Strategic assessment of international rice research potential and priorities for Asia

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On behalf of Strategic Assessment Taskforce:

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Acknowledgements: Andy Nelson

GRiSP
Global Rice Science Partnership

IRRI

What do we intend?

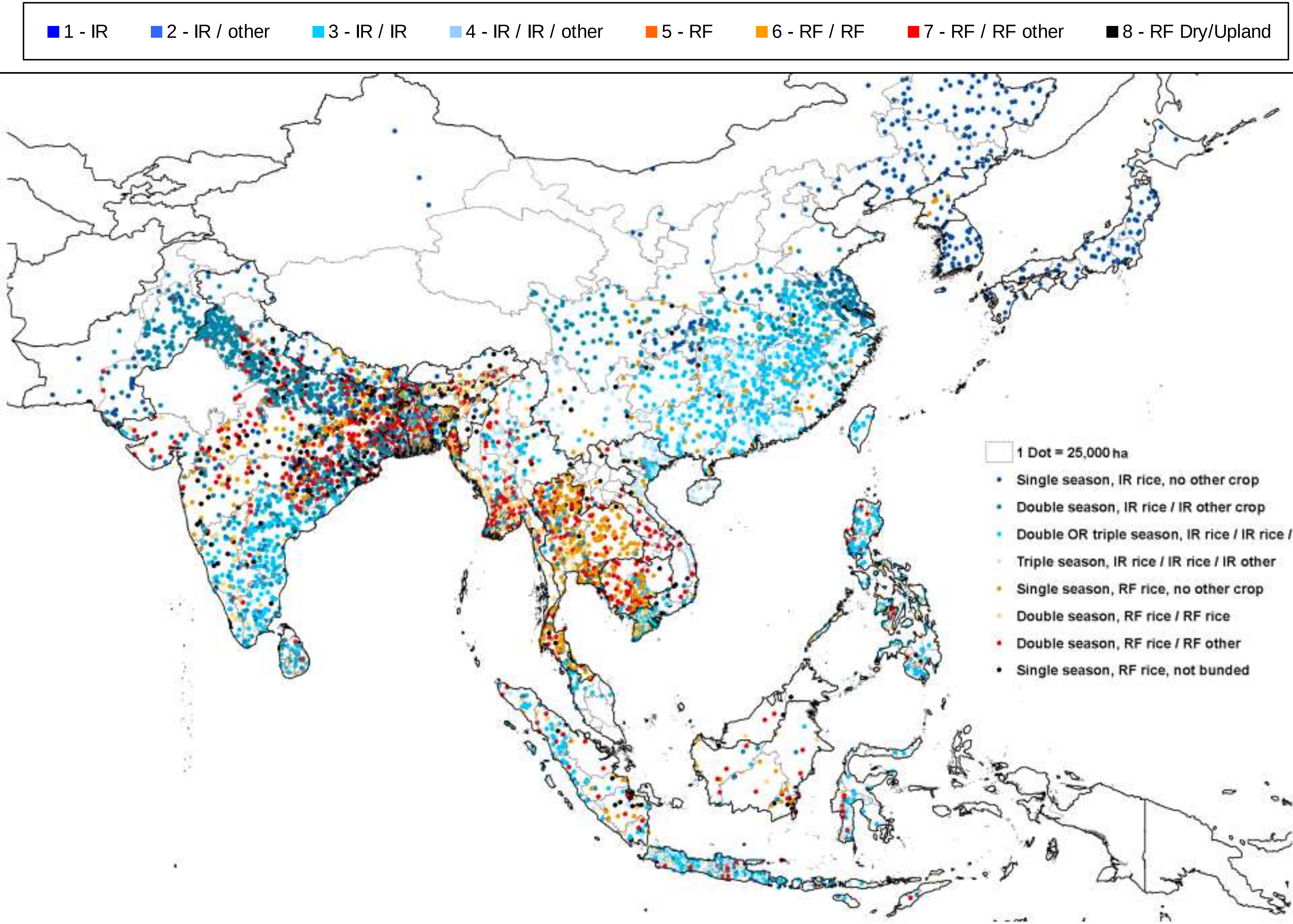
- Focus on innovations for the world's foremost food crop
- Product
  - Key intended findings: estimates of economic, poverty and environmental benefits in <u>Asia</u> per $ of investment in different potential international rice research areas under 25 year time horizon
  - Contrast with current resource allocation
- Process
  - A multidisciplinary process that engages scientists, but does not overburden them
  - Internalization of impact culture

Stage 1: Background analyses

- Definition of rice ecologies
- Yield gaps
  - Modeling of yield potential under current and 2035 climate conditions
  - Comparison with current and projected actual yields to identify magnitude of yield gaps

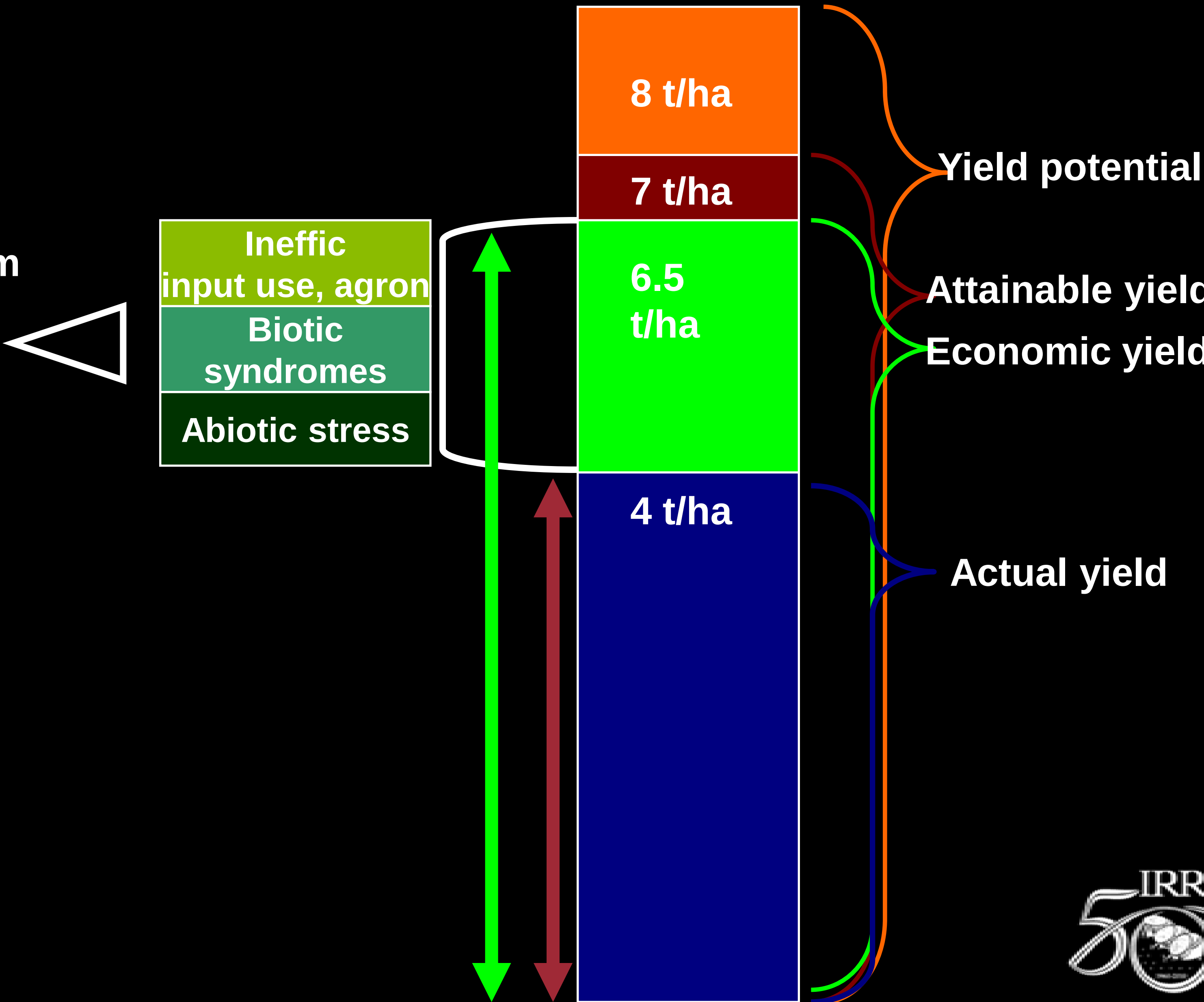
Definition of rice ecologies: purpose

- To provide a unit of analysis for the estimation of on farm research product adoption and performance within subregions (South Asia, East Asia, Southeast Asia)
  - Irrigated, rainfed, upland too coarse
  - Country by country estimation too detailed
- Iterative process of development with extensive feedback solicitation
- Stabilized version in March 2011


1 - IR
2 - IR / other
3 - IR / IR
4 - IR / IR / other
5 - RF
6 - RF / RF
7 - RF / RF other
8 - RF Dry/Upland
1 Dot = 25,000 ha
Single season, IR rice, no other crop
Double season, IR rice / IR other crop
Double OR triple season, IR rice / IR rice /
Triple season, IR rice / IR rice / IR other
Single season, RF rice, no other crop
Double season, RF rice / RF rice
Double season, RF rice / RF other
Single season, RF rice, not bunded

Yield gap approach

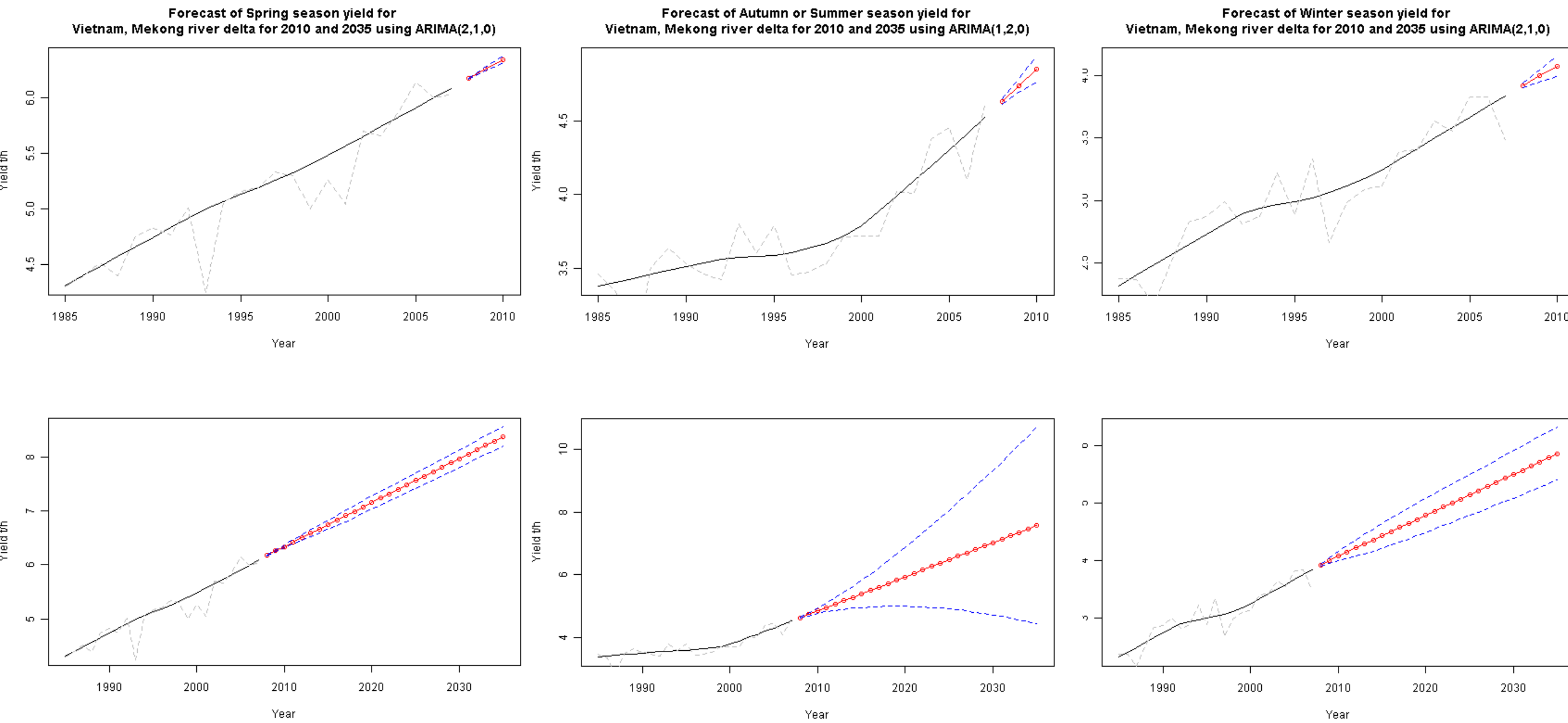
Maximum yield improvement from pest & disease control, stress tolerance, better agronomy



Forecasting actual yields through ARIMA*

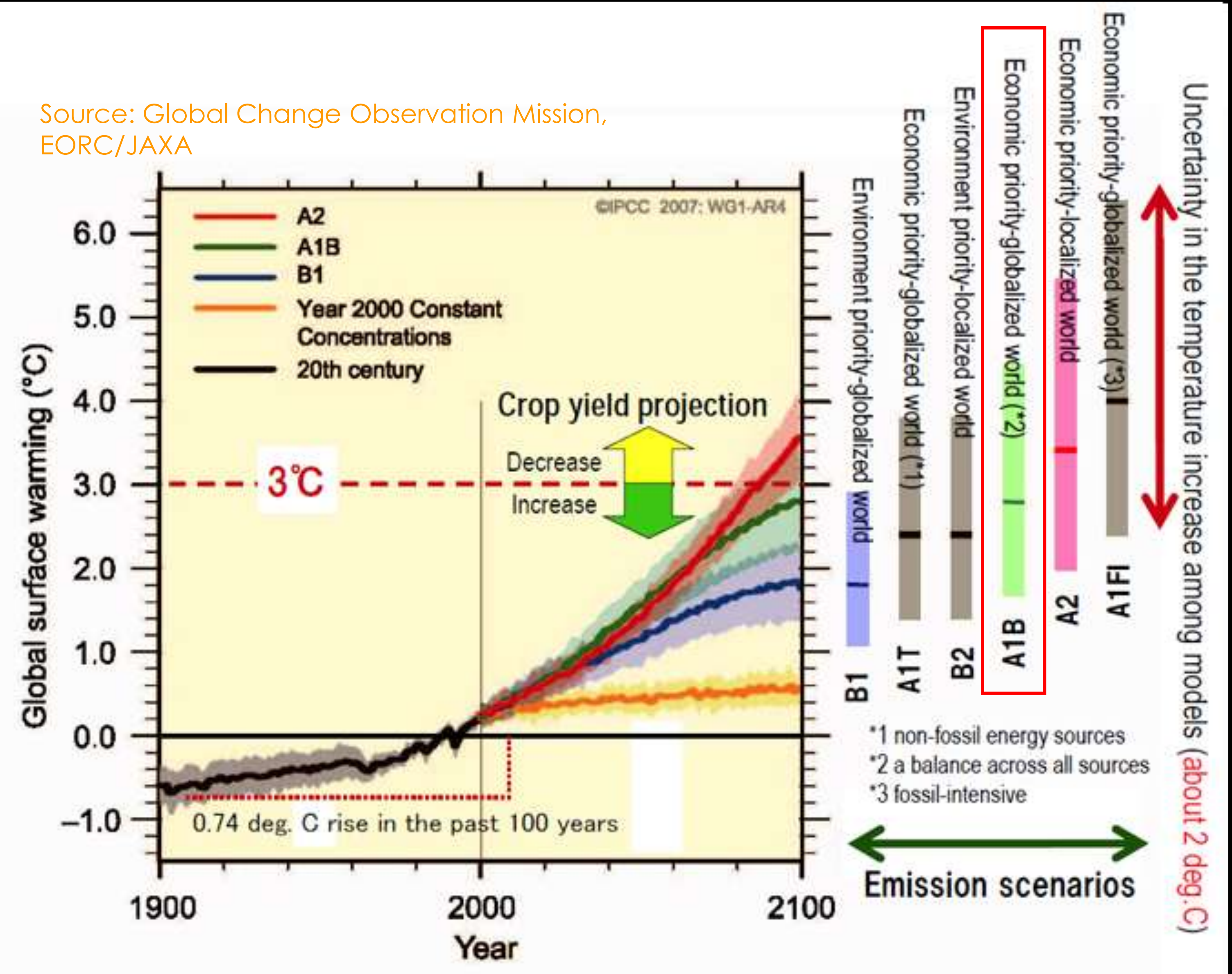
* ARIMA – Autoregressive Integrated Moving Average model, for forecasting with time series data

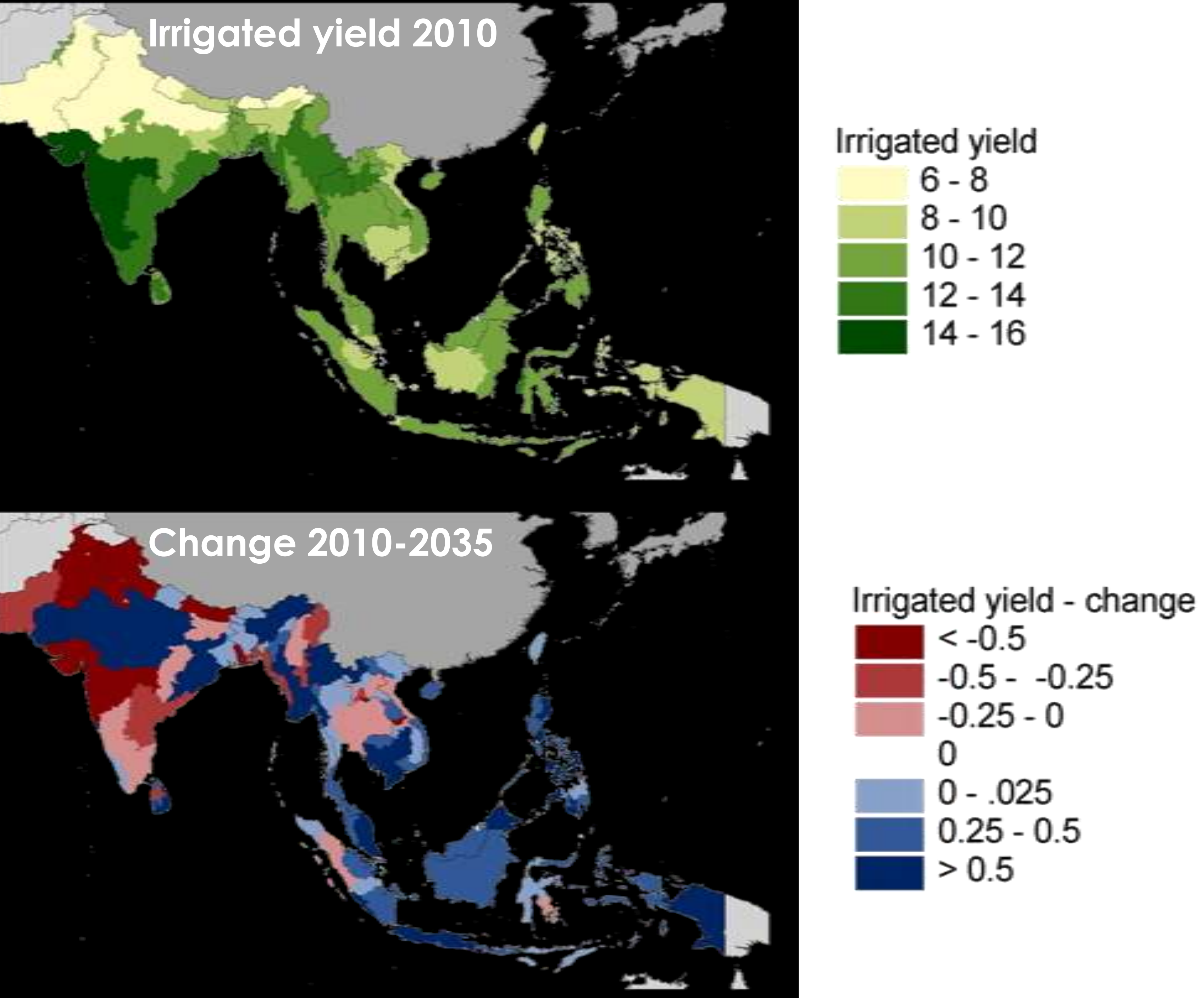
- 220 Spatial units in Asia
- Example for Mekong delta for 3 seasons. Top graph shows forecasts out to 2010, bottom graph out to 2035. Raw yield data in gray, Lowess trend in black, forecasts in red, standard errors in blue.



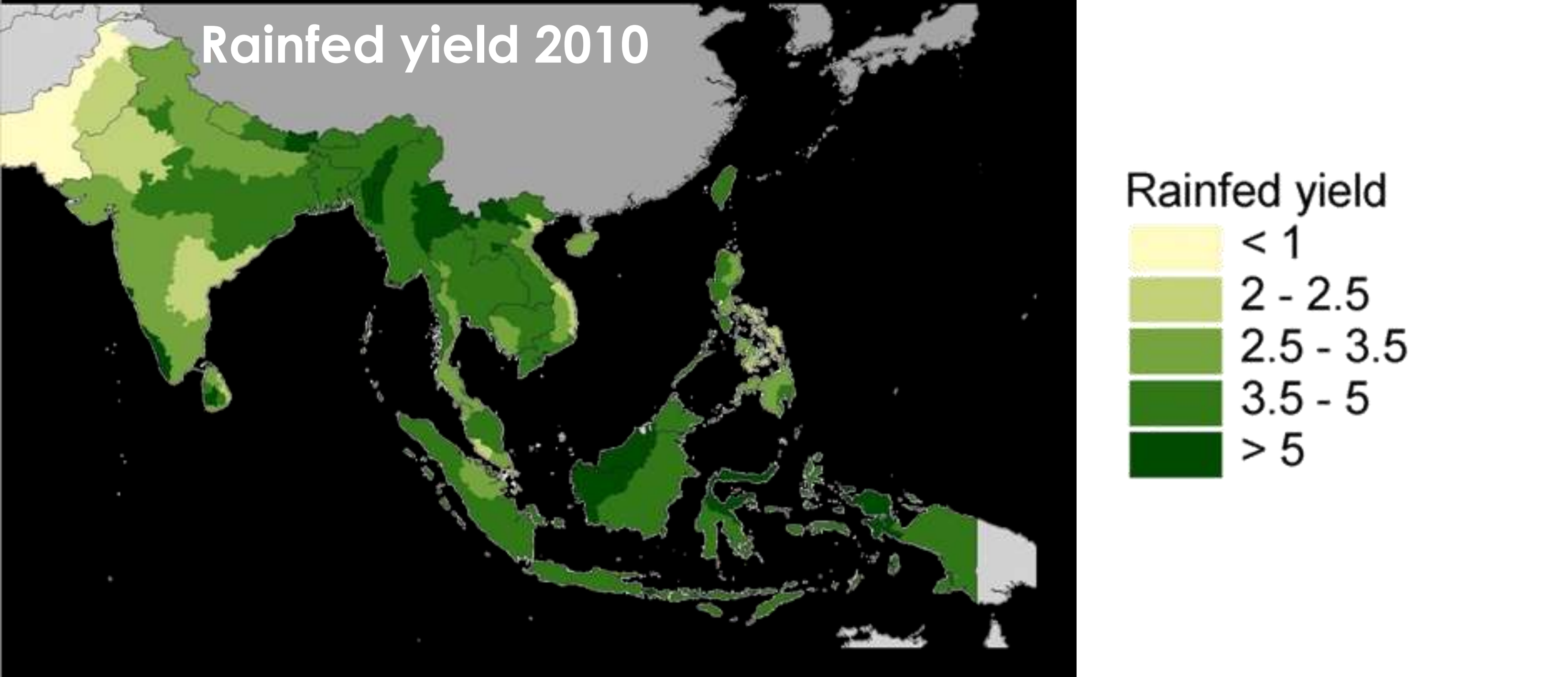
ORYZA2000 run on daily climate data downscaled from PRECIS to 2035 (9 months processing time) under A1B climate scenario to estimate modeled yield

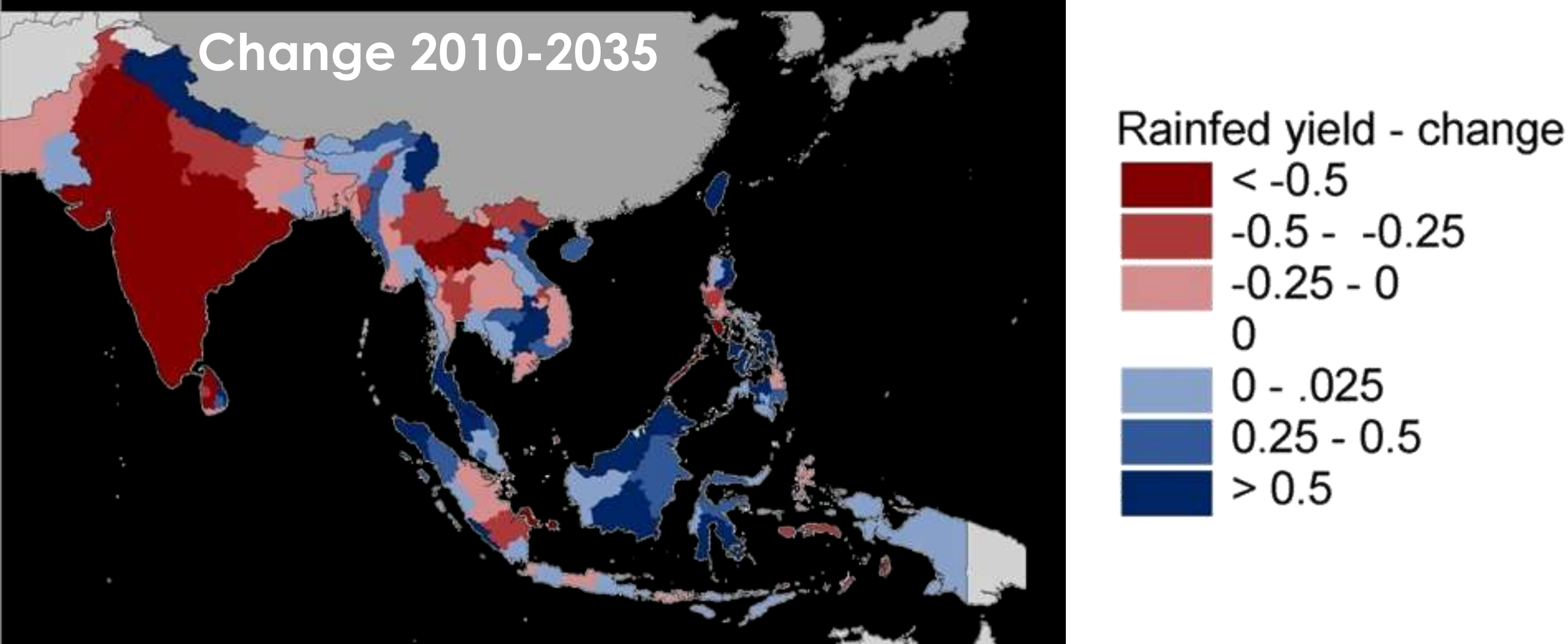
Source: Global Change Observation Mission, EORC/JAXA





Irrigated yield 2010
Irrigated yield
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16
Change 2010-2035
Irrigated yield - change
< -0.5
-0.5 - -0.25
-0.25 - 0
0
0 - .025
0.25 - 0.5
> 0.5

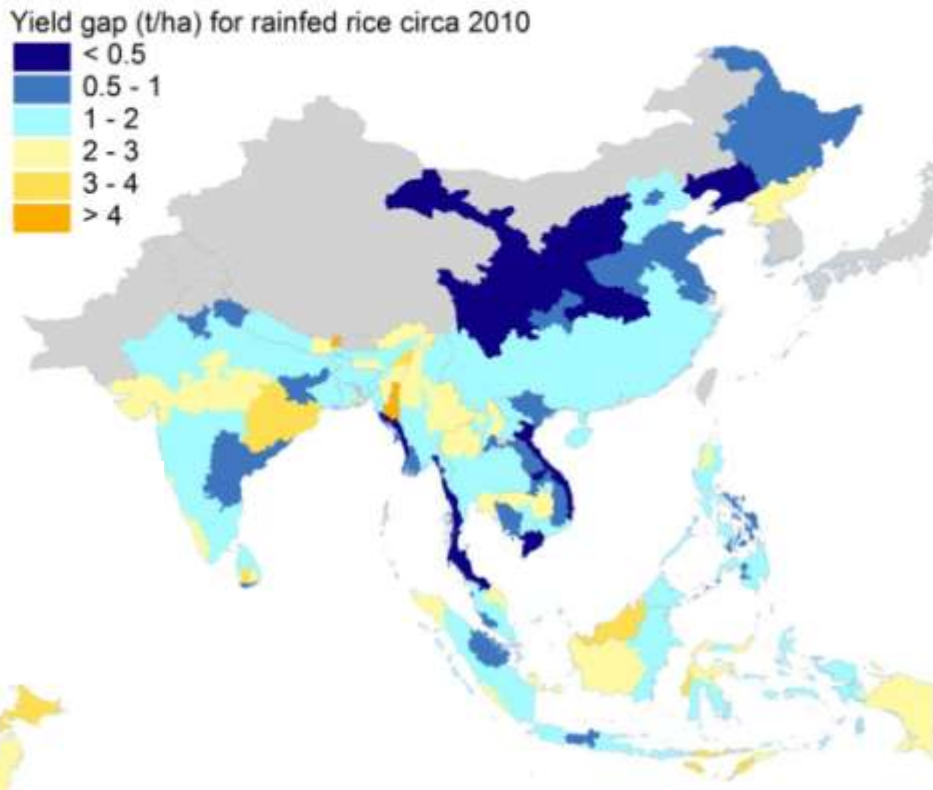

Rainfed yield 2010
Rainfed yield
< 1
2 - 2.5
2.5 - 3.5
3.5 - 5
> 5

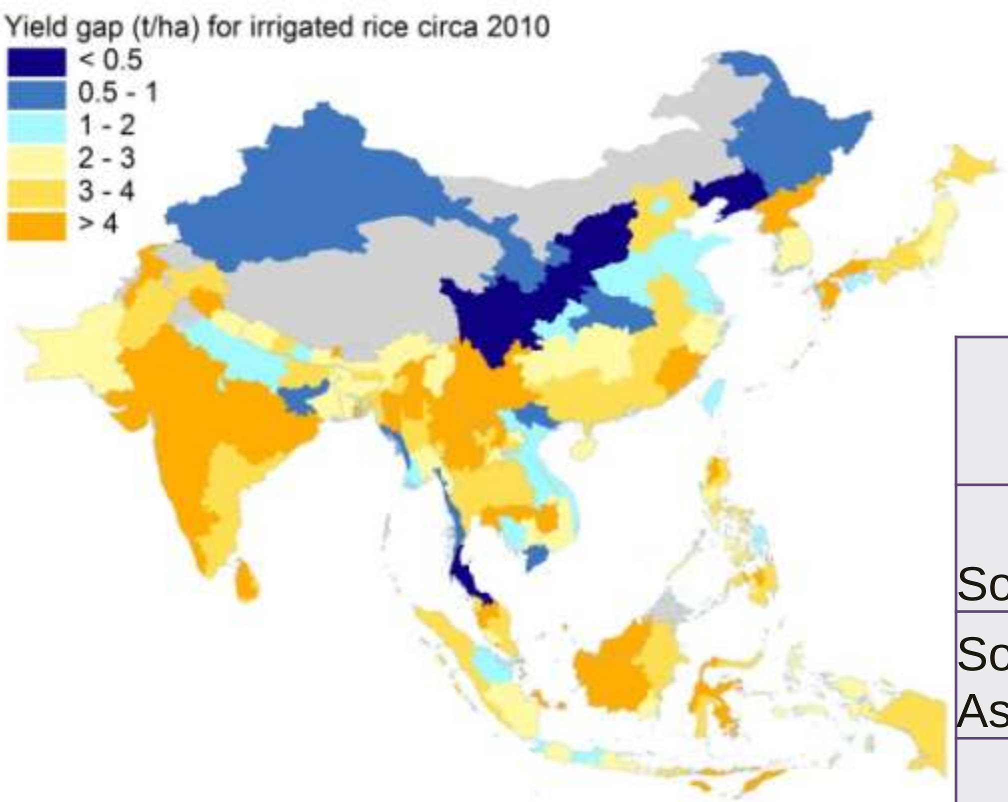

Change 2010-2035
Rainfed yield - change
< -0.5
-0.5 - -0.25
-0.25 - 0
0
0 - .025
0.25 - 0.5
> 0.5

Yield gap projections

- Attainable yield assumed to be 80% of modeled irrigated yield and 100% of modeled rainfed yield
- Actual yield is based on adjusted ARIMA forecasts:
  - Adjusted for overestimation of growth from 2000-2010
  - Adjusted to remove IRRI genetic improvement contribution (0.4% average annual growth, pro-rated according to yield growth)
  - Adjusted to reflect parallel shift to changes in yield potential caused by climate change for each spatial unit
- Gap = attainable yield – actual yield

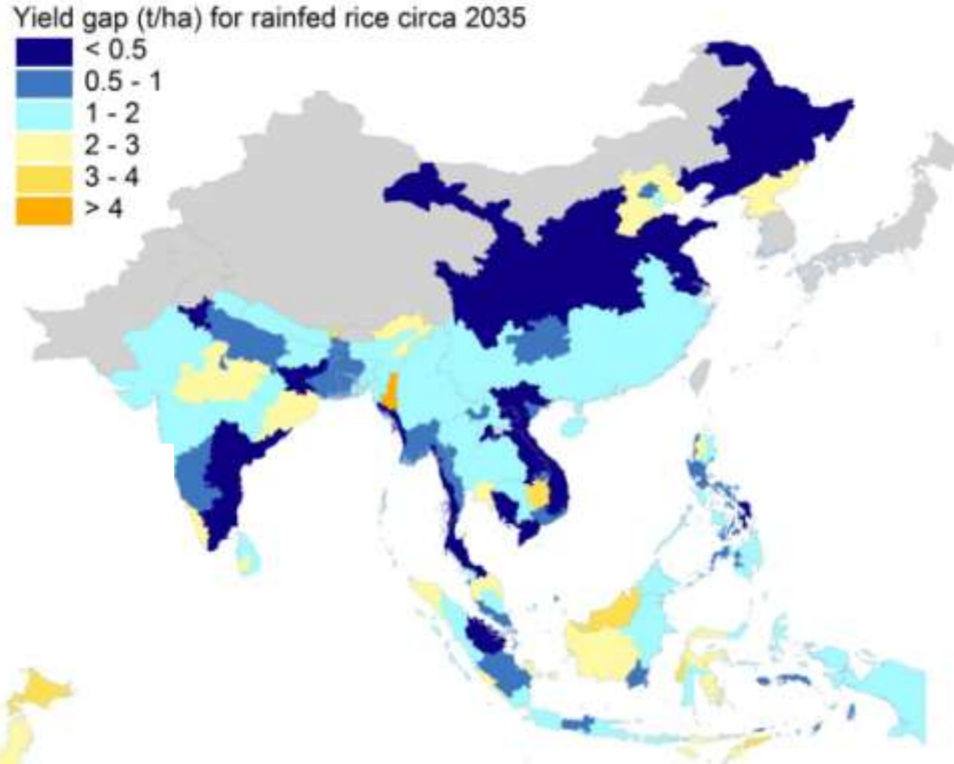
Yield gaps in 2010

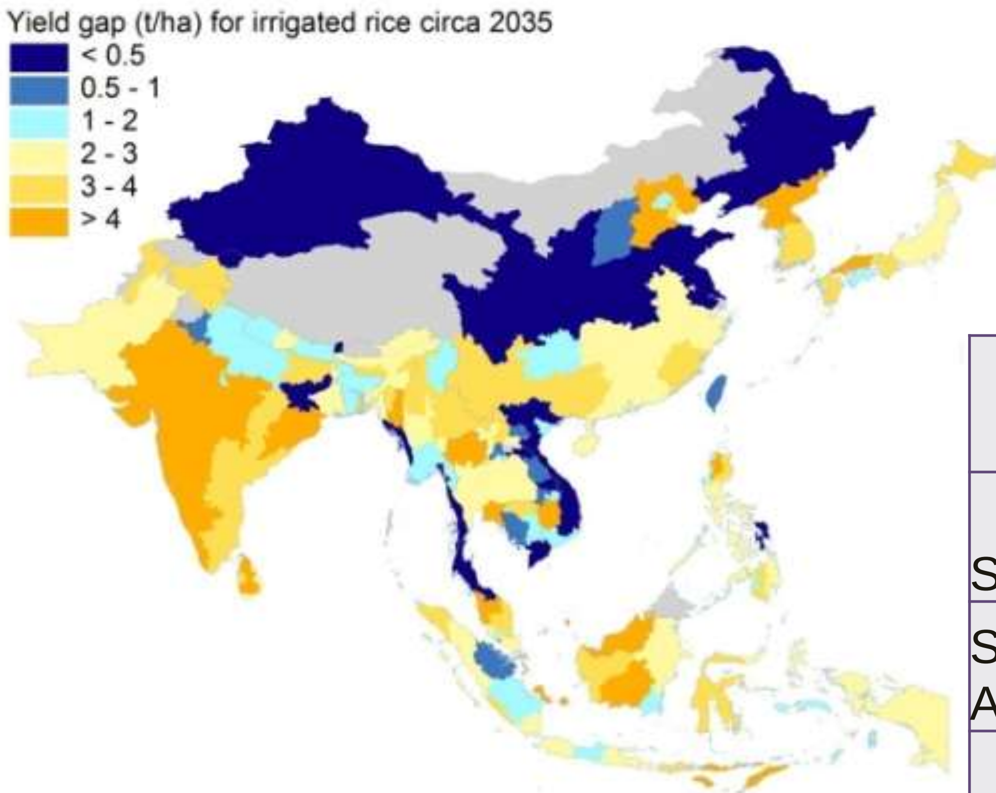




	Average gaps -2010 (t/ha)	
	Irrigated	Rainfed
South Asia	3.21	1.83
Southeast Asia	2.60	1.30
East Asia	2.03	1.43

Yield gaps in 2035 (no IRRI)





	Average gaps -2035 (t/ha)	
	Irrigated	Rainfed
South Asia	2.58	1.29
Southeast Asia	2.09	0.93
East Asia	1.54	1.15

Stage 2 – Disaggregate problem causes

Working Groups

1. Yield reducers (biotic) – pathogens, weeds and animals
2. Yield limiters (abiotic) – extreme temperature, toxicity (including salinity, alkalinity), submergence, waterlogging and drought
3. Efficiency gaps (including water, nutrients and labor, pre and postharvest)
4. Quality and nutritional content
5. Policies and markets
6. Yield potential

Stage 2: Working groups

- Define key problem/opportunities within category
- For each, characterize distribution, magnitude and frequency of problem by subregion, ecology, and production situation.
  - Draws on remote sensing (drought, salinity in South Asia), national data (submergence), climate data (heat, cold), crop loss models(biotic syndromes)
  - Translate into losses of yield, value/quality and/or excess input use
  - Appraise likely changes to 2035

Stage 3: Scientist assessment of scientific solutions

- Unit of analysis is constraint by technology (i.e. QTLs for drought tolerance)
- For each solution appraise:
  - Investment required (IRRI + partners)
  - Years of research to product
  - Probability of success, key factors affecting success
  - Alternative suppliers
  - Course of research progress without international effort
- For each solution in each ecology and subregion
  - Likely adoption profiles
  - Expected on farm costs and benefits of adoption by operation
  - Expected on farm environmental effects
  - Delivery and extension requirements
- 63 solutions * 31 spatial units * 23 parameters = 45000 estimates!

Example estimates: Safe AWD; double irrigated rice in South Asia

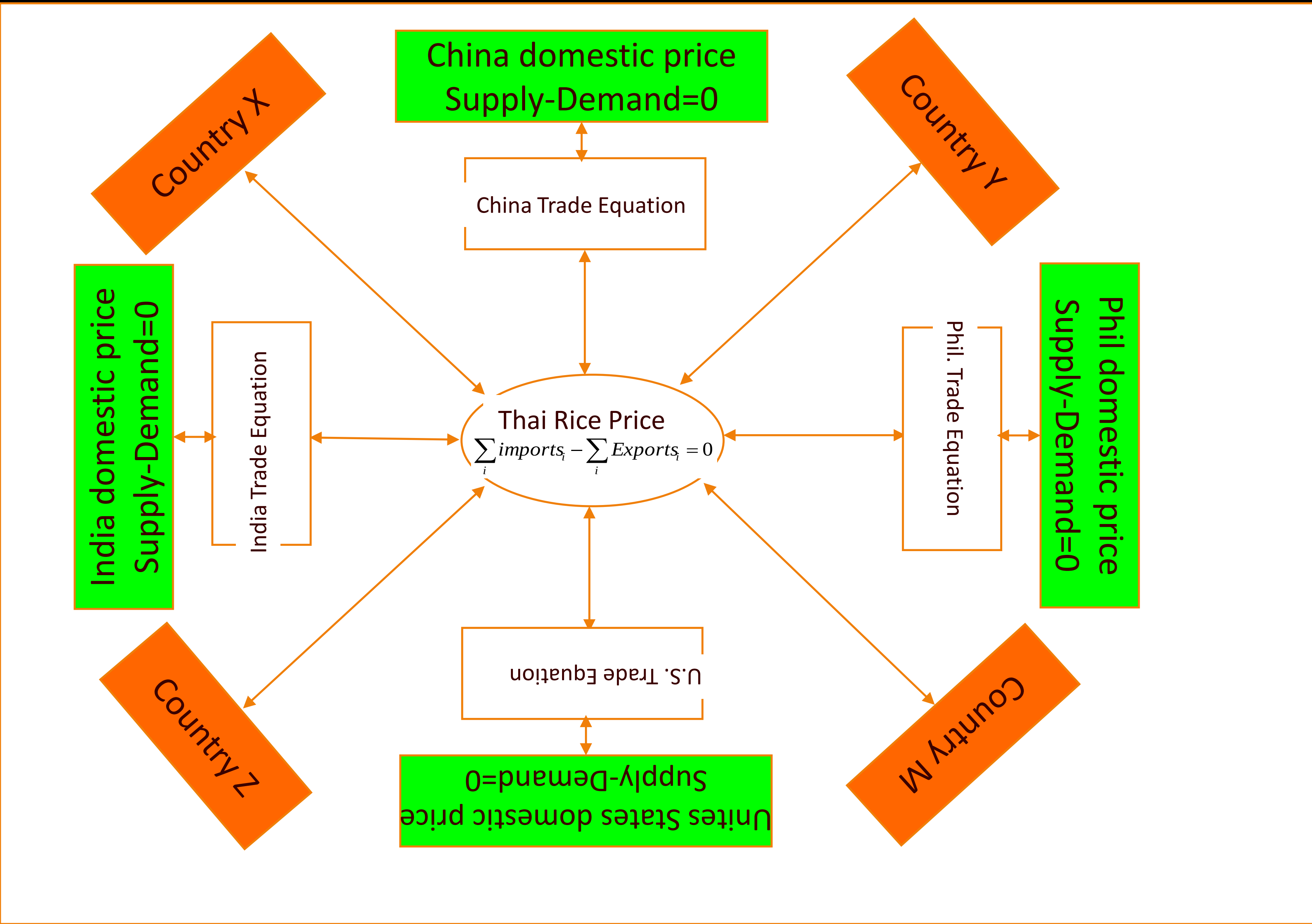
Portion of ecology that can benefit	100% (dry season only)
Adoption possible by 2020	20-30%
Change in yield	3% (reduced lodging)
Change in N fertilizer use	0%
Change in weed control costs	3%
Change in land preparation cost	-0
Change in irrigation water use	-20%
Change in greenhouse gas emissions	Less methane
Other benefits	Water saved can be used by others

Estimation of shifts in production costs and output

- Survey data from 6800 households have been used to estimate input and labor use by operation
  - For each agro-ecology & season
  - In each major Asian country
- Involves use of 19 diverse survey datasets
- Gains are set against counterfactual of delayed product availability without international efforts

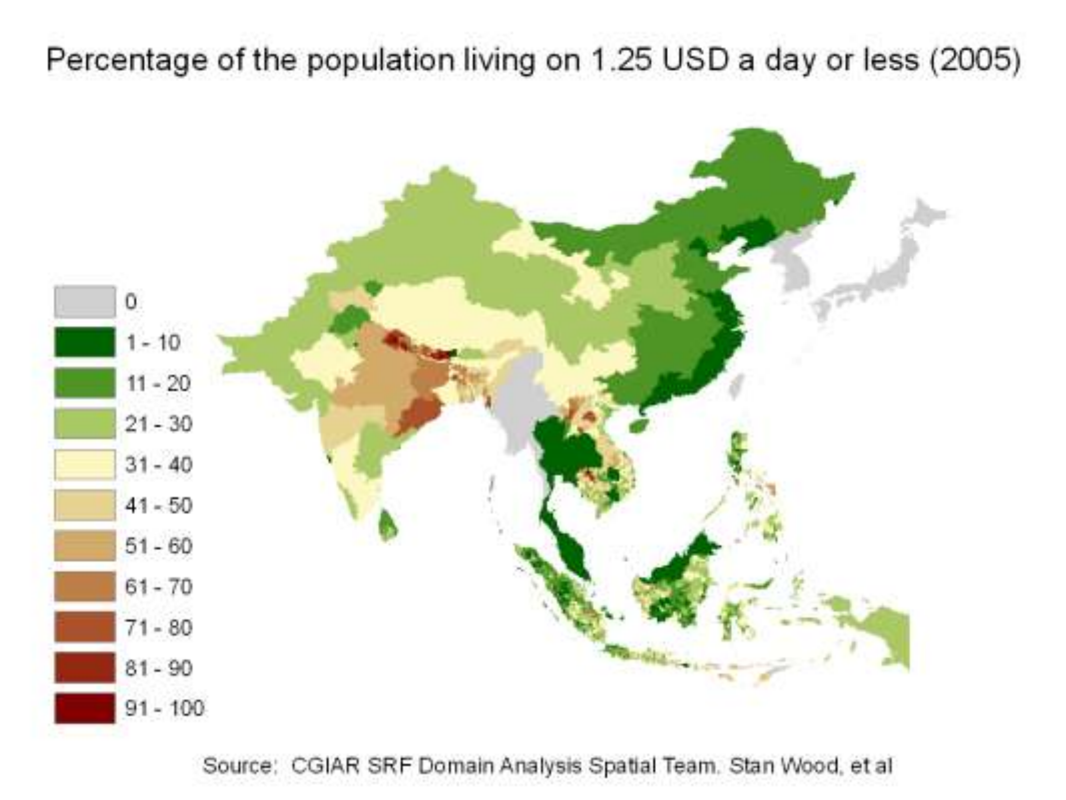
Subset of IRRI household survey database

IRRI Global Rice Model 18 Countries, 60 subnational units in Asia



Stage 4: Estimating impact from on farm estimates

- Input-output effects, price effects, poverty maps and poverty specific household rice areas and self-consumption ratios are used to calculate income effects for poor producers
- Data on rice expenditures by the poor are used to calculate expenditure savings by poor consumers and consumption enabled for the food insecure



Example analysis of consumer benefits

			Impacts by 2020				Impacts by 2035			
Country	**Pop below $1.25 a day (million) (2005)**	**Pop below $1.25 a day, rice expenditure share (%)[1]**	**Price decline due to productivity gain (from trade model)**	**Reduction in aggregate annual expenditure by those earning less than $1.25 per day (consumption constant; millions of $ PPP)**	**Number of people lifted above the $1.25 PPP poverty line (millions)**	**Number lifted out of hunger (millions of people)**	**Price decline due to productivity gain (from trade model)**	**Reduction in aggregate annual expenditure by those earning less than $1.25 per day (consumption constant; millions of $ PPP)**	**Number of people lifted above the $1.25 PPP poverty line (millions)**	**Number lifted out of hunger (millions of people)**
Cambodia	5.61	22.2%	9.40%	47.31	0.46	0.38	15.53%	78.16	0.76	0.50
China-Rural	198.37	22.4%	7.38%	1398.39	23.72	12.08	16.64%	3,153.01	53.49	22.03
China-Urban	9.32	10.5%	7.38%	32.67	7.96	0.28	16.64%	73.66	9.32	0.51
Indonesia	21.44	24.1%	4.87%	109.72	2.64	6.62	9.10%	205.03	4.93	8.13
Lao PDR	2.02	40.4%	4.87%	16.53	0.20	0.18	9.10%	30.89	0.38	0.23
Malaysia	0.14	12.3%	4.87%	0.38	0.14		9.10%	0.71	0.14	
Philippines	19.13	20.1%	8.51%	141.36	2.83	0.87	16.67%	276.91	5.54	1.66
Thailand	0.25	12.1%	10.42%	1.45	0.25	1.44	17.48%	2.42	0.25	1.87
Vietnam	18.96	24.4%	10.78%	216.58	4.89	1.49	17.69%	355.41	8.03	1.71
Bangladesh	77.36	26.2%	7.07%	562.19	4.35	4.67	13.22%	1,051.23	8.13	7.74
Bhutan	0.17	13.1%	5.44%	0.52	0.01		11.39%	1.09	0.02	
India-Rural	342.88	15.5%	5.44%	1179.08	12.12	8.96	11.39%	2,468.69	25.38	13.55
India-Urban	112.92	8.7%	5.44%	218.51	2.36	1.66	11.39%	457.50	4.93	2.51
Nepal	14.82	21.3%	5.44%	63.03	0.36	0.32	11.39%	131.97	0.74	0.49
Pakistan	35.19	2.9%	7.66%	33.64	0.85	0.48	17.82%	78.26	1.97	1.06
Sri Lanka	2.03	20.7%	5.44%	10.27	0.63	0.31	11.39%	21.50	1.32	0.47
Total	**860.60**			**4,031.63**	**63.76**	**39.74**		**8,386.44**	**125.33**	**62.46**

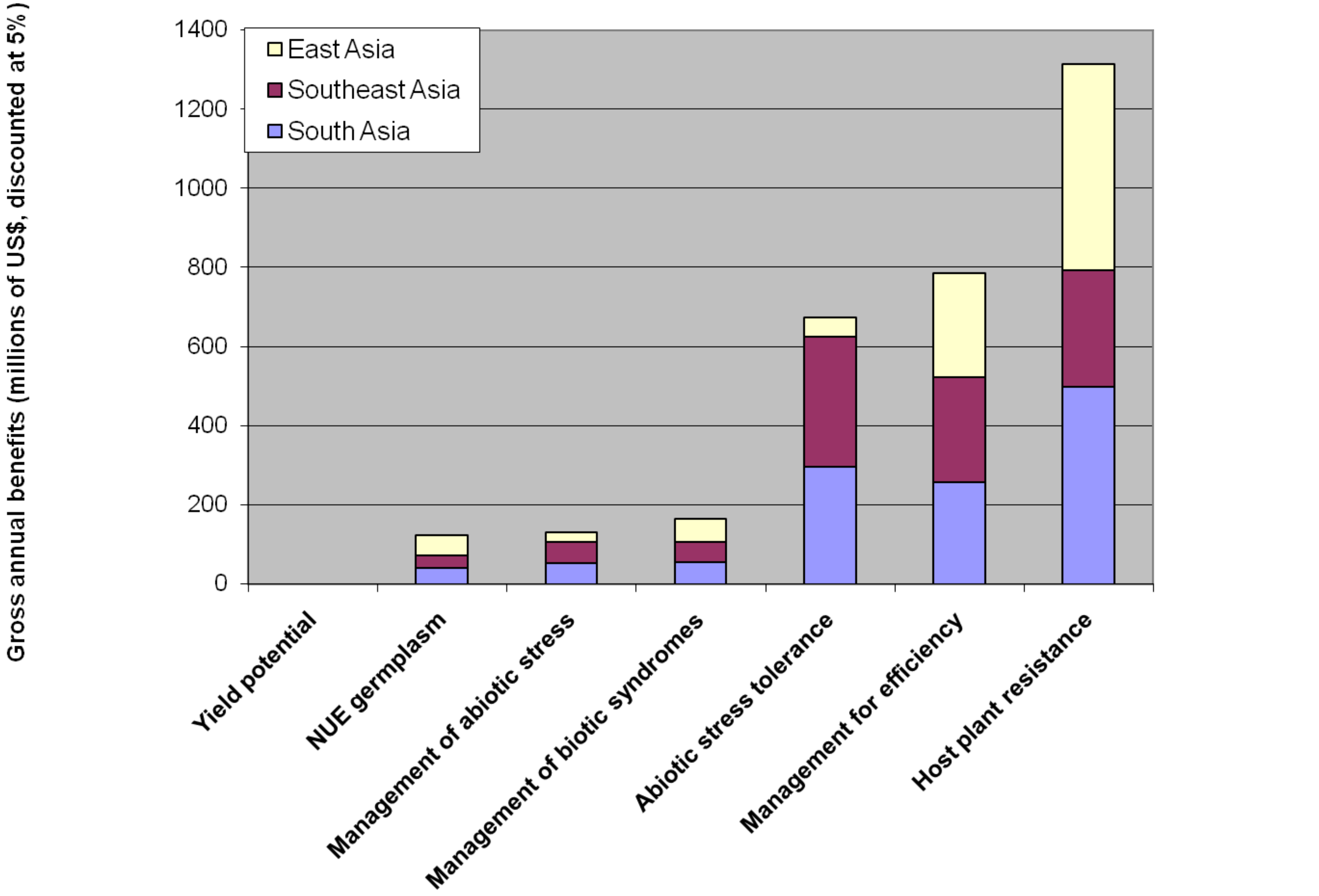
Incorporating environmental impacts

- Area responses to the price effects in particular locations will be compared with existing land cover to identify “natural” ecosystem services saved
- This will be combined with direct environmental benefits from reduced emissions and input use.
- Overall patterns of impact will be compared with patterns of resource allocation

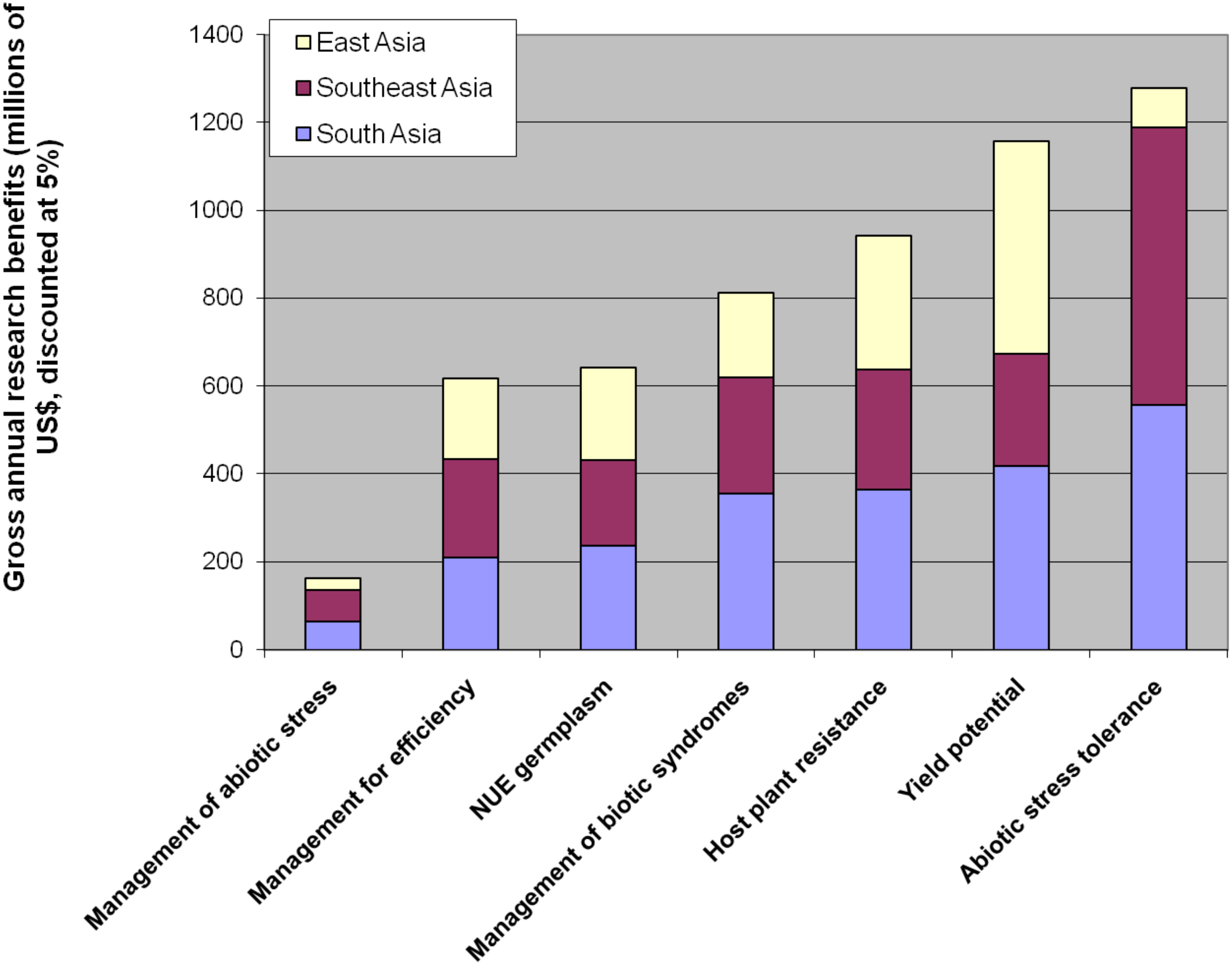
Indicative results

- Caveats – parameters not yet final, refinement and review ongoing
  - Background data being improved
  - Estimates will change!
  - A few technologies & policy research omitted
- Gross benefits only, as scientist estimates still being finalized
- Estimates reflect IRRI contribution, not total benefits of technology

Gross international research contributions - 2020



Gross international research contributions - 2035



Timeline

- Ongoing:
  - Improvement of abiotic stress loss estimates
  - Finalization of representative input-output information for all countries, ecologies and seasons
- Next steps:
  - Reconciliation of yield gaps and estimated research induced yield loss reductions
  - Partner consultations on estimates
  - Application of the trade model
- Finalization in early 2012 – stay tuned for detailed results

Thank you!