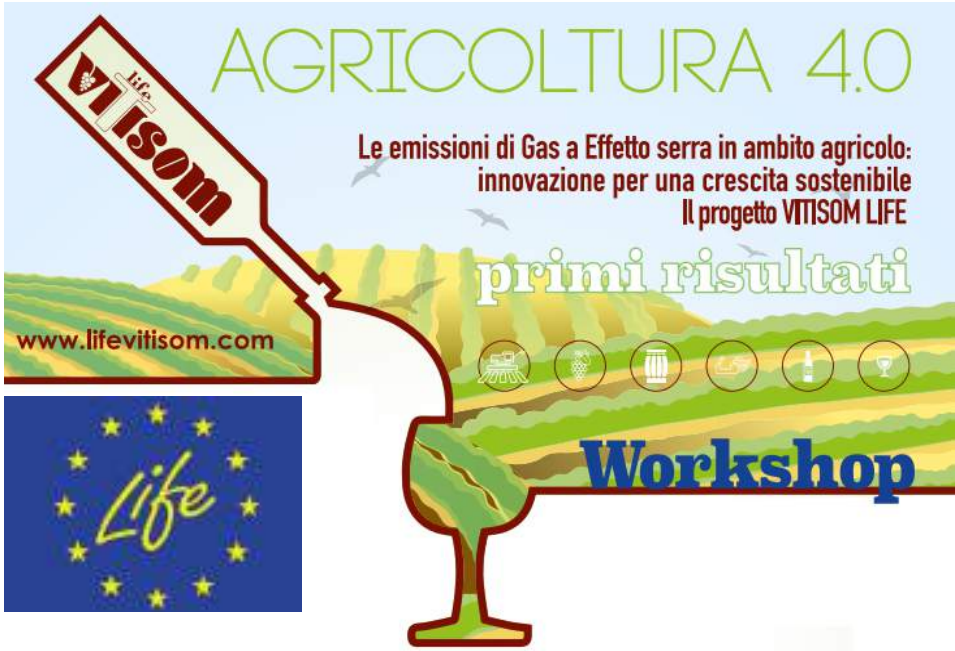
INSTITUTE OF LIFE SCIENCES

Scuola Superiore Sant'Anna



LIFE+IPNOA (LIFE 11 ENV/IT/000302): sviluppo di prototipi innovativi per il monitoraggio e la mitigazione delle emissioni di N_2O dai suoli agricoli

LIFE+IPNOA: Improved flux Prototypes for N_2O emission from Agriculture

Strategies for the mitigation of nitrous oxide emission from agricultural soils

- LIFE11 ENV/IT/302
- Cost of project € 2.008.796
- Amount financed by the European Union € 995.948
- When: July 2012 – November 2016
- Where: Tuscany Region
- Website: www.ipnoa.eu

IPNOA
Improved flux Prototypes for N_2O emission from Agriculture

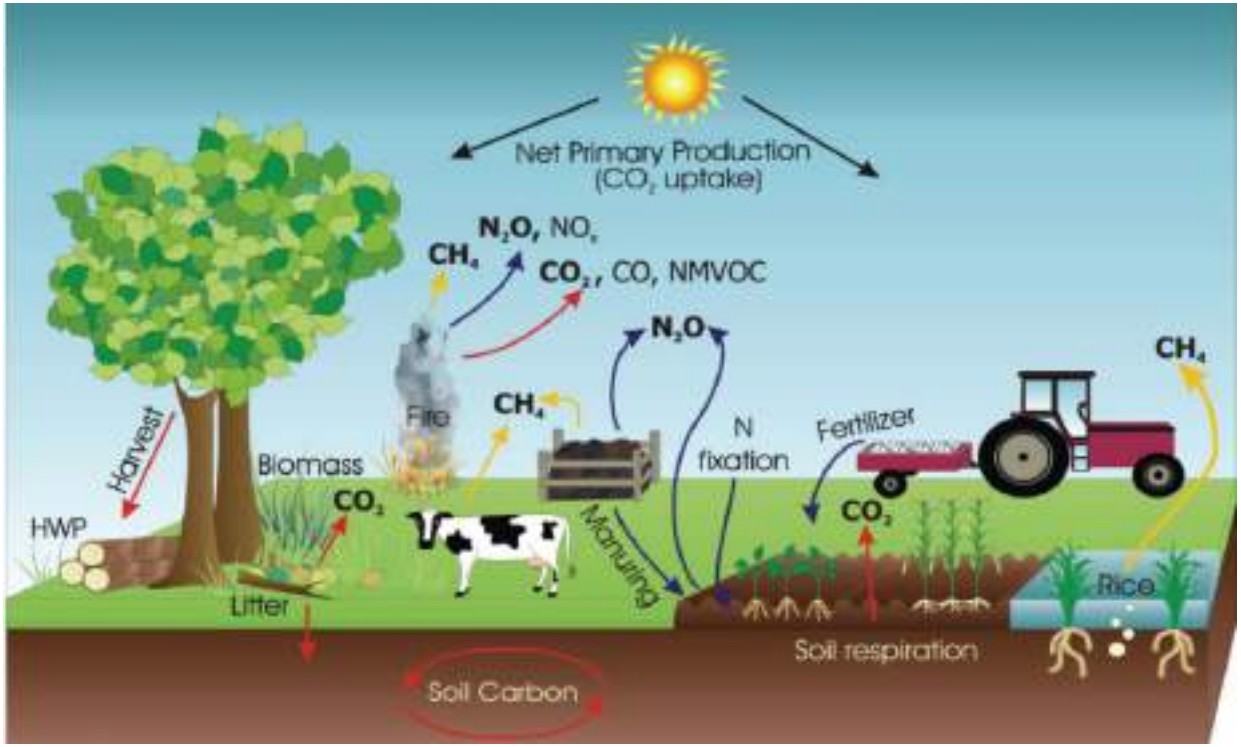
WEST Systems

INSTITUTE OF LIFE SCIENCES
Scuola Superiore Sant'Anna
INRA SCIENCE & IMPACT
REGIONE TOSCANA

LIFE+IPNOA objective

IPNOA
Improved flux Prototypes for N_2O emission from Agriculture

To identify the best management practices for N_2O emissions from agriculture in Tuscany without affecting the crop yield



Why nitrous oxide (N_2O)?

- ✓ Ozone depleting
- ✓ GWP
- ✓ Soil accounts for > 60% of all global N_2O sources
- ✓ In Italy: agricultural soils ~ 50% of tot. N_2O

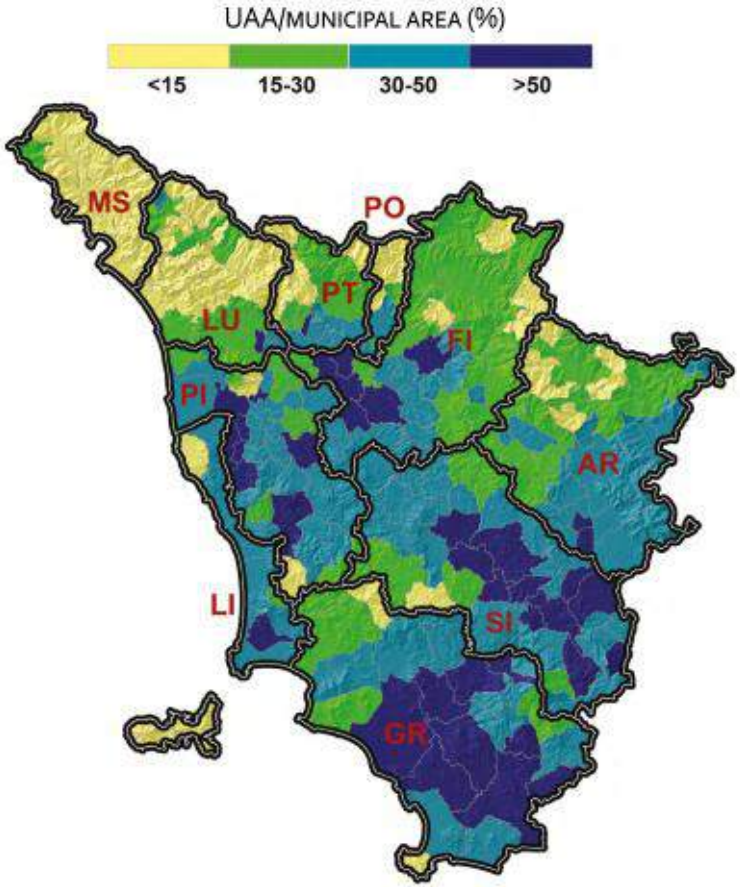
LIFE+IPNOA activities

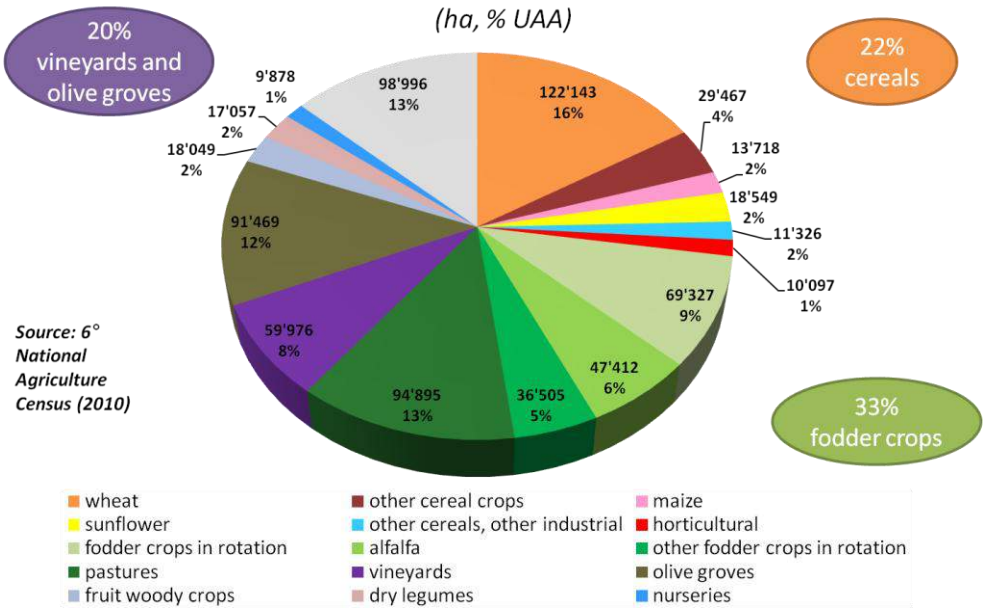
Improved flux Prototypes for N_2O emission from Agriculture

1. INVENTORY FOR THE IDENTIFICATION OF MAIN CROPPING SYSTEMS IN TUSCANY REGION
2. DEVELOPMENT OF THE PORTABLE INSTRUMENT AND THE CONTINUOUS MONITORING STATION
3. INSTRUMENTS VALIDATION
4. MONITORING OF SOIL EMISSIONS IN FIELD TRIALS (2 YEARS)
5. TERRITORIAL ANALYSIS OF N_2O MITIGATION SCENARIOS AT REGIONAL SCALE

1 INVENTORY FOR THE IDENTIFICATION OF MAIN CROPPING SYSTEMS IN TUSCANY REGION

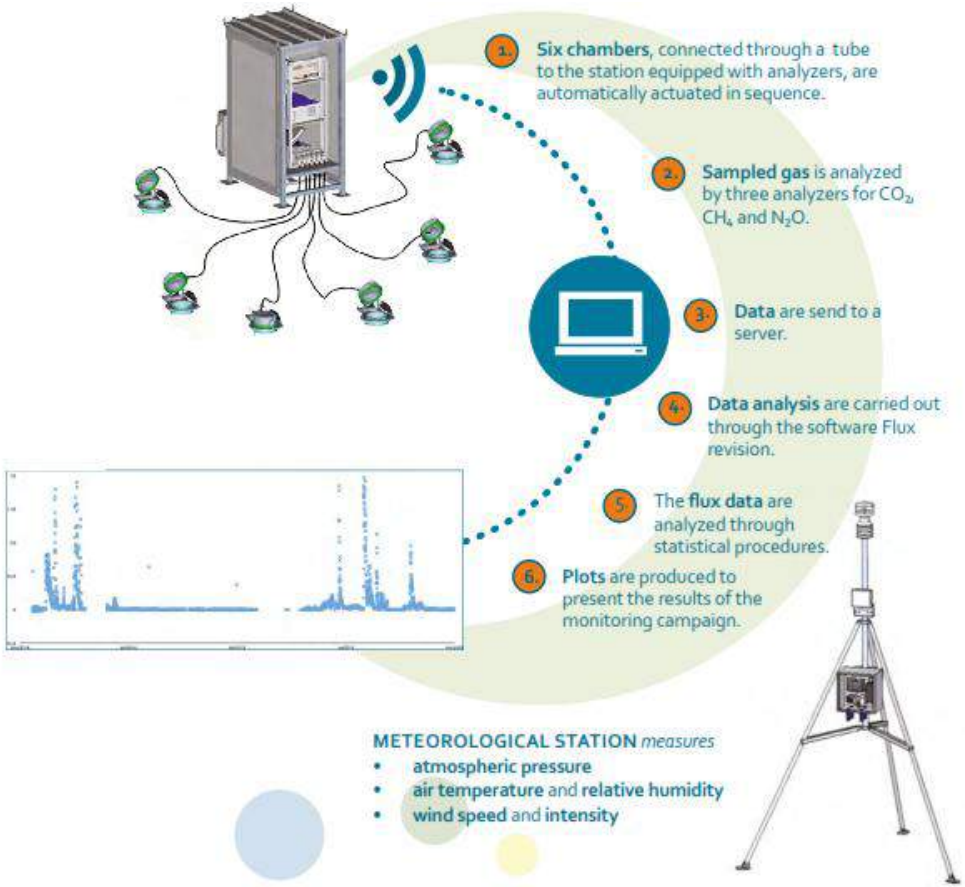
IPNOA
Improved flux Prototypes for N_2O emission from Agriculture





Data source: ISTAT, 2010

The continuous monitoring station



IPN2OA
Improved flux Prototypes for N_2O emission from Agriculture

Portable instrument

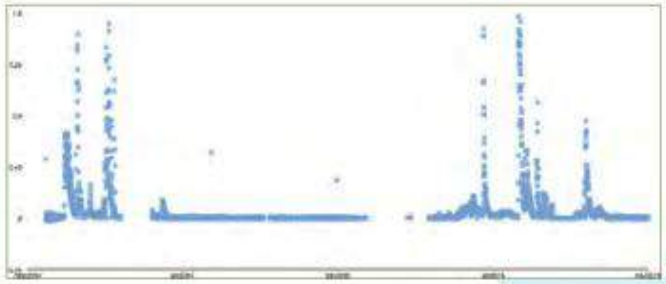
1. **Chamber** is closed manually to the ground, using a collar, and it is connected to the mobile instrument with a 20 m tube. Each measure lasts 2-3 minutes.

2. **Sampled gas** is analyzed through the analyzers placed in the mobile instrument for CO_2, CH_4 and N_2O concentration.

3. The **increment of concentration** in the chamber is showed in real time on a smartphone, connected by Bluetooth. It is possible to calculate first estimation of flux in the field.

4. **Data** are moved to a computer and analyzed through the software Flux revision.

5. The **flux data** are analyzed through statistical procedures.



6. **Plots** are produced to present the results of the monitoring campaign.

IPNOA
Improved flux Prototypes for N_2O emission from Agriculture

- Easterbush international campaign organized by InGOS “Integrated non-CO_2 greenhouse gas observing system”
- Validation at INRA
- Cross validation between the continuous monitoring station and the portable instrument

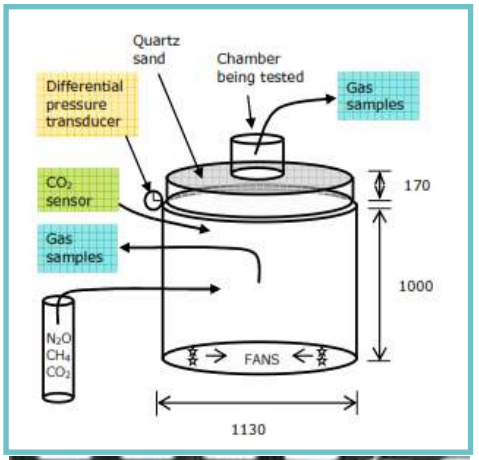
InGOS



IPN2OA
Improved flux Prototypes for N_2O emission from Agriculture

Chamber validation

- "N_2O chamber intercomparison campaign" at Hyttiala Forestry Field Station, Finland, InGOS project.



Some results:

- Good performance of the chamber
- Linear regression of N_2O flux: 0.84 – 0.91
- Leakage test: 52.9 ppb/h

4 MONITORING OF SOIL EMISSIONS IN FIELD TRIALS (2 YEARS)

IPNOA
Improved flux Prototypes for N_2O emission from Agriculture

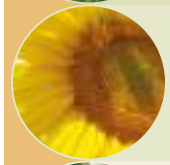
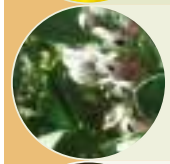
LOCATION OF TWO EXPERIMENTAL SITES IN TUSCANY

1 CIRAA (Pisa)
(Centre for Agri-environmental Research "Enrico Avanzi" (CIRAA), University of Pisa)

2 CATES (Cesa)
Terre Regionali Toscane Center for Innovation testing (CATES) (Cesa, Arezzo)

Picture 1. Instrumentation for continuous monitoring [CIRAA, Pisa]

Picture 2. Mobile instrument [CATES, Cesa]

	CROPS	Tillage level	Nitrogen level (kg di N ha^{-1})	Treatment of residues	Irrigation levels
	WHEAT	ploughing (30 cm) minimum tillage (10 cm)	N_0=0 N_1=110 N_2=170	removed	
	MAIZE [1]	ploughing (30 cm)	N_0=0 N_1=130 N_2=170	shredded and integrated into the soil	irrigation [2] (80% PET[3]) rainfed
	SUNFLOWER	ploughing (30 cm) minimum tillage (10 cm)	N_0=0 N_1=80 N_2=140	shredded and integrated into the soil	
	FABA BEAN [4]	ploughing (30 cm) minimum tillage (10 cm)		shredded and integrated into the soil	
	TOMATO [1]	tillage	N_0=0 N_1=120 N_2=170	shredded and integrated into the soil	50% PET[5] 100% PET[5]

[1] only at CATES
[2] drip irrigation;
[3] PET: potential evapotraspiration
[4] only at CIRAA
[5] with fertigation

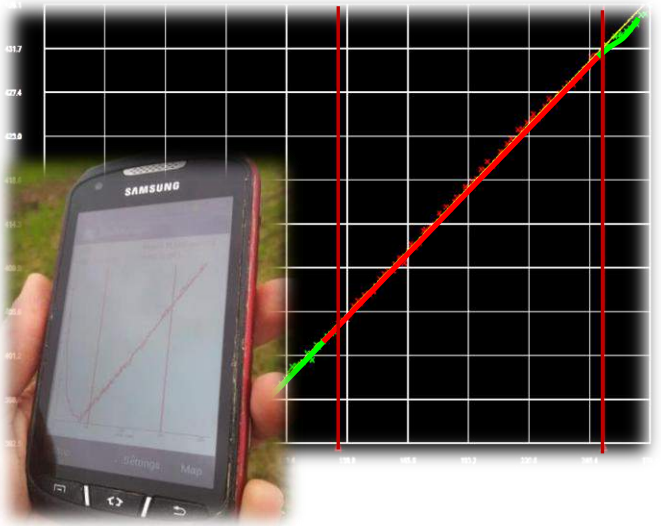
Field trials at CIRAA - PISA

Field trials at CATES – CESA, Arezzo

IPNOA
Improved flux Prototypes for N_2O emission from Agriculture

Monitoring protocol

- November 2013 – October 2015
- Frequency every 15 days, 2 times a week after nitrogen fertilizations, 4 replicates for each treatment
- 20-30 dates per crop per year $\rightarrow$ 6400 sampling points!



IPNOA
Improved flux Prototypes for N_2O emission from Agriculture

Main results of field trials

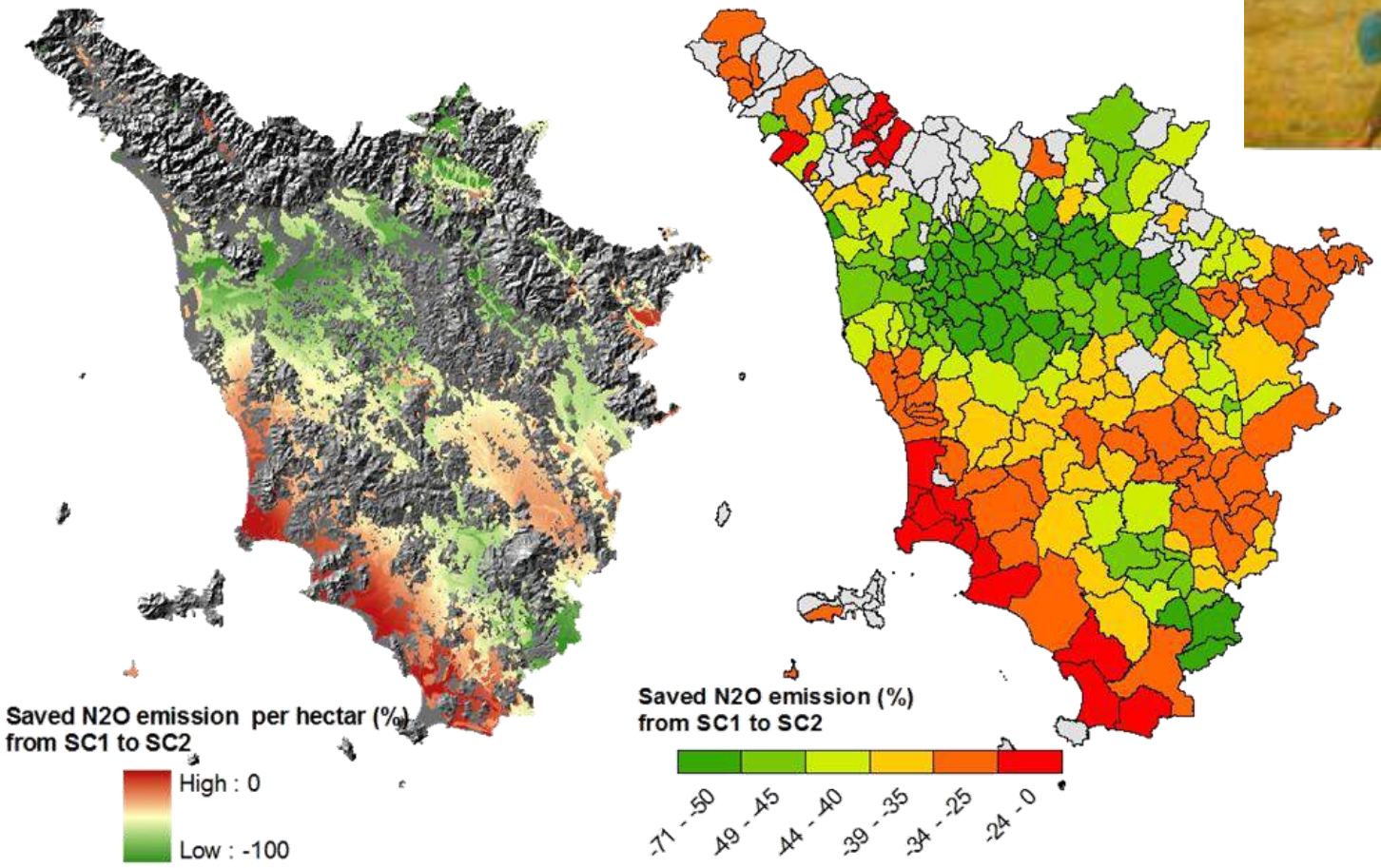
Summary of results based on average cumulative N_2O emissions recorded during crop growing period

Agricultural practices	BMPs	Mitigation potential	Effect on crop yield
Tillage	Ploughing → Minimum tillage	-60% faba bean, -25% sunflower	+35% faba bean -2% sunflower
Nitrogen fertilization	-30% nitrogen rate	-30% on all the fertilized crops	-12% durum wheat and tomato -2/4% maize and sunflower
Irrigation	-50% irrigation volume	-30% tomato in fertigation	-8% tomato

LARGE INTERANNUAL VARIABILITY DUE TO ENVIRONMENTAL CONDITIONS !!!

IPNOA
Improved flux Prototypes for N_2O emission from Agriculture

On DURUM WHEAT **-41** % N_2O of emission saving from 170 to 110 kg N ha^{-1}



Best Management Practices

IPNOA

Improved flux Prototypes for N_2O emission from Agriculture

A.P.	SPECIFIC ASPECT	EFFECTIVENESS	RECOMMENDED PRACTICE
NITROGEN FERTILIZATION	Nitrogen fertilizer **rate**	●●●	Calculate the rate according to the crop needs.
	Fertilizer **placement**	●●	Apply the fertilizer near the plants and, if possible, buried.
	Distribution period	●●	Apply the fertilizer when it is most needed by the crop.
	Fertilizer type	●●	N_2O can potentially be mitigated with the use of slow-release fertilizers or fertilizers with added nitrification inhibitors.
TILLAGE	**Tillage techniques**	●●	Reduce the tillage depth in sandy or loamy soils. Clay soils must be well drained to avoid compaction and stagnation.
IRRIGATION	**Water amount**	●●	Calculate the water amount in relation to the crop needs (water balance).
	Irrigation techniques	●●	Use irrigation systems that ensure a good uniformity of water distribution and a good irrigation efficiency.
CROPS MANAGEMENT	Crop **rotation**	●●	Involve in the rotation poliennial crops (forage crops) and crops with a low nitrogen requirement (leguminous).
	Cover crops	●	Cultivate cover crops in the interval between two main crops.
	Crop **residues**	●●	Incorporate crop residues into the soil, avoiding deep tillage with leguminous residues.
FIELD HYDRAULICS AND WATER MANAGEMENT	Ensure the **maintenance of the infrastructure controlling the field hydraulics**	●●●	Maintain the effectiveness of infrastructure to ensure the water drainage.

Dissemination

Improved flux Prototypes for N_2O emission from Agriculture

The Best Practices Manual

Farmers
Farmer associations
Policy makers
National and Regional agencies
Local authorities
Research Institutions
Environmental Organizations
Private Companies
Schools

Workshops & meetings

Layman report

Thanks for your attention!

- web-site:
  www.ipnoa.eu
- contacts:
  info@ipnoa.eu
  s.bosco@santannapisa.it

IPNOA
Improved flux Prototypes for N_2O emission from Agriculture

Giorgio Virgili, Simona Bosco, Iride Volpi, Nicoletta Nassi o Di Nasso, Ricardo Villani, Giorgio Ragaglini, Cristiano Tozzini, Simone Neri, Federica Mattei, Luca Ferrante, Davide Continanza, Patricia Laville, Stefania Nuvoli, Luigi Fabbrini, Enrico Bonari

WEST Systems

INSTITUTE OF LIFE SCIENCES
Scuola Superiore Sant'Anna

INRA SCIENCE & IMPACT

REGIONE TOSCANA