Alternate Wetting and Drying and the System of Rice Intensification for Sustainable Irrigated Rice Production

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What is SRI?

The System of Rice Intensification (SRI) is an agro-ecological and climate-smart rice production methodology that allows farmers to:

- increase yields by 30-50% or more
- use 90% less seed
- use 30-50% less irrigation water (through AWD and other methods)
- use 30-100% less chemical fertilizer and pesticides

Developed in the 1980s in Madagascar with the goal to **identify best growing conditions for irrigated rice to express its production potential**

System of Rice Intensification

1. Early and healthy plant establishment

Young seedlings (8-12 days old)

2. Minimize competition between plants

1 plant/ hill
Wider spacing

- High number of tillers and panicles
- Good grain filling

- Prolific deep root growth
- Delayed root senescence

Higher yields

Use manure, compost, crop residues

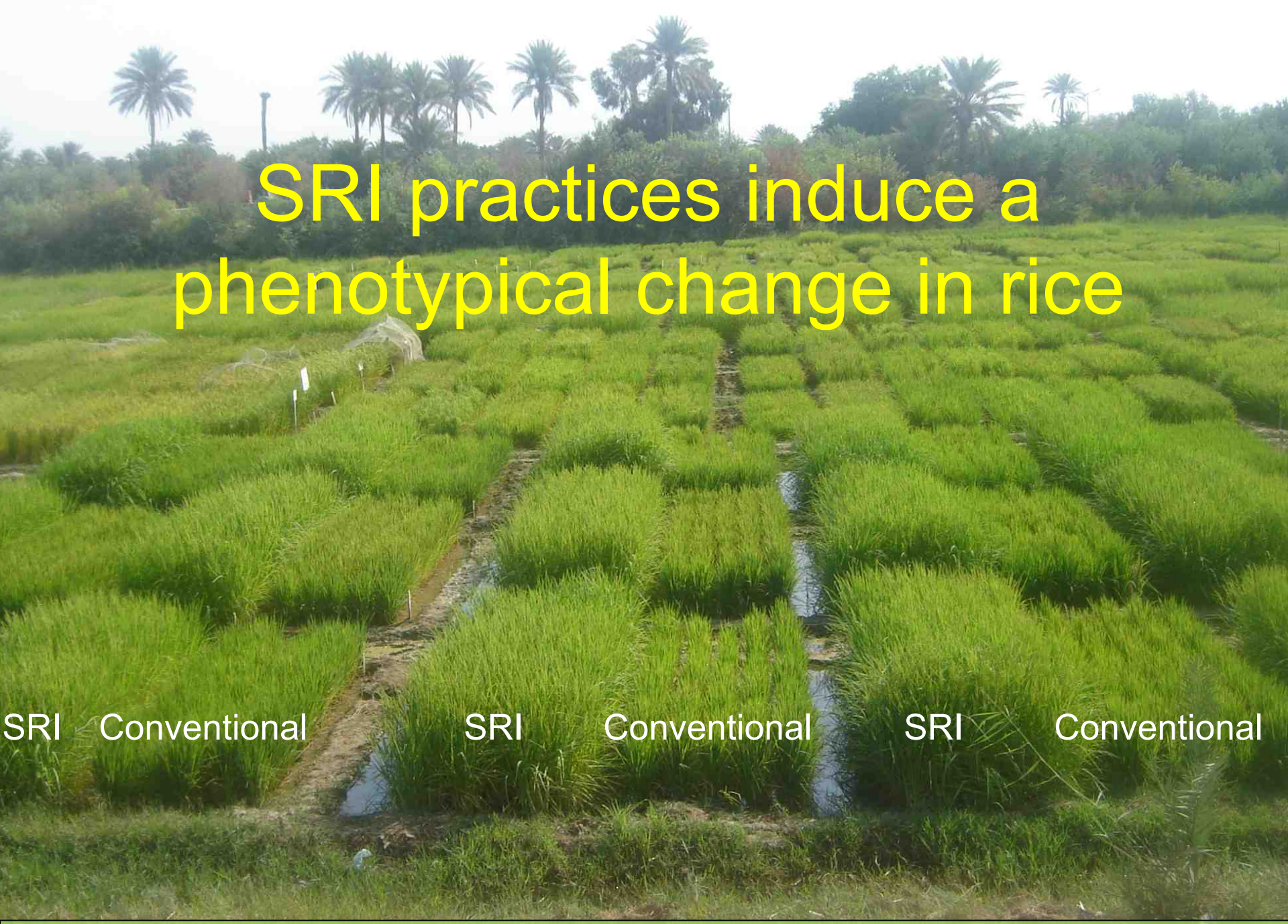
3. Build fertile soils rich in organic matter and soil biota

AWD for irrigated rice

4. Manage water carefully, avoid flooding & water stress, create aerated soil

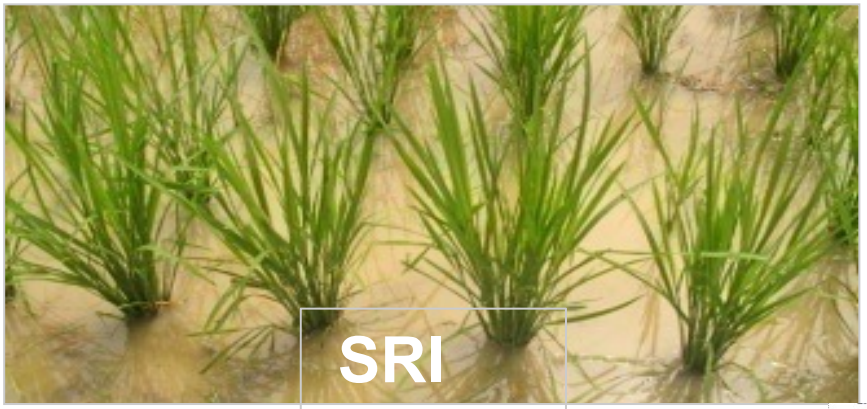
Effect of AWD on SRI plants

- Soil is aerated
- Roots can breathe
- Roots grow deep and large in volume
  - Allows for vigorous shoot growth (root/shoot ratio)
- Tillering is enhanced when young plants are not flooded
- Diversity and quantity of beneficial, aerobic soil organisms is increased
  - Improved nutrient and water uptake by plant


SRI practices induce a phenotypical change in rice
SRI
Conventional
SRI
Conventional
SRI
Conventional
IRAQ's Al-Mishkhab Research Center, Najaf

Changes above ground
SRI/AWD compared to flooded rice

- Thicker tillers (+38%), higher plants (+24%)
- More tillers/plant
- Wider canopy angle and higher leaf area index (+67%)
- Higher light interception (+15%)
- Higher levels of chlorophyll (+30%) and photosynthesis rate (up to 100%)
- Delayed leaf senescence



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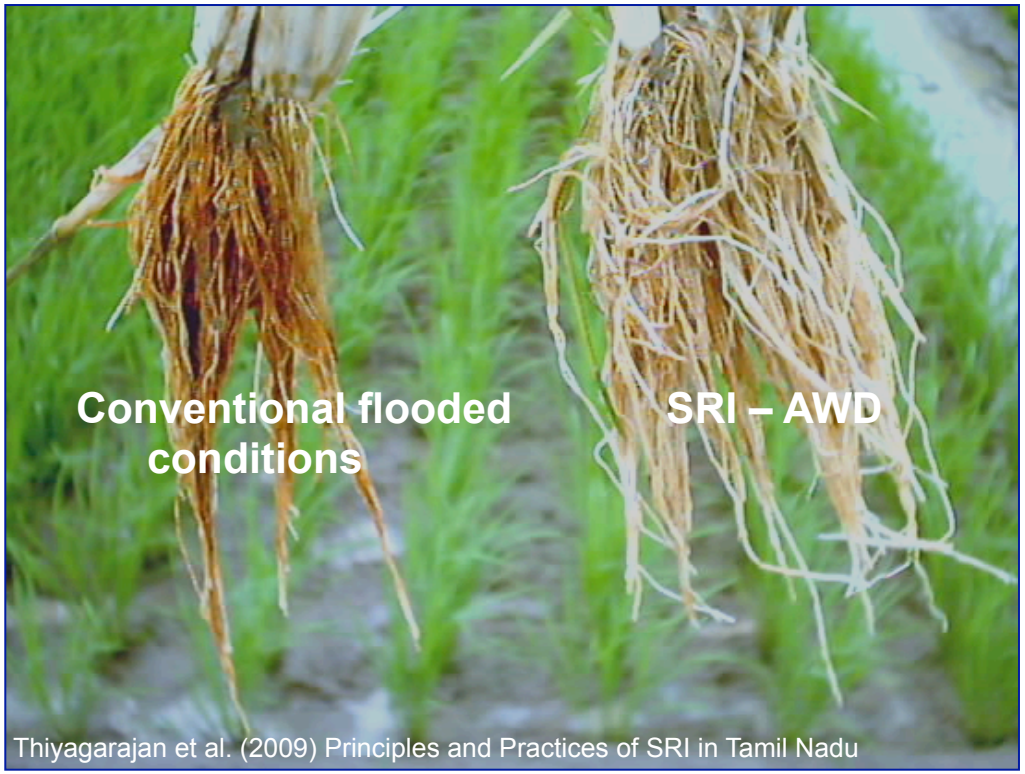
Thakur, A.K et al (2011)

Changes below ground
SRI/AWD compared to flooded rice

- Larger root volume
- Deeper root growth
- Increased root exudation
- Higher population of beneficial, aerobic soil biota
- Delayed root senescence



Thiyagarajan et al. (2009) Principles and Practices of SRI in Tamil Nadu

→ Longer grain filling period

Thakur et al, 2011; Mishra and Salokhe, 2011; Anas et al, 2011

Yield performance

- More/similar number of panicles/ m^2
- Longer panicles (+20%)
- More grains/panicle
- Fewer unfilled grains
- 1000 grain weight is heavier

Increased Yields (usually >30-50%)

Summary of Benefits I

Productivity

- Yield Increase: usually >30-50%
- Water savings: 30-50%
- Seed reduction: > 90%
- Less fertilizer and agrochemical inputs: 20-40% (up to 100%)
- Improved benefit/cost: higher yields with similar or lower production costs.
- Net return (+30% or more)


SRI/AWD in Mali

Summary of Benefits II

Adaptation

Improved tolerance:

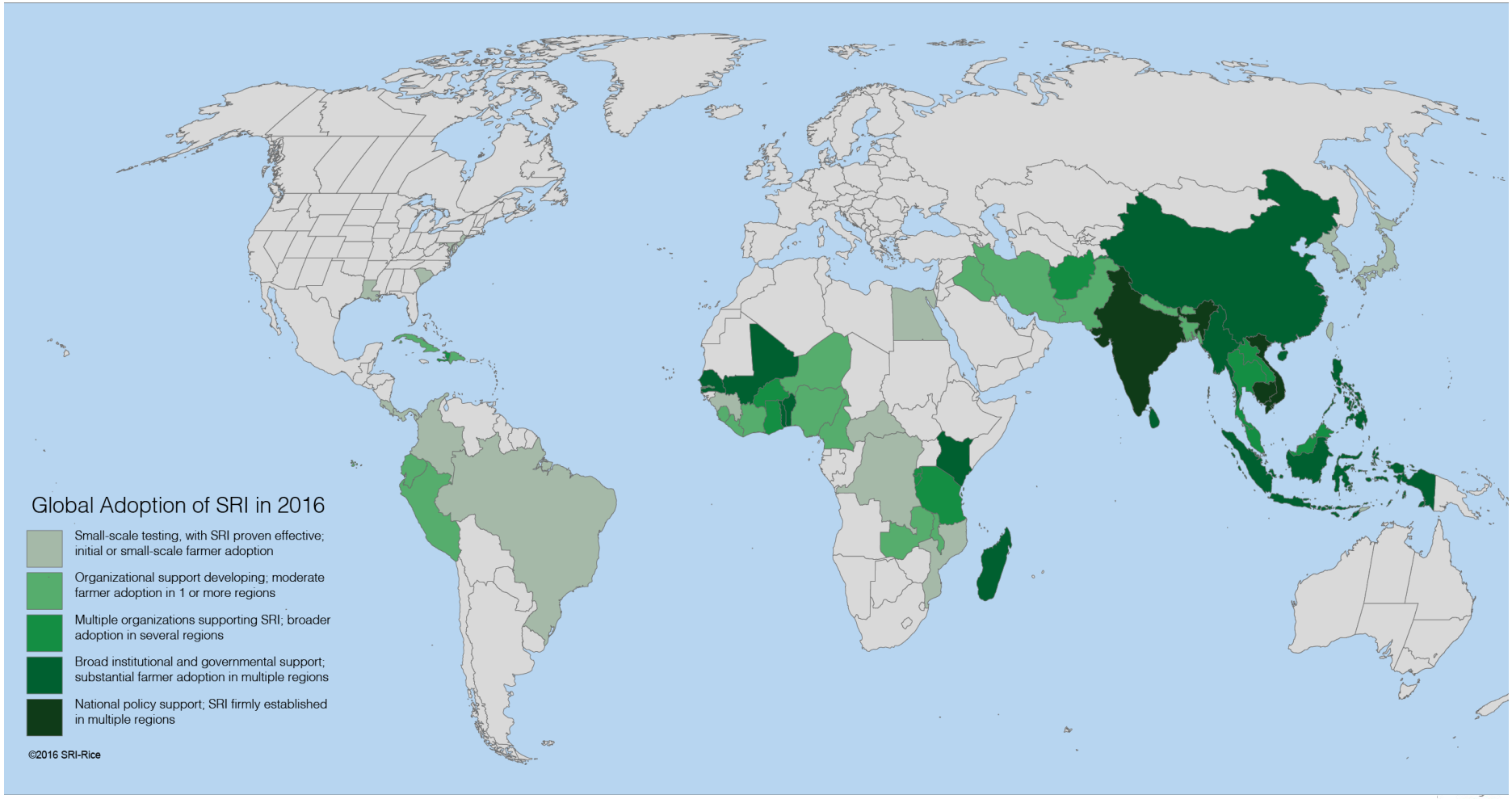
- Pests and diseases
- Drought
- Storms (less lodging)

Mitigation of GHG

- Methane: reduced by 10-64%
- Nitrous oxide: slight increase, similar or decrease
- Global warming potential: reduced by 21-73%

Gathorne-Hardy et al 2013; Rajikishore et al 2013; Suryavanshi et al 2013

Adoption rate of SRI in Asia, Africa and Latin America by 2016



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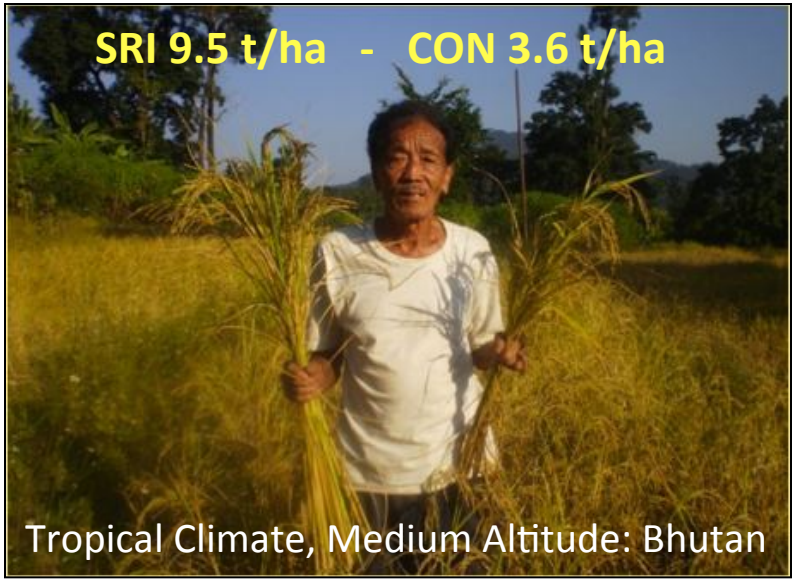
SRI 9.5 t/ha - CON 3.6 t/ha
Tropical Climate, Medium Altitude: Bhutan


CON 6.5 t/ha
SRI 9.5 t/ha
Tropical Savanna, Cuba


CON 5.6 t/ha
SRI 9.3 t/ha
High Altitude, semi-arid climate (1700m) Afghanistan


CON: 5.5 t/ha
SRI 9.1 t/ha
Arid Climate, Mali


CON: 1.8 t/ha
SRI 4.0 t/ha
Tropical Climate, Low Altitude
Cambodia – Rainfed SRI

Research on SRI and water management / AWD

- SRI research database* >1100 scientific publications with >900 journal articles
- 375 articles on SRI and water management / AWD
  - Reduction in water use (20-50%)
  - Increased yields in combination with AWD
  - Improved **water productivity** (kg rice /m^3 water used)

    SRI/AWD > Conv/AWD > flooded rice

    - **0.43** > **0.39** > **0.36** kg/m^3 (Geethalakshmi et al, 2013)
    - **0.68** > **0.57** > **0.44** kg/m^3 (Bhuvaneswari et al, 2014)
    - **0.77-1.02** > **0.44-0.54** > **0.25-0.39** kg/m^3 (Nay-Htoon et al, 2013)

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* Available through Zotero at sririce.org

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Comparison AWD/SRI with AWD/Conventional rice production

AWD with young, single seedlings/ hill, wide spacing, organic matter use	AWD with older, multiple seedlings/ hill, closer spacing, chemical fertilizer
• Higher tillering rate	• Limited tillering
• Root growth is deep	• Root growth is more shallow
• Minimal competition among plants	• Competition among plants
• Plants robust and healthy	• Plants less robust
• Plants more resilient to shocks and stress	• Plants are more drought and stress sensitive
• Higher water productivity	• Lower water productivity
• Yields increase	• Yields decline or same as under flooded conditions

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Geethalakshmi et al, 2013; Nay-Htoon et al, 2013; Lampayan et al, 2015;

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Summary findings AWD

AWD / SRI

- Used primarily to enhance plant productivity; secondarily to address water, GHG emission problems
- AWD is combined with three other crop management principles of SRI
- AWD is yield enhancing
- Good incentive for farmers to adopt AWD as it contributes to yield increase

AWD / Conventional Rice

- Used primarily to address water and GHG emission problems
- All other cropping practices same as conventional flooded rice
- AWD reduces yields slightly or yields are similar to flooded rice
- Limited incentives for farmers to adopt AWD unless faced with water use restriction

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Lampayan et al, 2015; Yamano et al, 2016; Thakur et al, 2014; Carrijo, 2017

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Recommendations for Scaling up SRI/AWD

- SRI is a climate-smart methodology with a triple win: productivity – adaptation - mitigation
- SRI is well tested, researched and known in Asia, Africa, less so far in LAC, with a broad institutional base
- Large demand from farmers
- Regional efforts would be most efficient
- Medium term commitment from governments and donors would be optimal (at least 5 years)
- Farmer-centered research and development approach can optimize practices at local level
  - Good technical follow up and monitoring at farmers' level
  - Adaptive research responding to constraints e.g. climate change

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Resources

- Global SRI Website, Cornell University
  - http://sririce.org
- Open access SRI Research Database (>1100 publications)
  - https://www.zotero.org/groups/344232/system_of_rice_intensification_sri_research_network
- CCAFS Practice Brief on SRI
  - System of Rice Intensification: Revisiting Agronomy for a Changing Climate
- SRI Global Facebook
  - https://www.facebook.com/SRIRice/
- Contact Erika Styger (eds8@cornell.edu) with questions


Thank you
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