VII International conference on Life Cycle Assessment in the agri-food sector

Bari, 22-24 September 2010

Innovative olive-growing models: an economic and environmental assessment

B. De Gennaro[1], L. Roselli[1], B. Notarnicola[2], G. Tassielli[2], E. Settanni[2]

[1]Dept. of Engineering and Management of the Agricultural, Livestock and Forest Systems

[2] II Faculty of Economics, Taranto , Italy

UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

Introduction

The Italian olive-growing sector has to face a new economic and institutional scenario:

1.deep changes on the olive oil market

–internationalization (global sourcing)

–increasing market power of both multinational bottling companies and modern retailer

2.the shift of the Common Agricultural Policy (CAP)

–from market and price policies towards decoupled direct aids (**Single Payment Scheme**)

–linked to stricter environmental obligations on farm management (**cross-compliance**).

The Italian olive-growing sector:

•**is mainly composed by small and medium-scale farms;**

•**is still dominated by traditional olive orchards** (with less than 200 trees/ha), even in the most suitable olive-growing areas;

•**has a relatively low productivity and high production costs,** due to the low level of mechanization of the harvesting and pruning operations;

•**has to face the cost-competitiveness of other producing countries** (non-EU Mediterranean country and "new producing countries").

In this scenario the Italian olive sector needs new competitive strategies to address the new challenges.

A possible strategy could be the **adoption of innovative olive-growing models** able to reduce production costs… **but without worsening environmental sustainability.**

• **<u>There are mainly two innovative olive orchard models</u>**:

- the **"High Density Orchard"** (**HDO**) with over 200 trees/ha, it is already widespread in the olive producing countries;

- the **"Super High Density Orchard"** (**SHDO**) with over 1,500 trees/ha, based almost exclusively on few Spanish low vigor cultivars, it was developed in Spain in 1990s and later introduced into some other olive producing countries.

Research objectives

Both intensive olive systems (HDO and SHDO) seem to have better economic performances, respect to traditional olive system, but they **could generate higher environmental impacts**.

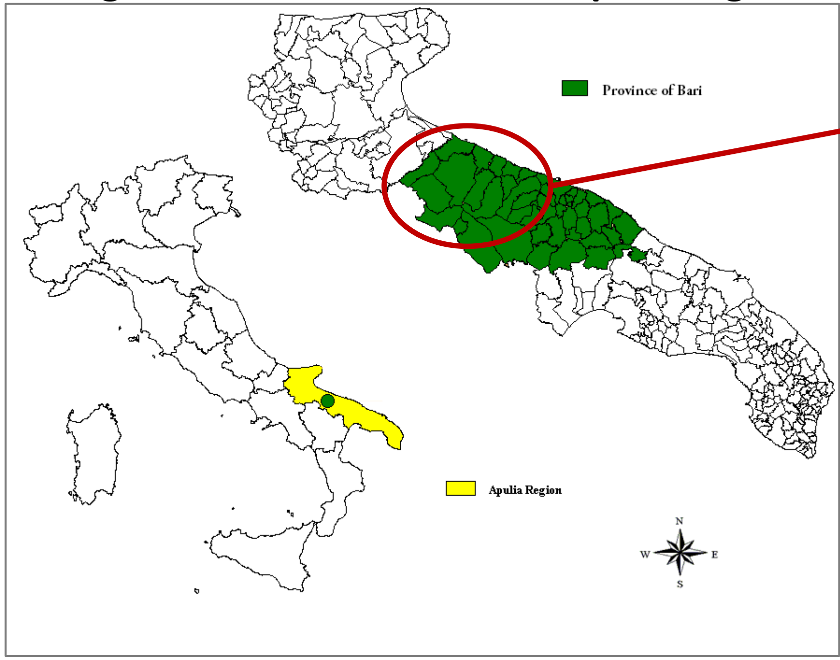
1. What are the environmental impacts of two olive models?
2. What are the economic performances of two olive models?

To reach this objectives **we carried out an integrated economic and environmental comparison** between the two innovative olive models along their life cycle, **using a common database**.

Data and methodology

To perform the analysis we made **some basic assumptions based on information coming from the agronomic literature** (Tous et al., 2006; Pastor et al., 2006; Camposeo e Godini, 2009).

Figure 1: Province of Bari – Apulia region



Reference olive production area:	Northern zone of the province of Bari (Apulia Region)
Reference period:	48 years
Reference production unit:	1 hectare olive orchard

Main hypotheses about the features of two olive models

PARAMETER	HDO	SHDO
Cultivar	Coratina	Arbequina
Planting density	400 trees/ha (6 m x 4 m)	1,667 trees/ha (4 m x 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	Shakers with a collecting umbrella	Straddle harvester
Yield (FP)	11,0	9,0
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

Starting from these assumptions and **with the support of some olive-growing experts we set-up the cultivation techniques for each phase of the two olive models**.

Inputs and outputs matrix of two olive models during the reference period (48 years)

	Short description	HDO	SHDO
INPUTS:			
Water (m3/ha)	Water for irrigation	87,360.00	86,700.00
Fertilizers (t/ha)	Nitrogen	12.01	12.06
	Phosphorus	3.45	3.51
	Potassium	6.28	6.54
Pesticides (kg/ha) (as active principle)	Glyphosate	0.00671	0.00958
	Glufosinate	0.00667	0.00952
	Copper sulphate	0.139	0.191
	Copper ion (Cu++)	0.259	0.339
	Phosmet	0.122	0.164
	Dimethoate	0.06764	0.09063
	White paraffin oil	1.728	1.944
Inputs of machineries (kg/ha)	Diesel fuel	37.057	37.666
	Lube oil	4.289	4.359
OUTPUTS:			
Olives (t/ha)	Olives for oil production	**476.84**	387.00
Wood (t/ha)	Pruning wood	165.20	**196.50**
	Explantation wood	**180.00**	150.00

The **SHDO model needs higher inputs** (fertilizers, pesticides and inputs of machineries), excluded water, **but produces less olives**, along the whole reference period.

Methodological approach

1. Life Cycle Costing (LCC)

To assess the economic profitability we applied the **Cash Flow Analysis**. The criteria utilized are: the Net Present Value (**NPV**) and the Internal Rate of Return (**IRR**).

THE EVALUATION PROCEDURE:

•all costs were assessed considering the **current hourly wage of workers** (manual operations) and current **tariffs charged by agricultural services providers** (mechanical operations);

•**annual revenues include** the **revenue from selling the olives production** and the **revenue from selling the explantation wood** at the end of the orchard economic life, but **exclude the CAP decoupled direct aid**;

•we assumed **the same olives price for both models** that was initially set equal to the price observed on the marketplace of Bari during the last harvesting campaign (350 €/t);

•the **discount rate (r) was initially set equal to 2.00%.**

2. Life Cycle Assessment (LCA)

•**the functional unit is 1 t olives** in the reference period 48 years;

•background data are mainly from **Ecoinvent**;

•the **emissions** of N_2O, NH_3, NO_3- **due to the use of nitrogen fertilizers have been modelled following: Houghton, 1997; ECETOC, 1994; Brentrup et al., 2000**;

•the **emissions of pesticide**s have been assessed following the model of **Hauschild, 2000**;

•the **inventory results**, expressed in physical units, **have been assessed by the CML 2000 method** (Guinèe et al., 2002).

•the **assessment method has been stopped to the characterization**, without going through the normalization and weighting steps.

IMPACT CATEGORIES	
Abiotic Depletion Potential (ADP)	Human Toxicity Potential (HTP)
Acidification Potential (AP)	Freshwater Aquatic Ecotoxicity Potential (FAETP)
Nutrification Potential (NP)	Marine Aquatic Ecotoxicity Potential (MAETP)
Global Warming Potential (GWP)	Terrestrial Ecotoxicity Potential (TETP)
Ozone Depletion Potential (ODP)	Photochemical Oxidant Creation Potential (POCP)

Results of the economic analysis

Comparison of plantation costs (€/ha)

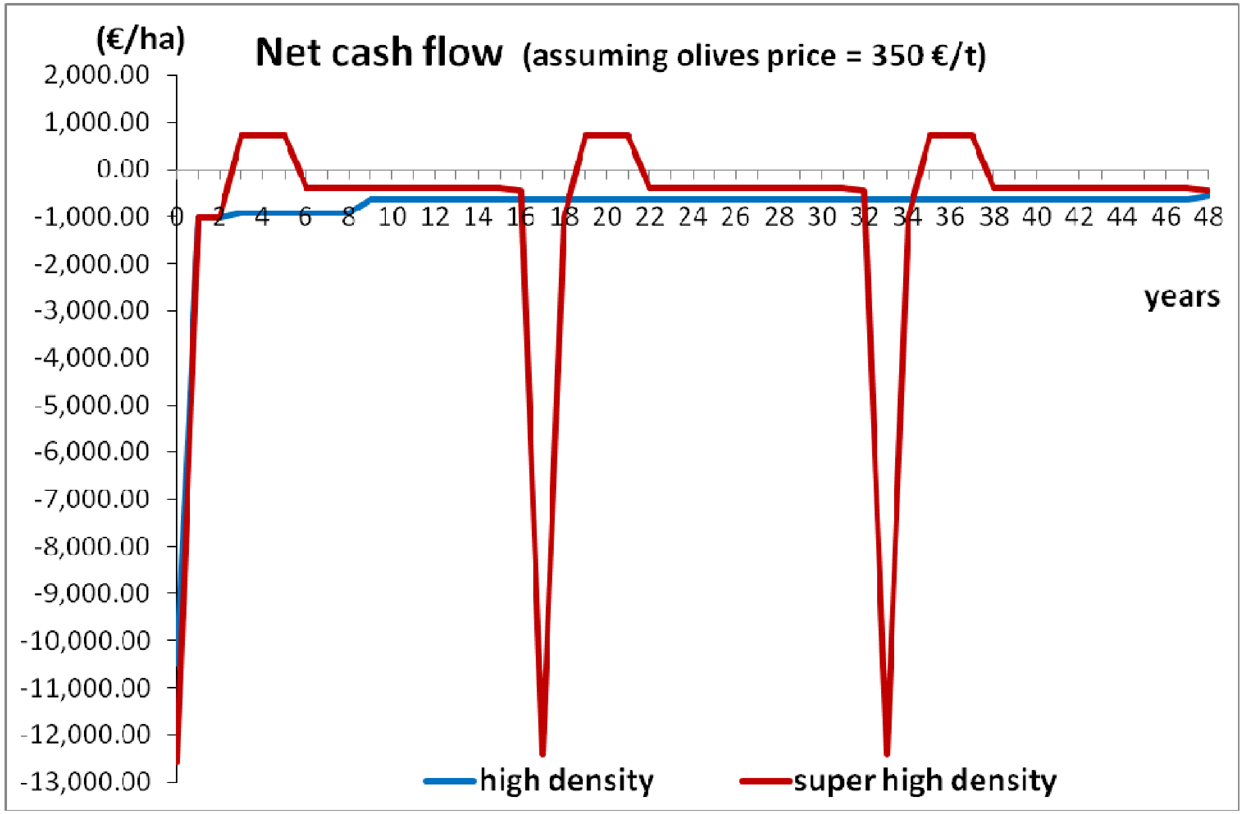
Cost items	HDO	SHDO
Soil preparation	1,430.00	1,430.00
Pre-planting fertilization	1,911.00	1,911.00
Plants	2,600.00	2,500.50
Plants support system	600.00	1,198.49
Trees plantation and support system installation	381.10	1,543.35
Drip irrigation system	3,550.00	4,000.00
Total plantation costs	**10,472.10**	**12,583.34**

The initial investment is higher in the SHDO and it has to be charged three times along the reference period.

Comparison of operating costs in FP (€/ha*year)

Cultivation operations	HDO	SHDO
	€/ha	€/ha
Soil tillage	250.00	250.00
Fertilization	621.54	617.52
Irrigation	339.96	348.96
Weed and diseases control	1,251.13	1,454.15
Pruning	877.50	406.25
Harvesting	1,145.58	466.67
Total operating costs	**4,485.70**	**3,543.55**

The operating costs are heavily influenced by the degree of mechanization. In fact, despite the higher use of inputs, **the SHDO show lower operating costs** respect to the HDO, due to **lower costs of pruning and harvesting operations**.

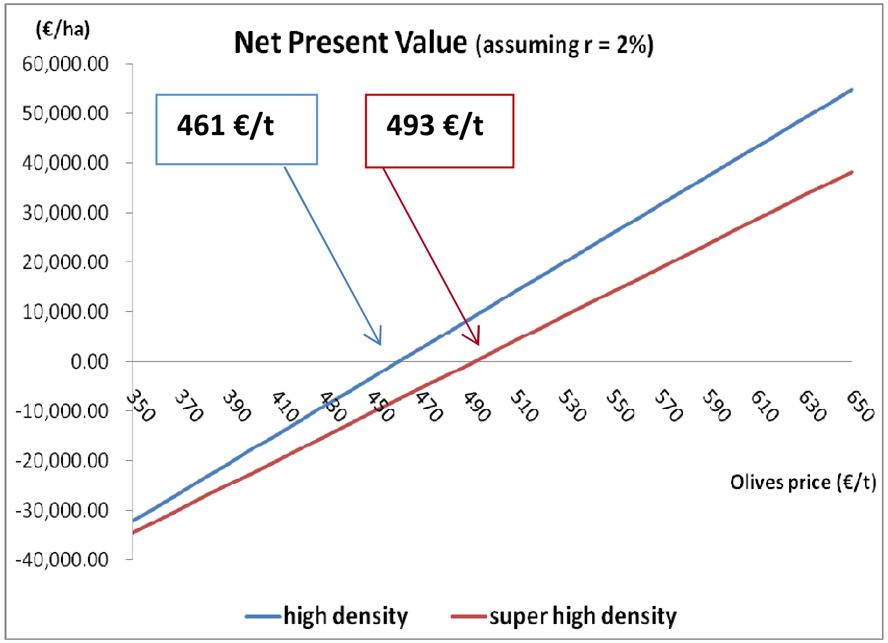


	NPV	IRR
HDO	-32,249.48	-
SHDO	-34,622.54	-

At the current olive price (350€/t) both olive model show negative NPV.

...for both models there is not economic profitability to invest.

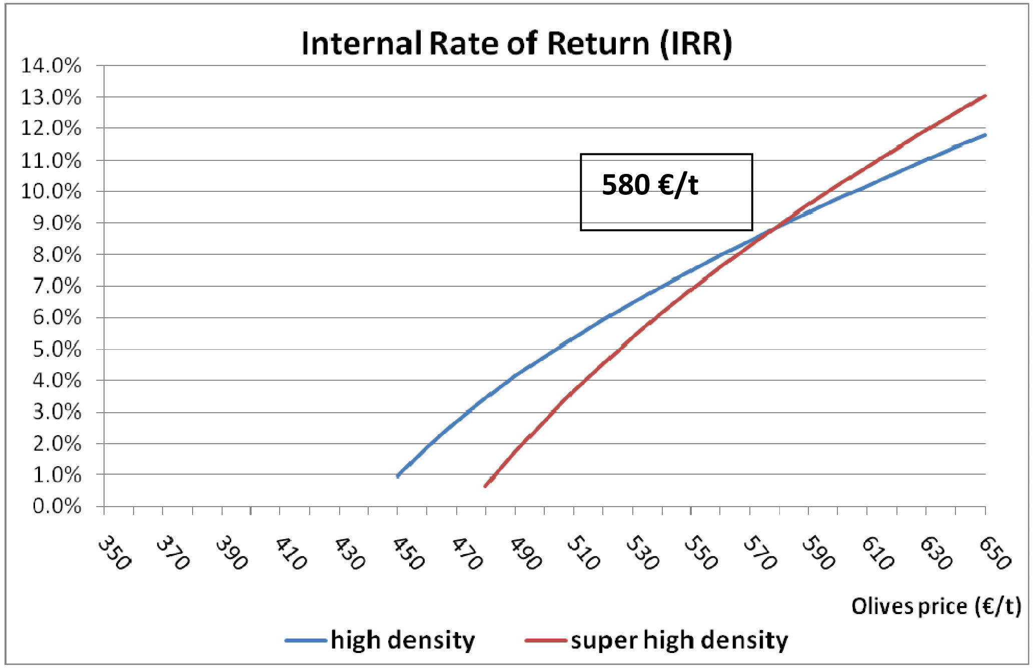
Trends of the NPV as a function of olives price



The **HDO has a higher NPV than the SHDO for each price level**...

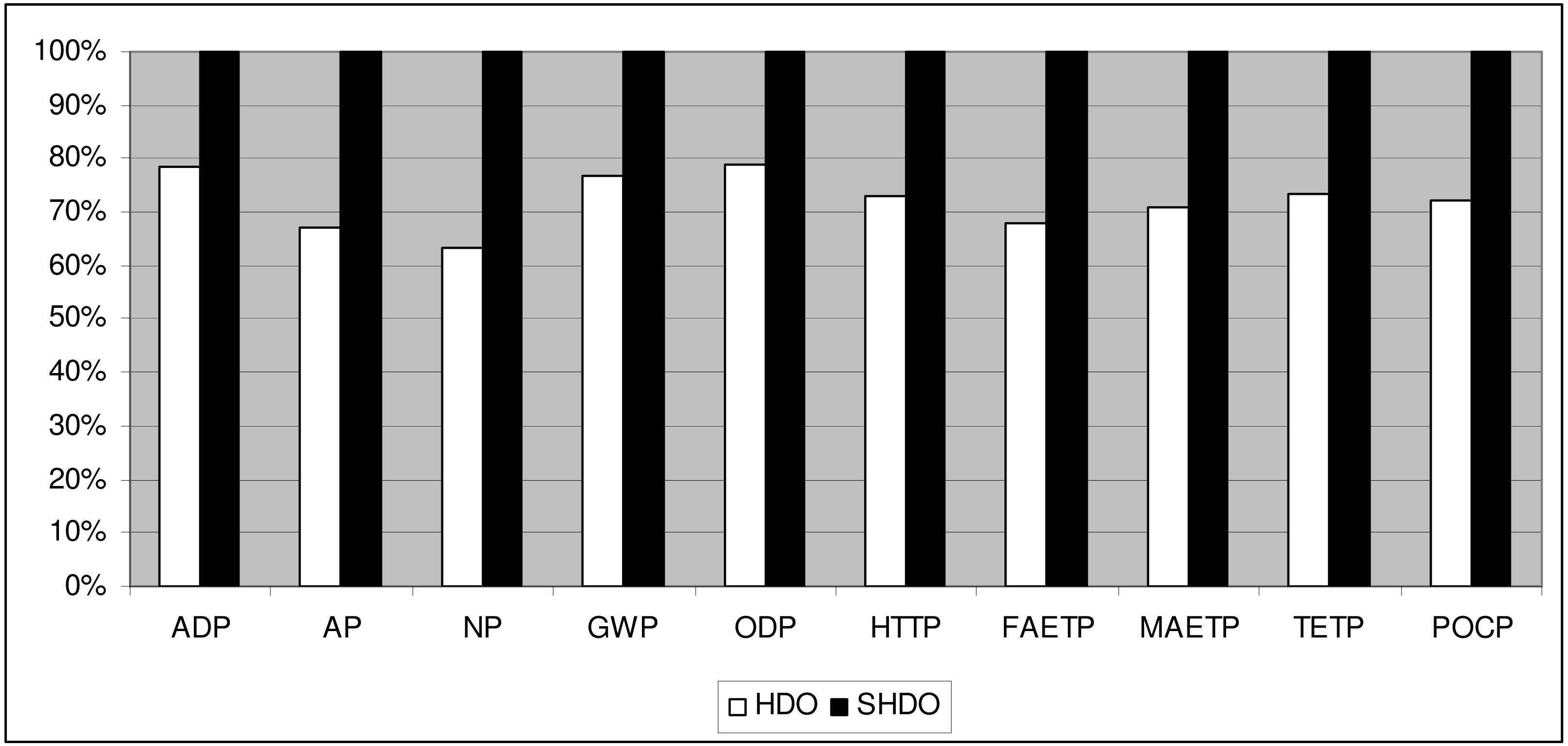
..but the **investment** in innovative systems **becomes economically convenient only if olives price grows up a certain level**.

The **IRR criterion is rather better for the HDO up to a certain price level**, above which the SHDO performance exceeds that of HDO.



Results of the environmental analysis

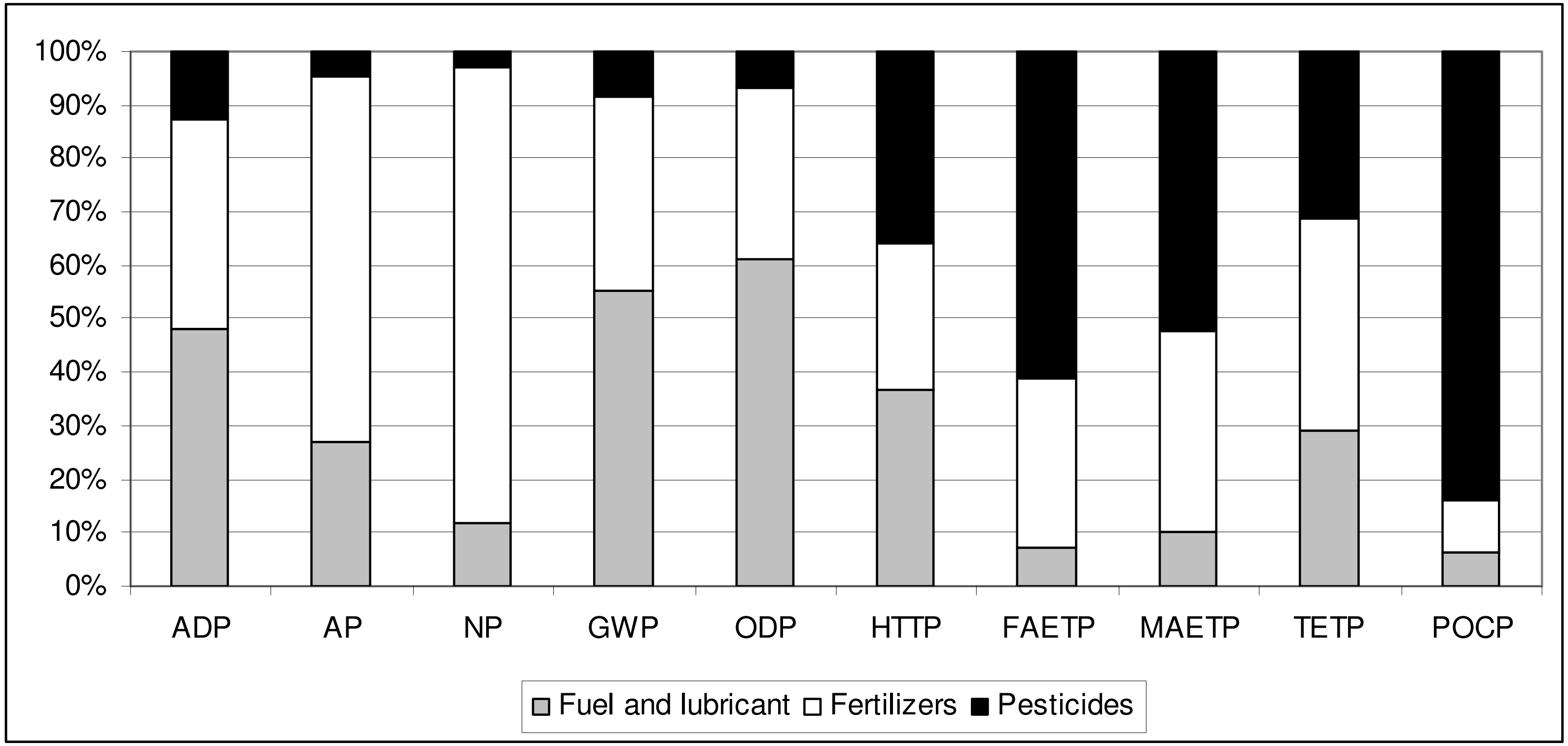
Environmental characterization of the two olive systems (during the reference period)



The **HDO system scores better than the SHDO** one in all the environmental impact categories with a percentage from 21% to 37%.

The FP phase presents in both the systems the major impact (more than 75% of the whole impact in all the impact categories in HDO, between 50-75% in SHDO).

Environmental characterization of the FP phase in the HDO system



In both models **fuels impact more on the categories linked to the energy supply and use** (**ADP, GWP, ODP, HTP**); fertilizers impact more on AP and **NP** due to the emissions of nitrogen and phosphorous compounds; **pesticides impact more on the toxicity categories** (**FAETP, MAETP, HTP**) **and on POCP**; **TETP is shared in almost the same way between the three items**.

Concluding remarks (1)

The **HDO has shown better economic and environmental performances respect to the SHDO.**

1.Despite the lower operating costs of the SHDO, due to the complete mechanization of pruning and harvesting operations, **these costs are counterbalanced by higher initial investment costs** that the farm has to charge three times than the HDO system.

2.The environmental analysis **has also shown a better performance of the HDO system for all the impact categories,** due to **a lower use of energy and chemical inputs** and **to higher olive yields**.

Concluding remarks (2)

At the current market conditions (olives price <400 €/t) and **without any public support** (subsidy to investment and decoupled direct aids) **the adoption of innovative olive-growing models is not a viable strategy**.

Despite our hypothesis that assume the two models produce olives with the same quality, **the SHDO produce a "commodity olive oil" that doesn't allow the adoption of any differentiation strategy** (e.g. **PDO label**).

When innovative systems are compared, the analysis must consider the whole life cycle (not only a single production phase or cultivation technique), **considering both economic and environmental performances by using a common database**.

Thank you for your attention!

Dr. Luigi Roselli
Dept. PROGESA
University of Bari, Aldo Moro
Via G. Amendola 165/A – 70126 Bari (ITALY)
Phone: +39 0805443603
Fax. +39 0805442527
Email: roselli@agr.uniba.it