ENVIRONMENTAL FRIENDLY AGRICULTURE:
new challenges for the farm of tomorrow

Massimo Fagnano
fagnano@unina.it

University of Naples
Federico II

OUR MAIN RESEARCH AREAS:

- Effects of environmental pollution on crops

Fagnano M., Maggio A., Fumagalli I., 2009. Crops responses to ozone in Mediterranean Environment. Environmental Pollution 157, 1438-44.

Fagnano M., Merola G., 2007. Ozone and water stress: effects on the behaviour of two white clover biotypes. Italian J. Agronomy, 2, 3-12.

- Soil fertility managment in Mediterranean environment

Spaccini R. , Sannino D. , Piccolo A. , Fagnano M., 2009. Molecular changes in organic matter of a compost-amended soil. European J. Soil Science 60, 287-9.

Fiorentino N., Fagnano M., Caputo R., Donatiello S., Quaglietta Chiarandà F., 2008. Green manure as a tool for improving C and N balance of Mediterranean cropping systems. Italian Journal of Agronomy, 3, 327-328.

- Environmental impact of agricolture

Diodato N., Fagnano M., Alberico I., 2009. CliFERM – Climate Forcing and Erosion Response Modelling at Long-Term Sele River Research Basin (Southern Italy). Natural Hazard and Earth System Science, 9, 1693-1702 .

Zampella M.V., Adamo P., Fiorentino N., Fagnano M., 2009. Nitrogen and potentially toxic metals accumulation in the soil-plant system after fertilization with compost from urban wastes in field condition. Waste management (submitted).

Fagnano M., 2008. The effects of irrigation on soil fertility: a relevant issue for organic farming. 16th IFOAM Organic World Congress, , 18 – 20 June 2008, Modena, Italy, pag 4.

NEW AIMS OF AGRICULTURE:

→ environmental (and cultural) services for the Society needs

Cultural heritage and traditions

- To protect the landscapes (and biodiversity)

- To produce typical (and high quality) foods

Atmospheric quality

-To reduce GHGs emissions

Water pollution

- To protect watertables (nitrate leaching)

Soil quality

-To reduce erosion

-To clean polluted soils

Urban sustainability

- To produce raw materials for biodegrable products

The aims (obviously) are not exclusive.
In other words,
the choice of the cropping system allows to satisfy more than one aim

i.e. Organic fertilization:

- **Soil fertility**
- **Erosion**
- **Soil C sink (GHGs reduction)**
- **Nitrate pollution**
- **Soil biodiversity**
- **Energy saving,**
- **…….**

Therefore we will show not only <u>main effects</u> but also <u>collateral effects</u> of the different cropping systems

CULTURAL HERITAGE AND TRADITIONS

To protect the landscapes (and biodiversity)
To produce typical (and high quality) foods

The protection of some millenary landscapes (from abandonment, urbanisation,…)

requires high quality (and high income) productions (*Organic farming and Typical products: wine, lemons, vegetables*) to allow the economical survival of farms

Collateral effects:
- **to reduce erosion,**
- **to improve biodiversity and fertility**
- **to increase soil C sink**

ATMOSPHERIC QUALITY (reducing GHGs emissions)

DIRECT EMISSIONS REDUCTION:

1) lowering soil tillage intensity

(i.e. disk harrow vs. moldboard plough)

Direct effect = **saving fossil fuels**

Collateral effects = **reducing SOM degradation**

(and CO_2 emissions form soils)

reducing soil compaction ***(and erosion, denitrification and N_2O emissions)***

2) Permanent crops in cropping systems (forage or cover crops in orchards)

Direct effect = saving fossil fuels (no tillage is required)

Collateral effects = reducing SOM degradation *(and CO_2 emissions form soils)*

reducing soil compaction *(and erosion, denitrification and N_2O emissions)*

increasing biodiversity

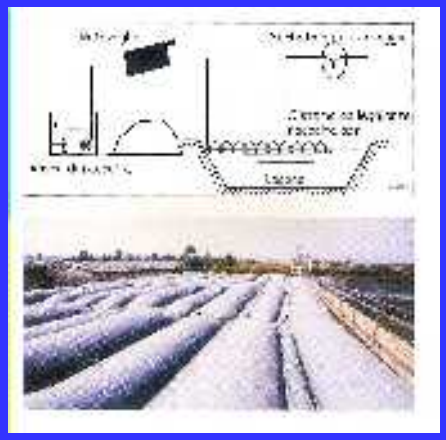
protecting watertable *(nitrate uptake)*

increasing income *(forage, milk, cheese and lower cost of winter pruning)*

RENEWABLE ENERGY PRODUCTION (saving fossil fuels)

Sugar → Ethanol

Oil → Biodiesel



Animal sludge → Biogas

Ligno-cellulosic biomass → electric energy, syngas, ethanol

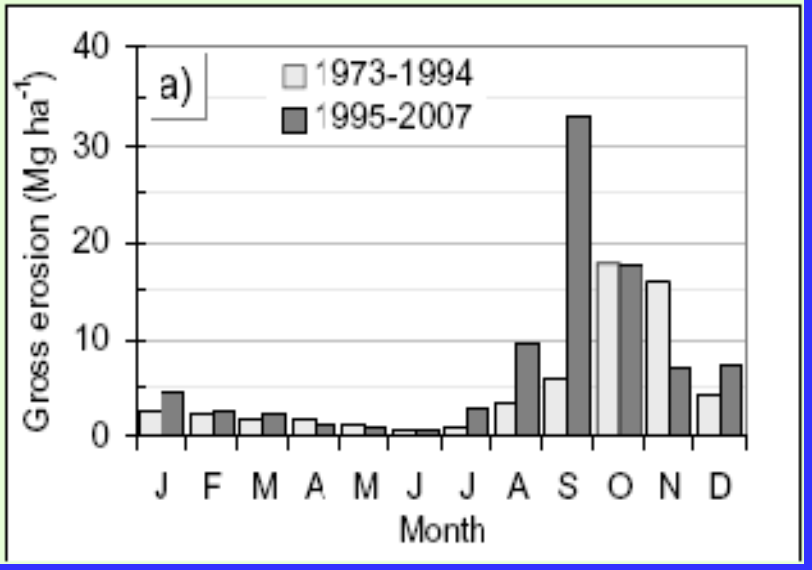
Direct effect = saving fossil fuels (substitution)

Collateral effects = CH_4 emission reduction (animal sludge)
= increasing food price !!!! (crops)

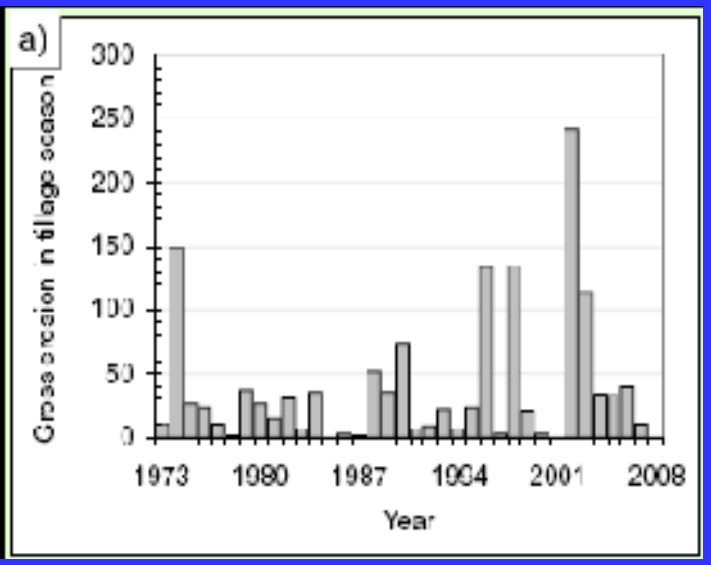
unless we use soils <u>not suitable</u> for food crops:
polluted soils = phyto-remediation
high slope soils = erosion control (SRF)
salinized soils = protect landscapes

Arundo donax growth in polluted soils from industrial deposition (Pb, Cd):

30 Mg ha^{-1} in 6 months !!!



Monthly gross erosion:
1973-1994 vs. 1995-2007



Gross erosion during tillage season of wheat: Aug.-Oct.

In clayey hilly areas, the cereal cropping systems causes very high erosion during the tillage period (August-Ocrober):
bare soil and high rain erosivity.

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Natural Hazard and Earth System Sci. 9, 1693-1702.

In these conditions wheat yield is very low (2-3 Mg ha^{-1}), but soil losses are very high (100-200 Mg ha^{-1}). Permament crops can protect this environment from erosion.

In areas affected by soil erosion, Short Rotation Forestry or permanent energy crops (i.e. Giant reed) could have an overall positive environmental impact

SOIL C SINK INCREASE

Compost amendment, crop residues burying, soil tillage intensity reduction, cover crops, localized irrigation (drip)

Direct effect = Atmospheric CO_2 reduction

Collateral effects
- = soil fertility increase
- = fuel saving *(tillage and irrigation)*
- = nitrate pollution decrease
- = biodiversity increase
- = soil erodibility decrease

N-FERTILIZATION REDUCTION

Direct effect = reduction of CO_2 emission (4 Mg CO_2/ Mg N)

Collateral effects
- = soil biodiversity improvement
- = nitrate pollution decrease
- = N_2O emission decrease *(clayey soils in rainy environments)*

WATER POLLUTION (*Watertables protection form nitrate leaching*)

- increase of Soil C (C:N ratio)
- decrease soil of Mineral N (post-harvest rainy period)
- increase of root uptake activity

COVER CROPS (mainly in autumn period = catch crops)

Collateral effects = See above….

+ reduction of:

- herbicide use
- soil compaction
- soil temperature *(and SOM degradation)*
- soil erodibility

ORGANIC FERTILIZATION (soil C sink increase)

Collateral effects = See above….

SOIL QUALITY

EROSION CONTROL

Cover crops

see above….. (soil C sink, soil compaction, biodiversity,…)

Organic fertilization

see above…. (soil C sink, soil biodiversity,..)

Conservative tillage

see above…. (soil C sink, fuel saving,…..)

Soil layout (i.e. terraces)

see above…. (lansdcape protection,….)

PHYTO-REMEDIATION (TO CLEAN POLLUTED SOILS)

Phyto augmentation (organic pollutants)
Phyto extraction (trace metals)
No-food crops (for energy or bio-polymers)

Several species are able to growth in polluted soils and:

- stimulate natural biodegradation of organic pollutants (ryzosphere bioaugmentation)
- extract metal pollutants from the soils
- allow a natural soil reclamation
- improve soil C sink and biodiversity
- produce raw materials for energy or biodegradable plastics
- reduce urban wastes and fossil fuel use

URBAN SUSTAINABILITY

-To produce raw materials for biodegrable products

-To reduce urban wastes

see above…..

Urban waste bales

Analyzing the environmental problems and the opportunities of some different agro-ecosystems:

(besides the global problems such GHGs emissions)

1) HILLY AREAS

Weak points: erosion, low income, farm abandonement

Strenght points: high biodiversity, low pollution, nice lanscapes

New farm aims: cover crops, conservative tillage, income increase (agro-tourism, typical foods, organic farming)

Italian "*calanchi*" are desertified hilly areas not more suitable for agricolture but only useful for western movies

2) IRRIGATED PLAINY AREAS

Weak points: nitrate pollution, low biodiversity, traffic and industrial pollution, landscape worsening

Strenght points: high yields (and income), easy logistic

New farm aims: nitrification reduction (organic fertilization and C sink increase), biodiversity increase (cover crops and hedgerows), pollution decrease (Phyto-remediation), historical landscapes protection

i.e. the Roman "*centuriazione*" (200 b.C.) was the first territory planning with the land divided in orthogonal fields bordered with grape, olive or fruit-tree hedgerows)


Thank you for attention