CLIMATE-SMART Agriculture 2015

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A review of contributions that the System of Rice Intensification (SRI) can make to climate-smart agriculture

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1. What Is <u>SRI/SCI</u>?

- SRI is a **management system** for rice and other crops changing how plants, soil, water and nutrients are handled -- to produce ***more productive, more robust plants*** from any given variety, i.e., <u>to get better **phenotypes** from any particular **genotype**</u>.
- SRI derives from decades of work with farmers and rice crops in Madagascar by Fr. Henri de Laulanié, S.J., who assembled **a set of PRACTICES** that could capitalize upon genetic potentials within both 'improved' and 'unimproved' varieties of rice plants.
- Now SRI is understood and presented in terms of **generalizable PRINCIPLES** that have solid support in agronomic science
- *These practices include: the use of young seedlings, wider spacing, no continuous flooding of paddies, active soil aeration (an effect of mechanical weeding), and increased soil organic matter.*
- The **RESULT** is enhancement of the health and functioning of **root systems** and more abundant, diverse **soil biota**

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CUBA: Two plants of <u>same variety</u> (VN 2084) and <u>same age</u> (52 DAS) – different phenotypes from same genotype

INDONESIA:
Stump of a rice plant (modern variety) grown under SRI management -- 223 tillers & massive root growth -- all from a single seed

Panda'an, E. Java, 2009

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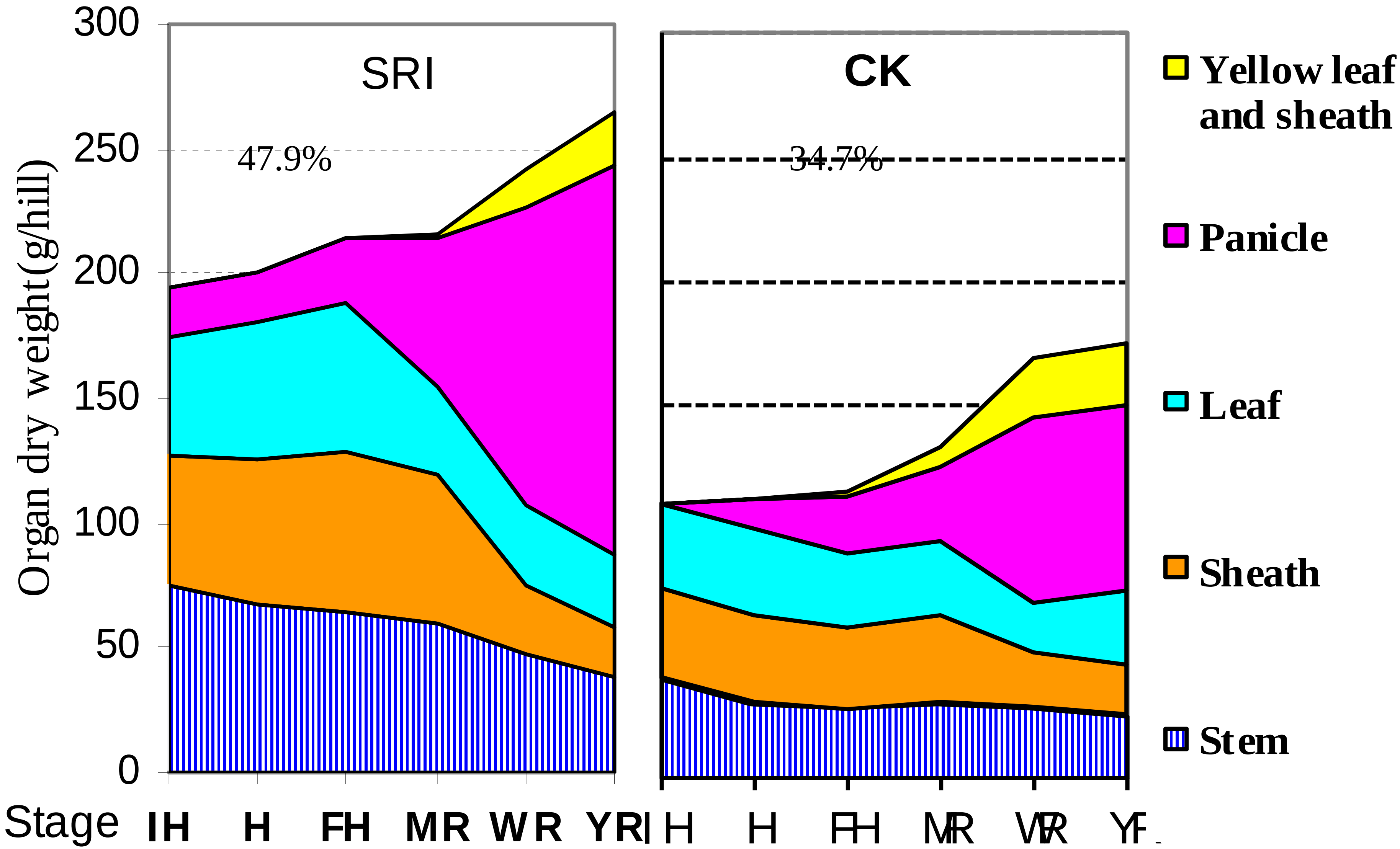
IRAQ: **Comparison trials at Al-Mishkhab Rice Research Station, Najaf**

CHINA: Measured Phenotypical Differences with SRI



Non-Flooding Rice Farming Technology in Irrigated Paddy Field
Dr. Tao Longxing, China National Rice Research Institute, 2004

2. What Benefits Can Be Achieved with SRI?

1. Higher grain yields – 20-50%, even >100%
2. Water savings – 30-50% reductions in irrigation
3. Reduced costs of production – usually 10-20%
4. Higher net farmer incomes – 50-100% or more
5. Shorter crop duration – often 5-10 days or more
6. Higher milling outturn by 10-20%, due to fewer unfilled grains & less breakage during milling
7. Greater resistance to pests and diseases and more tolerance of climatic stresses

HOW are these effects achieved? No 'magic' – good agronomic practices mobilizing existing potentials and interaction of ROOTS & SOIL BIOTA

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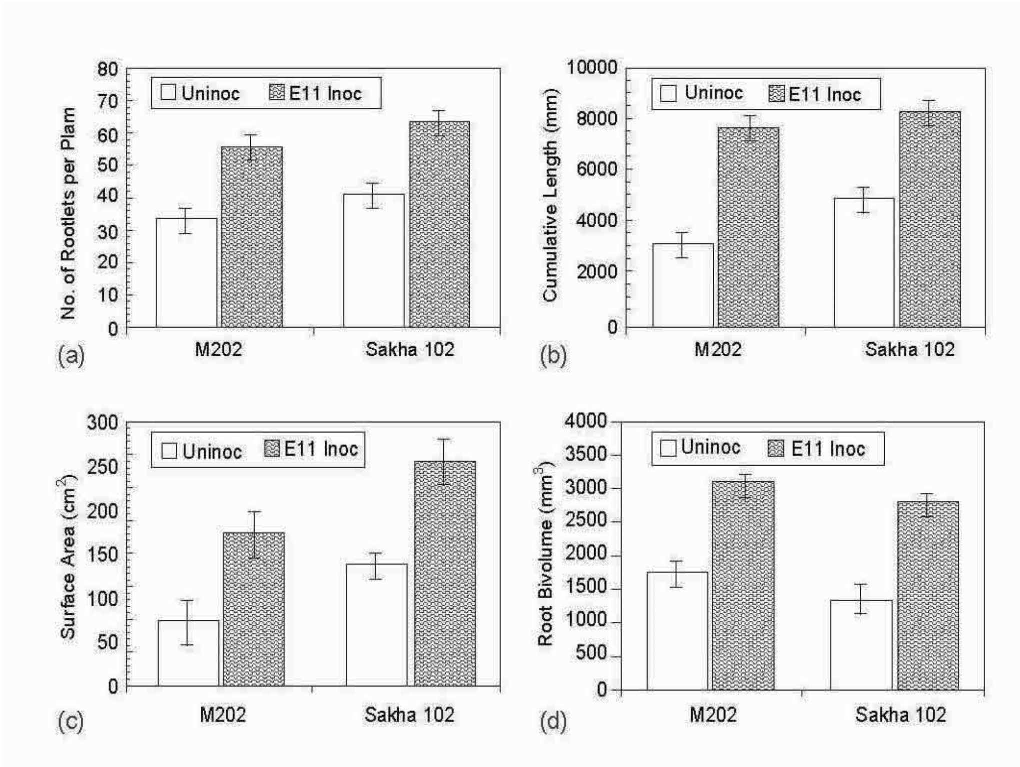
Positive interactions between soil microbes and growth of roots as shown by Egyptian research



Effects of inoculation with *Rhizobium leguminosarum* bv. trifolii E11 on root architecture of two rice varieties: (a) Rootlets per plant; (b) Cumulative root length (mm); (c) Surface area (cm^2); and (d) Root biovolume (cm^3). From: Y. G. Yanni et al., *Australian Journal of Plant Physiology*, 28, 845–870 (2001)

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3. Why SRI Is Climate-Smart Agriculture

- Reduced water requirements – higher crop water-use efficiency benefits both natural ecosystems and people in competition with agriculture for scarce water supplies
- Less use of inorganic fertilizer – reactive N is “the third major threat to our planet after biodiversity loss and climate change” - already returns are greatly diminishing
- Less reliance on agrochemicals for crop protection - which enhances the quality of both soil and water
- Buffering against the effects of climate change – drought, storms (resist lodging), cold temperatures
- Some reduction in greenhouse gases (GHG) – CH_4 is reduced without producing offsetting N_2O emissions; also some reductions made in ‘carbon footprint’ with less production, transportation and use of fertilizers

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Evidence on water saving and productivity:

A meta-analysis of 29 published studies (2006-2013), with results from 251 comparison trials across 8 countries

Water use:	SRI mgmt	12.03 million liters ha^{-1}
	Standard mgmt	15.33 million liters ha^{-1}

SRI reduction in total water use = 22%

SRI reduction in irrigation water use = 35%

with 11% more yield: SRI 5.9 tons ha^{-1} vs. 5.1 tons ha^{-1}

(usually, SRI yield increases are greater than this)

Total WUE	0.6 vs. 0.39 grams/liter (52% more)
Irrigation WUE	1.23 vs. 0.69 grams/liter (78%more)

P. Jagannath, H. Pullabhotla and N. Uphoff, "Evaluation of water use, water saving and water use efficiency in irrigated rice production with SRI vs. traditional management," *Taiwan Water Conservancy* (2013)

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

<u>Storm resistance</u>

Adjacent rice fields
after being hit by
a tropical storm
in Dông Trù village,
Ha Noi province.
Vietnam

Same variety was
used in both fields
-- on right, we see
serious lodging;
on left, no lodging

Disease and pest resistance in Vietnam:

Evaluation by National IPM Program – averaged 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

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<u>Resistance to both biotic and abiotic stresses</u> in Indonesia: fields hit by both a brown planthopper pest attack and by storm damage – the rice field on the left was managed with standard practices, while the field on right is <u>organic SRI</u>

Evaluations of GHG emissions

- Flooded rice paddies are a major source of CH_4
- Evaluation for GIZ in Mekong Delta of Vietnam found a significant 20% reduction in CH_4 and a 1.4% reduction (NS) in N_2O (Dill et al., 2013)
- A life-cycle analysis (LCA) in Andhra Pradesh, India found SRI management, compared to standard practices, reduced GWP emissions by >25% per ha, and by >60% per kg of rice produced (Gathorne-Hardy et al., 2013)
- Another Indian study found SRI methods lowered GWP per hectare by 28% (Jain et al., 2013) – we are not finding offsetting increases in N_2O

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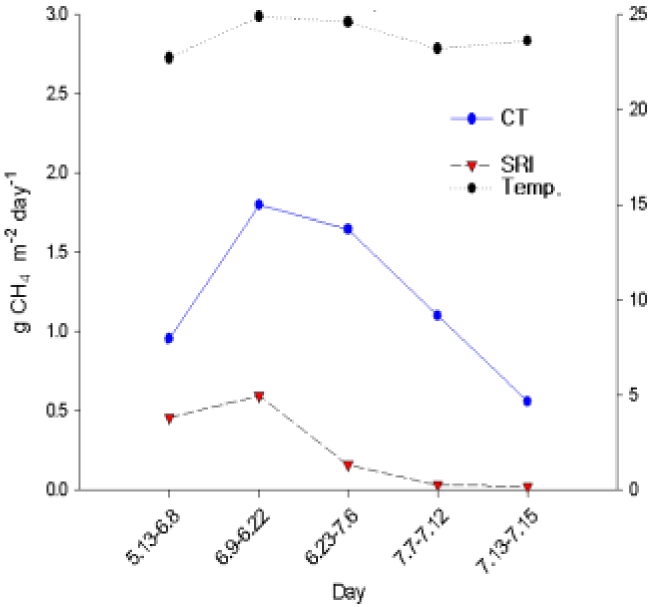
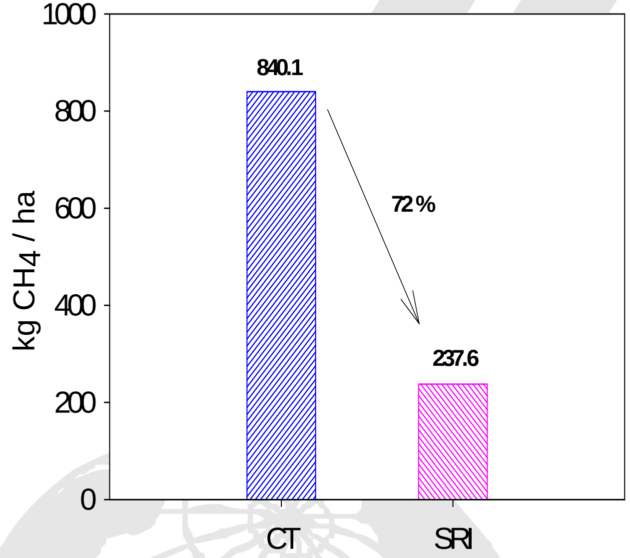
Comparison of methane gas emission





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

4. These changes in crop management (SCI) can also benefit other crops

- Development of stronger **root systems** and greater **soil biodiversity and biological activity** improves the productivity and CC robustness of many other crops, e.g.,
  - Wheat
  - Sugarcane
  - Finger millet
  - Tef (Ethiopia)
  - Legumes and many vegetables

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SWI wheat crop in Khagarla district, Bihar state of India – these wheat fields are same age and same variety

SSI sugarcane in Cuba
at 10.5 months --
yield estimated @ 150 t/ha

SSI sugarcane
in India

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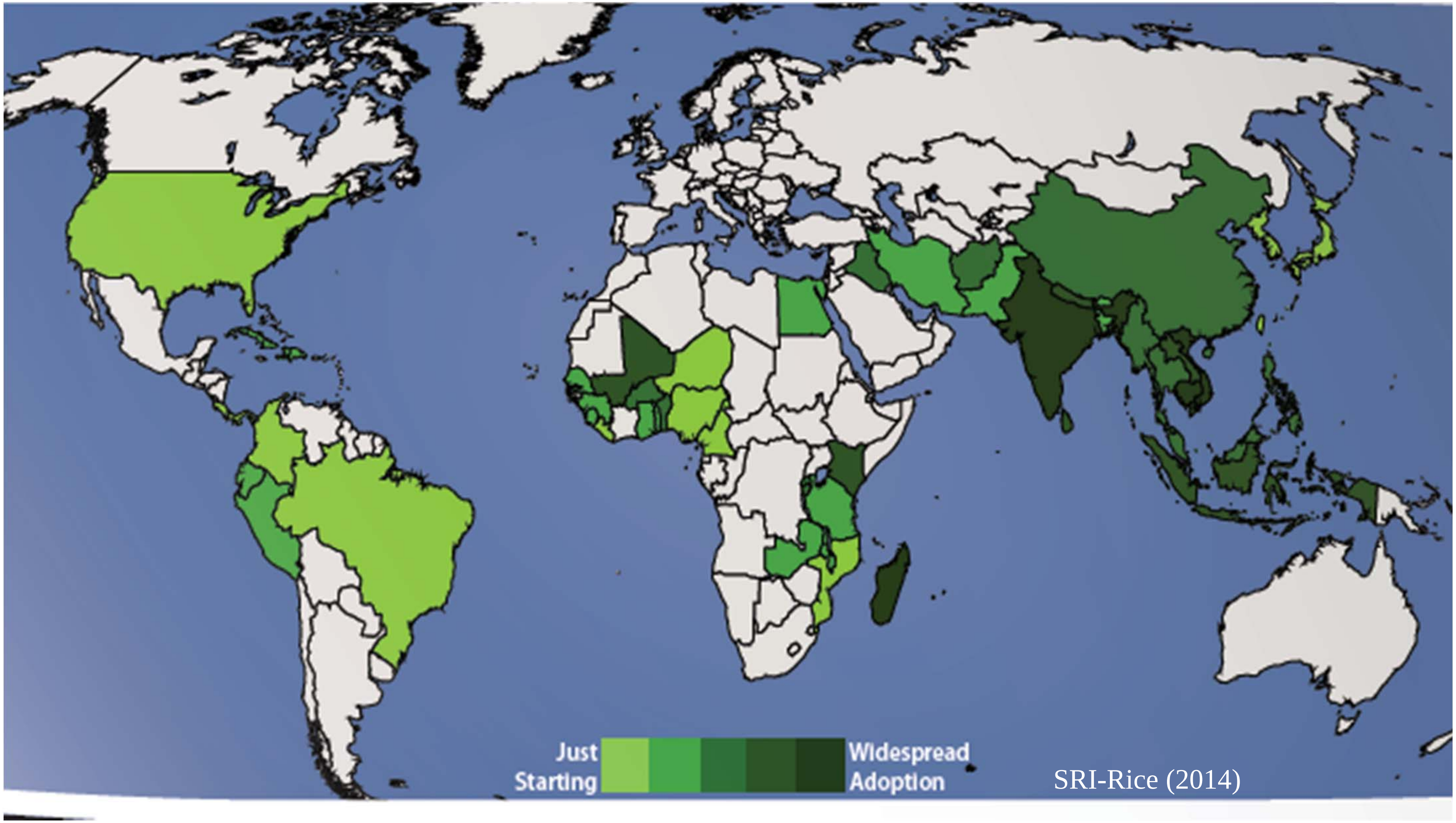
STI tef plants ready for harvest at Debre Zeit research station in Ethiopia

Spread and Adoption of SRI

More than 10 million farmers are benefiting from the use of SRI methods in 55 countries (end of 2014) on 3.5-4.0 million hectares



5. Reservations and Qualifications?

- SRI has had reputation for '**labor-intensity**' but this was compared to 'extensive' methods in Madagascar; usually SRI can <u>reduce labor</u>
- Only good for **small scale**? no longer true
  - various SRI practices can be <u>mechanized</u>
- SRI practices appear to be '**risky**' -- but studies for GTZ (Cambodia) and IWMI (Sri Lanka) showed <u>reductions in farmers' risks</u>
- But SRI/SCI are still '**a work in progress**' →
- so please " stay tuned " – and help us!

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