Climate change in Asian agriculture:

Mitigation and adaptation strategies in rice production

Alisher Mirzabaev
Senior Scientist, Policy Analysis and Climate Change

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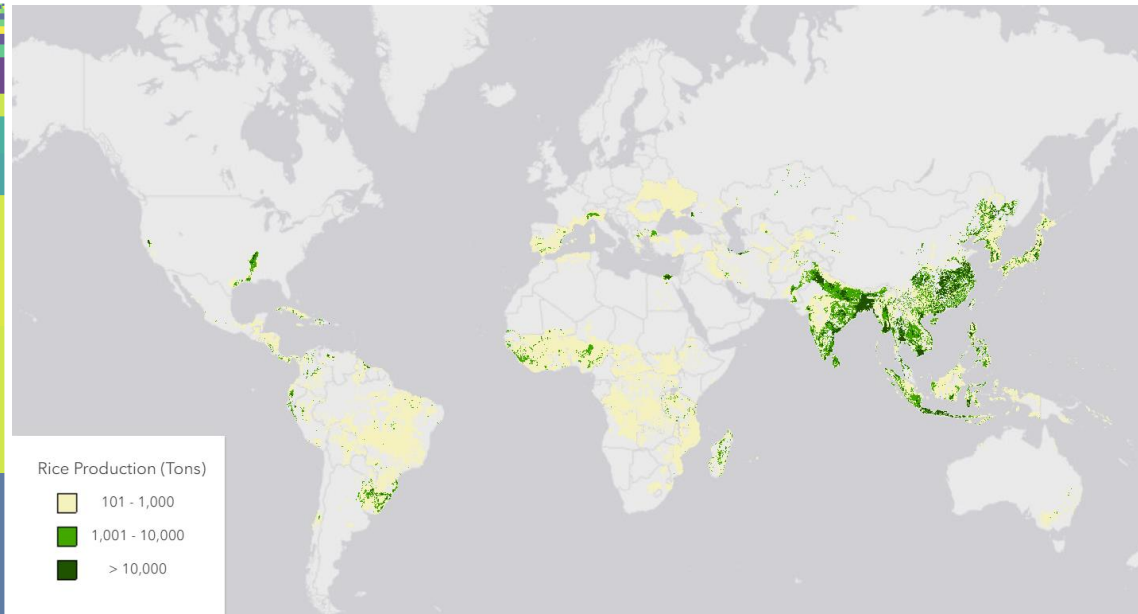
IRRI International Rice Research Institute
CGIAR

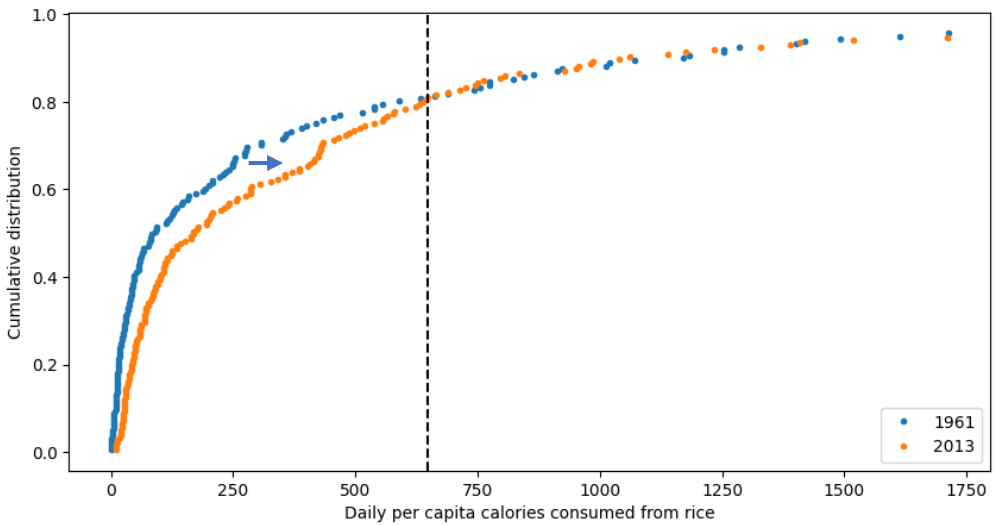
Top rice producing countries and areas in the world (2022)

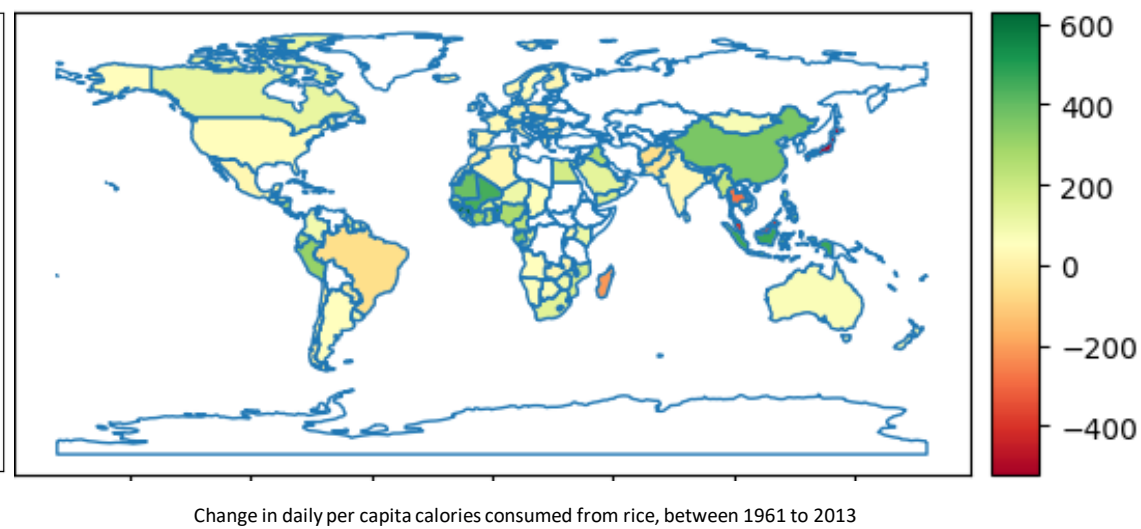


- Strong concentration of global rice production in Asia
- Top 10 countries produced about 82% of the global supply of 761 million tons in 2022.
- Only about 7% of rice was traded internationally in 2022.

Sources: FAO, USDA

Growing consumption of rice globally





Change in daily per capita calories consumed from rice, between 1961 to 2013

- Global consumption of rice increased from 157 million tons in 1961 to 520 million tons in 2022.
- Daily per capita consumption of rice has risen particularly among those countries which were at the lower end of rice consumption in 1961.

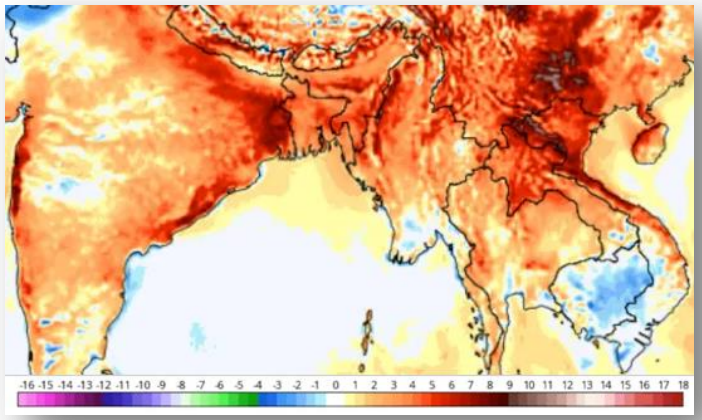
Source: based on FAO data

Rice is central to achieving Sustainable Development Goals

- About 4 billion people have rice as their staple food.
- More than 16% of the calorie intake of the world's population, and 70% of that of the poorest of the poor in Asia, come from rice.
- The rice sector provides a living for more than 20% of the world's population, of whom 400 million are poor and food insecure.

Source: IRRI Climate Change Strategy (2022-2027)

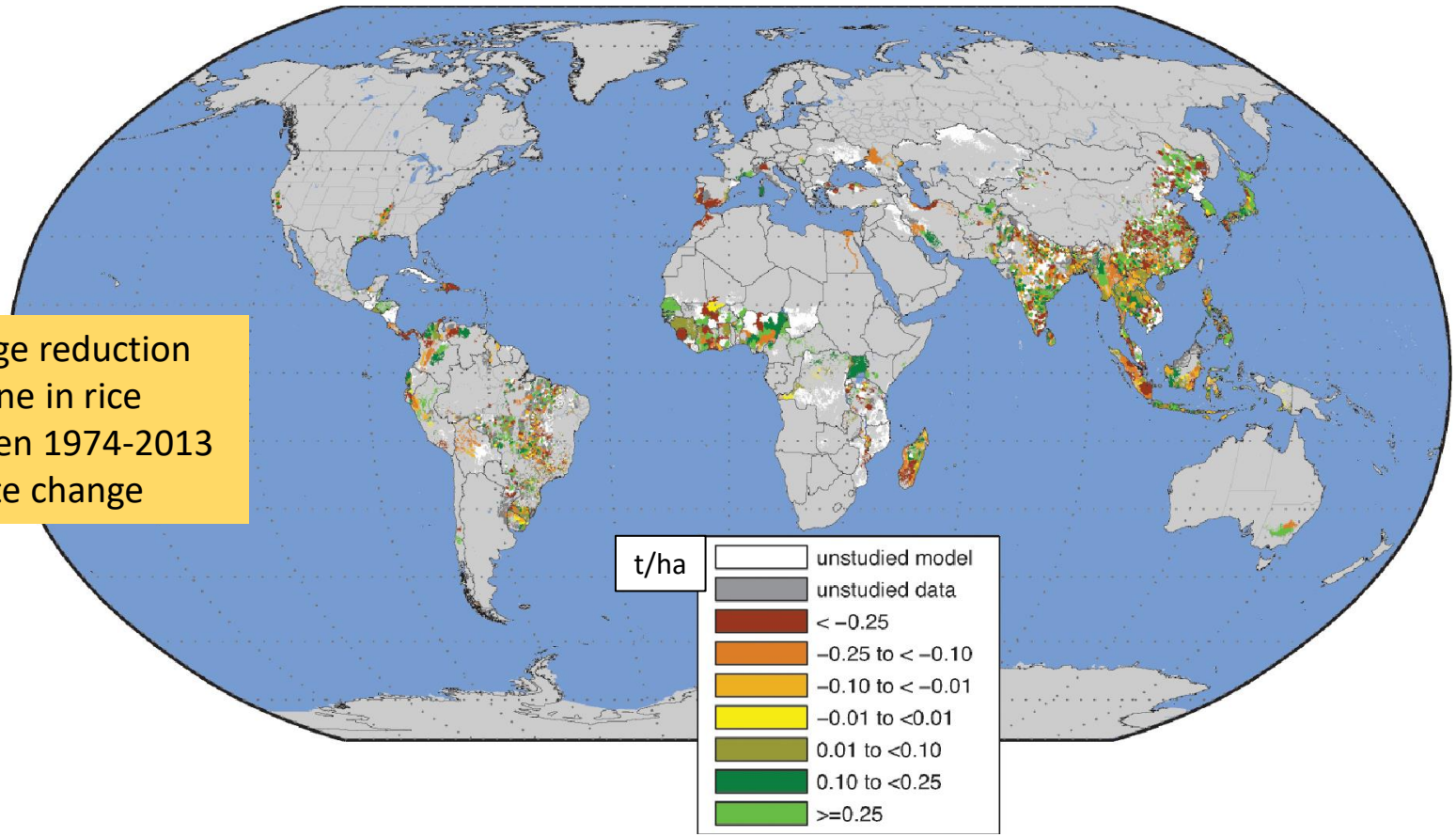
Climate change impacts on rice production



Extreme weather events

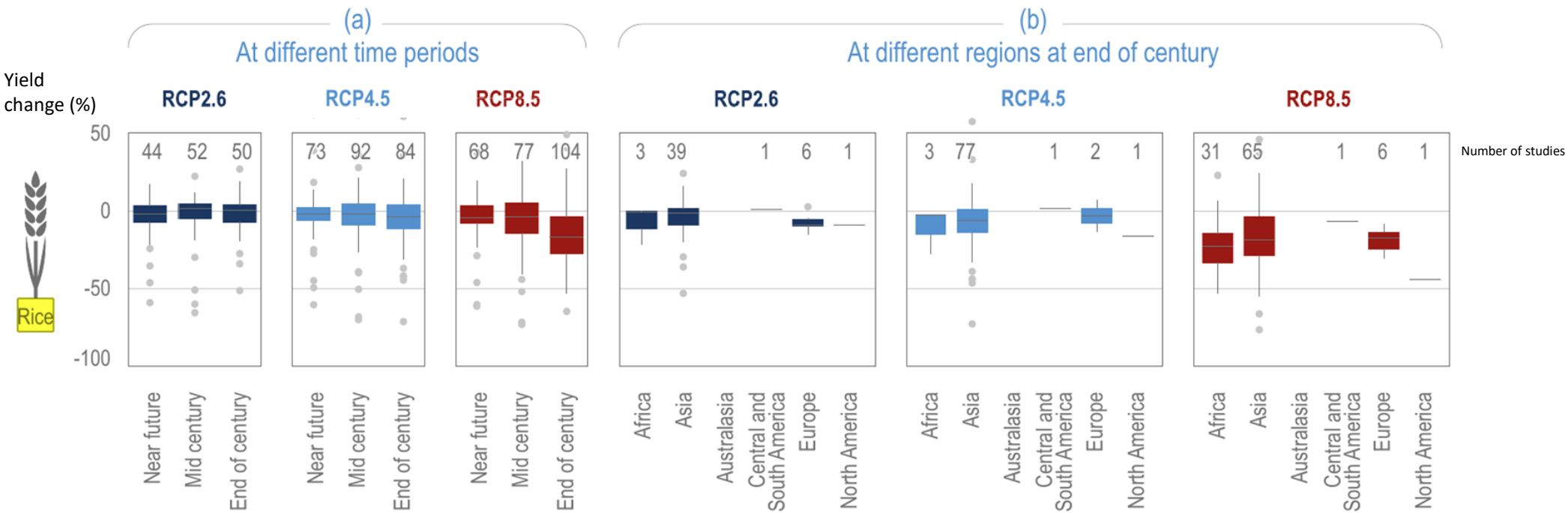
Climate change is already impacting rice yields

Global average reduction of 0.3% decline in rice yields between 1974-2013 due to climate change



Source: Ray et al. (2019)

Projected impacts of climate change on rice yields

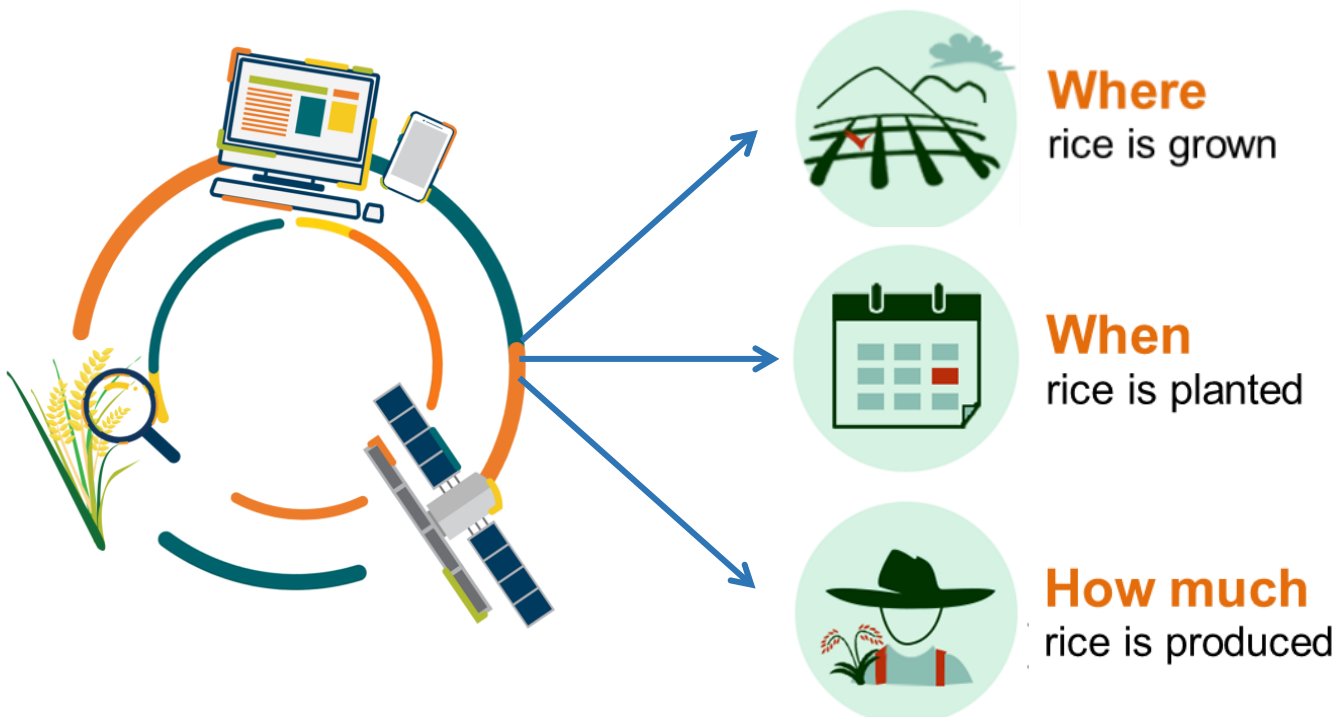


A median global decline of 0.7% in rice yields per decade across all scenarios

Source: IPCC (2022)

Mapping rice from space for climate change adaptation

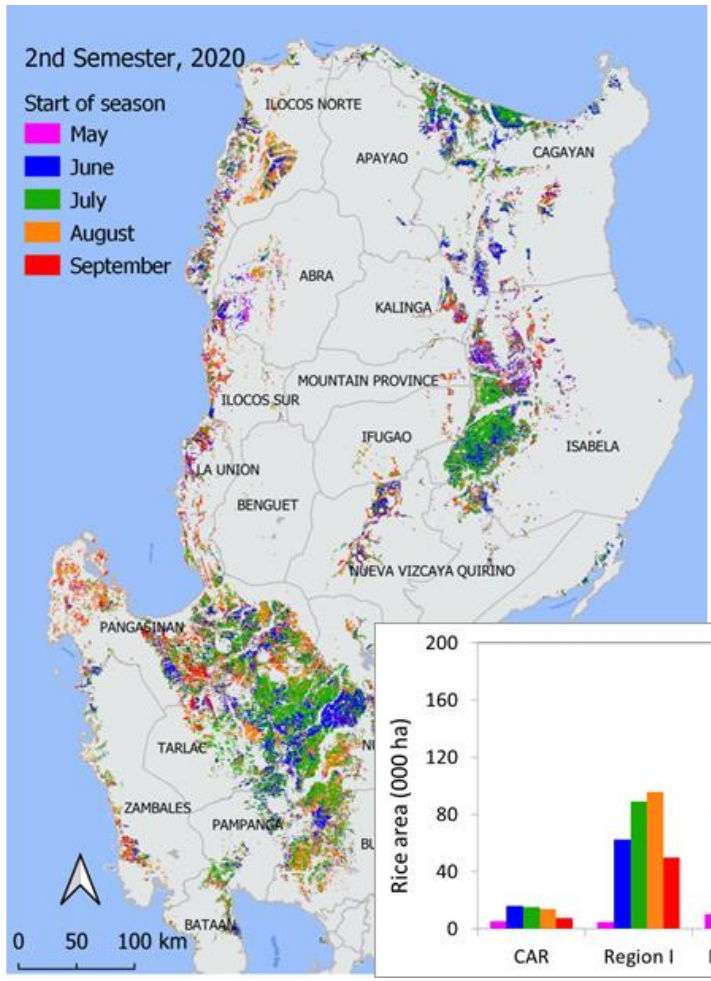
Use of remote sensing, crop modeling and smartphone-based surveys to generate information on rice.

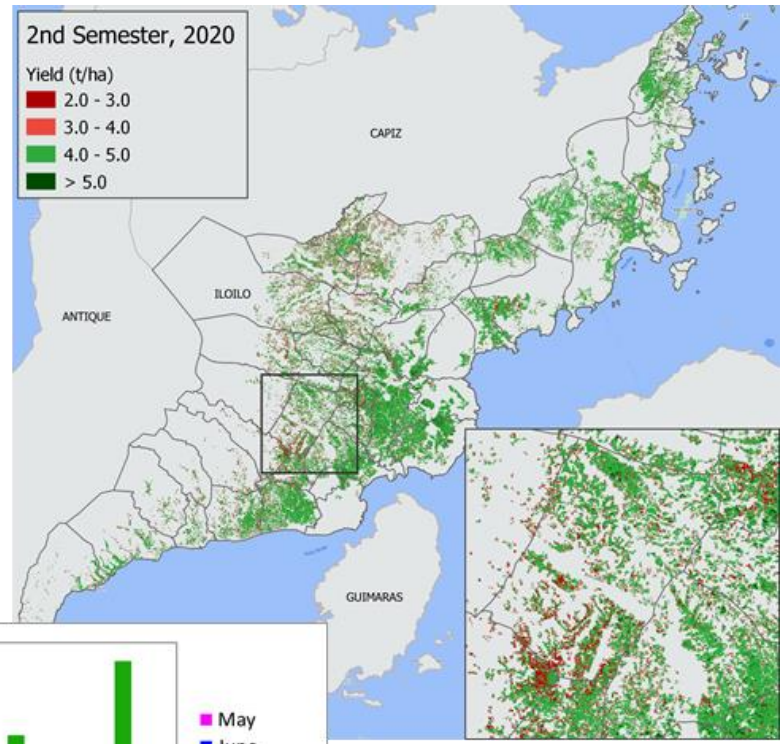


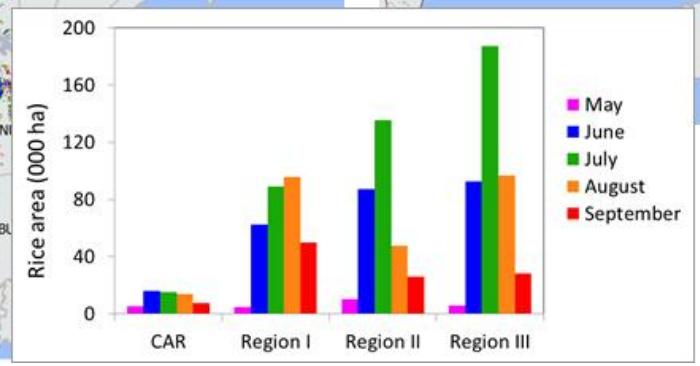
Where
rice is grown

When
rice is planted

How much
rice is produced



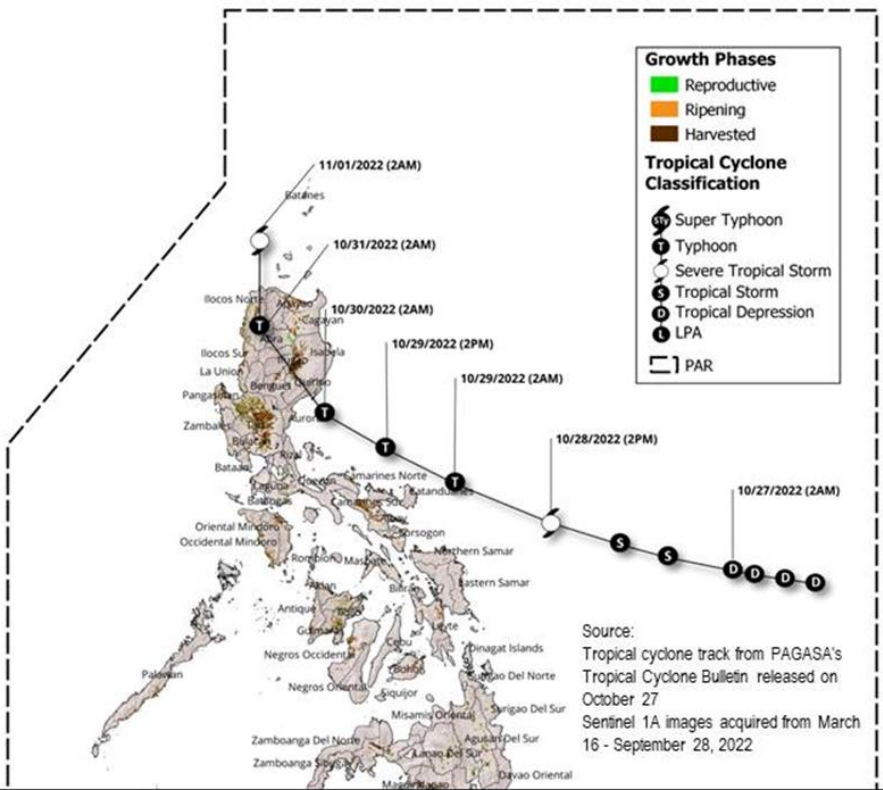




PRiSM
Philippine Rice Information System

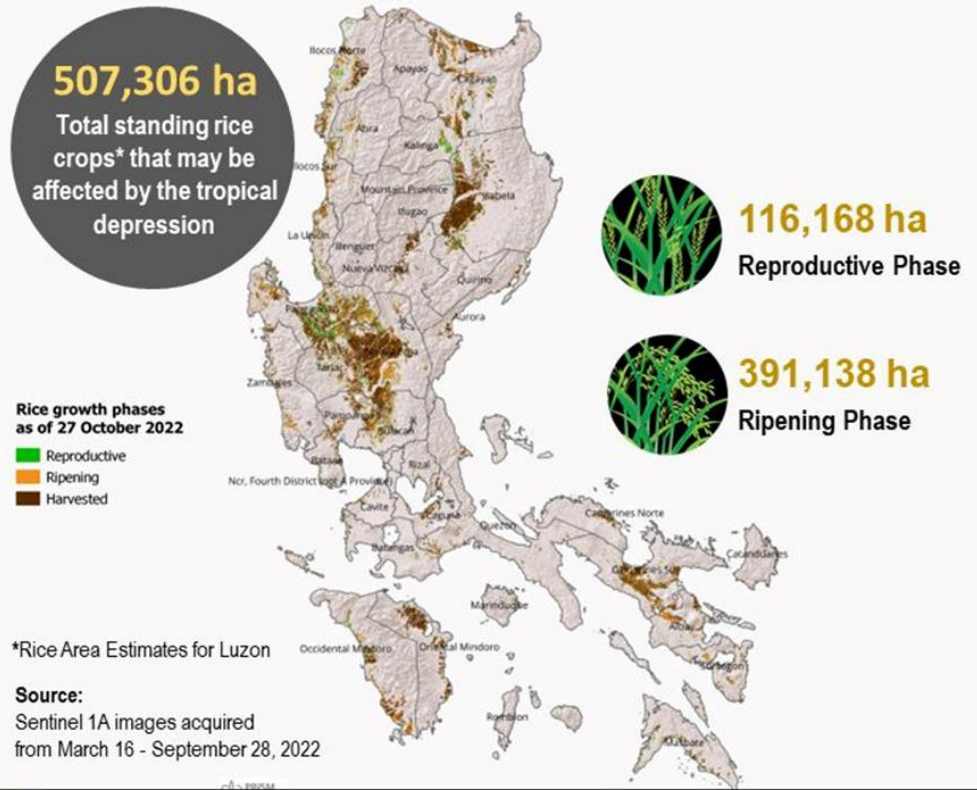
Flood assessment using satellite imagery

Track of Tropical Depression "Paeng" as of October 27, 2022



PRiSM Philippine Rice Information System prism.philrice.gov.ph/ PRiSMphilrice

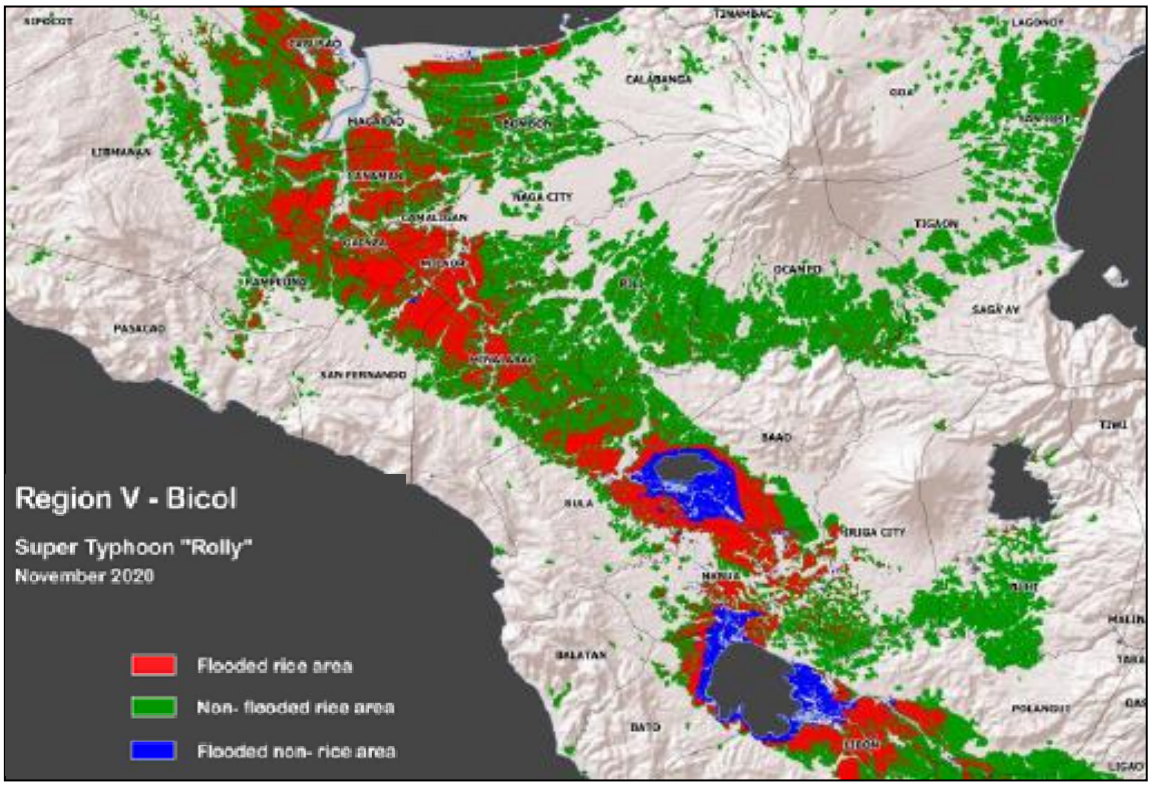
Rice Areas at Risk in Luzon along the Track of Tropical Depression "Paeng" as of October 27, 2022



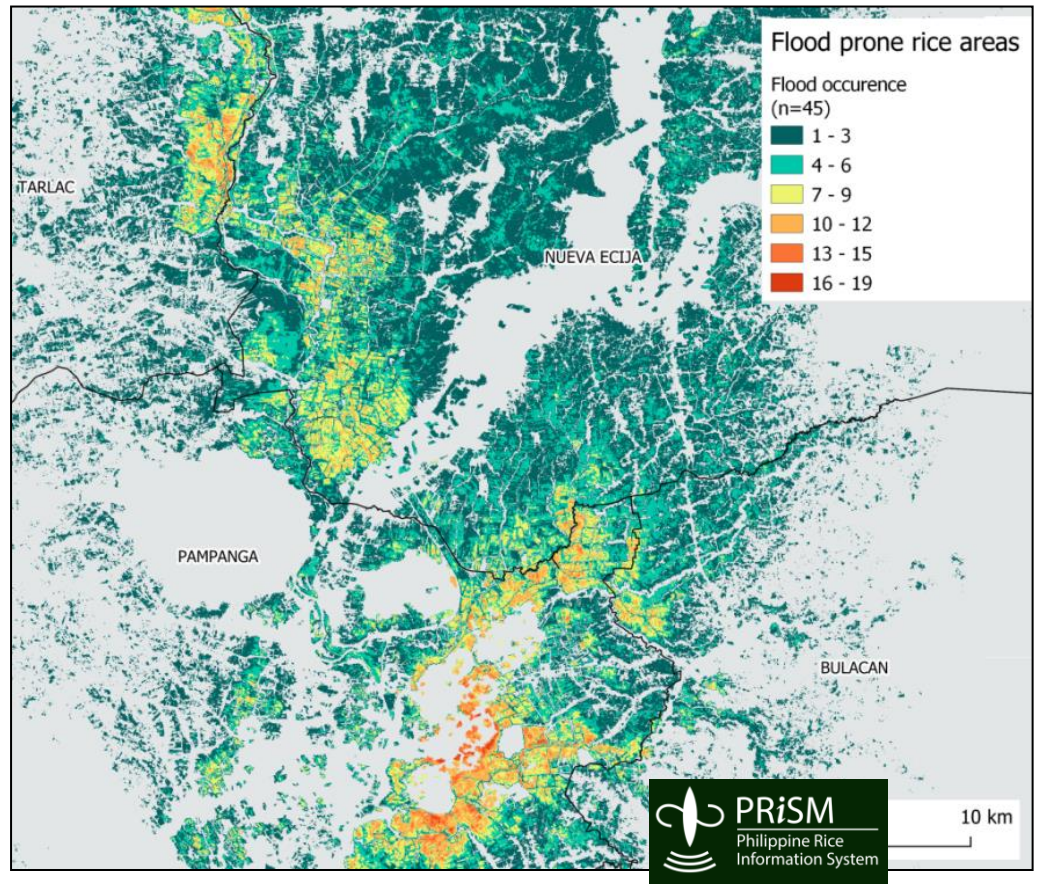
PRiSM Philippine Rice Information System prism.philrice.gov.ph/ PRiSMphilrice

Damage assessment

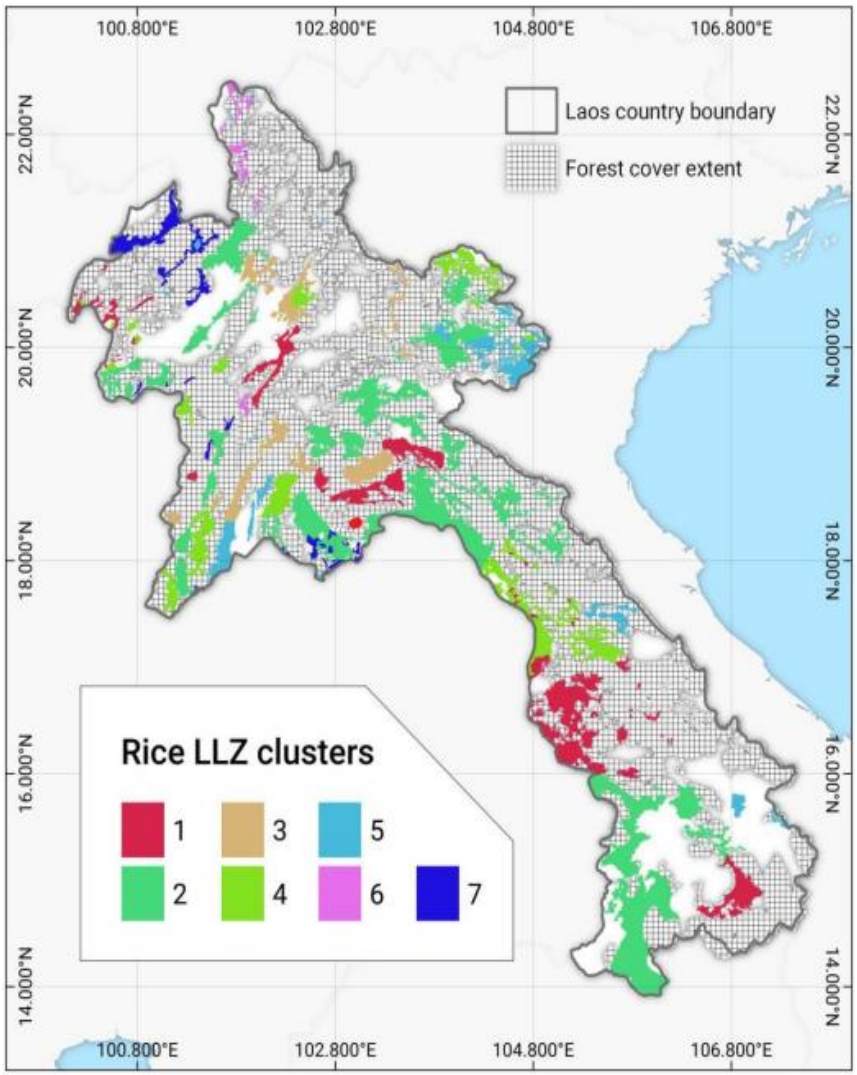
Effect of Super Typhoon Goni in the Philippines (2020)



Flood-prone rice areas in the Philippines (2014-2020)



Adaptation options – Lao PDR

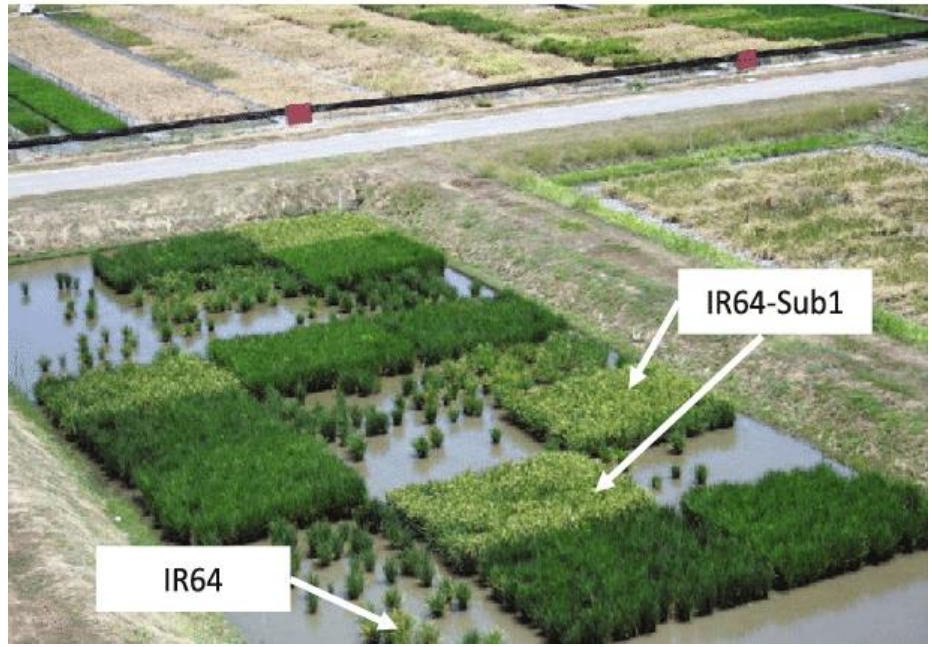


- ***Investment in irrigation*** to improve water availability and development of new farming practices will help farmers to mitigate potential impacts of climate change on rice, particularly for cluster 6
- There is a need to improve adoption/use of ***improved seed and crop varieties of rice*** to cope with challenges brought by CC, particularly for clusters 1 & 7
- Improvement in ***access to credit*** and income sources will help farmers particularly in areas where livelihood diversification is needed due to loses in climate suitability of rice – with emphasis for clusters 1 to 6
- ***Ecosystem-based adaptation*** may be explored in clusters with low levels of soil fertility and steep terrains, particularly for clusters 3 and 6

Palao et al. 2021

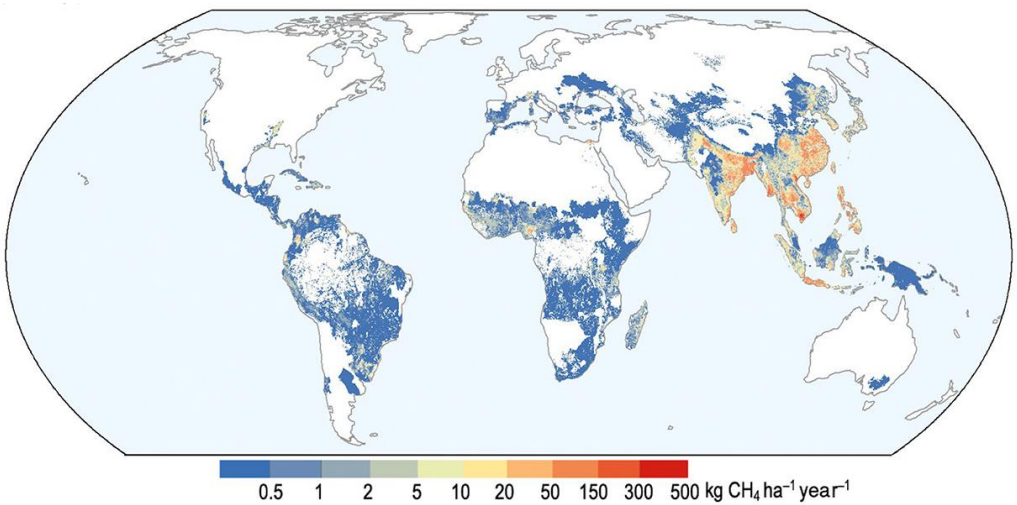
Breeding for climate resilience

- Breeding for tolerance to drought, flood, heat, cold, and soil problems like high salt and iron toxicity

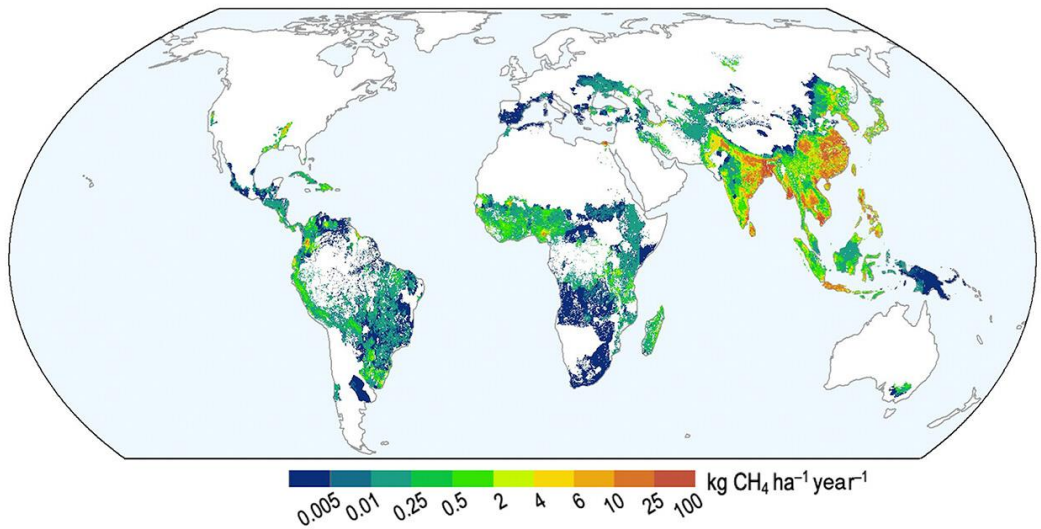


IRRI's speed breeding facility in India

CH_4 emissions from rice cultivation and mitigation potential



CH_4 emissions from global rice cultivation in 2020

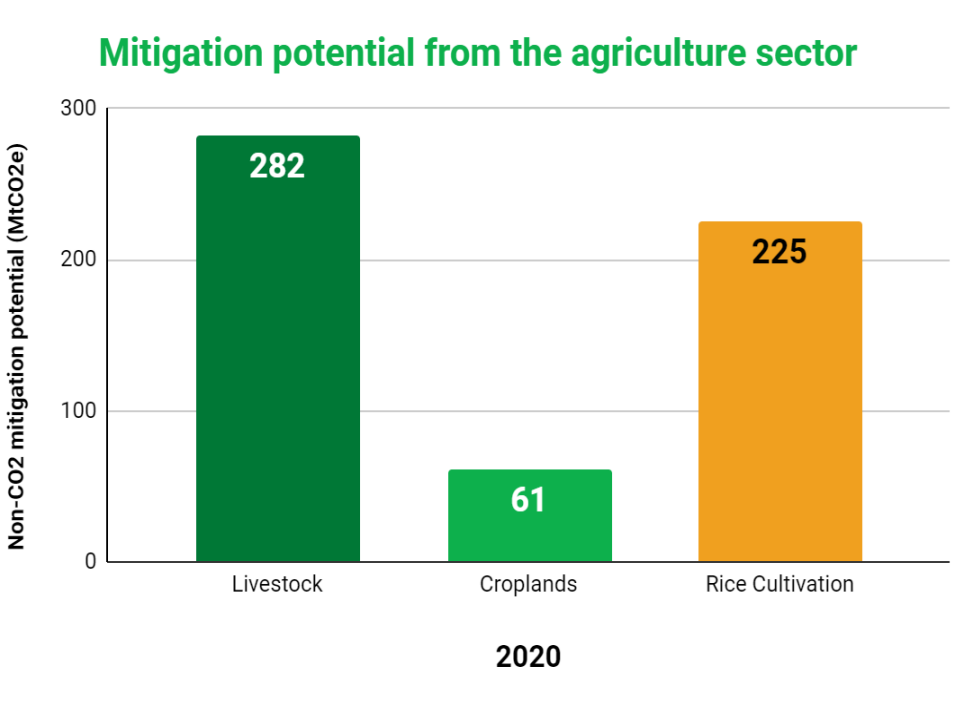


Technical abatement potential of CH_4 emissions from rice cultivation

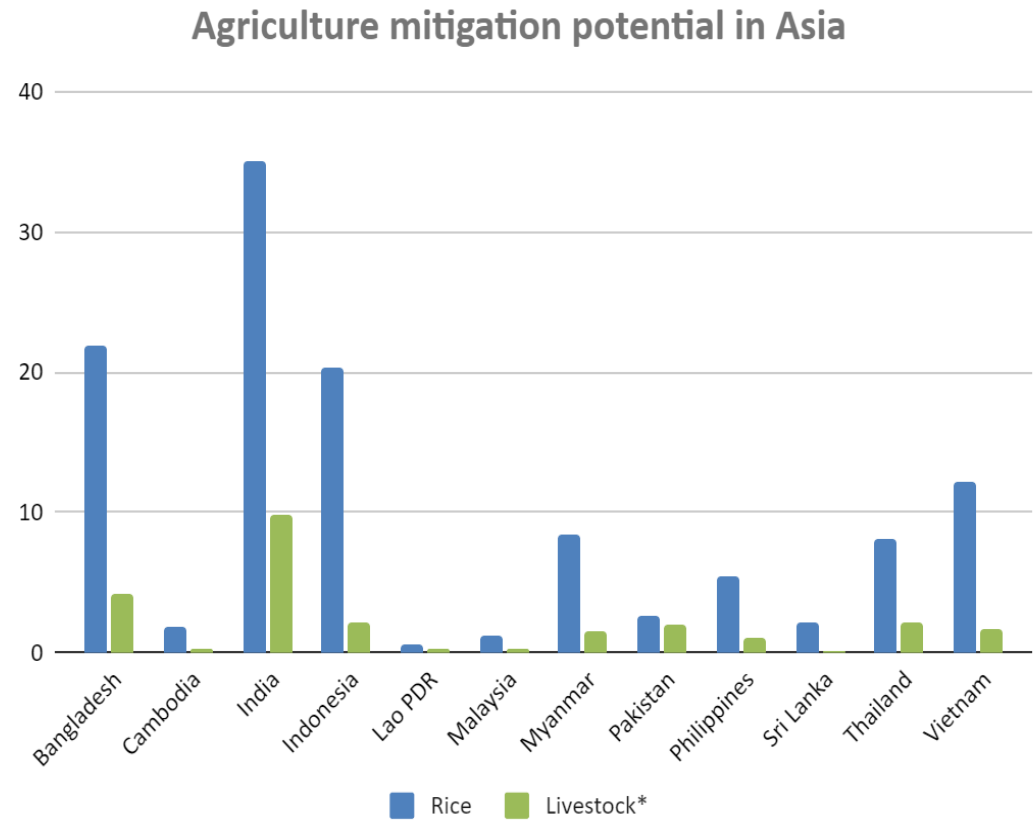
Rice production contributes 10% of the total greenhouse gas (GHG) emissions from the agricultural sector in the world, of which about 1/3 could be mitigated.

Sources: Wang et al. (2023), Roe et al. (2021)

Mitigation potential from rice

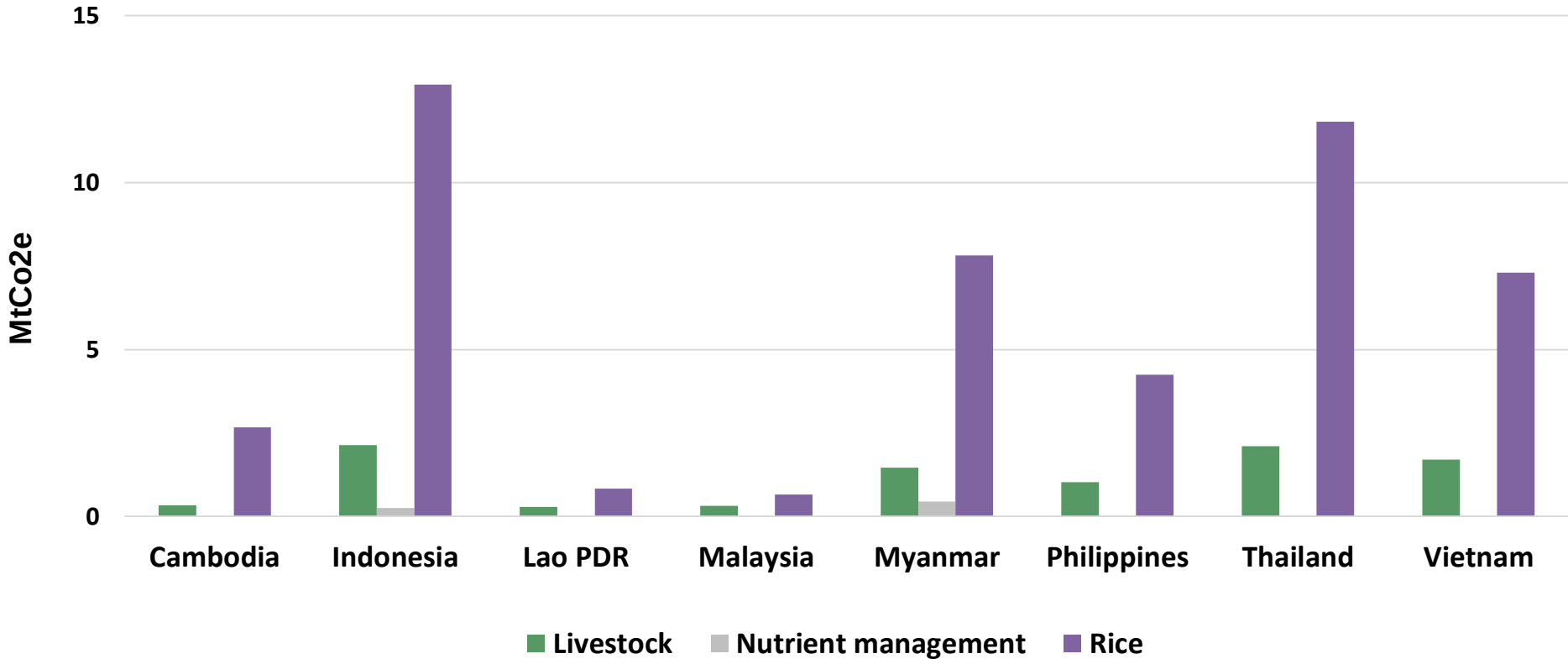


- The relative mitigation potential for rice (36%) is much higher than that of livestock (9%), and croplands (3%) (Roe et al., 2021; EPA, 2021)
- This presents immense opportunities for channeling climate funding to rural communities and smallholder rice farmers



By 2030, approximately 28% of the potential abatement in rice, or 62 $MtCO_2e$, can be abated at prices below \$0/tCO_2e with an additional 26% reduction from baseline possible between \$0 and \$20/tCO_2e (EPA, 2021).

GHG Reduction Potential in ASEAN agriculture



Sources: Roe et al. (2021), EPA (2021), Nelson (2023)

Existing mitigation options across the rice production cycle

can reduce as much as 65% - mostly methane

UP TO 10%
***Timing* of residue incorporation in field**

→

UP TO 7%
Planting short-duration rice varieties

→

Average 33%
Alternate Wetting & Drying, Efficient use of fertilizer

→

UP TO 15%
Amount of residue left after harvest, no straw burning

Different **rice cultivars** have different CH_4 emission potentials

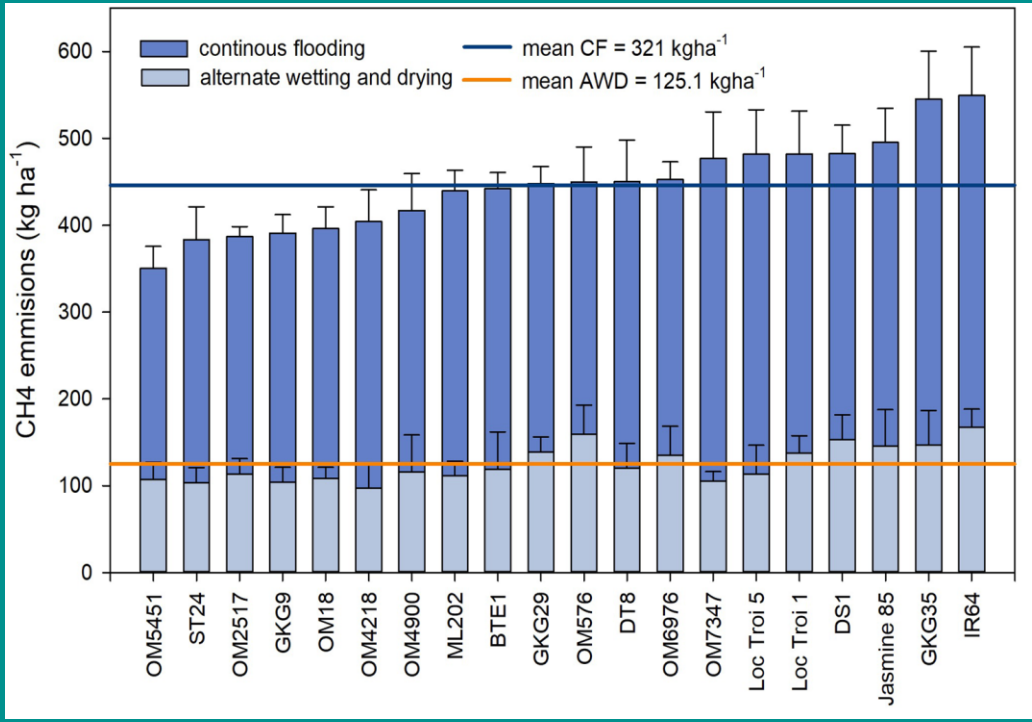
Water-saving technologies adapting rice production to climate change while reducing emissions

a) Mushroom production for a nutritious, profitable product

b) Mechanized composting to produce organic fertilizer

Technological innovations for low-emissions sustainable paddy rice production

New frontiers: Identifying low-emission rice varieties



Field experiment of Hohenheim University and IRRI in Vietnam

Source: Vo et al., 2023, manuscript in preparation

Common practices for managing rice straw

Rice straw produced (Asia)

*600 - 800 Million tonnes/year

Open-field burning (>50%)

- Nutrient loss
- GHGE and pollutions
- Biodiversity loss
  (soil-dwelling organisms such as fungi, bacteria and rotiferal)

Incorporation (>30%)

- CH4 (1 CH4 = 28 CO2-eq)
- Methane toxicity, black root diseases

(Source: https://www.irri.org/rice-straw-management)

Valorizing rice straw to enable low-emission practices

Mechanized Collection

Mechanized composting

Mushroom

Rice straw-based biomaterials/ products

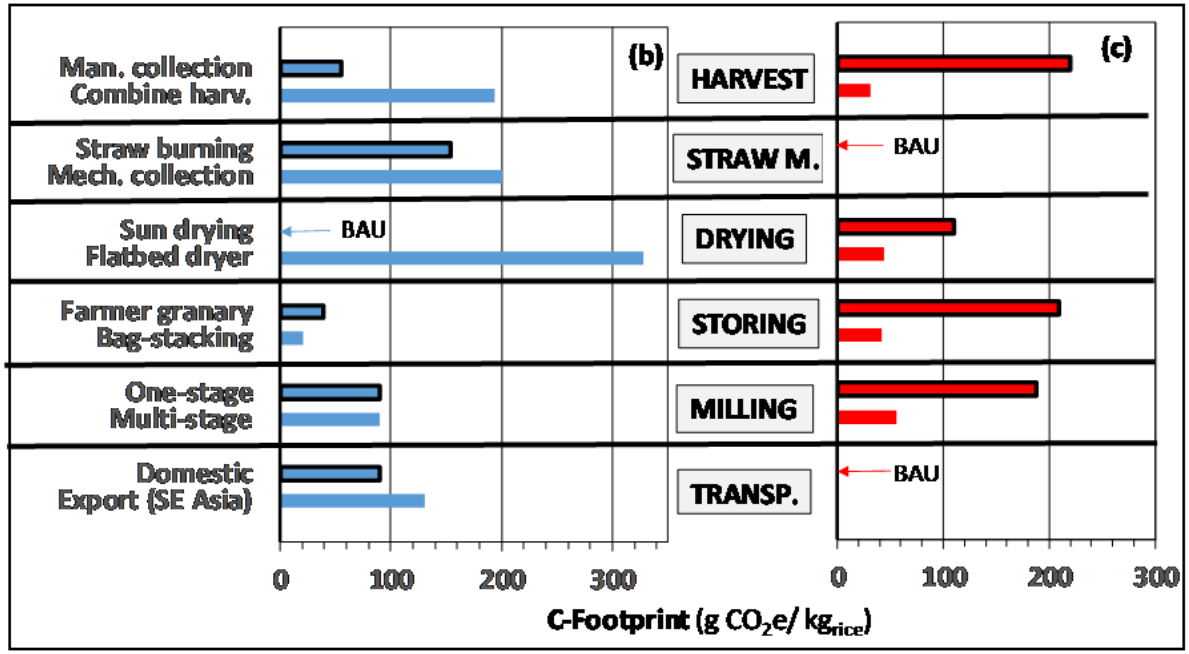
Rice straw based circular economy

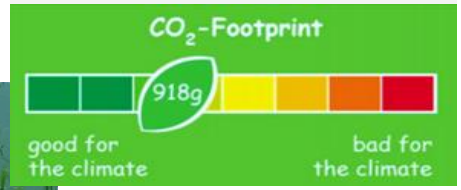
Rice straw-based circular economy with mechanized collection, mushroom, composting; adding 10% income and reduce up to 30% carbon footprint

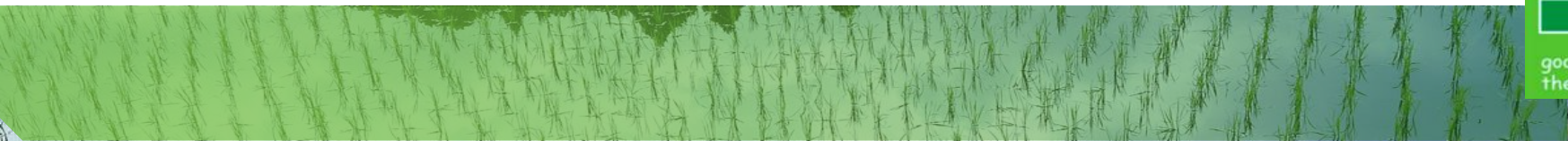
Low-emission rice value chains: Reducing losses

- Losses are unnecessary emissions
- Different technologies are associated w/ different amounts of GHGs (blue) and losses (red)

Manual harvest entails high emissions from losses; combine harvesters, although using diesel, are net climate-beneficial







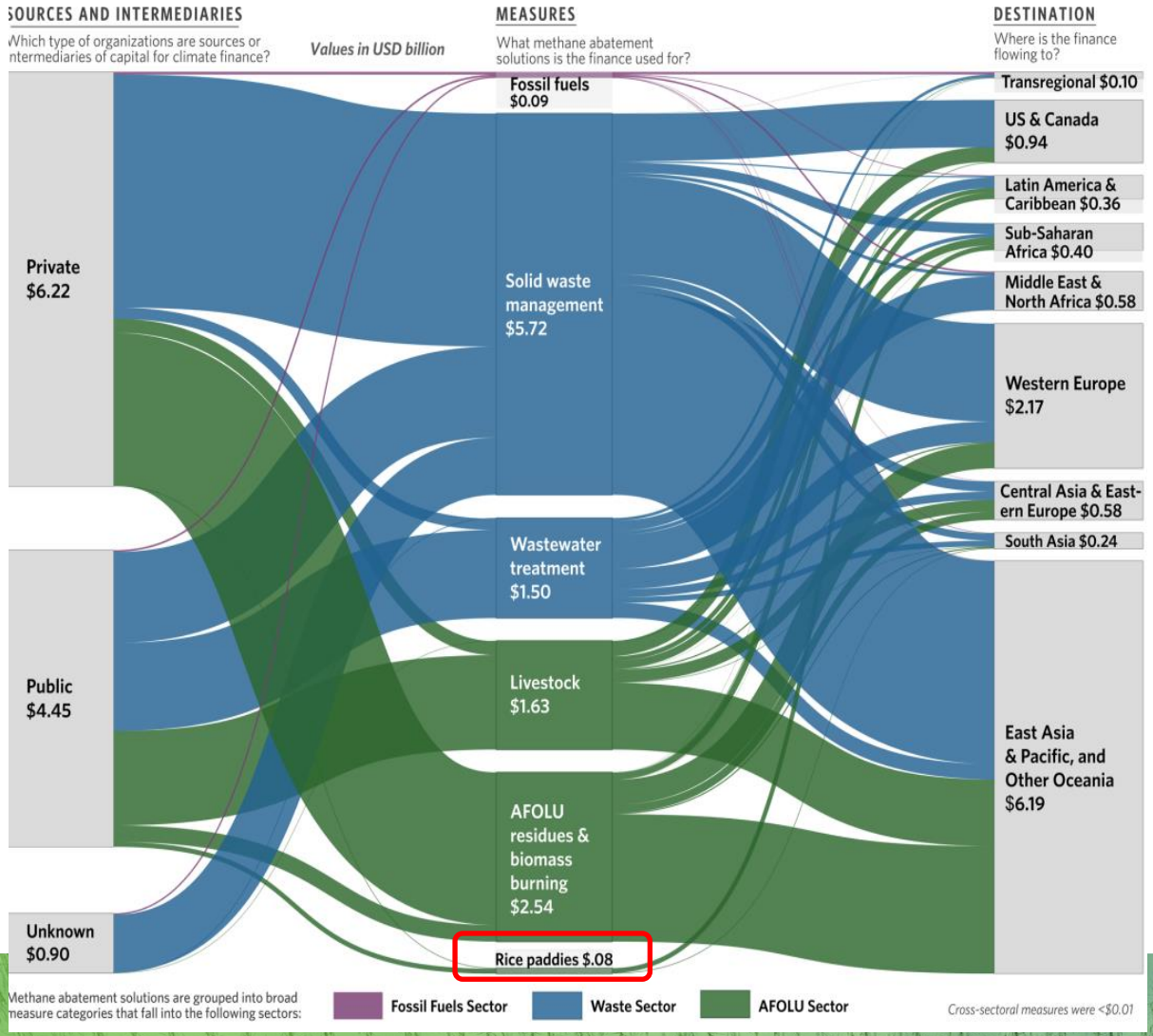
Combining adaptation and mitigation: SRP Standard for Sustainable Rice Cultivation

SRP standard, the world's first voluntary sustainability standard for rice

A framework of 12 performance indicators (PIs) is used to measure the economic, social and environmental outcomes of farmers applying the practices prescribed by the standard.

Integrated and comprehensive approach allows to achieve synergies and avoid tradeoffs

Rice Methane Reductions: yet Unrealized Opportunity



- Investments for methane reduction are geared towards waste management/ wastewater treatment, followed by livestock and residue burning
- Investments in GHG abatement in rice is very low compared to the mitigation potential
- By 2030, approximately 28% of the potential abatement in rice, can be realized at prices below \$0/tCO_2e, with an additional 26% reduction from baseline possible between \$0 and \$20/tCO_2e (EPA, 2021).

Sources: Climate Policy Initiative (2022), EPA (2021)

Carbon Registries for certifying emission reduction

United Nations Framework Convention on Climate Change

Gold Standard
Climate Security & Sustainable Development

Verified Carbon Standard
A VERRA STANDARD

SOCIALCARBON®

Methodologies

Methane emission reduction by adjusted water management practice in rice cultivation

- The only methodology for flooded paddy rice

- **Clean Development Mechanism (CDM): *AMS-III.AU***
  - Initially developed for Kyoto Protocol (mandatory emission reduction)
  - Previously accepted by voluntary carbon markets (VCS, Gold Standard, etc.) but as of March 20, 2023 Verra has inactivated the methodology

Voluntary carbon market approved methodologies:

- Gold Standard: Released July 7, 2023 - Methane emission reduction by adjusted water management practice in rice cultivation - includes N20; field stratification; standardized in-field measurements; all project sizes; new additionality requirements

- Verra VCS: ***VM0042*** *Methodology for Improved Agricultural Land Management* (complex models, not appropriate for flooded paddy soils or small-scale, highly variable management; focused on increasing soil organic carbon (SOC) storage)

What's needed to develop rice carbon market projects?

- Knowledge on carbon market eligibility and how to calculate emissions based on farmers' practices
- Training on practices that reduce emissions in rice production
- Capacity to monitor, report, and verify changes in practices that reduce emissions
- Financing for low-emission rice projects
- Government policies and regulatory frameworks for emissions trading

Contacts:

Alisher Mirzabaev

Senior Scientist, Policy Analysis/Climate Change,

International Rice Research Institute

Email: a.mirzabaev@irri.org