SECOND GLOBAL CONFERENCE ON AGRICULTURAL RESEARCH FOR DEVELOPMENT

CTA-Wageningen UR ACP/EU Think Tank Pre-Conference Event

Partnerships for Research, Capacity Building, Innovation and Foresighting:
Managing Water for Agriculture and Food in ACP Countries

28 October 2012
Punta del Este, Uruguay

In collaboration with

Wageningen UR
For quality of life

Partnerships for Research, Capacity Building, Innovation and Foresighting: Managing Water for Agriculture and Food in ACP Countries

Integrating Agroecological Crop Management within Integrated Water Resource Management: Lessons from Experience with the System of Rice Intensification (SRI)

Norman Uphoff, Cornell University, USA

GCARD2 Pre-Conference Meeting
Punta del Este, 28 October, 2012

Integrated water resource management =
> integrated land + water resource management

IWRM should also include improvements in
CROP MANAGEMENT

This can enable farmers to get
MORE CROP PER DROP -- and
more importantly, it can help them to achieve
MORE PRODUCTIVE PHENOTYPES
from available GENOTYPES

Essential elements for this are:
Growing better ROOT SYSTEMS and
Mobilizing the services of SOIL BIOTA

Agroecological management of crops, soil, water and nutrients differs from the GR strategy, in that it does not depend on either:

A. Changes in VARIETIES -- although we always want to use best available genotypes

B. Increases in EXTERNAL INPUTS -- although there will be times and places for using these

Agroecological methods seek to mobilize and utilize biological potentials and processes that exist within both PLANTS and SOIL SYSTEMS -- enhancing the abundance, diversity and activity of the PLANT/SOIL MICROBIOME

The significance and benefits of this phenomenon parallel those of the HUMAN MICROBIOME

For more productive and sustainable use of our land/soil and water resources, we need to achieve more productive PHENOTYPES from genotypes by making alterations in crops' growing environments

The System of Rice Intensification (SRI) from Madagascar is enabling farmers (in >50 countries) to get more productive rice plants from existing varieties (local, HYVs, hybrids) with:

- Reduced irrigation water requirements, and
- Greater resistance to climate-change effects
  - Increased DROUGHT resistance
  - Resistance to STORM damage (less lodging)
  - More resistance to PESTS & DISEASES
  - Even some tolerance of temperature extremes

Methods can be adapted to many OTHER CROPS

Basic Concepts for SRI/SCI:

- Establish healthy plants early (young) and carefully, making efforts to promote their root growth potential.
- Reduce plant density, giving each plant more room to grow (both above-ground and below-ground) to capture more sunlight and obtain more soil nutrients.
- Keep the soil well-aerated and enriched with organic nutrients, as much as possible, so that it can support better growth of roots and more aerobic soil biota.
  - Apply water in ways that can best support the growth of plant roots and of beneficial soil microbes, avoiding continuous inundation and *anaerobic* soil conditions.
  - Control weeds in soil-aerating way (mechanical weeder).

These practices *when used together* enable farmers to:

- Increase the size/functioning of *ROOT SYSTEMS,*
- Enhance the populations of *SOIL BIOTA.*

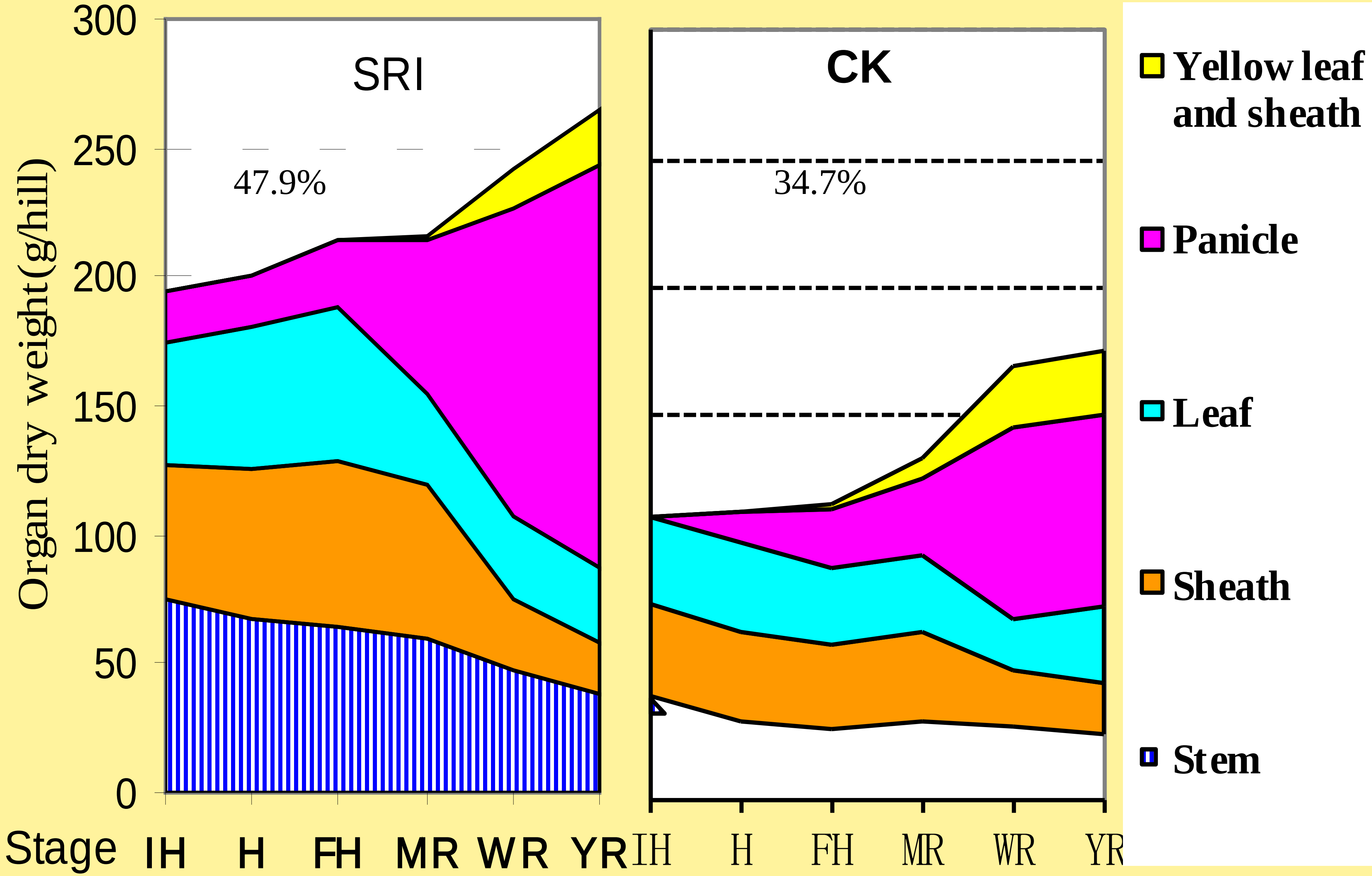
Additional Ideas for SRI/SCI:

- Farmer-centered, participatory process of agricultural improvement
  - Encouragement of farmer experimentation, evaluation and adaptation – FAs, SHGs, …
  - SRI is seen as a methodology rather than as a new *technology;* still a work in progress
  - Standard 'extension' approach is changed to emphasize farmer-to-farmer spread
- Multi-stakeholder strategy brings together NGOs, universities, govt. agencies, research institutions, private sector, and individuals in *collaborative efforts* with farmers

Farmer in Nepal with a rice plant grown from a single seed with SRI methods in Morang district

Farmer in <u>Cuba</u> with two plants of <u>same variety</u> (VN 2084) and <u>same age</u> (52 DAS)

Comparison trials in Iraq at Al-Mishkhab Rice Research Station, Najaf



Non-Flooding Rice Farming Technology in Irrigated Paddy Field

Dr. Tao Longxing, China National Rice Research Institute, 2004

Review of SRI management impacts on yield, water saving, costs of production & farmer income per ha in 13 countries

Country	(N)	Conventional yield (t/ha)	SRI yield (t/ha)	Yield increase (%)	Water saving (%)	Impact on cost per ha (%)	Impact on income per ha (%)
AFGHANISTAN	42#	5.6	9.3	55%	NM	NM	NM
BANGLADESH	1,073#	5.44	6.86	26%	NM	-7%	+59%
CAMBODIA	500*	1.63	2.29	41%	Rainfed	-56%	+74%
3-yr SRI users	120#	1.34	2.75	105%	Rainfed	-47%	+98%
CHINA	82*	6.6	9.37	42%	44%	-7.4%**	+64%
Sichuan (2004-10)	301,967 ha	7.7	9.5	23%	25.6%	NR	+US$320 mill
INDIA	108#	4.12##	5.47##	32%##	Rainfed	-35%	+67%
Andhra Pradesh	1,525#	6.31	8.73	34%	40%	NM	NM
INDONESIA	12,133#	4.27	7.61	78%	40%	-20%	>100%
KENYA	Trials	6.2	7.6	26%	28.2%	NM	NM
Mwea Scheme	"	8.66	14.85	70%	24%	NM	NM
MALI	53#	5.5	9.1	60%	10%	+15%	+108%
MYANMAR	612#	2.1	4.4	110%	Rainfed	+0.2%	8.7 times
NEPAL	412#	3.3	6.1	82%	43%	-2.2%@	+163%
Far West Region	890#	4.01	7.58	88%	>60%	+32%	+164%
PANAMA	46#	3.44	4.75	38%	71-86%	NM	NM
SRI LANKA	120*	3.84	5.52	44%	24%	-12%	+104%
VIETNAM	1,274#	5.58	6.79	22%	33%	-30%	+36%
Total N and Averages	18,870[a] + 300,000 ha	**4.77**	**7.12**	**50%**	**37.5%**	**-16%**	**94%[a,b]**

Complete data sets, no sampling   * Based on random sampling   NM: not measured   NR: not reported

Water use, water savings, and WUE -- 13 studies

	Year	Soil type	Water use *		Water saving	Water use efficiency		SRI WUE increase
			Conv.	SRI		Conv.	SRI	
China	2004	CL	1,360	898	33.9%	0.46	0.88	91.3%
	2005	CL	1,435	868	39.5%	NR	NR	68.0%
	2006	CL	1,763	933	47.1%	NR	NR	94.0%
India	2002	CL	NR	NR	NR	0.49	0.61	24.5%
	2002-03	CL	1,578	1,272	19.4%	0.28	0.31	12.1%
	2005-07	SL	1,254	962	23.3%	NR	NR	NR
	2005	BC	1,250	850	32.0%	NR	NR	NR
	2008	SCL	1,203	913	24.1%	0.36	0.72	100.0%
	2009	SCL	1,242	990	20.3%	0.36	0.65	80.6%
Kenya	2010-11	V	11,610*	8,422*	27.5%	0.40	0.70	75.0%
	2010-11	V	15,691*	11,573*	26.2%	0.20	0.50	150.0%
	2010-11	V	15,096*	10,420*	31.0%	0.50	1.00	100.0%
Iraq	2009	CL	34,500*	21,600*	38.5%	0.11	0.29	164.5%
Averages	mm ha^{-1}		1,386	961	30.7%	0.35	0.63	87.3%
	* m^3 ha^{-1}		19,224*	13,003*	32.4%			

STI in Ethiopia:
Application of SRI concepts & practices to production of **tef**

On left: transplanted tef; on right: usual broadcast tef

3-5 t/ha vs. 1 t/ha

Summary of results reported from farmers' fields for

System of Crop Intensification (SCI)

which applies SRI concepts and methods to other crops

Crops	Yield increases
Finger millet	3 to 4x
Legumes	50-200%
Maize	75%
Mustard	3 to 4x
Sugarcane	20-100%
Tef	3 to 5x
Turmeric	25%
Vegetables	100-270%
Wheat	10-140%
SCI crops are mostly rainfed; 30% water saving with wheat and sugarcane; 66% with turmeric	

INDONESIA

Caritas introduced SRI methods in Aceh in 2005 after *tsunami* devastation – local rice yields were raised 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."

'Rice Aplenty in Aceh,' Caritas News (2009)

Similar quadrupling of rice yields by poor, food-insecure, resource-limited households has been documented also in Madagascar, Cambodia, Madhya Pradesh (India)

<u>AFGHANISTAN</u>: SRI field in Baghlan Province, supported by *Aga Khan Foundation* Natural Resource Management program

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

2011: 106 farmers got SRI yields of 10.1 t/ha vs. 5.04 t/ha regular

-- All using less water

<u>MALI</u> -- SRI nursery in Timbuktu region – 8-day seedlings ready for transplanting

SRI transplanting in Timbuktu, Mali

Farmer working with the NGO *Africare* in Timbuktu region, Mali showing difference between regular and SRI rice plants

2007/08: 1 farmer - SRI yield of 8.98 t/ha
2008/09: 60 farmers- 9.01 vs. 5.49 t/ha
2009/10: 130 farmers – 7.71 vs. 4.48 t/ha with 32% less water

Gao average: 7.84 t/ha
Mopti average: 7.85 t/ha

<u>Drought-resistance</u>: Rice fields in Sri Lanka, same variety and same soil, 3 weeks after irrigation stopped because of drought -- conventionally-grown field on left, and SRI field on right

Results from Bihar State, 2007-2011

(data from Bihar Rural Livelihood Promotion Society, Govt. of Bihar)

SYSTEM OF RICE INTENSIFICATION -- state average 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 average yield (t/ha)	10.0	7.75	6.5	3.22*
Conv. average yield (t/ha)	2.7	2.36	2.02	1.66*

SYSTEM OF WHEAT INTENSIFICATION -- state average 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	NA
Conventional average yield (t/ha)	1.6	1.6	NA

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

CHINA: SRI extension/impact in Sichuan Province, 2004-10

Year	2004	2005	2006	2007	2008	2009	2010	Total
SRI area (ha)	1,133	7,267	57,400	117,267	204,467	252,467	301,067	941,068
SRI yield (kg/ha)	9,105	9,435	8,805	9,075	9,300	9,495	9,555	9,252
Non-SRI yield (kg/ha)	7,740	7,650	7,005	7,395	7,575	7,710	7,740	7,545
SRI increment (t/ha)*	1,365	1,785	1,800#	1,680	1,725	1,785	1,815#	1,708
SRI % increase in yield*	17.6%	23.3%	25.7%	22.7%	22.8%	23.2%	23.5%	22.7%
Grain increment (tons)	1,547	12,971	103,320	197,008	352,705	450,653	546,436	1.66 mill
Addl. net income from SRI use (million RMB)*	1.28	11.64	106.5	205.1	450.8	571.7	704.3	2,051 >$300 mill

*Comparison with Sichuan provincial average for paddy yield and SRI returns

#*Drought years: SRI yields were relatively better than with conventional methods*

Source: Data are from the Sichuan Provincial Department of Agriculture.

<u>Storm resistance</u>:
Dông Trù village, Hanoi province, Vietnam, after fields were hit by a <u>tropical storm</u>

Right: conventional field and plant;
Left: SRI field and plant

Same variety used in both fields -- on right, serious lodging is seen; <u>no lodging on left</u>

<u>Incidence of diseases and pests</u> in Vietnam:

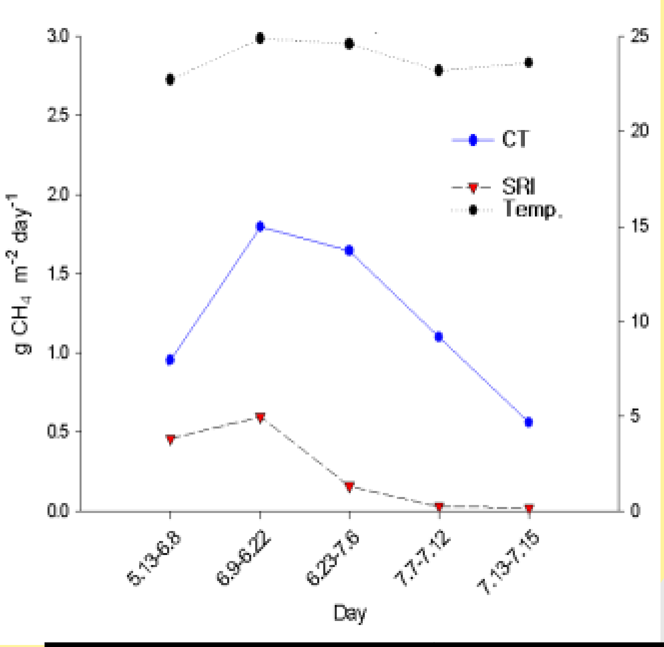
National IPM Program evaluation -- averages of data from on-farm trials in 8 provinces, 2005-06:

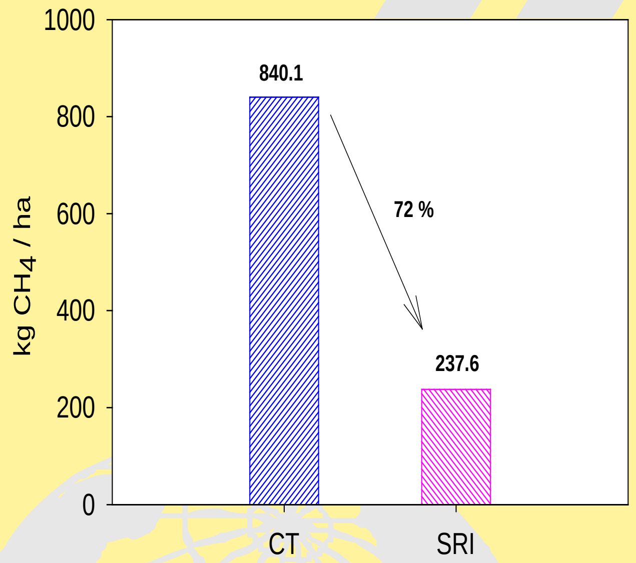
	Spring season			Summer season		
	SRI Plots	Farmer Plots	Difference	SRI Plots	Farmer Plots	Difference
Sheath blight	6.7%	18.1%	63.0%	5.2%	19.8%	73.7%
Leaf blight	--	--	--	8.6%	36.3%	76.5%
Small leaf folder *	63.4	107.7	41.1%	61.8	122.3	49.5%
Brown plant hopper *	542	1,440	62.4%	545	3,214	83.0%
AVERAGE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

* Insects/m^2

<u>Resistance to both biotic and abiotic stresses in Indonesia</u>: fields have been hit by both brown planthopper (BPH) and by storm damage (typhoon): rice on left was grown with standard practices; <u>organic SRI</u> is seen on right

Comparison of methane gas emission





Treatment	Emission (kg/ha)		CO_2 ton/ha equivalent
	CH_4	N_2O	
CT	840.1	0	17.6
SRI	237.6	0.074	5.0

Partnerships: Evaluations and dissemination of SRI carried out by diverse stakeholders with a farmer-centered focus

NGOs: Africare (Mali); Aga Khan Foundation (Afghanistan); BRAC (Bangladesh); CEDAC (Cambodia); Metta Development Foundation (Myanmar); Oxfam America (Vietnam); *Patronato de Nutriciòn* (Panama); WWF (India)

Government agencies: Morang District Agricultural Dev. Office (Nepal); Sichuan Provincial Dept of Agric (China); Ministry of Agriculture & Rural Development/PPD (Vietnam)

Universities: ANGRAU (India); China Agric. University; Jomo Kenyatta Univ. of Agriculture & Technology (Kenya)

Private sector: Nippon Koei (Indonesia); Syngenta (BD)

Donor agencies: FAO-EU (Nepal); GTZ (Cambodia); USAID (Mali, Tanzania); World Bank Institute

International research centers: ICRISAT (India); IRRI (Bangladesh); IWMI (India and Sri Lanka)

What is needed for scaling up?

* Overcoming mental barriers: farmer skepticism; but more resistance from *agronomists*, and even from *economists*
* Relatively little investment is needed:
    * Training is needed - for technicians as well as farmers, also for scientists
    * Some research is also needed re:
        - *water management/optimization*
        - *applied soil biology* – new frontier
        - *applications to other crops (SCI)*
        - *utilizing climate-smart opportunities*

Three key messages:

1. For *higher crop productivity* and for *greater water productivity*, we need to:

a. Focus on root system growth/function

b. Enhance soil organic matter – so as to increase our stocks of 'green water'

[note: these factors interact beneficially]

2. The concept of 'technology transfer' needs to be changed to support PTD!

3. We need a paradigm shift replacing genocentrism with an understanding and utilization of the plant/soil microbiome

For more information on SRI/SCI:

SRI International Network and Resources Center (SRI-Rice)
Website: http://sri.ciifad.cornell.edu

at Cornell International Institute for Food, Agriculture and Develoment (CIIFAD), Cornell University, or

Norman Uphoff: ntu1@cornell.edu