SRI IN ASIA:
Innovations, Impacts, Spread, and Challenges

Prof. Norman Uphoff, Cornell University

1st National SRI Conference for Malaysia
Putrajaya, July 5-6, 2011

Start with FAQ: What is SRI?

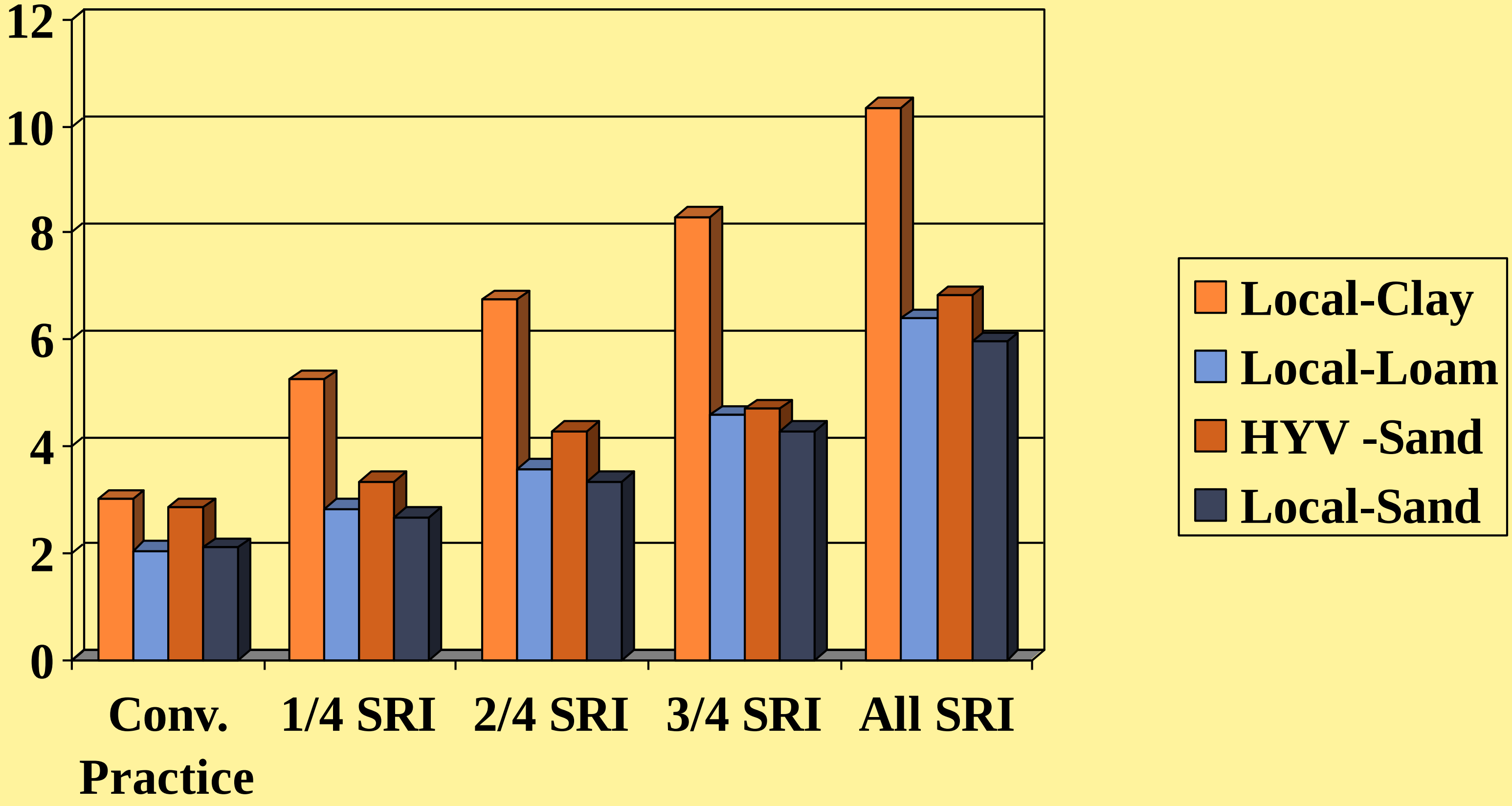
[Answers represent my understanding]

SRI is NOT a thing – the term is better used as an ***adjective*** than as a ***noun*** – denoting some new perspectives

There is an ideal type of SRI, based on ***experimentation*** and ***scientific evaluation*** -- But SRI is ***more a matter of*** **degree** than ***a matter of*** **kind**

Do not ask 'Is it SRI?' but rather:
'To what extent does it represent SRI?'

Factorial Trial Evaluations in Madagascar, 2000 and 2001: Effects of SRI vs. conventional practices comparing varieties and soil differences at Morondava [N=288] and Anjomakely [N=240] *



*Spacing and weeding {active soil aeration) were not evaluated

CONVENTIONAL	Clay Soil	Loam Soil	Average
SS / 20 / 3 / NPK	3.00 (6)	2.04 (6)	2.52 (12)
1 SRI Practice			
SS / 20 / 3 / C	3.71 (6)	2.03 (6)	
SS / 20 / 1 / NPK	5.04 (6)	2.78 (6)	
SS / 8 / 3 / NPK	7.16 (6)	3.89 (6)	
AS / 20 / 3 / NPK	5.08 (6)	2.60 (6)	
	5.25 (24)	**2.83** (24)	**4.04** (48)
2 SRI Practices			
SS / 20 / 1 / C	4.50 (6)	2.44 (6)	
SS / 8 / 3 / C	6.86 (6)	3.61 (6)	
AS / 20 / 1 / NPK	6.07 (6)	3.15 (6)	
AS/20/ 3 / C	6.72 (6)	3.41 (6)	
SS/ 8 /1/NPK	8.13 (6)	4.36 (6)	
AS/ 8 /3/NPK	8.15 (6)	4.44 (6)	
	6.74 (36)	**3.57** (36)	**5.16** (72)
3 SRI Practices			
SS / 8 / 1 / C	7.70 (6)	4.07 (6)	
AS / 20 / 1 / C	7.45 (6)	4.10 (6)	
AS / 8 / 3 / C	9.32 (6)	5.17 (6)	
AS / 8 / 1 / NPK	8.77 (6)	5.00 (6)	
	8.31 (24)	**4.59** (24)	**6.45** (48)
ALL-SRI PRACTICES			
AS / 8 / 1 / C	**10.35** (6)	**6.39** (6)	**8.37** (12)

SRI is NOT a technology,

Also **SRI is not yet finished** –
it is **a work in progress**

SRI is an **innovation** – a set of **ideas**,
agronomic **insights**, a paradigm **shift**

SRI is based on **scientific foundations** --
although it was **developed empirically** --
there is ***no mystery*** and ***no magic*** in SRI

1. SRI is a <u>different kind</u> of **intensification**: **not of <u>increased inputs</u>**, the usual meaning, but of ***knowledge, skills, and management***

2. SRI is something **<u>freely available</u>**, no IPR -- no patents, licenses, royalties -- nobody owns it – <u>open-access innovation</u>

3. SRI is **<u>continually changing and evolving</u>** we now have ***rainfed*** SRI, ***mechanized*** SRI, SRI for ***other crops*** (SCI, etc.)

SRI has been developed as **practices that work** – and these continue to evolve

We now understand most of the **principles** that can explain the success of SRI practices

While SRI gets communicated as **practices**, we should think of it & discuss it as **principles**

SRI should be b**oth pragmatic & scientific** **-- neither dogmatic nor a matter of belief**

How Does SRI Work?

SRI focuses on improving the **environment** for rice plants to grow better – rather than emphasize new/improved varieties

Most modern agricultural research and development has focused on **genetics**
We need to understand relationship between **GENOTYPES** and **PHENOTYPES**

$$P = f\ [G \times E]$$

CAMBODIA:
An example of phenotypical change -- rice plant grown from single seed in Takeo province

INDONESIA:
An example of enhanced phenotypical expression

Single SRI rice plant
(variety: Cv. Ciherang)
with 223 tillers

HM Sampoerna CSR program in East Java, Panda'an, near Malang

IRAQ: Comparison trials at Al-Mishkhab Rice Research Station, Najaf, same varieties: SRI management on left, standard management on right

<u>CUBA</u>: Farmer showing two rice plants of <u>same age</u> (52 d) and <u>same variety</u> (VN 2084), i.e., same genotype

How/Why Does SRI Work?

Reasons for SRI success lie below ground:

In larger, longer-lived, better functioning
ROOT SYSTEMS, and
In more active, abundant, and diverse
SOIL BIOTA – ***the life in the soil***

Rice plants can **survive** in standing water,
but they do not **THRIVE** when submerged

Root cross-sections of upland rice (left) and irrigated rice (right) varieties

ORSTOM research (Puard et al. 1989)

Figure 2a: Cross-Section View of Root of Upland Rice Variety (IRAT 13) Grown under Unirrigated Conditions (from Puard et al. 1986a: 125)

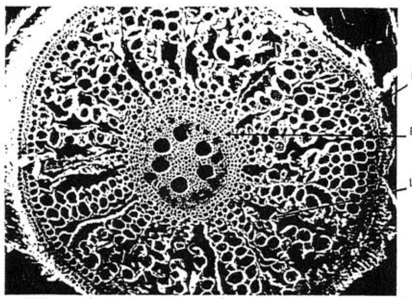


Figure 2b: Cross-Section View of Root of Upland Rice Variety (IRAT 13) Grown under Irrigated Conditions (from Puard et al. 1986a: 125)

Figure 2 Coupe d'une racine de riz IRAT 13 cultivé en conditions aquatiques.

Figure 3a: Cross-Section View of Root of Irrigated Rice Variety (IRAT 173) Grown under Irrigated Conditions (from Puard et al. 1986a: 126)

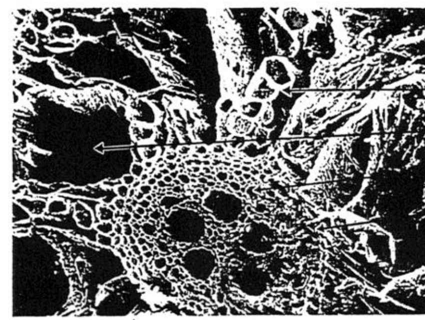
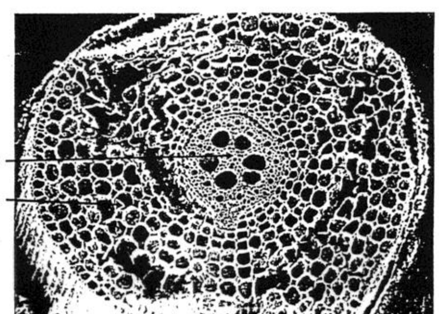


Figure 3b: Cross-Section View of Root of Irrigated Rice Variety (IRAT 173) Grown under Unirrigated Conditions (from Puard et al. 1986a: 126)



IRRI version of INTENSIFICATION:

"Intensification of rice systems implies the disturbance of existing equilibria in the soil by extensive submergence [flooding] and by elevated levels of agrochemicals [used] in nutrient and pest management.
"In keeping pace with the deployment of ever-higher-yielding rice varieties, nutrient management [chemical fertilizer use] risks adversely affecting the agronomic and environmental sustainability of rice lands."

W. Reichardt, A. Dobermann and T. George, "Intensification of rice production systems: Opportunities and limits. In: Dowling, Greenfield and Fischer, eds. ***Rice in the Global Food System***,. International Rice Research Institute, Los Baños, 1998.

SRI version of INTENSIFICATION:

Rather than **intensify the use of *material inputs*** (which are reduced), with SRI there is **more input** of ***knowledge, skill and management***

SRI works with ***existing natural processes and potentials*** to achieve **better phenotypes** from **available genotypes** – SRI practices raise the *productivity of land, labor, water and capital*

SRI produces **more from less** -- less seed, less water, less agrochemical inputs, **even less labor**

"Everyone cites India's Green Revolution. But I'm even more intrigued by what is known as SRI, or system of rice intensification, and I know this is also an area of interest for [Prime Minister] Manmohan Singh.

"Using smart water management and planting practices, farmers in Tamil Nadu have increased rice yields between 30 and 80 per cent, reduced water use by 30 per cent, and now require significantly less fertilizer.

"This emerging technology not only addresses food security, but also the water scarcity challenge that climate change is making all the more dangerous. These are all lessons for our world."

Robert Zoellick, President, World Bank
Hindustan Times, December 2, 2009

Two Paradigms for Agriculture:

- The GREEN REVOLUTION strategy was to:
  * Change the genetic potential of plants, and
  * Increase the use of external inputs -- more water, more fertilizer, insecticides, etc.
- SRI as a form of AGROECOLOGY changes the management of plants, soil, water & nutrients:
  * To promote the growth of root systems, and
  * To increase the abundance and diversity of soil organisms to better enlist their benefits

These changes produce BETTER PHENOTYPES

<u>IRAN</u>:

SRI roots vs. normal flooded roots: note the **differences** in **<u>color</u>** as well as **<u>size</u>**

From Haraz Technology Research Center, Amol, Mazandaran

INDONESIA:
article in
CARITAS NEWS
(Australia),
Spring, 2009

'Rice Aplenty in Aceh'

After a *tsunami* had devastated the area, SRI methods were introduced into Aceh by CARITAS in 2005. These new methods raised local rice yields from 2 t/ha to 8.5 t/ha: *"Using less rice seed, less water, and organic compost, farmers in Aceh have quadrupled their crop production."*

BHUTAN: Report on SRI in Deorali Geog, 2009

Sangay Dorji, Jr. Extension Agent, Deorali Geog, Dagana

Standard practice	3.6 t/ha	SRI @ 25x25cm	9.5 t/ha
SRI random spacing	6.0 t/ha	SRI @ 30x30cm	10.0 t/ha

AFGHANISTAN: Aga Khan Foundation, Baghlan/Takhar Provinces

2008: 6 farmers got SRI yields of 10.1 t/ha vs. 5.4 t/ha regular

2009: 42 farmers got SRI yields of 9.3 t/ha vs. 5.6 t/ha regular

- 2nd year SRI farmers got 13.3 t/ha vs. 5.6 t/ha
- 1st year SRI farmers got 8.7 t/ha vs. 5.5 t/ha

2010: 104 farmers got SRI yields of 8.8 t/ha vs. 5.6 t/ha regular

AFGHANISTAN: SRI field in Baghlan Province, supported by **Aga Khan Foundation** Natural Resource Management program, @ 1700 m elevation, with short growing season

SRI field in Baghlan district @ 30 days

SRI plant with 133 tillers @
72 days after transplanting

11.56 t/ha

MALI:

Farmer in Timbuktu region showing the difference between regular and SRI rice plants

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2007: first SRI yield = 8.98 t/ha

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Program managed by NGO **Africare** with support from Jim Carrey's **Better U Foundation**

MALI: SRI nursery in Timbuktu region – 8-day seedlings ready for transplanting

SRI transplanting in Timbuktu, Mali

MALI: Rice grain yields for SRI plots, control (BP) plots, and farmer-practice plots, Goundam district, Timbuktu region, 2008, on-farm comparison trials

	SRI Plots	Control Plots	Farmer Practice
Yield (t/ha)*	**9.1**	**5.49**	**4.86**
Standard Error (SE)	0.24	0.27	0.18
% Change compared to **Control Plots**	+ 66	100	- 11
% Change compared to **Farmer Practice**	+ 87	+ 13	100
Number of Farmers	53	53	60

* calculated for 14% grain moisture content

CHINA: National Rice Research Institute

Trials conducted over two years, 2004/2005 using two super-hybrid varieties with the aim of breaking the 'plateau' limiting hybrid yields

Standard Rice Mgmt

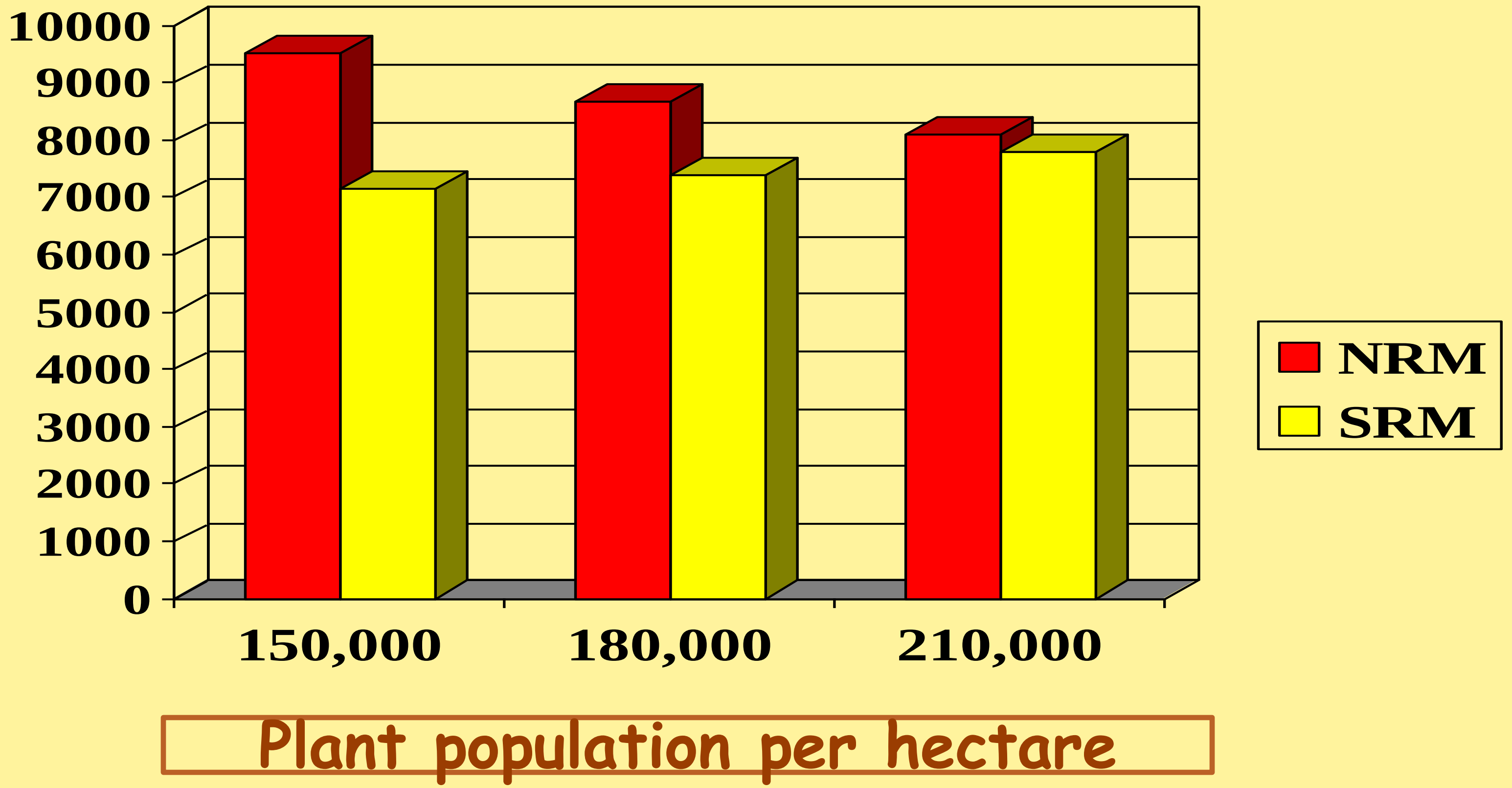
- 30-day seedlings
- 20x20 cm spacing
- Continuous flooding
- Fertilization:
  - 100% chemical

'New Rice Mgmt' ~ SRI

- 20-day seedlings
- 30x30 cm spacing
- Alt. wetting/drying (AWD)
- Fertilization:
  - 50/50 chemical/organic

XQ Lin, DF Zhu, HZ Chen, SH Cheng, N Uphoff (2009). Effect of plant density and nitrogen fertilizer rates on grain yield and nitrogen uptake of hybrid rice (*Oryza sativa* L.), *Journal of Agricultural Biotechnology and Sustainable Development* , 1(2): 44-53

Average super-rice YIELDS (kg/ha) with 'new rice management' vs. standard rice management at different plant densities ha^{-1}



SRI practices yield more productive phenotypes with additional benefits of reduced farmers' RISK

<u>Drought-resistance</u> in Sri Lanka:
Rice fields 3 weeks after irrigation supply stopped -- conventionally-grown field on left, and SRI field on right

Bihar State results, 2007-2011

SYSTEM OF RICE INTENSIFICATION -- state ave. yield: 2.3 t/ha				
	2007	2008	2009	2010
Climatic conditions	Normal rainfall	Water submergence occurred twice	Drought, but rainfall in Sept.	Complete drought
No. of smallholders	128	5,146	8,367	19,911
Area under SRI (ha)	30	544	786	1,412
SRI ave. yield (t/ha)	10.0	7.75	6.5	3.22*
Conv. ave. yield (t/ha)	2.7	2.36	2.02	1.66*

SYSTEM OF WHEAT INTENSIFICATION : state ave. yield: 2.4 t/ha			
	2008-09	2009-10	2010-11
No. of smallholders	415	25,235	48,521
Area under SWI (ha)	16	1,200	2,536
SWI average yield (t/ha)	3.6	4.5	NH
Conv. average yield (t/ha)	1.6	1.6	NH

* Results from measurements from SRI and conventional fields of 74 farmers'

Storm resistance

-- paddy fields in Dông Trù village, Hanoi province, Vietnam

after typhoon

SRI field and rice plant on left; conventional field and plant on right

Plant lodging as affected by irrigation practices when combined with different ages of seedlings and spacing, Chiba, Japan (T. Chapagain and E. Yamaji, *Paddy and Water Environment*, 2009)

Irrigation method	Seedling age	Spacing (cm^2)	Plant lodging (in percent)		
			Partial	Complete	Total
Inter-mittent irrigation (AWDI)	14	30x30	6.67	0	6.67
		30x18	40.00	6.67	46.67
	21	30x30	26.67	20	46.67
		30x18	13.33	13.33	26.67
Ordinary irrigation (continuous flooding)	14	30x30	16.67	33.33	50.00
		30x18	26.67	53.33	80.00
	21	30x30	20	76.67	96.67
		30x18	13.33	80	93.33

Cold tolerance: Data from an IPM evaluation, ANGRAU, Andhra Pradesh, India, 2005-06

Period	Mean max. temp. ^0C	Mean min. temp. ^0C	No. of sunshine hrs
1 – 15 Nov	27.7	19.2	4.9
16–30 Nov	29.6	17.9	7.5
1 – 15 Dec	29.1	14.6	8.6
16–31 Dec	28.1	12.2*	8.6

*Sudden drop in min. temp. during 16–21 Dec. **(9.2-9.8^oC for 5 days)**

Season	Normal (t/ha)	SRI (t/ha)
Rabi 2005-06	2.25	3.47
Kharif 2006	0.21*	4.16

* Low yield was due to cold injury for plants (see above)

Disease and pest resistence in Vietnam:
National IPM Program evaluation: average of data from on-farm trials in 8 provinces, 2005-06:

	Spring season			Summer season		
	SRI Plots	Farmer Plots	Differ-ence	SRI Plots	Farmer Plots	Differ-ence
Sheath blight	6.7%	18.1%	63.0%	5.2%	19.8%	73.7%
Leaf blight	--	--	--	8.6%	36.3%	76.5%
Small leaf folder *	63.4	107.7	41.1%	61.8	122.3	49.5%
Brown plant hopper *	542	1,440	62.4%	545	3,214	83.0%
AVERAGE			55.5%			70.7%

* Insects/m^2

Crop duration in Nepal: 16-day reduction from seed to seed for 8 rice varieties with SRI vs. conventional methods -- 125 days vs. 141 days, with yields of **6.3 t/ha** vs. 3.1 t/ha

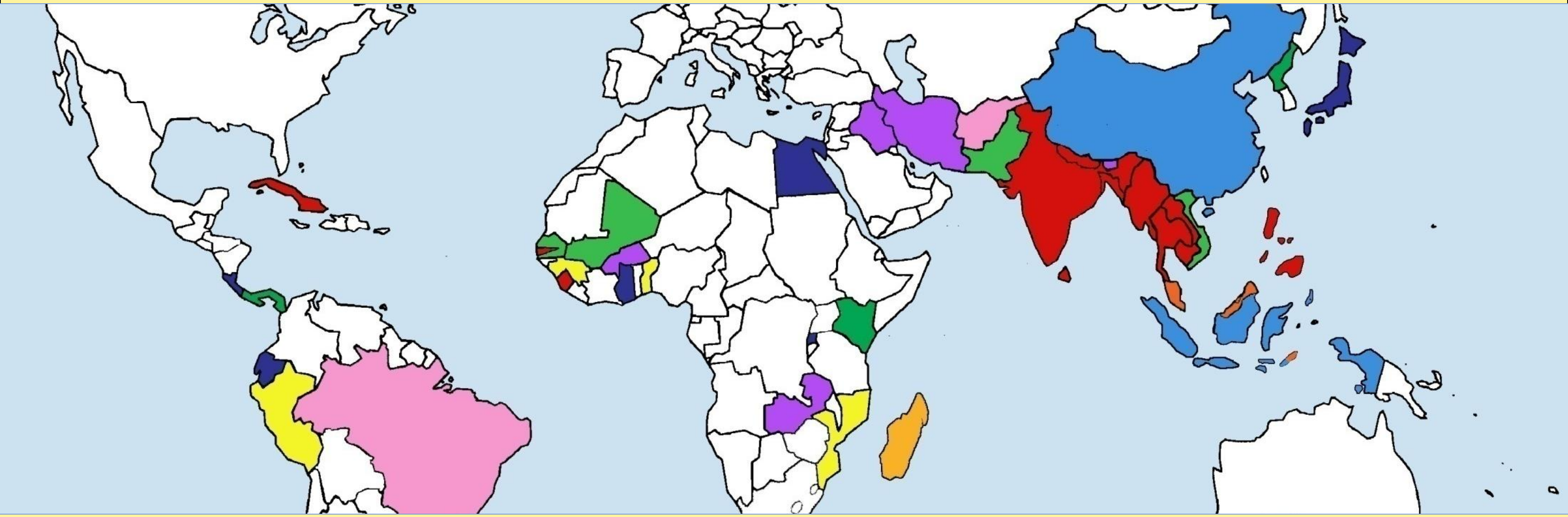
Varieties (N = 412)	Conventional duration	SRI duration	Difference
Bansdhan/Kanchhi	145	127 (117-144)	18 (28-11)
Mansuli	155	136 (126-146)	19 (29- 9)
Swarna	155	139 (126-150)	16 (29- 5)
Sugandha	120	106 (98-112)	14 (22- 8)
Radha 12	155	138 (125-144)	17 (30-11)
Barse 3017	135	118	17
Hardinath 1	120	107 (98-112)	13 (22- 8)
Barse 2014	135	127 (116-125)	8 (19-10)

The Six Basic Ideas – Classic SRI

1. Transplant young seedlings to preserve their growth potential -- but DIRECT SEEDING is now an option
2. Avoid trauma to the roots -- transplant quickly and shallow, *not inverting root tips, which halts growth*
3. Give plants wider spacing -- *one plant per hill* and in *square pattern* to achieve 'edge effect' everywhere
4. Keep paddy soil moist but unflooded -- soil should be mostly aerobic and *not continuously saturated*
5. Actively aerate the soil -- as much as possible
6. Enhance soil organic matter -- as much as possible

1+2+3 stimulate *plant growth* aboveground -- while 4+5+6 enhance the growth of *ROOTS & soil BIOTA* belowground → better phenotype

2010: Benefits of SRI management now validated in 42 countries of Asia, Africa, and Latin America



Before 1999: Madagascar
1999/2000: China, Indonesia
2000/01: Bangladesh, Cuba, Laos, Cambodia, Gambia, India, Nepal, Myanmar, Philippines, Sierra Leone, Sri Lanka, Thailand
2002/03: Benin, Guinea, Moz., Peru
2004/05: Senegal, Mali, Pakistan, Vietnam
2006: Burkina Faso, Bhutan, Iran, Iraq, Zambia
2007: Afghanistan, Brazil
2008: Rwanda, Costa Rica, Ecuador, Egypt, Ghana, Japan
2009: Malaysia, Timor Leste
2010: Kenya, DPRK, Panama, Haiti . . .

<u>CAMBODIA</u> – 28 farmers in 2000; >150,000 farmers in 2010 – 80% rainfed – adding 1.25 t/ha on average

- GOC made SRI part of Natl. Plan in 2006

<u>INDONESIA</u> – GOI has set target of 1.5 million hectares of SRI by 2015

<u>VIETNAM</u> – MARD officially declared SRI as 'technical advance' in 10/2007

- In 2006: about 4,000 SRI farmers
- In 2010: >820,000 farmers using SRI methods, 20% 'full SRI,' 80% 'partial' SRI

CHINA – Sichuan Province DA started promoting SRI on 1,120 ha in 2004; - - reached 251,000 ha in 2009; from total of 637,000 ha, 'extra' 1.04 million tons

Zhejiang PDA calculates 688,000 ha of SRI from 2005-09 added 862,000 tons

INDIA – probably >1 million farmers

- Bihar State has set targets for 2011 of 350,000 ha of SRI, 330,000 ha of SWI
- Tripura State: from 44 farmers in 2002 to 32,000 in 2005 and 250,000 in 2010

SRI ideas and practices spreading not just to and within countries, but to crops

- First step was to develop rainfed SRI
  - Cambodia, India, Myanmar, Philippines
- SRI concepts and methods have since been extended and extrapolated to:
  - Wheat (SWI): India, Mali, Ethiopia
  - Sugar cane (SSI): India
  - Finger millet (another SRI): India, Ethiopia
  - Teff (STI) and other crops: legumes (soya), vegetables (brinjal), mustard, etc.

Extensions of SRI to Other Crops, 2006-07: PSI in Uttarakhand / Himachal Pradesh, India

Crop	No. of Farmers	Area (ha)	Grain Yield (t/ha)		% Incr.
2006			Conv.	SRI	
Rajma	5	0.4	1.4	2.0	43
Manduwa	5	0.4	1.8	2.4	33
Wheat	Research Farm	5.0	1.6	2.2	38
2007					
Rajma	113	2.26	1.8	3.0	67
Manduwa	43	0.8	1.5	2.4	60
Wheat (Irrig.)	25	0.23	2.2	4.3	95
Wheat (Unirrig.)	25	0.09	1.6	2.6	63

Rajma (kidney beans)

Manduwa (millet)

PEOPLES' SCIENCE INSTITUTE

New farming method boosts food output for India's rural poor

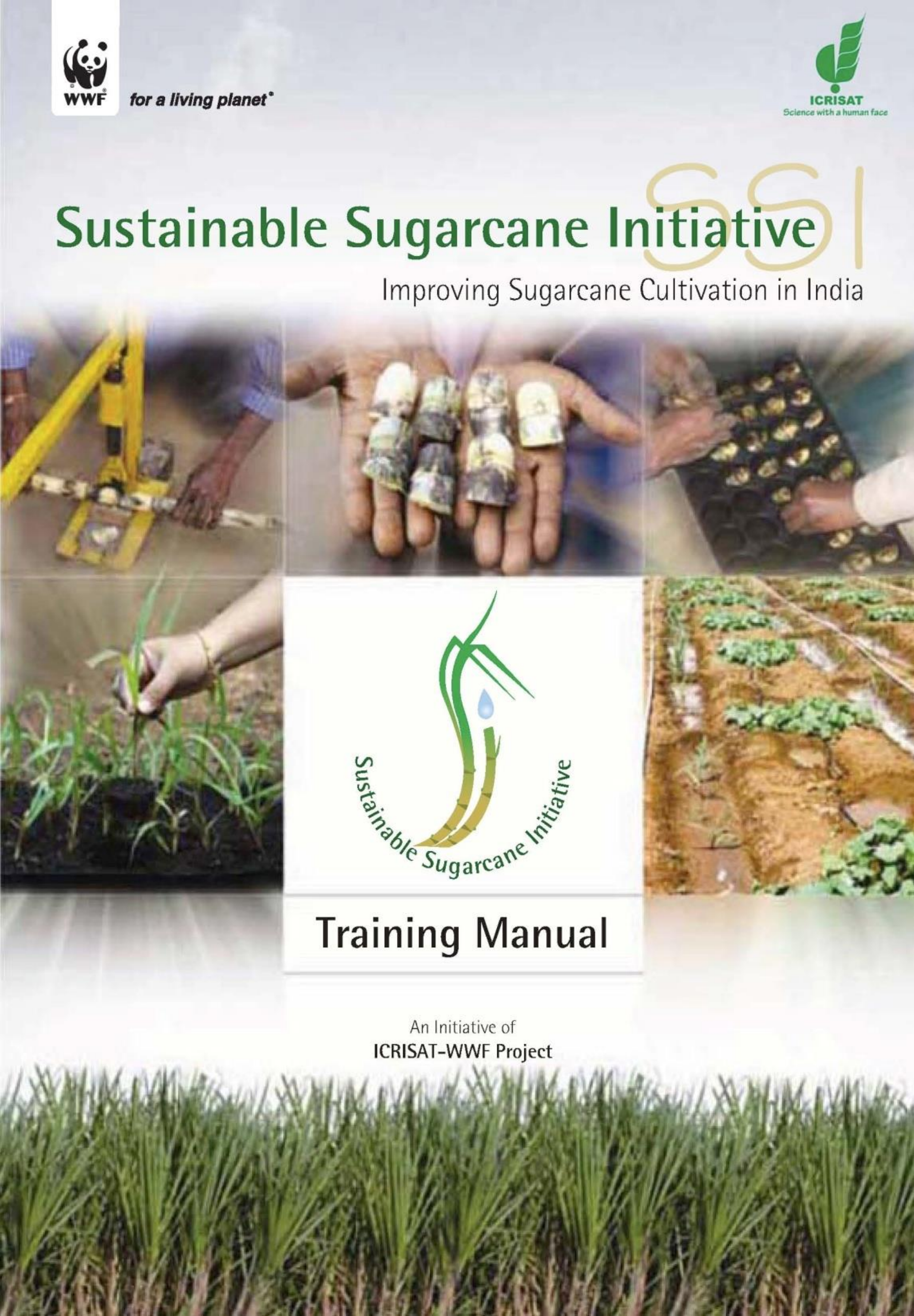
In Ghantadih village in Gaya district, more than half of the 42 farming households have switched to SWI from traditional practices.

Manna Devi, mother of three, was the first woman to use the technique in Bihar state. She says she decided to take a gamble despite jibes from neighbouring farmers who mocked her cultivation methods.

"We were living a hand-to-mouth existence before and we just couldn't manage to eat, let alone put our children through school," she says. "We were only producing about 30 kg of wheat which lasted us four months and we had to take loans, and my husband had also taken a second job as a rickshaw puller in order to make ends meet."

Devi says she now produces about 80 kg of wheat - enough to feed her family for a year – and hopes to start selling extra crop.

***Alert Net: Thomson-Reuters Foundation,* March 30, 2010**



ICRISAT-WWF <u>Sugarcane Initiative</u>:

at least 20% more cane yield, with:

- 30% reduction in water, and
- 25% reduction in chemical inputs

'The inspiration for putting this package together is from the successful approach of SRI – System of Rice Intensification.'

<u>System of Finger Millet Intensification</u> **on left; regular management of improved variety and of traditional variety on right**

HIGH-TILLERING TRAIT IN TEFF WHEN TRANSPLANTED WITH WIDER SPACING

Dr. Tareke Berhe, 'Recent Developments in Teff, Ethiopia's Most Important Cereal and Gift to the World,' Cornell seminar, 7/23/09 – Berhe was CIMMYT post-doctoral fellow with Norman Borlaug in 1970

Results of first STI trials in Ethiopia, 2008

Yields were even greater when NPK with micronutrients (S, Mg, Zn, Cu) were added to the test plots

VARIETY	SOWING METHOD	PELLETING	YIELD (Kg/Ha)
Cross 37	Broadcast	None	1,014
	Broadcast	Yes	483
	20 cm x 20 cm	None	3,390
	20 cm x 20 cm	Yes	5,109
Cross 387	Broadcast	None	1,181
	Broadcast	Yes	1,036
	20 cm x 20 cm	None	4,142
	20 cm x 20 cm	Yes	4,385

SMI in Gaya district, Bihar, India – picture of farmer's <u>mustard plant</u>; one plot had a measured yield of 4.8 tons/ha, instead of 1.0 tons/ha

What is going on that produces these kinds of phenotypes?

- Management practices support growth of much larger ROOT systems
- Practices also support SOIL BIOTA:
  - Bacteria: N fixation, P solubilization, nutrient access
  - Fungi: mycorrhizal associations (water, P uptake)
  - Protozoa, nematodes: nutrient cycling in rhizosphere
  - Soil organisms: protection, induced systemic resistance
  - Soil fauna: better aggregation of soil, soil structure and functioning, water absorption and retention, etc.

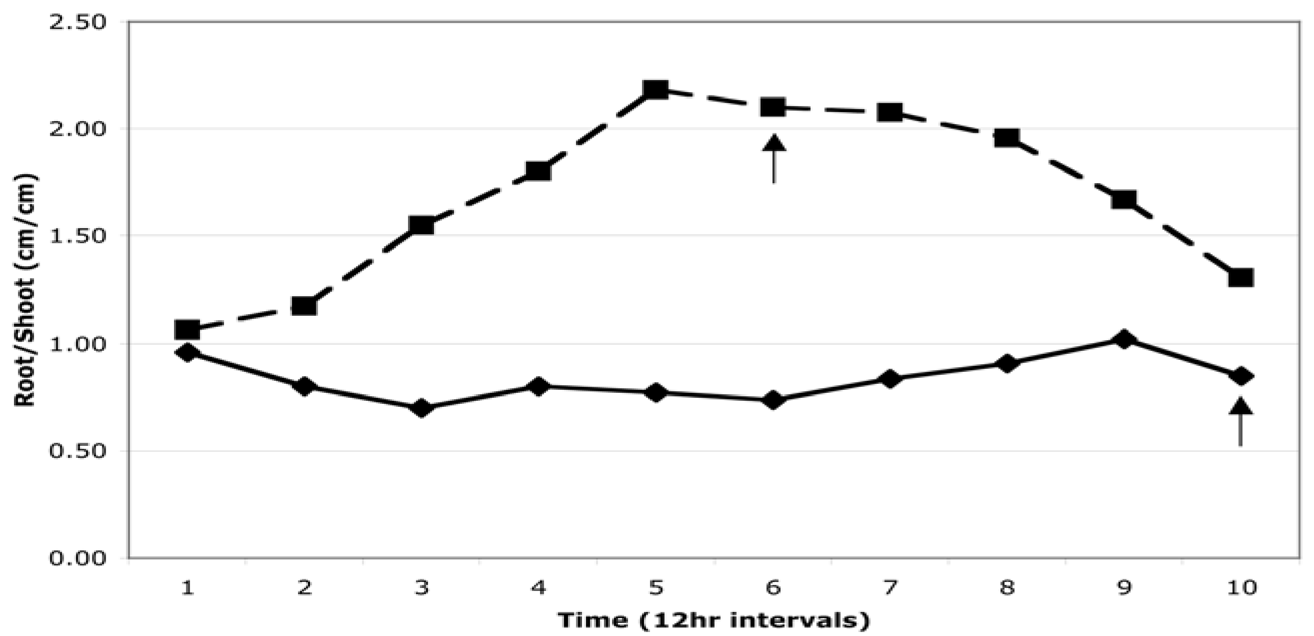
Ascending Migration of Endophytic Rhizobia, from Roots and Leaves, inside Rice Plants and Assessment of Benefits to Rice Growth Physiology

Rhizobium test strain	Total plant root volume/ pot (cm^{-3})	Shoot dry weight/ pot (g)	Net photosynthetic rate (μmol^{-2} s^{-1})	Water utilization efficiency	Area (cm^{-2}) of flag leaf	Grain yield/ pot (g)
Ac-ORS571	210 ± 36^{A}	63 ± 2^{A}	16.42 ± 1.39^{A}	3.62 ± 0.17^{BC}	17.64 ± 4.94^{ABC}	86 ± 5^{A}
SM-1021	180 ± 26^{A}	67 ± 5^{A}	14.99 ± 1.64^{B}	4.02 ± 0.19^{AB}	20.03 ± 3.92^{A}	86 ± 4^{A}
SM-1002	168 ± 8^{AB}	52 ± 4^{BC}	13.70 ± 0.73^{B}	4.15 ± 0.32^{A}	19.58 ± 4.47^{AB}	61 ± 4^{B}
R1-2370	175 ± 23^{A}	61 ± 8^{AB}	13.85 ± 0.38^{B}	3.36 ± 0.41^{C}	18.98 ± 4.49^{AB}	64 ± 9^{B}
Mh-93	193 ± 16^{A}	67 ± 4^{A}	13.86 ± 0.76^{B}	3.18 ± 0.25^{CD}	16.79 ± 3.43^{BC}	77 ± 5^{A}
Control	130 ± 10^{B}	47 ± 6^{C}	10.23 ± 1.03^{C}	2.77 ± 0.69^{D}	15.24 ± 4.0^{C}	51 ± 4^{C}

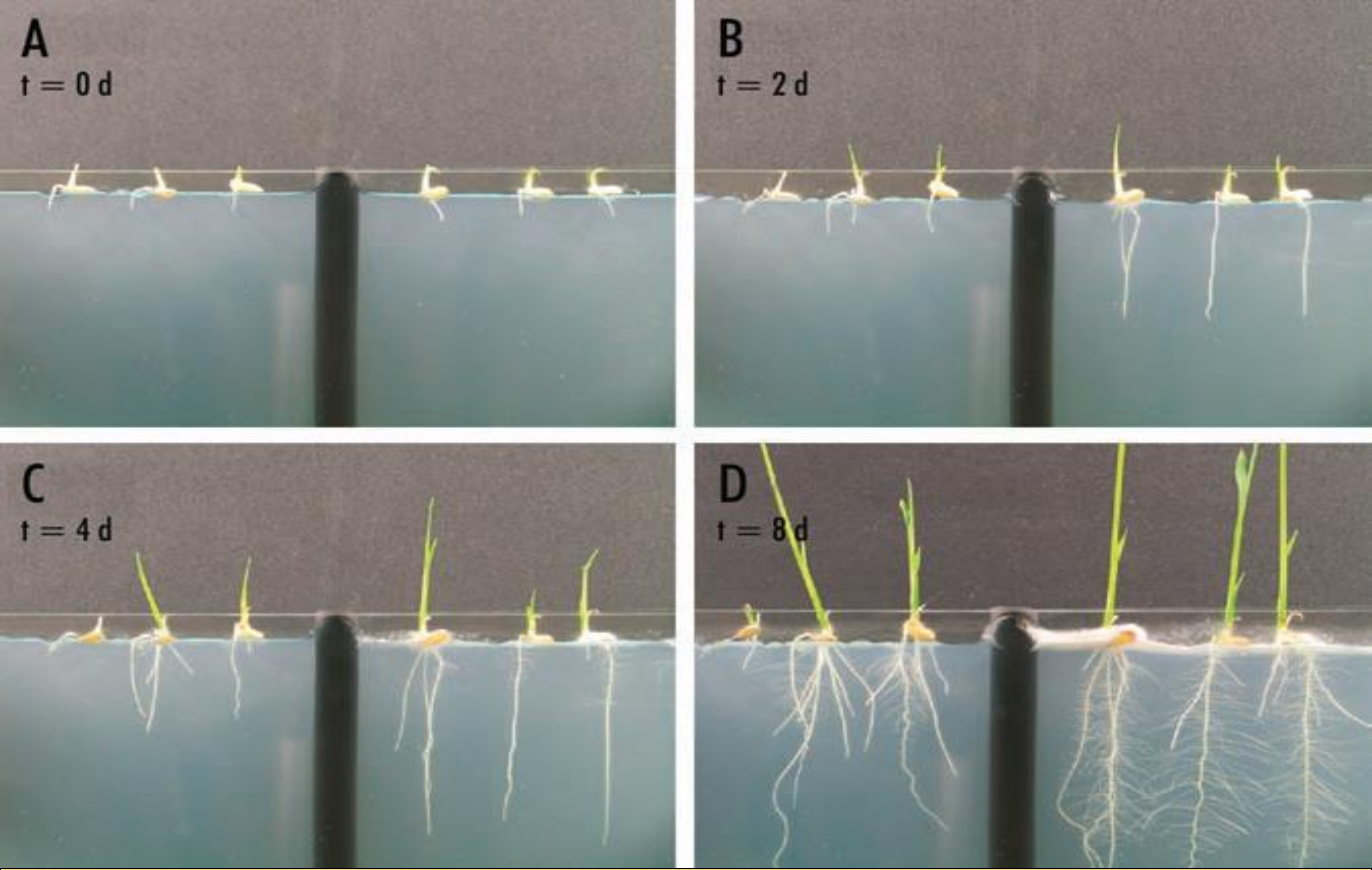
Feng Chi et al., *J. Applied & Envir. Microbiology* 71 (2005), 7271-7278

Ratio of root and shoot growth in symbiotic and nonsymbiotic rice plants -- symbiotic plants inoculated with fungus *Fusarium culmorum*

R. J. Rodriguez et al., 'Symbiotic regulation of plant growth, development and reproduction,' ***Journal of Communicative and Integrative Biology***, 2:3 (2009).



Data are based on the average linear root and shoot growth of three symbiotic (dashed line) and three nonsymbiotic (solid line) plants. Arrows indicate the times when root hair development started.



Growth of rice seedlings, nonsymbiotic (on left) and symbiotic (on right). On growth of endophyte (*Fusarium culmorum*) and inoculation procedures, see Rodriguez et al., *Communicative and Integrative Biology*, 2:3 (2009).

Common elements of Intensification:

- Plant mgmt – optimally wider spacing
- Weed mgmt – active soil aeration
- Nutrient mgmt – enhanced SOM !
- Pest mgmt – integrated pest mgmt
- Water mgmt – manage rainfall and utilize soil moisture by mulching
- Soil mgmt – minimum or zero tillage, often using permanent raised beds (CA)
- Stay tuned in for further elaboration

Challenges

- Labor-saving methods & mechanization
- Water control & crop establishment
- Biomass acquisition & processing
- Conservation Agriculture (ZT, PRBs)
- Pest control (IPM for GAS, etc.)
- Premium for higher-quality paddy
- Extrapolations to other crops
- Research to understand mechanisms
- Rebiologize (post-modern) agriculture

THANK YOU

- Check out the SRI-Rice website: http://sri.ciifad.cornell.edu

- Email: ciifad@cornell.edu
  or ntu1@cornell.edu
  or lhf2@cornell.edu