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Aberdeen, 09-12 June 2009

2007 - 2013 SEVENTH FRAMEWORK PROGRAMME

SUMMA

Italian Case Study

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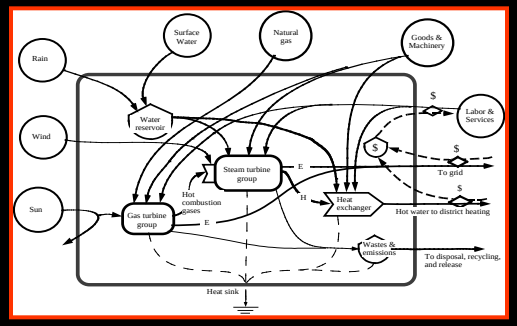
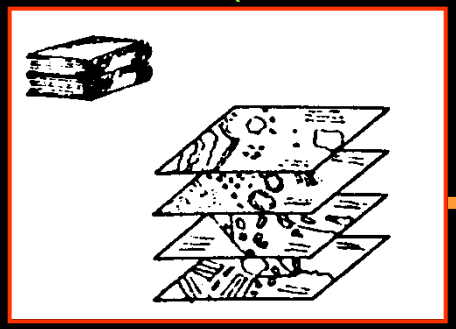
SUMMA: how it works

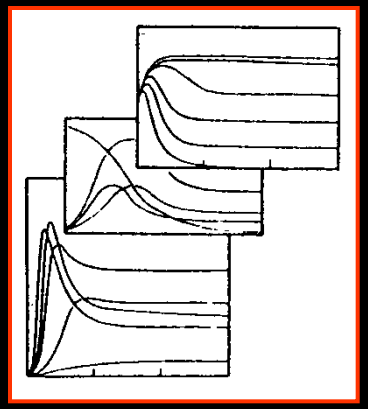
1. Identification of the problem and design of a system diagram



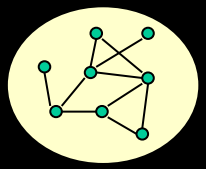
2. Data collection (on field, statistical, GIS)



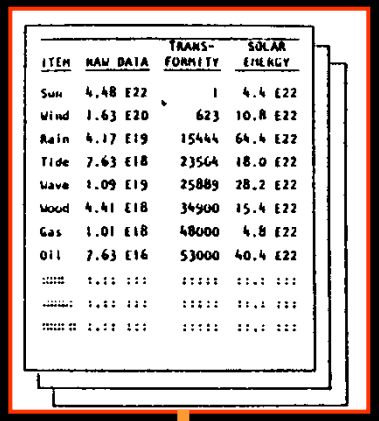
6.Trends, simulations



7. Assessing complexity and dynamics of the system



3. Calculation Procedures and Tables



ITEM	RAW DATA	TRANS-FORMITY	SOLAR ENERGY
Sun	4.48 E22	1	4.4 E22
Wind	1.63 E20	623	10.8 E22
Rain	4.17 E19	15444	64.4 E22
Tide	7.63 E18	23564	18.0 E22
Wave	1.09 E19	25889	28.2 E22
Wood	4.41 E18	34900	15.4 E22
Gas	1.01 E18	48000	4.8 E22
Oil	7.63 E16	53000	40.4 E22

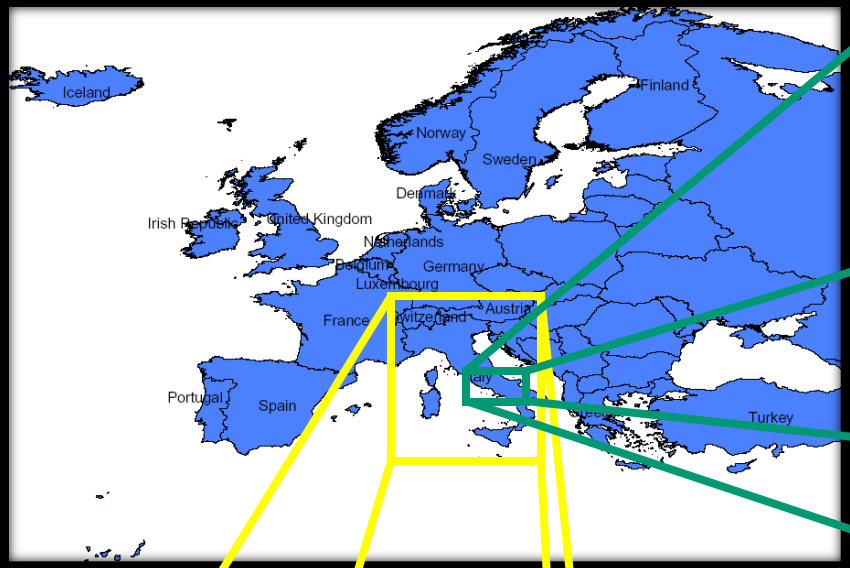
4. Results and Indicators
- Energy
- Material Flows
- Emergy
- Emissions

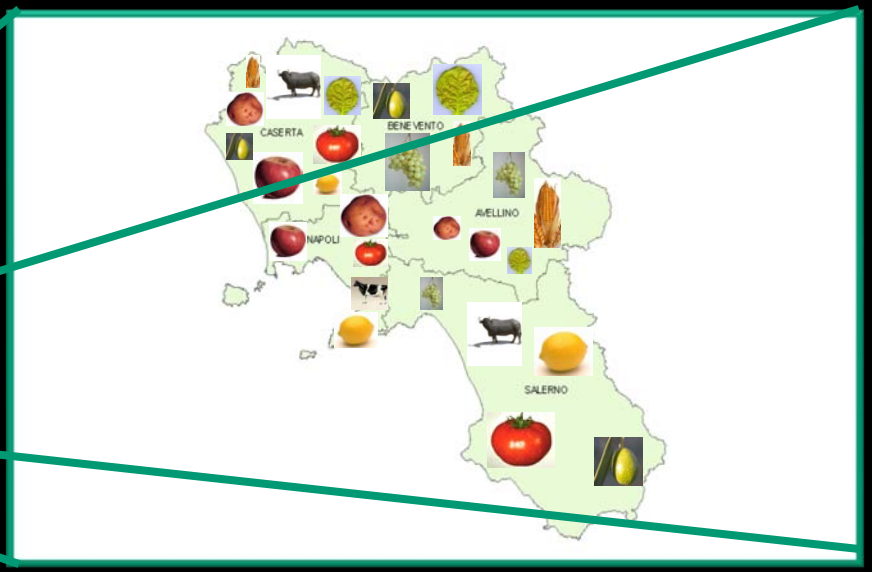
5. Aggregation into impact categories

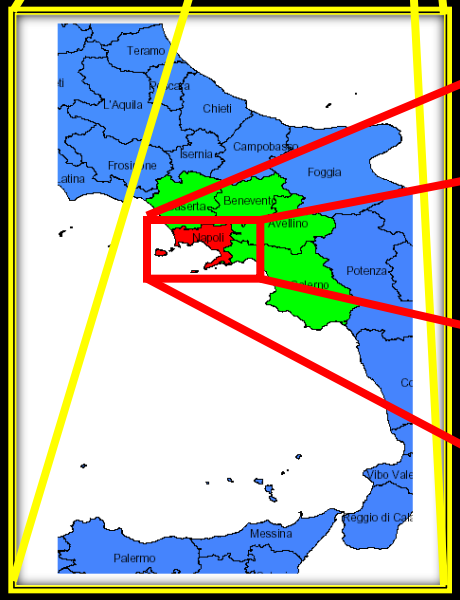
1. The system(s)

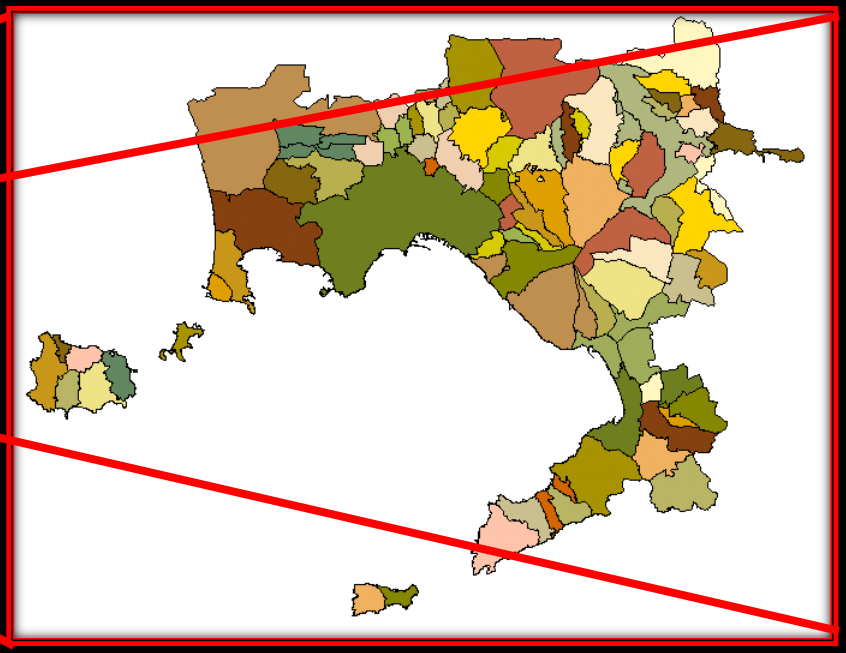
Agricultural Sector, tree different levels:

- N+1: Whole Italy
- N: Campania Region
- N-1: Farm Level (Lemon, Olive, Wineyard)

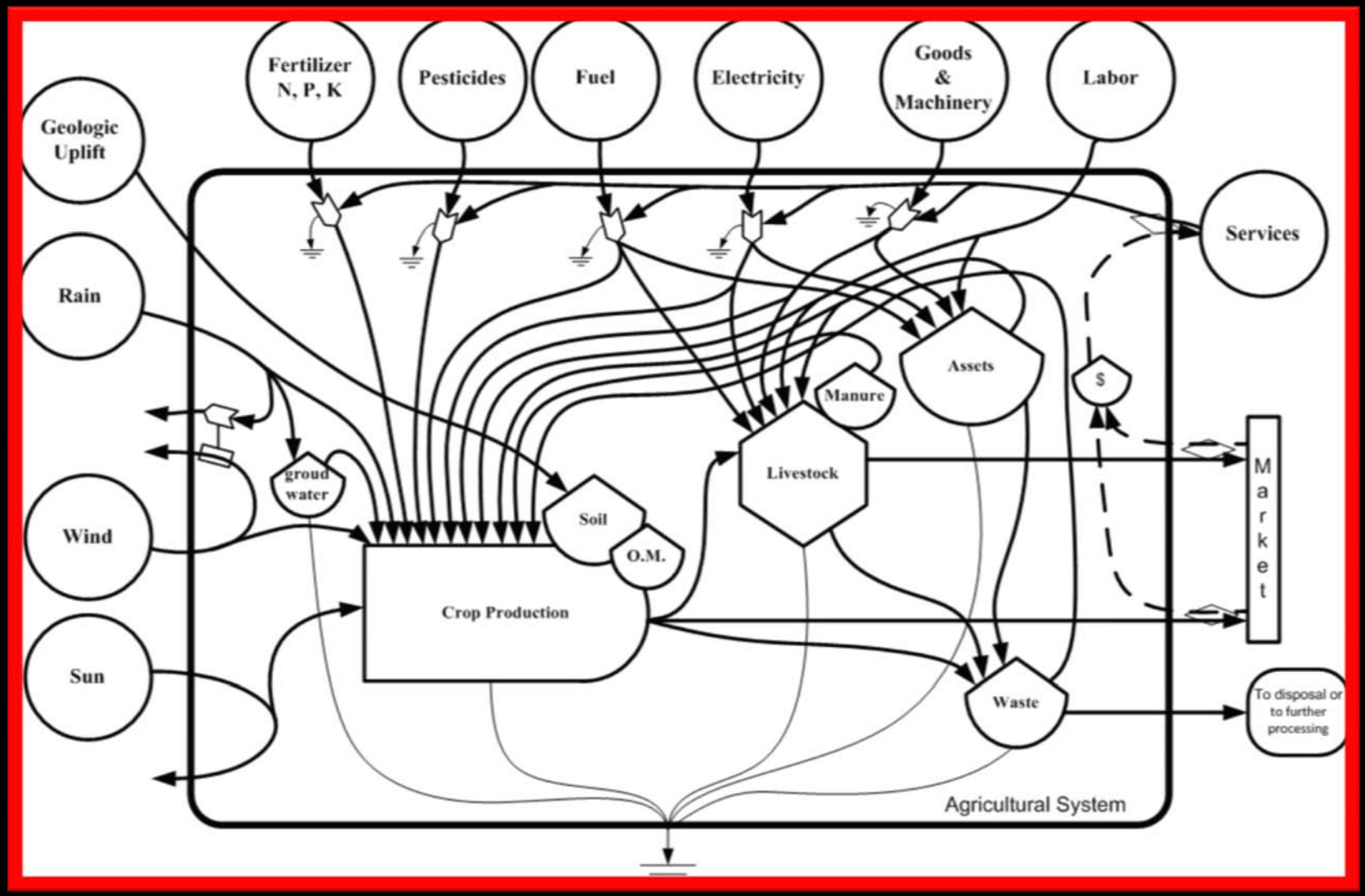

Iceland
Finland
Norway
Sweden
Denmark
Irish Republic
United Kingdom
Netherlands
Belgium
Germany
Luxembourg
France
Switzerland
Austria
Italy
Portugal
Spain
Turkey


CASERTA
BENEVENTO
AVELLINO
NAPOLI
SALERNO


Teramo
L'Aquila
Chieti
Campobasso
Isernia
Foggia
Benevento
Avellino
Potenza
Palermo
Messina



Systems diagram(s):



2. What kind of Data?

For the agricultural sector:

Environmental: Solar Radiation, Rainfall, Wind, Deep Heat, Land Used, Soil Erosion;

Goods: Fuels, Machinery, Electricity, Water, Fertilizers, Pesticides, other…;

Labor: hours invested within the process; cost of labor;

Services: Cost of goods (indirect labor) ;

Output: Energy Content, Dry Matter, GMP (Gross Money Value);

The SUMMA Calculation procedure must be adapted to the investigate system !

The User Interface:

Entering input data, units and references

Multi-Method Analysis

(Material Flow Accounting, Embodied Energy Analysis and Emergy Analysis)
Values refer to Italy Agricultural national scale in the year 1985

#	Item	Value	Unit	Reference
1	**Sun** Insolation (average)	1.28E+02	kcal/cm2/yr	[ENEA, 1989; average of different Italian locations]
2	**Wind** Wind velocity (average 1985)	4.06	m/s	[ISTAT-Meteorological statistics - 1985]
3	**Rainfall** Rain (average 1985)	0.68	m/yr	[ISTAT-Meteorological statistics - 1985]
	Fraction of water that is evapotranspired	0.45		[APAT- Gli indicatori del Clima in Italia nel 2005]
4	**Deep Heat** (Average heat flow per area)	1.85E+02	mW/m^2	[Map of Italy CNR, 1991]
7	**Soil Erosion**	1.56E+02	g/m^2/yr	[estimated from Magaldi et al., 1981]
8	**Gasoline (unleaded)**	1.79E+08	Kg/yr	[ISTAT-Agricultural statistics-1985]
	Gasoline price	0.73	€/L	[Unione Petrolifera - Relazione Annuale 1985]
9	**Diesel and heavy fuel**	1.54E+09	Kg/yr	[ISTAT-Agricultural statistics-1985]
	Diesel price	0.33	€/L	[Ribaudo-Prontuario dell'agricoltura-1983(*)]
10	**Electricity**	3.28E+09	kWh/yr	[www.tena.it - 1985 (§)]
	Electricity price	0.09	€/kWh	[Ribaudo-Prontuario dell'agricoltura-1983(*)]
11	**Water for irrigation**			
	Volume of water used	7.89E+09	m^3/yr	[average value, Ribaudo-Prontuario dell'agricoltura-1983]
	Water for irrigation price	0.12	€/m^3	[Ribaudo-Prontuario dell'agricoltura-1983]
12	**Fertilizers**			
12a	Nitrogen (N)	1.01E+07	q/yr	[ISTAT-Agricultural statistics-1985]
	Nitrogen (N) price	12.97	€/q	[Ribaudo-Prontuario dell'agricoltura-1983(*)]
12b	Phosphate (PO4)	6.10E+06	q/yr	[ISTAT-Agricultural statistics-1985]
	Phosphate (PO4) price	9.86	€/q	[Ribaudo-Prontuario dell'agricoltura-1983(*)]
12c	Potassium (K2O)	3.40E+06	q/yr	[ISTAT-Agricultural statistics-1985]
	Potassium (K2O) price	13.17	€/q	[Ribaudo-Prontuario dell'agricoltura-1983(*)]
13	**Fungicide**	8.39E+07	kg/yr	[ISTAT-Agricultural statistics-1985]
	Fungicide price	3.03	€/kg	[Ribaudo-Prontuario dell'agricoltura-1983(*)]
14	**Insecticides**	3.45E+07	kg/yr	[ISTAT-Agricultural statistics-1985]
	Insecticides price	2.04	€/kg	[Ribaudo-Prontuario dell'agricoltura-1983(*)]
15	**Acaricides**	1.94E+06	kg/yr	[ISTAT-Agricultural statistics-1985]
	Acaricides price	5.85	€/kg	[Ribaudo-Prontuario dell'agricoltura-1983(*)]
16	**Agricultural Machinery**			
16a	***Tractor (as a whole)***	3.40E+06	g	[average value, www.tuttoagri.com]
16b	***Pumps and miscellaneous machinery***	3.85E+05	g	[average value, www.vangatrici.com]
	Number of machinery	3.08E+06	number	[ISTAT-Struttura e produzione delle aziende agricole-1985]
	Total machinery	5.83E+12	g	
	Life time	10.00	yr	Our assumption
	Land served	1.70E+07	ha	[ISTAT-Agricultural statistics-1985]
17	**Plastics for greenhouse and land cover**	n.a	g/ha	
18	**Steel for crop support**	n.a	g/ha	
19	**Assets (mainly concrete of barns and infrastructure)**	n.a	g/ha	
20	**Human Labor**			
	Farm worker (women)	8.10E+05	persons	[ISTAT-Detection workforces-1985]
	Farm worker (men)	1.43E+06	persons	[ISTAT-Detection workforces-1985]
	Total Farm worker	2.24E+06	persons	[ISTAT-Detection workforces-1985]
	Total applied labor	5.47E+08	hrs/yr	[ISTAT-Detection workforces-1985]
	Unit labor cost	2.10	€/hrs	[average value, After Ribaudo, 1983 updated to inflation]
22	**Products**			
	Economic value of agricultural production	1.85E+10	€/yr	[ISTAT-http://www.istat.it/dati/dataset/20070601_00/-1985]
	Mass of agricultural production (dry matter)	1.25E+14	g dry matter/y	[our calculculation, INRAN[1]]
	Energy content of agricultural production	2.02E+18	J/yr	[our calculation from different reference: INRAN[1] and ENEA[2]]
	Total Agricultural area of Italy =	1.70E+07	ha/yr	[ISTAT-Agricultural statistics-1985]

3. Calculation of intensity factors

1	2	3	4	5		6
Note	Item	Raw amount	Units	Intensity Factor (unit/unit)		Total Amount (unit/yr)
			×			
1.	First item	xx.x	g or J/yr	xxx.x	=	xxx.x
2.	Second item	xx.x	g or J/yr	xxx.x		xxx.x
..						
..						
n.	n^{th} item	xx.x	g or J/yr	xxx.x		xxx.x
O.	Output	xx.xx	g or g/yr	xxx.x		$\sum_{n}^{1} Ej$

Intensity factor of output= Total Amount /Generate product

4. Results

Results: Assessing Efficiency and Performance

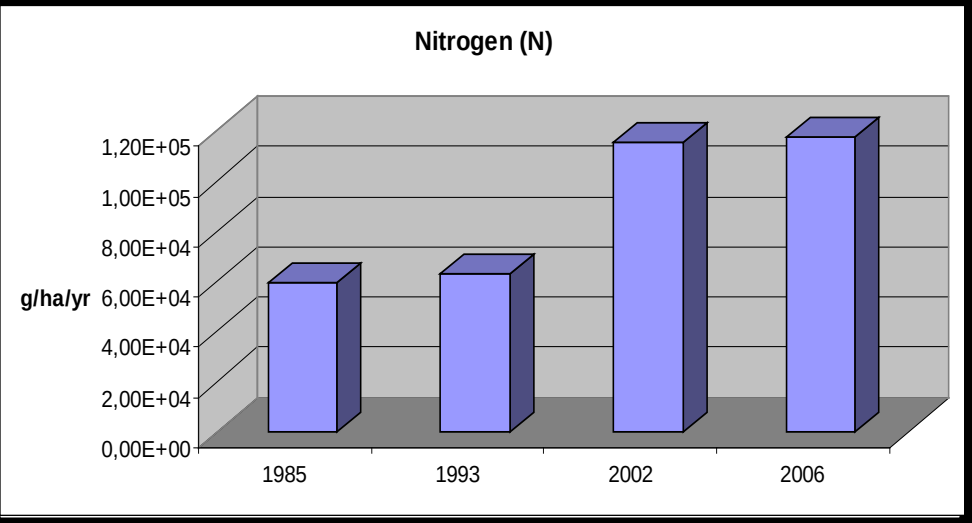
The first result of SUMMA is a set of input flows, intensity factors and performance indicators based on selected economic, material, energy and environmental evaluation methods, for a given system and a given year.

The inventory of input flows (e.g. amount of fertilizers, amount of water) indicates what kind of resources support the process (and need to be ensured).

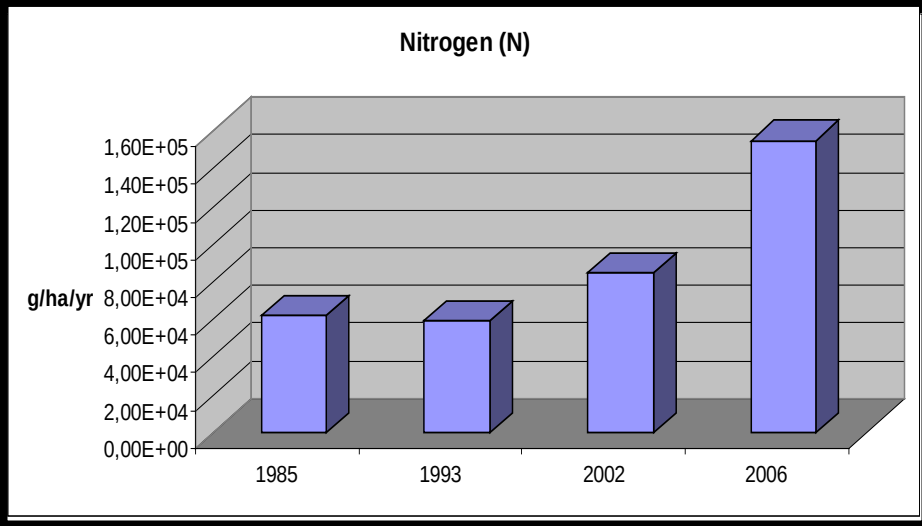
Intensity factors (e.g. price, energy cost per unit product,…) indicates the use efficiency of input resources within the system.

Performance indicators (e.g. environmental loading ratio) indicate how much the system responds to a given concern (e.g.: % use of renewables, or % use of local resources).

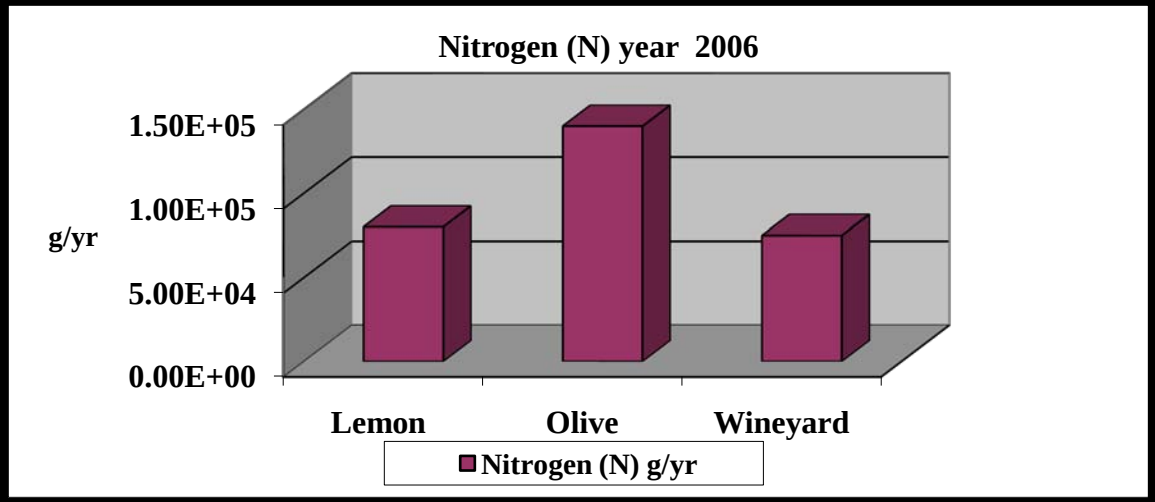
Input data: Nitrogen use



Italy-National level

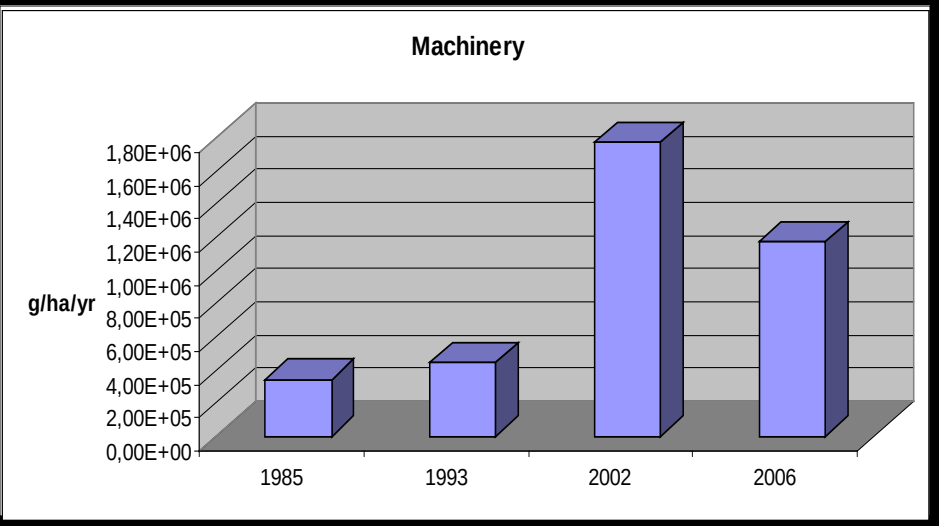


Campania Region

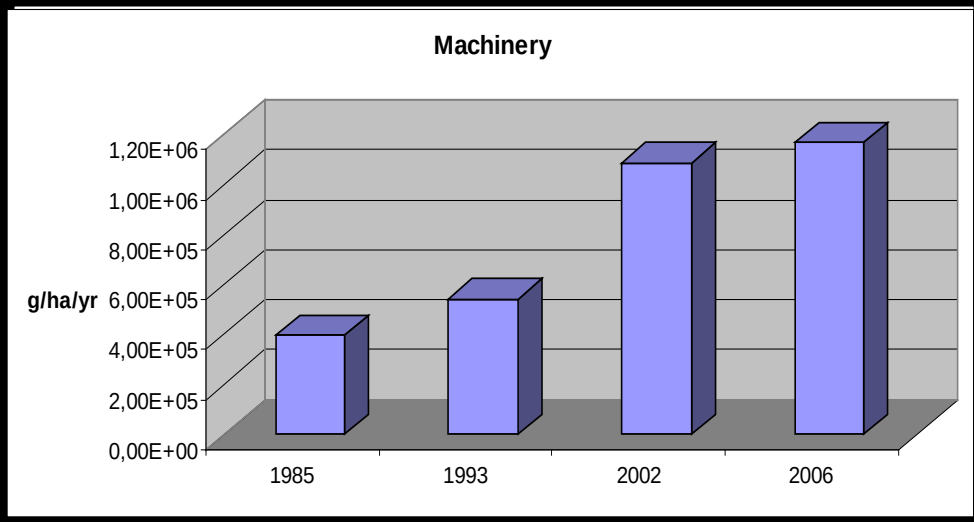


Farm Level

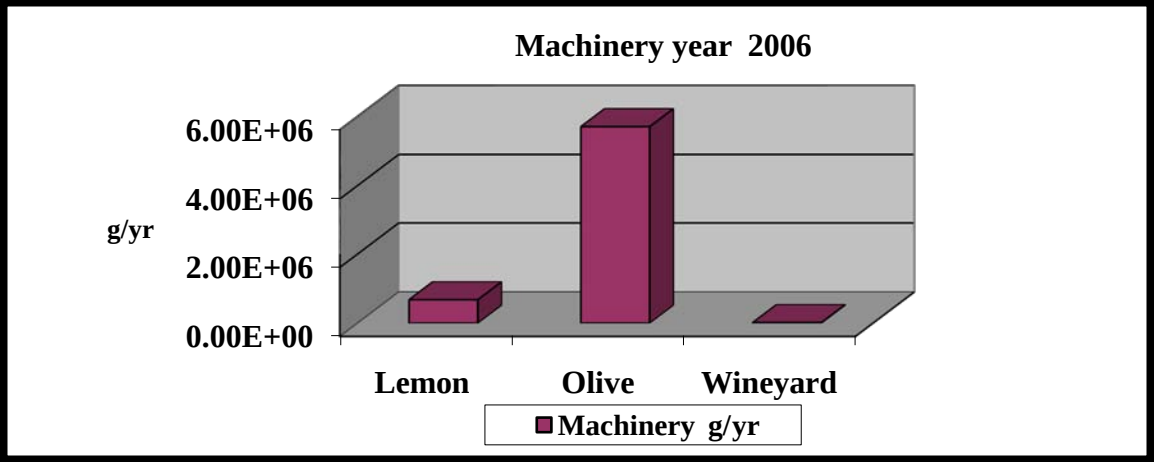
Input data: Machinery



Italy-National level

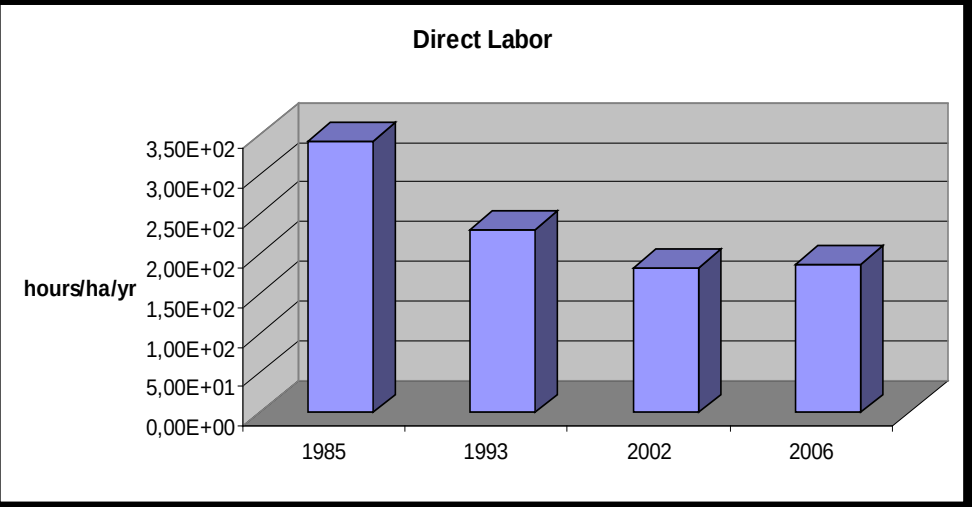


Campania Region

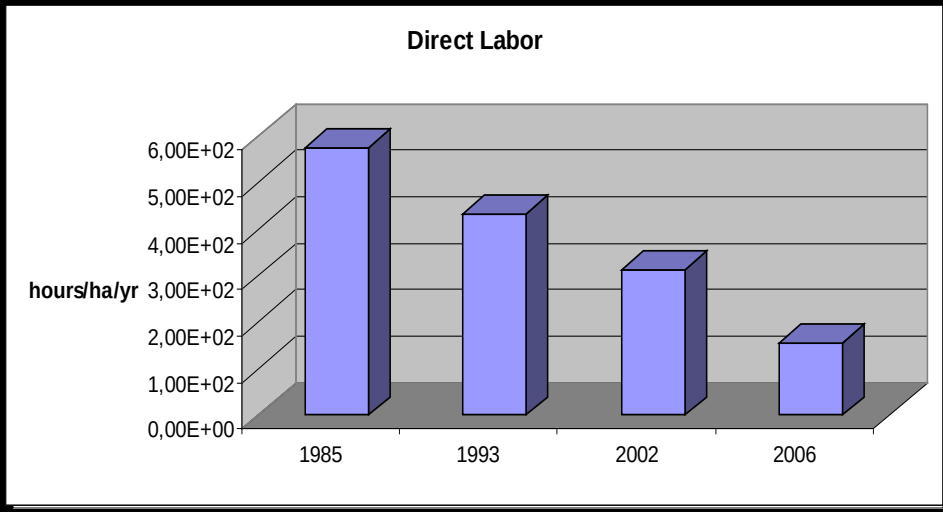


Farm Level

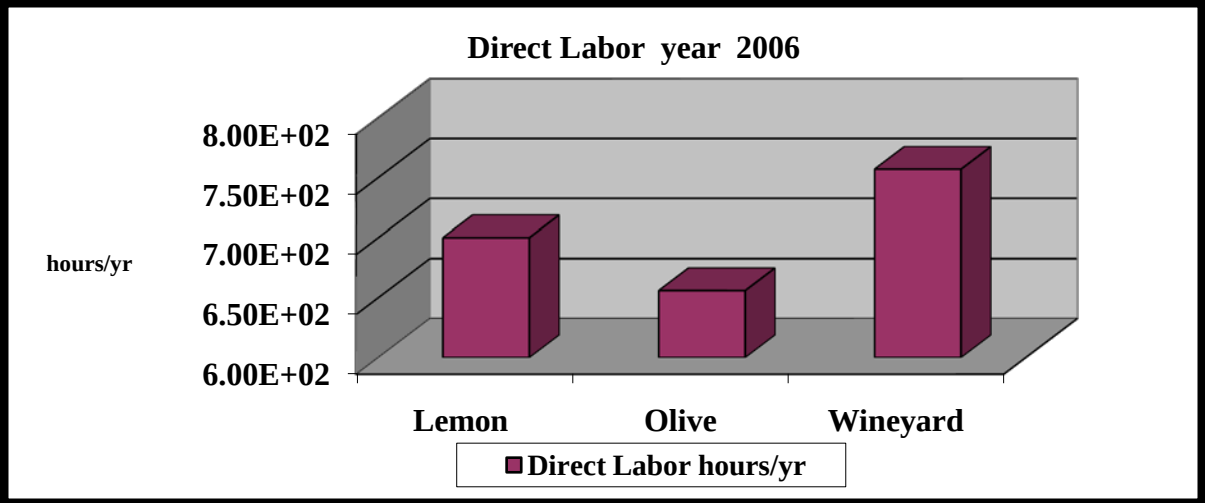
Input data: Direct labor



Italy-National level



Campania Region



Farm Level

5. Aggregation into impact categories

Embodied Energy Requirement (large scale)	Unit	2006
Intensive Indicators		
Oil equivalent intensity per € of product	g_{oil}/€	1.62E+02
Oil equivalent intensity per ha	goil/ha	5.97E+05
Oil equivalent intensity per g of dry matter	g_{oil}/g dry matter	0.07
Oil equivalent intensity per J of Energy content	g_{oil}/J	4.51E-06
Oil equivalent intensity per hour of labor	g_{oil}/hour	3.84E+03
Energy Intensity per € of product	J€	6.79E+06
Energy Intensity per ha	J/ha	2.50E+10
Energy Intensity per g of dry matter	J/g dry matter	2.96E+03
Energy Intensity per J of product	J/J	0.19
Energy Intensity per hour of labor	J/hour	1.61E+08
Extensive Indicators		
EROI (Energy of products/Total embodied energy applied)		5.30
Total emboded energy applied	J/yr	1.51E+16
Total oil equivalent applied	g $_{oil}$/yr	3.60E+11
Global to local Energy ratio		2.95
Emergy flows	Unit	2006
Intensive Indicators		
Specific Emergy of monetary value (with L&S)	sej/€	4.57E+12
Specific Emergy of ha (with L&S)	seJ/ha	4.33E+15
Specific Emergy of unit of dry matter (with L&S)	seJ/g dry matter	3.98E+09
Transformity (with L&S)	seJ/J	1.27E+05
Emergy Yield Ratio (with L&S) = U/(F+L+S)		1.13
EIR (with L&S) = 1/(EYR-1)		7.93
Environmental Loading Ratio (with L&S) = (N+F+S)/(R)		5.67
%REN (with L&S) = 1/(1+ELR)		0.15
EYR/ELR (with L&S)		0.20
Specific Emergy of monetary value (without L&S)	sej/€	1.17E+12
Specific Emergy of ha (without L&S)	seJ/ha	4.33E+15
Specific Emergy of unit of dry matter (without L&S)	seJ/g dry matter	5.08E+08
Transformity (without L&S)	seJ/J	3.26E+04
Emergy Yield Ratio (without L&S) = U*/F		1.77
EIR (without L&S) = 1/(EYR-1)		1.30
Environmental Loading Ratio (without L&S) = (N+F)/(R)		1.34
%REN (without L&S) = 1/(1+ELR)		0.43
EYR/ELR (without L&S)		1.32
Extensive Indicators		
Locally renewable inputs, R (without double counting)	sej/yr	1.11E+21
Locally nonrenewable inputs, N	sej/yr	2.18E+19
Purchased inputs to agricultural phase, F (without L&S)	sej/yr	1.47E+21
Direct Labor	sej/yr	2.72E+21
Indirect labor (services)	sej/yr	4.82E+21
Total emergy inputs to agricultural phase, U= (R+N+F+L+S)	sej/yr	1.01E+22
Total emergy inputs to agricultural phase, U*= (R+N+F)	sej/yr	2.61E+21

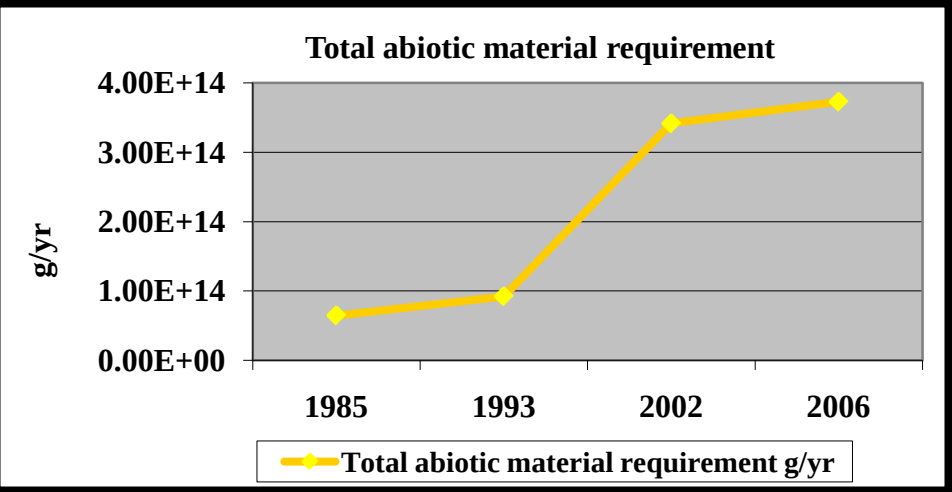
6. TRENDS

A second result from SUMMA is the possibility to generate performance trends over time.

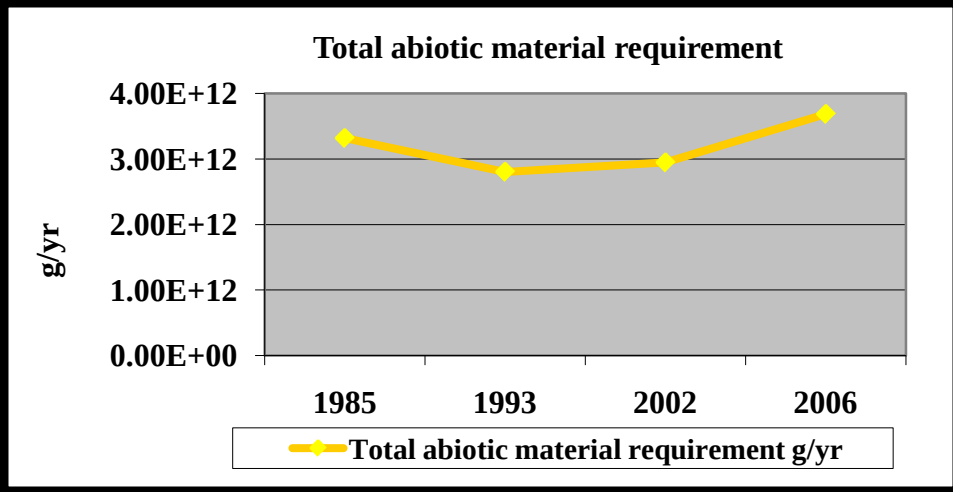
Our excel files (YEARLY PERFORMANCE) can be applied to several years and generate hystorical series.

Results are transferred into another excel file (TRENDS), in which yearly figures are used to generate diagrams over time.

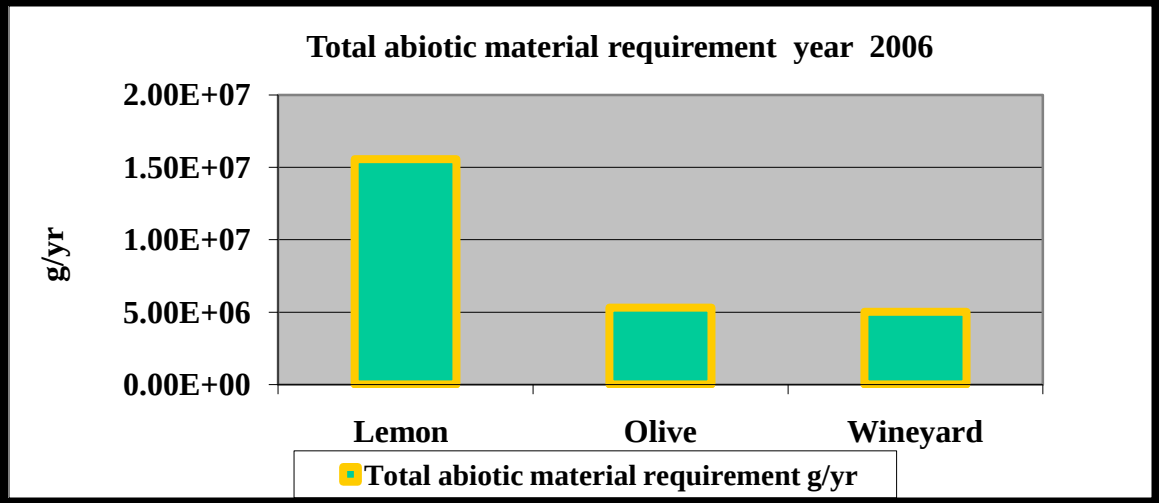
4. Trends: Material demand



Italy-National level

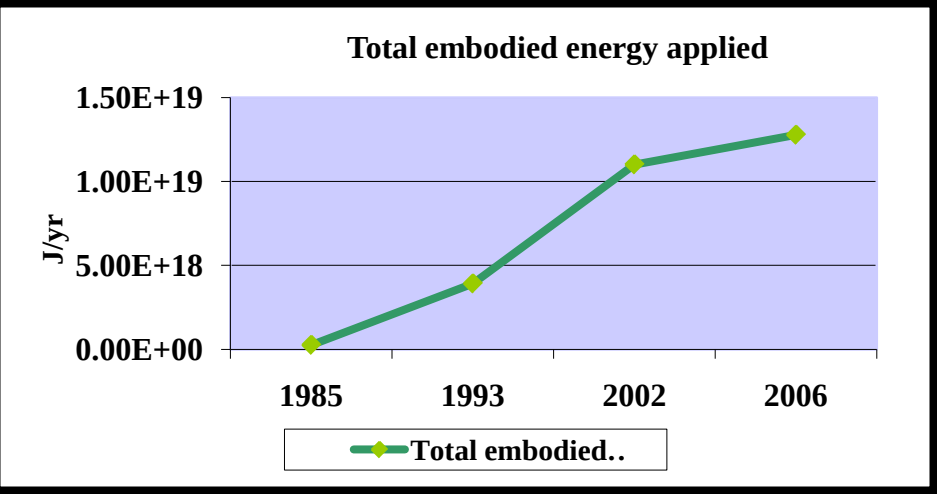


Campania Region

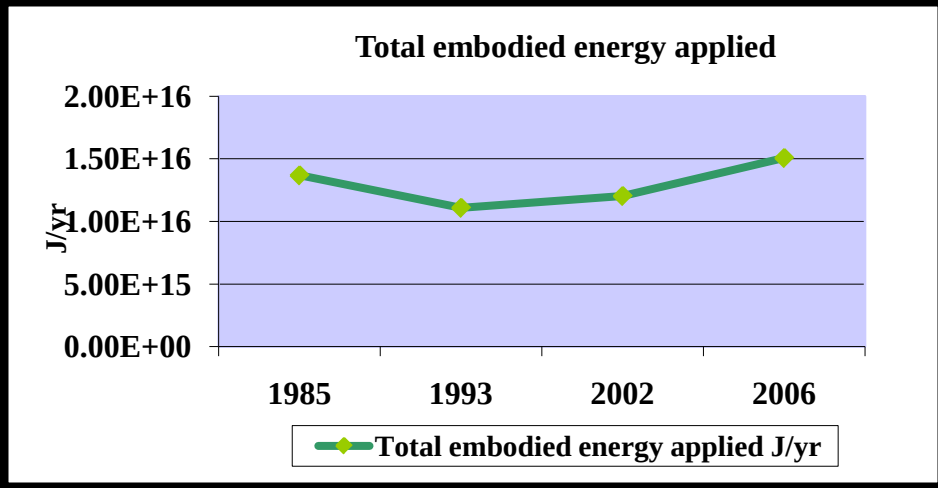


Farm Level

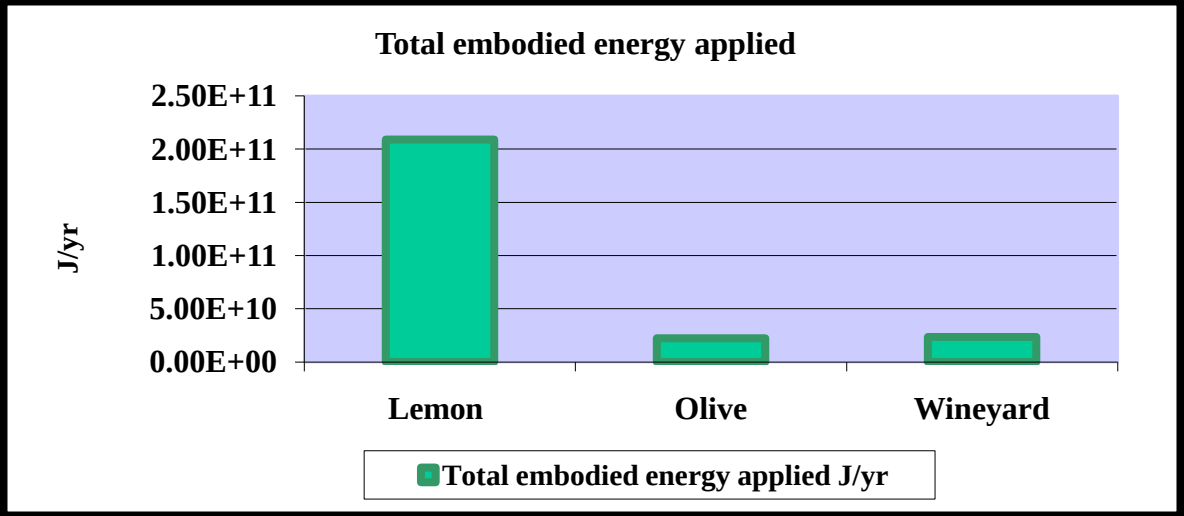
4. Trends: Energy demand



Italy-National level

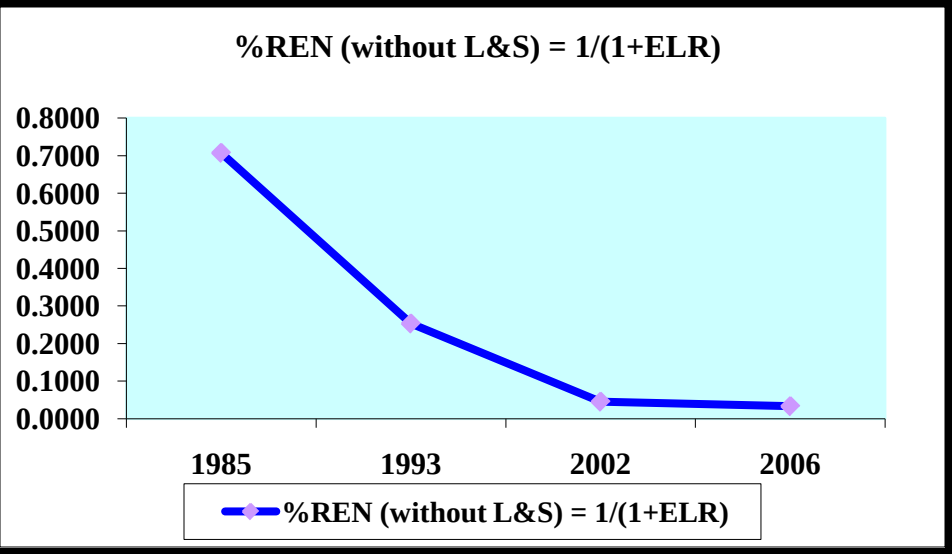


Campania Region

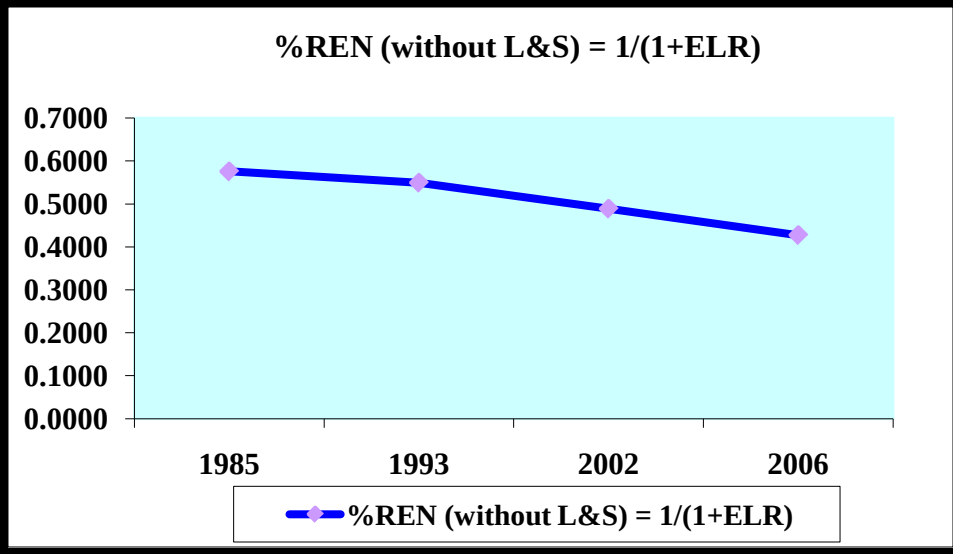


Farm Level

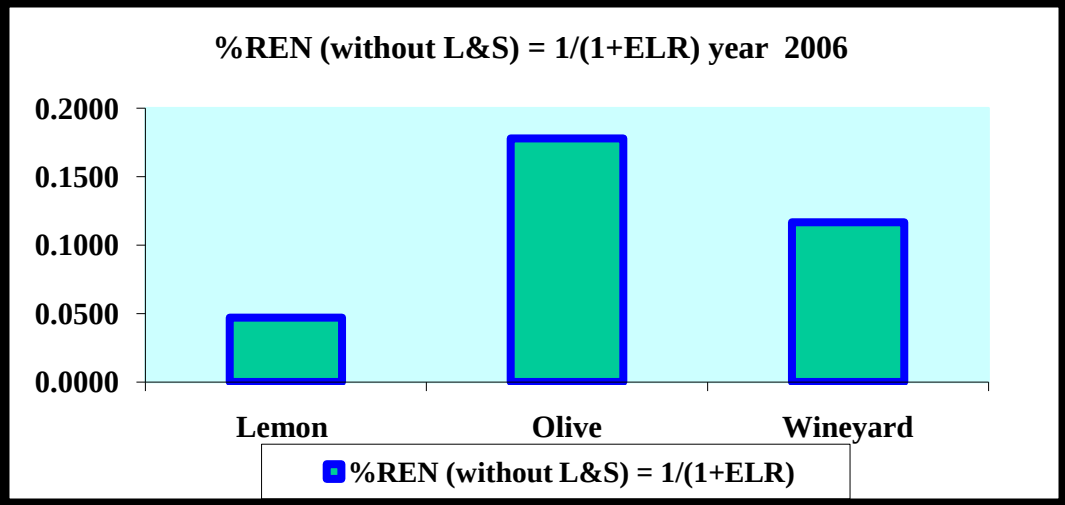
4. Trends: % renewable emergy



Italy-National level

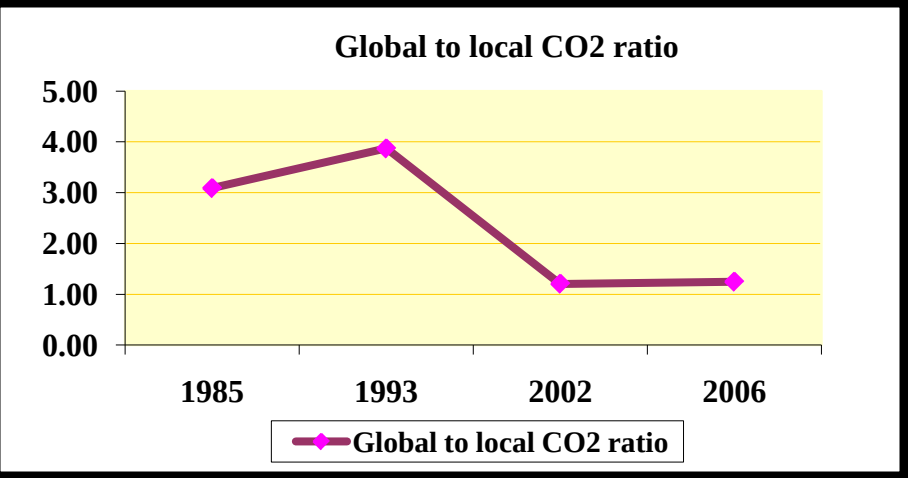


Campania Region

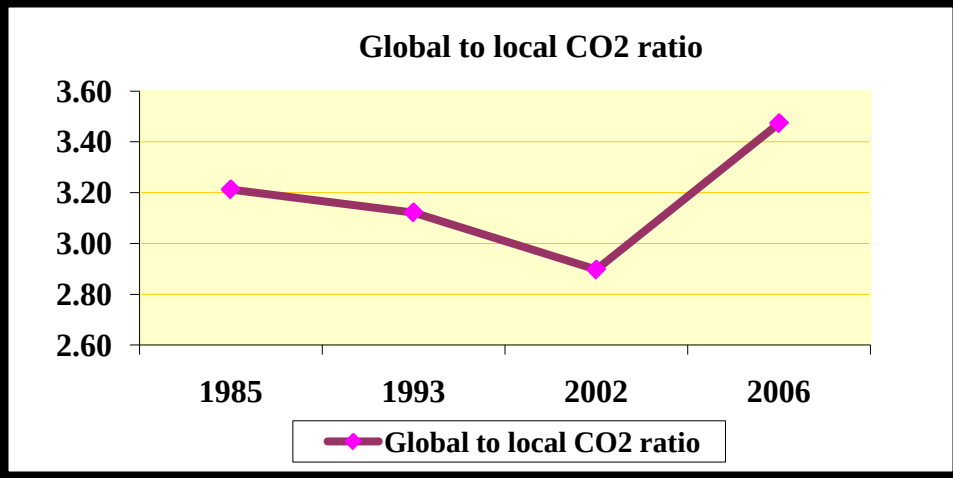


Farm Level

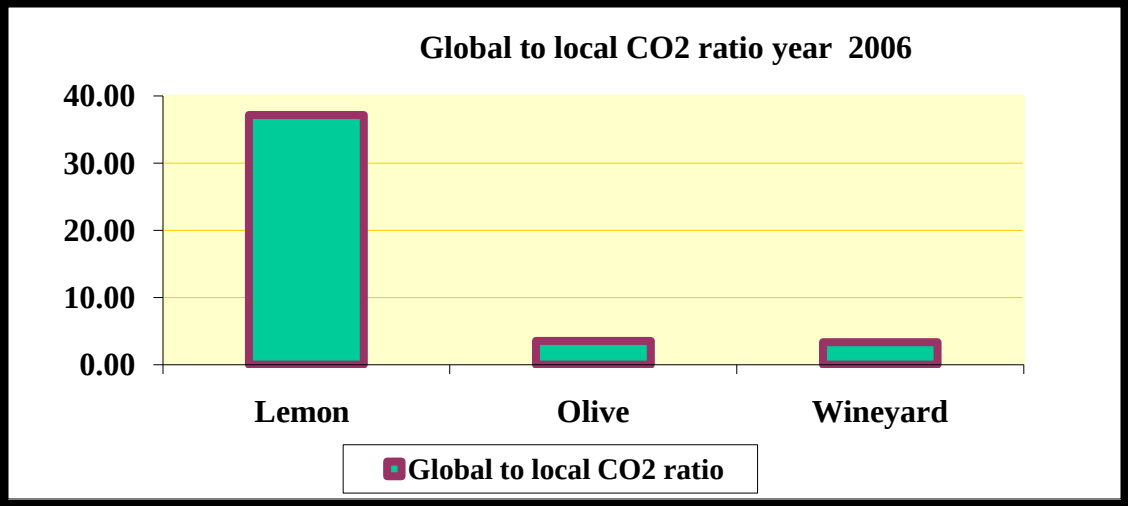
5. Trends: Global to local CO2 ratio (how local choices affect the global scale)



Italy-National level



Campania Region



Farm Level

Conclusions. 1

SUMMA is not a software in itself, applicable to all cases, but must be adjusted to each system by a person who knows the approach. It could become a software (linked to MUSIASEM and ASA) if software experts are involved.

Conclusions. 2

All methods used in SUMMA (MFA, EEA, EXA, EMA, Emission Accounting, Economic Accounting) are based on the same set of input data.

This makes all the results consistent to each other, even if they are obtained by means of different methods and according to different scales.

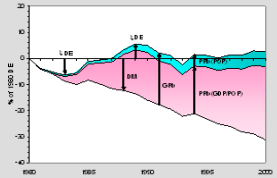
Conclusions. 3

Application of SUMMA to three levels of Italian agriculture (national, regional, farm) points out the different needs, intensities and performances in resource use.

Application of SUMMA to different years highlights trends at different scales.

SUMMA also allows to quantify the extent to which results are affected by changes of extensive and intensive parameters as well as by structural characteristics of the system.

SUMMA within the DECOIN Toolkit



Performance parameters

Cross-scale constraints

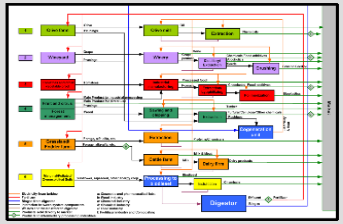
Scenarios

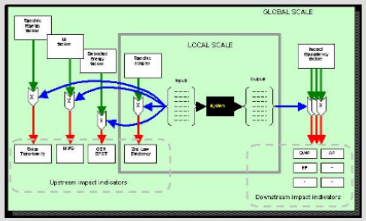
Investi-gated System

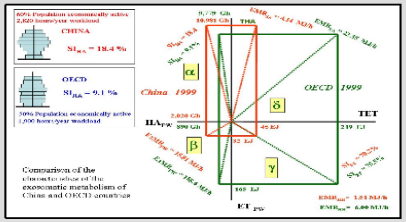
SUMMA

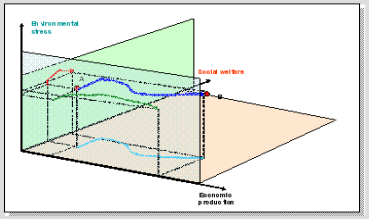
MSIASEM

ASA









Results from SUMMA must be transferred to MUSIASEM and ASA for final processing.

Perspectives

1. The DECOIN toolkit is not a software, but could become such if software experts are involved;

2. In the present project, the toolkit provides information about the dynamics of the case studies.

3. The potential conversion of the tookit into a software requires to develop: (a) a suitable structuring of selected typologies of case studies; (b) a series of calculation procedures; (c) libraries and a procedure for their update.

Thank you for your attention !

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