POLITECNICO DI TORINO
Technion Israel Institute of Technology
UNIVERSITÀ DEGLI STUDI DI TORINO

Politecnico di Torino
Technion Institute of Technology
University of Torino
EXPO 2015

GROWING RICE WITH LESS WATER AND ARSENIC FOR GLOBAL FOOD SECURITY

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Netafim Italia

50 YEARS OF SHAPING THE FUTURE

AGENDA

- Netafim approach
- Introduction
- Rice worldwide research topics
- Environmental research topics
- Gas emission
- Save water
- Arsenic uptake
- Rice by drip - conclusion
- Future is drip irrigation?

50 YEARS OF SHAPING THE FUTURE

NETAFIM

Celebrating 50 years of

ACHIEVEMENT

- Leveraging our broad global network, extensive manufacturing capabilities, and proven 50-year track record, we provide the highest level of agronomic and technological support and service to our customers, closely accompanying them from start to finish.

- In addition, we provide the most innovative and best-in-class irrigation and complementary solutions.

No.1
global market share of >30%

10 Million
hectares irrigated

28
subsidiaries

16
manufacturing plants

2 Million
customers in

110 Countries
in six continents

NETAFIM™

GROWING GLOBAL DEMAND

There are already more than 7 billion people living on the planet and this number is rising.

By 2050 the world’s population expected to surpass

9 Billion People

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** Source: International Finance Corporation 2014*

LIMITED WATER AVAILABILITY

WILL IMPACT OVER 25% OF THE WORLD'S POPULATION

1.8 BILLION

PEOPLE

Number of people that will live in areas affected by water scarcity in 2025

Data based on World Bank Research 2012

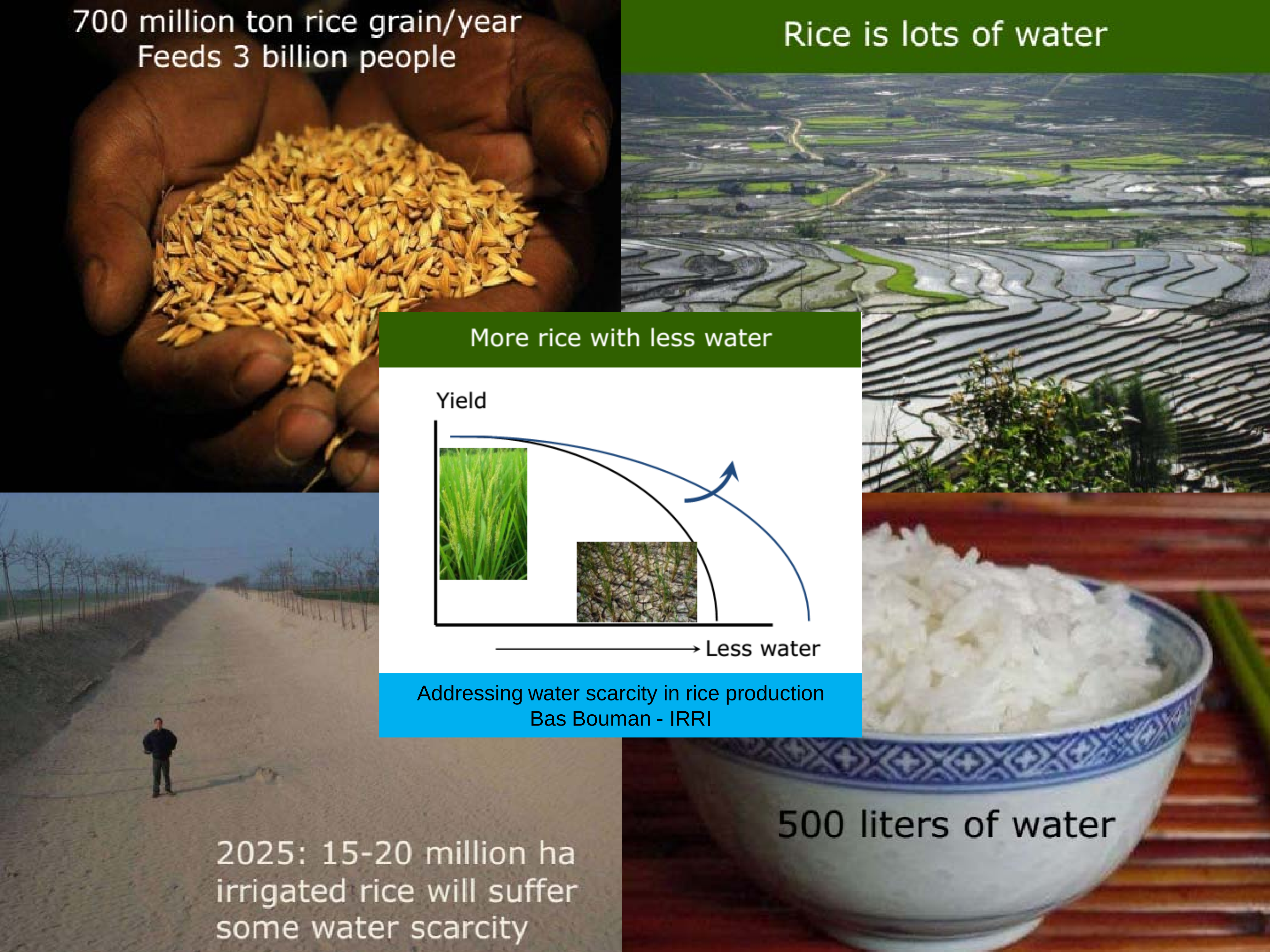
NETAFIM™

We are farmers

Netafim is founded by a group of farmers; drip irrigation is in our DNA

Our drip irrigation solution are applied in all the main food, feed and energy crops worldwide

Rice by drip is our way to answer to the water scarcity and the increasing of population


700 million ton rice grain/year
Feeds 3 billion people
Rice is lots of water
More rice with less water
Yield
Less water
Addressing water scarcity in rice production
Bas Bouman - IRRI
2025: 15-20 million ha irrigated rice will suffer some water scarcity
500 liters of water

CHALLENGES OF GROWING RICE ARE ALSO INCREASING

Resources are limited while demand is growing

- **Rice Fields today produce 4 ton/Ha. on average**
- **Land for growing rice is almost exhausted**
- **Water is becoming scarce in more and more areas and countries**
- **Flood requires much physical work, while labor is becoming scarce**
  Population moves to cities; remaining farmers are aging; youngsters not willing to do hard work.

The world becomes more and more concerned with environmental issues

- **Flooded rice fields produce much methane gas:**
  Un-aerobic conditions (created by the water that flood the field) are the cause of that.
- **Flooded rice fields pollute the soil with Nitrogen:**
  Rice requires much Nitrogen, which is poured into the flood water and washed into the soil
- **Flooded rice absorbs hazardous metals:**
  The roots absorb metals from the soil in the presence of flood water

Drip provides an excellent answer to the rice challenges

With drip, fields can produce 7-10 ton/Ha.	**Rice Fields today produce 4 ton/Ha. on average**
With drip, rice can be grown on hilly land and on sandier land than with flood	**Flat land for growing flooded rice is almost exhausted**
With drip, rice can be grown using 50-70% less water	**Water is becoming scarce in more and more areas and countries**
With drip, work required to maintain the irrigation system is far less than flood	**Flood irrigation requires much physical work, while labor is becoming scarce** Population moves to cities; remaining farmers are aging; youngsters not willing to do hard work.
With drip, the emission of methane gas is almost completely eliminated	**Flooded rice fields produce much methane gas:** Un-aerobic conditions (created by the water that flood the field) are the cause of that.
With drip, far less Nitrogen needs to be used, and is not washed away	**Flooded rice fields pollute the soil with Nitrogen:** Rice requires much Nitrogen, which is poured into the flood water and washed into the soil
With drip, the absorption of metals by the roots is dramatically reduced	**Flooded rice absorbs hazardous metals:** The roots absorb metals from the soil in the presence of flood water

INTRODUCTION

- Drip irrigated crops are several around the world
- The rice is the last fronteer explored
- Netafim since 2005 studies the application of drip irrigation on rice
- In Italy from **2010**
- Very important **economical, agronomical e technichal** implications
- Also **environmental** and **health**

COUNTRIES IN WHICH RESEARCH WAS DONE

- **Australia**
- **Brazil**
- **China**
- **India**
- **Italy**
- **Japan**
- **Spain**
- **Taiwan**
- **Thailand**
- **Turkey**
- **Ukraine**
- **USA (Texas)**

RICE WORLDWIDE TOPICS OF RESEARCH

i. Are rice varieties of significance in suitability to irrigation type?
ii. Is plant population of significance in suitability to irrigation type?
iii. How much water is needed to grow rice with drip irrigation (irrigation coefficients)
iv. How much fertilizer is needed at each growth stage?
v. What is the relationship between row spacing and dripline spacing?
vi. What drip type works best? Surface drip, subsurface drip, buried drip laterals?
vii. Weed control
viii. Nematode control
ix. Mycorrhiza inoculation
x. Early sowing with plastic mulching
xi. Using saline water for drip irrigation of rice
xii. Is it possible to harvest twice a year?

ENVIRONMENTAL RESEARCH 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**
j) Rice quality

GAS EMISSION

- Atmospheric methane (CH_4) is an important **greenhouse gas** it is approximately 20 times more effective than CO_2.
- The total annual **CH_4 emission** (both from natural and anthropogenic terrestrial sources to the atmosphere) is about 580 Tg*****/year (CH_4).
- The contribution of natural and man-made wetlands (as rice paddy) to this global total varies between 20 and 40%.
- **Rice agriculture** accounts for some 17% of the anthropogenic CH_4 emissions.
- This is because of the prevailing **anaerobic conditions** in these ecosystems, their high organic matter contents and their global distribution.

** 1Tg=10 milions of tons*

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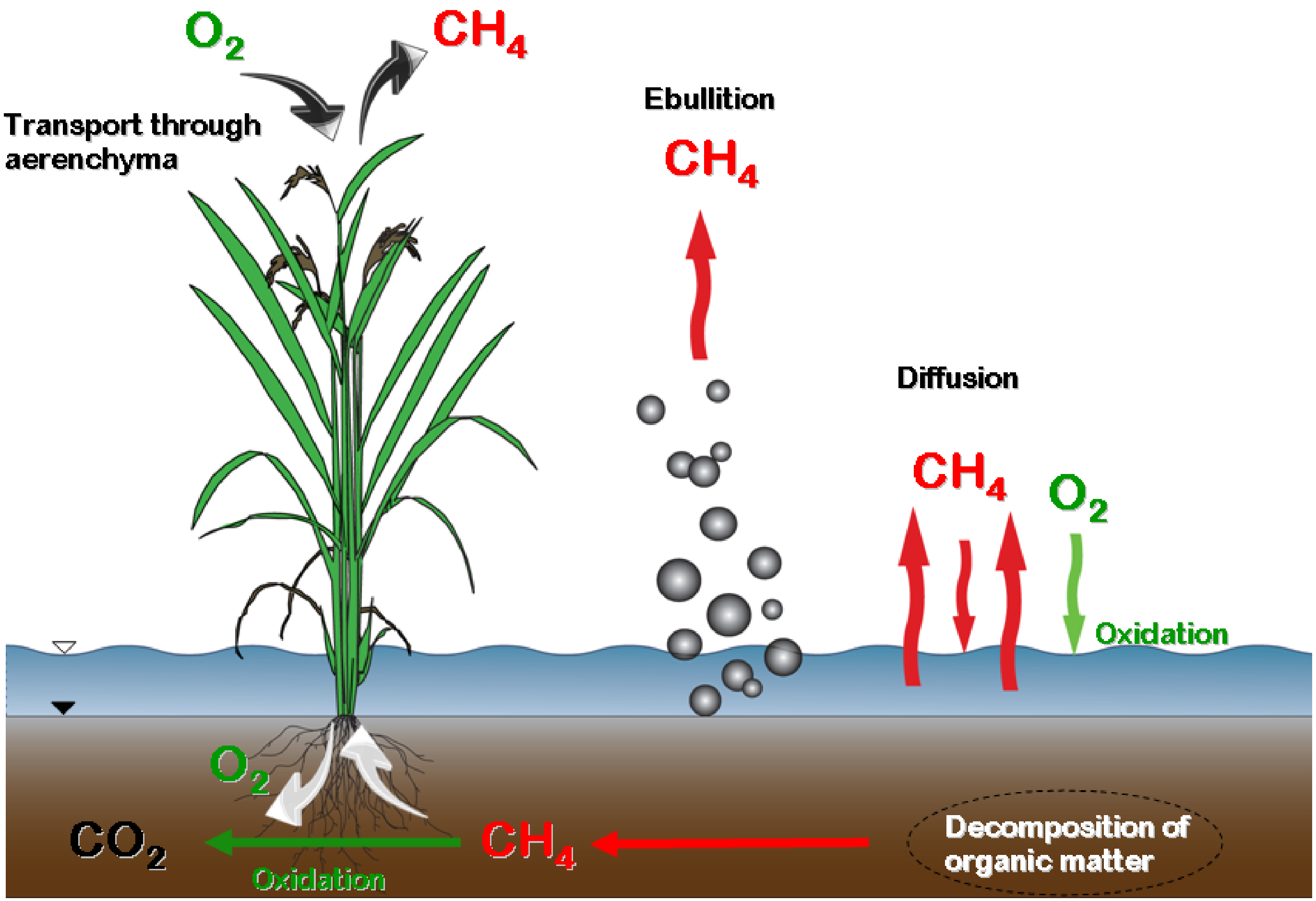
Source: Institute of Biogeochemistry and Pollutant Dynamics - Zurich

GAS EMISSION FROM RICE PADDY: CH4



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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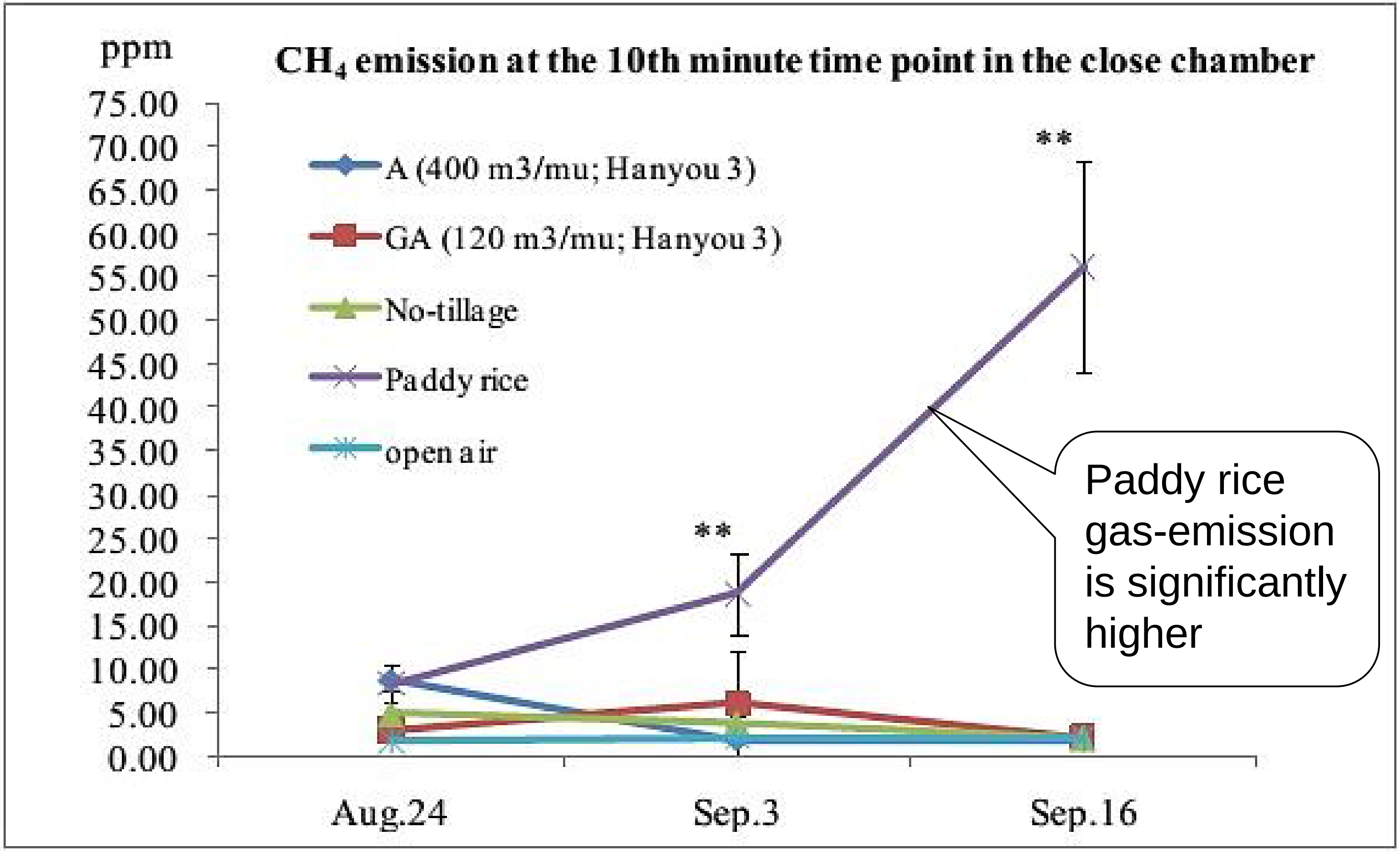
Source: Institute of Biogeochemistry and Pollutant Dynamics - Zurich

EMISSION MONITORING: CHINA TRIALS



Trial in China

EMISSION MONITORING: INDIA TRIALS

Treatments	Methane Flux (mg m^{-2} h^{-1})				Yield Observation		
	PI	FF	GF	Mean	GY (Kg ha^{-1})	SY (Kg ha^{-1})	HI (%)
T1	3.58	6.01	3.18	**4.26**	4201.0	6682.4	38.60
T2	4.31	7.90	4.31	5.51	3848.8	6266.7	38.04
T3	4.45	8.52	4.87	5.95	3691.2	6080.5	37.78
T4	4.08	6.57	3.81	4.82	4249.4	6763.9	38.58
T5	5.85	8.99	5.19	**6.68**	3523.1	6371.8	35.61

35% LESS

Treatments

T_1 - Lateral distance of 0.8 m, row spacing of 20 cm with dripper flow rate 1.0 lph SDI

T_2 - Lateral distance of 0.8 m, row spacing of 20 cm with dripper flow rate 1.0 lph on surface

T_3 - Lateral distance of 0.8 m, row spacing of 20 cm with dripper flow rate 0.6 lph on surface

T_4 - Lateral distance of 0.8 m, row spacing of 20 cm with dripper flow rate 1.0 lph + 30 % more water on surface

T_5 - conventional irrigation at IW/CPE ratio of 1.25 at 30 mm depth of irrigation (conventional irrigation).

PI Panicle initiation (45 days after planting)
FF Fifty % flowering (80 days after planting)
GF Grain filling (110 days after planting)

Variety : ADT(R) 45; Season : Summer (2012)

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METHANE EMISSION IN AEROBIC RICE UNDER DRIP IRRIGATION SYSTEMS - T. PARTHASARATHI, S. MOHANDASS & E. VERED
Water Technology Center, TNAU, Coimbatore - India. 2013

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** (- 75%) **FLUX (moles/m^2/day) 0.00045** (- 63%)	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**

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

Data Monitoring 2013 Lolini Farm – Grosseto, ITALY


Data Monitoring 2013 Lolini Farm — Grosseto, ITALY

SAVE WATER

DRIP FERTIGATION IN RICE
INTERNATIONAL RESEARCH CONFERENCE
Coimbatore – Tamil Nadu, INDIA
(17th to 19th October 2013)

RICE WITH DRIP IRRIGATION
A Paradigm Shift in Rice Cultivation
CLN Rao, Netafim India

- Traditionally rice cultivation in India involves transplanting of seedlings into puddled fields that is kept continuously flooded with water throughout the growing season.
- Irrigated rice with continuous flooding results in low water use efficiency as it consumes 3.000 – 5.000 liters of water to produce 1 kg of unprocessed rice.

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SAVE WATER

- 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 8000 m^3 and 9000 m^3/ha
- Respectively with a yield potential of 10 to 12 tons/ha
- *It is about 800-900 liters to produce 1kg of Rice with Drip Irrigation (instead of 3.000-5.000)*

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SAVE WATER

- High water savings & use efficiency can be achieved with drip method of rice cultivation.
- It also enables precise delivery of essential plant nutrients in small amounts, frequently according to crop developmental phases and physiological function.
- Additional benefits of drip ferti-irrigation include energy & labour savings, no leaching, higher water productivity and nutrient use efficiency etc.

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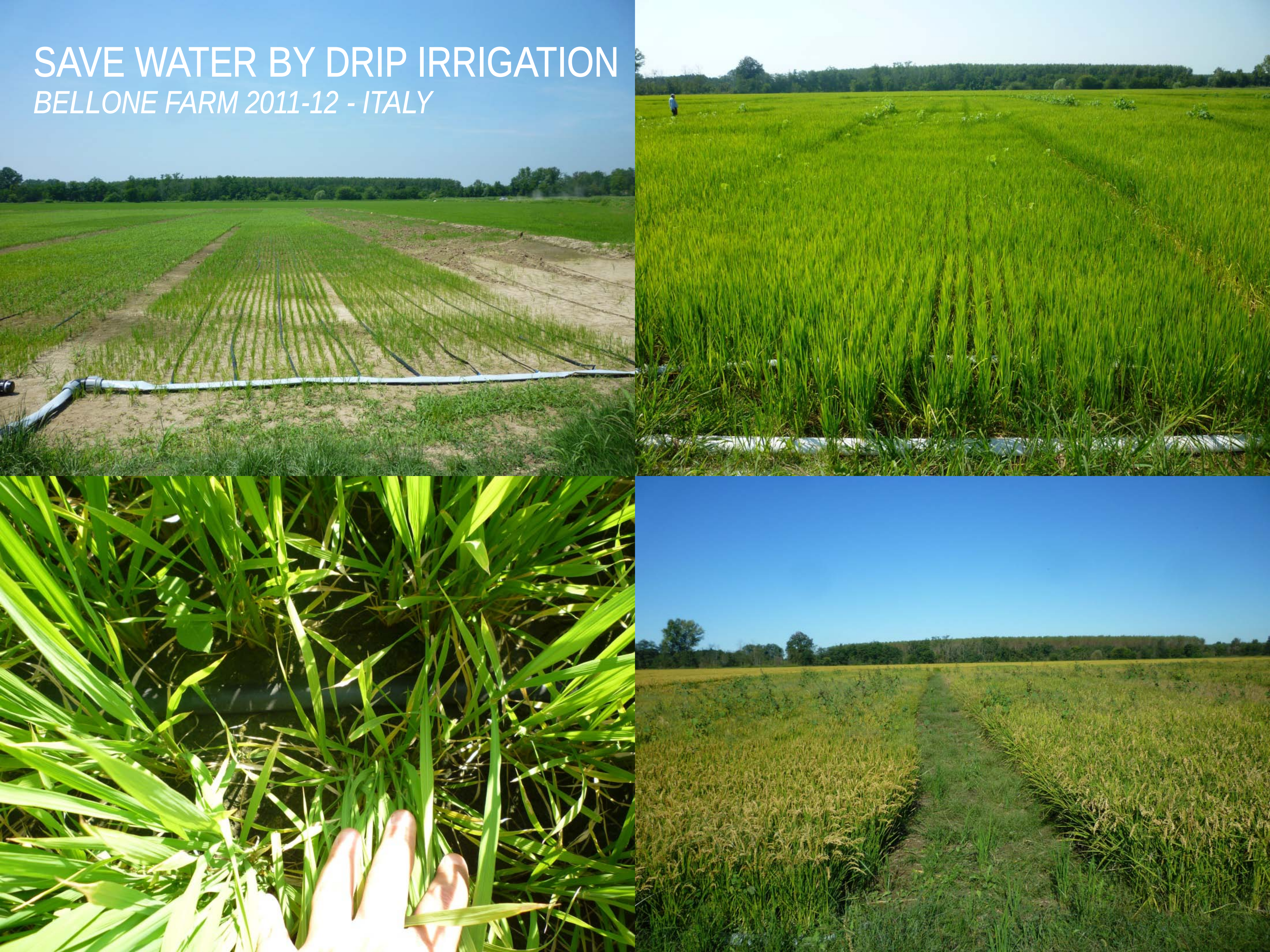
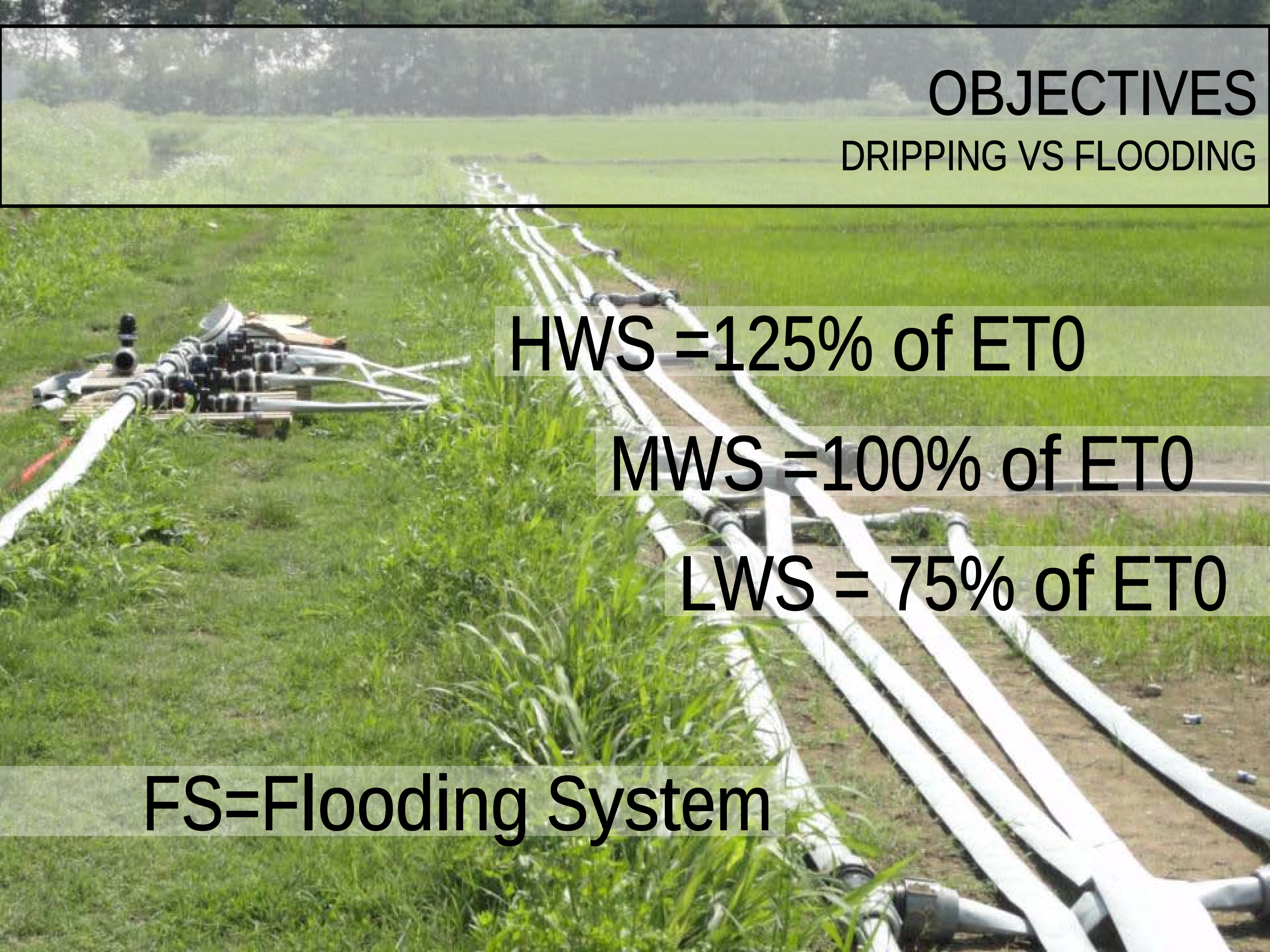
SAVE WATER: RESULTS

TOTAL WATER USE AND WATER SAVING OF RICE UNDER DRIP IRRIGATION SYSTEM

Treatments	Total Water Use (mm)			Water Saving (%)		
	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13
Drip irrigation at 125 % PE	780.1	706.7	678.5	36.0	40.3	40.2
Drip irrigation at 150 % PE	886.0	784.0	794.2	27.4	33.7	30.0
Surface flood (5 cm)	1220.1	1184.1	1134.5	-	-	-

Gurusamy.A and S.Krishnasamy, 2013


SAVE WATER BY DRIP IRRIGATION
BELLONE FARM 2011-12 - ITALY


OBJECTIVES
DRIPPING VS FLOODING
HWS =125% of ET0
MWS =100% of ET0
LWS = 75% of ET0
FS=Flooding System

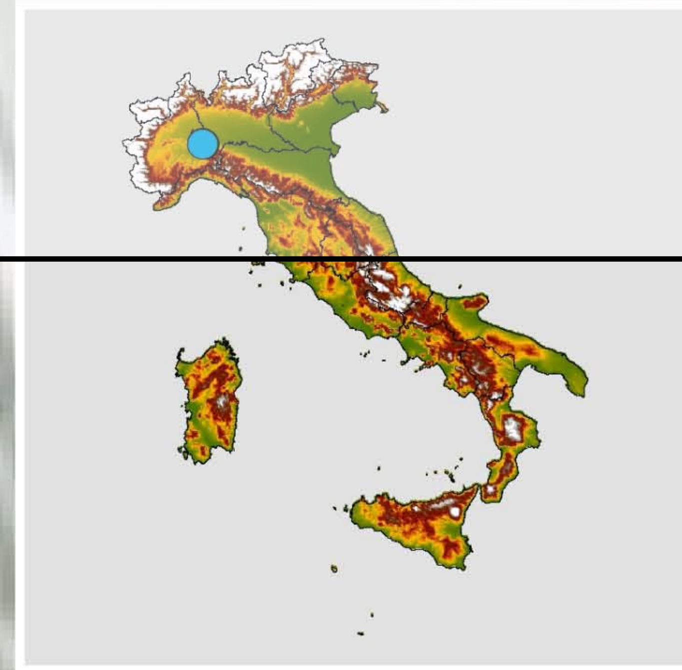
OBJECTIVES

DRIP LINES SPACING

MATERIALS AND METHODS
VARIETIES

MATERIALS AND METHODS

EXPERIMENTAL DESIGN

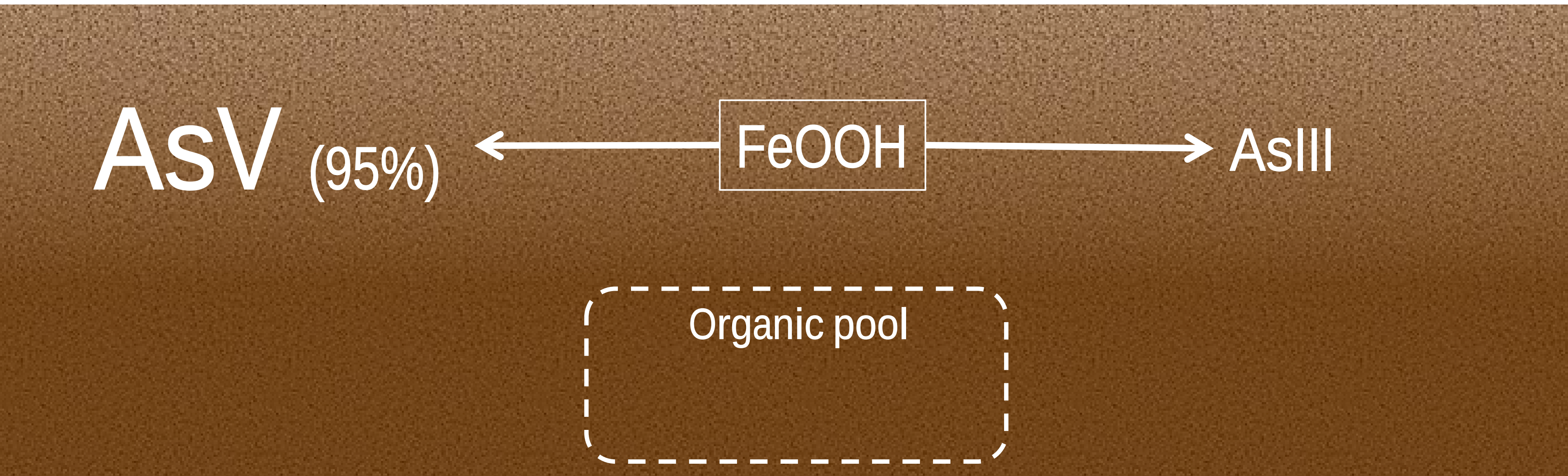


SAVE WATER: RESULTS

	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	-

ARSENIC UPTAKE

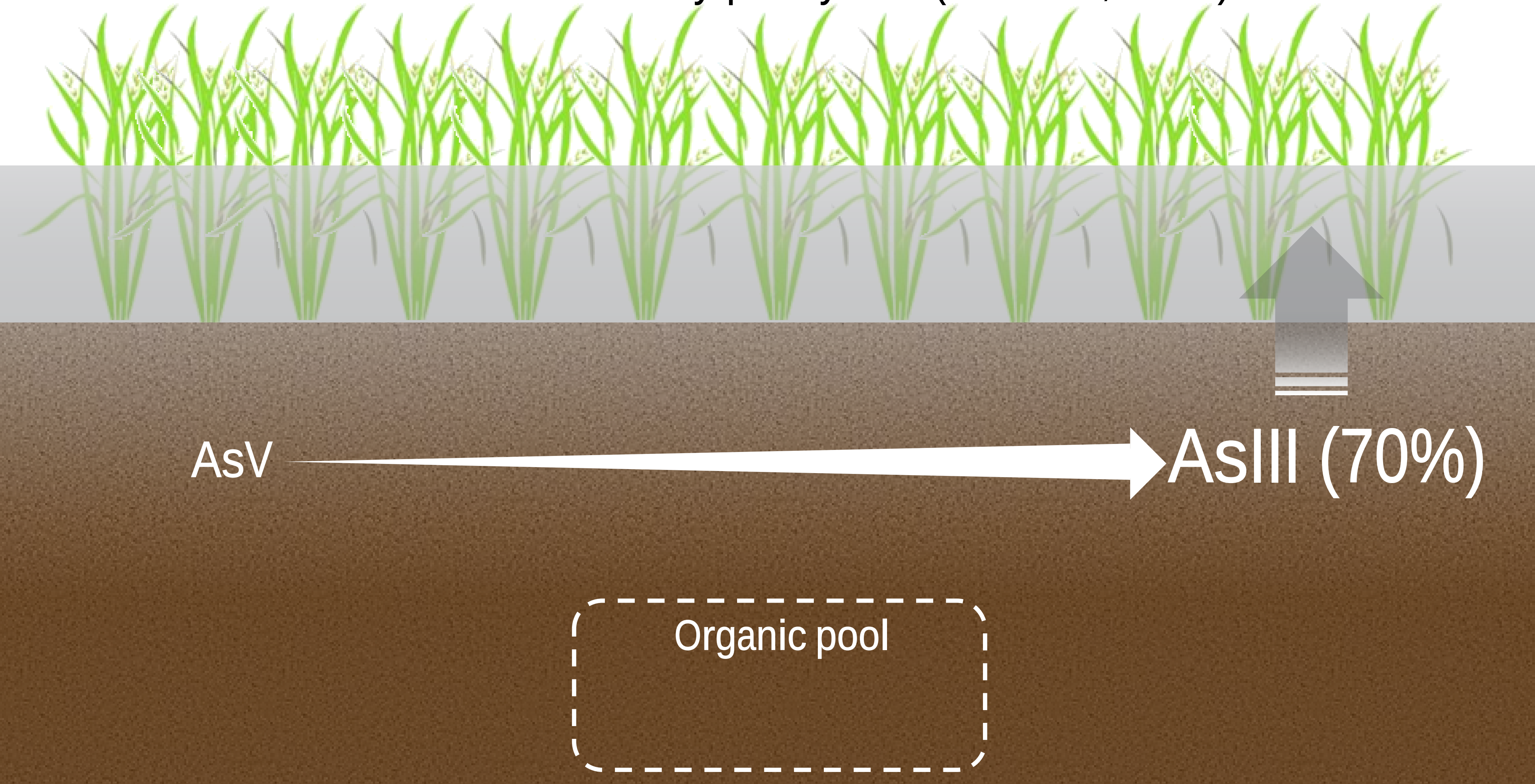
Low levels of As are naturally present in the soil (Matshullat, 2000)
The background levels worldwide are around 5 mg kg^{-1} (Mandal & Suzuki, 2002)



(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)



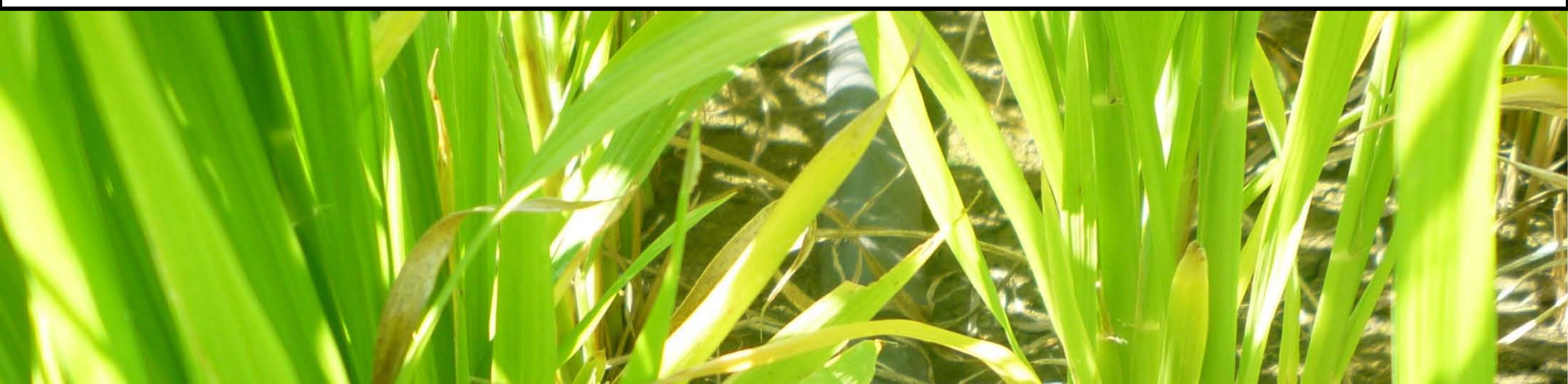
(Abedin et al., 2002; Fitz & Wenzel, 2002; Takahashi et al., 2004)

INSTITUTE OF LIFE SCIENCES

Scuola Superiore Sant'Anna

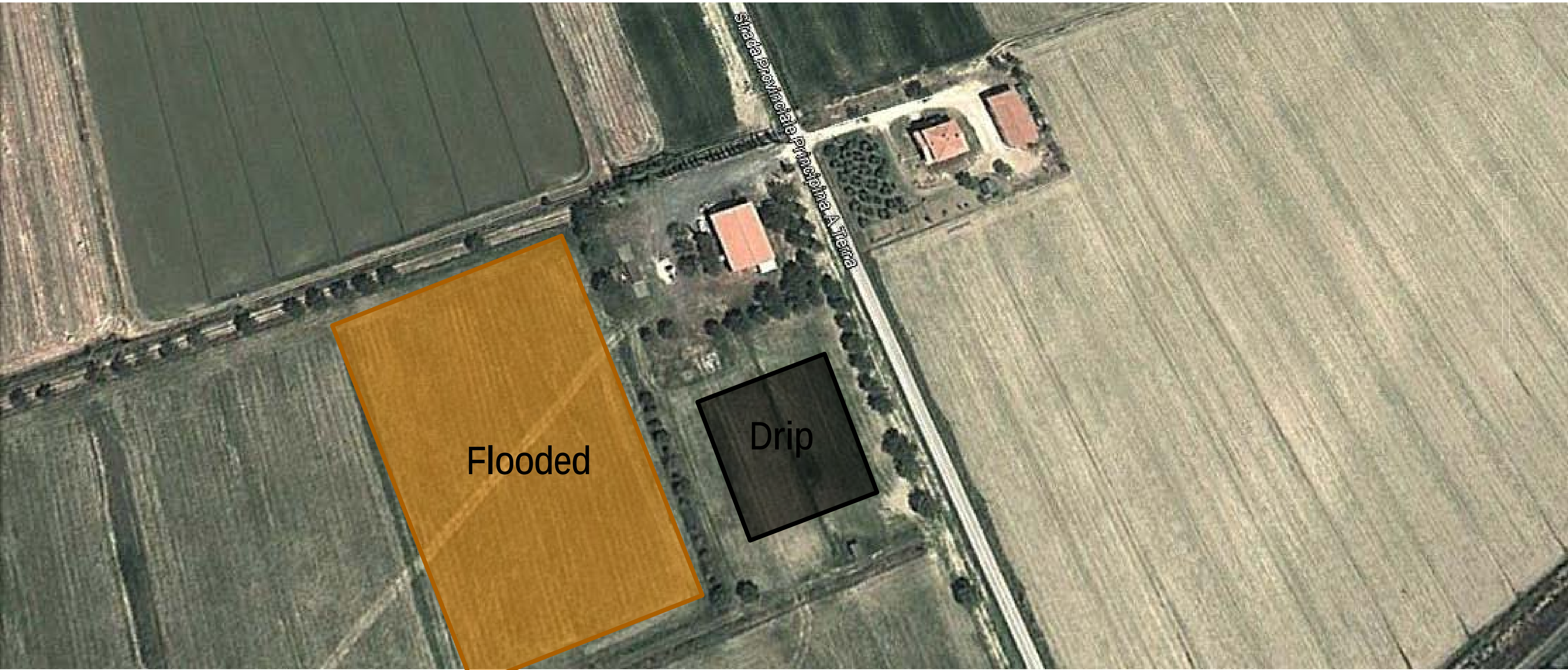
Water saving and reduced arsenic uptake in aerobic rice (*Oryza sativa* L.): feasibility of drip irrigation under Mediterranean climate

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



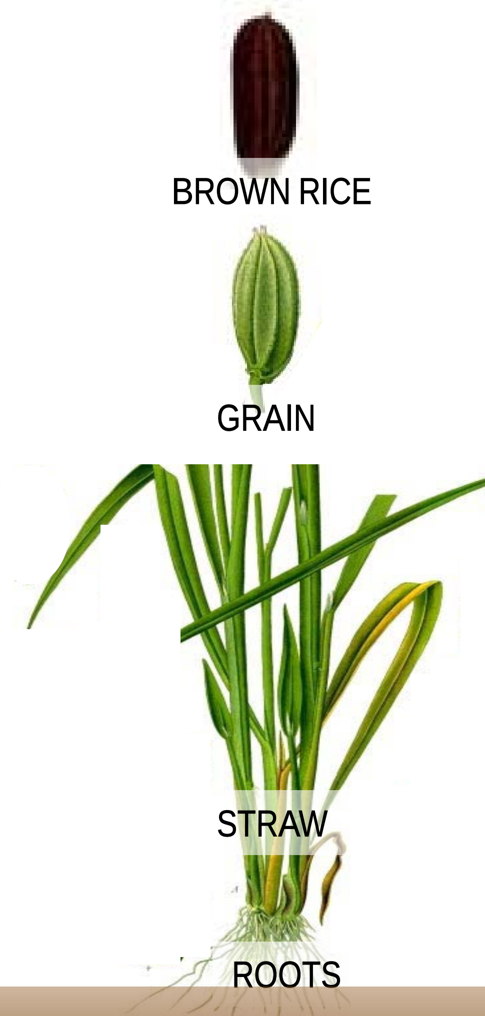
OBJECTIVE

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)

RICE BY DRIP - CONCLUSION

- 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 of nutrients to achieve the same target yield
- The drip irrigation, through the diffusion, is a technique which promotes aerobic conditions of the soil

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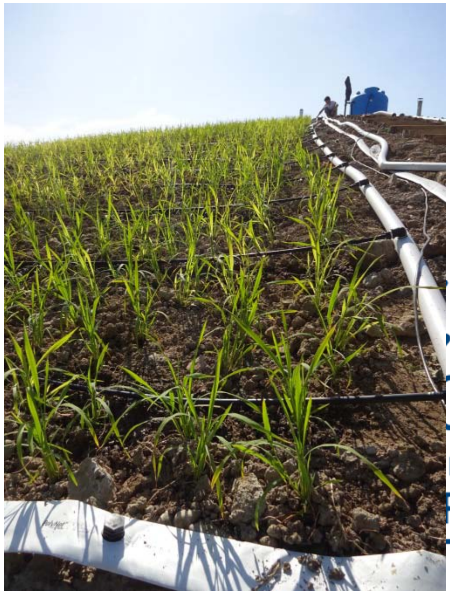
RICE BY DRIP - CONCLUSION

- The aerobic soil condition means many advantages and environmental benefits
- International experience in drip irrigation was observed significant reduction in emissions of greenhouse gases (CO_2 and CH_4) and groundwater pollution
- Netafim propose a drip system that demonstrates how the rice can be grown in all soil types and topographies, and with all types of water
- 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 technique



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RICE BY DRIP - CONCLUSION

- 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

- Drip irrigation could allow a significant reduction of water consumption

- Water saving between 10-20.000 m3/ha

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FUTURE IS DRIP IRRIGATION?

- The paddy is also Culture of Peoples and we want to preserve it
- But rice production can definitely be improved
- We look to technological and agronomic this primary culture
- After 10 years of experience in the major rice producing countries, by quantity produced and quality expressed, we feel ready to meet the future challenge
- We can bring out of the chambers of paddy rice cultivation using the technique drip
- Drip irrigation is a candidate to be the irrigation technique of the future (SDI in crop rotation)


EVERY DROP COUNTS
50
YEARS
OF SHAPING
THE FUTURE

THANK YOU

DEMOFIELD
AGRICULTURE OF TOMORROW