Modern Technologies of Rice Growing
Global Food and Environmental Safety
August 9-12/08/2016

National Academy of Agrarian Sciences of Ukraine

GROWING RICE BY DRIP WITH LESS WATER AND ARSENIC FOR GLOBAL FOOD SECURITY

Italian experience 2010-16

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NETAFIM GBU SOUTH EUROPE

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History of rice cultivation in Italy

- Probably introduced by **Arabs** in Sicily (14th Century)
- Middle Ages rice cultivated in botanical edges of monastic orders
- Monks **select** the first seed

- Cultivated over **500 years ago**
- 16th Century **increased area** from 5.000 to 50.000 ha

50 YEARS OF SHAPING THE FUTURE

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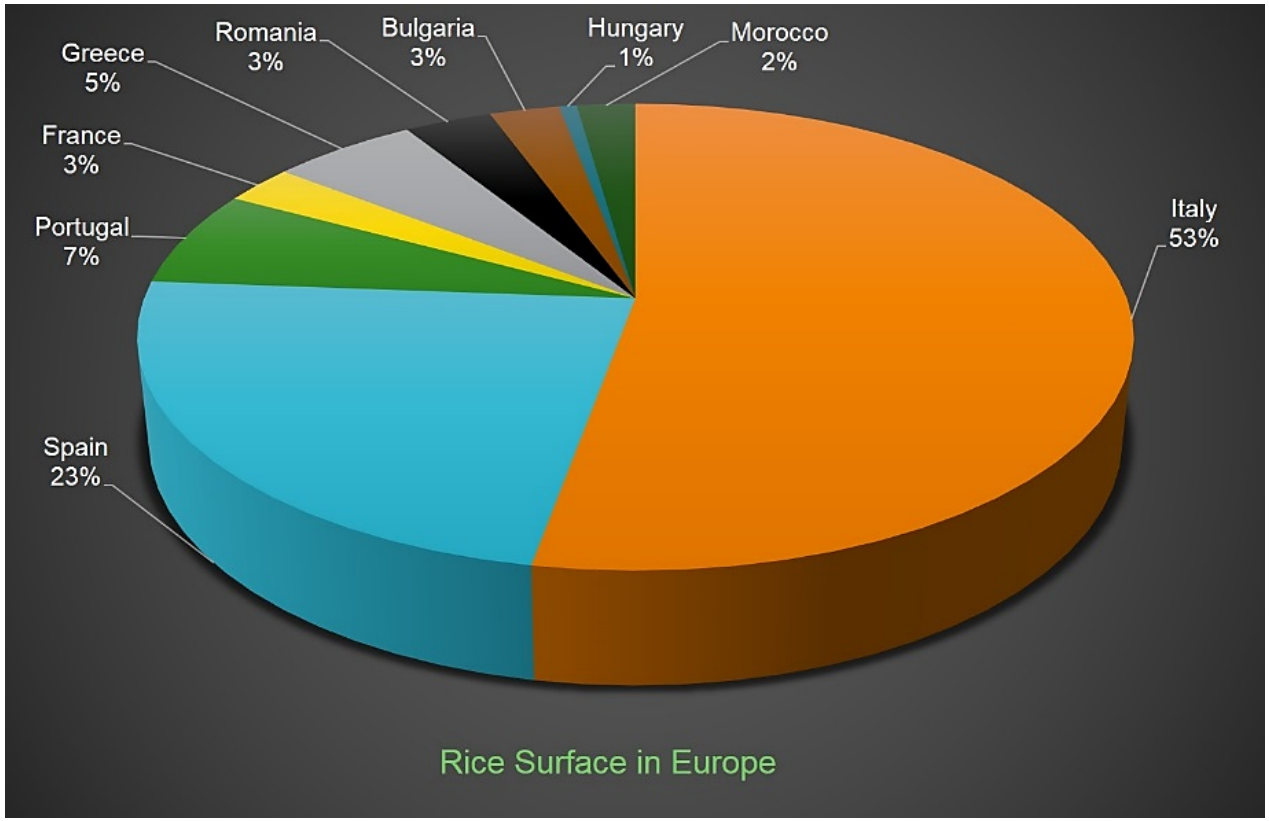
RICE SURFACE IN EUROPE



Country	Surface (ha)	%
Italy	237.500	53
Spain	105.000	23
Portugal	30.000	7
France	12.000	3
Greece	25.000	6
Romania	15.000	3
Bulgaria	12.000	3
Hungary	3.000	1
Morocco	10.000	2
Total	**449.500**	**100**

Source: World Association of Agronomists – 2015 mod. 2016 Ente Risi

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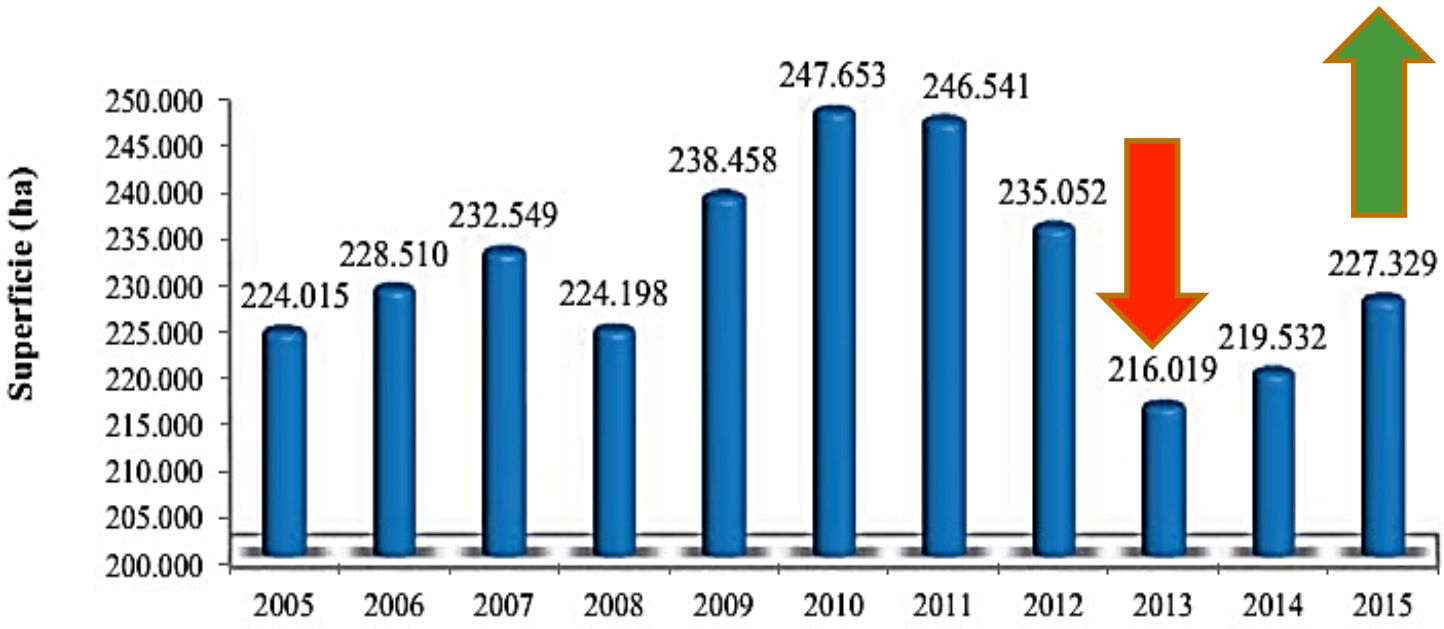
ITALIAN RICE SURFACE 2005-2015



Source: Ente Risi

- After the reduction of surface, from 2010 to 2013, the situation in 2016 is getting better for price and evolution in crop management (minimum tillage, dry sowing, etc.)

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ESTIMATION RICE SURFACE IN ITALY AT JULY 2016

Superfici coltivate a riso nel 2016
dati provvisori calcolati sull'80% della superficie
(20/7/2016)

GRUPPI VARIETALI	Previsione Superfici 2016 (ettari)	Superfici 2015 (ettari)	Differenza	
			ettari	%
TONDI	72.800	56.946	15.854	27,84%
LIDO E SIMILARI	2.500	1.412	1.088	77,07%
PADANO E SIMILARI	350	820	-470	-57,32%
VIALONE NANO	5.200	6.056	-856	-14,13%
VARIE MEDIO	1.750	1.183	567	47,97%
LOTO - ARIETE E SIMILARI	34.200	45.594	-11.394	-24,99%
S.ANDREA	8.000	11.039	-3.039	-27,53%
ROMA E SIMILARI	14.000	9.959	4.041	40,57%
BALDO E SIMILARI	10.500	21.037	-10.537	-50,09%
ARBORIO E SIMILARI	22.000	17.125	4.875	28,47%
CARNAROLI E SIMILARI	21.500	15.065	6.435	42,71%
VARIE LUNGO A	11.000	6.048	4.952	81,88%
LUNGO B	33.700	35.044	-1.344	-3,84%
TOTALE	237.500	227.329	10.171	4,47%

237.500 ha in 2016

227.329 ha in 2015

+ 10.171 hectares increased

Increased surface + 4,47%

Source: Ente Risi

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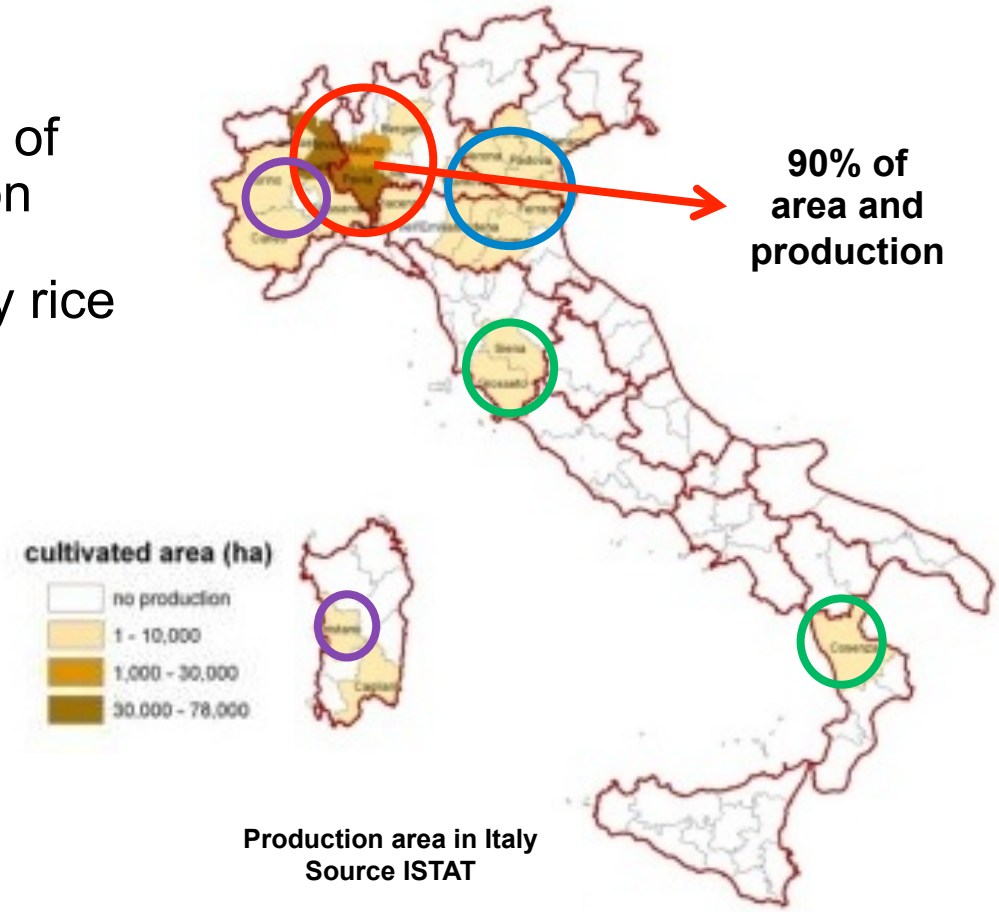
ITALIAN RICE

- Italy represent with **1.496.250 tons** of paddy rice, **0,4%** of world production
- Yield average **6,3 tons/ha of** paddy rice

- **32%** of total italian production is for **Risotto Varieties**
- **68%** others

- Export in EU: **56%** of production
- Export in other Countries: **12%**
- Turnover export **460-490 milion of euros** (510-543 milion of dollars)



Production area in Italy
Source ISTAT

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Source: World Association of Agronomists – 2015 mod. 2016 Ente Risi

VARIETIES IN ITALY AND «*RISOTTO*»

- **In Italy are registered 185 varieties of rice**
- **30 are actually cultivated in relevant area**
- **The *risotto* varieties are the most important**

- ***Risotto* is a kind of coocking process, very popular in Italy and needs kind of rice with high quantity of Amilose starch**
- *Its main feature is the retention of the starch jelly that due to the cooking, combine grains between them in a creamy compound*

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Italian experience 2010-16

RESEARCH TOPICS

From 2010-11 we drive research in aerobic rice irrigated by drip in collaboration with R&D Netafim Corporate mainly in the bold topics:

a) **Water use reduction**
b) Fertilizer use reduction
c) **Greenhouse gas emission reduction**
d) Reduction in leaching of fertilizers
e) Power saving
f) Reduction in manpower and labor
g) **Use of various soil types and topography**
h) Reduction in diseases and pests
i) **Arsenic uptake and Rice quality**
j) **Weeds control and mulching**

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WATER USE REDUCTION

- A different approach to reduce water inputs in rice is to grow the crop like an irrigated dry crop
- Such as Corn or Cotton using modern irrigation technologies such as drip irrigation
- Field experiments indicated seasonal water requirement per hectare of drip irrigated aerobic rice was **7000-8000 m^3/ha**
- Potential yield of **10-12 tons/ha**
- *It is about 800-900 liters to produce 1kg of Rice with Drip Irrigation (instead of 3.000-5.000 by submersion).*

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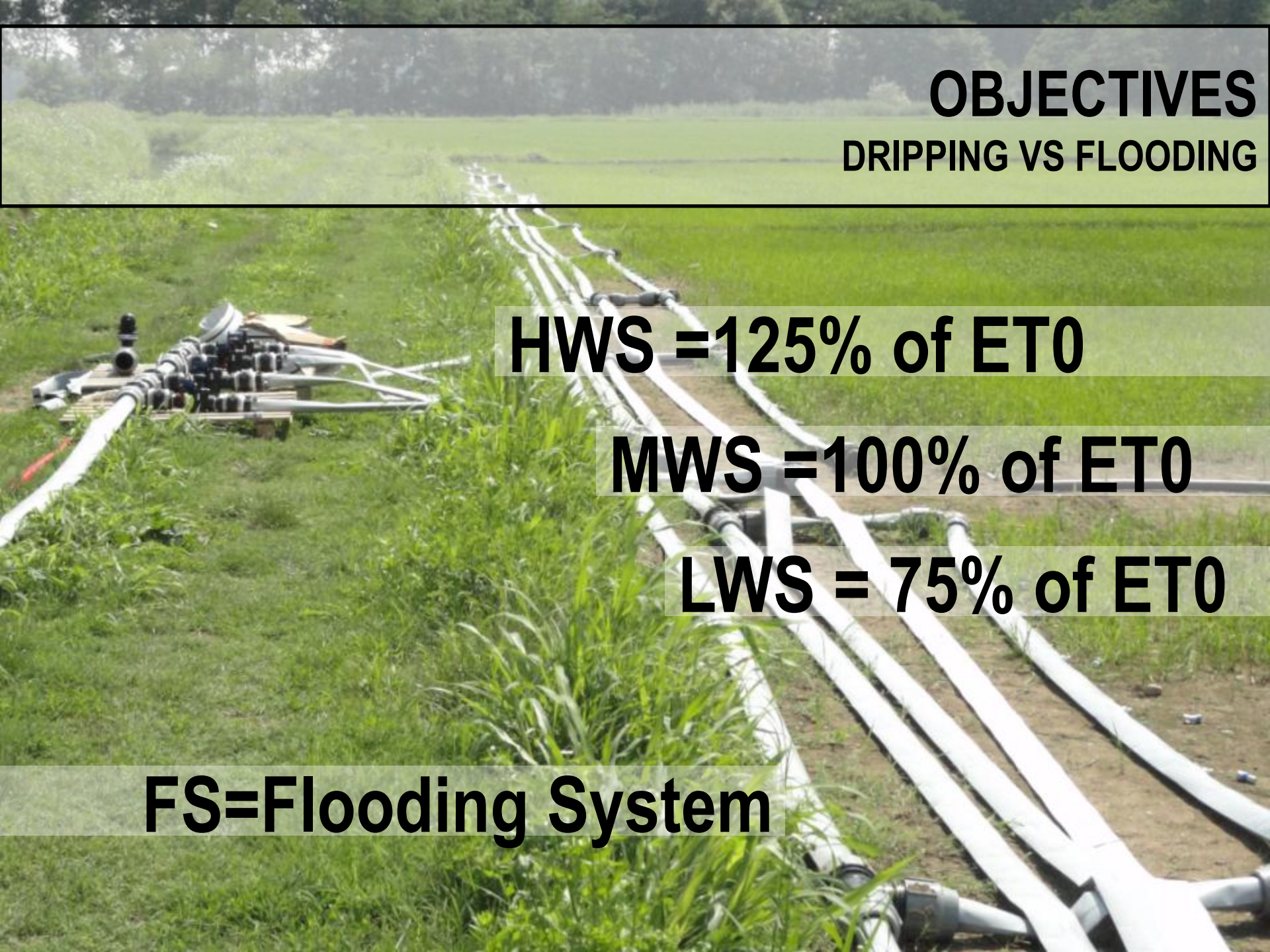
THE PIONEER FARM: FOLETTI BROS. 2010

- In 2010 decide to try drip irrigation on 13 ha of rice *Roma Var.*
- SDI 35 cm depth, Uniram AS compensated drip
- 90 cm between lines, 60 cm between drippers, 2,3 liters/hour

SAVE WATER BY DRIP IRRIGATION

BELLONE FARM 2011-12



OBJECTIVES

DRIPPING VS FLOODING

HWS =125% of ET0

MWS =100% of ET0

LWS = 75% of ET0

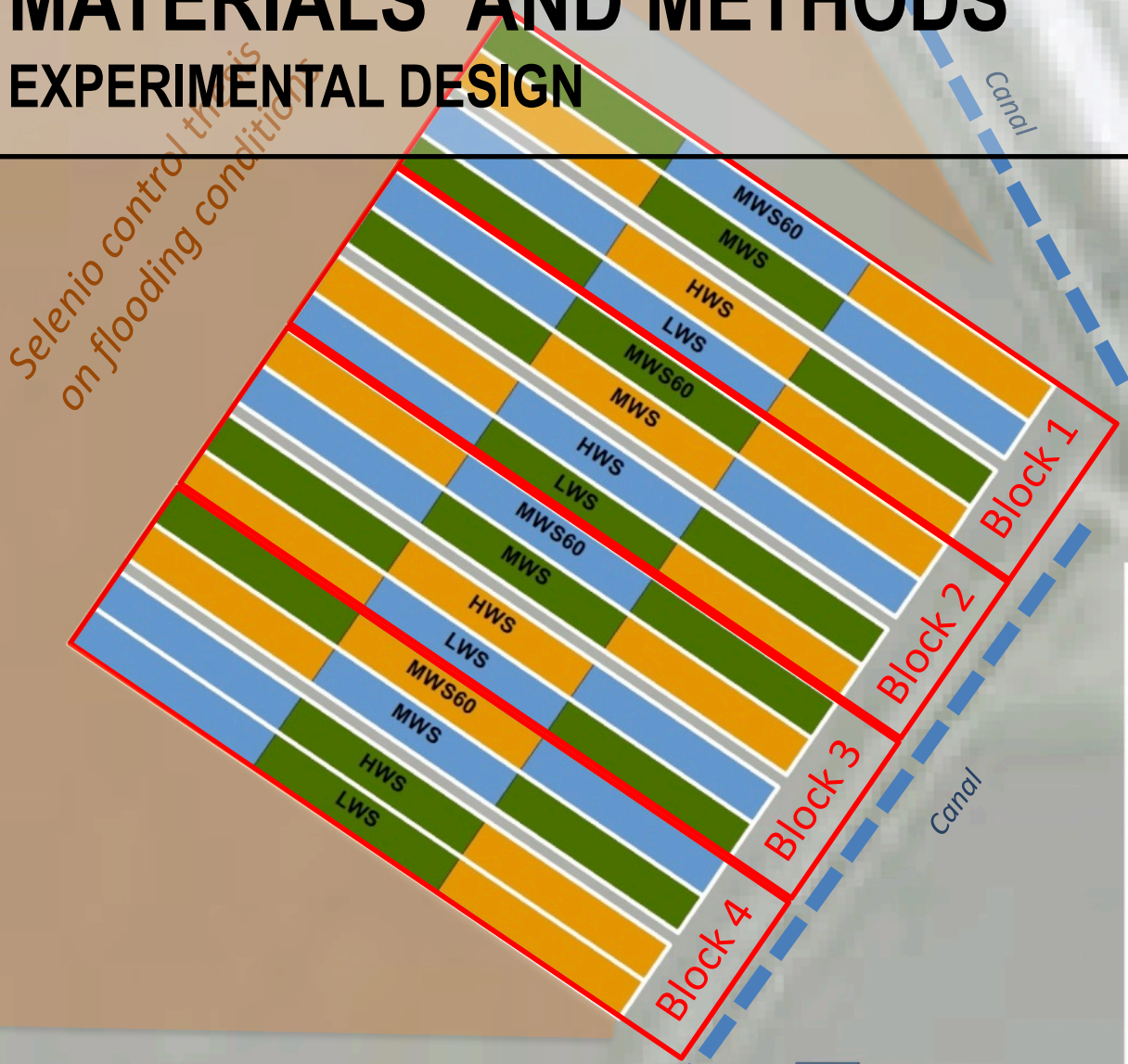
FS=Flooding System

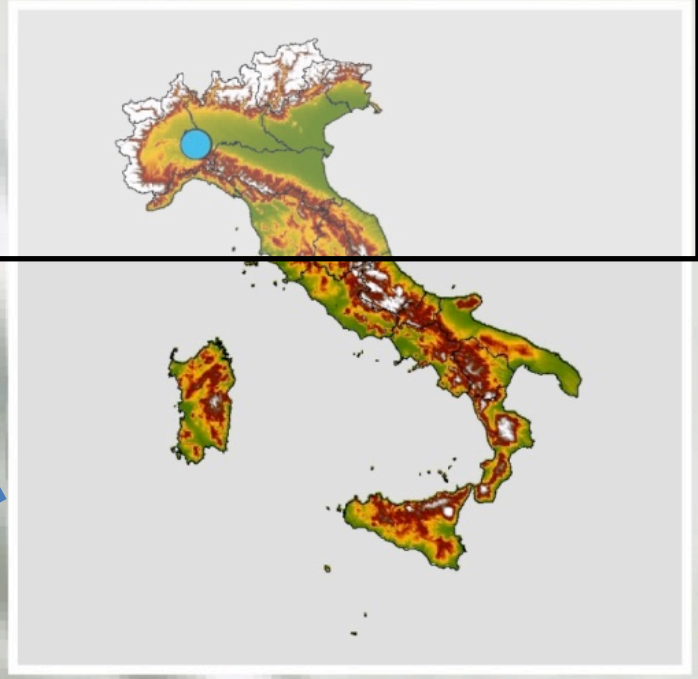
MATERIALS AND METHODS

VARIETIES

MATERIALS AND METHODS

EXPERIMENTAL DESIGN

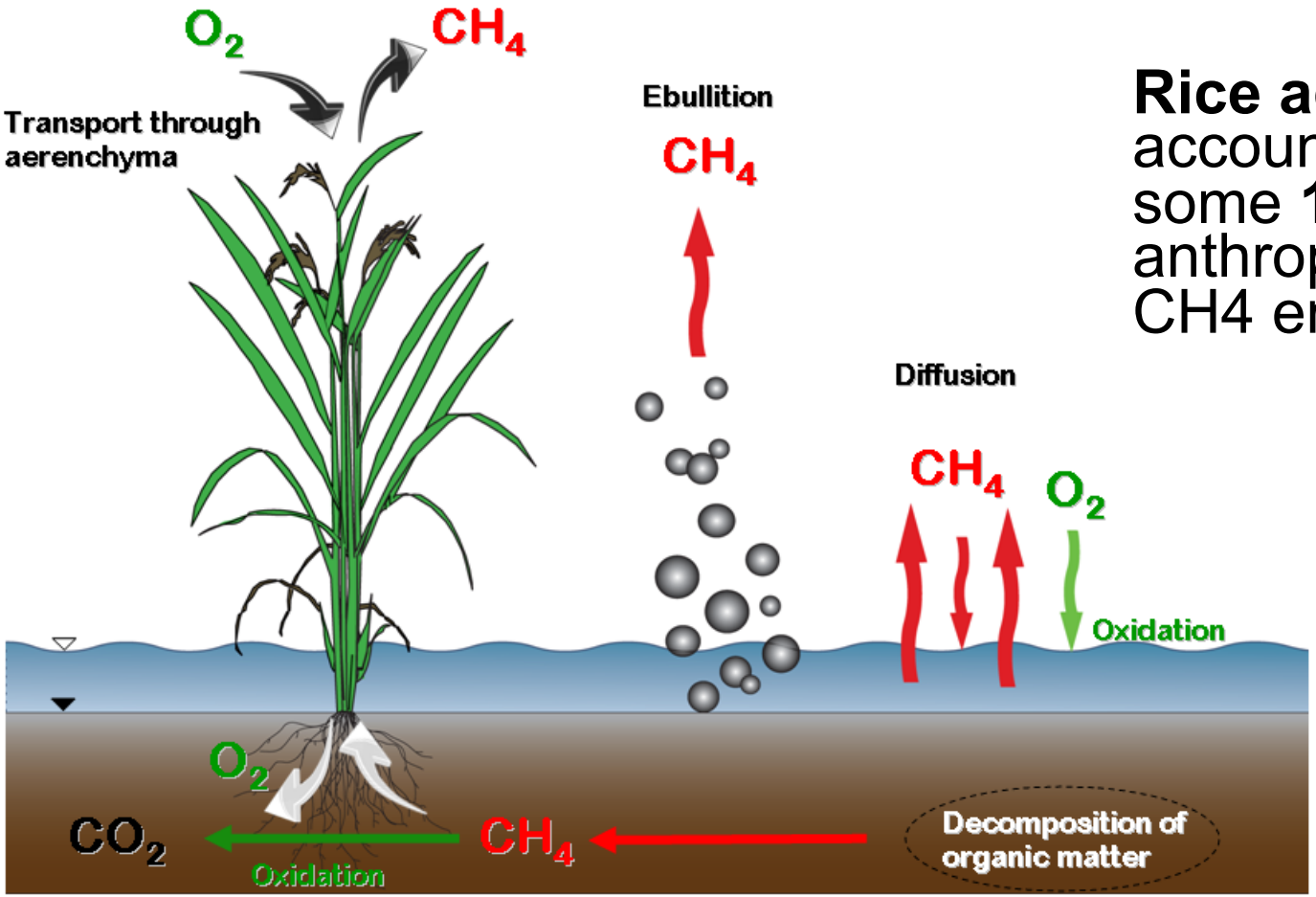




SAVE WATER: RESULTS

	WC [m^3/ha]	Grain [kg/ha]	WU [m^3/kg]	W_{saving} [%]
I-Kc	4,180	2,514	1.7	-52.2
I-150	5,880	3,080	1.9	-45.1
Control (flooded)	16,680	4,795	3.5	-

GAS EMISSION FROM RICE PADDY: CH4



Rice agriculture accounts for some **17%** of the anthropogenic CH4 emissions.

Methane oxidation:

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Methanogenesis:

Hydrogenotrophic: $CO_2 + 4H_2 \rightarrow 2\,H_2O + CH_4$

Acetotrophic: $CH_3COOH \rightarrow CO_2 + CH_4$

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Source: Institute of Biogeochemistry and Pollutant Dynamics - Zurich

Data Monitoring 2013 Lolini Farm — Grosseto, ITALY

EMISSION MONITORING: ITALY TRIALS

Example of results of gas emission from rice by drip compared with conventional measured by fluxmeter	
EMISSION in AEROBIC RICE DRIP IRRIGATION	**EMISSION in CONVENTIONAL RICE**
SENSOR#1 SENSOR_TYPE: CH4 **FLUX (ppm/sec): 0.001** **FLUX (moles/m^2/day) 0.00045**	SENSOR#1 SENSOR_TYPE: CH4 **FLUX (ppm/sec): 0.004** **FLUX (moles/m^2/day) 0.00124**
SENSOR#2 SENSOR_TYPE: CO2 **FLUX (ppm/sec): 0.519** **FLUX (moles/m^2/day) 0.18398**	SENSOR#2 SENSOR_TYPE: CO2 **FLUX (ppm/sec): 0.623** **FLUX (moles/m^2/day) 0.22074**

- 75%

- 63%

- Extract from text reports of a comparison between CH4 and CO2 Drip Laterals and Paddy in submersion (after emptying)

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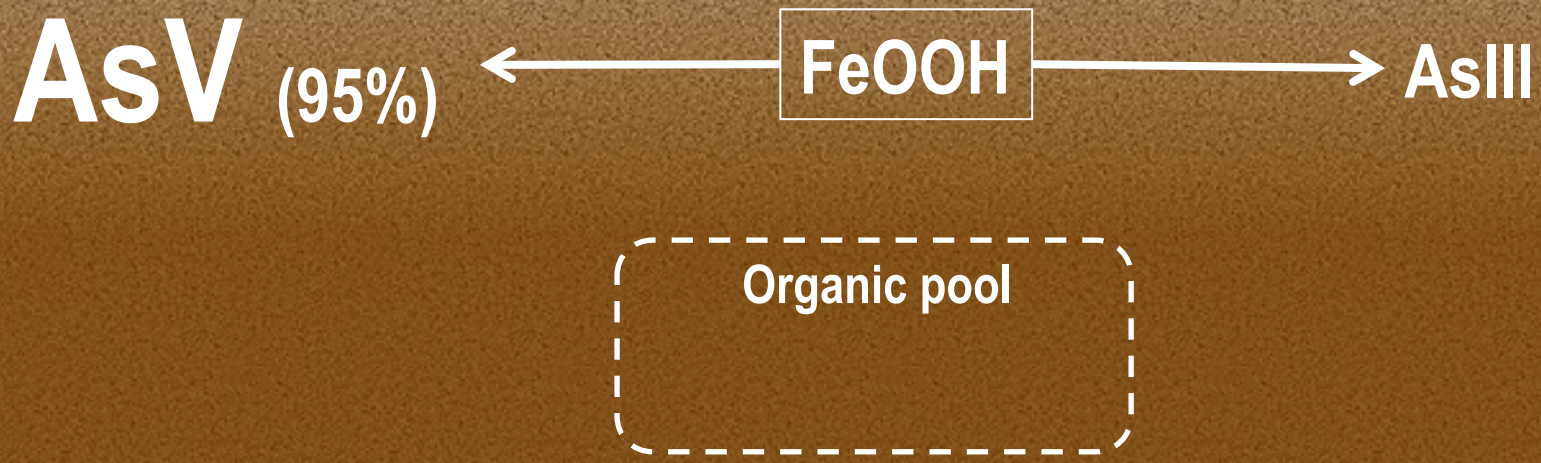
Data Monitoring 2013 Lolini Farm – Grosseto, ITALY

ARSENIC UPTAKE

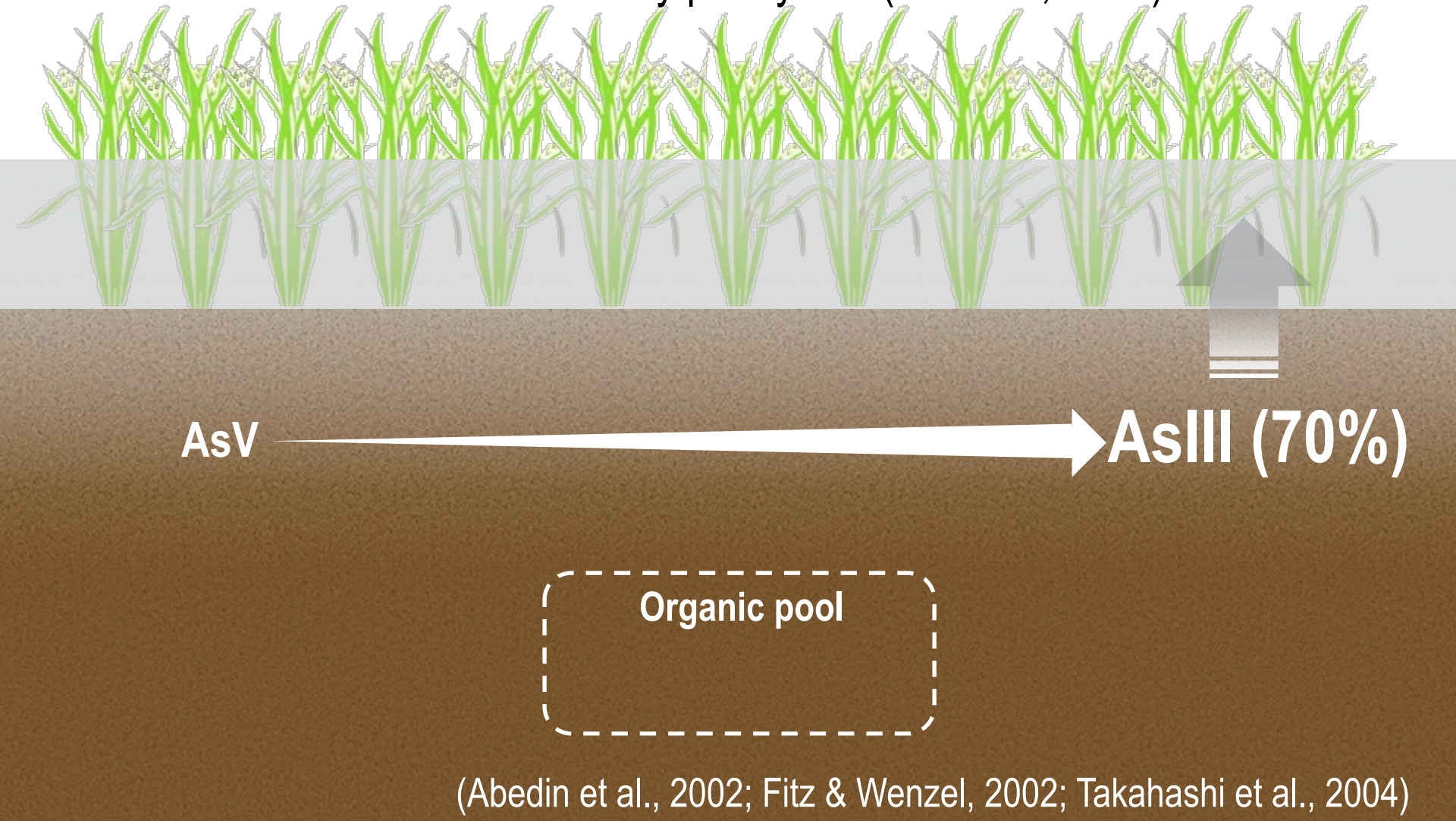
Low levels of As are naturally present in the soil (Matshullat, 2000)
The background levels worldwide are around 5 mg kg^{-1} (Mandal & Suzuki, 2002)



(Abedin et al., 2002; Fitz & Wenzel, 2002)

ARSENIC UPTAKE

The increased bioavailability of As under flooded conditions is the main reason for an enhanced *As* accumulation by paddy rice (Xu et al., 2008)



(Abedin et al., 2002; Fitz & Wenzel, 2002; Takahashi et al., 2004)

INSTITUTE OF LIFE SCIENCES

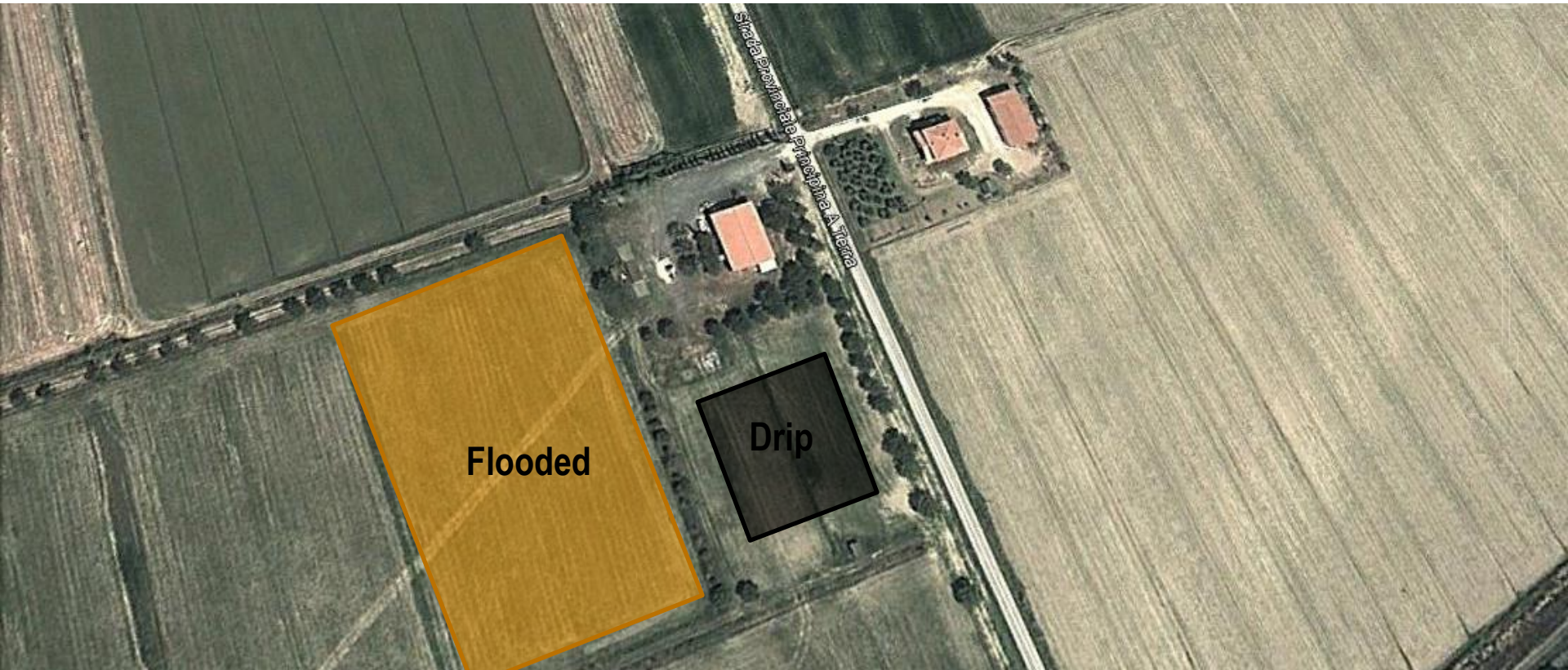
Scuola Superiore Sant'Anna

Water saving and reduced arsenic uptake in aerobic rice (*Oryza sativa* L.): feasibility of drip irrigation under Mediterranean climate

G. Ragaglini, F. Triana, C. Tozzini, F. Taccini, A. Mantino, A. Puggioni, E. Vered, E. Bonari

OBJECTIVE

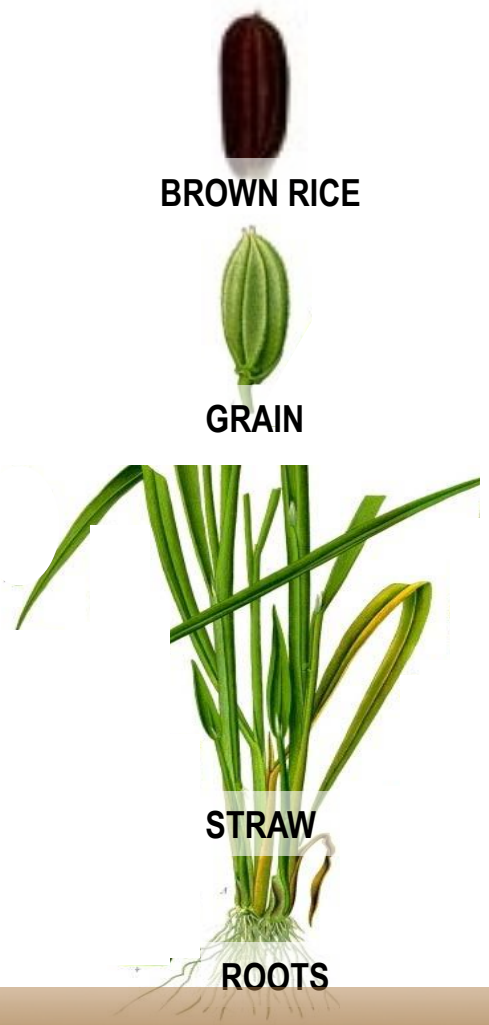
Evaluation of the potential of drip irrigation in reducing the risk of As accumulation and water consumption in rice, compared to the flooding system in field condition



RESULTS

As CONCENTRATION (mg kg^{-1})

FLOODED		DRIP
0.059 (±0.012)	BROWN RICE	<0.01
0.11 (±0.1)	GRAIN	<0.01
1.53 (±0.47)	STRAW	<0.01
23.33 (±7.79)	ROOTS	3.73 (±0.75)
5.7	SOIL	5.8



(Williams et al., 2007)

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AZ. PRIORA 2013-14 - PIEDMONT
RICE BY DRIP ON SURFACE: WEEDS CONTROL AND DELTA T° PROBLEMS

AZ. MENSANELLO 2014 – TUSCANY RICE BY DRIP IN MARGINAL SOIL AND BAD WATER QUALITY

AEROBIC RICE AND DRIP IRRIGATION

- Using drip irrigation: no **weeds control** due to the submersion.
- Using drip irrigation: no **buffer of temperature** due to submersion.
- North Italy: the **delta** of temperature con achieve **15°C** and this could be an issue for rice growth.
- We challenge those issues applying drip irrigation on surface **80cm** between lines and **30cm** between drippers with **1 liters/hour** flow.

THE FUTURE

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WEEDS CONTROL AND MULCHING 2015

- In collaboration of **Turin University** we investigate two different protocols of **weeds control in drip irrigation.**

- One for conventional varieties, the second for ***Clearfiled*** varieties.

- The biodegradable mulching can help the plants to reduce the effect of delta T° **keeping warm** the area under mulch.

- Can also permit to **reduce** the number of treatments for weeds control.

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WEEDS CONTROL AND MULCHING 2015

MULCH AND DRIPPERLINES IN 1 PASSAGE ON SEEDED SOIL

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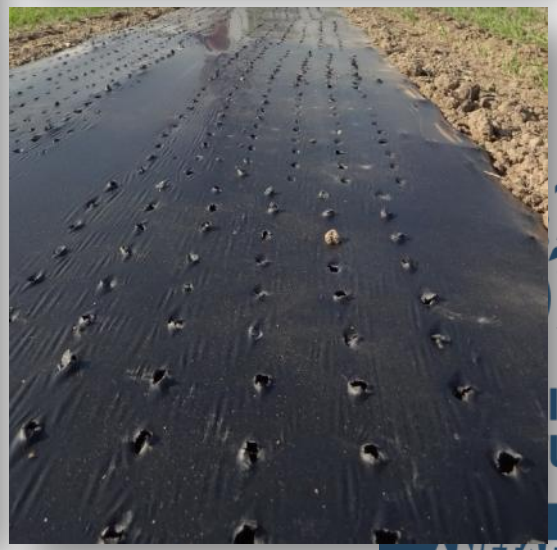
WEEDS CONTROL AND MULCHING 2015

PUNCHING THE MULCH BY HAND



WEEDS CONTROL AND MULCHING 2015

MULCH STRIPS WITH HOLES

RICE BY DRIP ON SURFACE

DRONE AgronFly & NETAFIM

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N

0 5 10 20 30 40

N

0 5 10 20 30 40

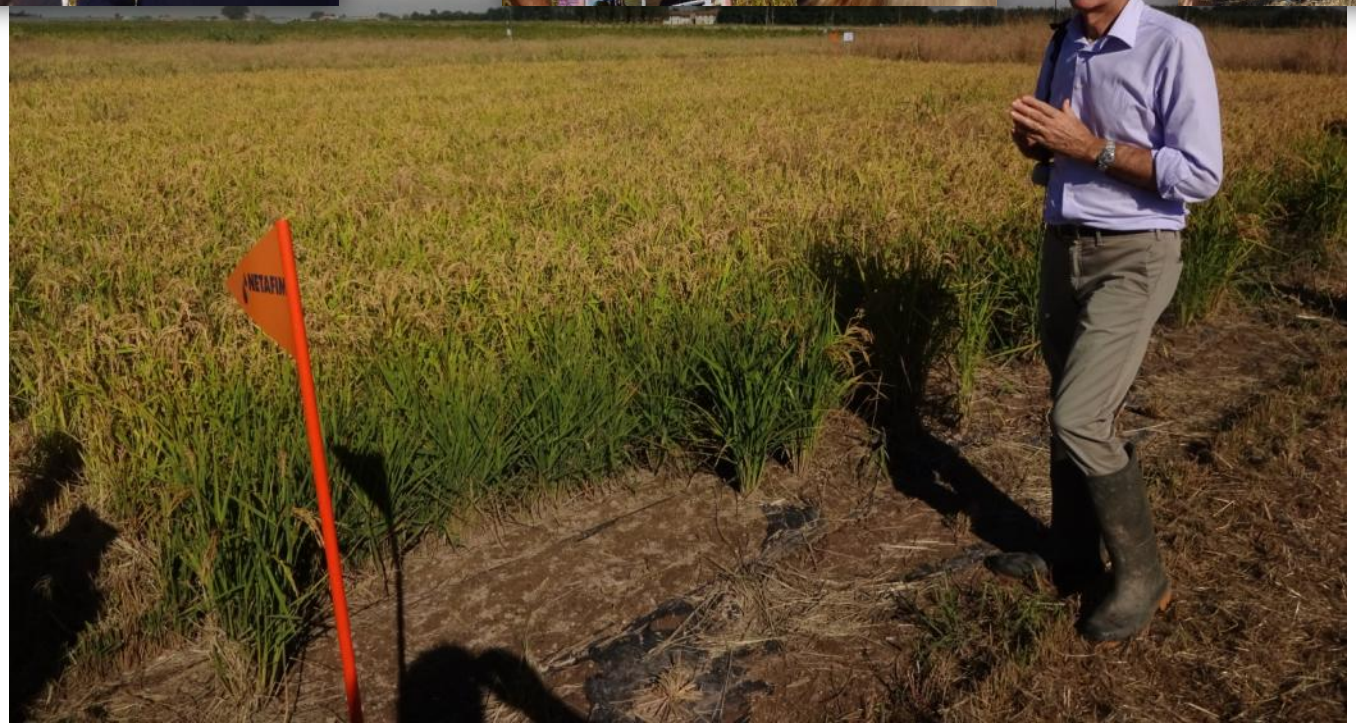
NDVI

High

Low

WEEDS CONTROL AND MULCHING 2015

FIELD DAY SEPTEMBER 2015



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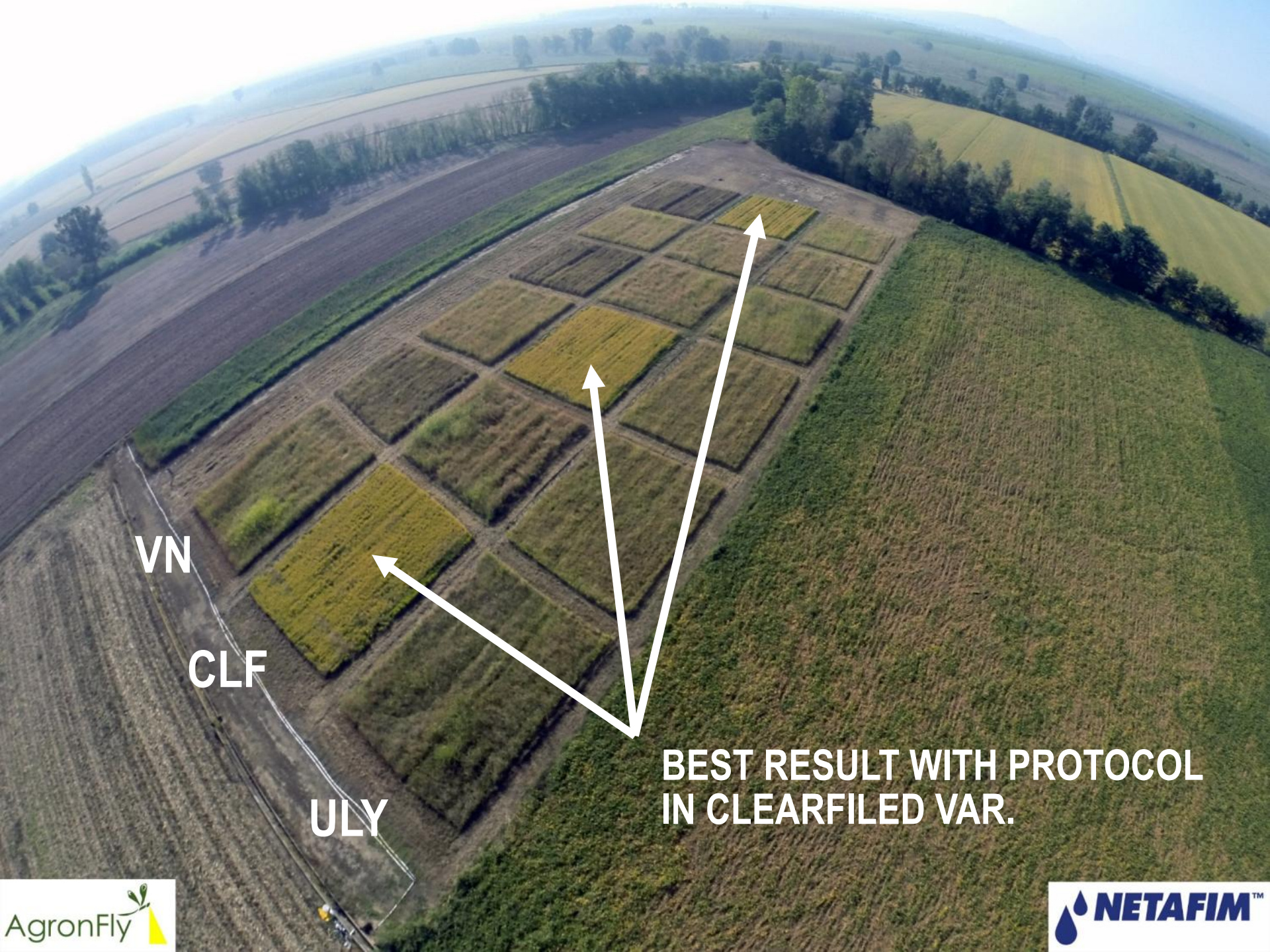
VN
CLF
ULY
BEST RESULT WITH PROTOCOL
IN CLEARFILED VAR.
AgronFly
NETAFIM™

DEMO FIELD EXPO 2015

USE SLOPE AND MARGINAL SOIL

Sorghum seeded in two times irrigated by drip by gravitation and solar pump

Rice seeded and transplanted irrigated by drip by gravitation and solar pump

Corn seeded in two times irrigated by drip by gravitation and and solar pump

Soybean irrigated by drip by gravitation and by solar pump

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DEMO FIELD EXPO 2015
USE SLOPE AND MARGINAL SOIL

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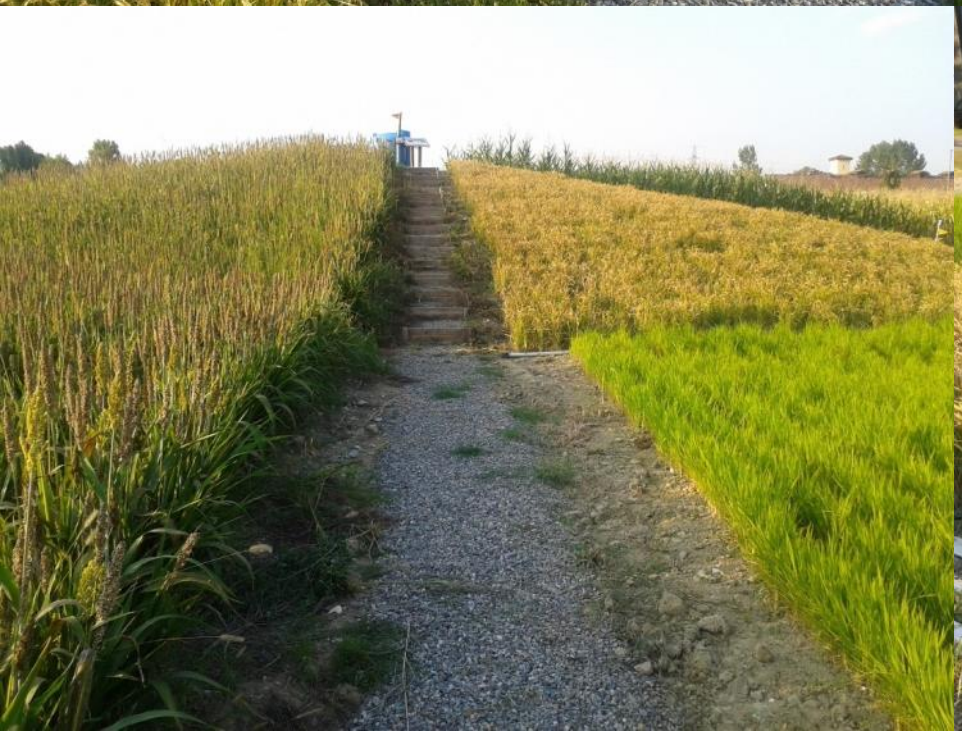
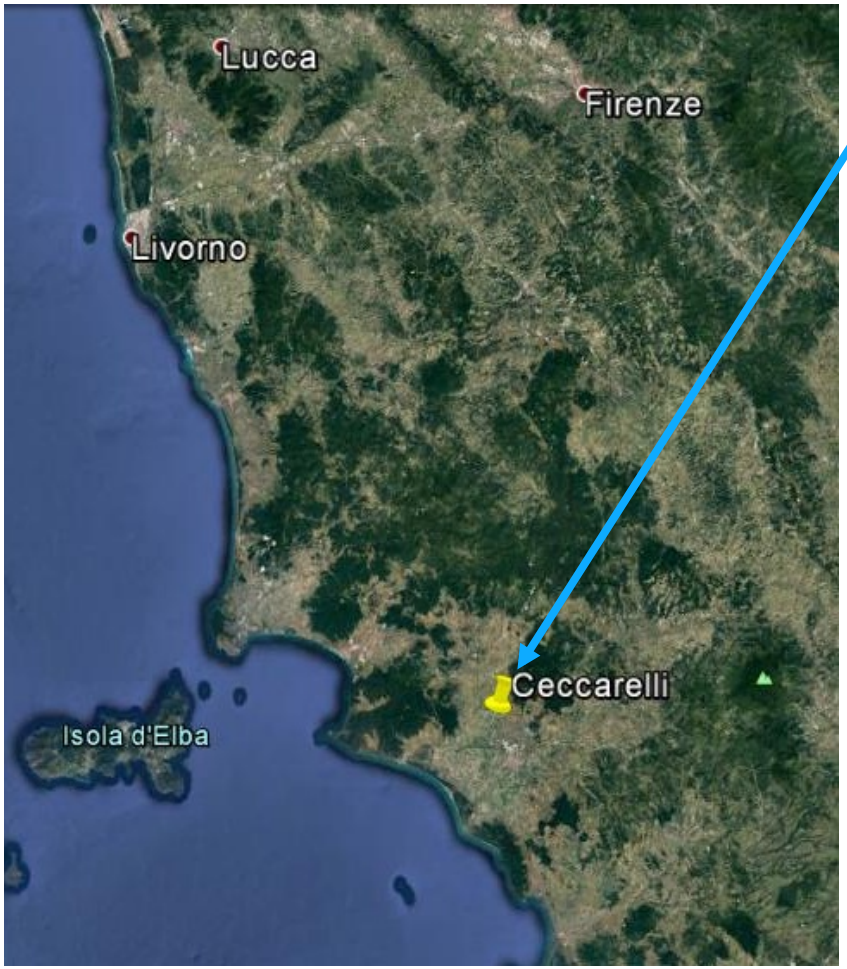
USE SLOPE AND MARGINAL SOIL



DRIP IRRIGATED RICE LIKE ROTATION CROP - 2016



- **Ceccarelli Farm** is using drip irrigation in SDI from 3 years
- Trial target: compare rice monoculture and a 3 year rotation
- 2 different drip irrigation systems, sub-surface vs surface drip irrigation
- 2 different fertilization system, fertigation alone vs a combined mechanical system

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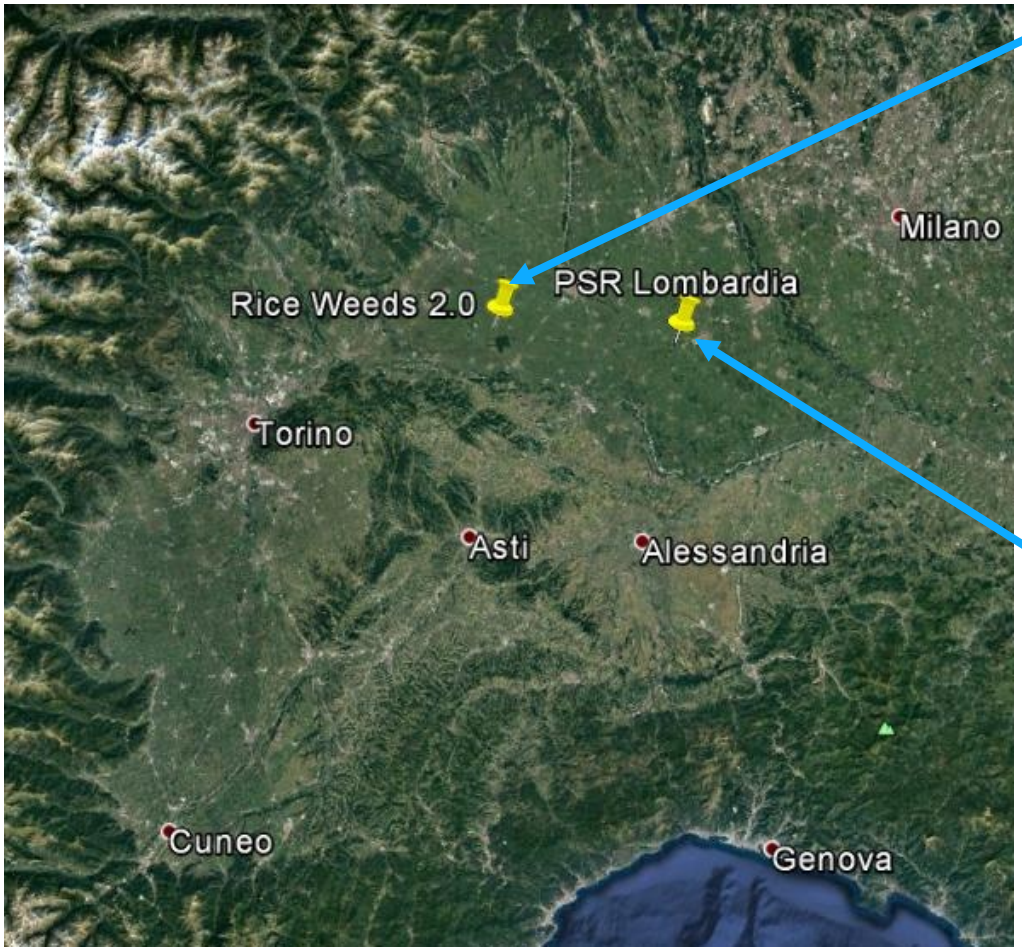
RICE SDI AND MULCHING FOR ORGANIC 2016



- **Rice Weeds 2.0** is a trial in SDI for weeds control and mulching on a typical soil for rice (medium-silty)
- Is in Garrione Farm, an historical place, in the core of the rice area
- **PSR Lombardia** is a trial in SDI for weeds control and mulching on very sandy soil
- Is in Baldi Farm, rice growers from 4 generations

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TRIALS 2016: RICE WEEDS 2.0 & PSR LOMBARDIA

- Use a **prototype machinery** for lay down the lines, mulching and rice seed

- Twin installation of drip irrigation in SDI 25 cm deep
- Two different kind of soil
- Verifiy and confirm the protocol for Clearfield var. (Luna CL) weeds control
- Achieve high yield by drip irrigation in shallow SDI

YEARS OF SHAPING THE FUTURE

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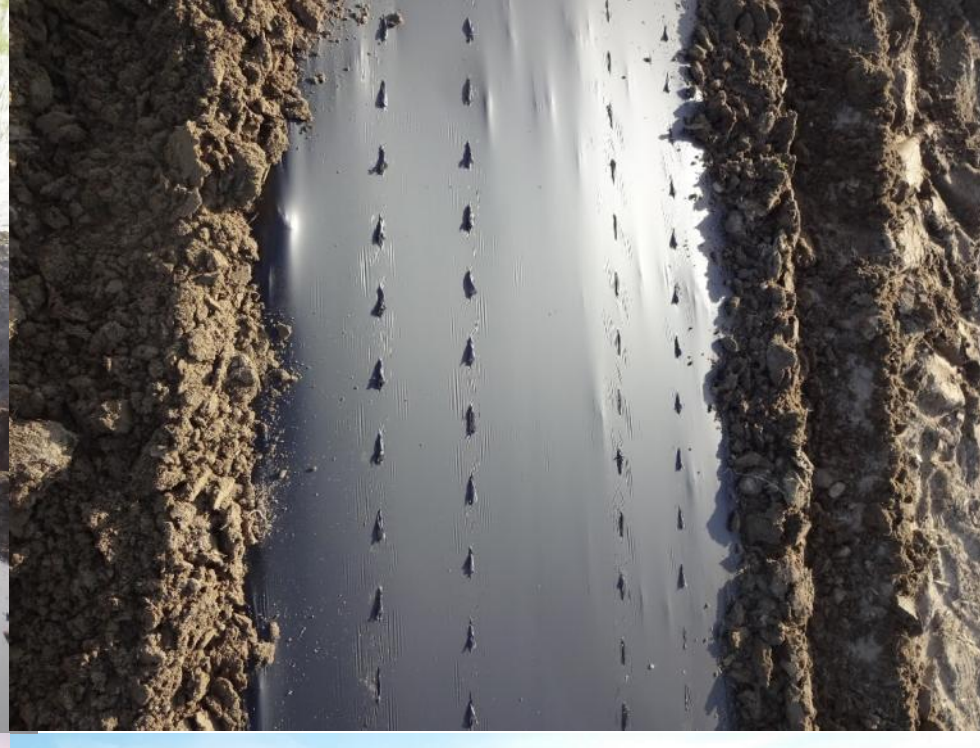

Baldi Farm May 2016

Baldi Farm July 2016

Garrione Farm May 2016

Garrione Farm July 2016

RICE BY DRIP - RESULTS

- Drip irrigation of rice is **innovative** technology, reliable and **sustainable**
- It makes use of the resources more effectively and efficiently **increasing the yield**
- **Drip irrigation** is used to provide, not only water, but also fertilizers (fertigation)
- The drip uses 45-50% **less water** and up to 30% **less nutrients** to achieve the same target yield
- Water saving between **10-20.000 m3/ha**

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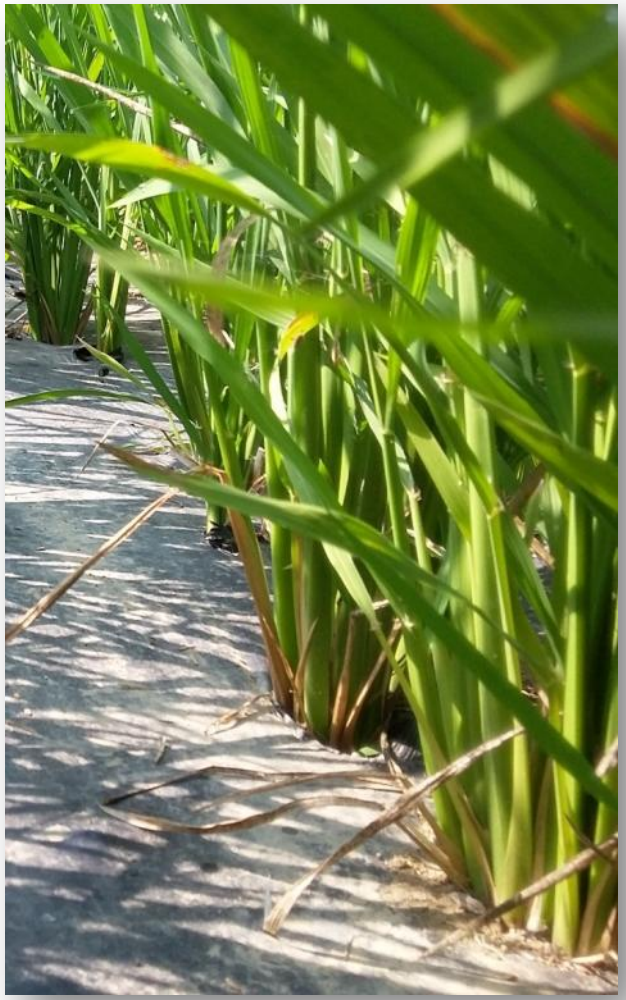
RICE BY DRIP - RESULTS

- The **aerobic** soil condition means many advantages and environmental benefits
- In **drip irrigation** was observed significant reduction in emissions of greenhouse gases (CO_2 and CH_4) and groundwater pollution
- The use of **marginal soils** would extend the UAA of at least 20%
- Produce more rice with less resources by limiting the **environmental impact** of the cultivation



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RICE BY DRIP - RESULTS

- The **drip irrigation**, through the diffusion, is a technique which promotes aerobic conditions of the soil
- **Arsenic accumulation** in rice grain is enhanced by flood irrigation even in soil with low *As* content
- Drip irrigation **can greatly decrease** the risk of *As* accumulation in rice grain
- **Weeds control** and **temperature delta** issues can be solved using the correct protocol, right varieties, and mulch
- **Mulching** is also an opportunity for organic rice cultivation and need specific machinery

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CONCLUSION

- More than **10 years** of experience
- We can bring out of the chambers of paddy rice cultivation using the **drip irrigation**
- Drip irrigation is a candidate to be the **irrigation of the future** (SDI in crop rotation)
- **Organic cultivation** and conservation agriculture are the partner elected for the drip irrigation
- Research continue to **demonstrate** that is the right way

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THANK YOU
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August 9-12/08/2016
Інститут рису НААН
Institute of Rice of NAAS
National Academy of Agrarian Sciences of Ukraine
Alberto Vezio Puggioni
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