LIFE04 ENV/GR/110

TECHNICAL FINAL REPORT

Covering the project activities from 01.11.2004 to 31.10.2006

Reporting Date
31/1/2007

LIFE PROJECT NAME

Life Cycle Assessment (LCA) as a Decision Support Tool (DCT) for the ecoproduction of olive oil

Data Project

Project location	Greece, Spain, Cyprus
Project start date:	01/11/2004
Project end date:	31/10/2006
Total Project duration (in months)	24 months
Total budget	€ 839.575
EC contribution:	€ 419.787
(%) of total costs	50
(%) of elibible costs	50

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1. LIST (I) KEY-WORDS AND (II) ABBREVIATIONS (WHEN APPROPRIATE)

(i) key-words:

Life Cycle Assessment, Decision Support Tool, olive oil, eco-production, waste management

(ii) Abbreviations:

LCA: Life Cycle Assessment

LCI: Life Cycle Inventory

DST: Decision Support Tool

OO: Olive Oil

EC: European Commission

TUC: Technical University of Crete

UCY: University of Cyprus

AGRIPOL: Agricultural Cooperative of Polemarchi

2. EXECUTIVE SUMMARY

This report refers to the activities of the LIFE project entitled: “Life Cycle Assessment (LCA) as a Decision Support Tool (DCT) for the eco-production of olive oil – ECOIL” that took place from 1.11.2004 until 31.10.2006.

The overall objective of the project was to design and implement a Life Cycle Assessment (LCA) during the full cycle of olive oil (OO) production in three Mediterranean countries, Greece Cyprus and Spain. By implementing the LCA in the above regions certain coefficients, characteristic to each situation (olive trees cultivation practices, OO production process, OO mills waste management systems and OO marketing) were provided and the effects to the environment and public health were determined. The results allowed comparisons and identification of those stages of the OO production cycle that can be optimised/redesigned. In addition, the novel LCA system could be used as an integrated decision support tool for all actors involved in the production of OO in order to apply practices of high efficiency, effectiveness and environmental – ecological performance (eco-production).

According to the action plan of the project, a series of activities were carried out for its technical development. In particular:

All the existing Greek, Spanish, Cypriot, European Union and international legislative framework and standards related to the implementation of LCA in production processes, eco-efficient agricultural practices, operation of industries in an environmental friendly way and environmental management systems were recorded and assessed. Then, the current situation concerning the olive oil production cycle in the three areas under examination was described and recorded in detail (olive tree varieties, olive oil cultivation practices, irrigation demands, applications of pesticides and herbicides, type of pesticides and herbicides, quantities of O.O produced, olive milling processes for the production of oil and olive mill waste management practices). Additionally, a significant number of cases concerning the development and application of successful systems and methods related to eco-efficient practices and LCA studies were recorded, examined, analysed and assessed. These success stories refer to several production processes at national, European and international level, in order to obtain a complete and representative picture on the subject of the project. These activities have taken place in the framework of the implementation of Task 1 of the project (1.11.2004 – 28.2.2005).

Moreover, the LCA principles and guidelines are described and presented in details in order to extract a representative and global view of the functions of this decision supporting tool. Then, the LCA tool specific for the purposes of the ECOIL project was developed and described in detail. More particularly, the stages of the LCA procedure were set, the exact material flows were determined, the measurement units for the coefficients were set and justified, the exact boundaries of the system were defined, the requirements for ensuring of data quality were set, the procedure for the collection of data (Life Cycle Inventory – LCI) was developed (determination of the necessary types of data, development of LCA software and supporting databases, setting of flow diagram, means and techniques for the collection of data, development of questionnaires for the collection of primary data, establishment of appropriate input-output databases, etc.), the procedure for Life Cycle Impact Assessment was described and analysed (production steps, processes associated with each step, inputs, outputs and by-products) etc. These activities have taken place in the framework of Task 2 of the project (1.12.2004 – 31.7.2005).

Then, the LCA was implemented in the three areas under examination, based on the methodology and software that were developed during task 2 (Implementation of LCI in the Municipality Department of Polemarchi and in general in Municipality of Voukolies in Crete island, in the area of Lythrodontas in the District of Nicosia in Cyprus and in the Navarra region in Aragon in Spain). It must be noted that the collection and collation of data in order

to build a life cycle inventory for olive oil was the most resource-consuming steps of the implementation of this LCA study. For each unit process, within the system boundary defined, quantified data on inputs and outputs were collected by the working groups.

For background processes, secondary data sources were used to collect, obtain and calculate the datasets from published sources such as industry data reports, validated life cycle inventory databases, laboratory test results, government documents and reports, reference books, previous life cycle inventory studies, equipment and process specifications, publications in scientific journals and special editions, technical editions etc. During the collection of data that was necessary for the background processes, a great attention was given to justify that each data source selected for background processes is representative with respect to the specification of the goal and scope of the ECOIL project.

The majority of data for foreground processes were collected and collated directly from grain growers (olive oil trees farmers) and processors/operators/owners of olive oil mills, agricultural and environmental experts and olive oil farming associations. A questionnaire specifically for this purpose was developed and distributed to the actors and stakeholders described above in order to be filled in. This questionnaire was distributed to the olive oil producers during the period January-February 2006. Additionally, site visits to farms and factories are being paid by the members of the working groups in the case study areas and telephone discussions taking place with the farmers and the operators of the mills. Furthermore, telephone discussions and face-to-face interviews held with agricultural and LCA experts to verify the reliability of the collected data.

These activities have taken place in the framework of Task 3 of the project (1.8.2005 – 30.6.2006)

The results that were obtained from the implementation of the LCI in the three areas (Task 3) were used in order to assess the environmental impacts. Then, taking into consideration the information that were gained from the assessment of the environmental impacts as well as the LCI results of task 3, comparisons were made both horizontally (overall hazard potential of each case study) as well as vertically (among similar pollutants for all case studies) and the weak points in regard to the environmental burden for each case study were identified.

Then, according to the overall results that were obtained through, guidelines for the improvement of the entire O.O production cycle in order to achieve the eco-production of O.O, were developed. Additionally, a policy document was developed which includes recommendations for the use of clean technologies, promotion of eco-production and eco-cultivation, modifications of production stages, adaptation of the principles of the integrated product policy, as well as specific suggestions for the application of market – based instruments e.g. tradable vouchers, tax incentives, tax breaks, subsidies, deposit – refund schemes and recommendations on potential funding opportunities. Towards to this direction, technical data and information were collected related to Integrated Product Policy, ecological production of O.O, good agricultural practices, available techniques for pollution prevention and control, technologies and systems for O.O. mills wastewater and solid waste treatment, clean technologies etc. This collected technical material was used as a well documented reference/basis for the development of the guidelines and specifications for the O.O. eco-production, according to the results obtained for each area under study.

Also, a framework of specifications for the implementation of the LCA methodology and software were prepared, a tool that is very useful for the adaptation of the know-how of the ECOIL project in other applications.

These activities have taken place in the framework of Task 4 of the project (1.12.2005 – 31.10.2006)

Regarding the project's dissemination (Task 5), several efforts have been made with notable results. The activities were implemented according to the dissemination plan, during the entire duration of the project, in order to achieve the highest diffusion of the know-how

developed through the project and the maximum public awareness. Also, all the training activities will be held according to the proposal.

As far as the management of the project is concerned (Task 6), everything is proceeding according to the established time schedule and the collaboration between the Beneficiary and the three partners is smooth and efficient. The changes made in the project's management structure after the approval of the EU (substitution of the one Greek partner – Municipality of Mantamados by another Greek partner – Agricultural Cooperative of Polemarchi AGRIPOL) did not affect the successful implementation of the project. In order for the activities described in the proposal to remain the same (qualitatively and quantitatively), the case study that would have taken place in the area of the Municipality of Mantamados was substituted with a case study applied in Cyprus (in the area of the Municipality of Lythrodontas, Nicosia). As a result, the number of the case studies remained the same (three) and the project was expanded to include another Member State, Cyprus (instead of case studies at two member states we had case studies at three member states.) Furthermore, the dissemination of the project was extended since another country was involved more actively in the project.

Concluding, the project, as it is documented in this final technical report, is characterised by a high level of reproducibility, replicability and transferability. Also it has a great innovative and demonstrative character and it is in fully accordance and relevance with environmentally significant issues and policy areas. Finally, its outcome could lead to significant direct and quantitative environmental benefits as well as to long-term qualitative environmental, economic and social benefits.

3. INTRODUCTION

Olive oil (O.O.) production has been a traditional agricultural activity maintained for centuries for all Mediterranean countries. O.O. production has gained significant attention lately due to the well promoted nutritional properties of olive oil. The milling process highly affects the type, composition and amount of waste generated during the milling process, which is one of the major environmental burdens during the O.O. production cycle. The main environmental problems related to the production of olive oil originate from:

i. irrigation and insecticide application matters

There are some areas where irrigation is regularly practised, while in other cases, irrigation has not ever been practised. In addition, insecticide application constitutes a major problem, if one also accounts for the way this application is practiced.

ii. Quantity and location of olive oil mills

These aspects relate to the transportation of olive crops to olive oil mills. Transportation has been traditionally related to environmental burdens due to the combustion of gasoline (a fossil fuel) used in transportation vehicles. Several small and decentralized olive oil mills are typical in Greece in contrast to the larger and fewer olive oil mills present, for example, in Spain.

iii. O.O. milling process

O.O. mills waste (OMW) is characterized by significantly high organic (mainly non-biodegradable) load and phytotoxic properties. In addition to that, there has not been any widely accepted technique to treat and dispose of OMW. Various novel techniques were examined but they are ever materialized in full scale due to their usually high cost for the owners of olive mills.

The ECOIL project aims to develop a Life Cycle Assessment (LCA) during production of O.O in 3 different regions in three Mediterranean countries. The regions have several differences during olive cultivation, olive milling processes and olive mill waste management systems. Therefore, the implementation of LCA results in the development of typical life cycle coefficients (material flows) for all three situations. Comparison of the above coefficients aided in identifying the weak parts of each process through the evaluation of the results, assessment of the environmental impacts, comparison among LCI coefficients of the three case studies and identification of the entire procedure that puts significant burdens on the product life cycle. The above eventually led to proposals and development of specifications for the optimisation or redesign of the system or certain parts of the system. Also, special attention was paid to the training of all those involved in the production of oil olive procedure.

The results can be treated as tools to support decision regarding: i) adoption of proper/sustainable olive trees cultivation processes (e.g. irrigation use of friendly biocides), ii) modernization of existing processes and systems for the production of O.O (e.g. conventional type press mills, two-phase and three-phase centrifugal systems), iii) increase in productivity, iv) prevention/minimization of waste generated/adoption of environmentally friendly waste management practices, v) production of high quality olive oil, vi) reduction in cost required for the entire olive oil production cycle, vii) harmonization with the EU and national policy, legislation and priorities in the field of industrial production processes, viii) self-centeredness in state of the art technology, and x) creation of new jobs. Also, this project serves as a pilot - demonstration tool for introducing the eco-efficient production of olive oil for all olive oil producing countries, since it will account for all processes starting from the cultivation of olives, olive fruit transportation, olive oil milling process and olive oil mill wastewater management.

4. LIFE-PROJECT FRAMEWORK

The project consists of four technical tasks plus one task for dissemination – training activities and one task for its management. In particular:

Task 1: Recording and assessment of existing situation (1.11.2004 – 28.2.2005)

Subtask 1.1: All the existing Greek, Spanish, Cypriot, European Union and international legislative framework and standards related to the implementation of LCA in production processes, eco-efficient agricultural practices, operation of industries in an environmental friendly way and environmental management systems are recorded and assessed.

Subtask 1.2: The current situation concerning the olive oil production cycle in the three areas under examination is described and recorded in detail (olive tree varieties, olive oil cultivation practices, irrigation demands, applications of pesticides and herbicides, type of pesticides and herbicides, quantities of O.O produced, olive milling processes for the production of oil and olive mill waste management practices).

Subtask 1.3: A significant number of cases concerning the development and application of successful systems and methods related to eco-efficient practices and LCA studies are recorded, examined, analysed and assessed. These success stories refer to several production processes at national, European and international level, in order to obtain a complete and representative picture on the subject of the project.

Task 2: Development of the LCA methodology (1.12.2004 – 31.7.2005)

Subtask 2.1: The LCA principles and guidelines are described and presented in details

Subtask 2.2: The exact material flows will be determined. In addition, the measurement units for the aforementioned coefficients are set and justified, while the exact boundaries of the LCA system are defined.

Subtask 2.3: An appropriate software will be developed that will perform the necessary calculation to extract site specific coefficients and also include all primary coefficients that will be the basis for further calculations

Task 3: Implementation of the LCA in the areas under examination (1.8.2005 – 30.6.2006)

Subtask 3.1: The LCI is applied in the Municipality of Voukolies (the Greek region involved in the study)

Subtask 3.2: The LCI is applied in the Municipality of Lythrodontas (the Cypriot region involved in the study)

Subtask 3.3: The LCI is applied in the Navara region in Spain (Spanish region involved in the project)

Task 4: Evaluation of results, impact assessment and systems optimisation (1.12.2005 – 31.10.2006)

Subtask 4.1: The environmental impacts of the LCI results that are obtained by the LCI implementation in the three regions under study are assessed.

Subtask 4.2: This subtask is based on the results of subtask 1.2 as well as the LCI results of task 3. Direct comparisons are made both horizontally (overall hazard potential of each case study) as well as vertically (among similar pollutants for all case studies). The weak points in regard to the environmental burden for each case study are identified.

Subtask 4.3: Guidelines for the improvement of the O.O production cycle in order to achieve the eco-production of O.O, based on the results of Tasks 3 and subtask 4.2 are developed as well as specifications and guidelines for the implementation of the LCA methodology and software. Also, a policy document is prepared that includes recommendations for the use of clean technologies, promotion of eco-production and eco-cultivation, modifications of production stages, adaptation of the principles of the integrated product policy, as well as specific suggestions for the application of market – based instruments.

Task 5: Dissemination and training activities (1.11.2004 – 31.10.2006)

This task includes: i. Training of all those involved in the production of O.O on the practices that could be applied for the improvement of the O.O. production cycle efficiency and effectiveness in the three areas under examination (e.g. owners and operators of olive oil mills, olive trees farmers, transporters) ii. informing of all other interested parties in Greece, Spain, Cyprus, Mediterranean countries and Europe on the project content and results (e.g. public, Communities, Municipalities, operators of olive oil mills, Central authorities)

Task 6: Management and Reporting to European Commission (1.11.2004 – 31.10.2006)

This Task includes i. all the activities for the effective management of the project and fulfilment of the activities included ii. preparation and submission of the required reports to EC

5. TECHNOLOGY

The main goal of the project is to develop and implement a Life Cycle Assessment for olive oil production in three Mediterranean regions: Voukolies region in Crete, Greece, Lythrodontas region in Cyprus and Navara region in Spain, in order to provide a comprehensive and transparent environmental life cycle profile of olive oil by identifying the stages of the production cycle, which have significant environmental impacts and thus should be optimised. The aim is the use of the results of this study by all actors involved in the production of olive oil as an integrated Decision Support Tool (DST) for the selection of particular processes, such as adoption of proper olive tree cultivation processes, olive fruit transportation, olive oil milling process and olive oil mill waste management in order to improve the environmental profile of olive oil production. In the following, the methods and technology applied are presented.

The boundaries of the system:

The system boundaries determine which unit processes shall be included within the LCA and therefore separate the system from the rest of the world. The boundaries of the system studied in this LCA are shown in Figure 1, while Table 1 lists the main unit processes within the system boundaries. All processes within the system boundary will be taken up for in-depth data collection and evaluation.

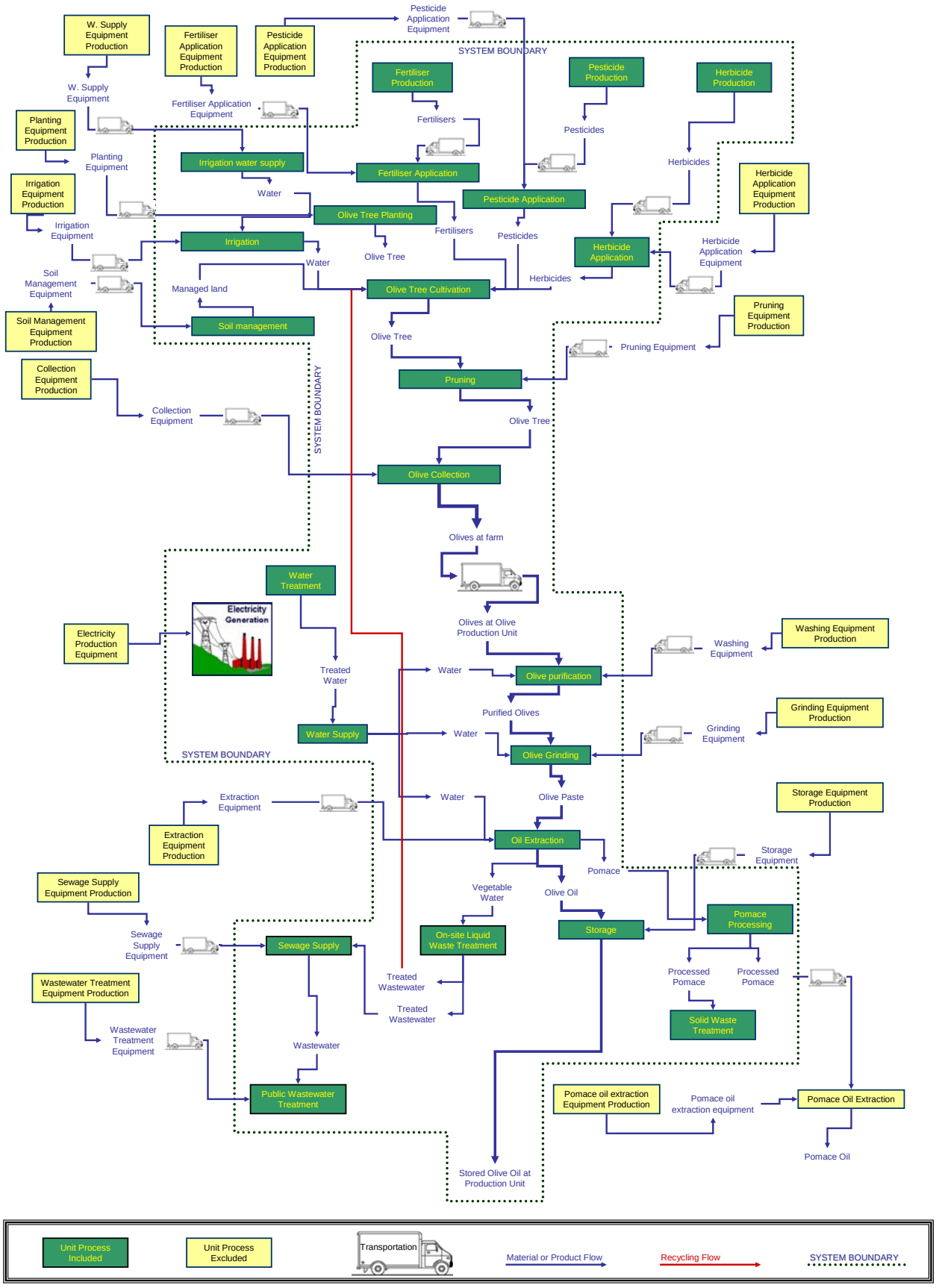


Figure 1: System Boundaries

Table 1: Olive Oil Product System

No.	Unit Process	Process Start	Nature of Transformations	Process Ends
1	Electricity production	Mining and extraction of fossil fuels	Energy conversion	Distribution to the grid at the points of use
2	Irrigation water supply	Water in aquifers or surface waters or treated wastewater lagoons	Physical	Water at farm
3	Irrigation	Water at farm	Physical	Water applied at olive tree root
4	Fertiliser production	Acquisition of raw materials	Chemical processing	Fertilisers at the production unit gate
5	Transportation of fertilisers to farm (may include intermediate storage and retailing)	Collection of fertilisers from production unit gate	Physical	Delivery of fertilisers to farm gate
6	Fertiliser application (including unpacking and incorporation into soil)	Fertiliser stored at farm	Physical	Fertiliser into agricultural soil (part of technosphere)
7	Pesticide production	Acquisition of raw materials	Chemical processing	Pesticides at the production unit gate
8	Transportation of pesticides to farm (may include intermediate storage and retailing)	Collection of pesticides from production unit gate	Physical	Delivery of pesticides to farm gate
9	Pesticide application (including unpacking)	Pesticide stored at farm	Physical	Pesticide applied to olive groves
10	Herbicide production	Acquisition of raw materials	Chemical processing	Herbicides at the production unit gate
11	Transportation of herbicides to farm (may include intermediate storage and	Collection of herbicides from production unit gate	Physical	Delivery of herbicides to farm gate

	retailing)			
12	Herbicide application (including unpacking)	Herbicide stored at farm	Physical	Herbicide applied to agricultural soil (part of technosphere)
13	Soil management	Soil at its natural state	Physical	Physically managed soil
14	Olive tree planting	Acquisition of olive trees	Physical	Planted olive grove
15	Olive Tree cultivation	Planted olive grove	Biological	Mature olive grove
16	Pruning (may include burning or chopping)	Olive grove not pruned	Physical	Olive trees pruned
17	Olive collection	Olive fruits on olive trees	Physical	Olive fruits detached from trees and packed
18	Transportation of olives from farm to processing unit	Collection of olives from farm gate	Physical	Delivery of olives to processing unit gate
19	Water treatment	Extraction of water from acquifers or surface waters	Physical, chemical and biological processing	Potable water at water works gate
20	Water supply	Potable water at water works gate	Physical	Water at olive oil processing unit gate
21	Olive purification (includes washing and removal of leaves and other materials from olives)	Olives as collected from farm	Physical processing	Olives without any foreign matter
22	Olive grinding	Olives without any foreign matter	Physical processing	Olive paste
23	Oil extraction	Olive paste	Physical processing	Olive oil, (vegetable water) and pomace
24	On-site liquid waste treatment	Vegetable water	Biological processing	Treated vegetable water
25	Wastewater supply through network	Treated vegetable water at	Physical	Treated vegetable water at

		processing unit		public wastewater treatment works
26	Wastewater treatment (public)	Treated vegetable water at public wastewater treatment works	Physical, chemical and biological processing	Treated wastewater
27	Pomace processing	Pomace with high water content	Physical processing	Dried pomace
28	Solid waste treatment (may include transportation)	Dried pomace	Biological processing (landfill or composting)	Compost
29	Storage of olive oil (kept under suitable physical conditions)	Olive oil ready	Physical processing	Olive oil at the production unit gate

The Functional Unit and Reference Flows:

The functional unit for this study is “olive oil to fulfil the food preparation needs of one person for one year”. According to statistics of the International Olive Oil Council for the year 2002, the average per capita consumption of olive oil in the European Union was 5.4 litres. Hence, based on this functional unit, a reference flow of 5.4 litres should be used. Nevertheless, purely for practicality reasons, the practitioner team decided the use of a reference flow of 1 litre, which corresponds to a functional unit of “olive oil to fulfilling the food preparation needs of one person for 68 days”.

Allocation Procedures:

Table 2 summarises the method, with which allocation issues encountered in this study are dealt. It is highlighted that allocation percentages will be derived after data collection, in the next stage of this project.

Table 2: Allocation issues and procedures to be used in this study

Unit Process	Issue	Method
Olive oil extraction	Production of vegetable water by-product	System boundary expansion
On-site liquid waste treatment	Part of treated liquid is sent to further treatment and part is recycled in a close-loop system through irrigation	Substitution allocation, avoided product for irrigation water supply
Olive oil extraction	Production of pomace by-product (to further treatment)	System boundary expansion
Olive oil extraction	Production of pomace by-product (for pomace oil extraction)	Allocation based on economic value

Methodology of Impact Assessment:

Figure 2 presents the impact identification matrix.

CAUSE	IMPACTS												
	Abiotic Resource exhaustion	Biotic Resource exhaustion	Greenhouse Effect/ Global warming	Ecotoxicological impacts	Human toxicological impacts	Ozone Layer Depletion	Photochemical oxidant formation	Acidification	Eutrophication	Land use	Solid waste	Heavy metals	Other
Use of fertilisers	■	■	■	■	■			■	■				
Use of pesticides/ herbicides	■	■	■	■	■			■					
Irrigation	■		■										
Burning of pruning residues			■								■		
Soil management	■		■							■			
Olive collection	■		■										
Waste from milling process									■		■		
Energy requirements	■		■				■						
Transportation	■		■				■					■	■

Figure 2: Impact identification matrix

Data Collection Plan:

Figure 3 illustrated the flow data that were required for the implementation of this LCA study.

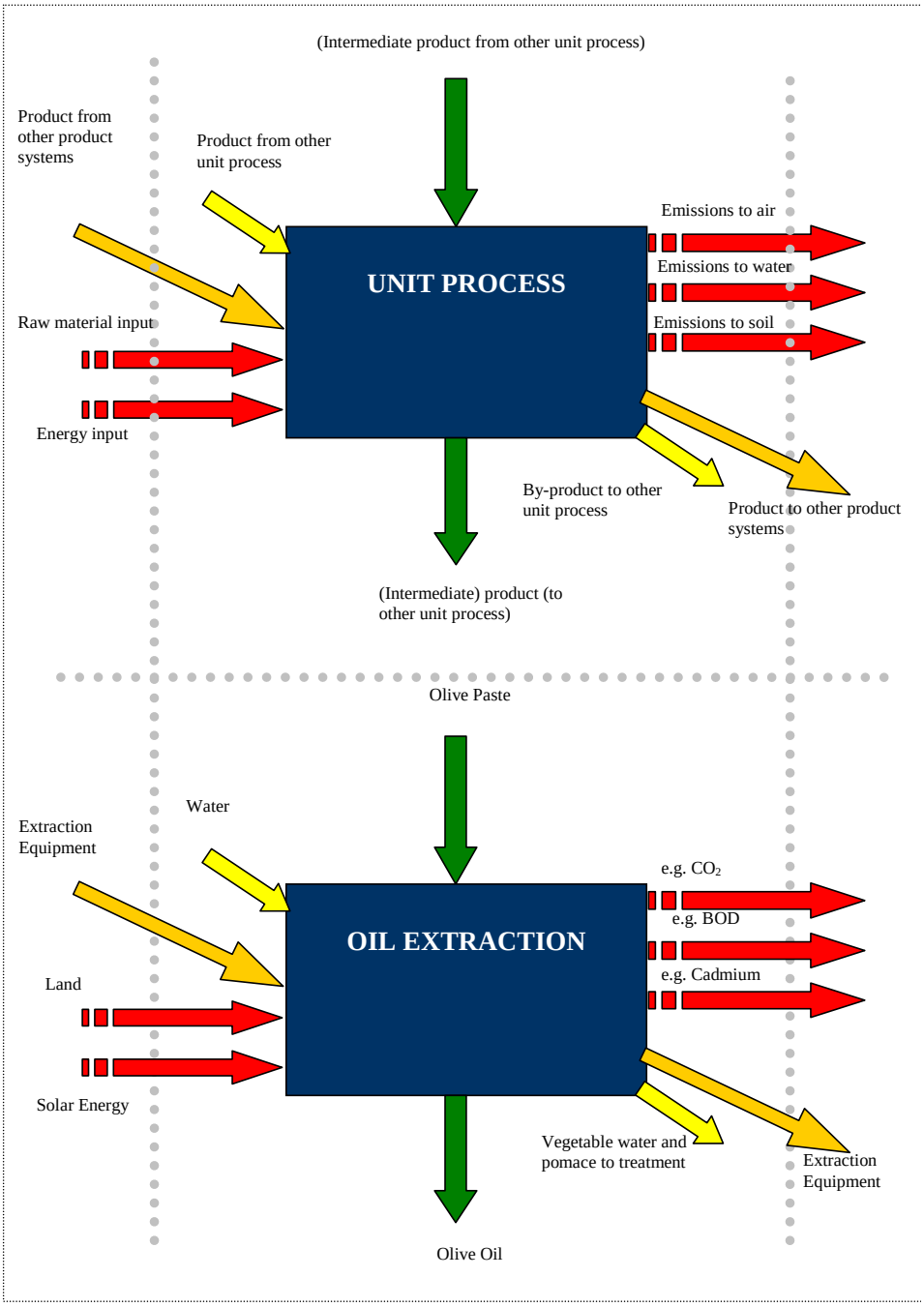


Figure 3: Flow Data Required

LCA of Olive Oil using SimaPro 6:

The software SimaPro 6 (System for Integrated environMental Assessment of PROducts), was used as a basis for the development LCA modelling and analysis tool. SimaPro is a well-known, internationally accepted and validated tool and since its development in 1990 has been used in a large number of LCA studies by consultants, research institutes, and universities. The software allows to model and analyse complex life cycles in a systematic and transparent way, following the recommendations of the ISO 14040 (1997) series of standards.

Olive Oil Life Cycle Modeling:

A list with the processes used in the model is provided in Table 5, whereas the model network created is shown in Figure 4.

Table 5: Unit processes included in basic olive oil model

No.	Unit Process	SimaPro Process Category	Known output to technosphere
1	Electricity production	Energy	Electricity produced (J)
2	Irrigation water supply	Material	Water supplied for irrigation (m^3)
3	Irrigation	Material	Irrigated water (m^3)
4	Fertiliser production	Material	Produced fertilisers (kg)
5	Transportation of fertilisers to farm	Transportation	Transported fertilisers (tonnes*km)
6	Fertiliser application	Material	Applied fertilisers (kg)
7	Pesticide production	Material	Produced pesticides (kg)
8	Transportation of pesticides to farm	Material	Transported pesticides (kg)
9	Pesticide application	Material	Applied pesticides (kg)
10	Herbicide production	Material	Herbicides produced (kg)
11	Transportation of herbicides to farm	Transportation	Transported herbicides (tonnes*km)
12	Herbicide application	Material	Applied herbicides (kg)
13	Soil management	Processing	Soil managed land (m^2)
14	Olive tree planting	Processing	Olive trees planted (p)
15	Olive Tree cultivation	Processing	Olive trees cultivated (p)
16	Pruning	Processing	Olive trees pruned (p)

17	Olive collection	Material	Olives collected (kg)
18	Transportation: Olive farm to production unit	Transportation	Transported olives (tonnes*km)
19	Water treatment	Material	Water treated (m^3)
20	Water supply	Material	Water supplied (m^3)
21	Olive purification	Material	Purified olives (kg)
22	Olive grinding	Material	Olive paste produced from grinding (kg)
23	Oil extraction	Material	Olive oil extracted (m^3)
24	On-site liquid waste treatment	Waste treatment	Liquid waste treated on-site (m^3)
25	Wastewater supplied through network	Waste treatment	Wastewater supplied through network (m^3)
26	Wastewater treatment (public)	Waste treatment	Treated wastewater (public) (m^3)
27	Pomace processing	Waste treatment	Pomace processed (kg)
28	Solid waste treatment	Waste treatment	Solid waste treated (kg)
29	Storage of olive oil	Processing	Storage time (hr)

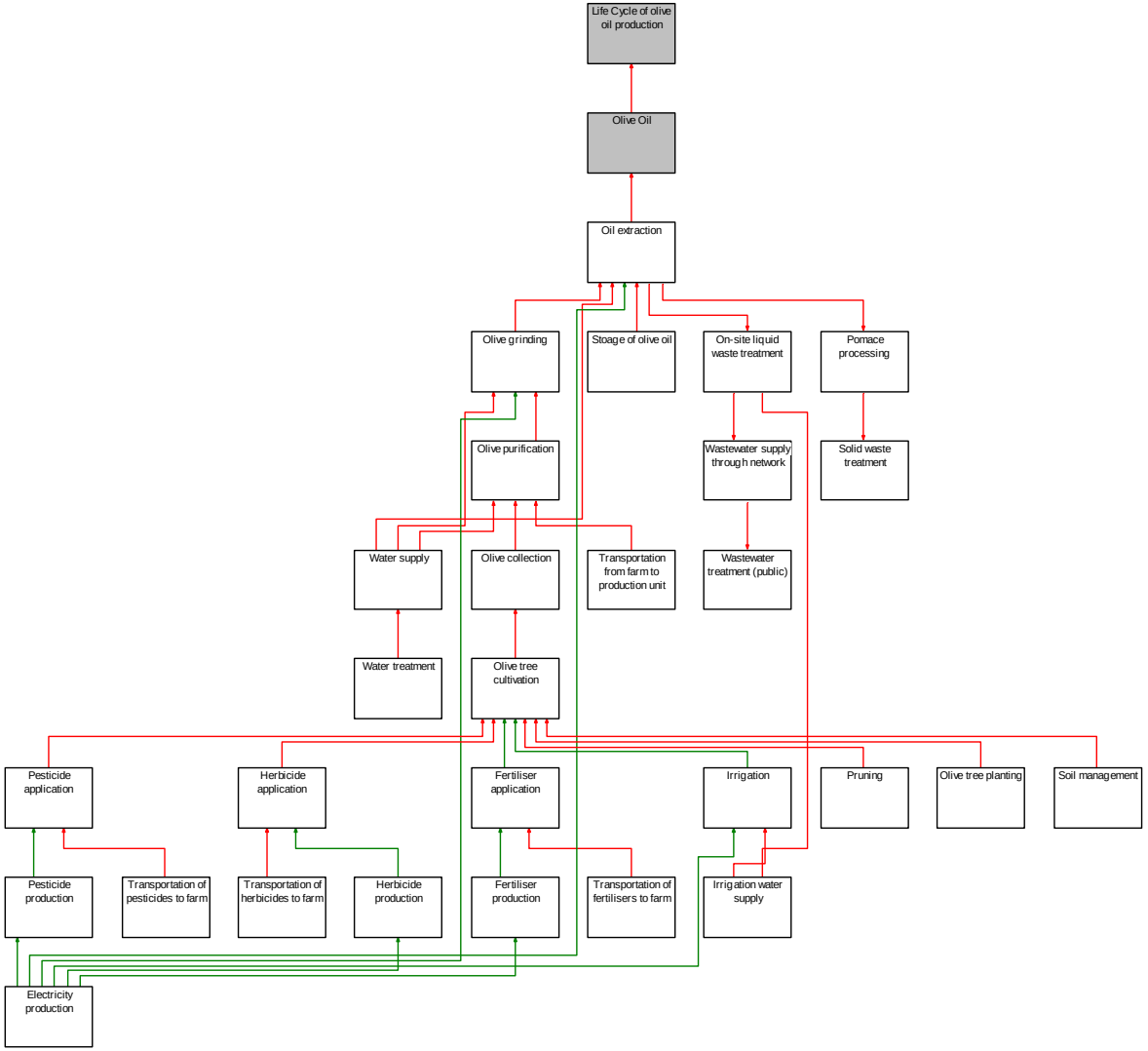


Figure 4: The model of the olive oil life cycle developed

Impact Assessment

The standard methodology for the assessment of impacts comprises of: [1] the definition of impacts to be assessed (category definition), [2] the classification of inventory input and output into the defined impacts and the consideration of their relative contribution to the impact (characterisation) resulting to an impact potential indicator for each category, as shown in Figure 5, [3] the normalisation of each impact assessed to a reference unit for the assessment of the importance of each and [4] the weighting of the "importance" of each impact based on political and/ or ethical values. According to ISO 14042 (2000a) steps [3] and [4] are optional in the impact assessment methodology.

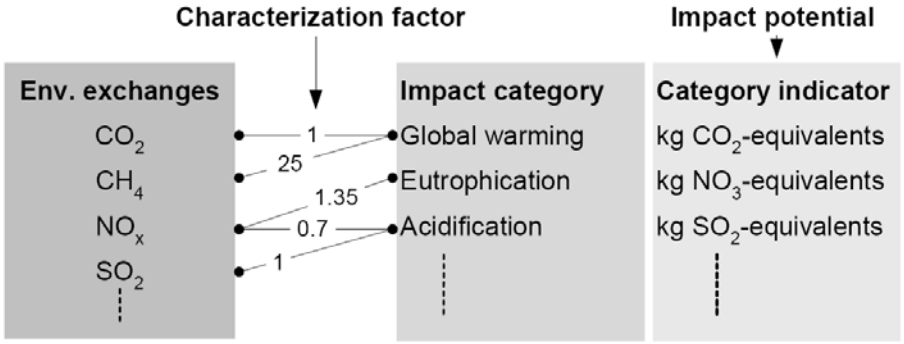


Figure 5: Example of classification, characterisation and category indicator

As shown in Figure 6, the impact chain describes the environmental mechanism from "exchanges" to "endpoints". An "endpoint" is something that we want to protect (a value item) such as trees, crops, rivers and human health. A "midpoint" in the other hand, refers to all elements in an environmental mechanism of an impact category that fall between environmental exchanges and endpoints.

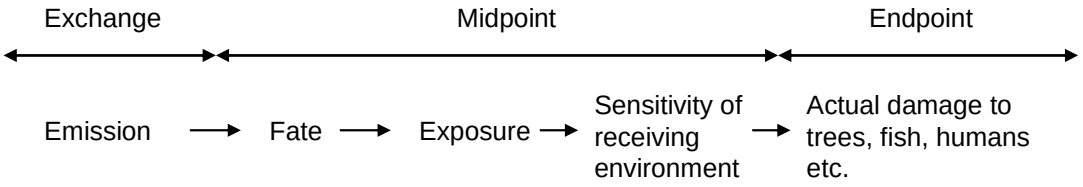


Figure 6: The impact chain for an emission of a given substance

Based on this chain, impact assessment methods can follow one of two main approaches. The first group, known as problem-oriented methods use a "midpoint" approach as these methods stop somewhere in the environmental mechanism between environmental exchanges and endpoints. The other group, known as damage-oriented methods use a so-called "end-point" approach as they model the potential damage on value items such as trees etc. Table 7 presents a number of standard methods for impact assessment.

Table 7 - Standard impact assessment methods

Methodology	Developer
CML 1992	Centre for Environmental Studies, University of Leiden part of Dutch Guide to LCA
Eco-indicator 95	PRé Consultants part of Integrated Product Policy of the Dutch Ministry of Housing, Spatial Planning and the Environment
Ecopoints 97	Swiss Ministry of the Environment part of Ecoipoint System
Eco-indicator 99	PRé Consultants part of Integrated Product Policy of the Dutch Ministry of Housing, Spatial Planning and the Environment
CML 2 baseline 2000	Centre for Environmental Studies, University of Leiden part of Dutch Guide to LCA
EPS 2000	Centre for Environmental Assessment of Products and Material Systems. Chalmers University of Technology, Technical Environmental Planning for Environmental Priority Strategies in product design
EDIP	Danish UMIP for Environmental Design of Industrial Products
IPCC 2001 GWP	Intergovernmental Panel on Climate Change (IPCC)
Cumulative Energy Demand	PRé Consultants

The Eco-Indicator 99, which is the successor of Eco-indicator 95 and the CML 2 baseline 2000 methods were chosen for application in this study. Therefore the impacts to be considered in this study are: abiotic resource exhaustion, global warming, eco-toxicological and human toxicological impacts, ozone layer depletion, photochemical oxidant formation, acidification, eutrophication and land use.

6. PROGRESS, RESULTS

The project consists of four technical tasks plus one task for dissemination – training activities and one task for its management. Until the 31.10.2005, the following activities have taken place:

Task 1: Recording and assessment of existing situation (1.11.2004 – 28.2.2005)

Through task 1, the following activities have already been completed:

Subtask 1.1: Identification of the EU, international and national legislation and standards

Within this subtask, all the existing Greek, Spanish, Cypriot, European Union and international legislative framework and standards related to the implementation of LCA in production processes, eco-efficient agricultural practices, operation of industries in an environmental friendly way and environmental management systems (ISO, EMAS) were recorded and assessed. The outcome of this subtask is a technical report with all the data collected and assessed (Deliverable 2 of the first progress report).

The collection of data for the purposes of subtask 1.1 was carried out mainly via internet research (specific websites), using of technical reports, studies and other technical documents.

The activities of subtask 1.1 were developed, as follows:

TUC: Collection and assessment of data concerning the Greek legislative framework,
LEIA: Collection and assessment of data concerning the Spanish legislative framework
UCY: Collection and assessment of data concerning the Cypriot legislative framework
TUC, LEIA and UCY: Recording and evaluation of data related to the EU and international legislative data and standards.

All the activities of subtask 1.1 have taken place under the supervision of the coordinator (TUC).

Subtask 1.2: Identification and evaluation of the existing situation related to the olive oil production cycle in the three areas under study

Through this subtask, the current situation concerning the olive oil production cycle in the three areas under examination (Greece, Spain and Cyprus) was described and recorded in detail. In particular, information about the following were collected, examined and assessed: olive tree varieties, olive oil cultivation practices (irrigation demands, applications of pesticides and herbicides, type of pesticides and herbicides), quantities of olive oil produced, olive milling processes for the production of oil (three or two phase olive mill systems) and olive mill waste management practices. The aforementioned information is provided in Deliverable 2 of the first progress report.

The data necessary for the implementation of subtask 1.2 was collected through site visits to the areas under examination and meetings with representatives of the actors and authorities involved (data kept by them in records). The primary data was recorded in appropriate questionnaires that were developed specifically for this purpose and were filled in during the meetings with actors involved. Complementary data was collected using technical reports/editions and internet sources. The questionnaire that was developed and used by the beneficiary and the partners for the collection of data was attached as Deliverable 3 in the first progress report.

The activities of subtask 1.2 were carried out, as follows:

TUC and AGRIPOL: Collection and assessment of data related to the olive oil production cycle in the area of Voukolies, Crete (Greek case study)

LEIA: Collection and assessment of data concerning related to the olive oil production cycle in the area of Navara (Spanish case study)

UCY: Collection and assessment of data concerning related to the olive oil production cycle in the area of Lythrodontas, Nicosia (Cypriot case study)

All the activities of subtask 1.2 have taken place under the supervision of the coordinator (TUC).

Subtask 1.3: Examination of success stories related to the application of eco-efficient policies and LCA studies in other agricultural and industrial products and processes

A significant number of cases concerning the development and application of successful systems and methods related to eco-efficient practices and LCA studies were recorded, examined, analysed and assessed. These success stories refer to several production processes at national, European and international level, in order to obtain a complete and representative picture on the subject of the project. The outcome of this subtask is included in Deliverable 2 of the first progress report.

The collection of data for the purposes of subtask 1.3 was carried out mainly via internet research (specific websites), using of technical reports, studies and other technical documents.

The activities of subtask 1.3 were developed by all the partners (TUC, AGRIPOL, LEIA and UCY, under the coordination of the beneficiary (TUC).

Instead of producing three separate reports, as it was foreseen in the submitted proposal, the technical reports of the subtasks were incorporated in one single report in the first progress report (Deliverable 2 - Date of delivery: 10/02/2005). The reason for this was that the compilation of all data in one document facilitates the flow of information and makes it easier to the reader to find the requested information. According to suggestions made by the EC (letter dated 25.7.2005), this deliverable has been re-organised and improved and it is resubmitted as **Deliverable 1** of the final technical report.

During this Task, local trips to the project areas were held for the collection of the necessary data, as well as for the information of the actors and authorities about the project.

The trip of representatives from the partners to Spain that was foreseen to take place during task 1 was transferred in order to be held during the implementation of tasks 2 and 3, since it was considered that the visits to sites that applied eco-efficient practices in the industrial and agricultural sector would be more useful for the implementation of these tasks. In particular, the trip to Spain was carried out from 5th to 6th of May 2005, and the results that were obtained from these site visits were comprise a significant input for the development and materialization of the LCA methodology, since they are based on applications that take place in practice, resulting to measurable data. The analytical information concerning the trip to Spain is given in Deliverable 1 of the interim report.

The trip of representatives from the partners to Italy that were foreseen to take place during task 1 initially, was transferred - as noted in the interim report - to be held during the development of Task 4: Evaluation of results, impact assessment and systems optimisation (ends on 31.10.2006). This change was made because it was considered that

the information which will be obtained through this trip will be more useful for the purposes of Task 4, since they will be used as an input for the development of guidelines for the improvement of the O.O production cycle in the areas under study (subtask 4.3). However, the working groups collected all the necessary data and information for the development of the guidelines through other resources and the trip to Italy would have not added any new input for the purposes of the project. As a result, this trip did not take place.

Task 2: Development of the LCA methodology (1.12.2004 – 31.7.2005)

Referring to Task 2, all the activities that are foreseen according to the proposal have been completed. In particular:

Subtask 2.1: Description and analysis of the LCA principles and guidelines

The life cycle assessment principles and guidelines (LCA system) were described and analysed, in detail (requirements, assumptions, restrictions, conditions of application, inputs, outputs, etc.). The activities of this subtask were carried out by the UCY, in close collaboration with the other partners and under the supervision of the beneficiary (TUC).

The collection of data for the purposes of subtask 2.1 was carried out by using of technical editions and reports, studies and other technical documents as well as by exploitation the experience of the working groups of the partners in the field.

Subtask 2.2: Determination of material flows and energy coefficients

This is one of the most important subtasks of the project since within it, the exact material flows were determined. In addition, under this subtask, the measurement units for the aforementioned coefficients were set and justified. Finally, through this subtask, the exact boundaries of the LCA system, which is one of the cores of the LCA methodology, were defined. The collection of data for the purposes of subtask 2.2 was carried out by using of technical editions and reports, studies and other technical documents, by collaboration with LCA experts as well as by exploitation the experience of the working groups of the partners in the field.

The activities of this subtask were carried out by the UCY, in close collaboration with the other partners and under the supervision of the beneficiary (TUC).

Subtask 2.3: Development of the LCA framework specific for the purposes of the project

Under this subtask, the appropriate framework of the LCA tool was developed. This tool will perform the necessary calculations to extract site specific coefficients and will also include all primary coefficients that will be the basis for further calculations. Again, the collection of data for the purposes of subtask 2.3 was carried out by using of technical editions and reports, studies and other technical documents, by collaboration with LCA experts as well as by exploitation the experience of the working groups of the partners in the field. Additionally, the activities of this subtask were carried out by the UCY, in close collaboration with the other partners and under the supervision of the beneficiary (TUC).

Instead of producing three separate reports (one for each subtask), as it was foreseen in the submitted proposal, the technical reports of the subtasks were incorporated in two individual reports (one for subtask 2.1 - Deliverable 2 of the interim report and one for subtasks 2.2 and 2.3 – Deliverable 3 of the interim report - Date of delivery: 31/07/2005). The reason for this was that the compilation of all data in one document facilitates the flow of information and makes it easier to the reader to find the requested information.

The content of the technical report - Deliverable 2 of the interim report that refers to the analysis of LCA system applied in several products or processes includes, among others, the following:

- Setting of the stages of a Life Cycle Assessment (LCA) procedure
- Determination of the functional unit and the system boundaries
- Requirements of data quality
- Description and analysis of the procedure for the collection of data (Life Cycle Inventory – LCI): Determination of the necessary types of data, development of LCA software and supporting databases, setting of flow diagram, means and techniques for the collection of data, development of questionnaires for the collection of primary data, establishment of appropriate input-output databases, etc.
- Description and analysis of the procedure for Life Cycle Impact Assessment
- Introducing of LCA methodology – analysis in the olive oil production (production steps, processes associated with each step, inputs, outputs and by-products)

The content of the technical report - Deliverable 3 of the interim report that refers to the determination of the material flows and coefficients as well as to the development of the LCA framework specific for the purposes of the project includes, among others, the following:

- The goal of the LCA that has been developed (reasons for carrying out the study, intended application, practitioner, intended audience and interested parties)
- Description of the product system (the olive oil life cycle is separated into five main stages: [1] agriculture (comprising of pre-farm activities and farm activities), [2] processing, [3] packaging [4] storage and distribution, [5] use and end-of-life)
- Setting of the system boundaries
- Description of the functions of the product system
- Identification and designation of the coefficients that will be used during the LCA implementation
- Determination of the functional unit and the reference flows
- Allocation of the inputs and outputs of the system
- Determination of types of impact and the methodology of impact assessment
- Plan for the collection of the necessary data from the three areas under study
- Setting of limitations and assumptions
- Setting of type and the format of the final report, after the implementation of the LCA
- Development of the LCA Decision Supporting Tool: Olive Oil Life Cycle modelling, inventory analysis and impact assessment

Task 3: Implementation of the LCA in the areas under examination (1.8.2005 – 30.6.2006)

The overall target of Task 3 was the implementation of the LCA in each case study based on the methodology and software developed during task 2. The task was comprise 3 individual subtasks:

Subtask 3.1: **Implementation of LCI in the Polemarchy Region of Crete**

This subtask included the implementation of LCI in the Municipality Department of Polemarchi and in general in the Municipality of Voukolies in Crete Island. The implementation of the LCI in the region in Crete produced certain site-specific LCI coefficients via the software tool developed under task 2 and based on site-specific conditions provided by the Municipality representation itself. Practices followed in Voukolies region are practices found in the majority of Cretan and Greek regions areas where olive oil production is as a vital economic activity. The activities of this subtask were developed by the Cretan partners of the project (TUC and AGRIPOL).

Subtask 3.2: **Implementation of LCI in the area of Lythrodontas in the District of Nicosia in Cyprus.**

This subtask referred to the implementation of LCI in the area of Lythrodontas in the District of Nicosia in Cyprus. One of Cyprus' main agricultural products is olive oil and the district of Nicosia is the area with the largest number of trees. Implementation of the LCI in Cyprus produced certain site-specific LCI coefficients via the software tool developed under task 2 and based on site-specific conditions provided by the district itself. The activities of this subtask were developed by the Cypriot partner of the project (UCY).

Subtask 3.3: **Implementation of LCI in the Navarra region in Aragon in Spain**

This subtask dealt with the implementation of LCI in the Navarra region in Aragon in Spain. Spain is the biggest olive oil producing country worldwide. The implementation of LCI in Spain produced certain site-specific LCI coefficients via the software tool developed under task 2 and based on site-specific conditions provided by the Region in Spain itself. The activities of this subtask are being developed by the Spanish partner of the project (LEIA).

As mentioned previously, the activities of subtask 3.1 were carried out by the TUC and AGRIPOL, while the activities of subtasks 3.2 and 3.3 were implemented by the UCY and LEIA, respectively. The three subtasks were developed in parallel, in close collaboration with the partners and under the supervision of the beneficiary (TUC).

It must be noted that the collection and collation of data in order to build a life cycle inventory for olive oil was the most resource-consuming steps of the implementation of this LCA study. For each unit process, within the system boundary defined, quantified data on inputs and outputs were collected by the working groups. The flow types for which data is required for each unit process within the system boundaries are shown in Figure 8, using the olive oil extraction unit process as example. Inputs are material or energy that enters a unit process, whereas outputs are material or energy that leaves a unit process. The categories of data e.g. energy, occupied land, CO_2 emissions etc. that are targeted during data collection, is correlated to the impact categories and characterisation factors included in the impact assessment method, in order to be used in task 4. It is highlighted that the data collected for flows have various units and it was necessary to be expressed in a common manner. Furthermore, indicator parameters such as chemical oxygen demand (COD) and biochemical oxygen demand (BOD) were used (see Figure 3 of Section 5).

During the development of task 3, a distinction between the unit processes was made (foreground and background processes). In particular: Foreground processes are those

unit processes for which case-specific primary data is used, while background processes are those unit processes for which more general information is used. It is noted that the larger the number of the unit processes treated as foreground, the more the detail and accuracy of the study but at the same time the more resource consuming. The classification of the unit processes that were examined through task 3, into foreground and background processes is given in Table 8.

Table 8: Classification of unit processes for which data is being collected

No.	Unit Process	Classification
1	Electricity production	Background
2	Irrigation water supply	Background
3	Irrigation	Foreground
4	Fertiliser production	Background
5	Transportation of fertilisers to farm	Background
6	Fertiliser application	Foreground
7	Pesticide production	Background
8	Transportation of pesticides to farm	Background
9	Pesticide application	Foreground
10	Herbicide production	Background
11	Transportation of herbicides to farm	Background
12	Herbicide application	Foreground
13	Soil management	Foreground
14	Olive tree planting	Foreground
15	Olive Tree cultivation	Foreground
16	Pruning	Foreground
17	Olive collection	Foreground
18	Transportation of olives from farm to production unit	Background
19	Water treatment	Background
20	Water supply	Background
21	Olive purification	Foreground
22	Olive grinding	Foreground
23	Oil extraction	Foreground
24	On-site liquid waste treatment	Foreground
25	Wastewater supply through network	Background
26	Wastewater treatment (public)	Background
27	Pomace processing	Foreground
28	Solid waste treatment	Background
29	Storage of olive oil	Foreground

Due to the fact that each unit process includes several flows of different inputs and outputs, the collection of all primary data was extremely time-consuming. For this reason certain criteria were set in order to decide which inputs and outputs to include in the study. Furthermore, during the collection of primary data, a consistent nomenclature of flows and other environmental exchanges was kept that is compatible with the nomenclature used by the software tool developed through the project and the standard impact assessment methods to be used.

The majority of data for foreground processes were collected and collated directly from grain growers (olive oil trees farmers) and processors/operators/owners of olive oil mills, agricultural and environmental experts and olive oil farming associations. A questionnaire

specifically for this purpose was developed and distributed to the actors and stakeholders described above in order to be filled in (the questionnaire was attached to the second progress report as Deliverable 3 - Date of delivery: 10/01/2006). This questionnaire was distributed to the olive oil producers during the period January-February 2006. Additionally, site visits to farms and factories are being paid by the members of the working groups in the case study areas and telephone discussions taking place with the farmers and the operators of the mills. Furthermore, telephone discussions and face-to-face interviews held with agricultural and LCA experts to verify the reliability of the collected data. In particular:

Voukolies – Crete - Greece: Olive trees in Crete are more than 35 million covering almost 25% of the area of the whole island. The average olive oil production is rather high, approximately 150.000 tons per year and is presenting an increasing trend, almost 3% yearly. Data where collected by local farmers with the questionnaire method. These questionnaires where apportioned to 26 farmers (15010 trees) that are registered in the local olive oil farmer co-operation of Polemarchi. Results showed that plough take place only once a year covering averagely the 50% of orchards. No plough procedure takes place according to 38% (72% of trees) of the farmers. The method used for irrigation is spray type sprinklers. Water is pumped from the local water supply system by electric pumps with an average frequency 3 times per year and average field coverage 81%. The average distance from water source is 100m. The average water use is 0,4385m3 of water per tree. Data obtained from the survey analysis shows that the majority of the farmers uses fertilisers labelled 20-10-10. The average pruning frequency per olive tree is one time per year by petrol chainsaws. In regards to the subsequent treatment of the pruning residue, all growers responded that pruned branches are burned in controlled open fires in vegetation free areas adjacent to the orchards. The residual ash is disposed to the agricultural land by manual methods. Only 15% of the farmers use machines to mill the pruning residue. Interviews with farmers showed that the most common pesticide application is spraying method with an average frequency 3 times per year. The main pest that causes problems to these trees is Bactrocera oleae (olive fly). The most common practice for olive oil collection is the use of “vibrating” poles powered by electric generators. Olives are collected from the underlying nets by hand and are put in plastic boxes or mesh bags, in which they are later transported to the processing plant. Typically, the processing of olives from Voukolies region into olive oil takes place locally. A modern olive oil processing unit is situated in the outskirts of Polemarchy village estimated to approximately 10 km from olive orchards. All farmers responded that for transportation of olives for processing, they use their private pickup vans.

Navarra – Aragon - Spain: After making some minor modifications to the first questionnaire developed by the ECOIL partners so as to be better adapted to the needs of Navarra Region (see Deliverable 3 of the second progress report), personal and telephone interviews took place with olive oil farmers. In quantitative terms, the interviews provided us information of 51% of total organic olive grove surface in the area, and a 5% of whole olive groves. During interviews, many answers remained unanswered or difficult to get, so they were highlighted as critical points or hotspots. Based on information collected by the interviews, 80 from 800 olive growers from this oil mill were selected, arguing that a 10% of total population of farmers were enough. Another questionnaire was then developed for collecting the missing data in two versions: long and simplified one (see Deliverable 3 of the second progress report). Telephone interviews were made with the selected farmers, but not all of them were able to answer the questions as some required technical expertise. Therefore, to enhance information provided from farmers, technical experts were asked to complete the long version of the questionnaire. After those steps, it was considered that the coverage of olive tree cultivation is very high, thus a representative picture of olive tree cultivation can be made.

Lythrodontas – Nicosia - Cyprus: The members of the working group have contacts/meetings with 87 farmers in the area of Lythrodonta and 26 of them have filled in the questionnaire. The quantity of the olive fruits that is produced by these 29 farmers represents the 25% of the quantity of olive fruits that is produced in Cyprus annually.

Also, it must be noted that samples of olive oil mills wastewater were collected and chemical analyses carried out in order to determine the polluting load of the effluents and verify the information provided by other relevant studies. The results obtained were used for the estimation of the inputs and outputs of the unit processes related to the practices that are applied for the management of olive oil wastewater under examination.

For background processes, secondary data sources were used to collect, obtain and calculate the datasets from published sources such as industry data reports, validated life cycle inventory databases, laboratory test results, government documents and reports, reference books, previous life cycle inventory studies, equipment and process specifications, publications in scientific journals and special editions, technical editions etc. During the collection of data that was necessary for the background processes, a great attention was given to justify that each data source selected for background processes is representative with respect to the specification of the goal and scope of the ECOIL project.

Finally, within the context of task 3, Mr Avraamides (member of the working group of the partner UCY) attended a training course on SimaPro software in Amsterdam between the 19th and 21st of March 2006. SimaPro software is being used for the analysis of olive oil production life cycle in all three case study regions. The intensive two-day training course gave a thorough understanding of LCA implementation through the use of this specialised software and provided the project implementation team with the capacity to implement tasks 3 and 4 successfully.

The development and the outcome of the subtask 3.1 that refer to the implementation of the LCI in the Municipality of Voukolies, Crete, Greece are included in a technical report which is attached to the final technical report, as Deliverable 2 (date of delivery: 30.6.2006).

Similarly, the development and the outcome of the subtask 3.2 that refers to the implementation of the LCI in the area of Lythrodontas, in the District of Nicosia, Cyprus, are presented in a technical report which is attached to the final technical report, as Deliverable 3 (date of delivery: 30.6.2006).

Finally, the development and the outcome of the subtask 3.3 that deals with the implementation of the LCI in the the area of in the Navarra, Aragon, Spain, are included in a technical report which is attached to the final technical report, as Deliverable 4 (date of delivery: 30.6.2006).

The main results that were obtained through the implementation of the LCI in the three areas under study are presented below, synoptically:

The aforementioned table allows making comparison of the results obtained for each region.

	Stage / Parameter	Crude Oil			fresh water			fossil CO2 to air			NOx to air		
	Country	Greece	Cyprus	Spain	Greece	Cyprus	Spain	Greece	Cyprus	Spain	Greece	Cyprus	Spain
Agricultural Stage	Olive tree Planting												
	Irrigation	12,10%	11,30%		94,20%	46,20%	100,00%	4,38%	15,80%			35,70%	
	Soil Management		15,10%						20,60%	6,92%		31,40%	10,53%
	applied fertilisers	35,90%	32,30%	38,38%	5,32%	25,80%		27,30%	26,70%	50,83%	30,70%	16,60%	36,60%
	applied pesticides	4,02%	18,50%	7,65%		26,60%			7,20%	8,86%	3,68%	2,70%	12,10%
	applied herbicides			10,02%									
	pruning	15,20%	10,00%					56,70%	23.3%		55,90%	11,50%	12,73%
	Olive Collection	7,28%		4,07%						2,86%	3,03%	0,90%	2,73%
Processing	olive tranportation	5,61%		18,10%				1,95%		12,53%	3,03%		12,40%
	olive oil extraction	14,90%	12,00%	18,49%	0,02%	1,40%		5,38%	5,90%	14,94%		0,90%	12,40%
Total	Agricultural	79,50%	87,60%	60,12%	99,70%	98,60%	100,00%	92,70%	93,90%	69,47%	95,60%	99,10%	74,69%
	Processing	20,50%	12,40%	36,59%	0,03%	1,40%	0,00%	7,33%	6,10%	27,47%	4,37%	0,90%	24,80%
	Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

	Stage / Parameter	SO2 to air			COD to water			BOD to water		
	Country	Greece	Cyprus	Spain	Greece	Cyprus	Spain	Greece	Cyprus	Spain
Agricultural Stage	Olive tree Planting									
	Irrigation	8,57%	4,30%		1,19%			3,99%		
	Soil Management		2,90%				10,19%			10,38%
	applied fertilisers	57,10%	61,70%	58,03%	5,86%	13,50%	40,75%	12,00%	23,50%	40,77%
	applied pesticides		9,60%	22,90%		7,60%	9,53%		13,20%	8,70%
	applied Herbicides									
	pruning	21,50%	9,60%	3,84%						
	Olive Collection	10,50%					4,10%			4,15%
Processing	olive tranportation			3,45%	0,87%		18,49%	1,82%		18,75%
	olive oil extraction		11,30%	7,10%	90,60%	78,90%	13,96%	80,60%	63,10%	13,94%
Total	Agricultural	88,80%	88,30%	84,77%	85,08%	21,10%	64,57%	17,50%	36,90%	64,00%
	Processing	11,20%	11,70%	10,55%	9,17%	78,90%	32,45%	82,50%	63,10%	32,69%
	Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

	Stage / Parameter	Lead to soil			Zinc to Soil		
	Country	Greece	Cyprus	Spain	Greece	Cyprus	Spain
Agricultural Stage	Olive tree Planting						
	Irrigation						
	Soil Management		0,70%			19,40%	
	applied fertilisers	0,08%		38,07%	0,85%	1,10%	39,80%
	applied pesticides	0,10%		4,42%	4,32%	2,20%	1,13%
	applied Herbicites				0,56%		
	prunning		45,20%	1,00%		47,80%	1,04%
	Olive Collection						
Processing	olive tranportation	0,06%			0,65%		
	olive oil extraction	99,80%	53,80%	56,10%	93,60%	29,10%	57,65%
Total	Agricultural	0,19%	46,20%	43,49%	5,73%	70,80%	41,97%
	Processing	99,80%	53,80%	56,10%	94,30%	29,20%	57,65%
	Total	100%	100%	100%	100%	100%	100%

Task 4: Evaluation of results, impact assessment and systems optimisation (1.12.2005 – 31.10.2006)

The overall target of task 4 was to complete the life cycle assessment, that is to assess environmental impacts and – according to the relative results – development of suggestions in order to optimise the overall O.O. production cycle. Task 4 was divided into 3 subtasks:

Subtask 4.1: Assessment of the environmental impacts of the LCI results.

Goal of subtask 4.1 was to assess the environmental impacts of the LCI results. Environmental impact assessment is one of the most difficult processes since it is always difficult to compare the impact of one pollutant with the impact of another. An impact index was assigned to each pollutant so that an overall hazard index for each case study will be calculated. In addition, socio-economical factors will be taken into account during hazard index assignment. The activities of this subtask were developed under the supervision of the beneficiary (TUC), while the partners were responsible for the assessment of the environmental impacts of the LCI results in their area, the Cretan partners (TUC and AGRIPOL) for the area of Voukolies, the Cypriot partner (UCY) for the area of Lythrodontas and the Spanish partner (LEIA) for the area of Navarra.

Subtask 4.2: **Comparison of the results obtained - Identification of weak points**

This subtask was based on the results of subtask 4.1 as well as the LCI results of task 3. Direct comparisons were made both horizontally (overall hazard potential of each case study) as well as vertically (among similar pollutants for all case studies) and the weak points in regard to the environmental burden for each case study were identified and system improvement can take place. As, in subtask 4.1, the activities of this subtask were developed under the supervision of the beneficiary (TUC), while the partners were responsible for the evaluation of the results that refer to their area, the Cretan partners of the project (TUC and AGRIPOL) for the area of Voukolies, the Cypriot partner (UCY) for the area of Lythrodontas and the Spanish partner (LEIA) for the area of Navarra.

Subtask 4.3: **Development of guidelines for the improvement of the O.O. production**

According to the results that were obtained through Task 3 and subtasks 4.1 and 4.2, guidelines for the improvement of the entire O.O production cycle in order to achieve the eco-production of O.O, were developed. Additionally, a policy document was developed which includes recommendations for the use of clean technologies, promotion of eco-production and eco-cultivation, modifications of production stages, adaptation of the principles of the integrated product policy, as well as specific suggestions for the application of market – based instruments e.g. tradable vouchers, tax incentives, tax breaks, subsidies, deposit – refund schemes and recommendations on potential funding opportunities.

Also, a framework of specifications for the implementation of the LCA methodology and software were prepared, a tool that is very useful for the adaptation of the know-how of the ECOIL project in other applications.

For the development of this subtask, the working team of the partners TUC, LEIA and UCY collected technical data and information related to Integrated Product Policy, ecological production of O.O, good agricultural practices, available techniques for pollution prevention and control, technologies and systems for O.O. mills wastewater and solid waste treatment, clean technologies etc. All the collected technical material was used as a well

documented reference/basis for the development of the guidelines and specifications for the O.O. eco-production, according to the results obtained for each area under study.

The development and the outcome of the subtasks 4.1 and 4.2 that refer to the assessment of the environmental impacts of the LCI results and is included in Deliverables 5-7 (date of delivery: 31.10.2006). The main outcome/conclusions of this Deliverables are presented below, synoptically:

Greece

1. The agricultural stage of olive oil production is the stage which pollutes more and has more effect in most impact categories.

2. In the agricultural stage, the main environmental impacts are related with the burning of the pruning waste, the use of fertilisers and pesticides.

3. The most important impacts of the agricultural stage are the emissions of carcinogens to the atmosphere resulting to human toxicity, photochemical oxidation, as well as eutrophication.

4. In the olive oil processing stage, the impacts are related with the disposal of liquid waste.

5. The environmental impacts of the disposal of liquid waste are toxicity in all level (fresh water, marine, terrestrial and human), as well as eutrophication.

6. As it was shown from the LCIA with both methods, in order to optimize the production of olive oil and minimizing the environmental impacts measures should be taken so as to:

    - Reduce the use of fertilisers
    - Reduce the use of pesticides
    - Find alternative method to deal with pruning waste
    - Apply appropriate treatment to liquid waste so as to protect the natural environment from the adverse effects of its disposal

Cyprus

The results of the life cycle impact assessment step using both CML 2 baseline 2000 (a problem-oriented method) and Eco-indicator 99 (a damage-oriented method), show that overall, the agricultural stage of the production system is more significant in regards to raw material consumption and air pollution, when compared to the processing stage. However, the processing stage is of primary importance when it comes to toxicity effects, mainly due to the particular management practice of liquid wastes from olive mills (disposal to evaporation ponds).

Based on the results of the study, individual processes of the overall system were classified in priority categories according to the effect a potential optimisation could have in the environmental improvement of the olive oil production system:

1. Tree planting, olive collection and transportation of olives to the processing unit do not raise any concern as their contribution to all environmental impacts and damage categories considered was less than 0.5%. Thus, their optimisation is not considered an effective way of optimising the system. They are classified as priority category 3.
2. Irrigation and soil management are classified in priority category 2. Irrigation, apart from the fact that, itself is a major consumer of fresh water in the system, most of environmental impacts arise as a result of the emissions from mechanical extraction of water from wells. Similarly, soil management consumes fossil fuels and causes heavy emissions of pollutants during tractor operation, causing moderate resource depletion and global warming impact problems, respectively.
3. The results of this study have shown that the use of fertilisers and pesticides, the particular residue management and the liquid waste management techniques, as used in Lythrodontas, shall be considered as priority-1 processes, since they are the major contributors to most of the environmental impacts and damage categories considered. Preventive management measures should therefore focus on these processes since their optimisation could potentially prove particularly effective in the environmental optimisation of the overall system of olive oil production.

Spain

1. The agricultural phase is the main pollutant stage when producing olive oil
2. In the agricultural phase, main environmental impacts come from production and transportation of agricultural inputs: fertilizers, pesticides (mainly copper oxychloride) and herbicides. On field application has a smaller environmental impact when using LCA:
3. In the industrial phase, pomace processing (transport) has a high environmental impact. It must be taken into account an environmental allocation of 7% when interpreting results.
4. In the overall life cycle, it has been shown that environmental impact comes from “occult” or non-visible processes that cannot be uncover without using Life Cycle Assessment.

The development and the outcome of the subtask 4.3 regarding the development of guidelines for the improvement of the O.O. production are separated into three individual technical reports. In particular: The first report (Deliverable 8 of the final report – Date of Delivery: 31.10.2006) includes guidelines and policy recommendations for the improvement of the olive tree cultivation cycle, the second report includes guidelines and policy recommendations for the improvement of the olive oil production cycle (Deliverable 9 of the final report – Date of Delivery: 3.10.2006) and finally, the third report refers to the development of a framework of specifications for the implementation of the LCA methodology and software (Deliverable 10 of the final report – Date of delivery: 31.10.2006)

The main points of these Deliverables are presented below:

Deliverable 8:

Guidelines for the olive cultivation stage that refer to:

- Selection of the plantation site
- Planting setout
- Preparing the site for plantation
- Planting of new trees
- Pruning (regulated pruning, pruning for fruiting, renovating Pruning)
- Irrigation
- Fertilization:
  - Types of nitrogen fertilizers and nitrogen application
  - Types of potassium fertilizers and Potassium application
  - Boron fertilizers and application
- Deficiencies of nutrient elements: Boron deficiency Potassium deficiency, Calcium and Magnesium deficiencies
- Organic fertilizers application
- Weed control – soil management – herbicides application:
  - Types of herbicides
  - Herbicides application
  - Weed control in new orchards
  - Weed control in established orchards
- Types of Pesticides and pesticides application (according to the insects of olive trees)
- Biodiversity and landscape conservation
- Fruit harvesting

Policy recommendations:

Short term proposals:

- Follow ITGA recommendations and guidelines referring to olive tree cultivation
- Avoid use of chemical inputs
- Take seriously the problem of soil erosion
- Plan training activities based in actual general guidelines in olive tree cultivation as a first step of environmental awareness.

Medium term proposals:

- Organic farming

- Management of on-field waste
- Local Good Agrarian Practices

Long term proposals:

- Agrarian co-operation
- Local Economy: Local consumption vs. distribution of goods

Other policy initiatives:

- The current olive farming subsidy based on the production should be changed into a payment that: i. is based on cultivated areas ii. is unconnected to the production level iii. has a flat-rate payment per hectare, not related to historic olive plantations. The use of a flat-rate area payment would provide a more solid basis for the viability of low-input plantations in marginal areas, through a higher and more consistent level of aid reflecting the high labour costs of these production systems. Replacement of production subsidies that are given to olive tree farmers with a flat-rate area payment unrelated to production or yield, could remove the incentive for intensification and increase the support for low-input, marginal plantations.
- National and regional authorities should require olive farmers receiving CAP support to comply with locally-established codes of good agricultural practice incorporating basic environmental protection, within the framework of Article 3 of Regulation 1259/1999.
- Inclusion of environmental data and information in the GIS data-base, based on aerial surveys, that is being developed by the EU in order to manage the olive support regime. By this way, a combination of agronomic and environmental data in one cartographic information system will be achieved. The inclusion of data such as slope of plantations, vulnerability to erosion, state of underground and surface waters (pollution and exploitation levels), presence of terraces, location of natural habitants etc., would allow the targeting of policy measures at national and European level for environmental objectives. This would support significantly towards environmental integration in agricultural policy making and would facilitate a more effective implementation of EU and national environmental law.
- Comprehensive agri – environment schemes for olive farming should be designed and implemented by the national and regional competent Authorities to address the full range of environmental issues in the country, region or area, promoting specific practices. All actions rewarded should go beyond Good Agricultural Practice while clear and quantified objectives should be established for these schemes as well as effective monitoring systems to check whether targets are achieved.
- Programmes to implement sustainability strategies for olive farming should be developed by the competent Authorities, including targeted funding/subside for:
    - Associations of farmers who employ a technical advisor for developing and pursuing more sustainable practices.
    - Grant-aid for investments in environmental improvements (e.g. machinery for changing to non- tillage systems).

    - Economic diversification, improved production quality and labelling schemes incorporating environmental criteria.

- The case studies stress the need to providing effective information, advice and training to olive farmers on environmentally beneficial – ecological practices. Currently this only occurs on an extremely limited scale. An effective mean for advising the olive trees farmers is the employment of a technical adviser by the farmer associations in each area (with financial aid from the government). By creating a much more direct link between the farmers and a specialist adviser, this system may be more effective than conventional farm advisory services.
- Also, special information campaigns and training courses should be held by the farmers' associations in collaboration with agricultural institutes, research centers, and the competent local, regional and national Authorities in order to promote the awareness of the farmers and to train them on viable ecological and environmental friendly methods and practices. The content of the dissemination campaigns and of the training courses must be adapted to:
    - Age and level of education of the farmers
    - Main employment of the farmers (full - time or part – time olive tree farmers)
    - Size of olive tree farms
    - Years that the farmers deal with the olive tree farming
    - Existing awareness and interesting level of the farmers in environmental issues
    - Current mode of getting information (personal observations and experience, advising by agriculturalist etc.)
- A European Organisation namely Conservation Agriculture Federation (ECAF) was established by a group of European scientists, technicians and farmers interested in the transfer of technology and the adoption of conservationist practices in the agricultural sector. At present, national associations from fourteen European countries (including Spain and Greece) belong to the ECAF. It is suggested that stakeholders from Cyprus to join this Federation.

Deliverable 9:

Guidelines for the olive oil production stage:

The guidelines are tailored to the needs of the areas under examination and refer to the following:

- Effective use of water and energy
- Minimization of air emissions, solid waste and wastewater generation
- General guidelines of good practices

Optimum consumption of water during olive oil production

- Adaptation of good operation practices (upgrading the mechanical equipment, installing automatic control systems for pumping, storing and transportation of water, training personnel, adopting hygiene practices, adopting adequate cleaning procedures, adopting procedures for equipment maintenance, measuring water consumption and detecting/fixing leaks in water piping networks).
- Recycle-Reuse of cleaning water.
- Recycling/Reuse of water contained in the boiler for other usage within installation.
- Waterjet cleaning - Segregated collection of polluted water, and send them to a pool - Segregate clean rain water.
- Always wash fruit on a closed circuit.
- Place a water meter on the water entrance in order to register consumption.
- Control water quality of the washing circuit, in order to replace it only when necessary.
- Send sewage water to evaporation pools.

Optimum consumption of energy during olive oil production

- Adaptation of practices for efficient operation (upgrading of the mechanical equipment and automatic control systems in the stages of production and transferring of energy, personnel training, cleaning procedures, maintenance procedures, measurement of energy consumption, and detection/fixing of leaks in the boiler's piping network, cooling systems and thermal energy transferring).
- Upgrading of the mechanical equipment.
- Improving the Efficiency of Steam-boilers.
- Heat recovery from exhaust gases.
- Heat recovery and Reuse from steam condensation.
- Minimization of Thermal Losses (use of insulation in equipment parts).
- Turn engines off while vehicles are waiting for unloading

Water saving during oil refining stages:

- Recycling of the water used in barometric condensers (deodorization unit). Implementation of a "secondary" cooling system (double circulation). The application of this innovative system not only allows water savings, but also prevents odours releases.
- Substitution of the water-operating barometric condensers with steam-operating barometric condensers and a steam condensation system in the deodorization unit.
- Re-circulation of all steam condensates into the steam-boiler. Prior to recirculation, an amount of steam produced should be removed.
- Re-circulation of the cooling water, which is used at the hydrogenation process.

- Cooling and recycling of cooling waters of all machinery (e.g. heat exchangers).
- Use, wherever possible, closed recycling cleaning system (C.I.P.). The application of such a system allows energy savings, as well.

Odour emissions

- Storage of olives in appropriate areas (e.g. in silos), but not for a long period of time
- Storage of the produced olive-kernels in covered areas with adequate ventilation until their shipment to kernel-oil mills
- Prevention of odorous substances release from the condensers during the oil refining, in no-working periods, by implementing an indirect cooling system. Odors produced during the deodorization process can be successfully controlled by a water-scrubber/ barometric condenser system.
- Other measures that may be applied to reduce the air emissions related to combustion is the optimization of the operating conditions, the regular maintenance of equipment, the continuous monitoring of machinery efficiency and the substitution of diesel oil by LNG.

Wastewater management

- All wastewater from oil refining may be passed through an oil-separator. Biological treatment usually follows for the reduction of BOD, suspended solids and other pollution parameters. Separation of waste streams may be appropriate in certain cases. In oil and fat refining units it is recommended to separate the wastewater of high pollution load from wastewater with low pollution load.
- Wastewater of high organic load is usually, and most cost-effectively treated by using the following procedure: They are collected in a tank and their pH is adjusted by adding $Ca(OH)_2$. Then, they are directed to another tank, where they are left to settle for several days. The solid impurities precipitate while, partial anaerobic decomposition of the biodegradable organic load takes place. After this, there are two alternatives: i. They are further treated by chemical coagulation-precipitation and discharged to a sewage system, or ii. They are directed to open lagoons, where they undergo physical biological treatment (aerobic or anaerobic), while their volume is significantly reduced through physical evaporation. This specific method is simple, cost-effective and efficient, but it may require excessive land use.

Wastewater from barometric condensers (low organic load):

- When *a single circulation system* is used:
    - Oil-separation by gravity
    - Dissolved Air Flotation (DAF)
    - Aeration in cooling towers
    - Collection tank
    - *Recycling to the barometric condensers*
- When *a double* circulation *system* is used:

    - Oil-separation by gravity
    - Cooling in heat exchangers (with “secondary” cooling water)
    - Recycling into the barometric condensers
- “Secondary” cooling water (heat exchangers)
    - Aeration in cooling towers
    - Collection tank
    - Re-circulation into the heat exchangers

Solid waste management

Olive oil production

Application of waste treatment practices in order to recover useful byproducts (natural coloring substances, proteins). The kernels should be transferred to units for the production of kernel oil. Also, the frequency and volume of waste discharge from centrifuges should be in line with the specifications of the manufacturers of the equipment. Storage of all waste susceptible of being dispersed by wind or water in closed and opened places. Other proposals include:

- Application for Small Producers Registry
- Characterization and quantification of all products produced in the facilities.
- Registration of all waste produced and given to third parts.
- Segregation of waste by their characteristics.
- Waste giving to authorized managers, prioritizing those ones who offer recycling processes
- Storage of waste properly packed and labelled in safe places
- Avoid incineration of dangerous waste in the boiler.
- Develop or Collaborate in studies about boiler ashes and evaporation pools’ mud valorization as agricultural land amendment.

Oil refining

Most of the by-products and solid waste produced in vegetable oil and fat refining industries can be used as raw materials in several other industries. The following are recommended:

- Lecithin (by-product). It can be used in food industry, pharmaceuticals, animal food production, etc.
- Soaps. They can be utilized in soap production industry, or they can be treated with dense sulfuric acid solution. The product of this reaction is a free fatty acid (FFA) that can be used either as raw materials in other industries or as bio fuels.
- Collection of fatty compounds and usage as raw materials in soap making industries
- Spent decolorizing agents. They can be utilized in cement production or they can be used as additives from the animal food production industries

- Nickel catalyst: It can be recycled (in the hydrogenation unit) until its activity is substantially reduced. The spent catalyst can then be directed to a nickel-recovering plant.
- Bottles, papers, paperboards and other packing materials. They can also be utilized in other industries (mainly paper recycling industries).

General guidelines of good practice

- Implementation of an administrative plan for Good operating practices.
- Upgrading of mechanical equipment.
- Measurement and control of water and energy consumption.
- Maintenance of the mechanical equipment.
- Prevention and management of leakages and fugitive escapes.
- Personnel training on pollution prevention and control.
- Assignment of responsibility for the monitoring of all pollution control systems performance.
- Monitoring of the volume and quality of solid waste and wastewater. This data should be stored at appropriate files (preferably electronic files) and be easily retrieved whenever it is necessary
- Control and maintenance of the equipment, according to the specifications of the producer of the equipment
- Detection and prevention of leakages, especially to wastewater spills, which may have significant impacts to the soil, surface and groundwater
- Tree plantation for the reduction of noise and aesthetic nuisance
- Implementation of an **ENVIRONMENTAL MANAGEMENT SYSTEM**. This is the best "Good Practice" that can be recommended.

Policy recommendations:

A policy motivating the implementation of sustainable practices in olive oil production would reduce the environmental burden linked to the oil production. The tools to develop such policy may include:

- Development of a strategic plan (national, regional or prefectural)) for the management of the wastewater from olive oil production, describing specific targets and actions to be taken
- Co-funding of the necessary infrastructures from EU funds. Co-funding may reach up to 50 – 70%. The infrastructure may include either construction of wastewater treatment plants or substitution of 3 phase systems with 2phase systems
- Tax releases, when environmental practices are implemented
- Funding of research and pilot projects for the management of wastewater (3-phase systems) or the management of humid by-products (2-phase systems)
- Imposition of taxes in the production of specific environmental pressures

- Strict control and monitoring of the performance of the olive oil mills – imposition of fines
- Establishment of financial motives for the implementation of environmental management systems or Eco-label products - Programmes to implement sustainability strategies for olive oil production could be developed by the competent Authorities, including targeted funding/subside for:
    - Associations of oil producers who employ a technical advisor for developing and pursuing more sustainable practices.
    - Grant-aid for investments in environmental improvements (e.g. machinery for changing to non- tillage systems).
    - Economic diversification, improved production quality and labelling schemes incorporating environmental criteria.
- Promotion of collective wastewater management and not separate management (neighborhooding mills could treat their waste together)
- Raising of awareness and training of the olive mills operators. The aim of the campaigns should be to inform the olive mills operators about the capabilities to improve their performance and the opportunities to receiving funding for the necessary infrastructures. The content of the dissemination campaigns and of the training courses must be adapted to:
    - Age, years of working experience and level of education of the operators
    - Size of olive mills
    - Existing awareness and interesting level of the operators in environmental issues
    - Current mode of getting information (personal observations and experience, etc.)

Deliverable 10:

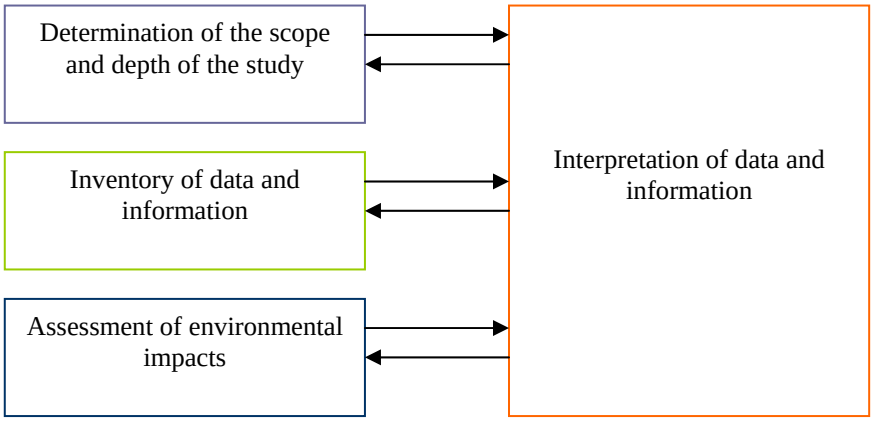
The report aims at describing the basic steps of the Life Cycle Assessment (LCA) methodology, for the assessment of the environmental performance of various processes (not only olive oil production). The LCA is a methodological framework for estimating and assessing the environmental impacts attributable to the life cycle of a product. This report will indicate the decisions and assumptions that need to be made, the software that needs to be used / developed and the results that may be obtained. More specifically, this report comprises the theory and the experiences gained during the implementation of LCA for the production of olive oil in Greece, Spain and Cyprus. Each step of the LCA, as described in the theoretical background is enriched with the methodology that was used for the purposes of this project.

LCA Stages

The main procedure steps for a Life Cycle Assessment are four:

1. Definition of goal and scope of the study.
2. Model preparation of the product life cycle including environmental inflows and outflows. This stage, during which data is collected, is usually referred to as Life Cycle Inventory (LCI).

3. The stage at which environmental relevance of all inflows and outflows are understood, is known as Life Cycle Impact Assessment (LCIA).
4. Finally, study interpretation.



Following, the methodology for the development of the aforementioned steps is described synoptically, based on the experiences and know-how gained during the implementation of the LCA in the olive oil production.

Definition of the goal and scope

The definition of the goal and scope of the LCA study is the first and perhaps the most significant step of the methodology. It affects the depth of the study to be carried out, the type of data that need to be collected and the type of results that need to be obtained. Based on this stage the action plan for data collection is developed and the appropriate software that needs to be used is selected.

Definition of the baseline unit

Having answered the above mentioned questions, the next step it to define the baseline unit (or functional unit). The results of the study need to refer to a specific functional unit in order to be comparable. The functional unit is the reference to which the inputs and outputs can be related to. This enables comparison of two essential different systems. The definition of a functional unit could be a difficult task. The unit has to be precise and comparable enough as well easy to be elaborated and connected to the downstream data.

The functional unit used for a project should be determined though the elaboration of the collected data and study. Also, potential restrictions with respect to the depth of the study, the sources and quality of data are determined during the process of the study.

Determination of the system boundaries

Having determined the functional unit the next step is to determine the product system and its boundaries. The product system is a collection of unit processes, processes, each representing one or several activities, linked to one another by flows of intermediate products and/or waste for treatment. The sum of the unit processes refers to the full “cradle to grave” cycle of the product/process under examination. According to the needs of the study and the assumptions been made it might be necessary to restrict the number of unit processes that will be part of the study. This action refers to the definition of the system boundaries.

The system boundaries determine which unit processes shall be included within the LCA and therefore separate the system from the rest of the world. According to VROM, CML (2001) there are three types of boundaries: [1] the boundary between the product system

and the environment, [2] the boundary between processes that are relevant and irrelevant to the product system and [3] the boundary between the product system under consideration and other product systems. The following boundaries can be considered:

- Boundaries between the technological system and nature.
- Geographical area.
- Time horizon.
- Boundaries between the current life cycle and related life cycles of other technical systems.

Determination of the system processes

The individual processes that are included in the life cycle under examination are recorded.

Determination of the assumptions and limitations of the system

During this stage, the assumptions and limitations of the system are determined in terms of pressures and impacts to be assessed, sources of the data and technical assumptions.

Model preparation

LCA is a modelling technique where simplifications and assumptions are necessary. The performer tries to describe as realistic as possible a system. Typically, the system is a static simulation model: it consists of unit processes, each representing one or several activities (e.g. production, transportation). In simple words, model preparation refers to the following:

- Determination of the main processes involved (as defined in the system boundaries)
- Determination of the type of inputs and outputs related to each process. The type of inputs and outputs may include: Energy – fuel, Water, Products, Waste, Wastewater, Air emissions, By-products
- Determination of the specific amount of each input – output in each process unit

During this stage, the data are collected, in order to complete the Life Cycle Inventory (LCI). Reliability of the results from LCA studies strongly depends on the extent to which data quality requirements are met. The following parameters should be taken into account:

- Time-related coverage.
- Geographical coverage.
- Technology coverage.
- Precision, completeness and representativeness of the data.
- Consistency and reproducibility of the methods used throughout the data collection.
- Uncertainty of the information and data gaps.

Threshold points can also be placed in addition to the boundaries, below or above which data collection for inflow or outflow can not be considered, increasing the quality and usefulness of the data. For the purposes of this project, the software SimaPro 6 (System for Integrated environMental Assessment of PROducts), developed by the Dutch PRé Consultants (PRé, 2005), was used.

Development of LCI

The main input and output data related to the several unit processes, is separated into two types:

- Foreground data: specific data required to model the specific system. Typically data describing a specific product and production system.
- Background data: information for generic materials, energy, transport and waste management systems. This type of data can be typically found in literature and databases.

The foreground data collection methodologies include:

- Development of questionnaires and distribution to appropriate actors
- Organization of site visits
- Organization of interviews
- Search in the internet and literature

Insertion of data into the LCA software

After all necessary data are collected they are imported into the LCA software in order to be processed and the preliminary results on environmental pressures derive. There are three types of inputs. The first type, inputs from nature, refers to inputs that are extracted from natural resources. The second input type, inputs from technosphere (materials /fuel) refers to materials and mass flows respectively supplied by other unit processes, whereas the third type, inputs from technosphere electricity/heat refers to non-mass flows including transport and energy supplied by other unit processes. In addition, data on five elementary output flows must be imported: emissions to air, water and soil as well as final waste flows and non-material emissions such as noise. These elementary data together with inputs from nature will be used in inventory analysis of the product system.

Life Cycle Impact Assessment

The phase called Life Cycle Impact Assessment (LCIA) is the evaluation of the data collected in the inventory, on the basis of potential human health and environmental impacts. More specifically, the purpose of the LCIA is to assess a product system's life cycle inventory (LCI) results in order to better understand their environmental significance (ISO, 2000). SimaPro 6 software includes a number of standard methods that have been primarily prepared for the assessment of a product or service and through a number of alterations but with minimum changes to the principal models they have been introduced to the software (PRé Consultants, 2004). Additional changes to the methods are made throughout the years according to new findings on the environment, processes etc.

Interpretation phase

Following the LCAI, comes the interpretation phase. The aim of the interpretation phase is to reach conclusions and recommendations in accordance with the defined goal and scope of the study. Results from the LCI and LCIA are combined together and reported in order to give a complete and unbiased account of the study. The life cycle interpretation of an LCA or an LCI comprises three main elements:

- Identification of the significant issues based on the results of the LCI and LCIA phases of a LCA.
- Evaluation of results, taking into consideration completeness, sensitivity and consistency checks.

- Conclusions and recommendations.

Type and format of the reports

Reporting is a crucial issue in LCA. A technically excellent LCA without a transparent and unambiguous report will be of limited value. Thus the basic requirement of the report is transparency. The reader of the report should be able to understand what has been analysed, how allocations issues were handled, and what data was used.

Additionally, two technical reports that include the main content of the Deliverables 6 and 7 of the final report (framework of guidelines for the improvement of the olive tree cultivation cycle and the olive oil production cycle, respectively) in Greek language, was developed and distributed to the participants of the training courses as well as to other olive tree farmers and olive oil producers (Deliverables 11 and 12 of the final report – Date of Delivery: September 2006 – Date of distribution: October 2006 to January 2007).

The actions that were developed for the implementation of the project are indicated in the summarised table (Gantt-chart) of Section 11. No technical problems or difficulties encountered during the materialization of the project and the project is implementing according to the proposed time schedule. The change in the partnership (as described at point 4 of the first progress report) has not affect the development, the activities, the results and the outcome of the project. The activities remained the same as described in the proposal (qualitatively and quantitatively), the number of the case studies remained the same (three) and the project is expanded to include another EU country member, Cyprus (instead of case studies in two member states we have case studies in three member states.) Furthermore, the dissemination of the project was extended since another country was involved more actively in the project.

The following Table summarises the deliverables that were prepared during the technical implementation of the project.

Table 9: Deliverables that were prepared for the technical implementation of the project

Tasks/subtasks	Type and Title of deliverable	Details on deliverable
Subtask 1.1: Identification of the EU, international and national legislation and standards Subtask 1.2: Identification and evaluation of the existing situation related to the olive oil production cycle in the three areas under study Subtask 1.3: Examination of success stories related to the application of eco-efficient policies and LCA studies in other agricultural and	Technical report that includes recording and Assessment of the Existing Situation	Date of delivery: 10/02/2005 It was submitted as deliverable 2 of the first progress report It was improved, re-organised and resubmitted as Deliverable 1 of the final report

industrial products and processes		
Subtask 2.1: Description and analysis of the LCA principles and guidelines	Technical report concerning LCA systems	Date of delivery: 31/07/2005 It was submitted as Deliverable 2 of the interim report
Subtask 2.2: Determination of material flows and energy coefficients Subtask 2.3: Development of the LCA framework specific for the purposes of the project	Technical report concerning the LCA tool developed for the purposes of the project	Date of delivery: 31/07/2005 It was submitted as Deliverable 3 of the interim report.
Subtask 3.1: Implementation of LCI in the Municipality Department of Polemarchi and in general in Municipality of Voukolies in Crete island.	A questionnaire for the purposes of the LCI in Crete Technical report concerning the implementation of LCI in Crete	Date of delivery: January 2006. It was distributed to the olive oil producers during the period January-February 2006. It was submitted as part of the Deliverable 3 of the second progress report. Date of Delivery: 30/06/2006 It is submitted as Deliverable 2 of the final report
Subtask 3.2: Implementation of LCI in the area of Lythrodontas in the District of Nicosia in Cyprus.	A questionnaire for the purposes of the LCI in Cyprus Technical report concerning the implementation of LCI in Cyprus	Date of delivery: January 2006. It was distributed to the olive oil producers during the period January-February 2006. It was submitted as part of the Deliverable 3 of the second progress report. Date of Delivery: 30/06/2006 It is submitted as Deliverable 3 of the final report
Subtask 3.3: Implementation of LCI in the Navarra region in Aragon in Spain	A questionnaire for the purposes of the LCI in Spain Technical report concerning the implementation of LCI in Spain	Date of delivery: January 2006. It was distributed to the olive oil producers during the period January-February 2006. It was submitted as part of the Deliverable 3 of the second progress report. Date of Delivery: 30/06/2006 It is submitted as

		Deliverable 4 of the final report
Subtask 4.1: Assessment of the environmental impacts of the LCI results.	Life Cycle Impact Assessment (LCIA) for the Polemarchi Region in Crete, Greece	Date of Delivery: 31/10/2006 It is submitted as Deliverable 5 of the final report
Subtask 4.2: Comparison of the results obtained - Identification of weak points	Life Cycle Impact Assessment for the Lythrodontas Region, Nicosia, Cyprus	Date of Delivery: 31/10/2006. It is submitted as Deliverable 6 of the final report
	Life Cycle Impact Assessment in Ribera Baja, Navarra, Spain	Date of Delivery: 31/10/2006. It is submitted as Deliverable 7 of the final report
Subtask 4.3: Development of guidelines for the improvement of the O.O. production	Guidelines for the eco-production of olive oil - Policy document for the improvement of the olive oil production cycle - The olive cultivation stage	Date of Delivery: 31.10.2006. It is submitted as Deliverable 8 of the final report
	Guidelines for the eco-production of olive oil - Policy document for the improvement of the olive oil production cycle - The olive oil production stage	Date of Delivery: 31.10.2006. It is submitted as Deliverable 9 of the final report
	The implementation of the LCA Methodology	Date of Delivery: 31.10.2006. It is submitted as Deliverable 10 of the final report
	Framework of guidelines for the improvement of the olive tree cultivation cycle in Greek language	Date of Delivery: September 2006. It was distributed to the olive tree farmers during the period October 2006 – January 2007. It is submitted as Deliverable 11 of the final report
	Framework of guidelines for the improvement of the olive oil production cycle, in Greek language	Date of Delivery: September 2006. It was distributed to the olive oil producers during the period October 2006 – January 2007. It is submitted as Deliverable 12 of the final report

7. DISSEMINATION ACTIVITIES AND DELIVERABLES

7.1 Dissemination Plan (summary)

The Dissemination Plan includes all the activities and means for informing all relevant parties for the developed methodology, the content and the outcome of the project. The dissemination campaign focuses on the spreading of the specific and practical benefits deriving from the behavioural change and the implementation of the proposed modifications to the O.O. production. These benefits may include cost and energy savings, improvement of environmental performance, improvement of the competitiveness of the companies, compliance with the existing legislation, etc. The target group includes all those involved in O.O. production cycle (owners and operators of O.O mills, olive trees farmers, transporters) in the three areas under examination (Voukolies - Crete, Lythrodontas – Nicosia and Navara-Spain), in the rest regions of Greece, Spain and Cyprus (responsibility of Partner 3), other Mediterranean countries and Europe. Additionally, other Greek, Spanish, Cypriot, Mediterranean and European parties interested in the project are informed properly (public, Communities, Municipalities, Central authorities, NGOs), in order to take all appropriate measures to implement similar systems in other places. Moreover, European Commission, research centres, universities, international associations will be provided with information and data. The means that were planned to be used for the dissemination of the project include:

- Organisation of a conference in Greece (Crete) where all relevant parties from Greece, Spain, Cyprus will be invited
- Publications in National and International scientific journals and conferences
- Publications in special technical editions
- Leaflets and brochures that will distributed in all actors involved in the field of the production of olive oil
- Direct mailing to all those involved in the production of olive oil
- Advertisements for promotion of environmental consciousness
- Website describing the project and its outcome
- Printed material describing the project and its results
- Personal meetings of the working groups with those interested in being informed on the project

Finally, before/after inquiries with the recipients of the dissemination materials will take place in order to assess the effectiveness of the dissemination activities and the overall project's results. The dissemination activities are carried out by all the partners, under the coordination of the beneficiary (TUC). Also, main participation is expected by the external assistant of TUC (PROSPECT Systems).

7.2 Activities and Output presented per tasks

For the dissemination of the project, a leaflet (leaflet 1) in Greek and English (Deliverable 4 of the first progress report, delivery in December 2004) has been developed. The Greek version's leaflet was distributed to the target groups in Greece and Cyprus (olive tree farmers, olive oil mills owners, farmers associations, local authorities), as well as to other Greek and Cypriot actors and authorities involved (Institutes, Research Centres, Ministries,

Prefectures). The total number of leaflets that were distributed exceeded 500. The English version's leaflet was distributed to representatives from European and other countries (Institutes, Universities, Research Centres, and Associations) that are involved in the field of the project (more than 200 leaflets). Also, this leaflet was translated into Spanish in May 2005 and distributed to actors involved in olive oil production (approximately 300 copies of the leaflet). This is attached as part of Deliverable 4 of the second Progress Report.

In addition, the content and the outcome of the project was presented at the workshop organised by the EC Delegation in Greece and took place on 15th April 2005 at the National Technical University of Athens premises (workshop where all the Greek LIFE projects related to environmental issues were presented). The presentation of the ECOIL project was attached as Deliverable 5 of the first progress report.

Moreover, members of TUC visit the area under study on July 15th and 16th of 2005 and met people involved in O.O production. The first part of the meeting took place in the City Hall of the Municipality of Voukolies. The Mayor of the Municipality of Voukolies, the Vice Mayor as well as the President of AGRIPOL attended the meeting. The TUC working team thoroughly informed the attendants on the activities of the project and the progress made so far. The results of Task 1 were also presented in detail to the participants of the meeting and the future involvement of AGRIPOL and the Municipality was discussed. Details of the meeting as well as the informative material distributed are annexed in Deliverable 6 of the interim report.

In addition, the summary of the report that was prepared for the purposes of the task 1 referring to the success stories of LCA implementation in various industrial sectors, was translated in Greek and Spanish languages, reproduced and distributed to all the target groups of the project, in Greece, Spain and Cyprus (Deliverable 4 of the interim report, delivery in July 2005).

A second leaflet in Greek and English language has been developed, describing the main functions of the LCA tool that is used for the purposes of the project (Deliverable 5 of the interim report). This leaflet was distributed to people involved in O.O production cycle (owners and operators of O.O mills, olive tree farmers, transporters) in the three area under examination, mainly during the development of activities of task 3 (collection of primary data for the implementation of the LCI). The Spanish version of this leaflet is part of Deliverable 4 of this Progress Report. (Delivery in September 2005, number of copies distributed for all partners: 1000).

For the dissemination of the project, UCY has distributed the informational leaflet developed (Deliverable 4 of the first progress report) to relevant Departments of the Cypriot Ministry of Agriculture, Natural Resources and Environment (Department of Agriculture, Department of Olive tree cultivation, Environment Service of Cyprus). Additionally, the website of the Laboratory of Environmental Engineering of the UCY (partner) gives, among others, information about the ECOIL project. www.eng.ac.cy/CEE/Labs/website%20A064/index.htm. Also, a link to the project's website is provided for people to get more information about the project.

Articles/advertisements were prepared and sent to three Cypriot daily newspapers, which were then published. Namely, the three newspapers were Philelefhteros (28th of July

2005), Politis (28th of July 2005) and Simerini (29th of July 2005) (the newspapers are also on line). These articles were included in Deliverable 6 of the interim report, where the dissemination material developed by the UCY is presented. It must be noted that the average daily circulation of the three newspapers is: Philelefhteros 29.000, Politis 13.000 and Simerini 9.000 issues. Philelefhteros is the newspaper with the highest readability in the country.

The project website has been updated according to the progress of the project (www.ecoil.tuc.gr). It contains information about the content, the methodology, the progress of activities, the expected results and the deliverables of the project according to time schedule of their completion.

A new leaflet describing the procedures for the planning and implementation of the Life Cycle Inventory in the O.O. production has been prepared and distributed to all the actors involved in the field in the three areas under study (olive tree farmers, operators of O.O. mills, representatives of Agricultural Associations etc.). All versions of the leaflet (English, Greek and Spanish) were included in Deliverable 4 of the second progress report (Delivery in March 2006, Number of Copies: 2000).

The working group of UCY prepared and submitted an article referring to the Life Cycle Analysis as a decision supporting tool for the ecological production of olive oil. In this article special reference is made to the ECOIL project. The article has been accepted for publication in the 1st issue of the technical journal that is edited by the Association of Scientists and Environmental Engineers of Cyprus (Publication in special technical edition). This was included in Deliverable 5 of the second progress report.

Furthermore, the ECOIL project and its outcome were disseminated by the members of the working groups during scientific meetings that they had in the framework of other projects that they participate. In particular:

TUC: During seminars that took place in Albania and Bosnia-Herzegovina on integrated solid waste management in the period July 2005 – April 2006, the representatives of TUC distributed the ECOIL leaflets and presented the ECOIL project. Great interest was expressed by the attendants on how can the LCA affect and improve the production of various agricultural and other goods.

More than 500 informative leaflets have been distributed to farmers and olive oil producers in the area of Voukolies giving the opportunity to promote the scope of the project and to invite interested producers to a wide discussion promoting the results of the work expected in the last period of 2006. During the first period of 2006 contacts have been made with organisers and managers of Oil and Olive tree museum at Sparti in Peloponissos Greece, in order to distribute the material of the project through the activities of the Museum.

In the case study area of Polemarchi, at a central point and a road junction to Polemarch village and Voukolies town, by the main road leading to Voukolies, a big road tag (road label 2m by 4m) has been erected, displaying the project title and organisations involved.

LEIA: Exact information covering the period until 30.4.2006, has been provided in Deliverable 6 of the second progress report

UCY:

i. LIFE-Environment project: "Sustainable Construction in Public and Private Works though IPP Approach": National Technical University of Greece, EPTA Greek environmental company, Scientific and Technical Chamber of Cyprus

ii. LIFE – 3rd Countries: "Development of Methods and Tools for the Establishment of Good Environmental Performance in the Tourist Accommodation Sector in Jordan - Implementation of Pilot Studies": Hashemite University of Jordan, Jordan University of Science and Technology, Jordanian Ministry of Environment, Jordanian Ministry of Tourism

Also, during the time period from 1.5.2006 until the end of the project, various additional actions were carried out by the partners. In particular:

TUC: On 21 – 24 May 2006, representatives from TUC participated in CISAP-2, the 2nd International Conference on Safety and Environment in Process Industry, which took place in Naples, Italy The representatives presented the ECOIL project to the participants of the Conference by distributing the ECOIL informative material to anyone interested.

In the end of August 2006, representative from TUC participated in the International Congress of Chemical and Process Engineering, CHISA 2006, which took place in Prague on 27–31 August 2006. The representative, presented the ECOIL project, distributed the ECOIL leaflets and had discussions about the project with researchers and professors from other countries, interested on the implementation of the LCA methodology in several products.

In addition representative from TUC participated in the SRA-E 2006, the 15th Annual Conference of the Society for Risk Analysis – Europe, which took place in Ljubljana, Slovenia, on 11 – 13 September 2006, where he had the chance of presenting the ECOIL project and distributing the ECOIL leaflets and results.

Finally articles and announcements have been edited that have been published in several local newspapers in all four cities of Crete during the summer 2006 period. Following the ECOIL Conference on 30 October 2006, representative from TUC gave an interview about the ECOIL project and it's results in a local TV station in Chania. Also another article was prepared and published in a local newspaper, covering the activities of the ECOIL Conference and presenting the main conclusions that derived from it.

Further details are included in Deliverable 13 for the dissemination activities in Greece

LEIA: Details are included in Deliverable 14 for the dissemination activities in Spain.

UCY: Details are included in Deliverable 15 for the dissemination activities in Cyprus.

AGRIPOL: Representative from AGRIPOL and TUC, participated in the SIAL 2006 International Exhibition for Food Industry Professionals which took place in Paris, France, on 22 – 26 October 2006. There he presented the ECOIL project with several means,

including presentation regarding the ECOIL project and its' results in a laptop at a kiosk inside the SIAL 2006 Exhibition, distribution of the ECOIL informative material, etc. Details are included also in Deliverable 13.

Additionally, the final conference of the project took place on 30th of October in Chania, Crete. Analytical information related to the conference is provided in Deliverable 16 of the final technical report.

The dissemination activities have been carried out by all the partners, under the coordination of the beneficiary (TUC) and they were implemented according to the objectives and output as stated in the dissemination Plan. It must be mentioned that positive reactions by all the target groups were observed and they have expressed their intent to participate actively in the project, to be informed on its content, analytically and on a constant basis as well as to undertake actions for further dissemination of the project.

Finally, in this Task, special attention was paid to the training activities. These activities included training courses for all those involved in the olive oil production procedures (farmers, producers, transporters). The training focused on the results of the LCA model in the three regions and more specifically on the implementation of the suggested interventions derived and the benefits that will be obtained. Three individual training courses were organised, one in each participated country (Crete – Greece on 30/10/06, Navara – Spain on 27/10/2006 and Lytrhodontas – Cyprus on 25/01/2007). Each partner had the responsibility for the implementation of the training course in its area and analytical information is provided in the Deliverables 14, 17 and 19 of the final technical report. For the training course in Crete there were some additional developments, which are described in detail, in Deliverable 19.

8 EVALUATION AND CONCLUSIONS

Project implementation

The process

The activities of the project have been carried out according to those foreseen in the proposal and all the targets were achieved in quantitative and qualitative terms.

The project management, the problems encountered, the partnerships and their added value

As described in the first progress report, changes in the project's management structure were incurred. Partner 1, Municipality of Mantamados, Lesvos has expressed its willingness to withdraw from the project partnership. The Beneficiary believed that such a withdrawal should be reconsidered and allowed sufficient time (a couple of months) to the partner for reconsideration. The decision of the partner did not change and a written request was received by the Beneficiary in March 2005. The main reason of this withdrawal, as informally presented by the representatives of the Municipality of Mantamados, was the high work load of the personnel of the Municipality due to the new increased responsibilities deriving from the re-designation of the responsibilities of the local Authorities in Greece by the Ministry of the Interior, Public Administration and Decentralization. As explained by the representatives of the Municipality of Mantamados, the number of personnel of the Municipality is limited and therefore, it would be difficult for them to fulfil their obligations arising from their participation in the project in parallel to their new increased responsibilities.

Following such developments, the Beneficiary and the other partners (from Spain and Cyprus) agreed to accept the substitution of the Municipality of Mantamados with a new partner, the Agricultural Cooperative of Polemarchi, Municipality Department of Polemarchi, Municipality of Voukolies, Chania Prefecture in West Crete.

The arguments for such a decision are the following:

- The Municipality of Voukolies is already participating actively in the project, as the one of the main areas where the case studies will take place. The Municipality Department of Polemarchi, Voukolies, is experienced in ecological cultivation of olive trees and in quality production of ecological olive oil. Their letter of interest has already been sent from the Municipality of Voukolies and the Agricultural Cooperative of Polemarchi to the Beneficiary in September 2004
- The new partner (Agricultural Cooperative of Polemarchi: AGRIPOL) is a NGO entity and the Municipality of Voukolies is the same type of organisation as the partner that withdrew from the project (both Greek Municipalities)
- The proposed new partner expressed its willingness to participate more actively in the project, not only as a case study but undertaking and sharing senior responsibilities in core tasks of the project

The responsibilities that the proposed new partner (AGRIPOL) is willing to undertake are more than those prescribed for the partner that withdraws (Municipality of Mantamados). In particular:

- Collection of data concerning the entire cycle of olive oil production in the area of the Municipality of Voukolies, an area that produces and exports to Europe and US gross amounts of very high quality olive oil.

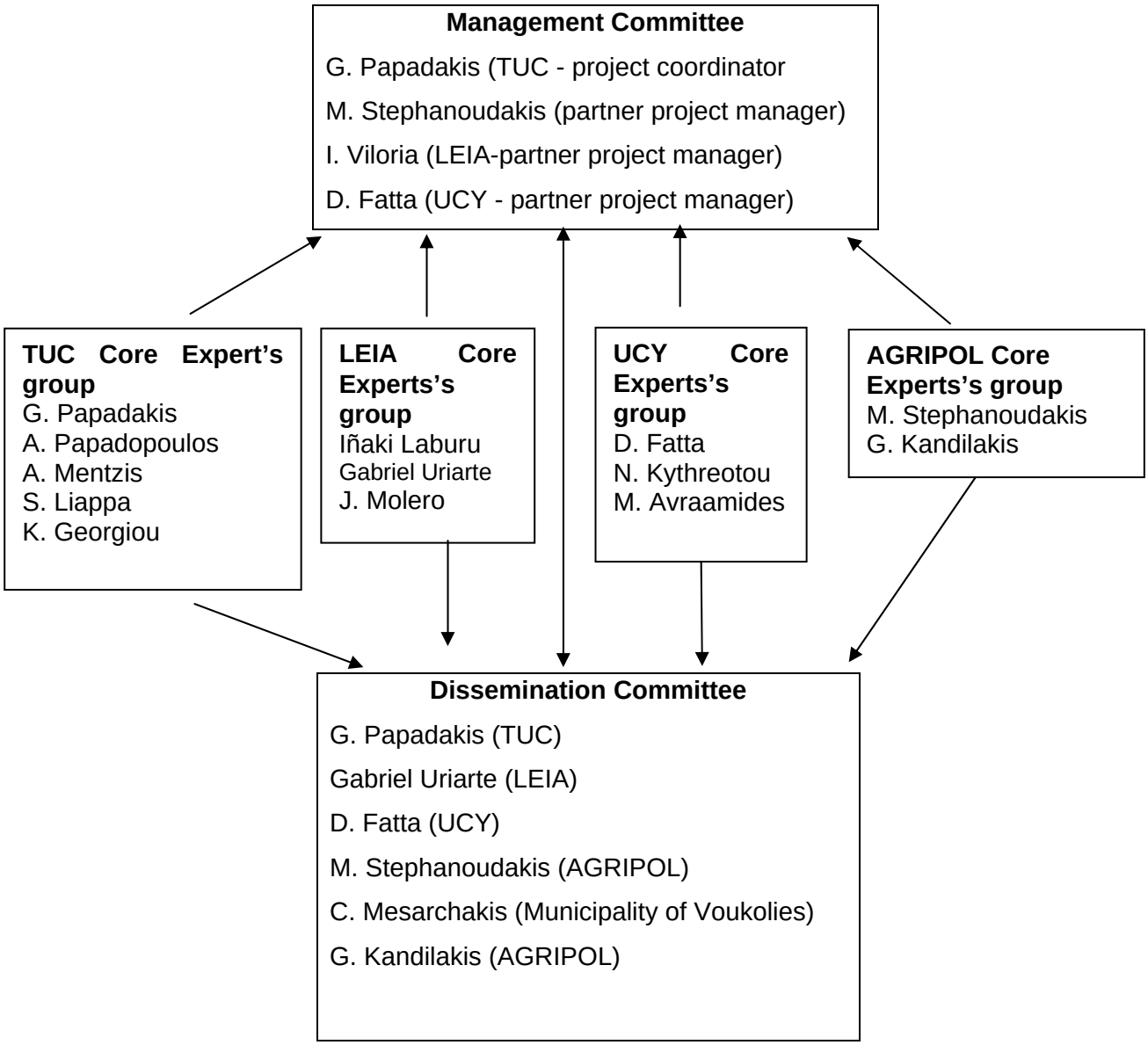
- Assessment of success stories concerning the operation of olive oil mills in an environmentally and ecologically sustainable manner
- Exchange of experience with operators from Spain and Cyprus
- Implementation of the LCA tool in the area of the Municipality where a growing interest by many olive oil producers has been recorded
- Participation in the training course that will take place in Crete
- Co-organizing with TUC and other partners the dissemination activities of the project in West and East Crete areas.

In order for the activities described in the proposal to remain the same (qualitatively and quantitatively), the case study that would have taken place in the area of the Municipality of Mantamados was substituted with a case study applied in Cyprus (in the area of the Municipality of Lythrodontas, Nicosia). As a result of this change – that was approved by the EC - the number of the case studies remained the same (three) and the project was expanded to include another Member State, Cyprus (instead of case studies at two member states we had case studies at three member states.) Furthermore, the dissemination of the project was extended since another country was involved more actively in the project. Also the dissemination activities were extended to further areas in Crete and Greece.

The total budget of the project, as well as the total own contribution of the partners and the EC contribution remained the same. In addition, no changes exceeding 10% or 10.000 Euro in a certain category of the project costs took place. The Beneficiary however proposed the transfer of money from the Beneficiary to Partner No 3 (University of Cyprus) due to the fact that this partner undertook more responsibilities and activities to carry out within the project. These increased responsibilities resulted from the addition of a case study in Cyprus (activities concerning the collection and assessment of data in the framework of the implementation of the case study, evaluation of the results of the case study and training activities in Cyprus), instead of a second case study in Greece as well as from its higher involvement in the main actions of the project (e.g. in the design and development of the LCA tool for the eco-production of olive oil, suggestions for improvement and redesign of the process, development of technical manual). The reallocation of the activities within the Beneficiary and partner 3 led to redistribution of the amount that had been foreseen for each of them individually. This redistribution of money was approved by the EC.

According to the modifications that have taken place in the partnership of the project and approved by the EC, the organigram of the project is presented below:

Informative organigram of the project:



During the project, several meetings among the partners took place. In particular:

A kick-off meeting took place on 5th of November 2004, in Athens, where the list of the key staff needed for the implementation of the project was set. Also, a detailed analysis of the project activities and the time schedule, involvement of each partner in the tasks' implementation as well as the responsibilities of each partner according to the project contract and the LIFE Common Administrative Provisions were determined. Furthermore, the activities foreseen for the project implementation were analysed and discussed. Analytical information concerning the kick-off meeting (minutes of kick-off-meeting) was given in Deliverable 1 of the first progress report.

A meeting between the members of the beneficiary's working group and the scientific responsible of the Cypriot partner was held on 05/04/2005 in Athens.

During this meeting:

i. the outcome of Task 1 (completed on 28th of February 2005) as well as the content of its deliverables were examined

ii. the work programme for the next six months was set

iii. the main characteristics and operational functions of the LCA tool were discussed (for the purposes of task 2 that is in progress)

iv. the trip to Spain (meeting with the Spanish partner and site visits) was planned to be carried out at the first week of May 2005

A managerial meeting took place in Nicosia, Cyprus (at the premises of the partner UCY) on 15th of February 2006. Details on the meeting were provided in Deliverable 1 of the second progress report). Additional managerial meeting was held in Chania, Crete (at the premises of the beneficiary TUC) on 10th of April 2006 (Deliverable 2 of the second progress report). The aim of these managerial/technical meetings was:

i. to discuss about the implementation of the technical tasks that were in progress (milestones, procedures that must be followed, difficulties that were arisen so far and ways to get over them, etc.)

ii. to ensure that the same approach in technical and scientific manner was applied by the three partners

iii. to set the time-schedule for the completeness of the remaining tasks and to allocate the work that must be undertaken by the partners, individually.

Another managerial/auditing meeting took place in Chania in the Park for the Preservation of Flora and Fauna of the Technical University of Crete on 7th June 2006. The meeting was organised in order for the ECOIL LIFE monitoring team to check the progress of the the project, and to agree with the partners the way forward for the successful completion of the ECOIL project. Details about the meeting are included in Deliverable 18.

Additionally, a technical meeting between the ECOIL project manager and representatives from the Spanish partner, LEIA, was held in Madrid on 25th September 2006. The meeting between TUC and LEIA took place for the manager to create an overall picture of the developments and to highlight the tasks to be completed for the completion of the project at the end of October 2006. Details about the meeting are included in Deliverable 18.

Finally the last managerial/auditing meeting took place in Chania on 31st October 2006. The meeting between ECOIL partners and Mrs Marouli (representative of the ECOIL LIFE monitoring team) took place at TUC administration building to create an overall picture of the developments and to highlight the completion of tasks for the reporting of the project by all partners. Analytical information about the meeting are included in Deliverable 18.

Moreover, the members of the working groups of the beneficiary and all the partners communicated and closely collaborated on a regular basis (via email and phone), in order to coordinate the actions for the effective implementation of the project.

<u>Reports that have been delivered since the start of the project:</u>

The following reports were submitted to the EC:

- First progress report of the project (first six-monthly report), covering the time period from 1.11.2004 to 30.4.2005
- Interim technical and financial report, covering the time period from 1.11.2004 to 31.10.2005
- Second progress report of the project (second six-monthly report), covering the time period from 1.11.2005 to 30.4.2006.

Finally, the project was implemented according to the proposed time – schedule and no extension of its duration needed.

Technical and commercial application (reproducibility, economic feasibility, limiting factors)

Reproducibility:

Setting, planning-design and implementation of the project is following an integrated methodology which combines:

- the assessment of existing situation concerning the legislative framework and standards about LCA and eco-efficient agricultural and industrial practices
- the identification and analysis of success stories relevant to the field under investigation
- the design and development of an appropriate prototype LCA system focused on the olive oil production procedures·
- the organization and implementation of the LCA system
- the evaluation of the results of the implementation·
- the development of suggestions for the improvement of the existing life cycle of olive oil production
- the development of a framework of specifications for the introduction of the system in other applications
- the set up of training seminars and dissemination events

These main stages of the project methodology do not respond only to ECOIL project but as a methodology could be implemented to a variety of other production processes such as fruit and vegetables canning, juice production, seed oil production, corn oil production, dairy industries, etc. Therefore, the content and outcomes of this project has a considerable reproduction potential to various industrial production sectors in any region or/and country. Furthermore, the project could be used as a guide for relative applications in all the countries producing olive oil, since its outcome based on case studies, which are representative for the entire sector of olive oil production. As a result, it could be used in all the olive oil mills in the countries participating the project (Greece, Spain, Cyprus) as well as in other countries – olive oil producers such as Italy, France and Malta. Finally, the nature of the know - how that was developed through the project as well as the well documented outcome enable the adoption of the technology by all those involved in the olive oil production procedures without problems, fact that ensures its high reproduction potential and transferability.

Economic feasibility:

The nature of the project presents a significant number of economic benefits that are vital and therefore they can compensate the economic cost of the project. The main economic cost deriving from the implementation of the main outcomes of the project referring to the investment cost in the re-design or improvement of the existing production processes and waste management practices.

The main anticipated economic benefits are the following:

- Operation of olive oil mills in an environmental friendly way/Improvement of the environmental performance of the olive oil mills/Harmonization with the EU and national policy, legislation and priorities in the field of industrial production processes: Avoidance of imputing of fines and penalties by the competent authorities for inappropriate olive mill waste treatment and disposal techniques could be achieved.
- Modernization of existing processes and systems for the production of olive oil: Reduction in operational and maintenance costs
- Production of high quality olive oil/Increase in productivity: Increase of income
- Application of optimum agricultural practices regarding olive trees cultivations (irrigation, use of biocides): Sustainable agricultural practices and increasing of the product quality, reduction in costs for application of agro-chemicals

Limiting factors:

The possible limiting factors for the technical application of the project's outcome could be overcome efficiently, taking into account the following:

- The main target groups of the project (olive tree farmers, O.O. mills owners and operators) have expressed their intent to adopt the outcome of the ECOIL project in their cultivations and premises, respectively.
- A document was prepared within the project (Task 4) that includes recommendations and guidelines for the promotion of eco-production and eco-cultivation, adaptation of the principles of the integrated product policy, as well as specific suggestions for the application of market – based instruments e.g. tradable vouchers, tax incentives, tax breaks, subsidies, deposit – refund schemes and recommendations on potential funding opportunities. This document could be used as a guide/tool for the development of the appropriate actions by the actors involved in the field.

Comparison against the project-objectives

The project was completed successfully and its outcome is in fully accordance to all the individual and overall objectives - targets set.

Effectiveness of dissemination activities

As noted at point 7.2, the dissemination activities have been implemented according to the objectives and output as stated in the dissemination Plan of the proposal. It is also mentioned that positive reactions by all the target groups were observed and they have expressed their intent to participate actively in the project, to be informed on its content, analytically and on a constant basis as well as to undertake actions for further dissemination of the project.

The future: continuation of the project + remaining threats

The main target groups of the project (olive farmers and O.O. mills owners and operators) have expressed their intent to adopt the outcome of the ECOIL project in their cultivations and premises and in particular, the recommendations and guidelines that were developed though the project for the promotion of eco-cultivation and eco-production and. It must be noted that the project focuses on the environmental problems that are observed in the sector of O.O. production and it suggests practical and well documented solutions to cope with them. The partners of the ECOIL project are examining all the potential funding opportunities in order to assist the olive farmers and olive oil producers to be provided with the necessary subsidies through existing regional, national and European funding programmes.

Analysis of long-term benefits

Environmental benefits

1. **Direct / quantitative environmental benefits (e.g. reductions of emissions, energy or resource savings)**

Within Task 3, by implementing the LCI methodology in the three areas under examination (case studies) the existing values of emissions and the energy consumptions were determined. During Task 4, the environmental impacts of the LCI results were assessed and direct comparisons both horizontally (overall hazard potential of each case study) and vertically (among similar pollutants for all case studies) will be made. The weak points in regard to the environmental burden for each case study were therefore identified. This led to the development of guidelines for the improvement of the O.O. production cycle in order to achieve the eco-production of olive oil. Specifications and guidelines for the implementation of the LCA methodology and software were also developed.

As an overall result, the reductions of emissions and energy and the resource savings that could be obtained by the re-design and the improvement of the O.O. production process were well documented in an integrated and technical way, fact that encourages the operators and the owners of the O.O. mills to proceed to the necessary actions towards to this direction.

2. **Relevance for environmentally significant issues or policy areas (e.g. industries/sectors with significant environmental impact, consistency with 6EAP or important environmental principles, relevance to the EU legislative framework (directives, policy development, etc.)**

The project focuses on production units (olive oil mills) that are characterized, in the most cases, by low operational efficiency (application of conventional production systems and practices) and low environmental performance (generation of solid waste and wastewater containing vast amount of hazardous and non biodegradable substances which are difficult to deal with). The project introduced an innovative approach, which examines the olive oil production cycle as a whole, and it led to an integrated solution concerning the weaknesses mentioned above.

Furthermore, the project methodology do not respond only to olive oil mills but as a methodology could be implemented to a variety of other production processes such as fruit and vegetables canning, juice production, seed oil production, corn oil production, dairy industries, etc.

Also, the methodology that was developed and applied through the project is based on the principles and the priorities of the EU environmental legislative framework and policy, such as: Prevention of the industrial pollution, minimization of industrial pollution,

Recover/Reuse/Recycling, Integrated Pollution Prevention and Control (IPPC), Integrated Product Policy (IPP), etc. Additionally, the outcome of the project is in complete accordance with the targets set by the European Environmental Technologies Action Plan – ETAP that focuses on the development and promotion to the market of new environmental technologies

Long-term sustainability

1. **Long-term / qualitative environmental benefits (e.g. long term sustainable technology, from product to functional focus, from end-of-pipe to prevention; high visibility for environmental problems and/or solutions; spin-off effect in other environmental areas etc.)**

The completeness of the project resulted in significant long-term environmental benefits. More specifically, the recommendations that were developed, based on the results that were obtained by the application of the LCA methodology, include the introducing of sustainable technologies in the sector of the O.O. production, such as: use of clean technologies and best available techniques in the production process, promotion of eco-production and eco-cultivation practices, adaptation of the principles of the integrated product policy, etc. This can be achieved by applying modifications in the individual production stages or/and by redesigning the entire cycle of O.O. production e.g. the switch to the use of non-chemical (biological) means during olive tree cultivations, fact that will assure the production of product of a high quality, since the quality of the product depends strongly on the quality of the raw material (olive crops), the minimization of energy requirements, the effective management of the waste/wastewater generated (appropriate treatment of wastewater, utilization of the organic solid waste for the production of compost that could be used for agricultural purposes etc.) and the switch to the application of two-phase centrifugal olive mills instead of the three-phase centrifugal mills (the two-phase olive mills have eliminated liquid wastes and water consumption while the three-phase olive mills produce both a solid and a liquid waste).

Furthermore, the outcome of the project focuses on the environmental problems that are observed in the sector of O.O. production and it suggests practical solutions to cope with them. These solutions could lead to reduction in the quantity of waste that is generated in the mills (resulting to lower cost for its management), energy savings, reduction in the operational and maintenance costs, etc. Additionally, the project provides solutions to the problems that are observed in the olive tree farming (resulting to control of the use of agro-chemicals, protection of the biodiversity, control of the use of water for irrigation purposes, increase of the productivity etc.).

Also, the project may have a spin-off effect in other industrial sectors, since the same approach could be implemented to a variety of other production processes such as fruit and vegetables canning, juice production, seed oil production, corn oil production, dairy industries, etc.

2. **Long-term / qualitative economic benefits (e.g. long-term cost savings and/or business opportunities with new technology etc., regional development, cost reductions or revenues in other sectors)**

The main long-term economic benefits that are obtained by the implementation of the project are the following:

- The improvement of the environmental performance of the O.O. mills and the harmonization with the provisions of the EU and national legislation should lead to

avoidance of imputing of fines and penalties by the competent authorities for inappropriate olive mill waste/wastewater management

- The modernization of the existing processes and systems for the production of olive oil will lead to reduction in operational and maintenance costs
- The production of high quality olive oil should lead to an increase in the quantity of product that is forwarded to the market, and consequently to an increase of the income for the owners of the mills
- The application of good agricultural practices regarding olive trees cultivations (irrigation, use of biocides) will lead to reduction in the relative cost for the farmers as well as in the protection of the environment and the public health.
- The appropriate management of the waste/wastewater generated in the mills will result to the prevention/minimization of natural recipients pollution, fact that lead to avoidance of cost for polluted sites restoration
- The technology that was developed through the project could be applied both in the entire sector of O.O production and in other industrial sector, fact that support the industrial development in regional level
- The redesign and/or the application of modifications in the industrial units will lead to the creation of new jobs (engineers and technicians, environmentalists, chemicals, etc.)

3. Long-term / qualitative social benefits (e.g. positive effects on employment, health, ethnic integration, equality and other socio-economic impact etc.)

As mentioned above, the outcome of the project could have positive effects on employment, since new jobs may be created. In particular: i. private technical companies will provide the necessary staff (engineers, technicians) for the re-design of the process and/or the materialization of the appropriate modifications in the existing systems ii. engineers and technicians will be employed by the owners of the mills in order to control and monitor the operation of the units iii. environmentalists and chemicals will be employed by the owners of the mills in order to control and monitor the environmental performance of the units and carrying out the appropriate chemical analyses and measurements, respectively.

Also, the effective and integrated management of the waste/wastewater generated in the mills will result to the prevention/minimization of natural recipients' pollution, fact that lead to the protection of the environment and the public health

Additionally, the switch to the use of non-chemical (biological) means during olive tree cultivations, will assure the production of olive oil of a high quality, fact that has a positive effect to the human health.

Furthermore, the reduction in the operational costs of the mills and the increase in their productivity will raise the income for the O.O. owners, fact that will reflect to an increase in the standard of living in a significant part of the entire population in the areas under examination (regions where the main economic activity is the production of O.O.).

Replicability, demonstration, transferability, cooperation

1. Transferability & Potential for Commercialisation, including cost-effectiveness compared to other solutions, benefits for users (e.g. improved health&labour

conditions, less nuisance to others), drivers and obstacles for replicability/reproducability, market conditions, pressure from the public, potential degree of geographical dispersion, specific target group information, high project visibility (eye-catchers), possibility in same and other sectors on local and EU level, etc.

The know-how developed through the project could be used in all olive oil producing regions and/or countries. In addition, the know-how could be implemented in any country as a guide for other industrial production activities and procedures. Furthermore, the nature of the know-how enables its easy adoption by all actors involved in the olive oil production cycle and in other industrial production processes. These facts ensure that all the actors mentioned above, could profit by the economic, environmental and social benefits that result from the application of the know-how developed (improvement of the environmental and operational performance and increase in productivity of olive oil mills, production of high quality olive oil, sustainable agricultural practices, prevention/ minimization of pollution, proper management of olive mill wastes, harmonization with EU and national environmental policy, legislation and priorities, avoidance of polluted sites restoration, reduction in operational cost). Also, the project includes the promotion of high quality and eco-efficient (or biological) olive oil. Biological olive oil has been observed to be a trend during the past years. This trend does not apply only to olive oil but is a rather generic trend involving the eco-efficient (or biological) production of several agricultural and other edible products.

All the points mentioned above, indicate that the level of transferability and reproducibility as well as the potential for commercialisation of the outcome and the results of the project are high. In addition, the project deals with a product (olive oil) that has the best properties related to human health, compared to other edible oils. As a result, the relative market conditions for the promotion of the product are significantly favourable.

Innovation

1. **Level of innovation on (inter)national level (including technology, processes, methods & tools, organisational & co-operational aspects)**

The technology, methods and tools developed through the project are characterized by high innovative level both on national and international level since:

- LCA is a novel decision support tool that has gained significant attention over the past decade in Europe. This particular tool – which has been introduced in some European laws, such as the 94/62/EC for the recycling of packaging wastes – records all environmental emissions and energy requirements during the whole production cycle of a product (or process). This recording takes place from “cradle” to “grave”, since it accounts for the time that raw materials are extracted from the earth to construct a product or used in a process as a primary material (cradle) till the time that the product is disposed of back to the earth (grave). LCA comprises 3 main parts, namely the Life Cycle Inventory part, the Impact Assessment part and the Process Optimization part. Usually, mosts LCAs include only the first part, since the other ones – especially the impact assessment part - are sometimes difficult to implement. Nevertheless, all three parts of the LCA will be performed under this project.
- The application of LCA in O.O production and within different regions of the Mediterranean area has not been implemented before, rendering it by itself an innovative approach. Results of the project will have a relative value, since comparison among LCI coefficients of the 3 different case studies will be performed. This comparison will aid in pinpointing the strong and weak points of each cycle and

identifying the processes that require most attention. Therefore, public authorities can benefit from the above, since they will be able to form the pertinent policy in that aspect of the cycle that creates the most environmental burden. For example, if the most environmentally harmful part of the cycle is the application of insecticides during olive tree cultivation, a switch to the use of non-chemical (biological) means to fight insects can be legally forced by the public authority.

- The project focuses on production units (O.O mills) that are characterized, in the most cases, by low operational efficiency (application of conventional production systems and practices), low environmental performance (generation of solid waste and wastewater containing vast amount of hazardous and non biodegradable substances which are difficult to deal with), relative high energy requirements, while the quality of the product depends strongly on the quality of the raw material (olive crops). The project introduces an innovative approach, which examines the O.O production cycle as a whole, and it will lead to an integrated solution concerning the weaknesses mentioned above.

From the data described above, it is concluded that the outcomes of the project present a high innovation level, in two main constituents: i. Development of know – how for the application of LCA procedure in a new environmental sector and ii. Introduction of know – how for a production cycle, in which the segmental solutions that have been applied up to now, did not lead to completed and integrated settlement of the operational and environmental problems that are raised.

9 AFTER-LIFE COMMUNICATION PLAN

The plan foreseen to be implemented in order to continue the dissemination of the project's results has already been set out by the working groups of the beneficiary and the partners. This plan includes the following activities and means:

- Continuous updating of the project's website with all new information related to the project subject
- Organisation of additional special dissemination events where all the actors and stakeholders involved will be invited to participate
- Visits to areas where the production of O.O is the main agricultural activity and discussion with the actors involved (these activities are implementing during the implementation of the project and they will continue after its completeness)
- Organisation of an Environmental Centre in the area of the partner 1 (Crete) through which all the actors involved in the cycle of O.O production (farmers, O.O. owners and operators, transporters) will be informed on the subject of their interest as well as on the new technologies and methods (state-of-the-art technologies and practices) that will be arise. It must be mentioned that the establishment of such a Centre has been suggested by the actors themselves and the working groups of the beneficiary (TUC) and the partner 1 (AGRIPOL) have agreed to contribute towards to this direction by providing their knowledge and their scientific background as well as by finding ways to cover the economical needs for the organisation and the operation of the Centre (through national or/and European funding programmes).

Additionally, the outcome of the project and in specific, the LCA methodology is planned to be implemented further in the three countries in order to determine and evaluate the olive

oil life cycle in other areas and provide the necessary recommendations for the improvement of the environmental performance of each case.

10 COMMENTS ON FINANCIAL REPORT

TOTAL PROJECT COSTS INCURRED

	Cost category	Total cost according to the Commission's decision* (a)	Costs incurred by 31.10.2006 (b)	%** (b/a*100%)
1.	Personnel	€ 678,000.00	€ 687,254.74	101.37%
2.	Travel	€ 58,750.00	€ 52,063.97	88.77%
3.	Outside assistance	€ 5,338.00	€ 5,338.00	100.00%
4.	Durables: total non-depreciated cost	-	-	-
	- Infrastructure sub-tot.	-	-	-
	- Equipment sub-tot.	-	-	-
	- Prototypes sub-tot.	-	-	-
5.	Consumables	€ 38,740.00	€ 35,165.35	90.77%
6.	Other costs	€ 4,000.00	€ 4,000.00	100.00%
7.	Overheads	€ 54,747.00	€ 54,747.00	100.00%
	SUM TOTAL	**€ 839,575.00**	**€ 838,569.06**	**99.88 %**

*) If the Commission has officially approved a budget modification indicate the breakdown of the revised budget

**) Calculate the percentages by budget lines: How many % of the budgeted costs are incurred by 31.10.2006

It can be seen that the incurred costs during the whole project are according to the expected costs in the whole period of two years and at normal rates as planed. No discrepancies from the planed costs for the whole project are exhibited. This is clear if we compare the incurred costs with the actual cost category budgets.

The incurred personnel costs have slightly exceeded (+1.37%) the planed personnel costs (€ 678,000.00). This was mainly due to some extra personnel costs incurred by the Spanish partner LEIA.

The incurred travel costs were somehow lower (- 11.23%) than the planed travel costs (€ 58,750.00). This was mainly due to optimisation of the number of trips, constant policy for economical fares and accommodation and also optimisation of the number of partners' personnel involved in each meeting. In addition initial travelling to Italy for data retrieval was found unnecessary and was replaced by travelling for dissemination activities. Finally, the partner AGRIPOL since it jointed the project some months after its start, incurred slightly less travel costs than planed.

The incurred consumable costs were somehow lower (-9.23%) than the planed (€ 38,740.00). This was due to scale economy at the implementation phase of the project in three regions but also due to the fact that costs related to the conference and meeting

such as room rent, meals, coffees etc. are not included in the incurred costs since are not eligible costs.

Due to delays that have taken place in the administrative procedures followed by the Research Committee of the TUC, the money of the first instalment was not available on time in order to use for covering expenses that were incurred for the purposes of the project. As a result, expenses actually incurred at the beginning of the project and in particular, expenses required for the organization of the kick-off-meeting were covered by other financial resources of the beneficiary, and they were included in the expenditures of the ECOIL project. These expenditures include: i. trips of members of the TUC working group to Athens, where the kick-off-meeting took place ii. preparation and reproduction of the material distributed in the kick-off-meeting (minutes) iii. other material distributed during the kick-off-meeting (e.g. folders) iv. room rent for the organization of the meeting v. other meeting expenses (e.g. meals, coffees etc.)

Details of all incurred costs and the documentation and accuracy of the declared costs as well as the accounting and auditing by the external auditors can be found in the financial report and the independent audit report, attached to this final report.

LIFE04 ENV/GR/110

FINANCIAL INTERIM REPORT

Covering the project activities from 01.11.2004 to 31.10.2005

Reporting Date
31/1/2007

LIFE PROJECT NAME

Life Cycle Assessment (LCA) as a Decision Support Tool (DCT) for the ecoproduction of olive oil

Data Project	
Project location	Greece, Spain, Cyprus
Project start date:	01/11/2004
Project end date:	31/10/2006
Total Project duration (in months)	24 months
Total budget	€ 839.575
EC contribution:	€ 419.787
(%) of total costs	50
(%) of elibible costs	50

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