

Increasing SRI-Organic Rice Yields through Double Rows Planting Pattern and Using Location and Season adapted Rice Cultivar*

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Introduction

Growth in aggregate crop production will come from **higher yields** and **increased cropping intensity**

→ productivity is a function of the yielding ability of rice varieties **G**, the environment **E** and management **M.....**

$$Y = G + E + \{(G * E) * M\}$$

Bruinsma (2009) .. 80% from higher yields, 20% from C.I.

Crop yield equation described as follows:

$$Y = G + E + \{(G * E) * M\}$$

where :Y = Yield

G = Genotype (variety)

E = Environment (climate, soil factor)

M = Management (Inputs applied, cultural practices i.e. land preparation, planting/timing, spacing, cultivation and weeding, fertilizer application practices, irrigation, harvesting/milling practices).

Source of > productivity

1. Variety: Hybrids—10-12 tons/ha

Inbreds-- 7-10 tons/ha

2. Crop Intensity :

Irrigated -2 3?

Rainfed - 1

3. Land area expansion : 2.7Mha

More areas to be irrigated---- 1.5 Mha

Can we irrigate +0.5Mha ?

Philippines

Rice is grown under 3 agro-ecological conditions : irrigated (45%),
rainfed low land (>50%) and rainfed upland (>5%) producing about
20 million tons of un milled rice



Rice is the staple food that supplies 40-65% of the caloric energy
requirements of more than 100 million Filipinos

With increasing population to be 140 million by 2025.

Rice production challenges

Produce more rice in
less land, water and nutrients ???

- ❑ The **International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) Report (2008)** stressed that the chemical/ **industrial or plantation approach, and monoculture farming** increased productivity but led to: social inequity, marginalization of small scale farmers, environmental degradation ,many debilitating health issues

- ❑ Global sales of the pesticide industries continue to rise, reaching to almost USA\$50 Billion at the manufacturer level in 2012 and continue to increase with impunity.
 - Resulted in widespread and worsening environmental pollution and extensive poisoning of wildlife, ecosystems and human populations and exacerbation of lifestyle diseases and incidence of cancers and ill-health conditions.

- ❑ The greatest threat now to our biological environment is the dangers posed by genetically modified organisms (GMOs).

Current rice yields

→ Yields under chemically grown rice had increased up to 7-9 t /ha or higher

PhilRice has an on-going nationwide contest on rice called 10-5, *producing rice at 10t/ha at a cost of PhP5/kg.*

Some contestants (Bayer, Pioneer, SL-Agritech) are getting 10t/ha (in 0.2 ha plot size).

Many farmers are getting more than 9 tons/ha

Conventional/chemically grown rice

Water intensive 4- 5,000li/kg rice.

Water has become critical limiting resource.....

Water for domestic household, industries or for rice fields
Cost to irrigate has increased: pumped water to irrigate is so expensive

- Huge budget is required @P0.5M to irrigate 1 ha
- Source of water for areas that are difficult to irrigate

High oil-based inputs → energy intensive

- ❖ Deteriorating soil health-low SOM, acidic, saline
- ❖ **Increasing cost of production**- higher input prices, particularly energy-based inputs
- ❖ **Increasing environmental & health concerns**
- ❖ **Climate change**— super typhoons, floods, El Nino drought

High carbon and water footprints of rice

Current rice yields under Organic systems

→ Rice yields grown under organic systems of production had plateaued @ 4-5 t/ha

→ **Some organic farmers had also reported 10/t/ha up to 12t/ha-1.**

→ Organically grown rice should have comparable yield output relative to chemically grown rice.

Prospects are there... Some organic farmers had also reported 10/t/ha up to 12t/ha

→ the needed yield increase in rice to feed the growing population in the Philippines should be done using sustainable/ ecologically sound methods...

There is a need to find alternative system of rice production...

→ high yield

..that addresses the pitfalls of chemical/ conventional rice production

→ Low in water and carbon footprint

One alternative....SRI

- **A system of rice intensification (SRI) (Madagascar) improved the production of irrigated rice for poor, resource-limited households. (Uphoff,2012; Stoop and Kassam 2005; Stoop 2011).**
- **SRI methods have been tried in almost 50 countries & higher yield were achieved compared with the usual rice-growing practices**
- **The yield increases are achieved with reduced inputs of seeds and water, and resulting in rice plants that are less vulnerable to pests and disease losses and to climatic stresses (Uphoff 2011).**

In 2011, a new world record of **22.4 tons** per hectare using SRI obtained by a farmer Sumant Kumar in India

beating the world record held by the Chinese scientist Yuan Longping by 3 tons (Chang,2013;Vidal,2013).

These super high Yield Claims open SRI to many criticisms...

Sinclair asserted that SRI reports were based on “unconfirmed field observations (UFOs)”

(Dobermann (2004), Sheehy et al (2004))

They questioned the reported yields, pointing out the needs for clear and detailed information about experimental procedures, environmental conditions, methods of yield measurements, biomass determination, and N uptake before accepting the yield data reported from SRI-based experiments.

McDonald et al (2008) also asserted more rigorous and systematic research is needed to identify the potential advantages of SRI practices

T.R. Sinclair, Agronomic UFOs waste valuable scientific resources, in: Rice Today, July–September, International Rice Research Institute, Los Baños, Philippines, 2004, p. 43. T.R. Sinclair, K.G. Cassman, Agronomic UFOs? Field Crops Research 88 (2004) 9–10.

→Glover's characterization of SRI ..a phenomenon rather than as a technology.

why there was so much resistance to SRI from some quarters of the scientific community.

>>>Glover ascribed disagreements over the efficacy of SRI in particular to a focus on and preoccupation with just the technical factors in agricultural innovation. He called attention to a failure to construct holistic understandings of technological systems and their dynamics, asking for more consideration of social and behavioral factors.

D. Glover, The System of Rice Intensification: Time for an empirical turn, NJAS – Wageningen Journal of Life Sciences 57 (2011) 217–224.

SRI is a set of agronomic principles and practices .Stoop (2011) listed the following practices of SRI to achieve the best results:

- 1. Use of very young, 8- to 12-day-old seedlings with just two leaves and transplanted, quickly, shallow and carefully, to avoid trauma to the roots and to minimize transplanting shock;**
- 2. Widely spaced hills, ranging from 20 × 20 up to 50 × 50cm; to permit more growth of roots and canopy and to keep all leaves photosynthetically active;**
- 3. Alternate wet and dry soil moisture regime (no permanent flooding) to maintain aerobic soil conditions .This improves root growth and supports the growth and diversity of aerobic soil organisms;**
- 4. Use of organic, rather than mineral, fertilizers**
- 5. Frequent weeding, preferably performed using a surface rotary hoe, during early crop development stages so as to control weeds , aerate the soil and promote deeper root growth.**

SRI is a system and not as a package of technology (POT) characterizing Green Revolution technology.

When someone adopts SRI – organic, 2 basic questions are asked and they are as follows:

a) Is the square planting pattern best for SRI-organic?

b) What cultivar type or genotype (inbred, or hybrid) yields well or highest under SRI-organic?

Need to identify Adapted variety for SRI- Organic

Current varieties are not bred for organic .

& also for SRI –they are low tillering

→*SRI CULTIVATION is inducing them to produce lots of tillers (planted in wide spacing)lead to differential age of tillers*

→*late tillers become “useless metabolic sinks” as they are simply aborted (> 50%)*

Need to identify the optimum planting pattern to get high yield

Two studies were conducted:

1) 20 different varieties were tested

(a multi location trial, ours in Laguna, Philippines)

2) 3 different planting patterns

→ (20 x 20) cm

→ (10 x 40) cm

→ [(20 x 10) x 40] – the double row

Setting –up the trials, Maitim , Bay , Laguna, Philippine



Fig.1. Crop establishment from land, seedlings preparation, marking prepared land to facilitate planting at 1 seedling/hill.

For nutrient management.....

the following practices were adopted from Nature Farming but modified to use locally available resources* ...

a)Compost mixture of cattle manure & carbonized ricehull (1:1 ratio) sprayed with IMO at 1 li per ton, and applied at 5 tons per ha before the final harrowing.

**Hill and Macrae (1995)*

b) Indigenous microorganisms (IMO) was applied during the first harrowing at 2 gal/ha to facilitate crop/ weeds residues decomposition.

c) Liquid cattle manure fertilizer (2 kg cattle dung + 2 kg molasses in 200li water plastic drum). Mixture was stirred clock and counter clockwise for 10 minutes, done every day for 7 days. The liquid slurry was spread evenly in the test plots. This was repeatedly done at 2 weeks, 4 weeks, 6 weeks after transplanting.

d) At grain filling period, another preparation was applied. The middle soft tissues of the banana stem ,cut into small pieces and mixed with molasses at 1:1 ratio by weight. This mixture was allowed to ferment for 3 weeks and diluted at 1:10 fresh water ,then sprinkled the diluted solution to the test plots.

Figure 1 shows the crop establishment starting from land and seedling preparation, marking the field to facilitate planting at one seedling per hill.



Fig.2. The double row planting pattern (20x10cm—40cm) at various growth stages.

Results.... discussions

Grain yield (t/ha) yield Of the 20 cultivars (Bay,Laguna, Dry season , 2014)

	Grain Yield	Harvest
Variety	ton/ha	Index (HI)
PSB RC14	5.45 abcd	0.54
Burdagol	5.79 abc	0.57
PSB RC18	5.98 abc	0.58
PSB RC82	4.70 bc	0.55
NSIC Rc 222	6.81ab	0.62
Ennano 11	5.91abc	0.51
Hangangchal	6.27 abc	0.59
NSIC Rc 218	5.38 abcd	0.6
SL8	5.88 abc	0.64
Saegyenjinnii	4.94 bcd	0.49
NSIC Rc 240	6.99 ab	0.56
hanareumbeyo	5.40 abc	0.68
Dasanbeyeo	4.64 cd	0.62
hanamrebyeo2	5.95 abc	0.59
Milyang 23	7.44 ab	0.61
NSIC Rc 238	6.44ab	0.56
Masipag 10-1	6.38ab	0.61
NSIC Rc 200X	5.00 abc	0.51

Table 2. Summary of Grain yield data of PSB RC grown in 3 planting configurations, SRI-ORGANIC.

Planting configuration(PC)	Hill per ha	Grain yield t/ha	Weight of grains/10 panicles	No.of panicles per ha x1,000,000	Harvest Index (HI)	No.of filled Grains/panicle	No.of unfilled Grains/panicle	%Filled Grains/panicle	Weight of 1000 grains(gm)
PC 1- 20cm X20cm	250,000	6.67b	223.7a	2.95c	0.57	109	11.7	89.40	21.4
PC 2- Single row	250,000	6.54b	283.7a	3.13b	0.59	122	12.3	89.00	21.1
PC 3- Double row	333,333	8.49a	223.0 a	3.49a	0.57	108	7.7	93.60	22.3

PC 2..Single row at 40cm between rows ant 10 cm between hills

PC 3.. Double row at 40cm between double rows and 20cm x 10 cm between hills of the double rows

Note. We took crop cut samples (2mx2m quadrat) in adjacent fields farmed the convetional way separated only by few meters and we obtained the following yield data:

Sample1=5.33t/ha,2= 3.78t/ha, 3= 4.35 t/ha or an average of 4.49 t/ha.

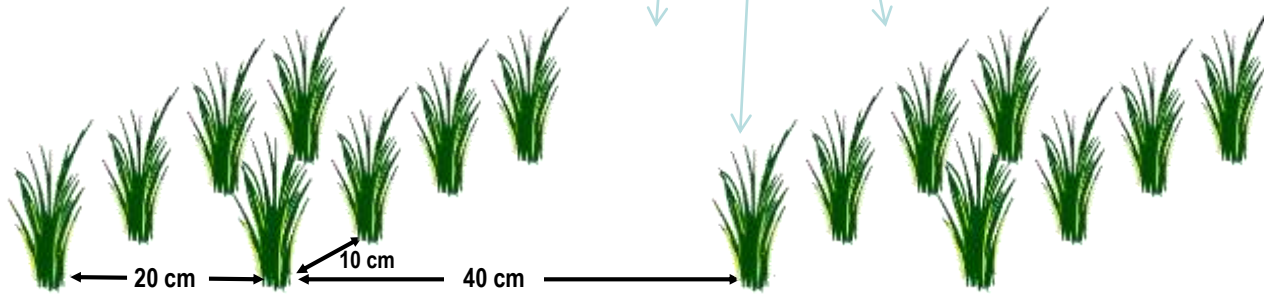
conventional farming , transplanted seedling in clump of not less than 5 at 23cm x 23cm spacing , irrigated the flooding way , fertilized at 6 bags (2 complete, 4 urea) fertilizer , sprayed with pre- and post-emergent herbicides, one spraying for molluscides, and one spraying at grain filling stage,

Why the yield in the double row planting pattern was the highest?

→ More tillers produce panicles with filled grain per panicle and weight of grains were comparable to the single rows

The initially high plant population 333,000 (33% higher than the single row) was sustained → 3.5 million tillers





Double Row Planting Pattern :

20 cm X 10 cm - 40 cm = 333,333 hills/ha

20 cm X 15 cm = 333,333 hills/ha

20 cm X 20 cm = 250,000 hills/ha

ADVANTAGES OF DOUBLE ROW PLANTING PATTERN

Longer duration of canopy closure between the double rows (40 cm)

- ⇒ allows light to penetrate longer (light needed by blue green algae for N – fixation)
- ⇒ not so dark, not so high relative humidity, less favorable for hopper population build-up
- ⇒ more space, easier to perform rotary weeding
- ⇒ ample space for ducks to graze

Why yields in the in the organic method of rice cultivation surpassed the commonly reported yield of 4-5 t/ha?

Song Chen et al.(2008)

→sink size and more grains per panicle and more panicles per square meter are the main determinants of high yield in rice

Higher number tiller (3.45million) became productive or panicle bearing in double rows under organic and SRI managed relative to conventional.

Stepwise regression analysis showed that the number of productive –panicle bearing grains & high % filled grains

→the main determinant of high yield for organic rice.

→Stoop (2011) suggested the need to study the optimum plant spacing

→to have more plants producing tillers(Zhu et al.2002)

→to maximize the interception of solar radiation at the time of panicle initiation and flowering (Tao et al.2002), instead of aiming for early canopy closure within rows that would minimize weeding expenditures.

→The interdependence of plant spacing on weeding, irrigation , age of seedlings , and cultivar types inorganic farming must also be studied as Murphy et al.(2007)

Impacts (benefits) of the study

- **Reduce the water consumption of rice from the repeated 5,000 li/kg to as low as 2,250 li/kg rice (55% reduction) – the possibility of expanding the area to be irrigated using the same irrigation facilities**
- **Growing rice through the organic method excluded agro-chemicals (fertilizer and pesticides)**

40-50% of the energy bill

- Recall: water-energy- food nexus

Phil.Fertilizer sale in 2006= 1.7 million tons

The nitrogen content = 385,505 tons

@1kg N= 1.8 li diesel oil to manufacture

→693 million li diesel oil eq. to manufacture

@12Kg CO₂e per Kg N

→4.62 tons CO₂ emission

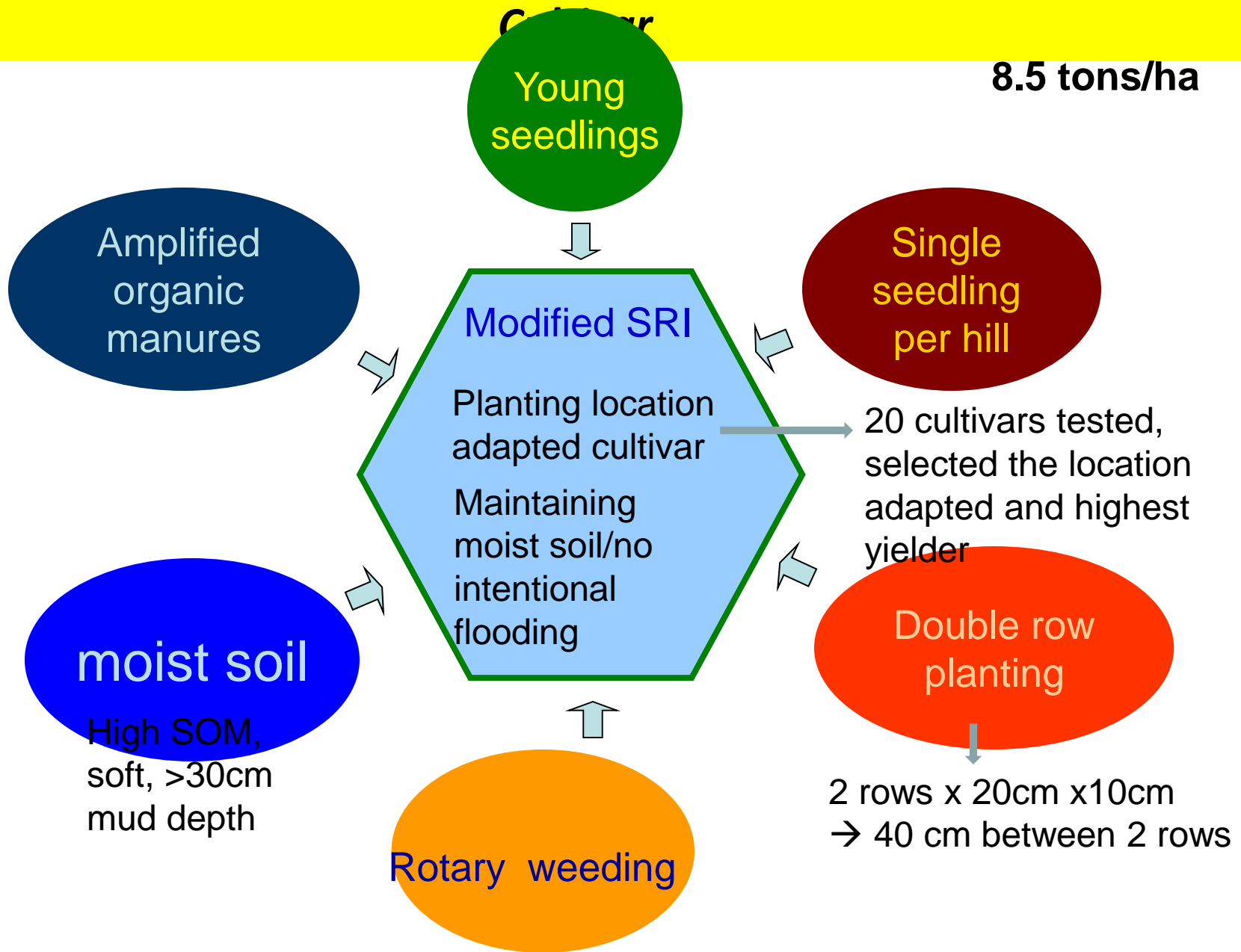
Provide additional employment in rural areas

→ 38 additional mandays (seedling preparation, transplanting, rotary weeding and manual weeding)

→ Prospect of increasing rice output using less water, less energy, (less CO₂e from chemicals) at the same time decarbonizing rice production

Summary...Increasing SRI-Organic Rice Yields through Double Rows

Planting Pattern and Using Location and Season adapted Rice





Conclusion

SRI-Organic Rice grown through Double Rows Planting Pattern and Using Location and Season adapted Rice Cultivar

- Increase rice yield
- Minimizes/eliminates the toxicity/health risks in the use of pesticides(farmers & the community, consumers)
- Reduces the water, energy bill and the carbon emission associated with the oil-based input, in turn , reducing the carbon emission in rice production

Modified SRI-Organic rice is
water ,
energy ,
climate change adaptive farming

Health & wellness



Thank you for listening
ted mendoza ... Philippines

United Nations
Climate Change Conference

Bonn, Germany

