

ISTITUTO
DI SCIENZE
DELLA VITA



Scuola Superiore
Sant'Anna

Società Italiana di Agronomia
XLV Convegno Nazionale
Sassari 20 – 22 Settembre 2016



Different Soil Tillage and Nitrogen Fertilization In Durum Wheat: Effect On Yield And Nitrogen Utilization

Nassi o Di Nasso N., Volpi I., Bosco S., Trabucco J., Tozzini C.,
Taccini F., Dragoni F., Nuvoli S., Fabbrini L., Bonari E.



LIFE+IPNOA “Improved flux Prototypes for N₂O emission reduction from Agriculture” (2012-2016)



Partners

**WEST
Systems**



Scuola Superiore
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REGIONE
TOSCANA



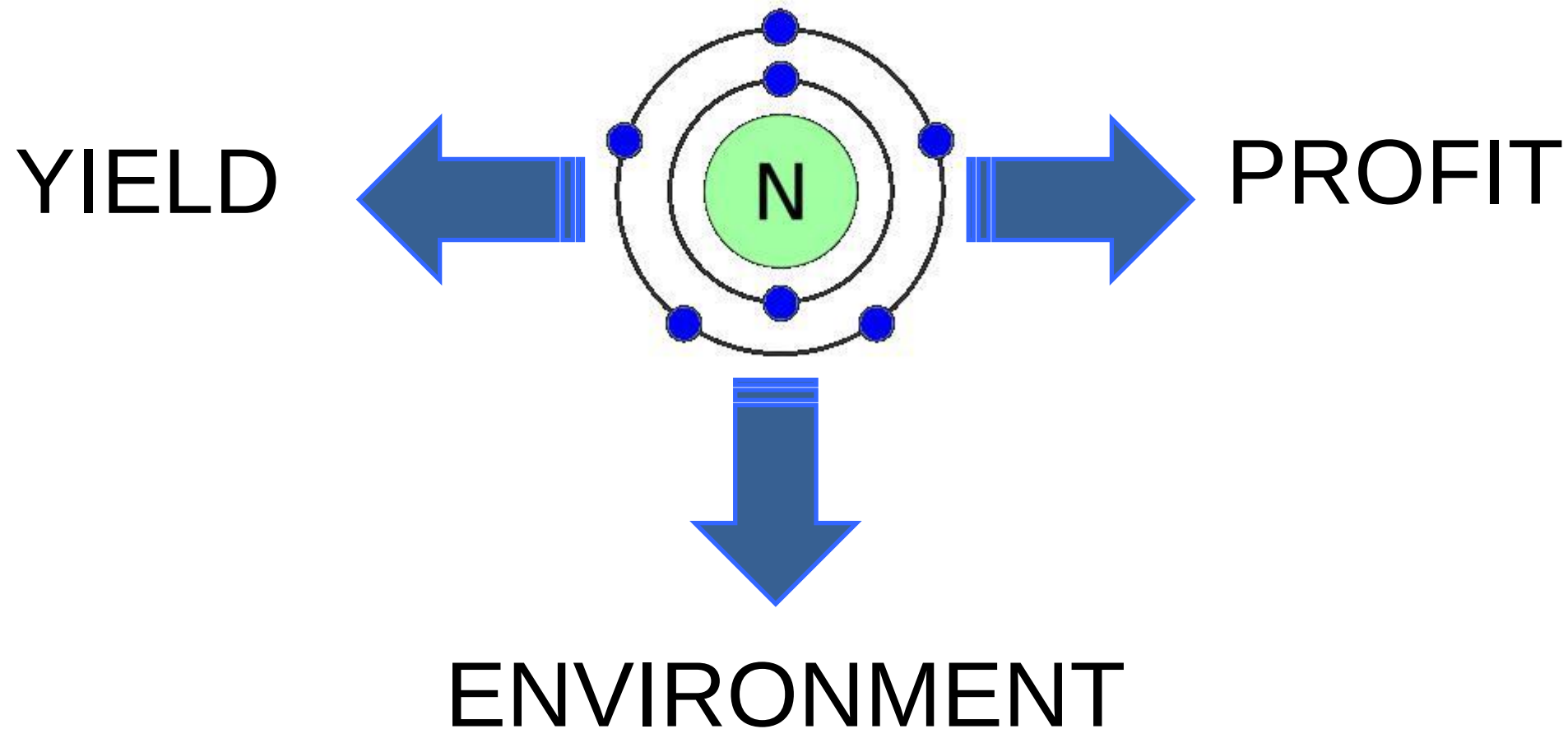
The main objectives of the project:

1. To develop and validate two prototypes for measuring soil N₂O fluxes and to improve the monitoring of N₂O from agricultural soils.
1. To carry out field trials in two representative sites in order to identify the best management practices (BMPs) for reducing N₂O emissions from the main arable crops of Tuscany.
2. To scale up these BMPs from field to regional level, through suitable modeling in order to identify and to promote the measures for an effective reduction of the N₂O emissions.

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Objectives



To analyse the response of durum wheat to different soil tillage and N fertilization level in terms of:

Productivity N uptakes

And *agronomic, environmental and economic* nitrogen efficiency





MATERIALS & METHODS



TWO EXPERIMENTAL SITES IN TUSCANY

1. **CIRAA** Center for Agro-Enviromental Research E. Avanzi, San Piero a Grado, Pisa
2. **CATES** Center for Agricultural Technologies and Extentsion Services (Tuscany Region), Cesa, Arezzo.



CIRAA silty clay loam soil
CATES clay soil

Parameter	Unit	Pisa		Cesa	
		2013-14	2014-15	2013-14	2014-15
Sand (2 mm – 50 mm)	g kg ⁻¹	171	196	423	421
Silt (50 - 2 mm)	g kg ⁻¹	471	462	154	142
Clay (< 2mm)	g kg ⁻¹	357	342	423	436
pH	1:1 w/v	7.8	7.9	8.0	7.5
Organic matter	g kg ⁻¹	21.8	20.0	12.0	10.2
Total Kjeldhal N	g kg ⁻¹	1.5	1.5	0.5	0.5
Assimilable P	mg kg ⁻¹	22.1	28.7	108.3	172.5
Exchangeable K	mg kg ⁻¹	246.0	247.4	91.4	82.3
C/N		8.5	7.8	12.8	12.2

- Total annual precipitation

Site	2014	2015
CIRAA (mm)	1560	913
CESA (mm)	924	632

- Precipitation from sowing to harvest

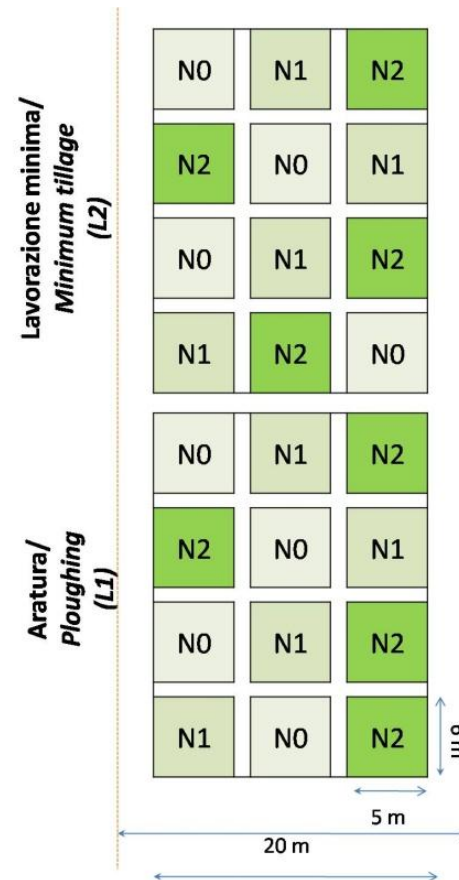
Site	2013-2014	2014-2015
CIRAA (mm)	780	350
CESA (mm)	580	450



MATERIALS AND METHODS

Treatments:

- **Soil tillage:**
ploughing (30 cm)
minimum tillage (10 cm)
- **N fertilization:**
N0 = 0 kg N ha⁻¹
N1 = 110 kg N ha⁻¹
N2 = 170 kg N ha⁻¹



	CIRAA	CATES
Sowing date	26 November 2013 4 November 2014	3 December 2013 8 January 2014
Harvest date	30 June 2014 6 July 2015	4 August 2014 8 July 2015

Fertiliser split	Amount of fertiliser (kg)
Sowing (urea)	N ₁ = 78; N ₂ =78
Tillering (nitrate ammonium)	N ₁ = 110; N ₂ =200
Stem elongation (urea)	N ₁ = 80.4; N ₂ =145.7

DETERMINATIONS:

- ✓ Yield component at harvest (fresh and dry);
 - ✓ Wheat plant height;
 - ✓ Number of spikes;
 - ✓ Thousand grain weight;
 - ✓ Harvest Index;
- ✓ N content of above-ground organs (Kjeldhal method);
 - ✓ N uptakes;



Materials and methods

N EFFICIENCY PARAMETERS

Index		Unit	Calculated as.....	Notes
Agronomic efficiency	A_E	kg kg ⁻¹ N	$A_E = (GY_{NX} - GY_{NO}) / N_X$	GY = Crop Yield; N _x = N fertilisation
Nitrogen Utilization Efficiency	N_{UTE}	kg kg ⁻¹	$N_{UTE} = GY_{NX} / TNU_{NX}$	GY = Grain Yield; TNU = Total above-ground N uptake
Nitrogen Harvest Index	N_{HI}	%	$N_{HI} = GNU_{NX} / TNU_{NX}$	TNU = Total above-ground N uptake GNU = Grain N uptake
Physiological Efficiency	P_E	kg kg ⁻¹	$P_E = (GY_{NX} - GY_{NO}) / TNU_{NX} - TNU_{NO}$	
Apparent Recovery Fraction	RF	%	$RF = (TNU_{NX} - TNU_{NO}) / N_X$	
Nitrogen Economic Efficiency	NEE	€ € ⁻¹	$NEE = (GY_{NX} - GY_{NO}) * \text{grain price} / (N_X - N_O) * \text{N selling price}$	





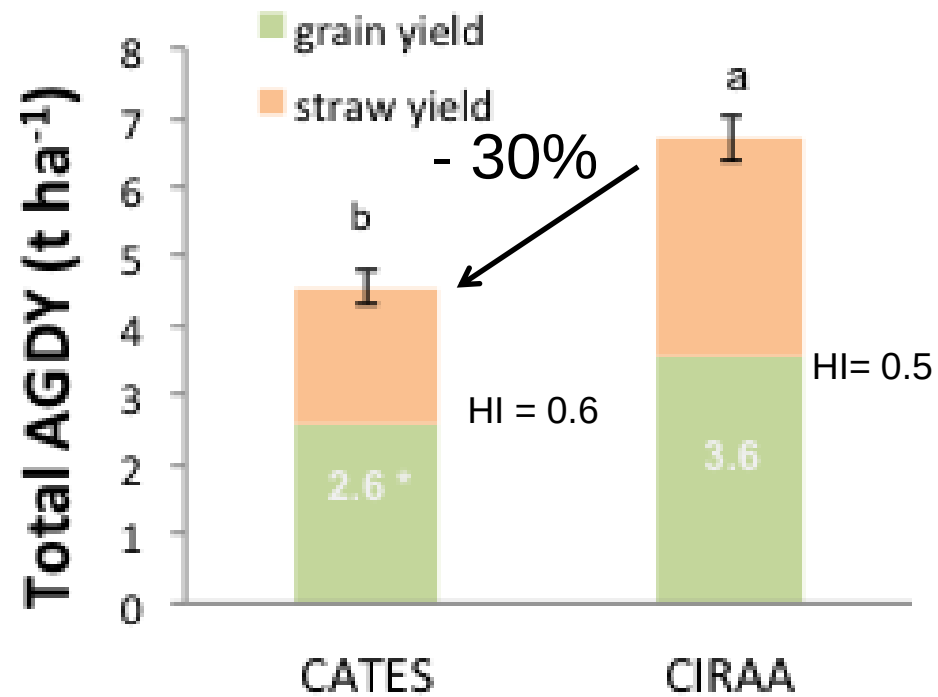
RESULTS



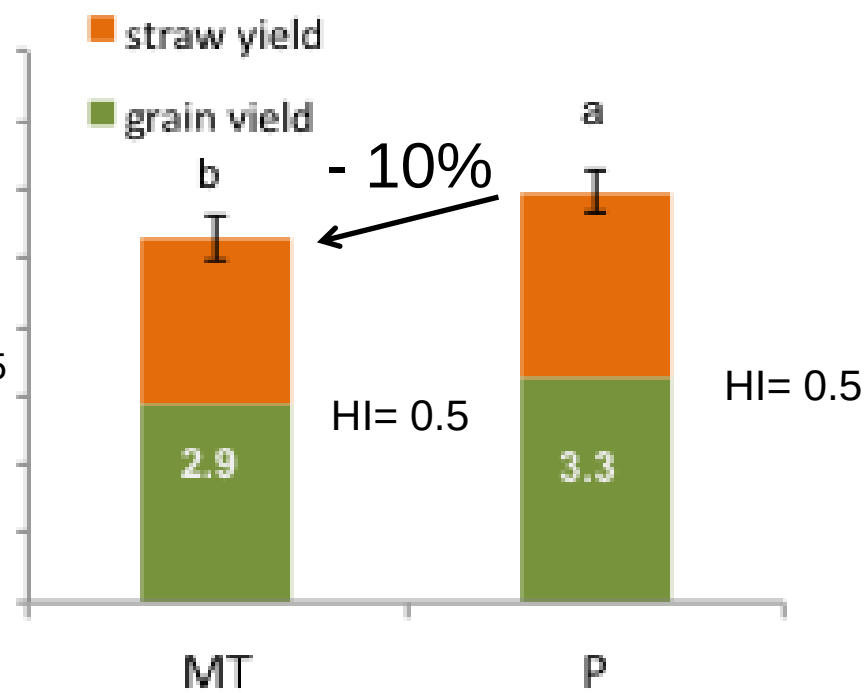
RESULTS

Source	Dry grain t ha ⁻¹	Dry straw t ha ⁻¹	Total AGDY t ha ⁻¹
Site (S)	***	***	***
Tillage (T)	***	*	**
N rate (N)	***	***	***

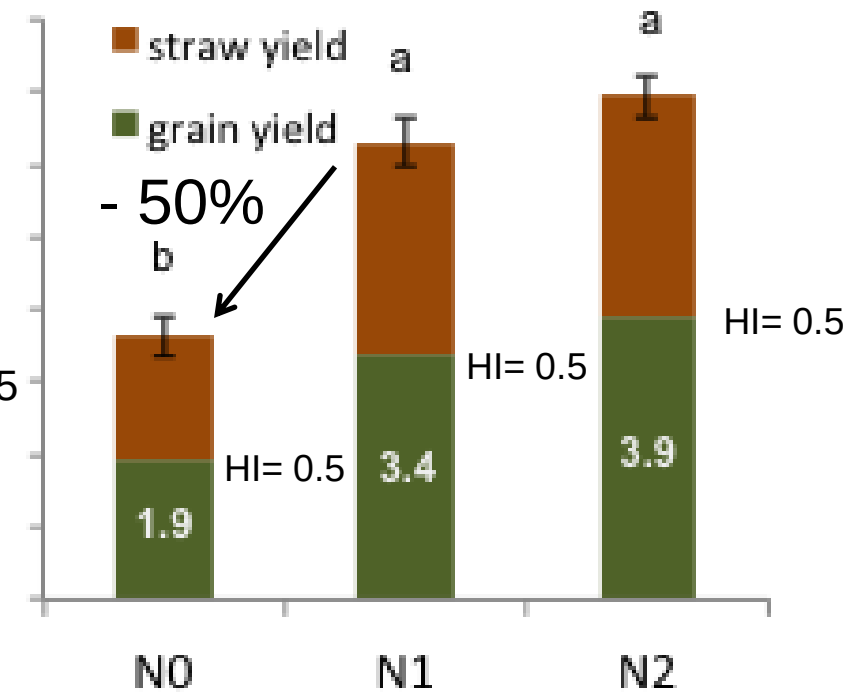
Site



Soil tillage



N fertilisation level



ISTAT DATA Mean 2014 - 2015	Grain Yield (t ha ⁻¹)
Arezzo	2.8
Pisa	3.0
Toscana	3.2

Soil tillage	Grain Yield (t ha ⁻¹)
Conventional	2.8
Minimum	2.7

(Seddaiu et al., 2016)

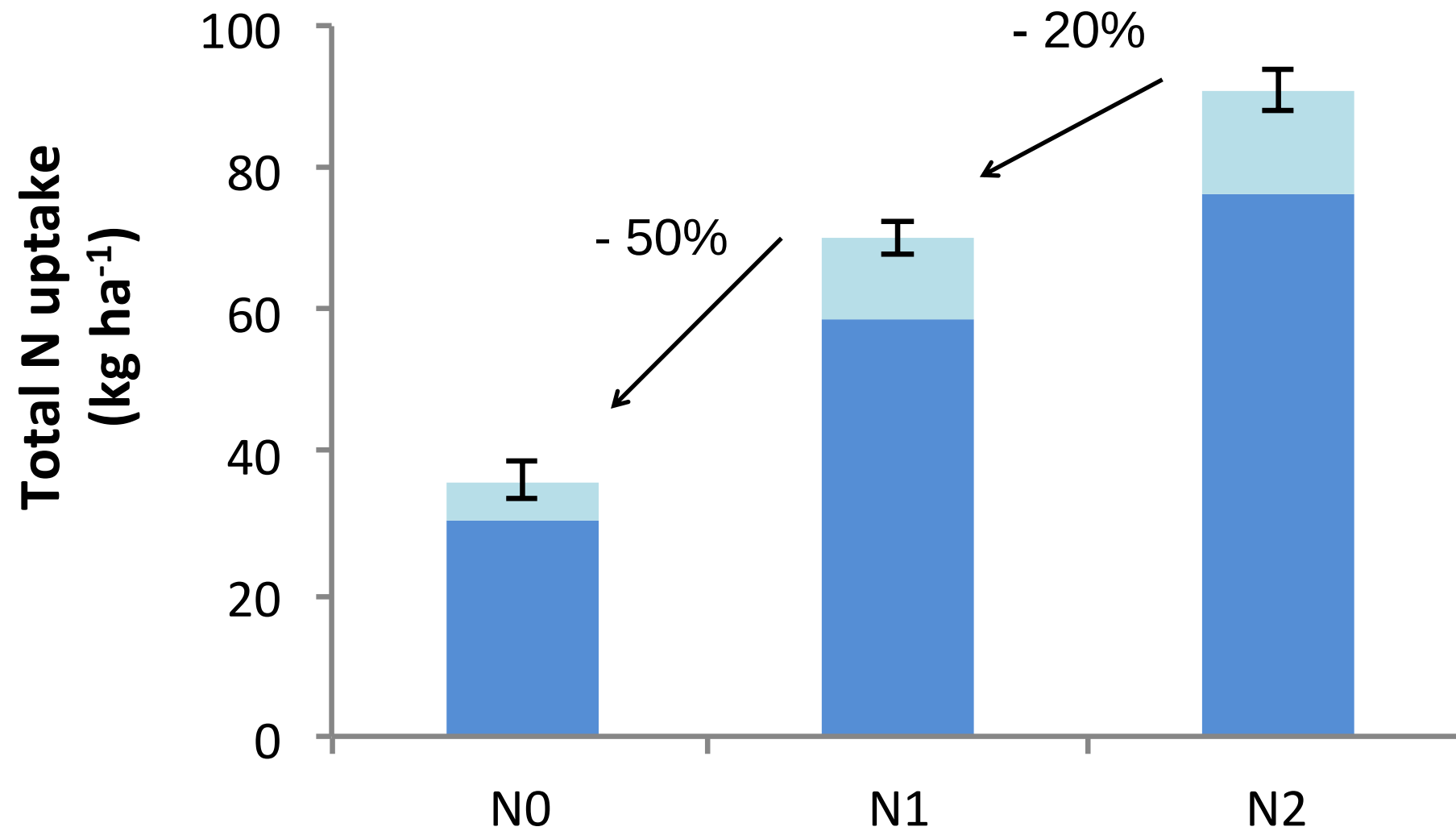
N level (kg ha ⁻¹)	Grain Yield (t ha ⁻¹)
N 0	1.4
N 90	3.0
N 180	3.8

(Seddaiu et al., 2016)



RESULTS

■ Ngrain ■ Nstraw



N level (kg ha ⁻¹)	Grain Yield (t ha ⁻¹)	Total N uptakes (kg ha ⁻¹)
N 0	2.3	64
N 50	2.5	72
N 100	2.9	87
N 150	3.0	91

(Lopez-Bellido et al., 2001)

Protein content (%13 Umidity)

N0 = 10.2

N1 = 12.1

N2 = 13.9



RESULTS

The increase of Gross Production
per € invested in fertilisers

	A _E	N _{UtE}	N _{HI}	P _E	RF (%)	NEE
<u>N level</u>	kg _{grain} kg ⁻¹ N _{fertiliser}	kg _{grain} kg ⁻¹ N _{uptake}	kg N _{grain} kg ⁻¹ N _{uptake}	kg _{grain} kg ⁻¹ N _{uptake}	kg N _{uptake} kg ⁻¹ N _{fertiliser}	€ € ⁻¹
N0		53.7a	84.5			
N1	13.6	48.6b ↓ - 10%	83.8	58.3a	25.3a	4.6a
N2	11.5	43.5c ↓ - 10%	84.0	36.3b	17.1b	2.2b ↓ - 32%

Other studies

<u>N level</u>	A _E kg kg ⁻¹	N _{UtE} kg kg ⁻¹	N _{HI} %	P _E kg kg ⁻¹	RF %
N0		44	73		
N140	9.3	36	71	19	49
N210	9.0	31	65	16	56

Source: Delogu et al., 1998

<u>N level</u>	A _E kg kg ⁻¹	N _{UtE} kg kg ⁻¹	N _{HI} %	P _E kg kg ⁻¹	RF %
N0		36	75		
N50	7.2	35	75	23	24
N100	6.6	33	73	20	25
N150	4.9	32	72	21	19

Source: Lopez-Bellido et al., 2001

CONCLUSION

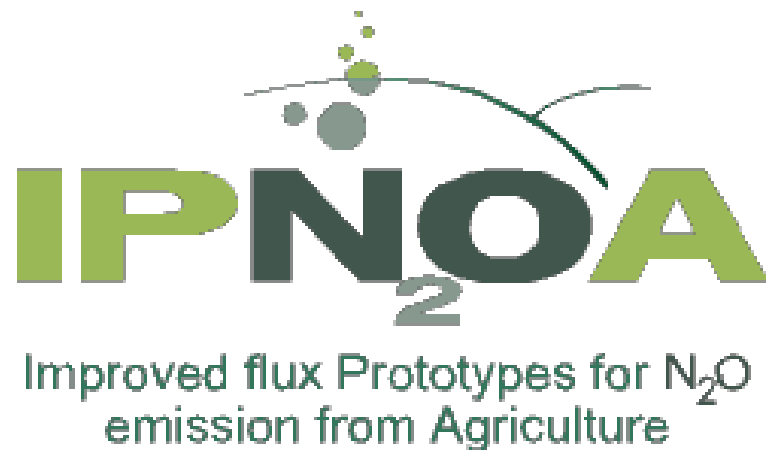
- ✓ Durum wheat Yields were affected by: (i) the pedo-climatic characteristics varying of about 30% between the sites, (ii) soil tillage intensity ($\pm 10\%$) and (iii) N rate;
- ✓ Under low-input condition (N1, 110 kg N ha⁻¹), durum wheat achieved satisfactory yield level as N2 (170 kg N ha⁻¹) with higher nitrogen efficiency and lower N₂O emissions (-50%) (Bosco et al., 2016 *under submission*).
- ✓ Further investigations are in progress to complete the N balance, the analysis of energy efficiency and the evaluation of economic aspects for this experiment.



Thanks for your attention!

LIFE+ IPNOA

Final Workshop



*Climate change
mitigation strategies,
a challenge for
agriculture*

Pisa, 13 Ottobre 2016
Scuola Superiore Sant'Anna,
Piazza Martiri della Libertà, 33

Ore 9.30 - 18.00

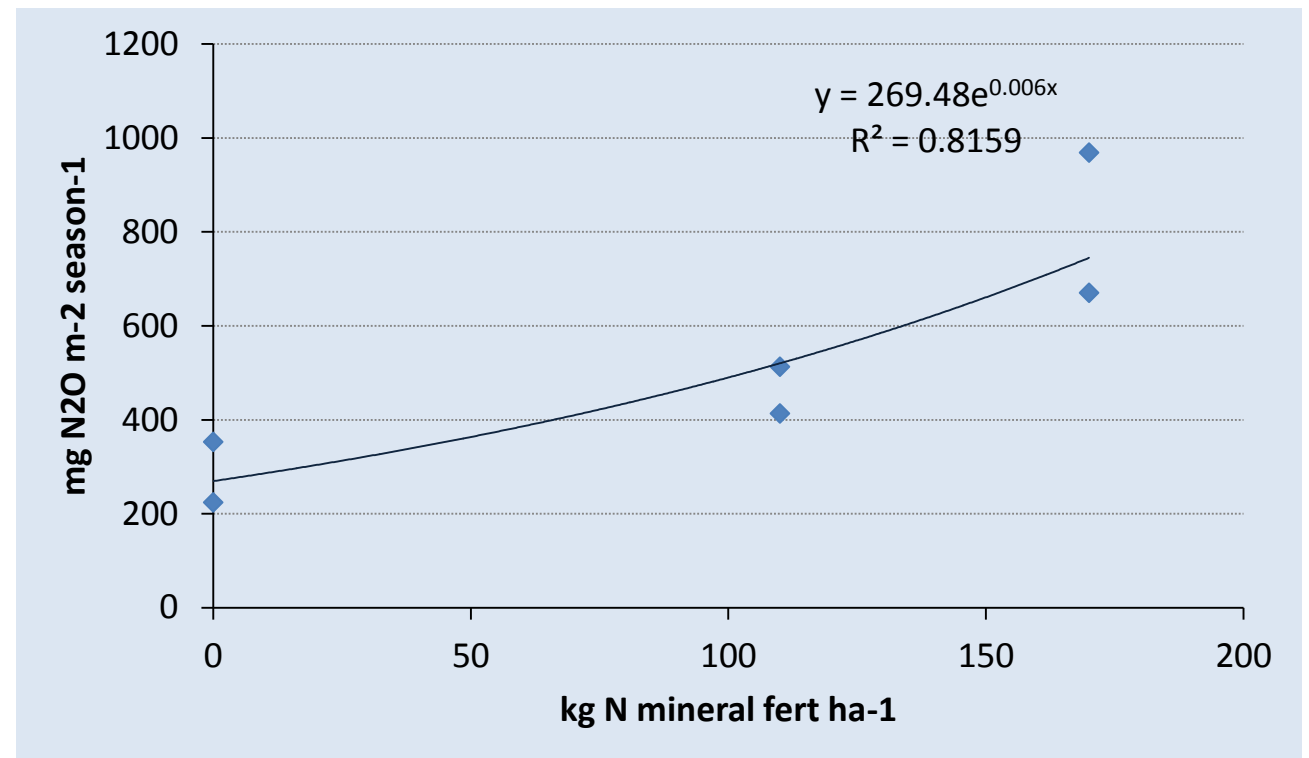
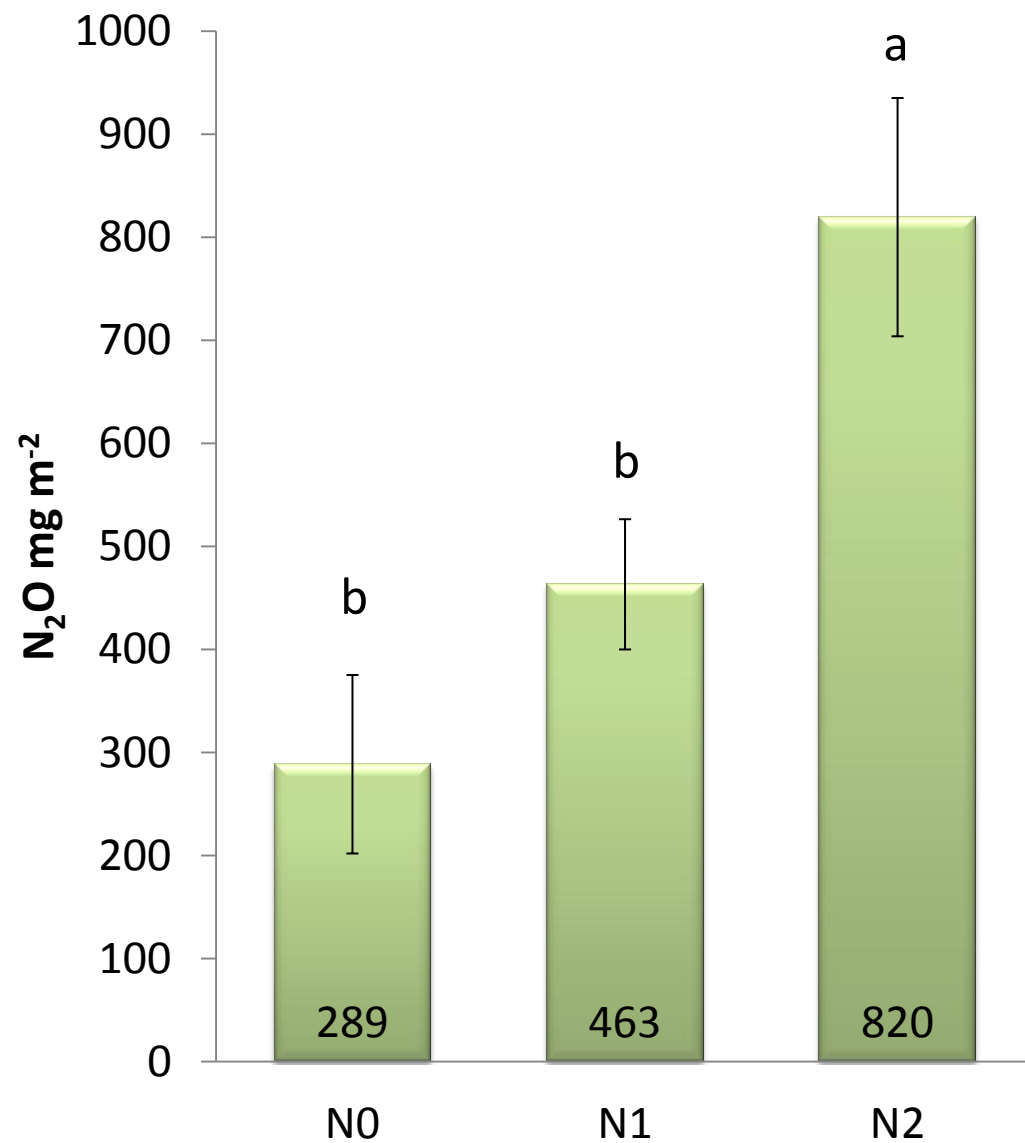
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Cumulated N₂O flux

Tillage: n. s.

N fertilization: $p < 0.001$



EMISSION FACTOR OVER THE GROWING SEASON

N level	% N-N ₂ O N added
N1	0.5
N2	1.5