ENHANCING SOIL HEALTH FOR RICE GROWTH

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Is our soil healthy?

Soil health?

- Continued capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain biological productivity, to promote the quality of soil, water and air environment, and to maintain plant, animal and human health

Why rice is soo important in ASIA?

It is the staple food for more than half of the world's population

- *A billion people depend for their livelihoods on rice cultivation*
- *Most rice is cultivated according to these standard methods:*
  - *flooded conditions,*
  - *transplanting of older rice seedling*
  - *narrow distance between plants*
  - *using mostly inorganic NPK fertilizers.*

FLOODED CONDITIONS: HEALTHY SOIL CONDITIONS?

SRI practices enhance soil health for rice to grow better! Why?

- Moist soil conditions, but soil is not continuously flooded, so mostly aerobic soil conditions prevail
- Weeding by using rotary weeder, aerates the soil as it controls weeds
- Application of good quality of organic fertilizers is recommended, to 'feed the soil' so that the soil can then feed the plant
- All these practicers enhance soil health for rice to grow
- Why?

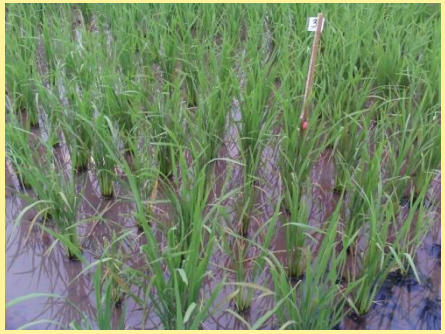
FLOODED CONDITIONS: ARE THEY REALLY HEALTHY FOR RICE TO GROW?

- LESS O_2 IN THE SOIL, WHICH MAKES IT DIFFICULT FOR ROOTS TO GET THE NEEDED O_2
- - REDOX POTENTIAL IS LOW - 200 mVolt
- - TOXIC ELEMENTS BUILD UP such as Fe^{2+}
- - UNFAVOURABLE CONDITIONS FOR POPULATIONS OF MOST BENEFICIALA (MICRO) BIOTA TO LIVE
- IS THIS FAVOURABLE FOR RICE PLANT TO GROW?

RICE CULTIVATION

CONVENTIONAL

- FLOODED SOIL CONDITION
- MORE SEED: 40 KG/HA, SYNTHETIC FERT @ 500-600 KG/HA, PESTICIDE
- 6-8 SEEDLINGS/HILL
- SEEDLINGS 30 DAYS OLD
- NARROW PLANTING DISTANCE: 20 X 20 CM



S.R.I.

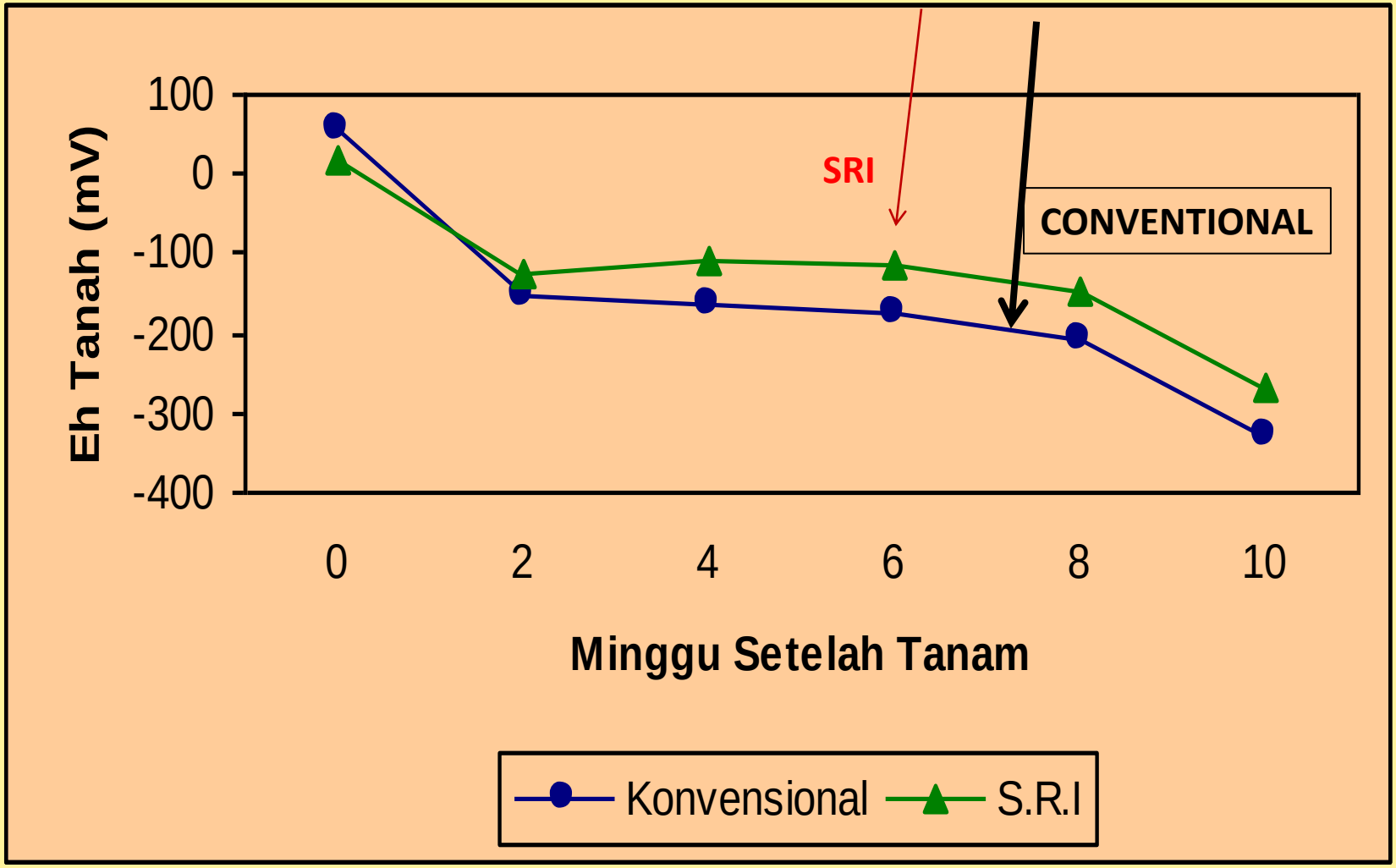
MOIST SOIL, NOT ALWAYS FLOODED

LESS SEEDS, EFFICIENT FERTILIZER

YOUNG SEEDLINGS 8-10 DAYS OLD, WITH ATTENTION TO ROOTS

WIDER PLANTING DISTANCE: 25 X 25 CM OR 30 X 30 CM

SOIL Eh



FORMATION OF CH_4 -150 mVolt Methanogens active

Eh: flooded vs SRI

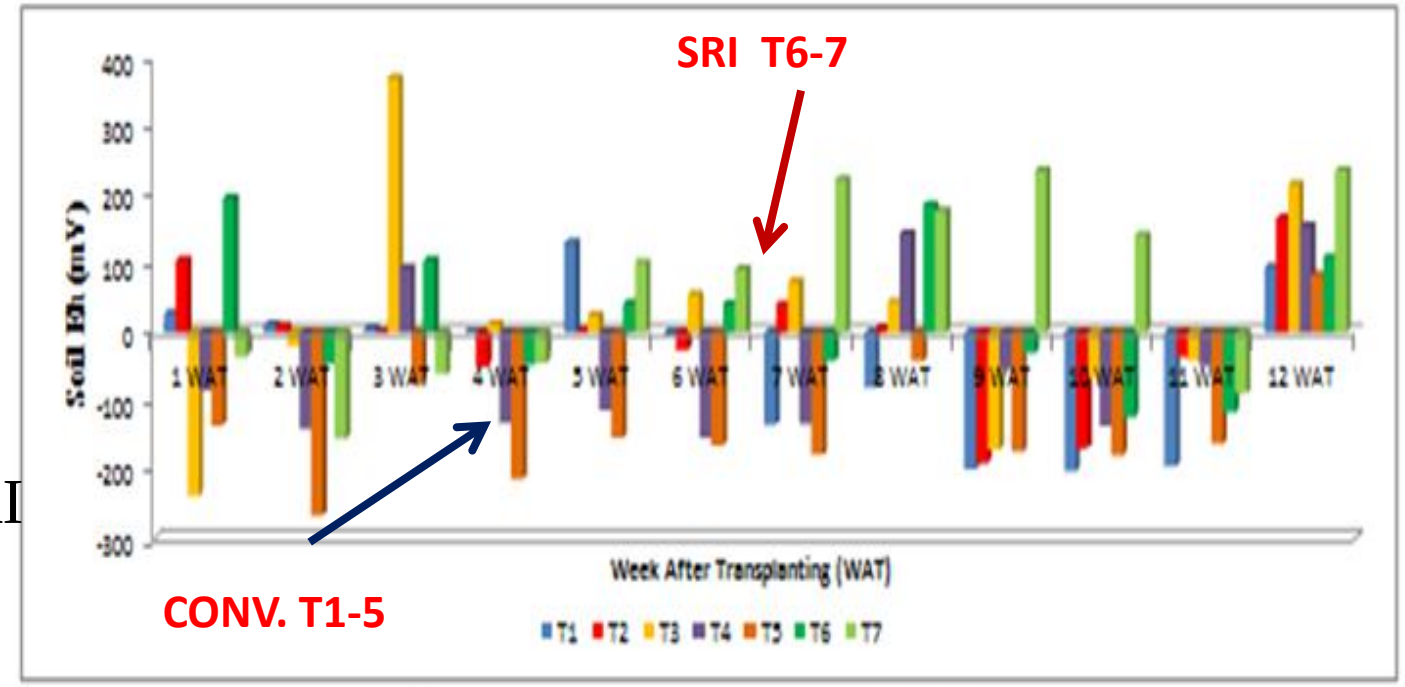


Figure 4. Effects of AgriPower (Slag and Minekal) to soil Eh (Including SRI trial)

‘WEEDING Soil Aeration is inducing a better growth condition

GET RID OF WEEDS

SOIL AERATION

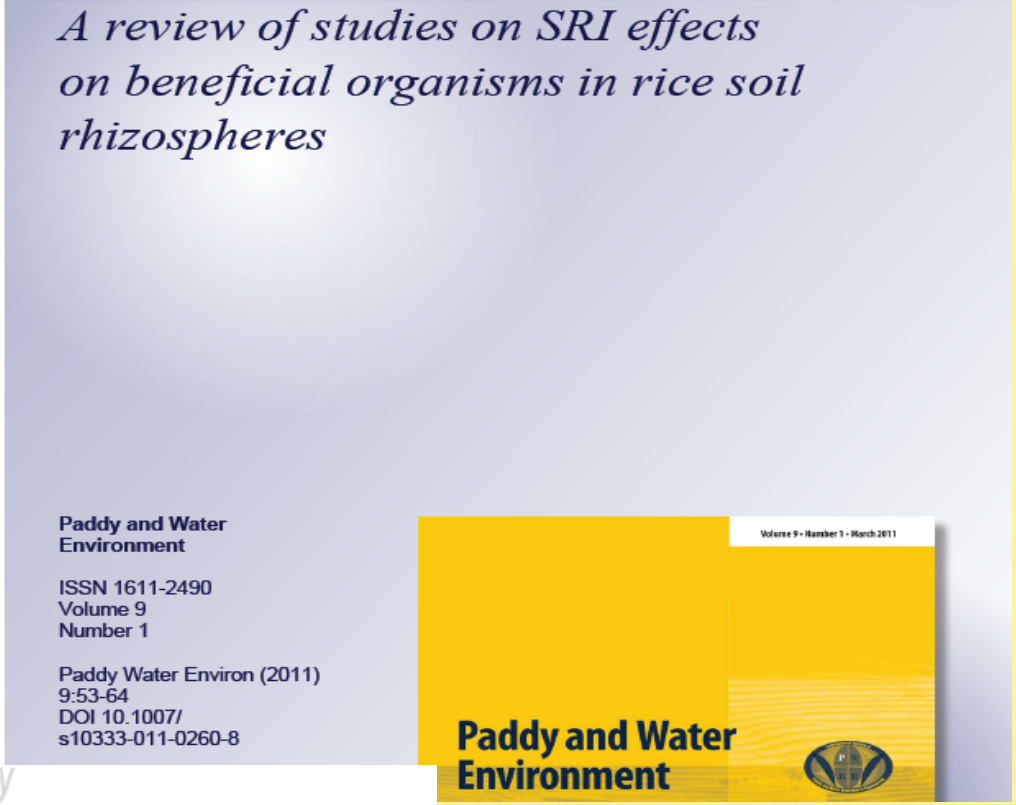
STIMULATE ROOT GROWTH

SRI

- 29 PROVINCES (2012)
- 196 DISTRICTS
- >80,000 HA
- MUCH LARGER AREA : NGO FARMERS

- 4.9 TONS/HA ---- 7.25 TONS/HA

Stimulate microbial activity and populations



Paddy Water Environ (2011) 9:53–64
DOI 10.1007/s10333-011-0260-8

REVIEW

A review of studies on SRI effects on beneficial organisms in rice soil rhizospheres

Iswandi Anas · O. P. Rupela · T. M. Thiyagarajan · Norman Uphoff

Table 7 Summary comparison of increases in number and activity of beneficial soil organisms in the rhizospheres of SRI rice plants compared to conventionally grown plants, from Indian and Indonesian evaluations

Increases in	TNAU study: Gyathry (2002)	ICRISAT study:[a] Rupela et al. (2006)	IPB study: Iswandi et al. (2010)
Total bacteria	312%	ND	65%
Total diazotrophs[b]	61%	6.4%**	NM
Azospirillum[b]	32%	NM	211%
Azotobacter[b]	36%	NM	94%
P-solubilizing microbes	53%	3.6%ns	78%
Dehydrogenase (μg TPF g^{-1} 24 h^{-1})	140%	22.5%**	125%
Microbial biomass N (mg kg^{-1} soil)	NM	20%**	NM

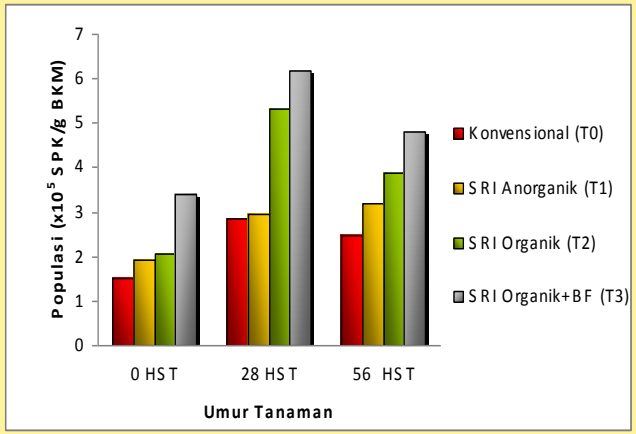
ND no difference, *NM* not measured

[a] These trials included wet-season results when water control was incomplete and therefore aerobic soil conditions were difficult to maintain

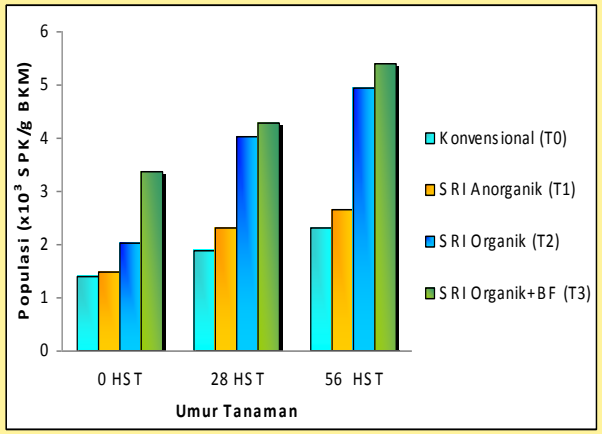
[b] N_2-fixing bacteria

** Significant at 0.05 level of confidence

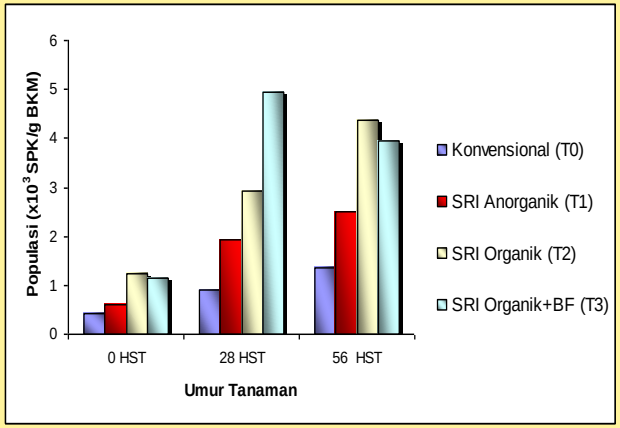
2008



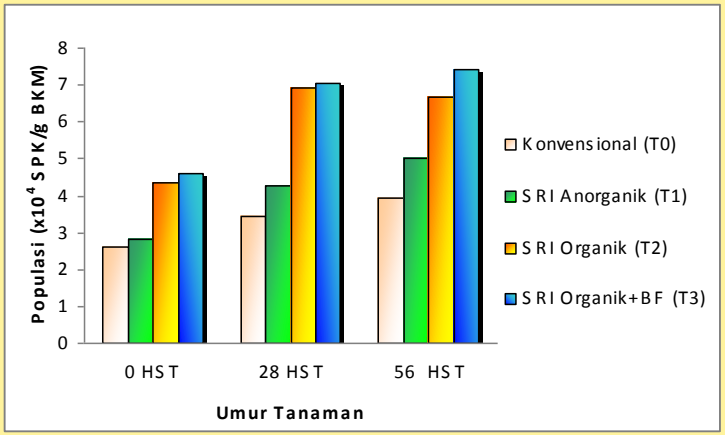
TOTAL



AZOTOBACTER



AZOSPIRILLUM



PSM

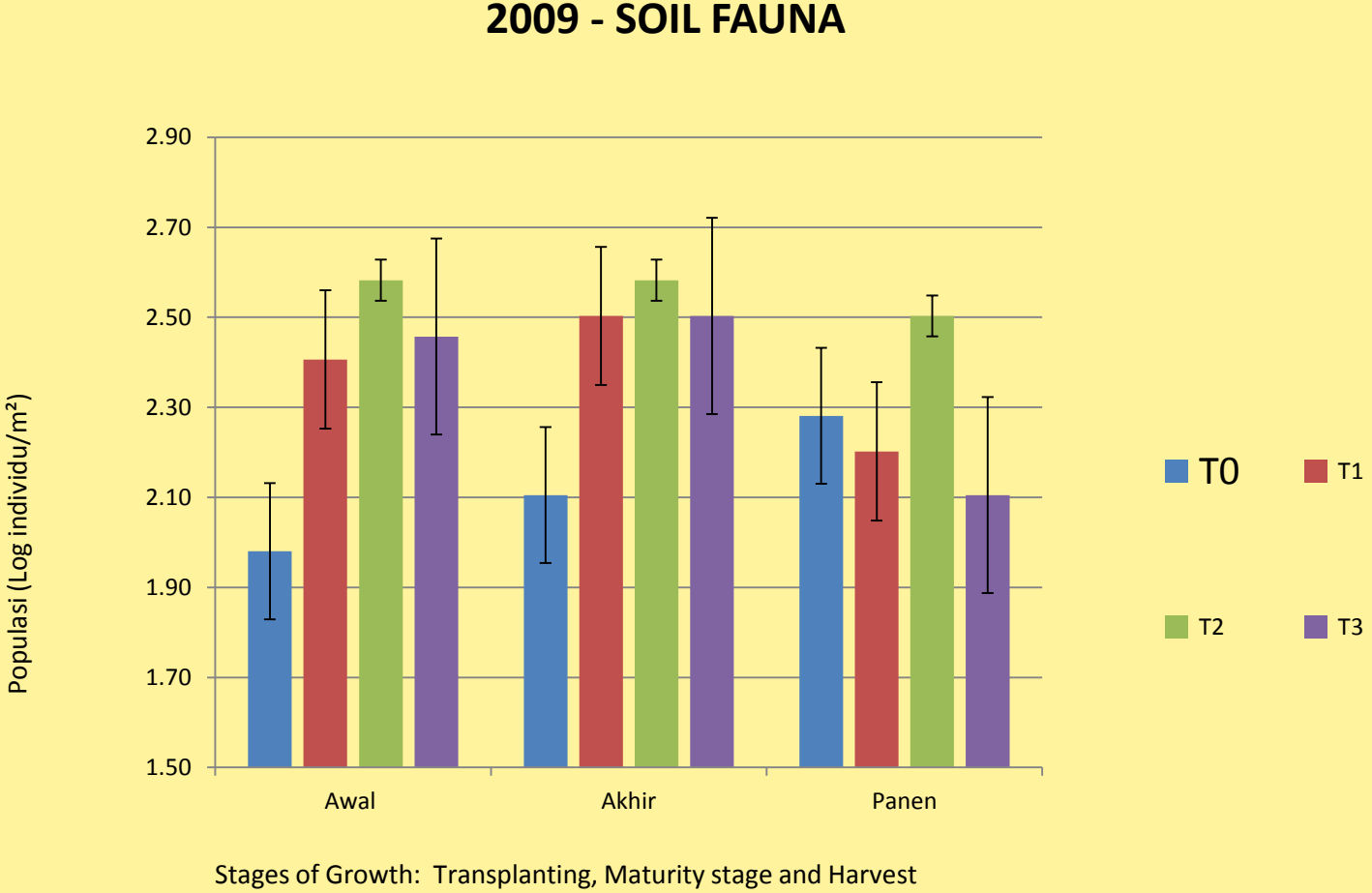
Total microbes, numbers of beneficial soil microbes under Conventional and S.R.I Rice Cultivation Methods at Nagrak, Sukabumi (Iswandi *et al* 2008)

2009 - SOIL MICROBES

Treatments	Total Microbes* ($x10^5$)	*Azotobacter** ($x10^3$)	*Azospirillum** ($x10^3$)	PSM* ($x10^4$)
Conventional (T0)	2.3a	1.9a	0.9a	3.3a
In-Organic S.R.I (T1)	2.7a	2.2a	1.7ab	4.0a
Organic-S.R.I (T2)	3.8b	3.7b	2.8bc	5.9b
In-organic S.R.I + BF (T3)	4.8c	4..4b	3.3c	6.4b

*CFU/g soil PSM = Phosphate Solubilizing Microbes

Total microbes and number of beneficial soil microbes under conventional and SRI rice cultivation methods at Tanjung Sari, Bogor (Iswandi *et al* 2009)



Population of soil fauna (numbers/m^2) under conventional (T0) and SRI rice cultivation (T1, T2 and T3) (Iswandi *et al.* 2009)

AERENCHYMA? ARE THESE NEEDED?

Conventional Management
(note hole in the middle)

Inorganic S.R.I.
(more solid tissue)

Organic S.R.I.
(most solid tissue)

Photos by Iswandi Anas and Fakhrur Razie, 2009

Photo by Iswandi and Fakhrur Razie 2009

CONVENTIONAL

INORGANIC S.R.I.

ORGANIC S.R.I.

Root length (cm) (Iswandi *et al.* 2009

Location	Method	Weeks after transplanting (WAT)		
		4	6	8
Sukabumi	Conventional	21.20	26.10	23.50 b
	Inorganic S.R.I	42.50	41.00	53.33 a
	Organic S.R.I	24.40	29.67	37.43 a
Depok	Conventional	16.57	21.27	20.20 b
	Inorganic S.R.I	33.63	42.00	47.40 a
	Organic S.R.I	20.20	21.10	24.33 a
Bogor	Conventional	25.67	27.07	31.67
	Inorganic S.R.I	36.00	46.53	54.83
	Organic S.R.I	25.50	33.73	33.13
Tanjung Sari	Conventional	22.30 a	73.07 a	24.83
	Inorganic S.R.I	75.00 b	48.50 b	49.93
	Organic S.R.I	70.43 b	30.83 b	30.13

ROOT DRY WEIGHT (g)

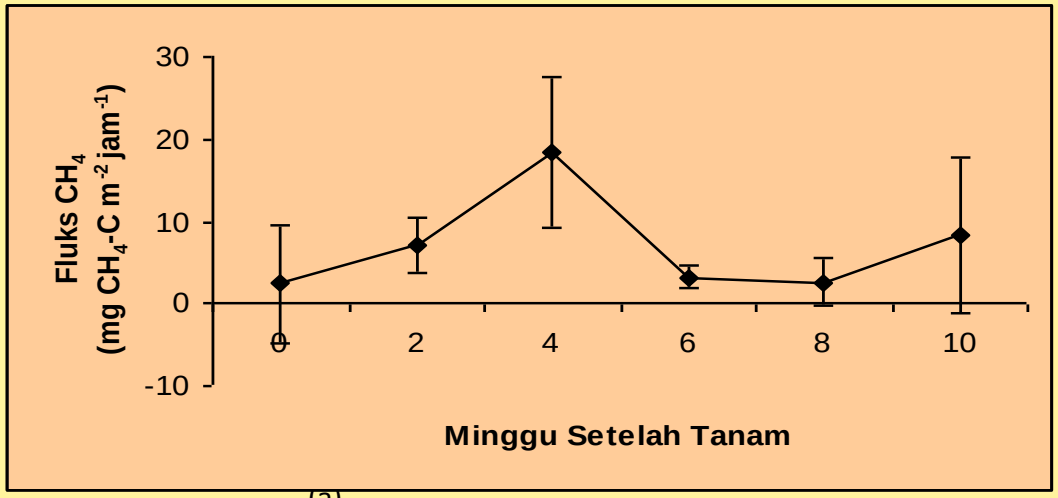
Location	Methods	Weeks after transplanting (WAT)		
		4	6	8
Sukabumi	Conventional	8.89	18.28	18.31b
	Inorganic S.R.I	**15.77**	**26.59**	**52.07a**
	Organic S.R.I	**6.70**	**20.83**	**32.96 ab**
Depok	Conventional	1.11 a	3.73 b	4.92
	Inorganic S.R.I	2.41 c	11.86 a	22.98
	Organic S.R.I	1.70 b	6.72 b	6.79
Bogor	Conventional	16.49	19.61	20.12
	Inorganic S.R.I	5.69	20.71	26.58
	Organic S.R.I	2.94	17.10	31.63
Tanjung Sari	Conventional	2.34	4.78 b	7.85 c
	Inorganic S.R.I	11.92	7.54 ab	51.25 a
	Organic S.R.I	5.99	14.22 a	27.07 b

Other advantages of unflooded conditions

- Reduce methane emissions from rice field
- Reduce toxicity such as Fe toxicity

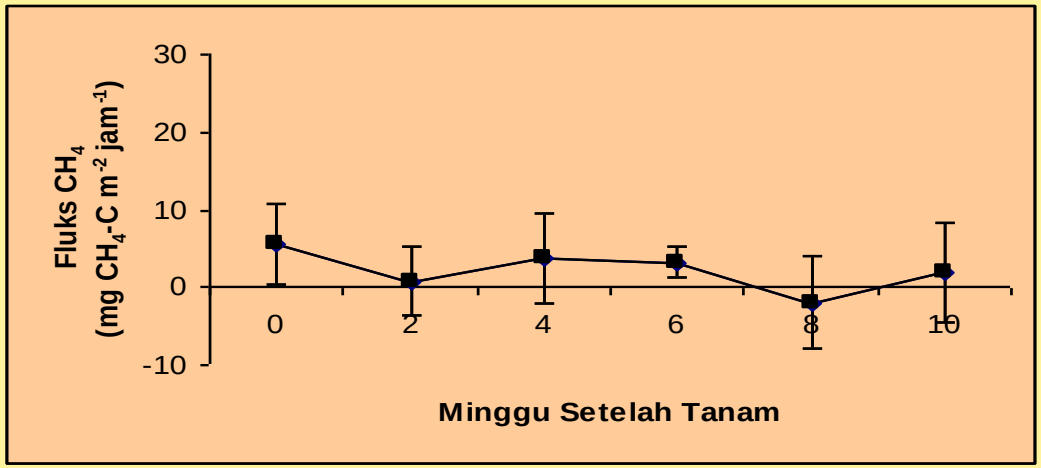
- It remains to be evaluated conclusively whether there is offsetting increase of N_2O in response to SRI management; so far, studies have shown little or no increase

Methane Fluxes (Hutabarat, 2010)



(a)

CONVENTIONAL



SRI

Table 14. Effects of Slag (AgriPower and Minekal) on C-CH_4 emission

Treatment	T1	T2	T3	T4	T5	T6	T7
Average	4.363	7.848	4.945	7.299	3.383	0.462	1.253

*T1=100% NPK; T2=100% NPK+500 kg ha^{-1} AgriPower; T3=100% NPK+1000 kg ha^{-1} Minekal; T4=100% NPK+Mid-Session Drainage; T5=50% NPK+500 kg ha^{-1} AgriPower; T6= 100% NPK as farmer' level + 1,000 kg Minekal (Particle Size : -<3.3mm) + SRI; T7:100% NPK as farmer' level + SRI.

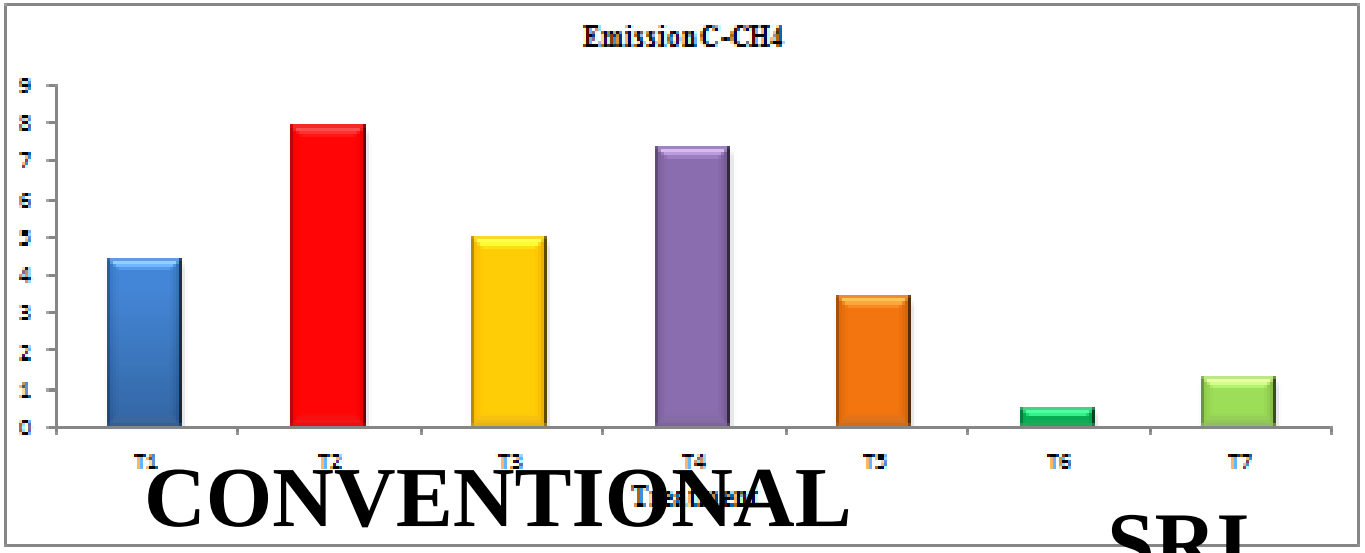
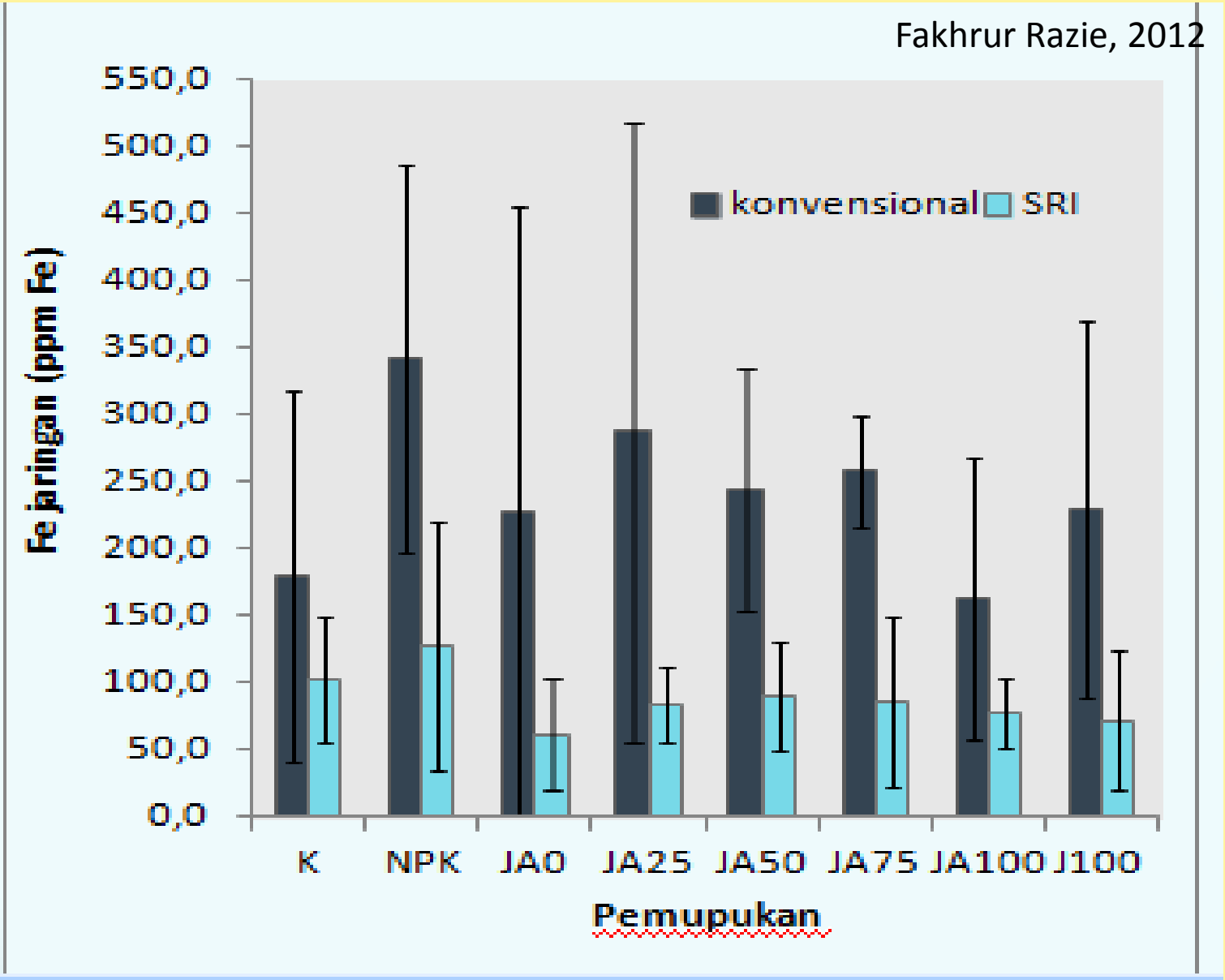


Figure 12. Effects of AgriPower (Slag and Minekal) to C-CH_4 emission

Fe-toxicity In ACID SULFATE SOILS

Fakhrur Razie, 2012



CONVENTIONAL SRI

S.R.I NEEDS MORE STUDY:

AGRONOMY
SOIL AND SOIL BIOLOGY
MANAGEMENT
ENVIRONMENTAL IMPACTS
PEST AND DISEASES
WEED SCIENCE: WEEDERs, ETC.
POST-HARVEST
NUTRITIONAL VALUES
SOCIAL-ECONOMY ASPECTS
FARMER INCOMES
CULTURE
GENDER

PROF DR ISWANDI ANAS KULIAH UMUM DIES NATALIES UNB 30 JULI 2014

SRI-Mas

Indonesian System of Rice Intensification

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