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ΚΑΙ ΑΓΡΟΤΙΚΟΥ ΠΕΡΙΒΑΛΛΟΝΤΟΣ
Εργαστήριο Δενδροκομίας

Αποτύπωμα νερού

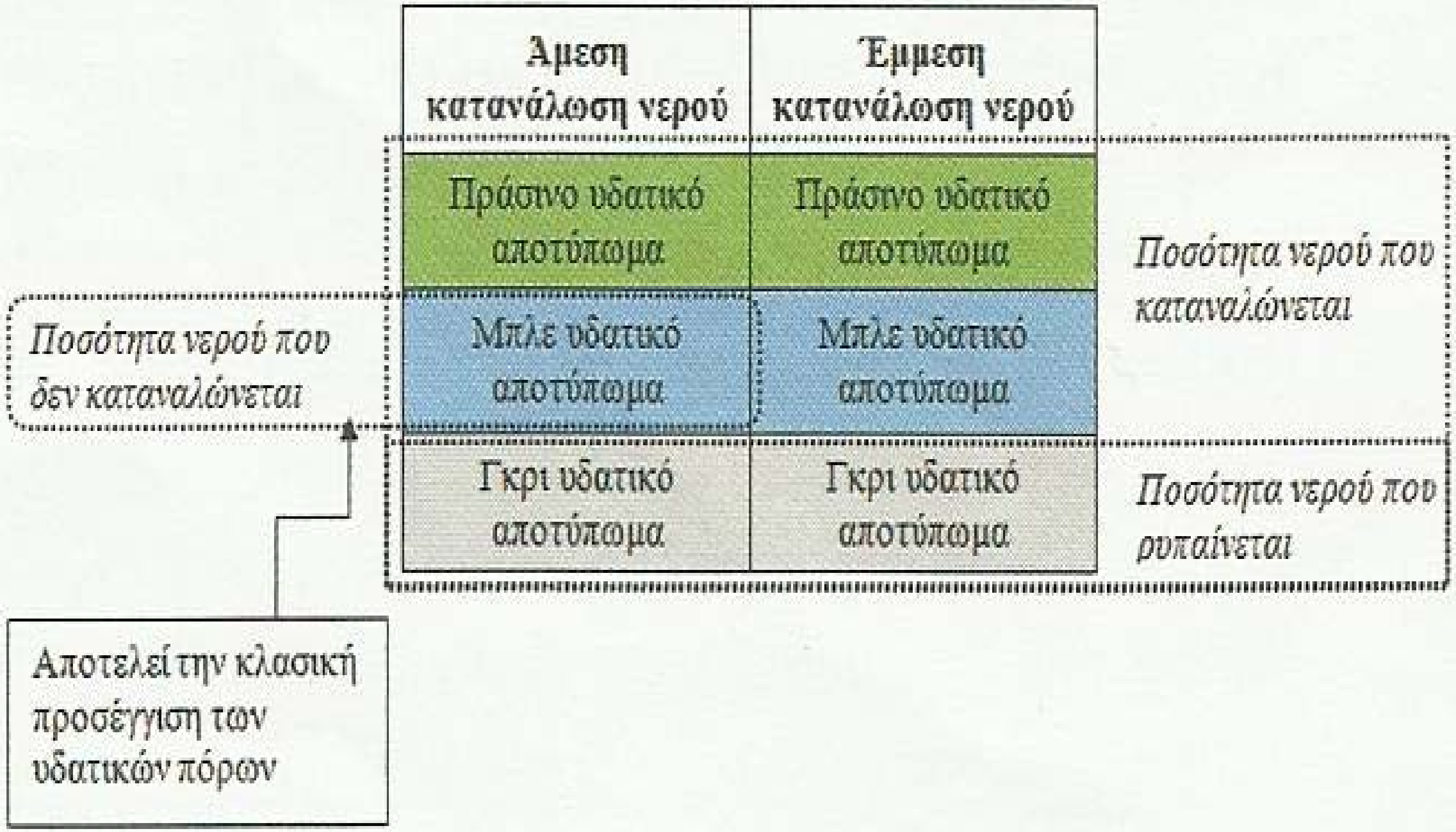
Γιώργος Δ. Νάνος

Ορισμός

- **Είναι το νερό που ξοδεύτηκε για να παραχθεί μια μονάδα προϊόντος που βρίσκεται στο ράφι ενός μαγαζιού!**
- **Σχετίζεται με την αποτελεσματικότητα χρήσης νερού (στη γεωργία), αλλά είναι όλο το νερό που χρησιμοποιείται από όλες τις διεργασίες για την παραγωγή και χρήση όλων των υλικών και πρώτων υλών έως και τη μεταφορά στο λιανεμπόριο**

Περιγραφή

- **Μπλε υδατικό αποτύπωμα: η κατανάλωση από επίγειες (λίμνες, ποτάμια) ή υπόγειες δεξαμενές νερού**
- **Πράσινο υδατικό αποτύπωμα: το νερό της βροχής που αποθηκεύεται στο έδαφος και χρησιμοποιείται από τα φυτά (αύξηση ΟΟ, αυξάνει το πράσινο νερό) (δεξαμενές συλλογής βρόχινου νερού;)**
- **Γκρίζο υδατικό αποτύπωμα: το νερό που απαιτείται να αποφορτίσει τους παραγόμενους ρύπους της όλης διαδικασίας**



Διαφορετικές προσεγγίσεις για τη διαχείριση των υδατικών πόρων.

Πειραματικά (JCP 28:113, 2012)

• **Κολοκύθα βιολογική ή ολοκληρωμένης ή μεγάλη εκμετάλλευση.**

•**Ελάχιστη φυτοπροστασία.**

• **Μπλε νερό (Λίτρα ανά κιλό κολοκύθας) για άρδευση και πλύσιμο προϊόντος (όχι για τις υπόλοιπες διεργασίες έως τον καταναλωτή!): 0,4 στην ολοκληρ., 0,9 στη βιολογική, 9 στη μεγάλη εκμετάλλευση.**

Τι άλλα ‘νερά’ διαθέτουμε;

- **Μεγάλες ποσότητες ‘γκρι’ νερού από βιομηχανίες (Απόβλητα; Βιολογικός καθαρισμός;)**
- **Απόβλητα ελαιουργείων**

Όταν το 'μπλε' νερό λίγο;

- **Αποδοτικότερη χρήση στις υπάρχουσες καλλιέργειες**
- **Αλλαγή καλλιεργειών ή αλλαγή εποχής καλλιέργειας (μπορώ να χρησιμοποιήσω περισσότερο 'πράσινο' νερό στην καλλιέργεια μου;**

ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΕΣΣΑΛΙΑΣ
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Εργαστήριο Δενδροκομίας

Ανάλυση Κύκλου Ζωής (Life Cycle Assessment)

Γιώργος Δ. Νάνος

ΑΚΖ ορισμός

- **Ανάλυση Κύκλου Ζωής ενός προϊόντος, π.χ. ενός μήλου, είναι η σφαιρική εξέταση όλων των δραστηριοτήτων που σχετίζονται με αυτό, ξεκινώντας από το πώς γίνονται τα εφόδια για την παραγωγή του (π.χ. τα ορυχεία για τις πρώτες ύλες των λιπασμάτων) μέχρι την κατανάλωση του, αλλά και πολύ μετά μέχρι να εξαϋλωθεί το μέσο συσκευασίας του. Cradle to Grave.**
- **Έτσι ένα προϊόν πια έχει το περιβαλλοντικό του αποτύπωμα (επιβάρυνση στο περιβάλλον) …**

Βάση αναφοράς

- **Το ISO 14040:2006 (και τα παλιότερα 14041, 14042, 14043) και το PAS 2050 (2008), ISO 14064**

- **Υπάρχουν software (SimaPro) για τον υπολογισμό της κάθε εξειδίκευσης**

LCA ΕΞΕΙΔΙΚΕΥΣΕΙΣ Ανάλυσης Κύκλου Ζωής

1 Abiotic Resource Depletion

This impact category indicator is related to extraction of scarce minerals and fossil fuels. The Abiotic Depletion Factor (ADF) is determined for each extraction of minerals and fossil fuels based on the remaining reserves and rate of extraction. It is based on using the equation, Production/(Ultimate Reserve)2 and comparing this to the result for Antimony (Sb), which is used as the reference case. The reference unit for abiotic depletion is therefore kg Sb equivalent.

2 Acidification

Acidic gases such as sulphur dioxide (SO_2) react with water in the atmosphere to form "acid rain", which can cause ecosystem impairment. Acidification Potential (AP) is expressed using the reference unit, kg SO_2 equivalent. The revised method only accounts for acidification caused by SO_2 and NO_x.

3 Climate Change

Climate change is caused by the release of "greenhouse gases" such as carbon dioxide (CO_2). The characterisation model as based on factors developed by the UN's Intergovernmental Panel on Climate Change (IPCC). Factors are expressed as Global Warming Potential over the time horizon of 100 years (GWP100), measured in the reference unit, kg CO_2 equivalent.

4/5 Ecotoxicity to Freshwater and Land

The emission of some substances can have impacts on ecosystems. Ecotoxicity Potentials are calculated with the USES-LCA6 which is based on EUSES7, the EU's toxicity model. This provides a method for describing fate, exposure and the effects of toxic substances on the environment. Characterisation factors are expressed using the reference unit, kg 1,4-dichlorobenzene equivalents (1,4-DB)/kg emission, and are measured separately for impacts of toxic substances on: *Fresh-water aquatic ecosystems or Terrestrial ecosystems*

Characterisation factors are also available for marine ecotoxicity, and ecotoxicity to marine and fresh water sediments. The sedimentary ecotoxicity factors are not included within the CML baseline characterisation factors and there are concerns within the LCA community over the marine ecotoxicity category, with regard to the impact of hydrogen fluoride and the normalisation figures. As a result we do not propose to use these three categories.

6 Eutrophication

Nitrates and phosphates are essential for life but increased concentrations in water can encourage excessive growth of algae, reducing the oxygen within the water and damaging ecosystems. Eutrophication potential is based on the work of Heijungs (1992), and is expressed using the reference unit, kg PO4 equivalents.

7 Human Toxicity

The emission of some substances can have impacts on human health. Characterisation factors, expressed as Human Toxicity Potentials (HTP), are calculated using USES-LCA, as with Ecotoxicity, which describes fate, exposure and effects of toxic substances for an infinite time horizon. For each toxic substance HTPs are expressed using the reference unit, kg 1,4-dichlorobenzene (1,4-DB) equivalents. Indoor air quality and its effect on human health is not covered by this category.

8 Photochemical Ozone Creation (Summer Smog)

In atmospheres containing nitrogen oxides (NOx, a common pollutant) and volatile organic compounds (VOCs), ozone can be created in the presence of sunlight. Although ozone is critical in the high atmosphere to protect against ultraviolet (UV) light, at low level it is implicated in impacts as diverse as crop damage and increased incidence of asthma. Photochemical Ozone Creation Potential (POCP, also known as summer smog) for emission of substances to air is calculated with the United Nations Economic Commission for Europe (UNECE) trajectory model (including fate), and expressed using the reference unit, kg ethene (C2H4) equivalents/kg emission.

9 Stratospheric Ozone depletion

Damage to the ozone layer by chlorinated and brominated chemicals increases the amount of harmful UV light hitting the earth's surface. The characterisation model has been developed by the World Meteorological Organisation (WMO) and defines ozone depletion potential of different gases relative to the reference substance chlorofluorocarbon-11 (CFC-11), expressed in kg CFC-11 equivalent.

10 Solid Waste

The impact from emissions and infrastructure associated with waste disposal, for example, the emissions associated with landfill, incineration and composting. However, this will not cover other environmental issues associated with landfilling such as dust, noise and odour, and the loss of resource implied by the final disposal of waste. We feel these issues must be accounted for within the Methodology. Other characterisation methodologies, for example the Dutch EcoIndicator and the Swiss Ecopoints, use the mass of solid waste as a category. Any waste that is finally disposed of in landfill will be measured. Waste that is incinerated will not be included within this category, but any resulting waste (eg ash) that needs to be landfilled will be included. No differentiation will be made between hazardous, inert or organic wastes, though different impacts from these routes will be included within the waste treatment models (landfill, incineration and composting) for these wastes.

11 Radioactivity

Radioactivity can cause serious damage to human health, and as yet, no treatment or secure storage location exists for higher level radioactive wastes, such as that generated by the nuclear power industry and from decommissioning nuclear power stations. Such wastes need to be stored for periods of up to 1,000 years before their radioactivity reaches safe levels. The World Nuclear Association states that higher level nuclear waste (high and intermediate level waste) accounts for a very low percentage of nuclear waste, around 10% by volume, but 99% of its radioactivity.

Other characterisation methods, such as the Swiss Ecopoints, use the volume of highly active radioactive waste as a category, measured in m3 of spent fuel, high and intermediate level radioactive waste.

12 Minerals Extraction

Although the Abiotic Resource Depletion category covers mineral ores extracted from the ground, minerals such as sand, limestone and granite are such widely available resources that, even at the high current levels of extraction, there is not an issue of scarcity of resource.

However, we feel that there are considerable environmental impacts associated with minerals extraction not covered by the resource depletion issue. This view is shared by the UK government, which has introduced an aggregates levy, which is a tax on primary sand, gravel and rock that has been extracted from the ground and dredged from the sea. We suggest this impact category to address the environmental damage caused by these activities in the form of noise, dust and loss of biodiversity.

We, therefore, propose that, as with the existing Environmental Profiles Methodology, an impact category for minerals extraction is included. This would be based on each tonne of mineral extracted (including overburden) and would be a proxy for the noise, dust and biodiversity impacts, and problems with subsidence and spoil associated with quarrying and mining.

As the extraction of scarce minerals with abiotic resource depletion factors also causes quarrying impacts, this minerals extraction impact will also apply to them but this is not double counting as two distinct environmental impacts are being considered.

13 Water extraction

Around the world, water is becoming an increasingly scarce resource, due to increased demand, and changes in patterns of rainfall. To recognise the value of water as a resource, and the damage that over extraction from rivers and aquifers can cause, BRE propose to refine their existing water extraction category.

The category would therefore include all water extraction, except:

- Sea water
- Water extracted for cooling or power generation and then returned to the same source with no change in water quality (water lost through evaporation would be included in the category)
- Water stored in holding lakes on site for recirculation (top-up water from other sources would be included)
- Rainwater collected for storage on site

The category would be measured using m3 of water extracted.

Πως υπολογίζω πόσο αρνητικό αποτέλεσμα θα έχω από μια ενέργεια:

Τριπλέτα: Aspect → Impact → Endpoint

Use of fertilizers → **Pollution by ammonia** → **Air**

Impact Significance = P x (L + I + A + C)

where:

P (0-100) = The probability that the impact will occur

L (0 or 5) = Violation of legal requirements (L=5) or not (L=0) if the impact will occur

I (0 - 5) = Expected intensity of the impact (I = 0 means negligible, and I = 5 means extreme)

A (0 - 5) = Area that will be affected by the impact (A=0 when it will be restricted only to the area of the activity, while 5 = very broad diffusion of the impact, even to the stratosphere).

C (0 – 5) = Cost to recover the previous status, or correction cost (C=0 is when natures recovers spontaneously and fully, while 5 is a long term effect, costly to bring back to previous state).

The parameters that have been identified as contributing to this triplette are the following.

a. Type of fertilizer

b. Time between application and rain

c. Temperature post-application

d. Soil ion exchange

e. Soil pH

To predict the significance of the impact under the circumstances highlighted in the table below, it is supposed that fertilizer rate of use is within reasonable limits, i.e. no surplus conditions are created. (values are only indicative):

	Value Classes		
Parameters: Weight	Low (Best)	Medium	Low (Worst)
a. Type of fertilizer	No Ammonia	Ammonia	Ammonia+Urea
b. Time between application and rain	Within 24 hours	1-4 days	>4-7 days
c. Temperature post application	<10C	10C-20C	>20C
d. Soil ion exchange capacity (meq/100gr)	>18	12-18	<12
e. Soil pH	6-8	5-6 ή 8-8,5	<5 or >8,5

In the above example the values of a worse case scenario could be:

P = 100% probability of pollution as the farmer is a user of ammonia+urea containing fertilizer

L = 0 as there is no law against using it.

I = 3 i.e. intermediate intensity, as it is used in cool and rainy period but in soil with low IAC,

A = 5 as ammonia can be broadly diffused at this temperature, and

C = 5 for Cost. As there is no way that the farmers can reverse the diffusion of ammonia in air

The quantification of impact's significance is 100*(0+3+5+5) = **1300 points, i.e. quite high.**

The conclusion is that the tradition of the farmer to use ammonia or urea containing fertilizers in early spring causes a significant impact. An improvement objective for the specific parcel would be to reduce the fertilizer gradually and use appropriate quantities later.

The advisor can propose alternative plant nutrition / fertilizer method that can be tested by the farmer, so that pollution will be systematically nullified.

The advisor has to combine the objective of reduction of pollution with the improvement of economic efficiency of plant nutrition. So, it is not simply a replacement of one fertilizer with another one but a holistic review of plant nutrition.

Σκεφτείτε

- **Η ΑΚΖ ενός μήλου είναι από την παραγωγή έως και τη διάθεση με όλα τα άλλα πριν και μετά που σχετίζονται με το περιβάλλον. Για τον άνθρωπο όμως;**

- **Αλλά η ΑΚΖ για την παραγωγή ενός δέντρου πάρκου για σκιά είναι ένα πράγμα όπως ανωτέρω. Τη χρήση του κατά την ανάπτυξη για σκίαση, απορρόφηση C, συλλογή ρύπων, μείωση ψύξης των κτιρίων, ευεξία ανθρώπων, υγεία κ.λπ., πως τα μετράς;**

Από άρθρο ανασκόπησης (έως 2008)

- **Κατέγραψαν τις εργασίες που είχαν γίνει έως το 2008 και με ποιο αντικείμενο περιβαλλοντικής ανάλυσης είχαν καταπιαστεί στη Δενδροκομία.**

Οι εργασίες περιείχαν ένα από τα 4 κατωτέρω αντικείμενα

Development of methodology. The objective of these studies is to develop methodology and create a common analytical base which can be used to assess the environmental impact of fruit production. These studies are usually more important in terms of methods and protocols than direct results.

Environmental profiling. These studies aim at assessing the environmental profile of a study crop in a specific region by examining a number of orchards (or farms) that are representative of the region. The main result is quantification of the ecological burden for the study crop and often an analysis of aspects of the production system which can be improved in order to improve environmental performance.

Comparison of agronomic protocols. The objective of these studies is to evaluate the environmental performance of different agricultural practices in the fruit sector. The studies mainly compare conventional, integrated and organic fruit production. This comparison is often made on experimental orchards or representative farms.

Domestic versus imported fruit. The objective of these studies is to compare fruit produced locally with fruit produced elsewhere and transported to the site of consumption. These studies discriminate between the impacts generated in the production phase and in the distribution and commercialisation phase, i.e. transportation and packaging.

Life Cycle Assessment (LCA): defined by ISO standard (ISO14040:2006) as the compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle. The origin of LCA can be found in the late 1960s within an American industrial context (Hunt and Franklin, 1996) and numerous studies have been carried out in order to adapt this method to the agricultural sector (Audsley et al., 1997). Nowadays, LCA is considered a useful tool in order to compare alternative food products, processes or services, and as background for environmental product declaration (Schau and Fet, 2008). The results of an LCA are commonly presented as impacts in a range of different impact categories such as global warming, acidification, nitrification, ozone depletion, toxicity, etc. (Pennington et al., 2004). However, as an optional step of the analysis these categories can be weighted against each other to produce an indicator of the total impact of a given amount of product.

Ecological Footprint Analysis (EFA): introduced by Rees (1992) and further developed by Wackernagel and Rees (1996). This method leads to an aggregated indicator which quantifies the total area of the terrestrial and aquatic ecosystems necessary to supply all resources utilised and to absorb all resultant emissions involved in the production of particular products. The indicator is considered an ecosystem-based index (Singh et al., 2009) because it is a composite index of different ecological parameters. As EFA results are both scientifically robust and easy to understand by non-experts, the method is a useful pedagogic instrument to make our dependence on ecosystems visible (Cuadra and Bjorklund, 2007).

Emergy Analysis (EM): the emergy concept was formalised by Odum (1988) and it represents all the work which has to be carried out by the environment and human labour to sustain a certain system and produce a given unit of product. This method is also called emergy accounting and it uses the thermodynamic basis of all forms of energy and materials, converting them into equivalents of one form of energy, usually sunlight (Odum, 1996). The result of this analysis shows how much a certain activity drains a system of energy (Cuadra and Bjorklund, 2007) and indicates the sustainability of a production system in a thermodynamic framework. Thus, EM is considered one of the most appropriate approaches for analysing the systems that are at the interface

between natural and human systems (e.g. Bastianoni et al., 2001).

Energy Balance (EB): produces an indicator from an energy input-output analysis of a system and results in a measure of the energy efficiency of the system. The main principle of this method is that efficient use of energy is one of the main requirements of sustainable agriculture (e.g. Strapatsa et al., 2006; Guzmán and Alonso, 2008). The EB is commonly used to indicate ways to decrease energy inputs and increase energy efficiency without impairing the economics of crop production (Kaltsas et al., 2007). Thus, energy efficiency is frequently used in combination with other environmental or economic indicators in order to obtain the

best management strategies.

Table 1

List of all papers presenting applications of environmental indicators in orchards since August 2010 from ISI Journal and conferences. Indicators considered are: Life cycle assessment (LCA); Ecological footprint analysis (EFA); Emergy analysis (EM); Energy balance (EB). Country category considers the area of the study and not necessarily the origin of the research group. The dataset column shows the kind of dataset, with the number of farm or scenarios considered in brackets. In boundaries, different kinds of limitation of the system are considered; cradle-to-gate* refers to a cradle-to-gate scenario, but considers the final product at the gate (e.g. juice or oil); cradle-to-market (int) considers a cradle-to-market scenario with an international market. Other information about the orchards include: cg = capital goods, n = nursery, p = plantation of the orchard, d = destruction of the orchard.

	Reference	Product	Country	Indicator	Dataset	Reference flow	Boundaries
Methodological issues	Mouron et al., 2006	Apple	Swiss	LCA	Commercial orchards (12)	Land based (FU = ha); Receipt based (FU = $)	Cradle-to-gate (cg)
	Cerutti et al., 2010	Nectarine	Italy	EFA	Commercial orchards (1) + validation	Mass based (gha/t)	Cradle-to-gate (n,p,d,cg)
	Strapatsa et al., 2006	Apple	Greece	EB	Commercial orchards (26)	Land based (GJ/ha)	Cradle-to-gate (cg)
	Panzieri et al., 2002	Cherry	Italy	EM	Commercial orchards (3)	Land based (seJ/ha)	Cradle-to-gate (cg)
Regional/National profile	Mila i Canals et al., 2006	Apple	New Zealand	LCA	Commercial orchards (3) + validation	Mass based (FU = t)	Cradle-to-market (int)(cg)
	Soler-Rovira and Soler-Rovira, 2008	Apple	Spain	LCA	Literature and other databases	Land based (FU = ha); Mass based (FU = t)	Cradle-to-market (int)
	Williams et al., 2008	Strawberry	UK, Spain	LCA	Literature and other databases	Mass based (FU = t at distribution)	Cradle-to-market (int)
	Coltro and Mourad, 2009	Orange	Brazil	LCA	Commercial orchards (30)	Mass based (FU = t)	Cradle-to-gate
	Yusoff and Hansen, 2007	Palm oil	Malaysia	LCA	Literature and other databases	Mass based (FU = t final product)	Cradle-to-gate* (n)
	Cuadra and Bjorklund, 2007	Pineapple	Nicaragua	EFA; EM	Commercial orchards (3) + validation	Land based (gha/ha; seJ/ha); Energy based (gha/Gcal); Receipt based (gha/$)	Cradle-to-market (p,cg)
	Mohammadi et al., 2010	Kiwifruit	Iran	EB	Commercial orchards (86)	Energy based (MJout/MJin); Mass based (MJ/kg); Receipt based (MJ/$)	Cradle-to-gate
	Kizilaslan, 2009	Cherry	Turkey	EB	Commercial orchards (87)	Land based (MJ/ha)	Cradle-to-gate
Comparison agro-techniques	Niccolucci et al., 2008	Grape	Italy	EFA	Commercial orchards (2)	Mass based (gha/t); Land Based (gha/ha)	Cradle-to-market (p,cg)
	Reganold et al., 2001	Apple	Washington	EB	Experimental field	Land based (MJ/ha)	Cradle-to-gate
	Pizzigallo et al., 2008	Grape	Italy	LCA; EM	Commercial orchards (2)	Mass based (FU = t final product; seJ/t)	Cradle-to-gate* (p,cg)
	de Barros et al., 2009	Banana	Guadalupe	EM	Commercial orchards (8)	Land based (seJ/ha)	Cradle-to-market (p)
	Kaltsas et al., 2007	Olive	Greece	EB	Commercial orchards (24)	Land based (MJ/ha)	Cradle-to-gate (cg)
	Sanjuán et al., 2005	Orange	Spain	LCA	Literature and other databases	Mass based (FU = kg)	Cradle-to-gate
	Gundogmus, 2006	Apricot	Turkey	EB	Commercial orchards (20)	Land based (MJ/ha)	Cradle-to-gate
	Guzmán and Alonso, 2008.	Olive	Spain	EB	Commercial orchards (241)	Land based (GJ/ha); Energy based (GJout/GJin); Mass based (GJ/l)	Cradle-to-gate*
	La Rosa et al., 2008	Orange	Italy	EM	Commercial orchards (4)	Mass based (seJ/g)	Cradle-to-gate
	Liu et al., 2010	Pear	China	LCA	Commercial orchards (5)	Mass based (FU = t)	Cradle-to-market
Domestic versus Imported	Mila i Canals et al., 2007	Apple	UK, New Zealand	EB	Literature and other databases	Mass based (FU = kg)	Cradle-to-market (int)
	Blanke and Burdick, 2005	Apple	Germany, New Zealand	EB	Literature and other databases	Mass based (FU = kg)	Cradle-to-market (int)

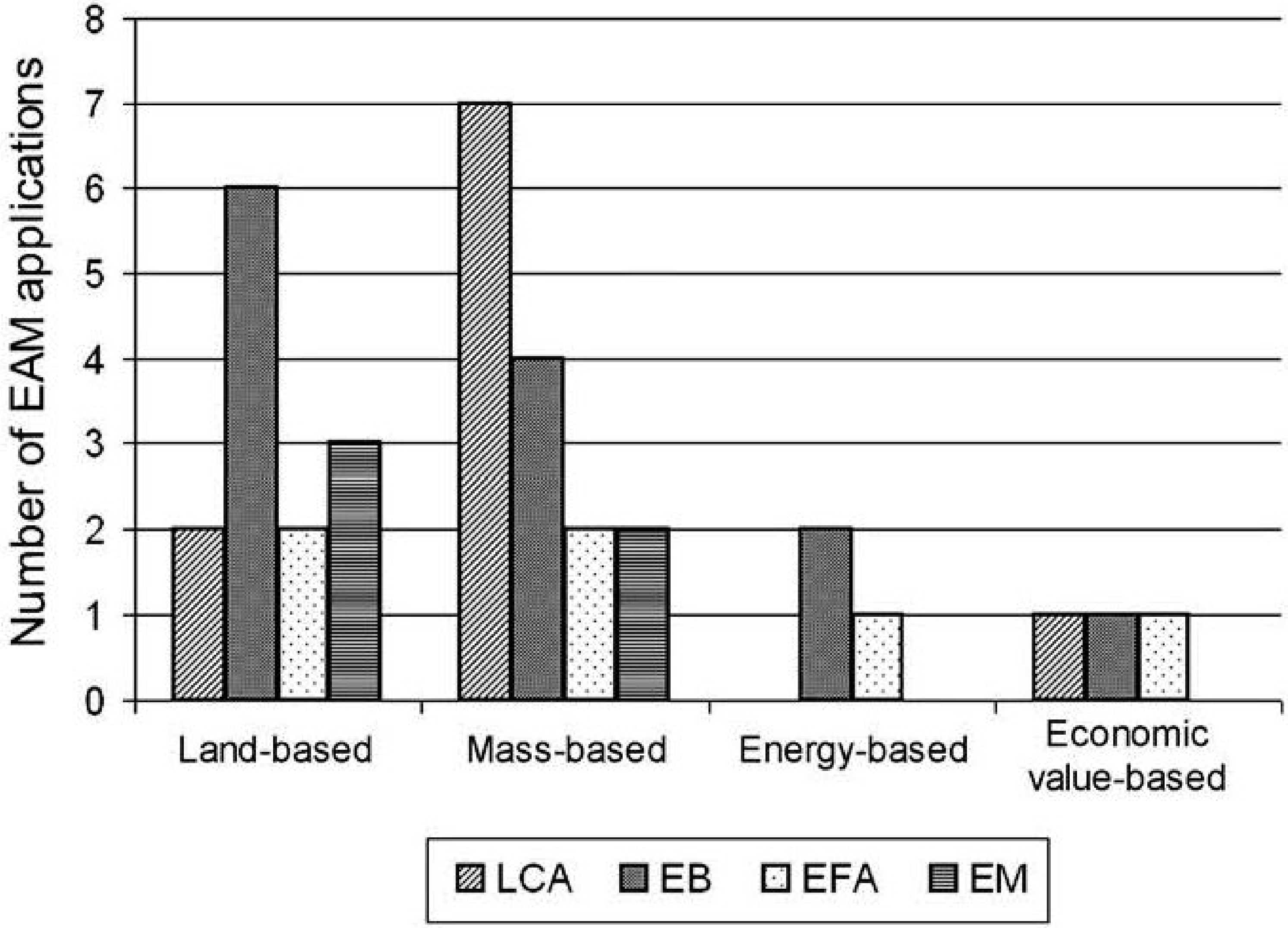


Fig. 1. Distribution of the four functional unit categories (land based, mass based, energy based and economic value-based) in each of the environmental assessment methods studied.

ΑΚΖ Ελιά ελαιοποίησης, Κύπρος

(JCP 16:809-821, 2008)

Table 1
Specification of the system characteristics

Process	Process characteristics considered in the system
Planting the olive trees	Transportation by pickup van, water use
Soil management	Operation of chisel plough attached to agricultural tractor (average soil management frequency of 2.18 operations per year)
Field water supply and irrigation	Operation of electricity generators, electric turbine pumps and sprinkler systems, water use
Fertilisation	Application of 20-10-10 compound fertiliser by hand, water use
Fertiliser production and transportation	Production of ammonium nitrate, ammonium sulphate, monoammonium phosphate, diammonium phosphate and potassium sulphate, transportation by freight ship, lorry and pickup van
Pruning and residue management	Operation of hand-held petrol chainsaw (average frequency: 0.74 per year per tree), pruning residue burned in open fires, manual ash disposal to agricultural land
Pest control	Application of dimethoate based pesticides, operation of compressed air sprayers
Pesticide production and transportation	Production of dimethoate, mixing with inactive ingredients, transportation by freight ship, lorry and pickup van
Weed control	No herbicides included in the system
Collection of olives	Operation of hand-held pneumatic combs
Transportation of olives to processing plant	Transportation by pickup van
Supply of electricity to processing plant	Electricity generation in oil-fuelled power stations
Water supply for processing unit	Operation of pump stations
Water treatment	Water use, operation of plant, production and transportation of treatment chemicals (chlorine, aluminium sulphate, polyelectrolyte)
Olive purification	Operation of conveyor belt, washing machine and electronic scale, purification residue waste stream
Olive grinding and malaxing	Operation of conveyor belt, grinder and mixing vat, water heating
Olive oil extraction	Operation of decanter, separator and pumps, disposal of liquid waste into evaporation pond, part-utilisation of pomace as fuel for boiler furnace, residual pomace waste stream
Olive oil storage	No fuel or energy consumption for storage operation

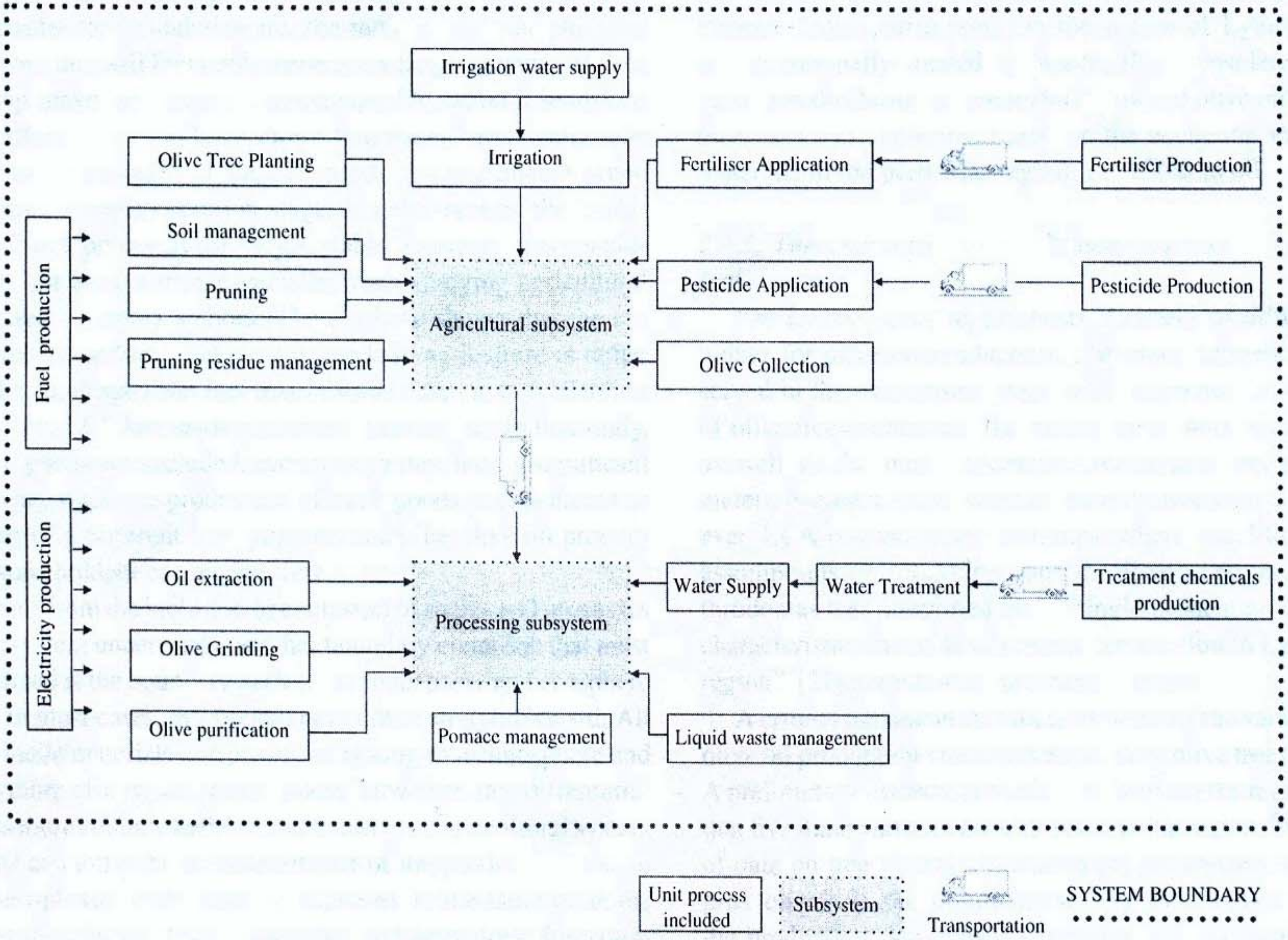


Fig. 1. Schematic presentation of the system under study.

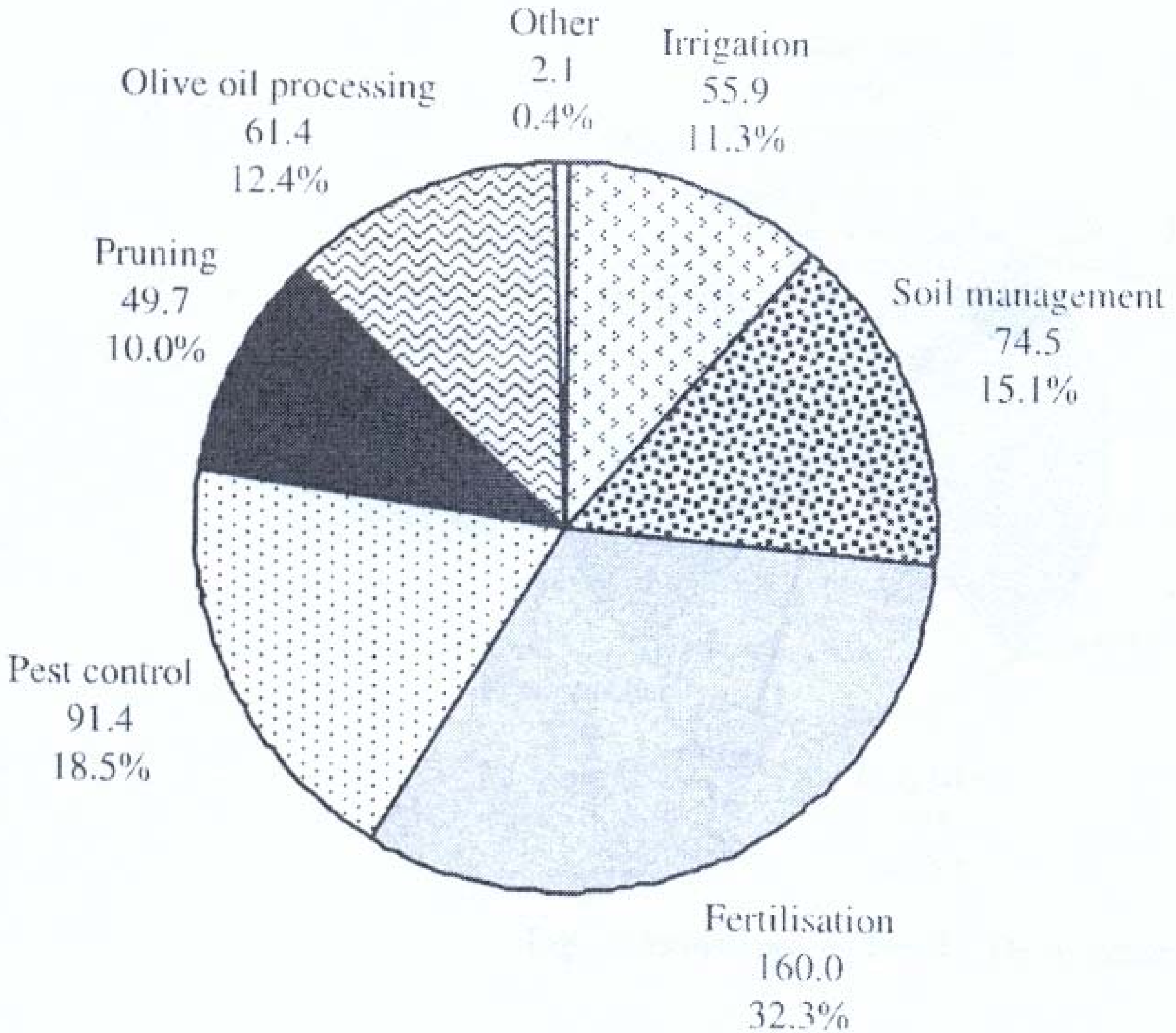


Fig. 2. Crude oil consumption in grams and % process contribution to overall consumption.

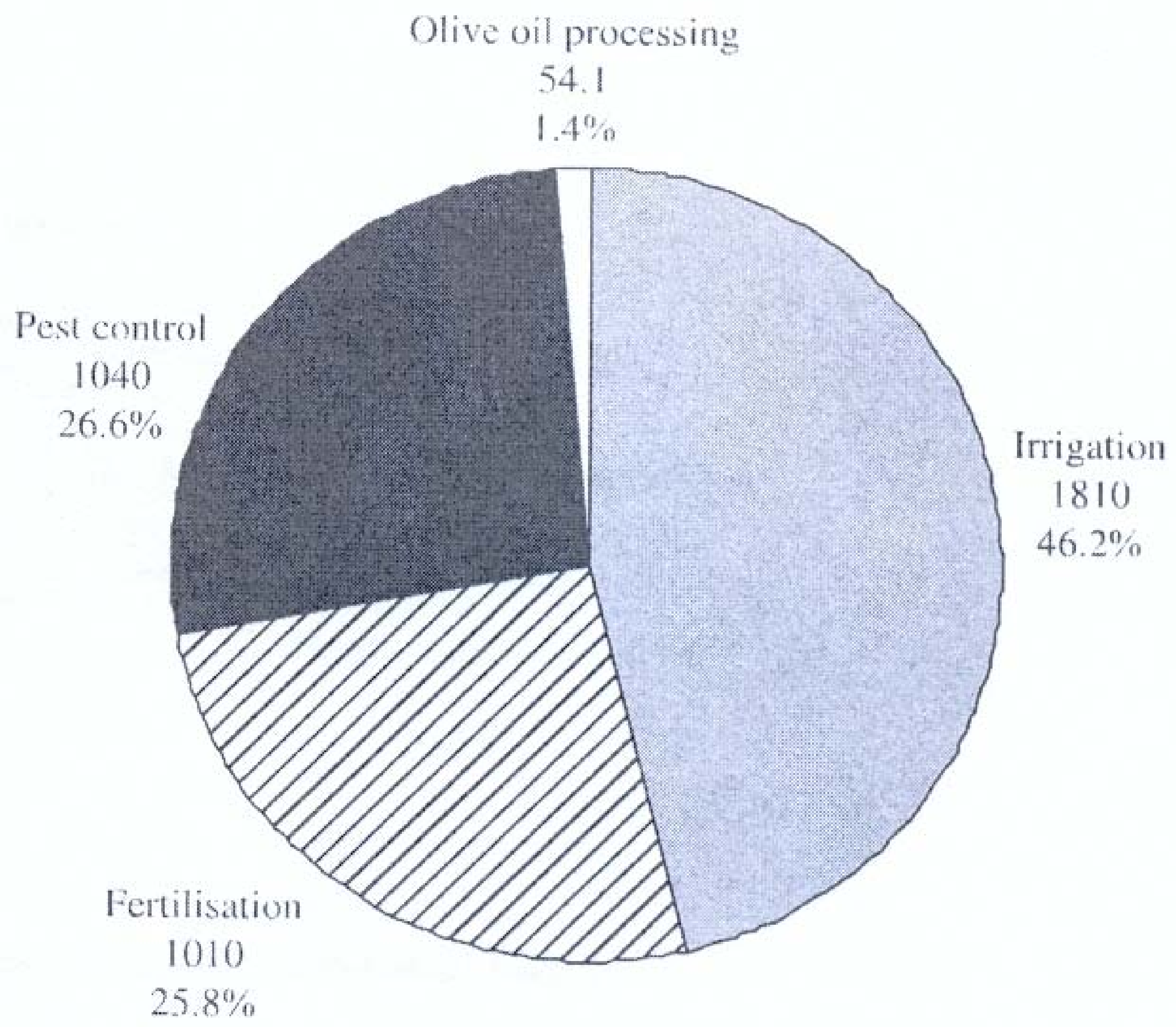


Fig. 3. Fresh water consumption in litres and % process contribution to overall consumption.

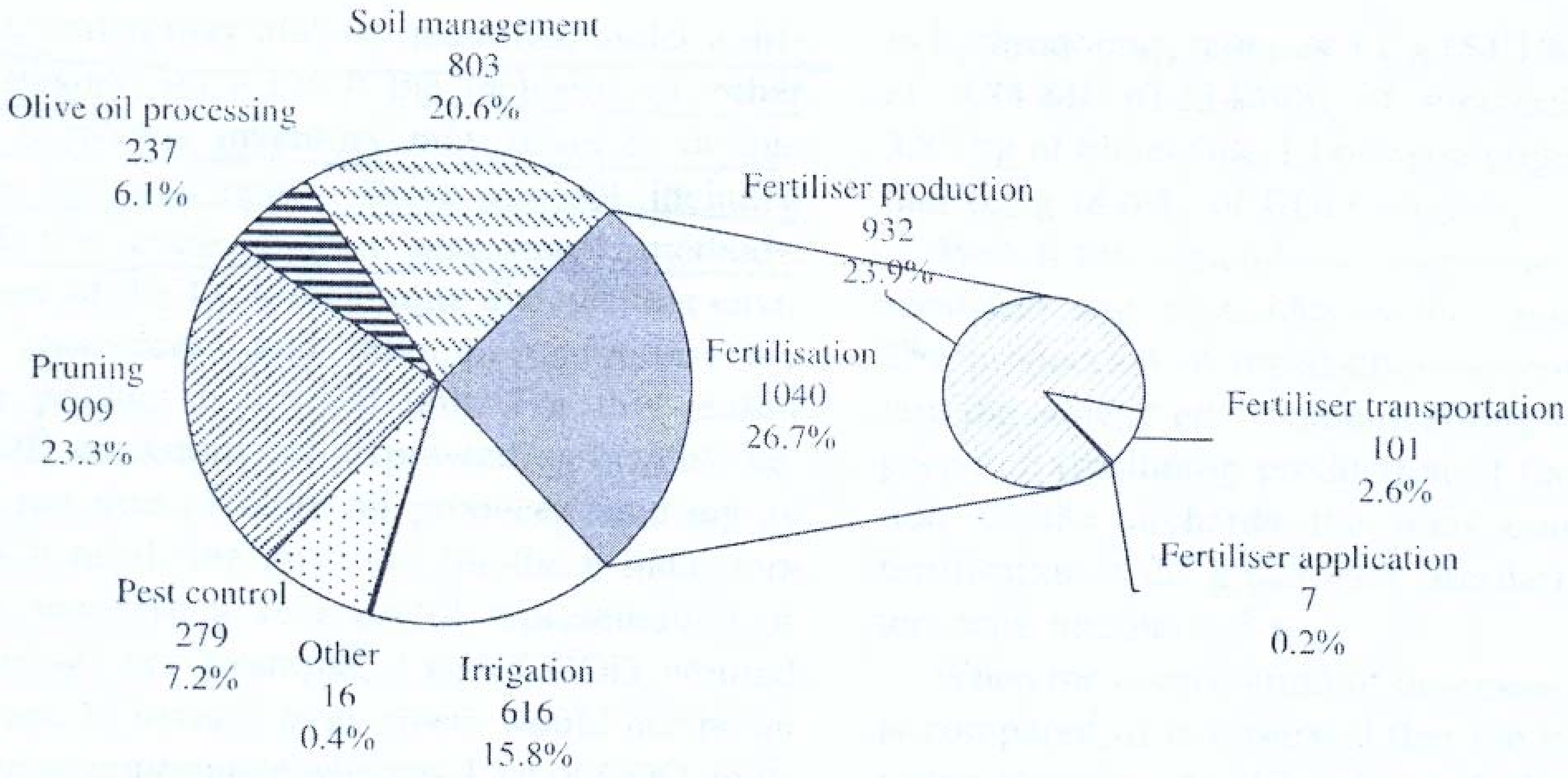


Fig. 4. Emissions of fossil CO_2 in grams and % process contribution to overall load.

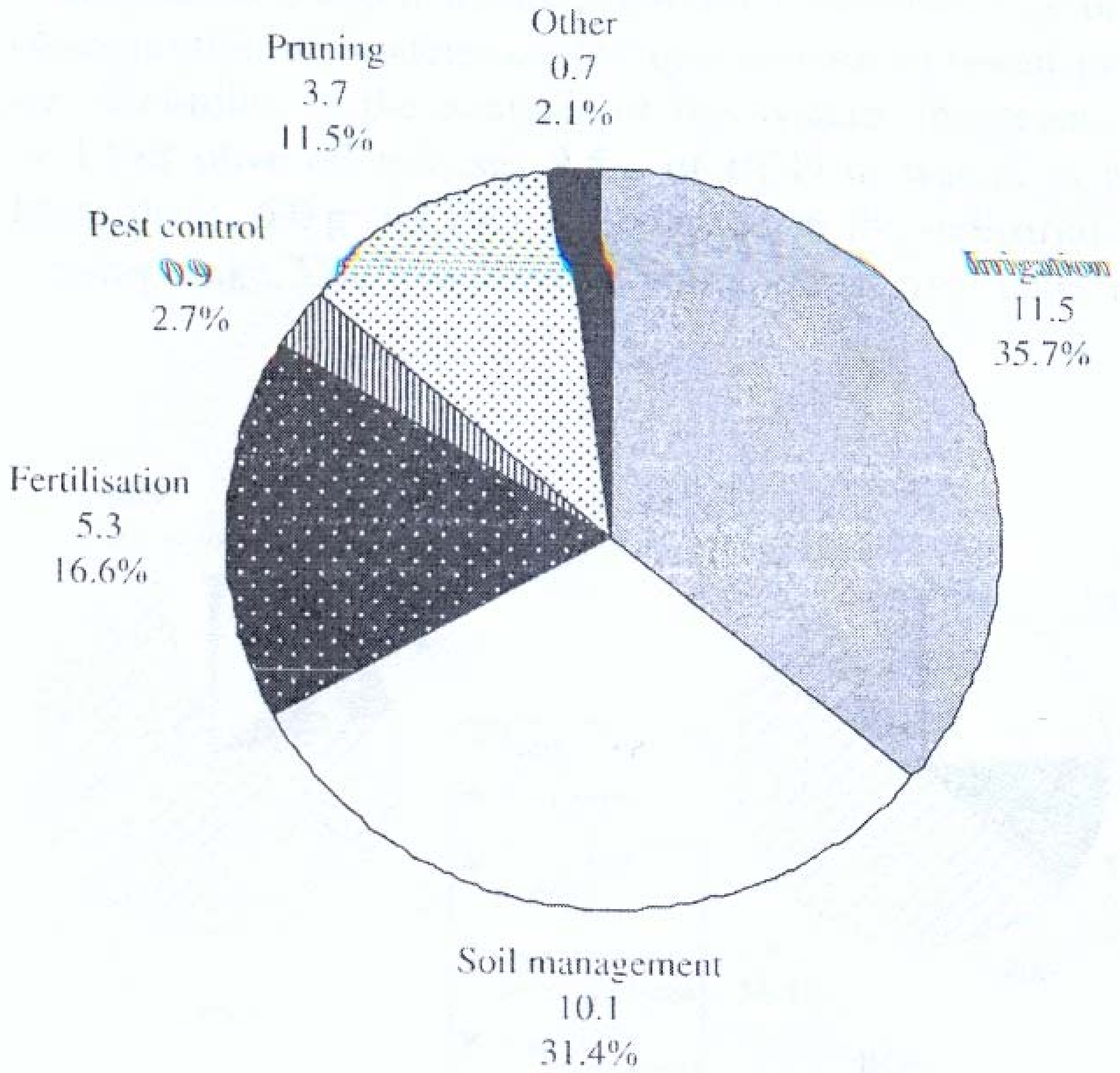


Fig. 5. Emissions of nitrogen oxides in grams and % process contribution to overall load.

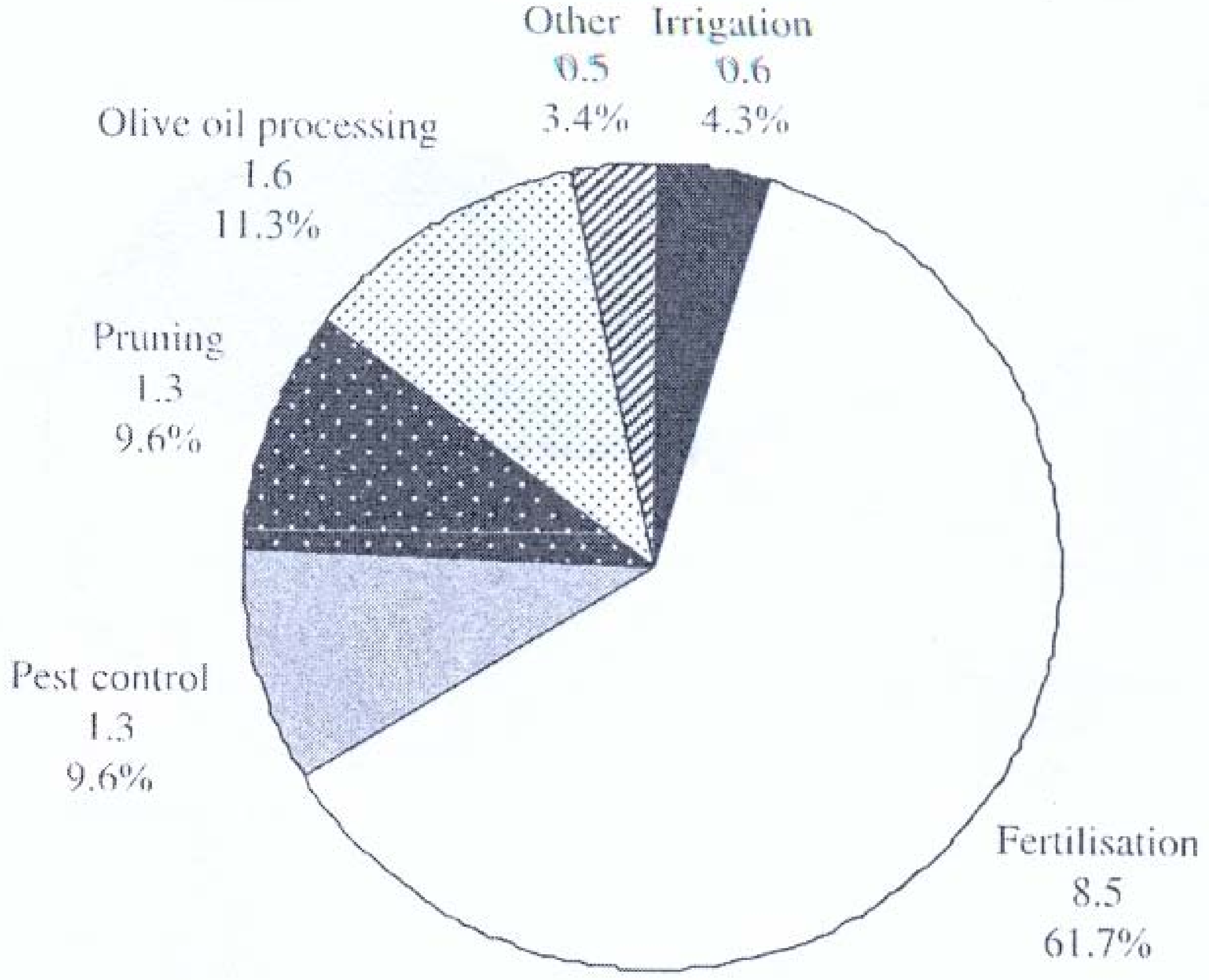


Fig. 6. Emissions of sulphur dioxide in grams and % process contribution to overall load.

Ελιά στην Ιταλία: συμβατική vs αειφόρος (SH 162:380-386, 2013)

- **Νότια Ιταλία, ξηροθερμικές συνθήκες: συμβατική με όργωμα και ξηρική, αειφόρος με άρδευση από αστικό βιολογικό καθαρισμό και μη αναμόχλευση**
- **Στο βιολογικό καθαρισμό: επεξεργασία με χλωρίνη, φίλτρα άμμου, και απολύμανση με υπεριώδη**
- **Μελέτη για 8 έτη: ανάλυση ενεργειακή, οικονομική, περιβαλλοντική**
- **Παρότι η αειφόρος κατανάλωσε περισσότερη ενέργεια, η παραγωγικότητα και οικονομικότητα ήταν πολύ υψηλότερες, με αποτέλεσμα τη χαμηλότερη 'ρύπανση' ανά κιλό ελιές και πολύ υψηλότερο εισόδημα**

Table 1
Main agronomic features of the two management systems, conventional system (CS) and sustainable system (SS).

Cultivar	CS Maiatica	SS Maiatica
Planting density	156 trees ha^{-1} (8 m × 8 m)	156 trees ha^{-1} (8 m × 8 m)
Training system	Vase trained	Vase trained
Pruning	Manual, heavy, every two years	Manual, light, annual
Pruning residues	Removed from the field	Cut and left on the ground as a mulch
Irrigation	-	Reclaimed urban wastewater
Fertilization	Empirical fertilization	Annual - guided fertirrigation
Weed control	Shallow tillage	Soil covered by spontaneous weeds mowed at least twice a year
Pest and disease control	-	Regional agricultural extension service protocol
Harvesting	Semi-mechanized, every two years	Semi-mechanized, annual
Products	Oil olives and table olives	Oil olives and table olives

Table 2

Farm inputs and outputs in the two management systems, conventional system (CS) and sustainable system (SS). Yields and percentage distribution between olives for table and oil-use are also reported. Data are averages from the reference period (2001–2008).

Input	CS	SS	Output	CS	SS
Total fertilizers ($kg\ ha^{-1}$)	75	150	Average 2001–2008		
Ammonium sulphate	0	110	Yield ($kg\ ha^{-1}$)	4210	9733
Urea	0	40	Oil olives (%)	52%	7%
Ammonium nitrate	75	0	Table olives (%)	48%	93%
Chemicals ($kg\ ha^{-1}$)	0	6			
Pesticides	0	4			
Copper	0	2			
Treated wastewater ($m^3\ ha^{-1}$)	0	3425			
Plastic container[a] (n°)	131	302			
Human labour ($h\ ha^{-1}$)	158	363			
Machinery ($h\ ha^{-1}$)	160	343			
Diesel – oil (kg)	163	628			
Lubricants (kg)	3	10			

[a]Estimated life span: 15 years.

Table 3
Materials and inputs referred to one hectare.Conventional system (CS) and sustainable system (SS).

Materials and inputs	CS	SS
Pruning		
Diesel and lubricants (kg)	3.05	4.06
Agricultural machinery (kg)	0.14	0.14
Pruning residues cutting		
Diesel and lubricants (kg)		83.39
Agricultural machinery (kg)		3.37
Pest and diseases control		
Diesel and lubricants (kg)		166.78
Agricultural machinery (kg)		7.73
Copper (kg)		2
Pesticide unspecified (kg)		4
Weed control		
Diesel and lubricants (kg)		125
Agricultural machinery (kg)		5.05
Soil tillage		
Diesel and lubricants (kg)	83.34	
Agricultural machinery (kg)	5.29	
Irrigation		
Treated wastewater (m^3)		3425
System (polyethylene pipes) (kg)		312
Fertilization		
Diesel and lubricants (kg)	7.11	41.47
Agricultural machinery (kg)	0.29	1.77
Ammonium nitrate (kg)	75	
Ammonium sulphate (kg)		110
Urea (kg)		40
Harvesting		
Diesel and lubricants (kg)	87.29	254
Agricultural machinery (kg)	3.22	9.64
Plastic containers (kg)	17	40

Table 4
Energy consumption for the examined orchard systems per land unit. Conventional system (CS) and sustainable system (SS).

Agricultural operations	CS	SS
	MJ ha^{-1}	
Pruning	310	393
Pruning residues cutting	–	4316
Diseases control	–	8832
Weed control	–	6474
Soil tillage	4478	–
Irrigation	–	1305
Fertilization	771	3230
Harvesting	4733	13,741
Total energy input	10,293	38,291

Ανά καλλιεργητική τεχνική

Table 5
Energy consumption and its distribution in the two management systems, conventional system (CS) and sustainable system (SS).

	CS		SS	
	MJ ha^{-1}	%	MJ ha^{-1}	%
Labour	308	3	707	2
Machinery and maintenance	1125	11	3437	9
Diesel fuel	7521	73	29,029	76
Lubricant	208	2	803	2
Fertilizers	402	4	1016	3
Chemicals	–	–	330	1
Irrigation system	–	–	1305	3
Materials (plastic containers)	728	7	1684	4
Total energy input	11,074	100	38,291	100

Ανά συντελεστή παραγωγής

Table 6

Total output, production costs and gross profit (mean 2001–2008) calculated for the two management systems, conventional system (CS) and sustainable system (SS).

	CS	SS
	(€ha^{-1})	
Oil olives sales	723	137
Table olives sales	2154	9542
Total output	2877	9679
Total production costs	1360	3403
Gross profit	1517	6276

Abiotic Depletion
Global Warming Potential
Ozone Layer Depletion
Ecotoxicity Potential
Photochemical Oxidation
Acidification
Eutrophication

Table 8

Life cycle impacts per hectare calculated for the two management systems: conventional system (CS) and sustainable system (SS). Impact categories: abiotic depletion (AD); global warming potential (GWP); ozone layer depletion (OLD); ecotoxicity potential (EP); photochemical oxidation (PO); air acidification (AA); eutrophication (EU).

Impact categories	Environmental impact ha^{-1}	
	CS	SS
AD (kg Sb eq)	5.96	24.64
GWP (kg CO_2 eq)	411.29	723.15
OLD (kg CFC-11 eq)	0.00	0.00
EP (kg 1,4-DB eq)	189626.24	607197.55
PO (kg C_2H_4)	0.11	0.45
AA (kg SO_2 eq)	2.00	6.17
EU (kg PO_{4-3} eq)	0.25	0.48

Table 9

Energy consumption, production costs and impact assessment of the global warming potential (GWP) referring to 1 kg of olives: comparison between the two management systems, conventional system (CS) and sustainable system (SS).

	CS	SS
Total energy input (MJ kg^{-1} olives)	2.80	4.43
Production costs (€kg^{-1} olives)	0.37	0.39
Farm net income (€kg^{-1} olives)	0.41	0.73
GWP (kg CO_2 eq kg^{-1} olives)	0.11	0.08

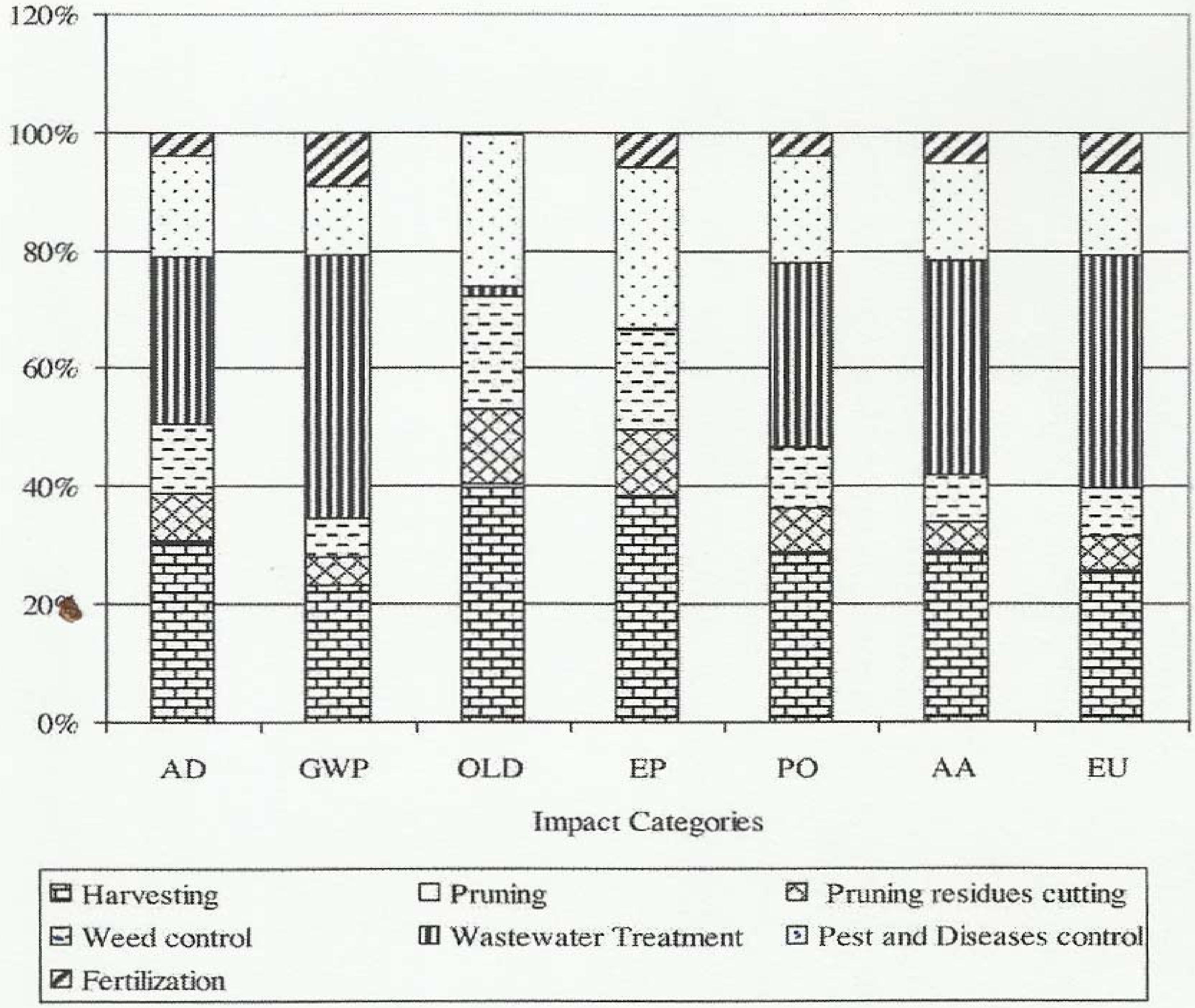


Fig. 2. The contribution of the agricultural operations to impact categories per hectare for sustainable system.

LCA σε εντατική ελαιοκαλλιέργεια

- **Στην Ιταλία μελετήθηκε η ανάλυση κύκλου ζωής για ελαιώνες από τη φύτευση έως και την πλήρη παραγωγή έως τα 48 έτη ζωής με μοντέλο ανάλυσης**
- **Μελέτησαν μια εντατική μορφή και μια υπερεντατική μορφή ελαιοκαλλιέργειας**
- **Η εντατική μορφή μικρότερο αποτύπωμα καθώς έχει μικρότερο κόστος εγκατάστασης (3 φορές!), μακρά παραγωγική ζωή, υψηλότερη παραγωγή καρπών και υψηλότερη αποτελεσματικότητα χρήσης των εισροών από την υπερεντατική καλλιέργεια (παρά τη μηχανοποίηση κλαδέματος και συγκομιδής αυτής)**

Table 1
Main features of two olive models.

Parameter	HDO	SHDO
Cultivar	Coratina	Arbequina
Planting density (orchard layout)	400 trees/ha (6 m × 4 m)	1667 trees/ha (4 m × 1.5 m)
Plants quality	Grafted trees (over 80 cm)	Rooted Cuttings (40–50 cm)
Training system	Free vase and central leader	Central leader
Pruning	Manual, annual	Mechanical and manual, annual
Irrigation system	Drip irrigation and fertilization	Drip irrigation and fertilization
Weed control	Mechanical tillage and herbicides	Mechanical tillage and herbicides
Disease control	Conventional technique	Conventional technique
Harvest method	Vibrator with a collecting umbrella	Straddle harvester
Yield (FP)	11.0 t/ha	9.0 t/ha
Fruit quality	Normal size and oil content	Smaller size but normal oil content
Economic life:	48 years	16 years
– Young phase (YP)	1st–2nd year (2 years)	1st–2nd year (2 years)
– Growing production phase (GP)	3rd–8th year (6 years)	3rd–5th year (3 years)
– Full production phase (FP)	9th–48th year (40 years)	6th–16th year (11 years)
Number of productive cycles	1	3

Table 6
Inputs and outputs of two olive models during the full production phase (FP) (annual average).

	Short description	HDO	SHDO
INPUTS			
Water (m^3/ha)	Water for irrigation	1980.00	2040.00
Fertilizers (t/ha)	Nitrogen	0.23	0.22
	Phosphorus	0.05	0.05
	Potassium	0.10	0.10
Pesticides (kg/ha)	Glyphosate	0.15	0.23
(as active principle)	Glufosinate	0.15	0.23
	Copper sulphate	3.00	4.50
	Copper ion (Cu++)	6.00	9.00
	Phosmet	2.82	4.23
	Dimethoate	1.52	2.28
	White paraffin oil	38.40	48.00
Fuel for machineries (t/ha)	Diesel fuel	0.79	0.85
	Lube oil	0.09	0.10
OUTPUTS			
Olives (t/ha)	Olives for oil production	11.00	9.00
Wood (t/ha)	Pruning wood	4.00	5.00

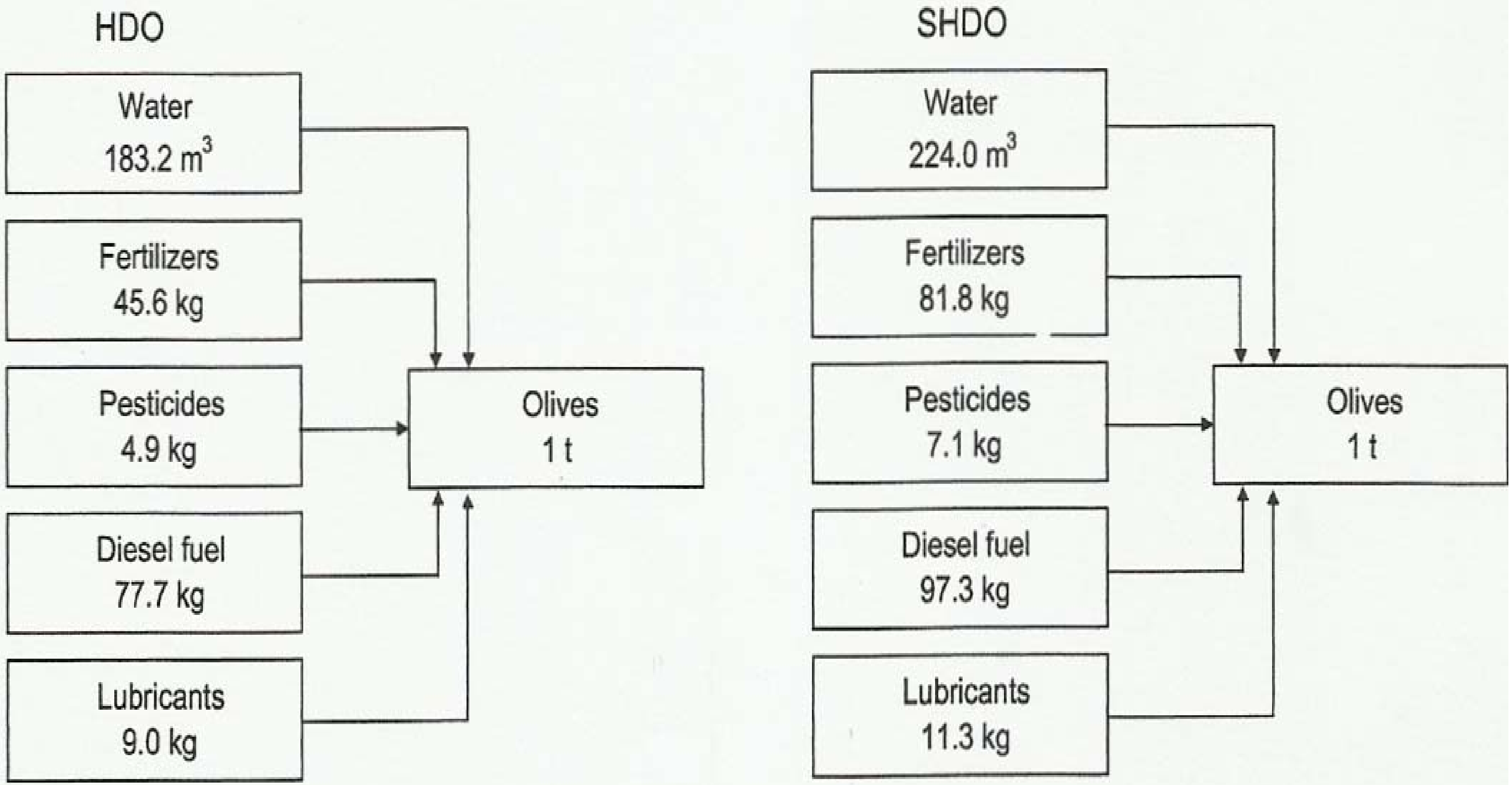


Fig. 1. Flow chart of the two system per functional unit.

Table 9

Characterization results of the two systems per functional unit (FU = 1 t olives) and relative coefficients of var

Impact category	Characterization results		
	Unit	HDO	SHDO
Abiotic depletion	kg Sb eq	4.4	5.6
Acidification	kg SO_2 eq	8.2	12.3
Eutrophication	kg PO_4- eq	4.2	6.7
Global warming (GWP100)	kg CO_2 eq	542.2	707.1
Ozone layer depletion	kg CFC-11 eq	0.00008	0.00010
Human toxicity	kg 1,4-DB eq	484.7	664.7
Fresh water aquatic ecotoxicity	kg 1,4-DB eq	78.0	114.5
Marine aquatic ecotoxicity	kg 1,4-DB eq	199024	28120
Terrestrial ecotoxicity	kg 1,4-DB eq	3.7	5.1
Photochemical oxidation	kg C_2H_4	0.7	0.9

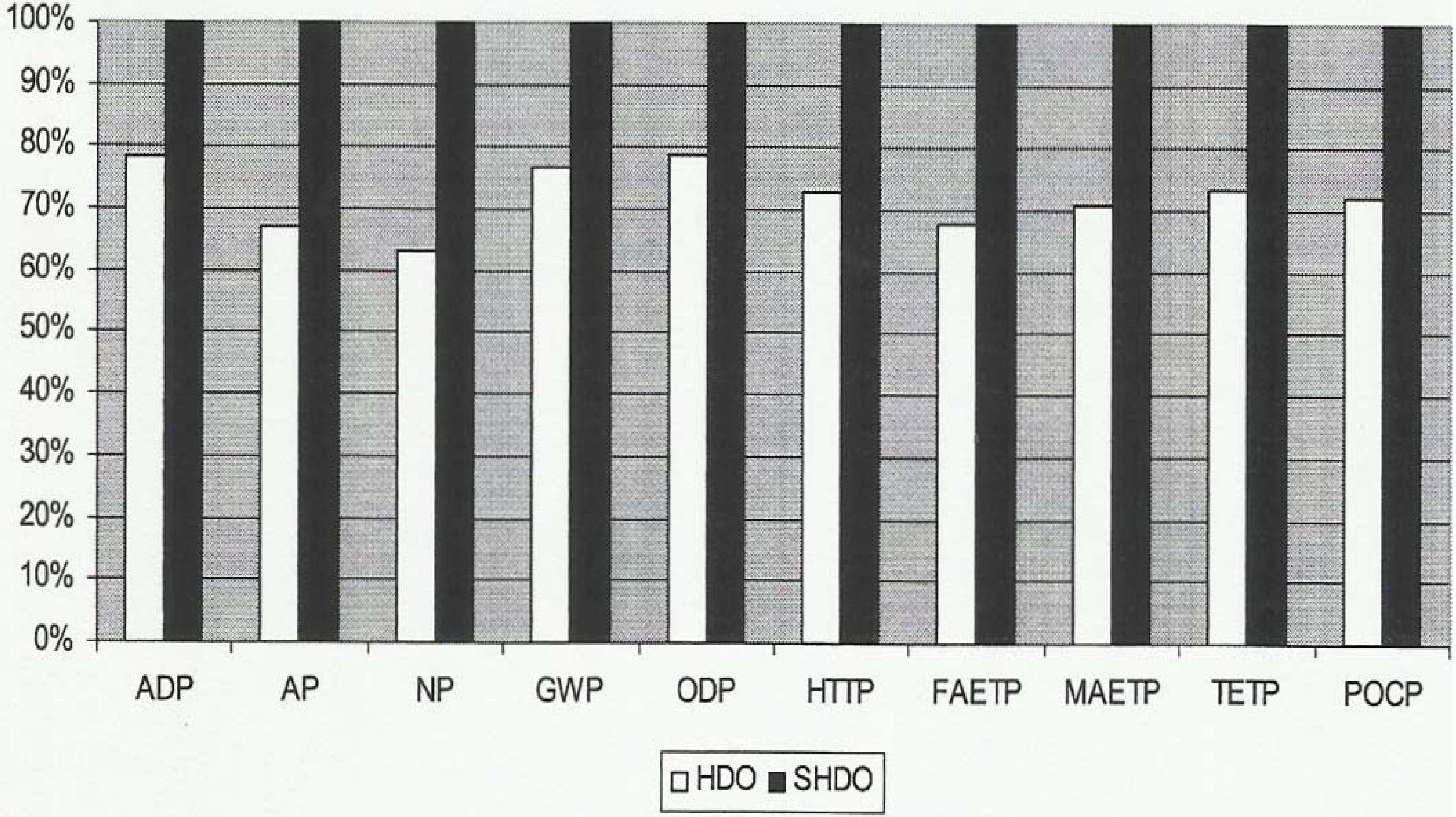


Fig. 2. Characterization of the two systems.

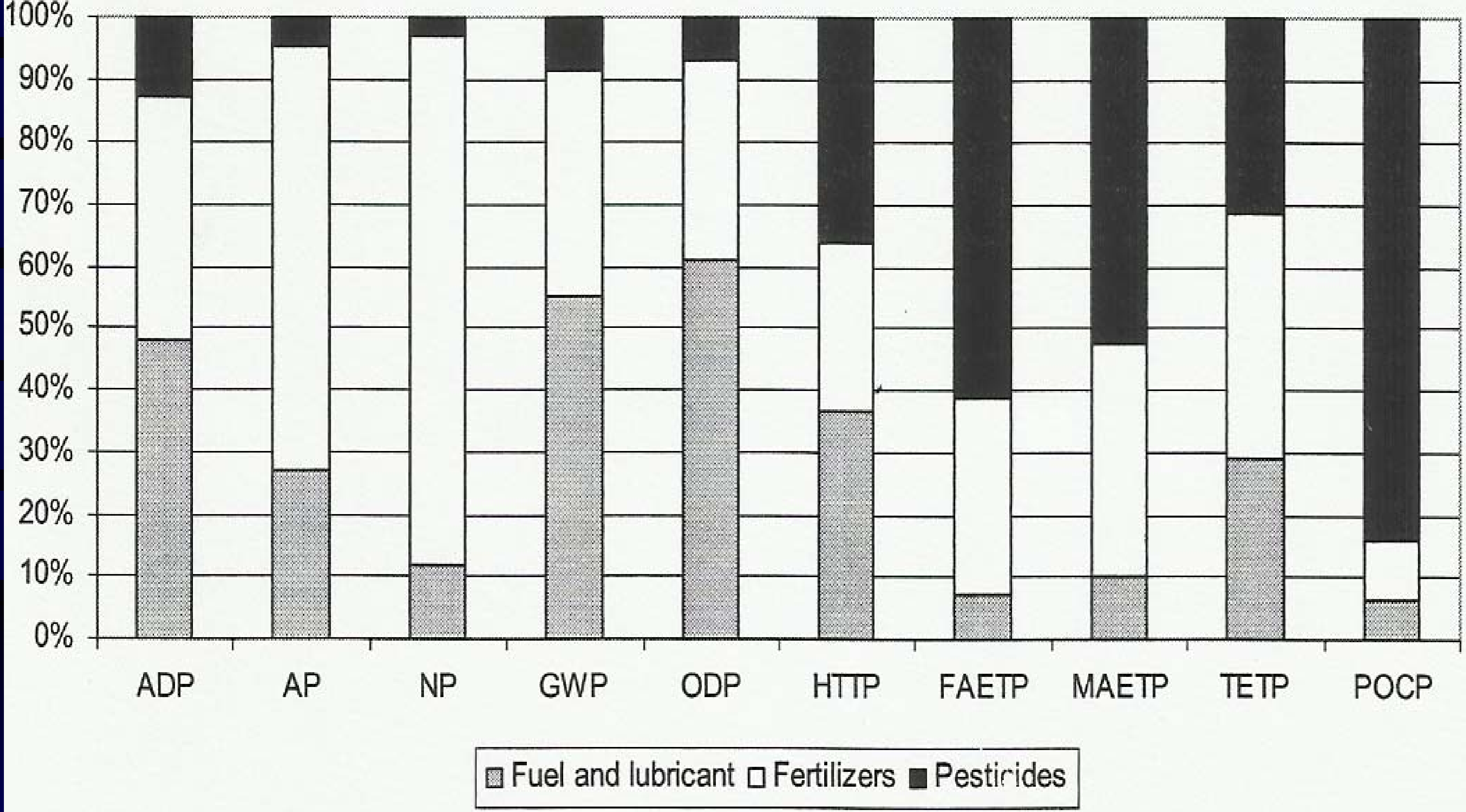


Fig. 3. Characterization of the full production phase in the HDO system.

ΑΚΖ Ελιά Κρήτη Μεσσηνία

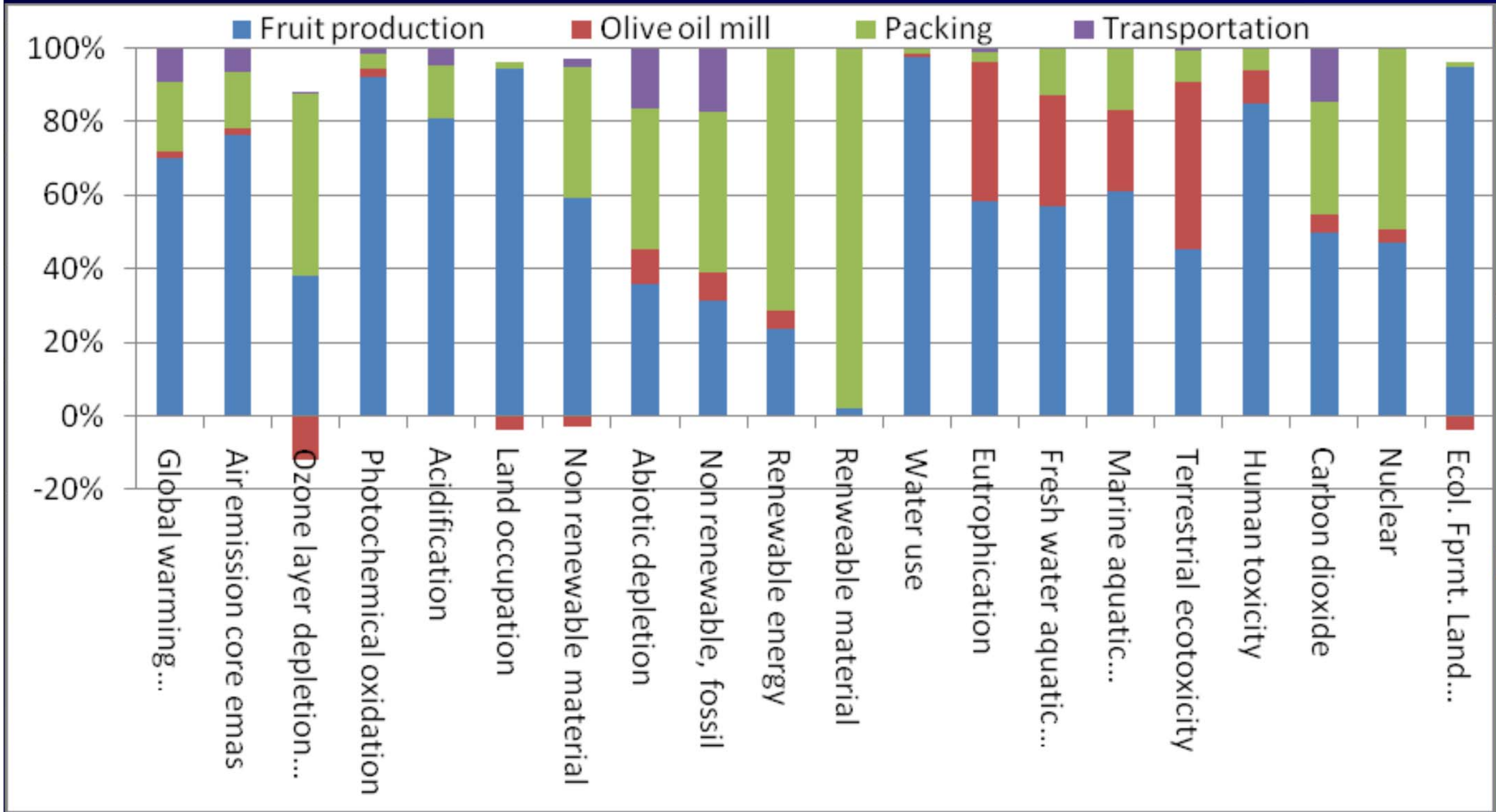
Ο Γ. Μιχαλόπουλος έχει δημιουργήσει τις προδιαγραφές για την ανάλυση κύκλου ζωής στην ελιά και τις έχει εφαρμόσει σε τρεις ομάδες παραγωγών για τη δημιουργία του αποτυπώματος του γυάλινου μπουκαλιού με 750 ml ελαιόλαδο που πουλιέται στη Στοκχόλμη.

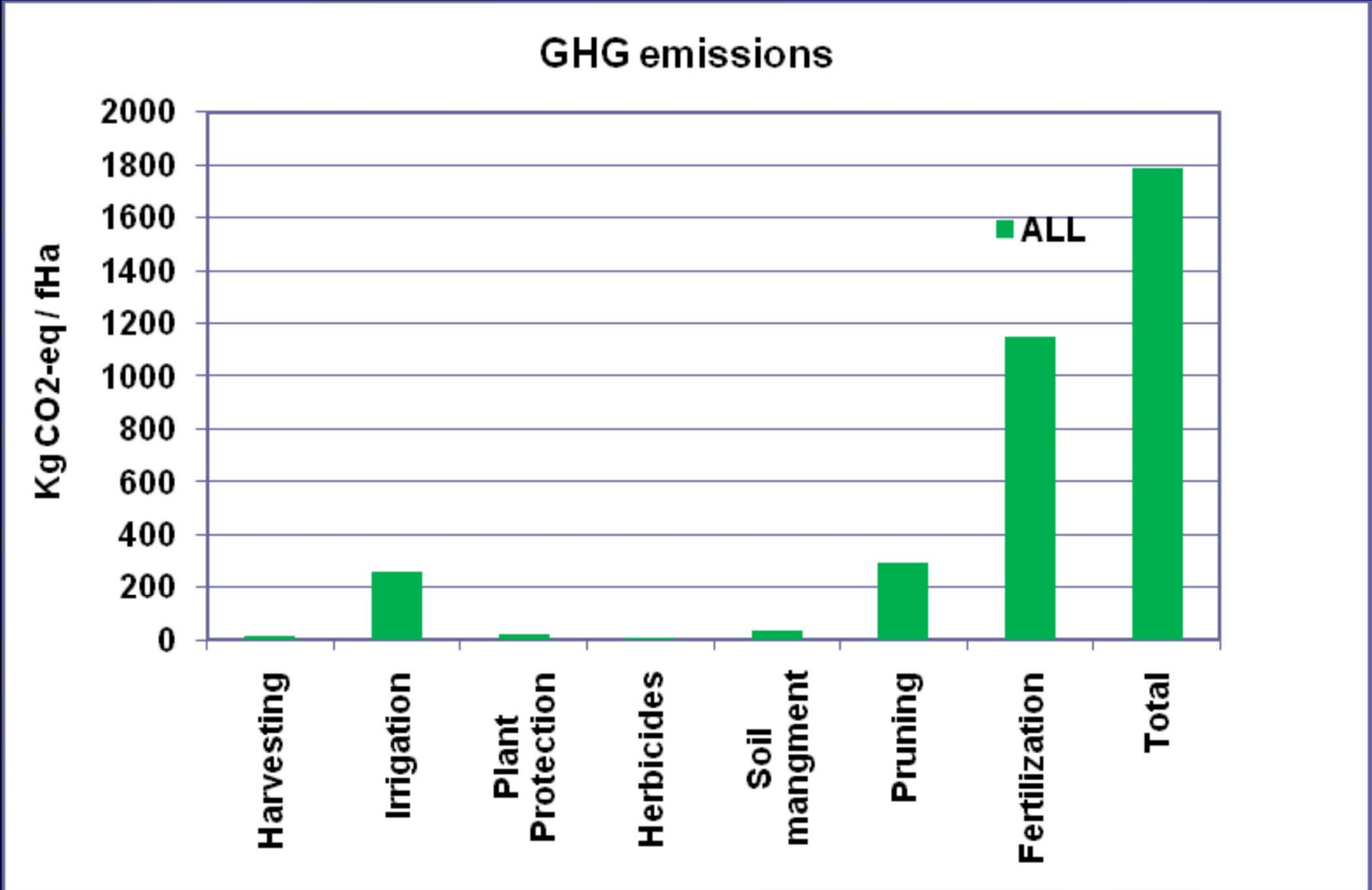
Climate information: For every bottle of the present extra virgin olive oil that has been produced, packed and transported to the markets of northern Europe **2.51 Kg CO2 eq.** of fossil origin CO2 eq. have been emitted to the atmosphere.

Climate information: For any bottle of the present extra virgin olive oil that has been produced, packed and transported to the markets of northern Europe and taking into account the CO2 fixed by photosynthesis and greenhouse gas emissions, at least 370 g of CO2 per year may be removed from the atmosphere and stored in the soil of Greek olive groves.

ENVIRONMENTAL PERFORMANCE			Upstream	Core		Downstream
POTENTIAL ENVIRONMENTAL IMPACT		Total	Field	Extraction	Packing	Transportation
1. Global warming (GWP100)	kg CO_2 eq.	**2.506**	1.757	0.043	0.480	0.226
2. Emissions to air	kg	**0.030**	0.023	0.001	0.005	0.002
3. Ozone layer depletion (ODP)	kg CFC-11 eq	**0.000**	0.000	0.000	0.000	0.000
4. Photochemical oxidation	kg C_2H_4 eq	**0.008**	0.007	0.000	0.000	0.000
5. Acidification gases	kg SO_2 eq.	**0.023**	0.019	0.000	0.003	0.001
6.1 Materials to recycle/other use	kg	**0.354**	0.106	0.248	0	0
6.2 Waste for renewable energy	Kg	**1.716**	0.576	1.140	0	0
6.3 Other waste	Kg	**3.719**	0	3.719	0	0
6.4 Hazardous/Active material	Kg	**0**	0	0	0	0
6.5 Toxic emissions	kg	**0**	0	0	0	0
7. Land occupation	m2a	**9.723**	9.945	-0.400	0.178	0.000
8. Non renewable material	kg	**0.387**	0.244	-0.012	0.146	0.009
9. Non renewable (fossil) energy	MJ eq.	**18.579**	5.838	1.414	8.145	3.183
9.1 Abiotic resources	(kg Sb eq.)	**(0.010)**	(0.003)	(0.001)	(0.004)	(0.002)

POTENTIAL ENVIRONMENTAL IMPACT		Total	Field	Extraction	Packing	Transport ation
10. Renewable material	Kg	**0.046**	0.001	0.000	0.045	0.000
11. Renewable energy	MJ eq.	**1.518**	0.357	0.077	1.079	0.004
12. Water use	m3	**0.277**	0.271	0.002	0.004	0.000
13. Electricity use	MJ	**8.315**	4.048	0.60	3.666	0.000
14. Eutrophication	kg PO4 eq.	**0.026**	0.015	0.010	0.001	0.000
15.1 Ecotoxicity – fresh water	kg 1,4-DB eq.	**0.837**	0.478	0.252	0.107	0.000
15.1 Ecotoxicity – marine	kg 1,4-DB eq.	**1 691**	1 031	0 374	0 284	0 003
15.1 Ecotoxicity – terrestrial	kg 1,4-DB eq.	**0.011**	0.005	0.005	0.001	0.000
16. Human toxicity	kg 1,4-DB eq.	**5.402**	4.586	0.479	0.329	0.007
17 Ecological footprint	Global m2a	**25.409**	23.928	-0.67	1.619	0.586


Fruit production
Olive oil mill
Packing
Transportation
100%
80%
60%
40%
20%
0%
-20%
Global warming...
Air emission core emas
Ozone layer depletion...
Photochemical oxidation
Acidification
Land occupation
Non renewable material
Abiotic depletion
Non renewable, fossil
Renewable energy
Renweable material
Water use
Eutrophication
Fresh water aquatic...
Marine aquatic...
Terrestrial ecotoxicity
Human toxicity
Carbon dioxide
Nuclear
Ecol. Fprnt. Land...



GHG emissions
Kg CO2-eq / fHa
2000
1800
1600
1400
1200
1000
800
600
400
200
0
ALL
Harvesting
Irrigation
Plant Protection
Herbicides
Soil mangment
Pruning
Fertilization
Total

2. Emissions to air

Beyond green house gases (GHG) the following have been found to be emitted to air, mainly from the field phase as shown in Chart 5. More specifically, they are linked to the N2O emissions of inorganic fertilizers as shown in Chart 6. Sulphur dioxide is linked to glass production. Particulates are linked to lignite burning for electricity production.

3. Emissions related to Ozon Layer Depletion (ODP)

The emission related to packing prevail in this impact category, followed by field phase with fertilizers again being primarily responsible. Some relief is offered by the use of leaves -separated from olive fruit in olive oil mills- as fertilizers substitute. The same occurs with the use of pruned wood as fuel replacement, since fuel production is also linked to production of ODP gases.

4. Photochemical oxidation

This is almost exclusively due to the field phase, namely to burning of wood from pruning. Some of the gases produced during this incomplete burning (carbon monoxide, benzene, NMVOC) are important for human 10

health as well as for the deterioration of olive oil quality if burning takes place at the same time with harvesting and milling of the fruit. And, of course, wood burning deprives the soil of valuable organic matter.

5. Acidification

Mostly due to the field phase and secondarily to packing, emissions consist of nitrogen oxides (47%) ammonia (25%) and sulphur dioxide (27%). About 80% of the two first gases are emitted locally after applications of nitrogen fertilizers, while the remaining 20% as well as all the sulphur dioxide are emitted at the fertilizer production phase. Practically no ammonia is emitted in the core phase. Some nitrogen oxides are also emitted during packaging due to glass production for the bottles.

6. Waste

This water and wood ashes from dry pomace burnt as fuel in olive mills furnaces are local waste emissions. Also local is the empty packages of plant protection products and empty fertilizer bags.

6.1 Waste for recycling or other use

No recycling of waste –except for lubricants- has been considered in Greece, but only in the country of destination, i.e. Sweden for packing material. However, a number of items is used for other purposes such as ash from pomace used as fuel in oil mills and leaves separated from olive fruit in the oil mills are used as replacement for fertilizers. Also a part of pruned wood is used for fences, tool making etc.

6.2 Waste used as renewable energy source

Pomace from 3-phase oil mills is used as fuel in oil mills, in greenhouses for growing vegetables etc, as fuel replacement. The same is true for large pieces of pruned wood which is used in farmers? houses in stoves and fireplaces also as fuel replacement.

6.3 Other waste – Final waste flows

This includes water from olive fruit-washing process and Oil-Mill-Waste-Water for which emissions have been included in the overall pattern. Also, the empty packages of plant protection products and of empty fertilizer bags.

7. Land occupation

This can be attributed almost exclusively to olive groves, which have not undergone land use change during the last centuries in order to accomodate olive culture. Almost 10 m2 (9.99 m2) of olive grove are required for the production of one functional unit.

8. Use of non renewable material

An amount equal to 0.39 Kg is required in total per functional unit. As shown in Chart 11 it is used mainly for fertilizers (Sylvite is required for K) production, while also glass manufacturing requires gravel from the ground.

9. Consumption of non renewable fossils.

Resources used for energy production as shown in Charts 12 & 12a are used up for all the phases in the life cycle of olive oil summing up to 18.579 MJ/functional unit. In the field phase though (Chart 12b) the net effect is negative due to the replacement of fuel oil by pruned wood.

9.1 Abiotic resources depletion

From another angle, a pattern similar to non renewable fossil fuels resources above is found (pie-chart 13) for abiotic resources, equivalent to about 10 g of Sb per functional unit, according to CML baseline 2000 method.

10. Renewable material.

Almost exclusively renewable material (wood) is used for corrugated paper production

11. Renewable energy

There is only a small use for fertilizers production and for electricity production in Greece.

12. Water use

Irrigation is by far the main use of water, so local extraction is the issue. Also local comsumption is related to water used for oil extraction in olive oil mills which represents the 2% of all water usage (Water, well in ground as shown in the pie chart below). In a life cycle perspective, a significant use of water is indirect, i.e. for insecticides and fungicides manufacturing (Water salt, sole equal to 20% of total water use) and for irrigation of the juta plants from which the harvesting sacks are made (water, river).

13 Electricity

Its use is shared between field and packing phases as shown below.

ELECTRICITY	Unit	Total	Field	Extraction	Packing	Transport
	MJ	**8.315**	4.048	0.60	3.666	0.000

14. Eutrophication

Two are the main sources of emissions related to eutrophication, fruit production and olive oil extraction. For fruit production stage it is obvious that fertilization and to some extent irrigation are the principal sources of emissions.

The extraction phase is marked by the difference between 2 phase mills and three phase mills, as shown in the graph below.

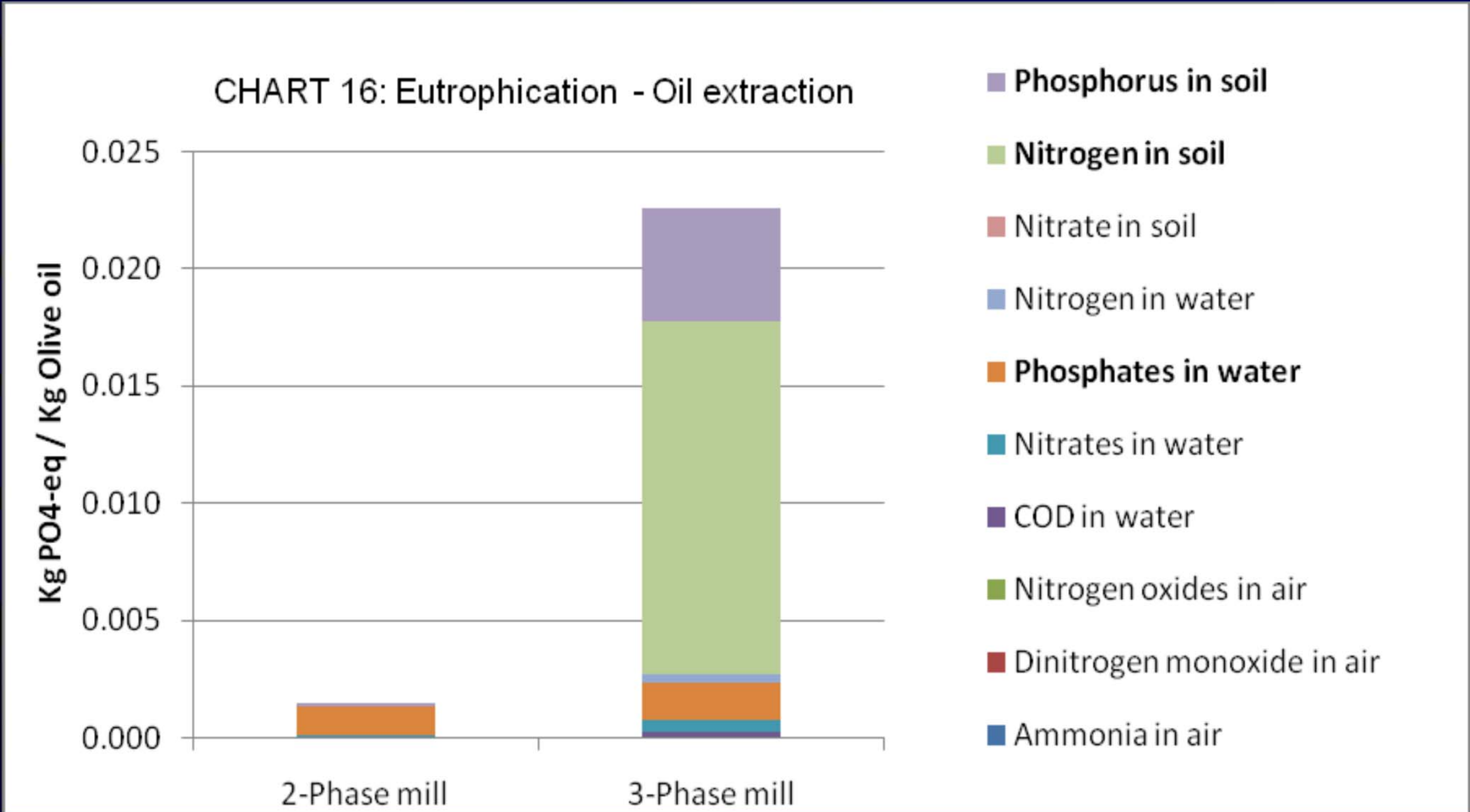


CHART 16: Eutrophication - Oil extraction
Kg PO4-eq / Kg Olive oil
0.025
0.020
0.015
0.010
0.005
0.000
2-Phase mill
3-Phase mill
Phosphorus in soil
Nitrogen in soil
Nitrate in soil
Nitrogen in water
Phosphates in water
Nitrates in water
COD in water
Nitrogen oxides in air
Dinitrogen monoxide in air
Ammonia in air

15. Ecotoxicity

Both, fresh water and marine ecotoxicity are influenced by heavy metals emitted from lignite burning electricity production units. In addition to them for terrestrial ecotoxicity insecticides also play a small role.

16. Human toxicity is related almost exclusively to wood burning after pruning, as one of the products, benzene predominates as an emission.

17. Ecological footprint.

It is calculated to be 25.43 m2a, which is quite high but not so important since it almost all due to the field phase i.e. the olive grove area as shown in chart 18 below. The significance of land occupation for olive fruit production is highlighted by the fact that it is an extensive, relatively low input olive-culture as it is practiced in all three areas of interest is nothing else but a natural, millennium old olive forest.

Υποστρώματα λαχανικών

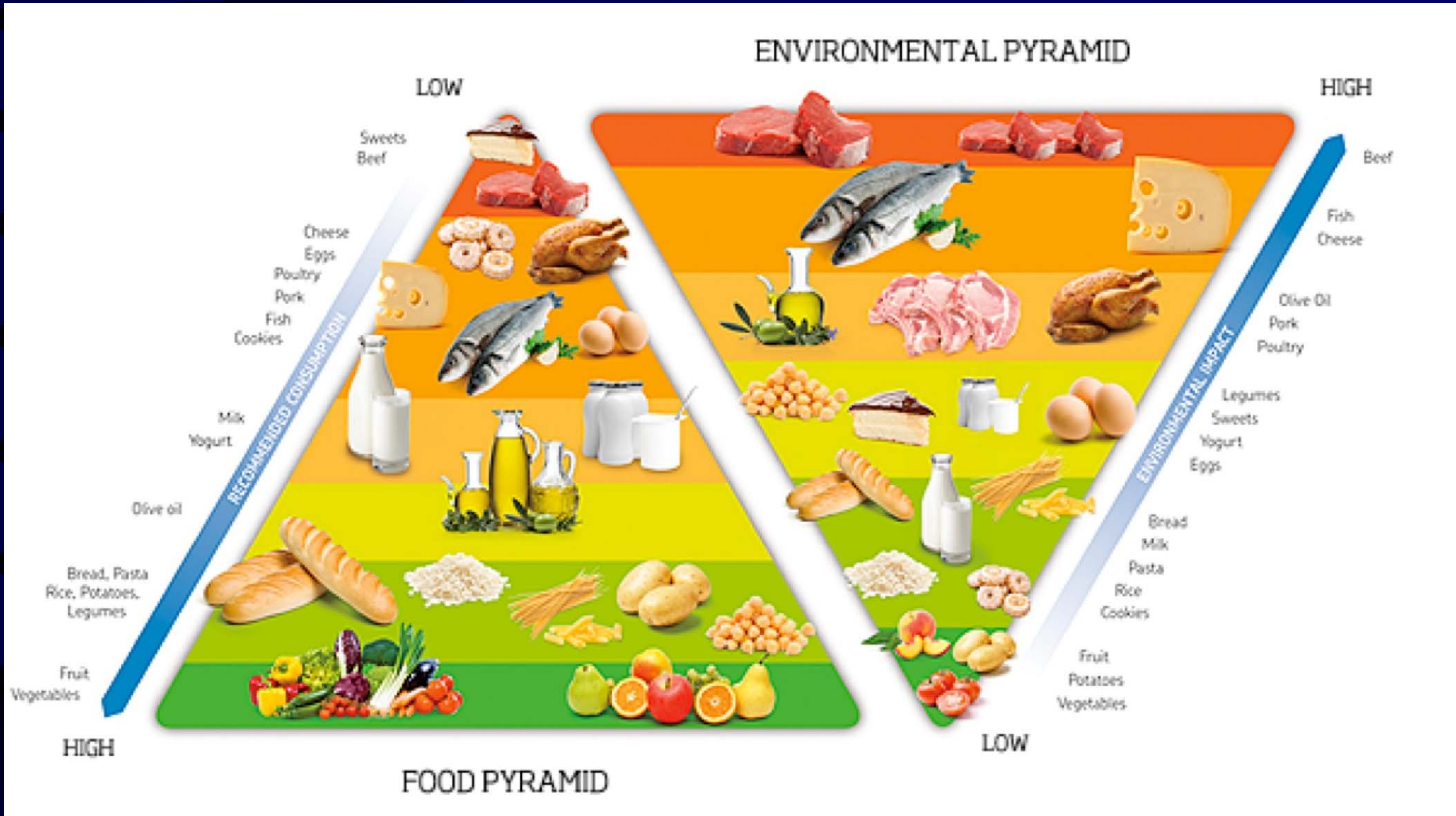
Table1: Greenhouse gas emissions (LCA approach) for selected growing media at end-use stage; reported by weight (kg CO2e t-1) [the use of '\' indicates the range of values]

Growing media	Extraction & Harvest	Processing	Transport	End of life-Growth sequestration	total
Peat	36	24	331\412	543	934\1015
Green compost	37	408	51\132	358-358	496\577
Pig manure		578*			
Coir	4\160	40	141\223	294-294	186\423
Bark	4	13	141\223	793-793	158\240
Wood fibre	5	32	72\273	661-661	109\310
Perlite	65	536	24\64	0	625\665
Vermiculite	65	536	24\64	0	625\665
Pumice	65		24\64	0	99\129
Zeolite	65		24\64	0	99\129
Rockwool		1455	24\64	0	1479\
Foams (EPS)		1752	331\412		2083\ 2164

Table1 is a revision of similar table of Defra (2005) for Greek case, enriched also with other data (Papadopoulos 2006, TIMSA 2000)

Οικολογικό Αποτύπωμα

- **Ecological footprint**
- **Είναι μια προσέγγιση του πόση επιφάνεια βιοπαραγωγικής γης και νερού απαιτείται για ένα άτομο, ένα σύνολο ή μια δραστηριότητα ώστε να παραχθούν όλοι οι πόροι που καταναλώνει και για να απορροφηθούν όλα τα απορρίμματα που παράγει, χρησιμοποιώντας την τρέχουσα τεχνολογία και διαχείριση.**



Διπλή πυραμίδα της Barilla (περιβαλλοντικό ή οικολογικό αποτύπωμα σε m^2 γης που απαιτούνται ανά kg ή L)

Το δίκαιο εμπόριο

Σε αντίθεση με το συμβατικό εμπόριο που οι περισσότεροι γνωρίζουν περισσότερο, το 'δίκαιο εμπόριο' παρουσιάζει όποιες σημαντικές διαφοροποιήσεις, καθώς **έχει και κοινωνικό χαρακτήρα**, δείχνοντας σημαντικό **ενδιαφέρον για τον περιορισμό της φτώχειας και την ενίσχυση των οικονομικά ασθενέστερων παραγωγών όλου του κόσμου**. Σκοπός του είναι πέρα βέβαια από την επιτυχή έκβαση της συναλλαγής -να δίνονται ίσες ευκαιρίες σε όλους ανεξάρτητα από τα φυλετικά, κοινωνικά ή οικονομικά τους χαρακτηριστικά και ιδιαίτερη έμφαση **στην ποιότητα των προϊόντων και στις ασφαλείς συνθήκες εργασίας εκείνων σι οποίοι τα παράγουν**.

Τα πρώτα γεωργικά προϊόντα «δίκαιου εμπορίου« που διακινήθηκαν. ήταν τσάι και καφές και ακολούθησαν τα αποξηραμένα φρούτα, κακάο, μπανάνες, ζάχαρη, διάφορα φρέσκα φρούτα, ρύζι, μπαχαρικά και ξηροί καρποί. Ενώ το 1992 η αναλογία των πωλήσεων ανάμεσα σε κομψοτεχνήματα και γεωργικά προϊόντα ήταν 80% έναντι 20%, το 2002 τα ποσοστά έφτασαν αντίστοιχα το 25,4% και το 69,4% -υπέρ των γεωργικών προϊόντων.


1,94 €
φροντίδας
Πατάτες κοινωνικής καλλιέργειας
από την Πέλλα
3kg e
Καρπός φροντίδας
Πατάτες κοινωνικής καλλιέργειας
από την Πέλλα