SII-5

RICE PRODUCTION AND GLOBAL CLIMATE CHANGE: PREVIOUS AND ONGOING RESEARCH OF THE INTERNATIONAL RICE RESEARCH INSTITUTE

Reiner Wassmann and Achim Dobermann
International Rice Research Institute, DAPO Box 7777, Metro Manila, Philippines

ABSTRACT

The presentation will give an overview of the interaction of rice production and global climate change by encompassing the work conducted by the International Rice Research Institute (IRRI) and its partners from national research agencies since 1991. Rice is a source of the greenhouse gas methane. IRRI's research on this aspect has initially focused on the in-situ quantification and upsacling. Since all rice growing nations have signed the UN Framework Convention on Climate Change, the possible options for mitigating methane emissions from rice have gained more attention over recent years. Rice production will also be affected by climate change. Adverse effects of climate change could seriously threaten rice production levels -- unless preventive measures are taken to adjust rice production systems. Recognizing the significance and urgency of the problem, IRRI has established the ‘Rice and Climate Change Consortium’ in 2007 as a platform to deepen research jointly with national research institutions on short-term and long-term adaptation of rice production systems. The specific issues presently under investigation are (i) improved tolerance to higher temperatures, (ii) intensification of rice production with higher resilience to more extreme events like droughts and submergence and (iii) sea level rise in Asian mega-deltas.

KEYWORDS

Rice, Global Climate Change, adaptation, mitigation

Rice Production and Global Climate Change: Previous and ongoing Research of the International Rice Research Institute

Reiner Wassmann[1] and Achim Dobermann[2)]

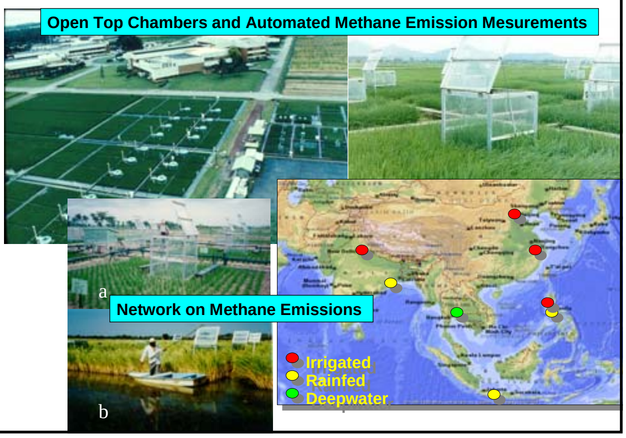
[1)] Coordinator of the Rice and Climate Change Consortium

[2)] Deputy Director General - Research

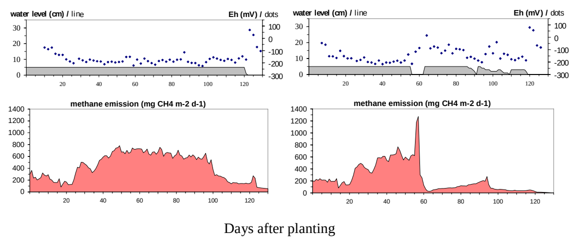
IRRI's Previous Projects on Climate

- In 1961-62, IRRI studied the effect of temperature on japonica and indica rice in the growth chamber.
- In 1971-72, IRRI studied the effect of CO_2 enrichment on rice plants in open-top chambers.
- Several projects on Methane Emissions from 1991-1999
- Open top chamber experiments on Temp./ CO2 effects and crop modeling (1991-1995)

Research on 'Rice and Climate Change' in the 1990's



Mid-season drainage



Field experiment at Hangzhou, China (Lu et al. 2000)

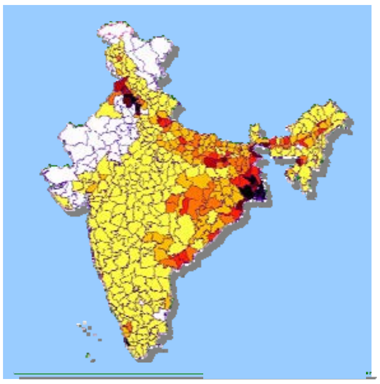
Regional estimate of CH_4 emission from Indian rice fields

Simulated emissions:

* MERES model

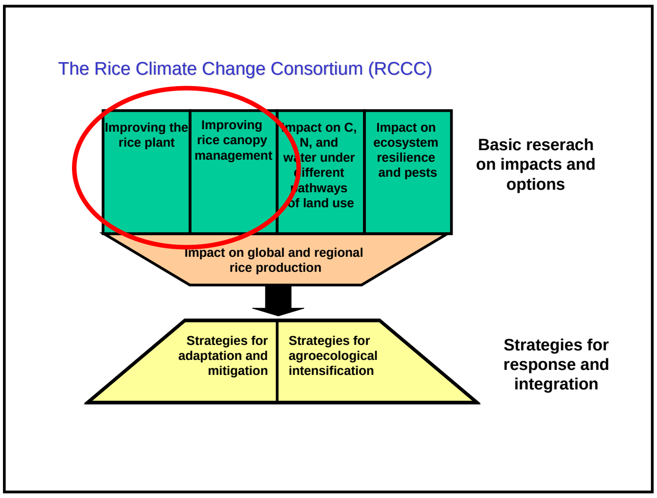
* GIS data
  - rice ecosystems
  - soils
  - weather

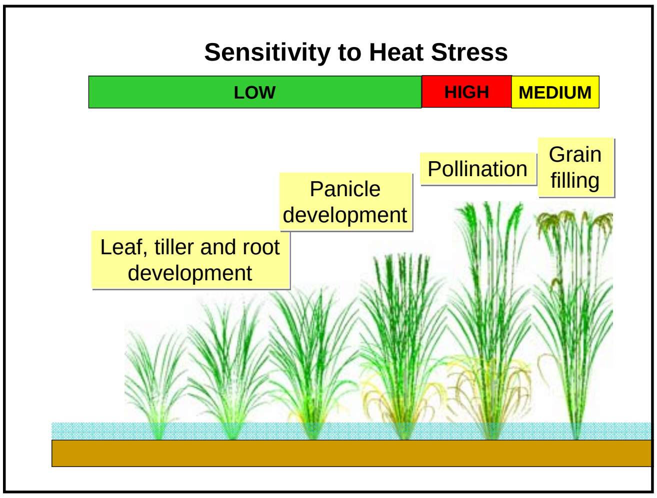
from Matthews et al. 2000

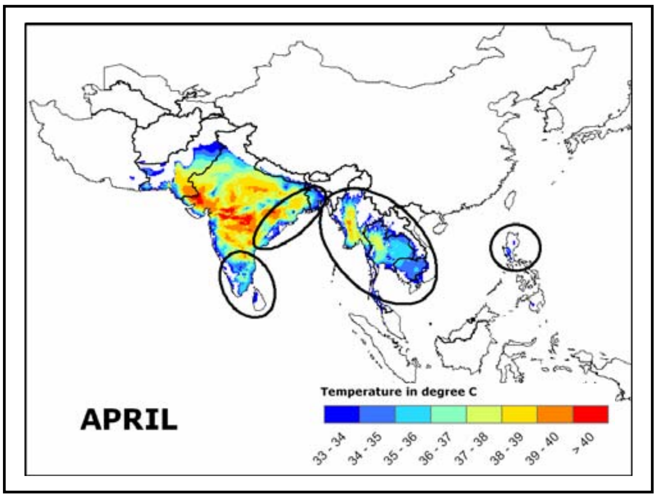


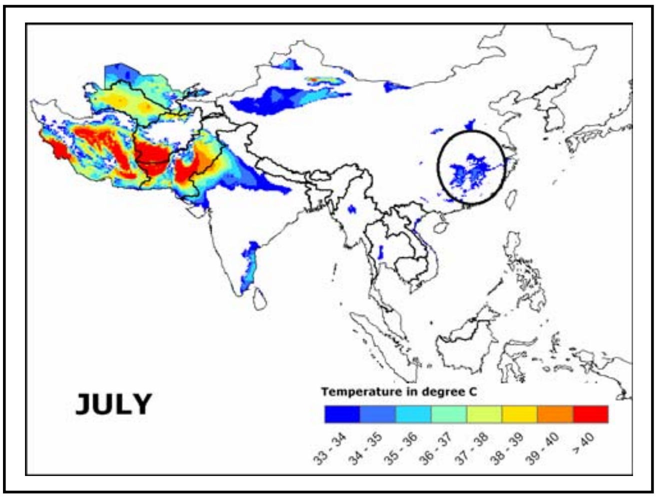
Rice and Climate Change Consortium (since 2007)

- Work in an interdisciplinary consortium in collaboration with leading institutions and already existing global and regional networks
- Establish "integrated sites" for conducting long-term, interdisciplinary research on climate impact on rice and impact of rice on climate change under field conditions.
- Use regional case studies and transects along climatic gradients for addressing specific research questions

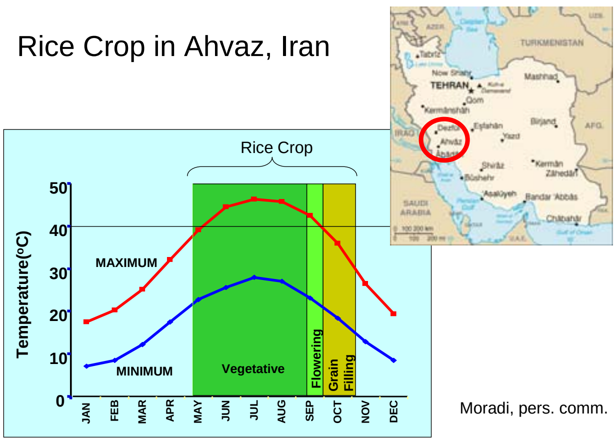








Rice Crop in Ahvaz, Iran

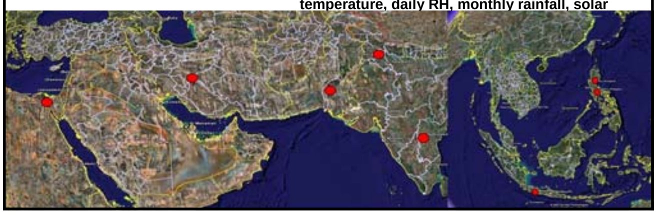


Moradi, pers. comm.

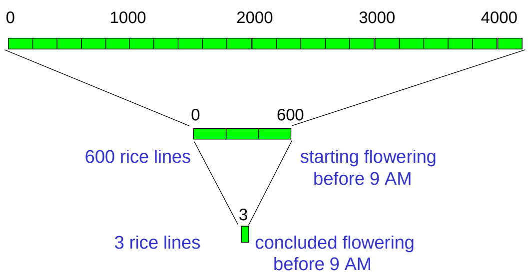
	IRTP No.	Desigination	Flowering
1	07719	BALILLA	60
2	16737	Carreon	77
3	07332	CR547-1-2-3	84
4	17232	Dular	76
5	00042	GIZA 172	68
6	18216	Giza 176	65
7	20912	Giza 178	86
8	10559	GZ948-2-2-1	65
9	10561	GZ951-7-1-2	64
10	22564	IDSA 77	84
11	00563	IR1552	90
12	00533	IR1561-228-3-3	82
13	09546	IR19746-28-2-2	75
14	00197	IR22	90
15	04477	IR2307-247-2-2-3	85
16	00266	IR36	81
17	07847	IR50	81
18	00195	IR8	101
19	03911	N 22	70
20	07736	VIALONE NANO	69
21	19771	WAB 56-125	78
22	19465	WAB 96-1-1	84

Heat Tolerance Network

- **22 varieties from Asia, Africa, Europe, Near East**
- **6 test sites**
  - Hyderabad, India
  - Kojestan, Iran
  - Dokri, Pakistan
  - Sakha, Egypt
  - Nueva Ecija, Philippines
  - IRRI
- **Rice data: phenotypic acceptability, spikelet fertility, seedling vigor, plant height, days to heading, time of day flowering, days to maturity, yield**
- **Site data: Daily maximum/minimum temperature, daily RH, monthly rainfall, solar**

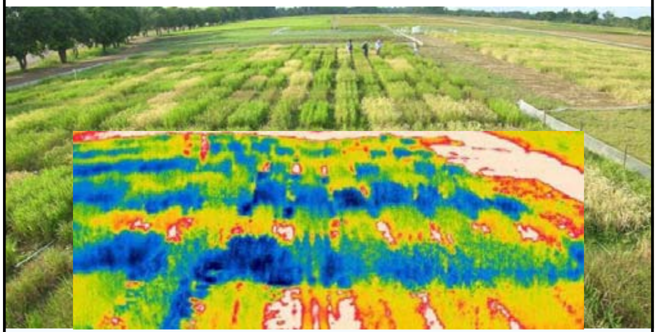


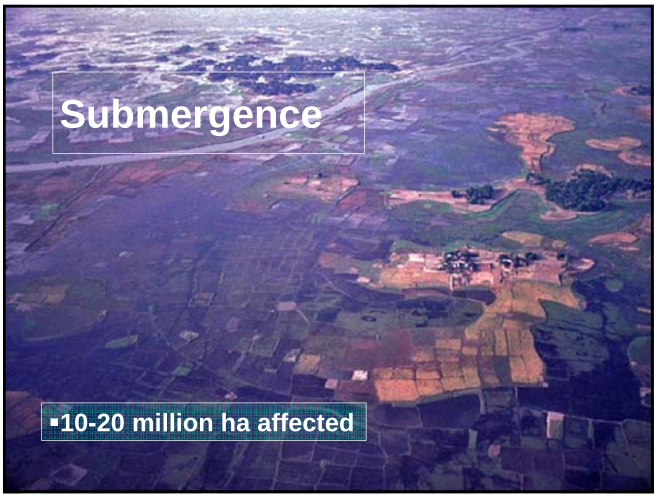
Field testing of 4200 rice varieties (in 2007)



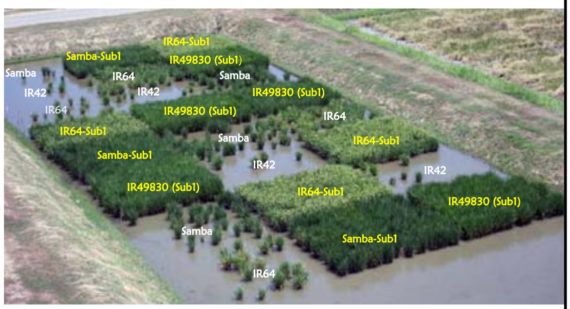
Drought Screening Field Arrays:

Phenotyping plant water status & WUE traits





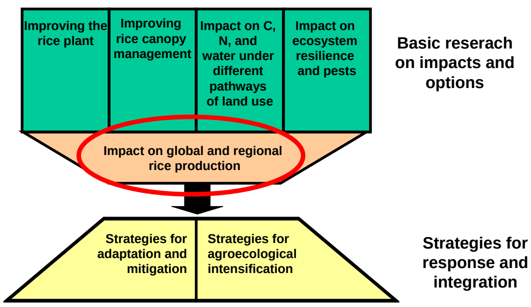
New *Sub1* lines after 17 days submergence in field at IRRI



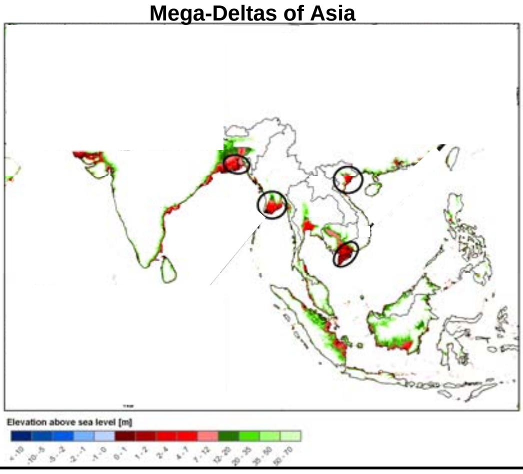
Stress-tolerant rices CAN be developed

- Currently-grown varieties (mega varieties) are often intolerant of new climatic stresses
- Good donors for tolerance to abiotic stresses have been identified, but are low-yielding.
- Tolerance is usually controlled by a small set of genes.
- Transferring these genes into mega varieties is an effective strategy to develop rice varieties for the unfavorable rainfed areas.

The Rice Climate Change Consortium (RCCC)

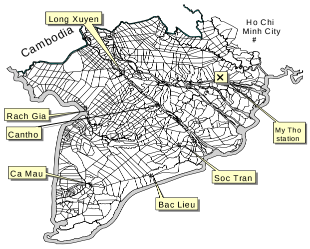


Mega-Deltas of Asia



VRSAP **(Vietnamese River System and Plains)** Model

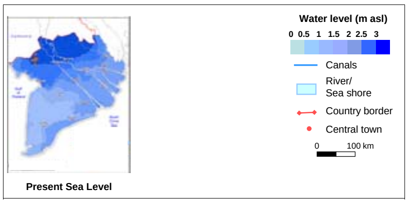
Southern Institute for Water Resource Planning, HCMC



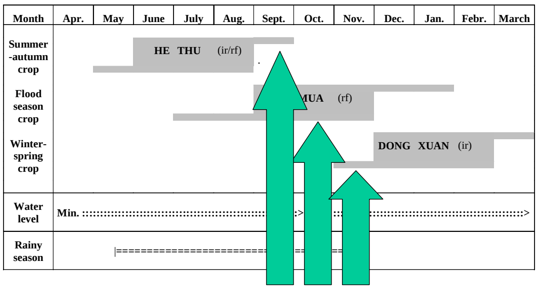
Components:
- 2,111 segments,
- 1,505 nodes and
- 555 storage plains.

Boundaries:
- Cambodian stations
- Sea level

Maximum Water Levels of the Year 2000



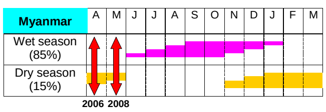
Rice cultivation: Impact C



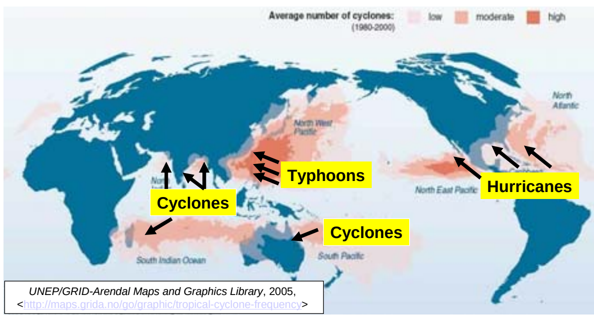
Enhanced flooding risk

Impact of Cyclone Nargis in Myanmar (May 2008)

Cropping seasons/ Myanmar



Frequency of Tropical Cyclones

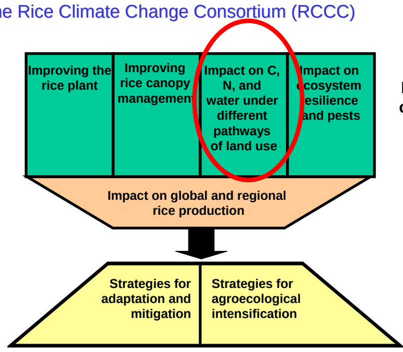


Typhoon Effects in Philippines vs. Myanmar

Xangsane (Sep. 06)	Track over land	> 150 km/h wind speed:	1022 km
		> 180 km/h wind speed:	365 km
	Area affected	Standing rice crop:	33,000 ha
		Salinity intrusion:	?
Nargis (May 08)	Track over land	> 150 km/h wind speed:	348 km
		> 180 km/h wind speed:	55 km
	Area affected	Standing rice crop:	16,000 ha
		Salinity intrusion:	1,750,000 ha*

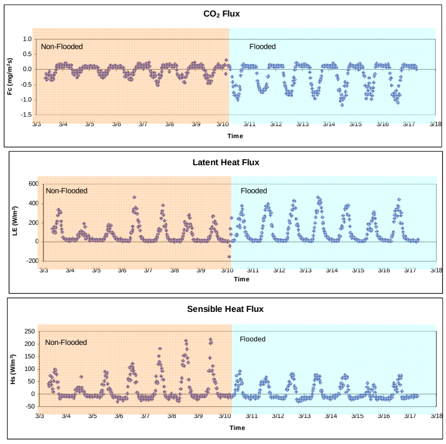
* http://www.pecad.fas.usda.gov/highlights/2008/05/Burma_Cyclone_Nargis_Rice_Impact

The Rice Climate Change Consortium (RCCC)

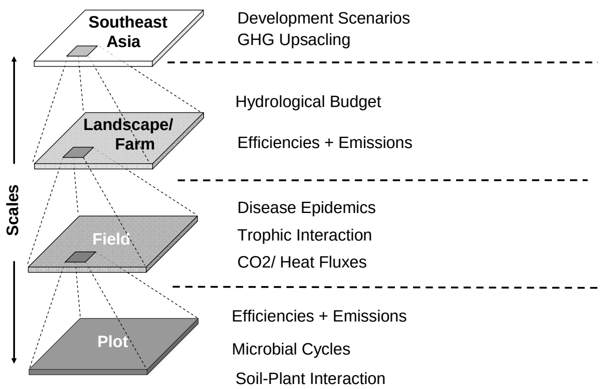


Basic reserach on impacts and options

Strategies for response and integration



ICON Project (Impact on Carbon,Nitrogen and Water Budgets)



RCCC Project No. 3: Expected Outputs

- Complete budgets of C, N, water, and energy under diversification and intensification of rice production.
- Innovative management guidelines for balancing productivity, sustainability and net global warming potential.
- New agroecosystem simulation models capable of predicting the consequences of climate and land-use changes .
- A new scientific foundation for policymakers and recommended pathways for future transformations of irrigated rice systems in Asia.

Conclusion/ I

- In spite of existing uncertainties, rice research cannot ignore climate change and has to aim at rice productions systems with higher resilience to climate extremes.
- There is reasonable optimism that gradual changes such as increasing temperatures can be dealt with by exploiting the existing genetic variation of rice in different habitats.

Conclusion/ II

- While rice production is NOT the main culprit of climate change, possible mitigation programs in rice production might in fact have beneficial results for production efficiencies and rural development.
- Multi-disciplinary approaches – from molecular to GIS techniques – as well as collaborative efforts have to be fused to ensure high-yielding and low-emitting rice production systems under future climatic conditions.