PIATTAFORMA delle CONOSCENZE
Buone pratiche per l'ambiente e il clima

MINISTERO DELL'AMBIENTE
E DELLA TUTELA DEL TERRITORIO E DEL MARE

IPN2OA
Improved flux Prototypes for N_2O emission from Agriculture

A strategy to reduce N_2O emissions from agriculture

Giorgio Virgili – WEST Systems

MARRAKECH COP22 | CMP12 | CMA1
UN CLIMATE CHANGE CONFERENCE 2016
مؤتمر الأمم المتحدة لتغير المناخ

LIFE11 ENV/IT/302 - IPNOA PROJECT

The project assumptions:

- Tuscany needs to reduce its GHG emissions by 20% in 2020 vs. 1990
- Co-responsibility of agriculture:
  - The agriculture sector accounts for about 7% of national GHG emissions, but
  - the 50-70% of N_2O emissions in Italy come from the agricultural sector, mainly as a result of nitrogen fertilization and consequent nitrification and denitrification processes mediated by bacteria in the soil.
- Best agricultural practices: in order to facilitate the containment of GHG emissions it is necessary to promote sustainable cropping systems and agricultural practices

The project objectives:

1. Find a strategy to reduce N_2O emissions from agriculture in Tuscany without affecting the crop yield

2. Development of innovative instrumentation to improve the monitoring of N_2O emissions from soil;

3. Identification of the best agricultural practices for N2O mitigation through field trial and monitoring on numerous crops

4. Results upscaling to Regional Level

5. Promotion of Best Practices application in Tuscan agriculture.

WEST Systems supplies instrumentation and services worldwide for the monitoring of diffuse degassing emissions (CO_2, CH_4, H_2S, hydrocarbons and also **nitrous oxide...**);

The **Institute of Life Sciences, Scuola Superiore Sant'Anna**, carries out research in the field of plant biology, energy- and food-related crops, agro-biodiversity and agro-ecosystem sustainability.

The REGIONE TOSCANA is the Regional Government of Tuscany : It is an autonomous entity with legislative powers.

INRA: ECOSYS Joint Research Unit INRA / AgroParisTech aims to treat in an integrated way the functioning of agro-ecosystems and their relationship with the environment.

LIFE + Environmental Policy and Governance

- Supporting projects that contribute to the development of policies, technologies, methods and innovative tools.

- **607 projects submitted in 2011, 113** of them financed (23 in Italy)

LIFE 11 ENV/IT/302 IPNOA:
Improved Flux Prototypes for N_2O emissions reduction in Agriculture

Period	June 2012 – November 2016
Total Budget	€ 2.058.612
EC Contribution:	€ 995.648

The project phases:

1. Inventory of cropping systems and setup of trials
2. Design & development of instrumentation
3. Instrumentation cross-calibration
4. Two years monitoring of trial crops
5. Best Practice Manual drafting and divulgation
   Regional scale modeling

Life

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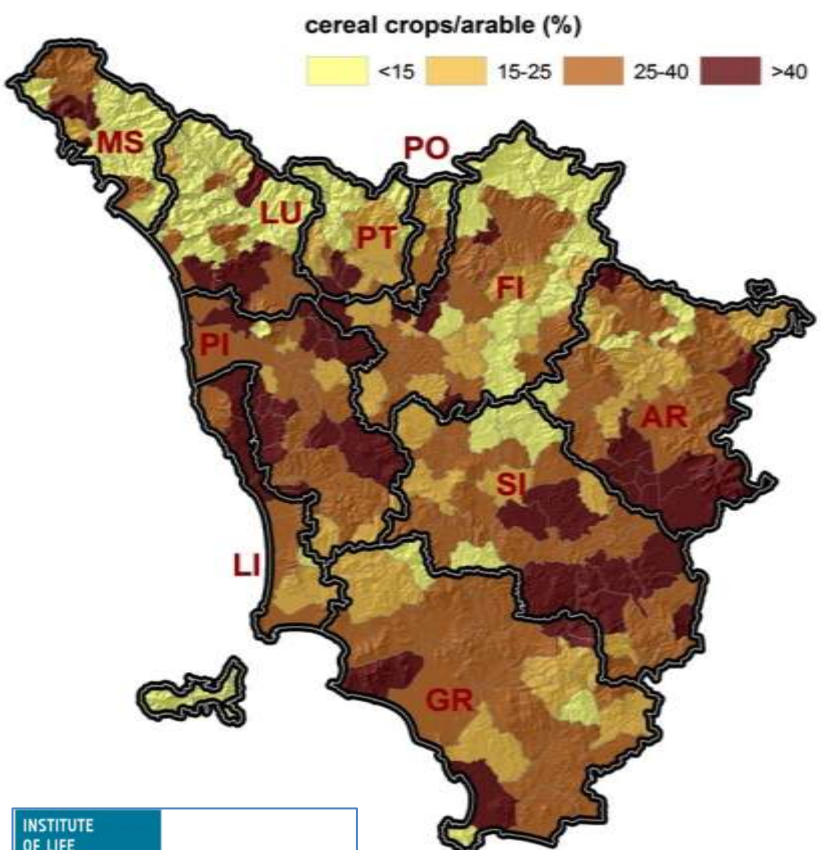
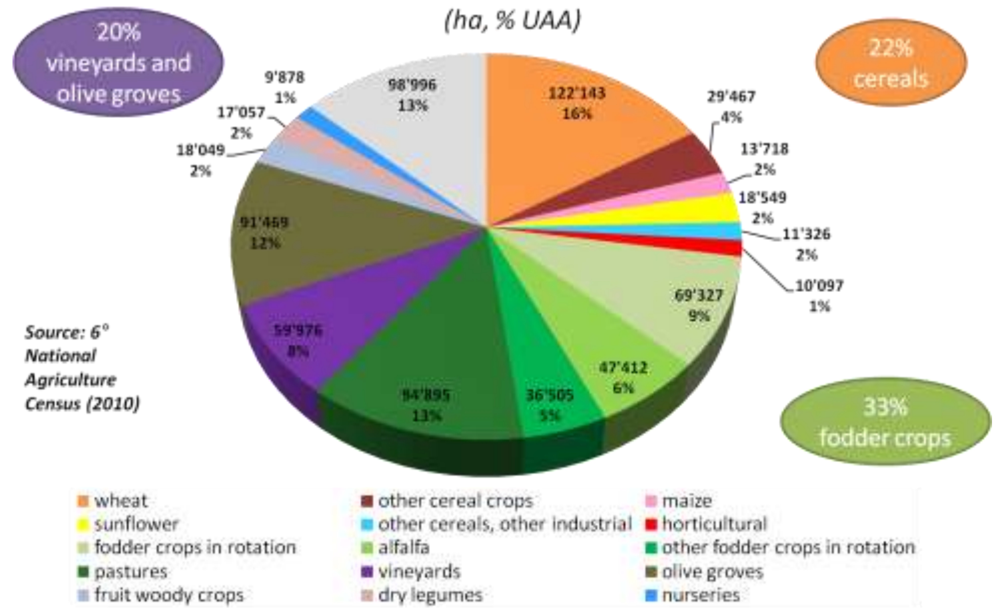
Improved flux Prototypes for N_2O emission from Agriculture

Main cropping systems in Tuscany





Crop trials:

- Durum Wheat
- Sunflower
- Maize
- Tomato
- Fava Bean

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Factors that affect N_2O emissions from soil

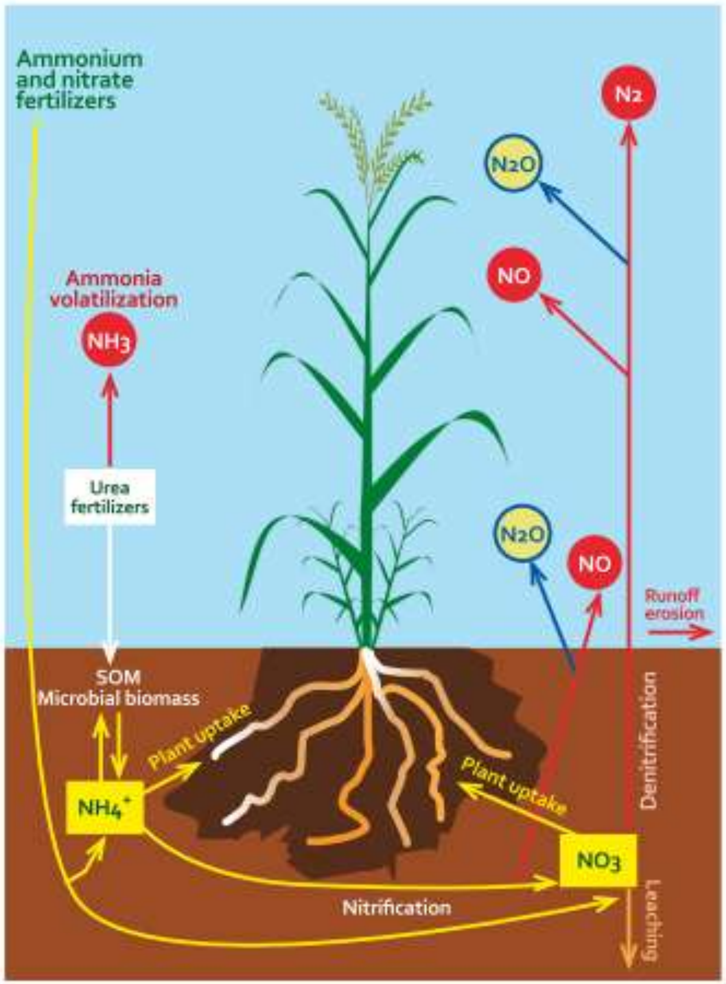
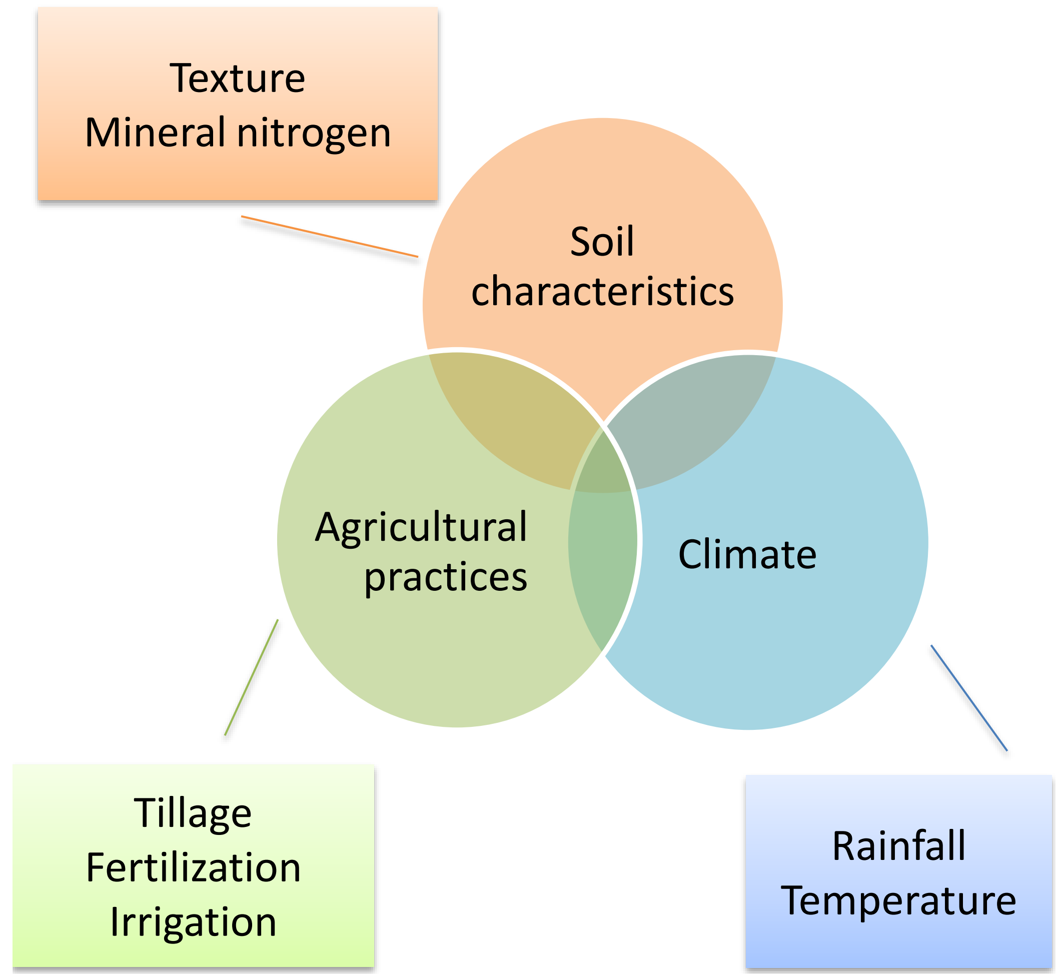
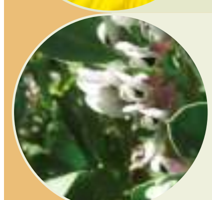


Figure 3: The processes that regulate the production of N_2O in the soil.



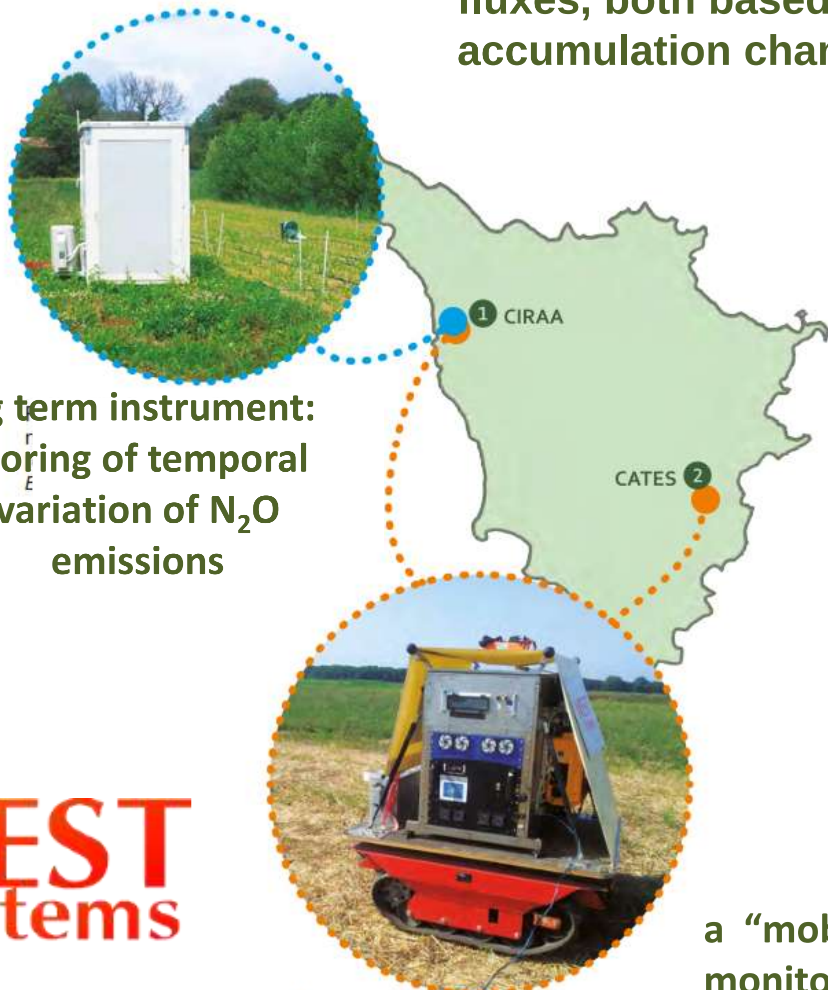
1 - Inventory of cropping systems and setup of trials

	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

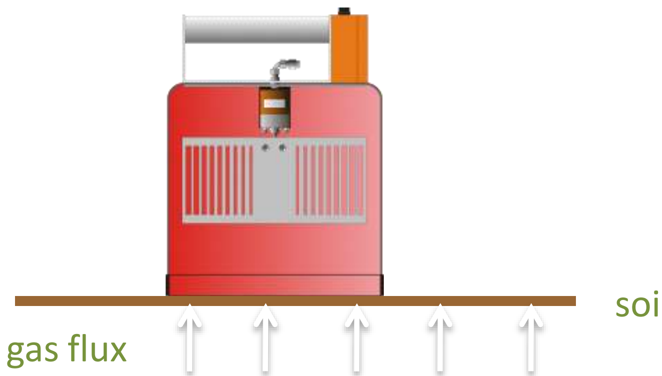
2 - Instrumentation design & development

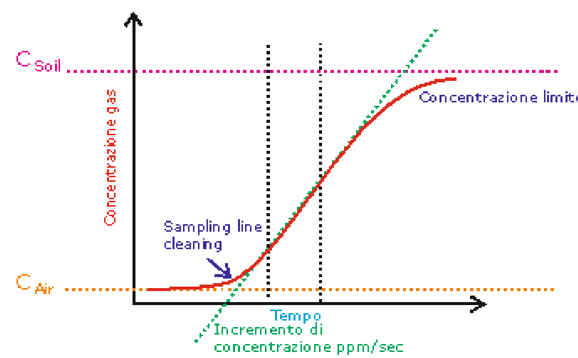
We developed two instruments to measure N_2O fluxes, both based on non steady accumulation chamber:



a long term instrument: monitoring of temporal variation of N_2O emissions

Foto 2. Strumentazione mobile
[Centro di Collaudo di Terre Regionali Toscane - Cesa (AR)]





a "mobile" instrument: monitoring of spatial variation of N_2O emissions

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The "mobile" instrument:
monitoring of spatial variation of N_2O emissions
"tracked off-road vehicle with electric traction"

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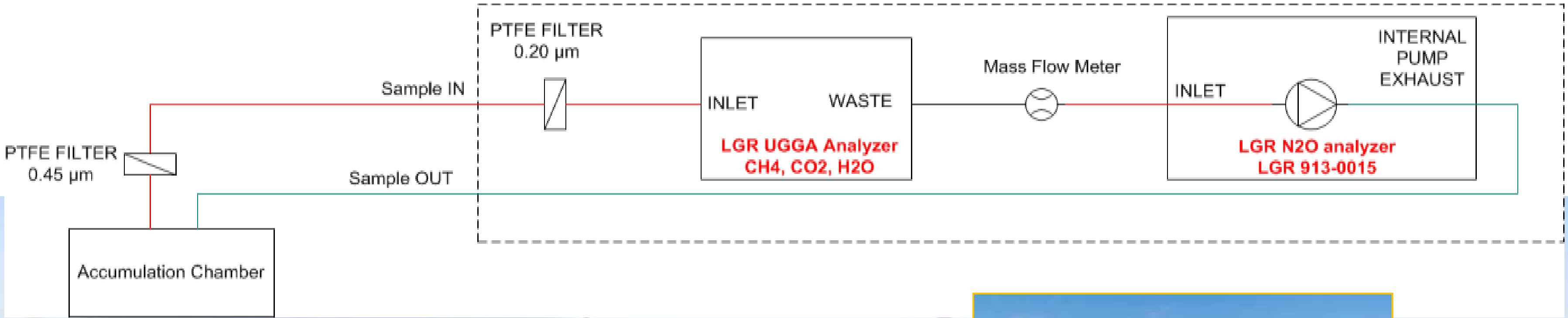
2 - Instrumentation design & development

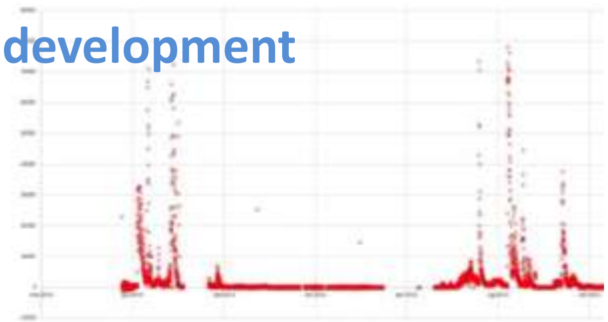
Spatial variations monitoring



Accumulation chamber and collar

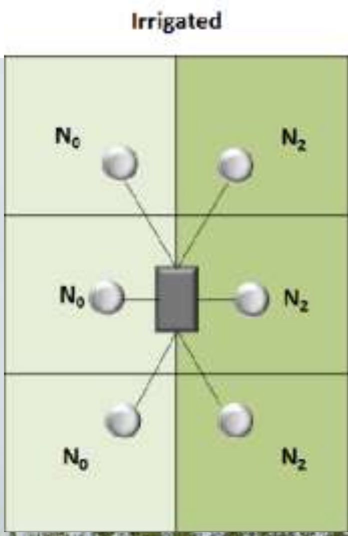
The measure

2 - Instrumentation design & development



Improved flux Prototypes for N_2O emission from Agriculture

Temporal variation of N_2O , CH_4 and CO_2 emissions employing a multi-chamber system



2 – Instrumentation design & development

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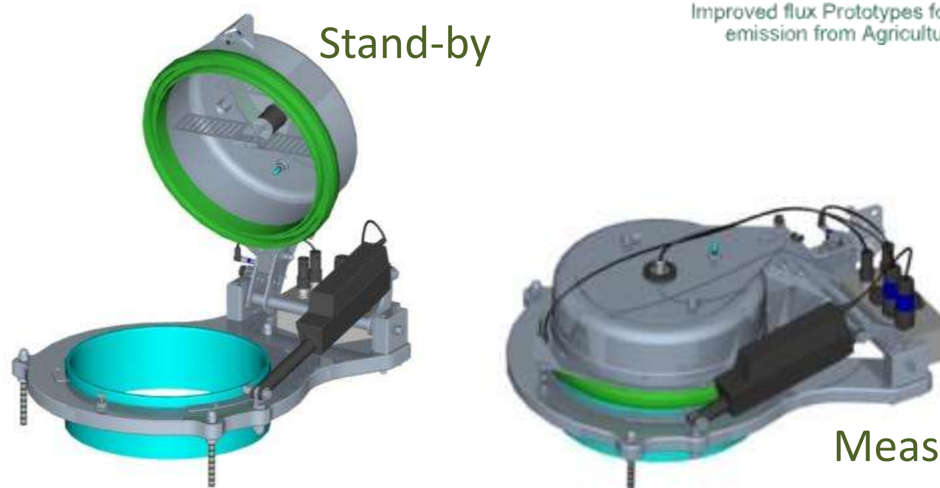
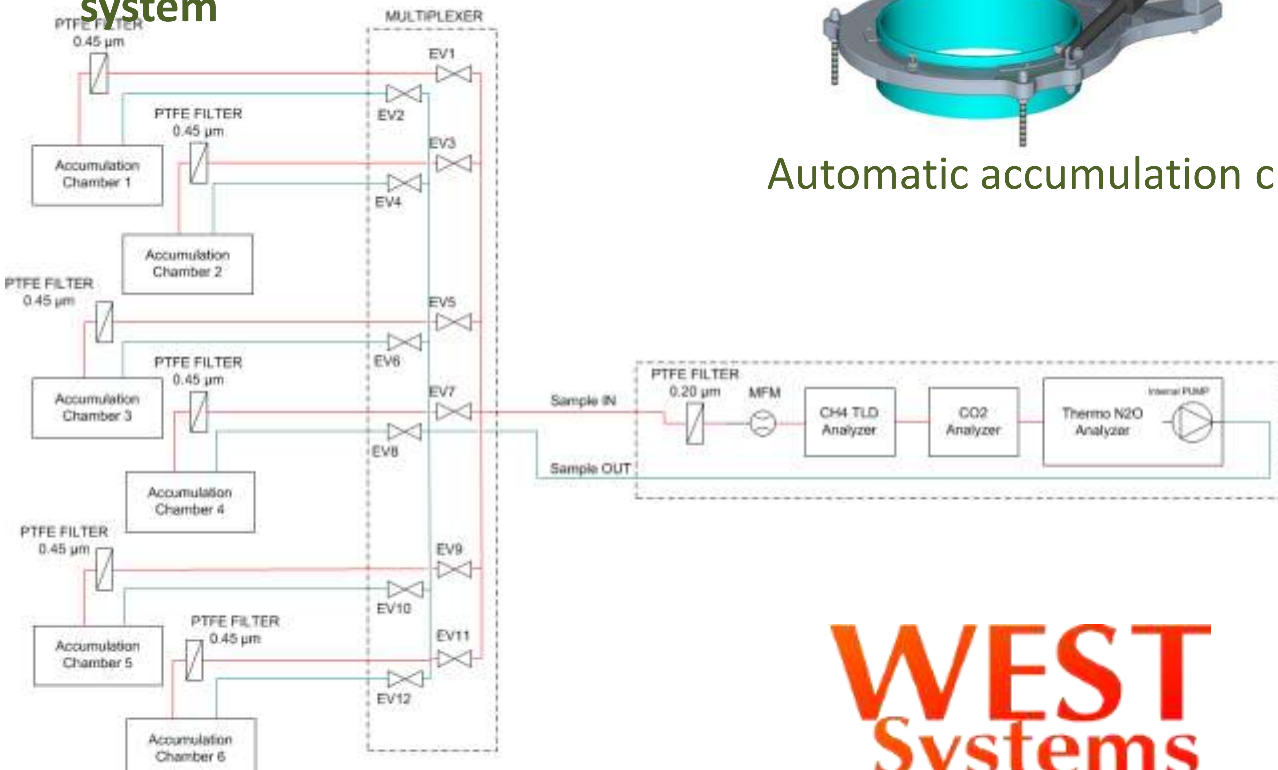
Long term monitoring unit



Automatic accumulation chamber(s)

Scheme of a multi-chamber system



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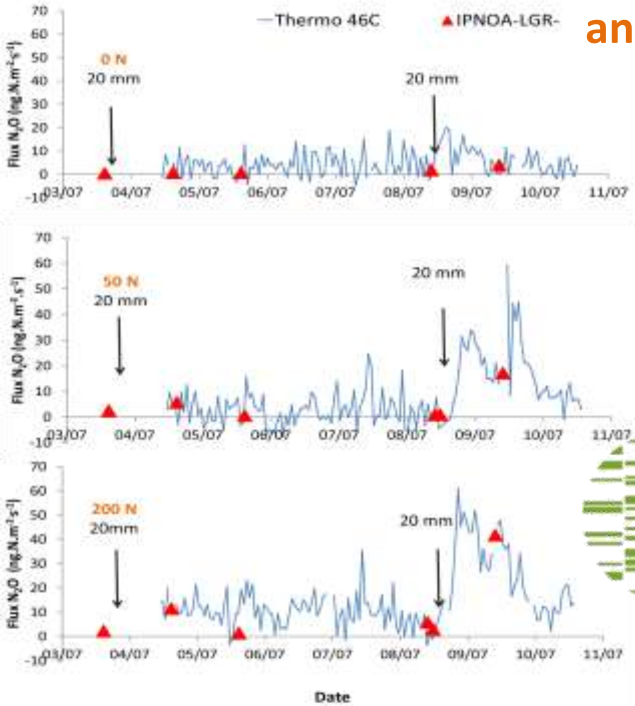
Instrument cross validation

Both instruments were cross-calibrated by INRA and compared with other instrument types



Eddy covariance

INRA long term chambers

Soil N_2O flux monitoring protocol

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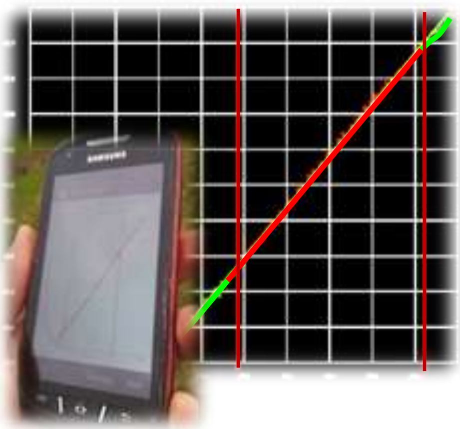
Discrete monitoring (mobile unit)

- Two years - November 2013 – October 2015
- Every 15 days, 2 times a week after nitrogen fertilizations
- 4 replicates for each treatment
- 20-30 dates per crop per year → 6400 sampling points!



Long term monitoring (multi-chamber unit)

- 2 years on 6 parcels

Monitoring Parameters (Both surveys)

Quasi Real Time

- N_2O, CO_2, CH_4 flux , Soil temperature and soil moisture, meteorological variables;

In the lab

- Crop yield, Soil nitrate and ammonium, N uptake in different biomass fraction.




2 years monitoring - main results summary:

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***Best Management Practices* (BMPs) for soil N_2O reduction** *as average of two sites and two years*

Agricultural practices	BMPs	Mitigation potential	Effect on crop yield
Tillage	Ploughing → Minimum tillage	-60% fava bean, -25% sunflower*	+35% fava 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

Wheat : Regional scale modeling

denitrification decomposition model

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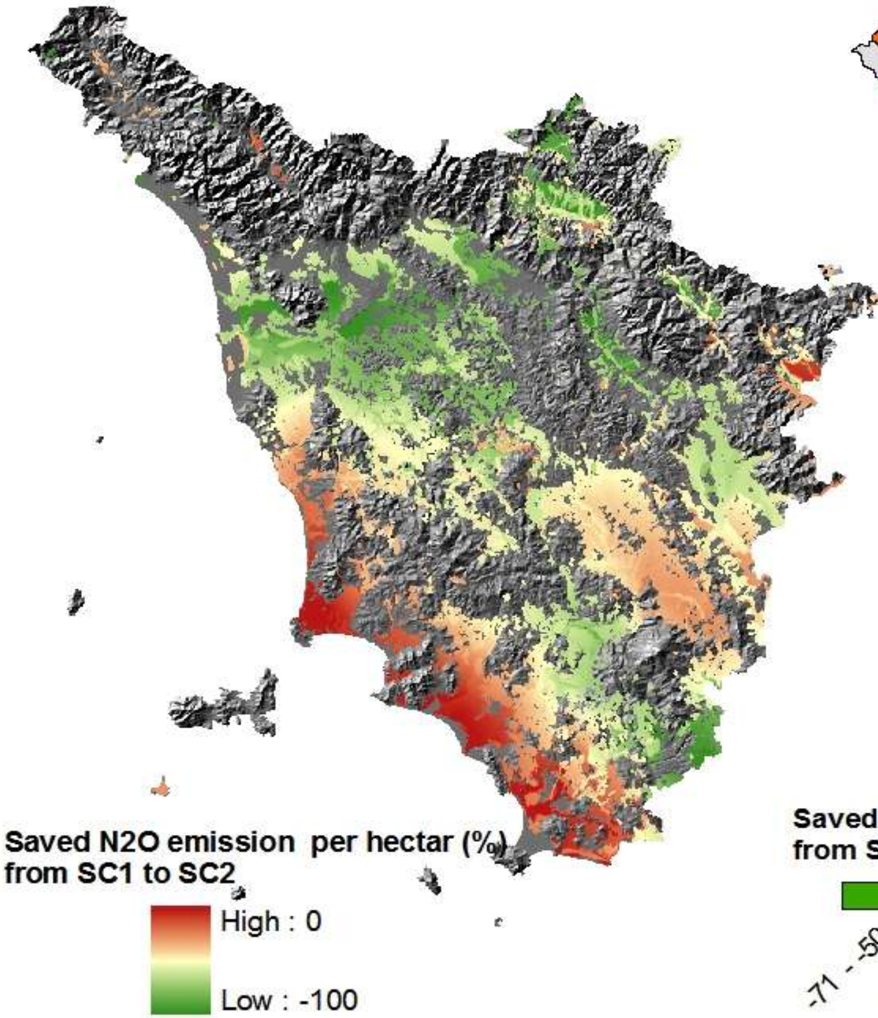
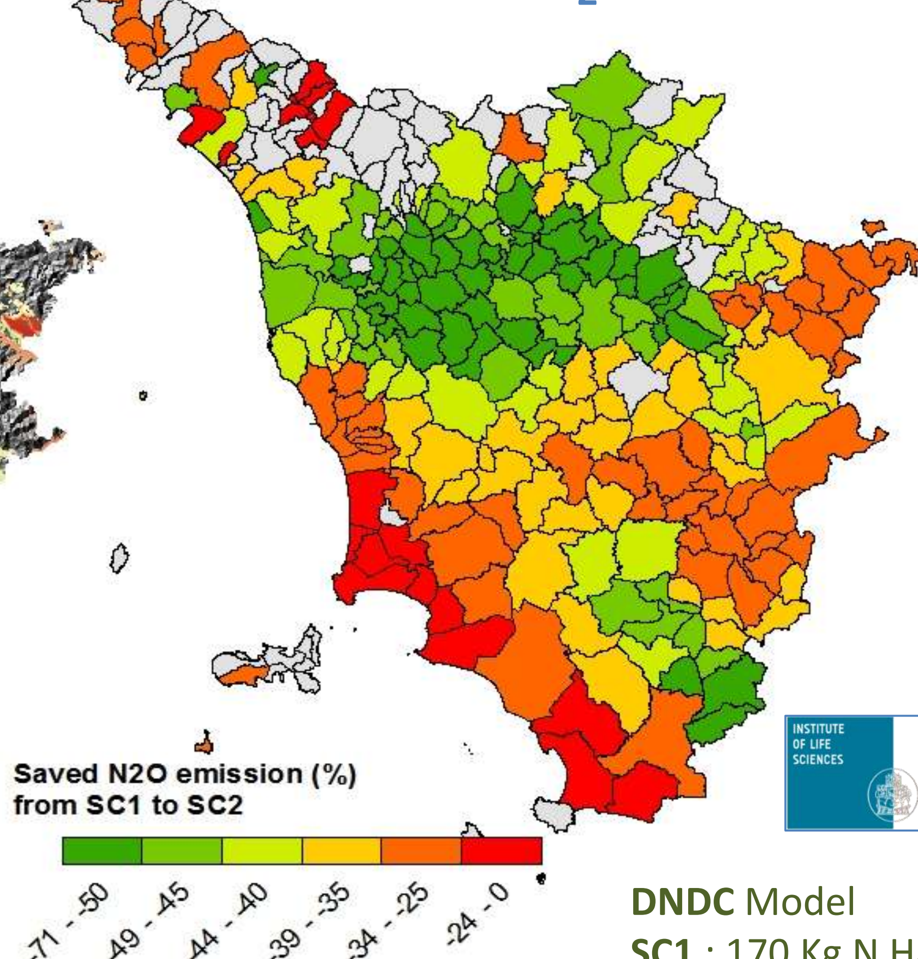
What will happen by:

reducing N input from 170 to 110 kg ha^{-1} :

- 41 % N_2O emissions





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DNDC Model

SC1 : 170 Kg N Ha^{-1}

SC2 : 110 Kg N Ha^{-1}

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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.

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The Best Practices Manual

A.P.	SPECIFIC ASPECT	EFFECTIVENESS	RECOMMENDED PRACTICE
IRRIGATION	**Water amount**	**	Calculate the water amount in relation to the crop needs (water balance).
IRRIGATION	**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).
CROPS MANAGEMENT	**Cover crops**	*	Cultivate cover crops in the interval between two main crops.
CROPS MANAGEMENT	Crop **residues**	**	Incorporate crop residues into the soil, avoiding deep tillage with leguminous residues.
FIELD HYDRAULICS AND WATER MANAGEMET	Ensure the **maintenance of the infrastructure controlling the field hydraulics**	***	Maintain the effectiveness of infrastructure to ensure the water drainage

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Dissemination

Improved flux Prototypes for N_2O emission from Agriculture

The Best Practices Manual

Report for policy maker

Farmers
Trade associations
Stakeholders
Policy makers
Italian Ministries
National and Regional agencies
Local authorities, Research Institutions
Environmental Organizations
Private Companies
Schools
and any individual that may be interested in relevant issues

Workshops & meetings

Layman report


On field demonstrations

Transposition by the policy makers

Action B7 : The contents of the best practices manual will be used as a technical input for the planning of regional activities in the Tuscany Region, in particular for the new rural development policy, the Rural Development Plan 2014-2020, and the legislation for the environmental impact of agriculture .....

- Soil protection and maintenance of organic soil matter: *no-till seeding, cover crops..*

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The PSR (Rural Development Plan) supports the diffusion of organic farming and farming practices (proper management of nitrogen fertilizer and irrigation, reduction of soil processing, use of cover crops ...) that IPNOA highlight as capable of contributing to the reduction of greenhouse gas emissions

Measure 4 Productive and non-productive agriculture investments

- *Precision farming equipments, no-till grain seeding technologies, water management and irrigation plants, surface water control works*

Measure 1 Knowledge transfer and Informations actions

Measure 2, 16,....

The results of the project can be easily applied to other areas that present both pedo-climatic conditions and cropping systems similar to Tuscany.

The methods tested in this project can be replicated in areas with different soil and climatic conditions and/or that use different cropping systems by replicating the scheme that allowed IPNOA to identify a viable strategy:

Inventory of cropping systems at regional level and setup of trials

Monitoring of emissions of major crops under various conditions of irrigation, fertilization, tillage and crop management

Identification of good practices and regional-scale modeling of project results

Dissemination and adoption of the best practices

VITiculture Innovative Soil Organic Matter Management: variable-rate distribution system and monitoring of impacts 2016-19

Development and demonstration of Variable-rate technology (VRT) for vineyard fertilization

Implementation of the VRT in order to improve the organic fertilization distribution systems. Construction and testing of five prototypes adapted to 5 different pilot contexts, representatives of UE vineyard variability

Increase sustainability improving the vineyard soil management

Improve the quality of vineyard soils in terms of soil structure, organic matter content and biodiversity, monitoring different environmental and socio-economic aspects.

life VITISOM

VITiculture Innovative Soil Organic Matter Management: variable-rate distribution system and monitoring of impacts
2016-19

Monitoring GHGs soil emissions in order to compare the different soil management, using IPNOA [illegible]es

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Analysis of Biological Quality of soils (QBS-Ar) (Sata Studio Agronomico)

CASTELLO BONOMI FRANCIACORTA

FRANCIACORTA BERLUCCHI

Monitoring CO2 emissions at eco-system level with Eddy Covariance in Berlucchi and Bosco del Merlo Winery (Prof. Pitacco UNIPD)

CONTI DEGLI AZZONI

UNIVERSITÀ DEGLI STUDI DI PADOVA

DAFNAE
Department of Agronomy Food Natural resources Animals Environment

casella Macchine Agricole s.r.l.

Chemical analysis of soils (Prof. Adani UNIMI)

Collection of data regarding both vine-productive parameters, grape musts quality and microvinifications (Prof Valenti UNIMI)

Consorzio Italbiotec

DiSAA

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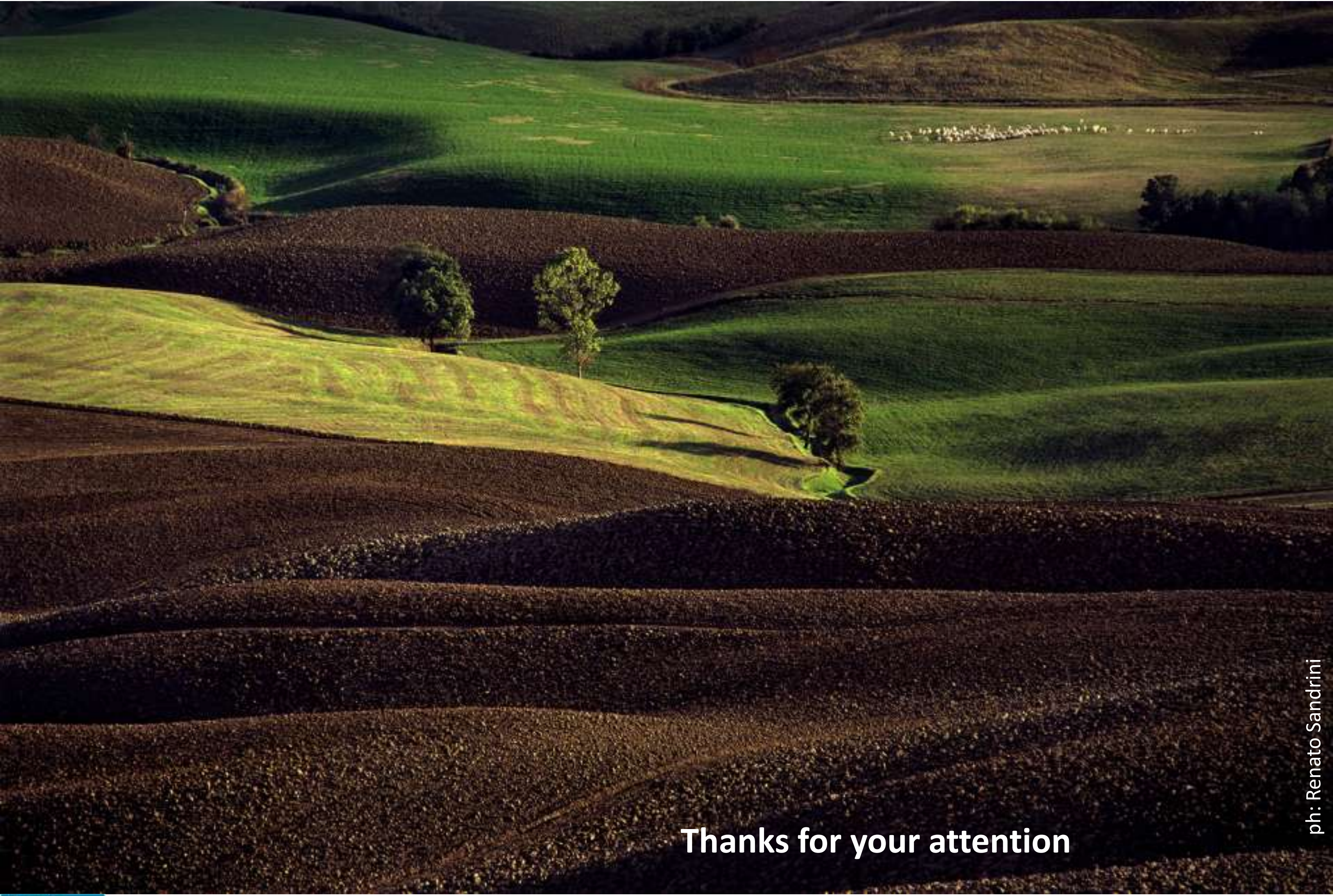
FACOLTÀ DI AGRARIA



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