables, cereals, ornamentals) using treated wastewater and composts produced from different AW treatment options.
- Periodical sampling and chemical analysis of plant tissues and soil samples to assess potential long-term phytotoxicity.
- Periodical monitoring of plant development indicators, soil quality parameters and input consumption to assess improvements in growth, yield, nutrients and water consumption as well as, soil degradation process.
- Identification of soil-nutrient loading capabilities, following application of wastes, for different soil types.
- Life Cycle Analysis (LCA) for all processes implemented in Spain and Italy, in terms of raw materials consumption, energy use and emissions.
- Risk Analysis to assess the impacts of the proposed practices and processes in soil and waters.
- Techno-economical and environmental assessment for the practices and processes developed during the project.
- Development of a Code of Waste Management Practices for Agricultural Application.
- Extensive analysis of European and national legislative frameworks as well as comparison between national laws and EU directives.
- Establishment of a set of actions, measures and means that should be taken by Mediterranean national policy makers to conform to European legislation requirements.
- Legislative recommendations for AW reuse policy.
- Establishment of a network between scientific/research; industry/market and policy makers communities.

Beneficiaries

Coordinating beneficiary

Technical University of Crete

Technical University of Crete (TUC) was established in 1977 in Chania, Crete and today comprises five academic engineering departments. The Department of Production Engineering and Management, the Department of Mineral Resources Engineering, the Department of Electronic & Computer Engineering, the Department of Environmental Engineering and the Department of Architectural Engineering, assisted in their curriculum by the Sciences Department. The mission of the TUC is to develop modern engineering specialties, to place emphasis on research in fields of advanced technologies as well as to establish close cooperation with the industry and other production organizations in Greece.

Department of Mineral Resources Engineering

The primary goal of the Department of Mineral Resources Engineering is to educate engineers in a broad range of scientific and technical activities related to the extraction and processing of minerals as well as environmental geotechnology. More particularly, the Department offers basic engineering training as well as education in new technologies such as detection of ore bodies, observation of geodynamic phenomena through satellites, geophysical techniques of high resolution for archaeology, structural works and environmental applications, evaluation of raw materials by means of electronic microscopy etc.

The Department consists of three major divisions corresponding to three main directions of research:

1. Exploration and Positioning
2. Mining Technology
3. Minerals Exploitation

The Research Unit of "Management of Mining/Metallurgical Wastes and Rehabilitation of Contaminated Soils" belongs to the third division, under the direction of Prof. K. Komnitsas. The following research areas are related to the protection of the environment and sustainable development in the industrial sector:

- Soil decontamination
- Clean-up/management/stabilization of solid wastes, effluents and offgases
- Risk assessment in industrial and disposal areas
- Secondary and environmental uses of wastes aiming at their valorisation

For further information please visit the links:

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Associated beneficiary

CEBAS- CSIC Institute

The mission of CEBAS-CSIC is, through its investigation, to contribute to generating the knowledge necessary to improve its competitiveness, developing strategies to attain the sustainability of the scant resources existing in semiarid areas their correct management, and making possible a quality agriculture, which produces healthy and safe plant food products. The increase in knowledge generated by the proposed research will contribute to facilitating the decision- taking process necessary for implementing the political action necessary in this respect. In addition, the research carried out will contribute to coping with specific problems, such as the scarcity of water, create a better environment and contribute to reducing the greenhouse effect through conserving soil, vegetation and organic matter content. High quality sustainable agriculture producing high quality and healthy foods, will contribute to the socio-economic progress and to an environment safeguarded for future generations.

The CSIC (State Agency) is the Spanish National Research Council and Spain's largest and most important public research organization. With 126 centers and 145 associated units, it is present in all of Spain's Autonomous Regions. The CSIC's mission is to promote, coordinate, develop, and disseminate multidisciplinary scientific and technological research in order to contribute to economic, social, and cultural development and the progress of knowledge. Furthermore, it aims to train research personnel and provide advice to public and private institutions on subjects within its areas of expertise.

The CSIC is subdivided into eight science and technology areas:

- Humanities and Social Sciences.
- Biology and Biomedicine.
- Natural Resources.
- Agricultural Sciences.
- Physical Science and Technologies.
- Chemical Science and Technologies.
- Materials Science and Technology.
- Food Science and Technology.

For further information please visit the link:
http://www.cebas.csic.es
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Associated beneficiary

Ce.R.S.A.A. - Centro di Sperimentazione e Assistenza Agricola

The Centre for Agricultural Experimentation and Assistance is a special agency of Chamber of Commerce, Industry, Handicraft and Agriculture of Savona. Greenhouses, plastic houses and open fields used for trials, demonstration and extension cover 40,000 m^2. Two laboratories are involved in analysis mainly on plant pathogens and pesticides residues on vegetables offering a service to technicians and farmers operating in the Albenga area and even in the Savona province.

The Center is actively involved in experimental and demonstration activities funded by public bodies about environmentally friendly control strategies of plant pathogens, soil disinfestations techniques, management and disease control of ornamental and vegetable key crops, water recycling in soilless cultivation, dosage of fertilizers, quality of substrates for potted plants, evaluation of new species or cultivars of flowers, valorization of agricultural wastes for crop cultivation. More recently the field of interest has broadened to renewable energy sources, being approved demonstrative projects about solar and wind energy. Specifically, in the last years, more than 50 national and European projects were carried out with strong attention to result extension.

The Center can rely on a strong connection with extensionists, growers and their local association.

Finally it is active in the dissemination of the results of its activity publishing papers on national and international journals (more than 600 in forty years of activity) and organizing courses and workshops.

For further information please visit the link:
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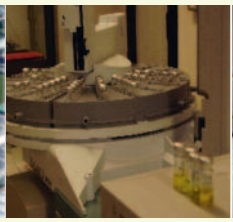


Associated beneficiary

Azienda Speciale per la Formazione Professionale e la Promozione Tecnologica e Commerciale della Camera di Commercio Industria e Agricultura di Savona (Laboratorio Chimico CCIAA)

The Laboratorio Chimico of the Chamber of Commerce of Savona involves specialized scientific staff of significant research capacity with modern laboratory and field infrastructure and operates at the premises of the Chamber of Commerce of Savona. New scientific knowledge and technical innovations are directed towards creating a dynamic and competitive agriculture, which is protective of the environment and capable of providing excellent and inexpensive nutrition for the people.

The Laboratorio Chimico operates mainly for the development of SME's and for quality of ornamental and vegetable crops while is actively involved in the following sectors and matrixes of analysis:

1. Environment: waters, nutrient solution used in the agricultural sector, soil, fertilizers;
2. Food: pesticide residues, olive oil, wine, milk and others;
3. Atmosphere: air pollutants, work environments;
4. Microbiology: water, food, work surfaces;
5. Sensory (panel test): test on oil samples, test on wine samples, test on different food types.

Moreover, the accreditation according to ISO 17025 for almost 80 analytical methods ensures accurate and precise analytical results. The research and scientific team has been involved in EU projects and demonstration actions also in cooperation with CERSAA since the two institutes belong to the same agency (Chamber of Commerce, Industry, Handicraft and Agriculture of Savona), operate at the same area in Albenga, share and use the same lab, equipment and infrastructure in general, although administratively are two separate institutes.

For further information please visit the link:
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Associated beneficiary

SIGNOSIS

Signosis Sprl. (www.signosis.eu) is an innovative consulting and research company, founded in Belgium. Signosis possesses a diverse and in-depth knowhow in the design and management of R&D projects and offers consultancy in several areas.

Consulting areas range from Information and Communication Technologies (ICT) to sustainability and social policy as well as additional disciplines focusing on promoting and implementing innovation in companies and public organisations. The company, which is based in Brussels, Belgium, has many years experience in the Management and Consultancy sector and operates a network of professionals and experts from around Europe. Signosis is keen on international project management, carrying out research activities and programmes, implementing studies and assessments. Its targeted clients are Ministries, Local Government Departments, Public and NGOs and private companies, whenever they are aiming in obtaining services with high quality and integrity. Signosis conducts research and provides innovative consulting services at the highest level of professionalism and commitment. This ability derives from the longstanding experience and expertise on project management, at international level, in correlation with the undisputable belief that knowledge except from power, is the ultimate business strategic priority.

Signosis has the vision to become the most innovative company in managing knowledge as a commodity. Our aim is to explore and develop all necessary mechanisms and breakthrough practices in order to achieve the goal of managing our knowledge resources coherently, timely and effectively.

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