



Australian Centre
for International
Agricultural Research



From salinity to food security – transforming cropping systems in the Ganges delta

Mohammed Mainuddin, CSIRO Environment

11 August 2026

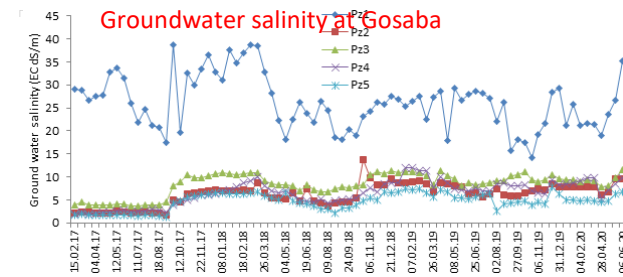
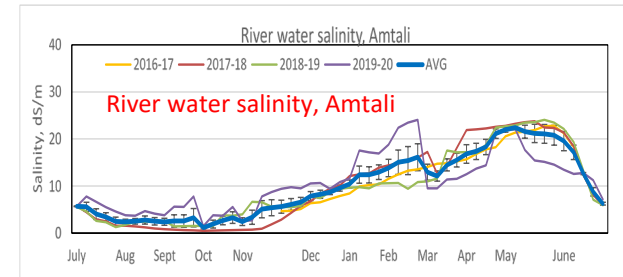
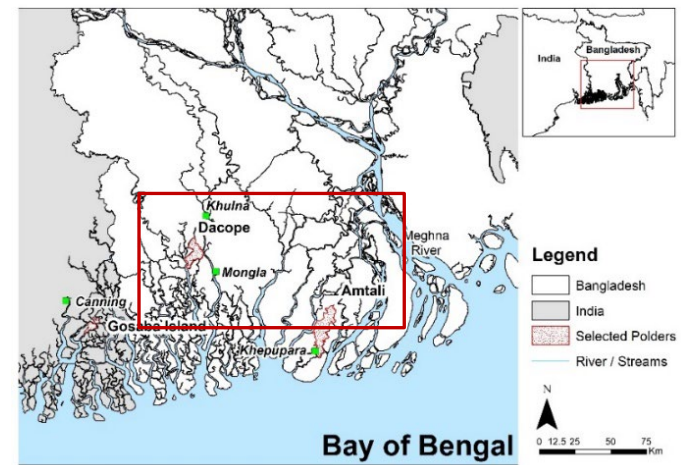




Background

- Low lying deltaic region with embankments (polders)
- 65% of the area affected by salinity in the dry season
- Groundwater and surface water is saline
- Apparent lack of irrigation water
- Monocrop region – only Rice in the monsoon season
- Dry season mostly remains fallow
- One of the worst affected areas by climate change
- 20 M people in the salt-affected lower region
- Food insecurity and limited livelihood opportunities
- **How to increase productivity and cropping intensity?**
- **How can we grow crops in the dry season by managing salinity with limited freshwater irrigation?**

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Cropping system intensification (CSI4CZ) Project

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Partners:

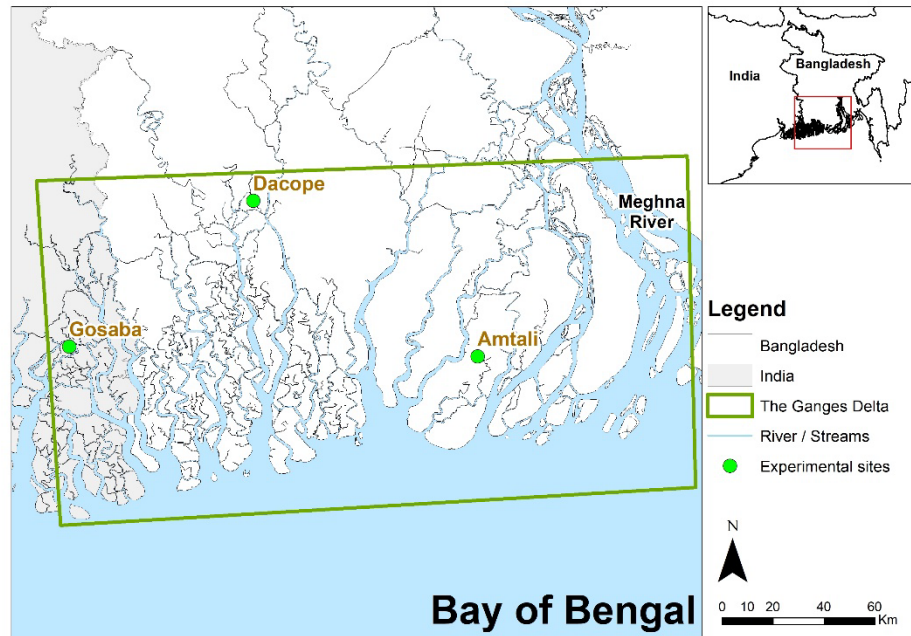
1. CSIRO
2. Murdoch University
3. 6 organisations from Bangladesh
4. 4 from India

60+ scientists, multidisciplinary

1st Phase: 2015-2021 (field and polder scale), started at 3 polders

2nd Phase: 2021-2026 (integration at the regional scale)

Funding: ACIAR, Australia and Krishi Gobeshona Foundation (KGF), Bangladesh



Project locations – 2 polders (Dacope, Amtali) in Bangladesh and one island (Gosaba in West Bengal)

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Phase I – Field and polder scale

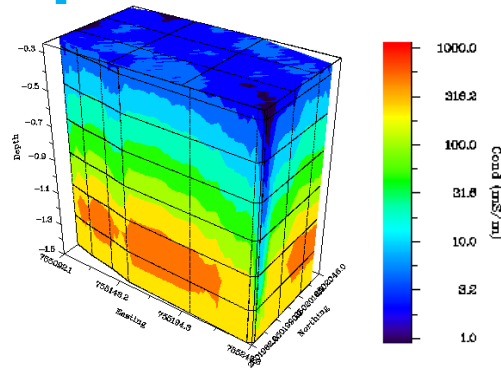
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4 main components:

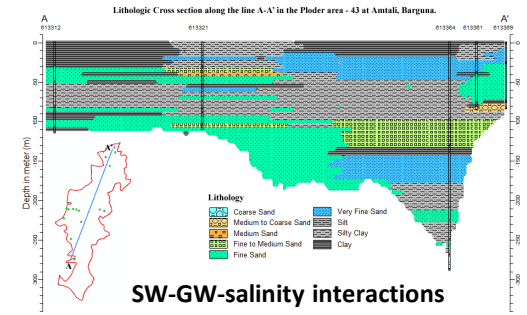
1. **Polder level modelling** – understanding salt-water interaction and salinity distribution and process
2. **Field experiments** – to understand salinity-soil-water-plant relationship
3. **Crop modelling** using APSIM
4. **Socio-economic and community** aspects

Seasons:

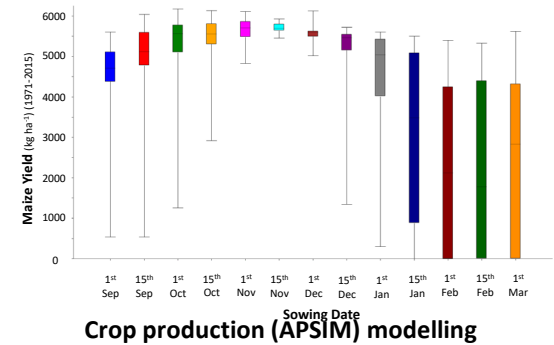
1. Kharif-I (monsoon)
2. Kharif-II (pre-monsoon)
3. Rabi (dry)



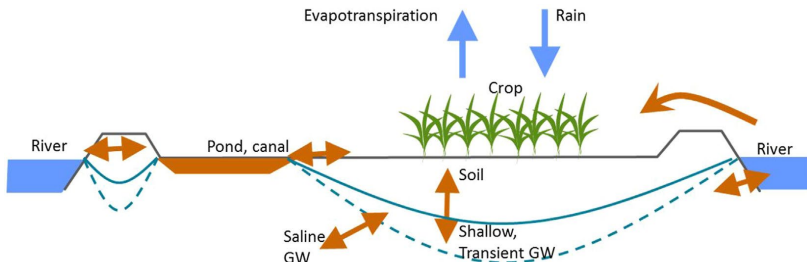
3-d soil salinity modelling



SW-GW-salinity interactions



Crop production (APSIM) modelling



Salt and water balance at polders



Research papers

A water and salt balance model for the polders and islands in the Ganges delta

M. Mainuddin^{a,*}, M. Maniruzzaman^b, D.S. Gaydon^c, S. Sarkar^d, M.A. Rahman^e, S.K. Sarangi^f, K.K. Sarker^g, J.M. Kirby^a

Contents lists available at ScienceDirect

Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol



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Experiments on soil- salt- water - plant-relationship

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- Introduction of new salt-tolerant rice varieties
- Testing new crops for suitability
- Experimenting with agronomic management
- Introduction of salt-tolerant rice in the dry season
- Experiment on irrigation and water management

Worked throughout all seasons

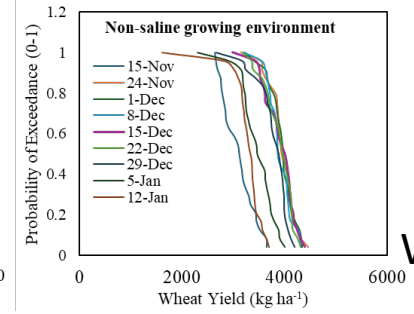
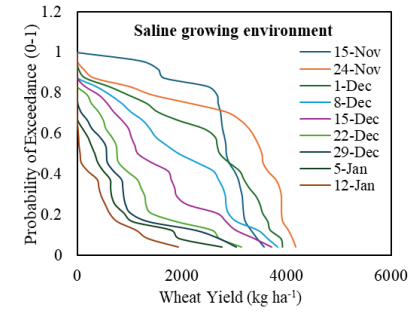
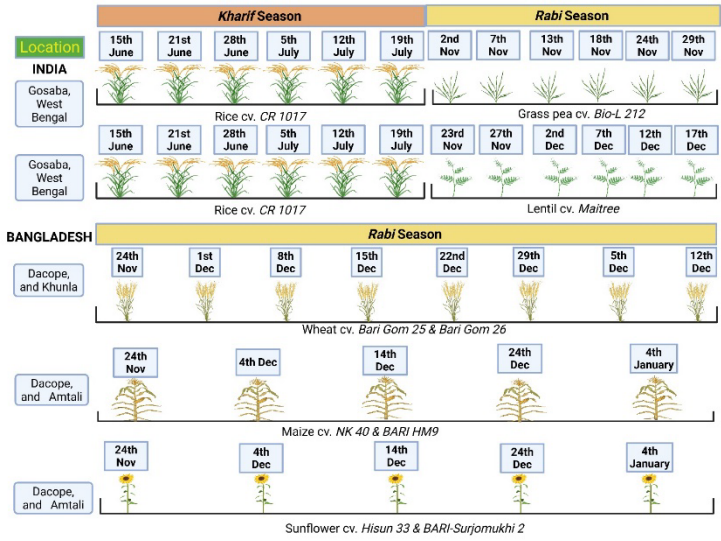


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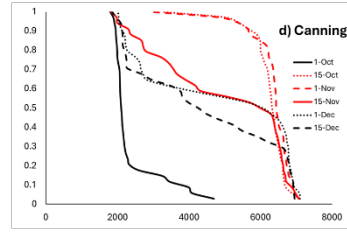
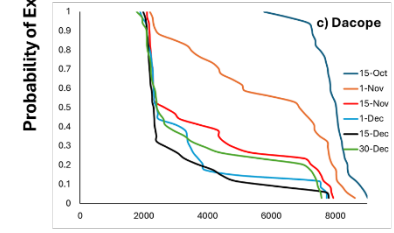
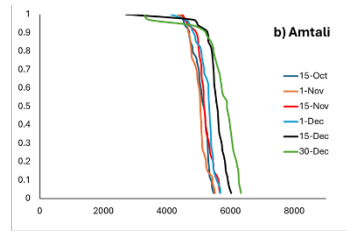
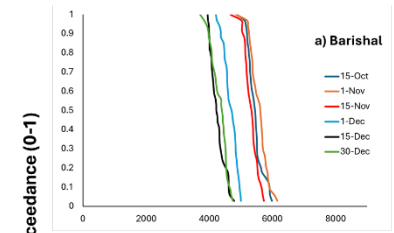


Suitable sowing date and agronomic management

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Wheat



Boro rice

Contents lists available at ScienceDirect

Agricultural Systems

journal homepage: www.elsevier.com/locate/agsy

Research Paper

Achieving the once-unthinkable: Successful Rabi cropping via technology integration in coastal saline Bengal

Donald S. Gaydon^{a,*}, Sukamal Sarkar^{a,b,*}, Mohammed Mainuddin^c, Edward G. Barrett-Lennard^d, Richard W. Bell^d, Koushik Brahmachari^e, Md. Maniruzzaman^f, Buddheswar Maji^g, Md. Alimur Rahman^h, Md. Enamul Kabirⁱ, Md. Harunor. Rashid^h, Md. Shahidul Islam Khan^h, Mustafa Kamal Shahadat^h, Khokan Kumer Sarker^h, Mark R. Gloverⁱ, Sukanta Kumar Sarangi^h, Apurbo Kumar Chaki^h, Dhiman Burman^g, Md. Belal Hossainⁱ, Uttam Kumar Mandal^g, Jatish Chandra Biswas^f, Mst. Shetara Yesmin^f, Priya Lal Chandra Paul^f, Md. Jahangir Kabir^f, Kshirendra Kumar Mahanta^g, Palash Kumar Kundu^f, Manoj Kumar Nanda¹

The APSIM-simulated probability of exceedance for grain yields

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- Zero tillage
- Dibbling and pit
- Transplanting of crops usually sown
- Use of machine – PTOS
- Relay cropping





Irrigation

- Drip irrigation
- Conjunctive use of saline and fresh water
- Use of mulch to prevent soil ET
- Drainage

Plant Soil
https://doi.org/10.1007/s11104-023-06169-2

RESEARCH ARTICLE



Flowering is the critical growth stage for adverse effects of salinity on the grain yield of sunflower

Afrin Jahan Mila¹ · Richard W. Bell² ·
Edward G. Barrett-Lennard³ · Enamul Kabir⁴ ·
Bernard Dell⁵



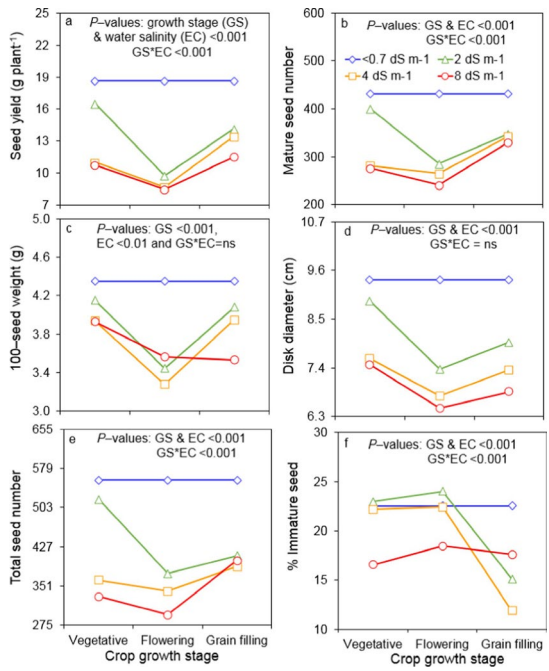
Contents lists available at ScienceDirect
European Journal of Agronomy
journal homepage: www.elsevier.com/locate/eja



Shallow drains and straw mulch alleviate multiple constraints to increase sunflower yield on a clay-textured saline soil I. Effects of decreased soil salinity, waterlogging and end-of-season drought[☆]

Mohammad Nazrul Islam^{a,b,*}, Richard W. Bell^a, Edward G. Barrett-Lennard^{a,c},
Mohammad Maniruzzaman^d

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Effect of salinity at different growth stages

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Storing surface water in canal and ponds

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- Fresh water storage developed by trapping the water within Dec. in the existing canals and ponds
- Another option is to re-excavate of existing canal



RESEARCH ARTICLE

RESEARCH ARTICLE

WILEY

Strategies of water resource utilization and agricultural water management in the coastal saline zone of Bangladesh

Md. Belal Hossain¹ | Debjit Roy¹ | Priya Lal Chandra Paul¹ |
Mst. Shetara Yesmin¹ | Palash Kumar Kundu¹ |
Mohammad Rezoan Bin Hafiz Pranto¹ | Md Aklimuzzaman² |
Mousumi Paul² | Md. Maniruzzaman¹ | Mohammed Mainuddin³



Working with community for water management

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- Conflict of water resources uses among different stakeholders
- Lack of coordination among institutes for water resource management
- To resolve these conflicts a series of discussion meetings were held among the stakeholders in both the study sites



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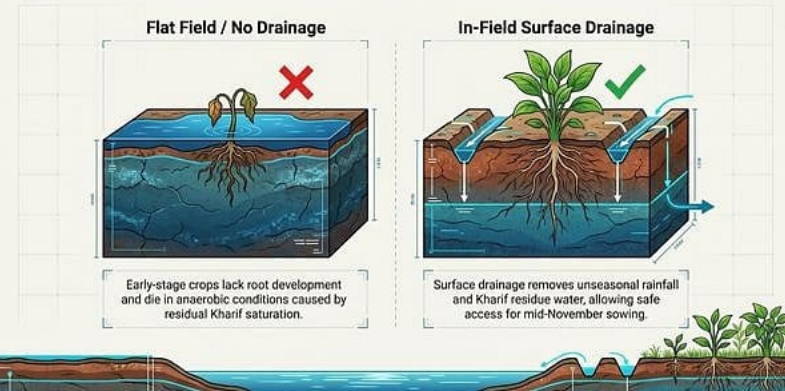
Strategies for growing crops in the dry season

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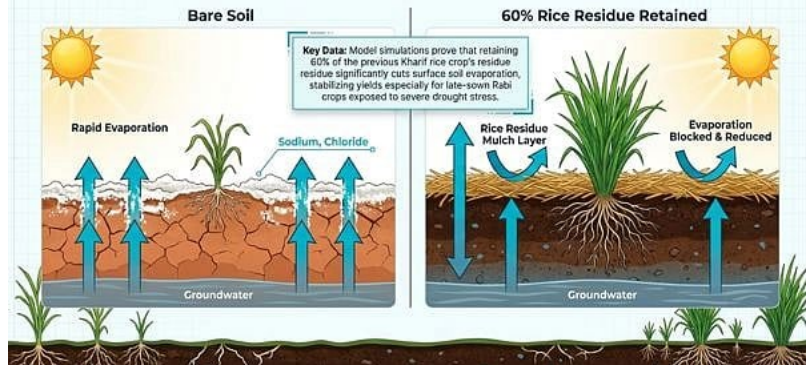
Pillars 1 & 2: Shifting the Timeline to Escape Salt



Pillar 3: Beating the Early-Season Waterlogging Risk



Pillar 4: Mulch as a Physical Salt Shield



The Once-Unthinkable Formula: A 4-Part Integration



Image credit: India water portal (based on the paper of the project Gaydon et al., 2026)

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Growing vegetables with rice in the monsoon season

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মুগাচর

জনপ্রিয় হয়ে উঠছে বস্তা পদ্ধতিতে সবজি চাষ

এইচ এম মিলন, কালকিনি (মাদারীপুর)

১৩ সেপ্টেম্বর ২০২২, ১১:১২:২৭ | অনলাইন সংস্করণ



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Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol



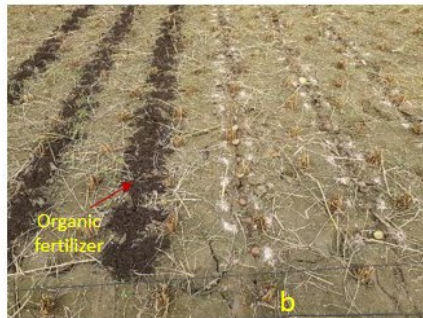
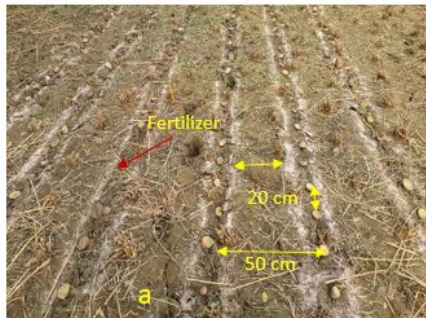
A novel system for boosting land productivity and income of smallholder farmers by intercropping vegetables in waterlogged paddy fields in the coastal zone of the Ganges Delta

M. Maniruzzaman^{a,1}, S.K. Sarangi^{b,c,1}, M. Mainuddin^{c,1}, J.C. Biswas^a, R.W. Bell^d, M.B. Hossain^a, P.L.C. Paul^a, Md.J. Kabir^a, S. Digar^e, S. Mandal^f, B. Maji^e, D. Burman^e, U.K. Mandal^e, K.K. Mahanta^e

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Zero-tillage potato cultivation with straw mulch

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Potato Research
<https://doi.org/10.1007/s11540-020-09478-6>



Potato (*Solanum tuberosum* L.) Cultivation by Zero Tillage and Paddy Straw Mulching in the Saline Soils of the Ganges Delta

Sukanta K. Sarangi, et al. [full author details at the end of the article]



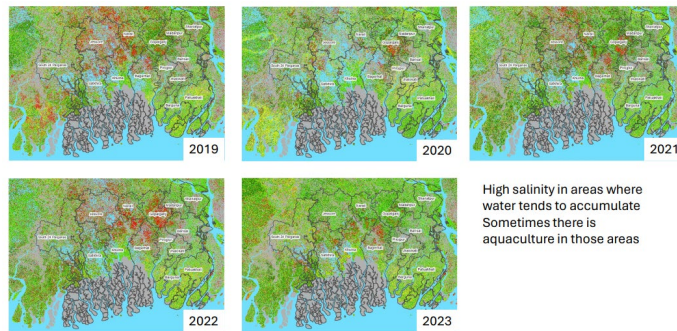
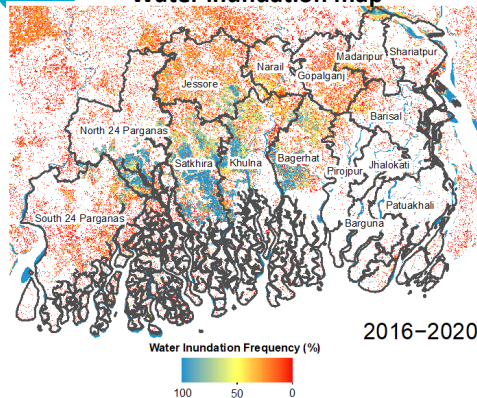
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Cultivation of a range of other crops in the dry season

Official

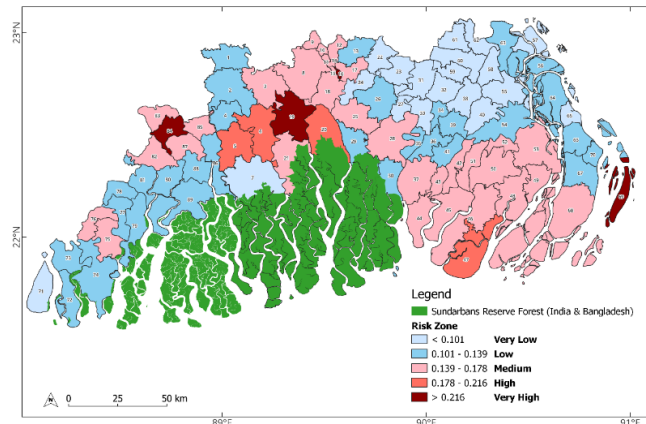


Water inundation map



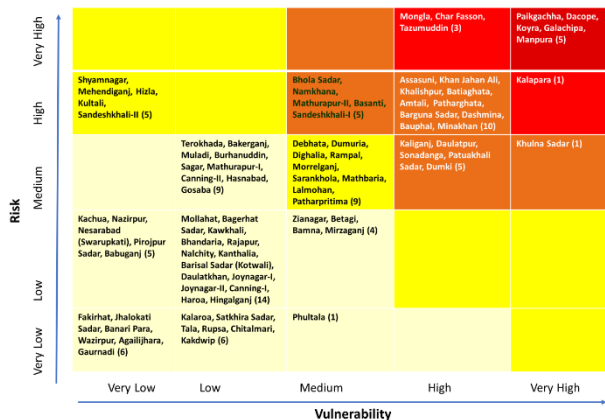
High salinity in areas where water tends to accumulate
Sometimes there is aquaculture in those areas

Soil salinity map



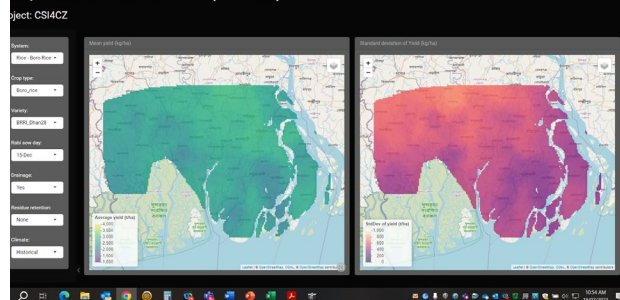
Climate risk and vulnerability

Characterization of the whole coastal zone using RS

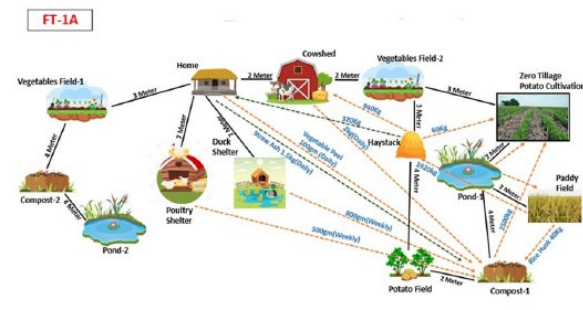


Two-dimensional decision framework for intervention prioritisation

Prop Performance Tool (APSIM)



APSIM modelling at regional scale

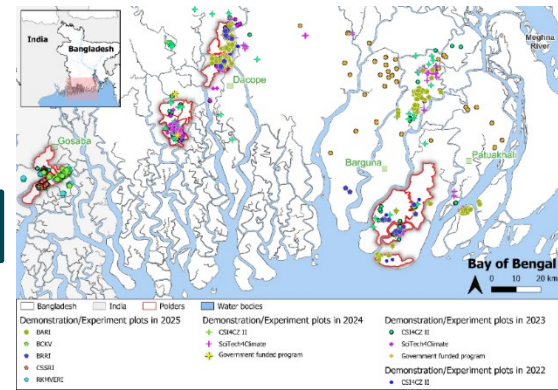
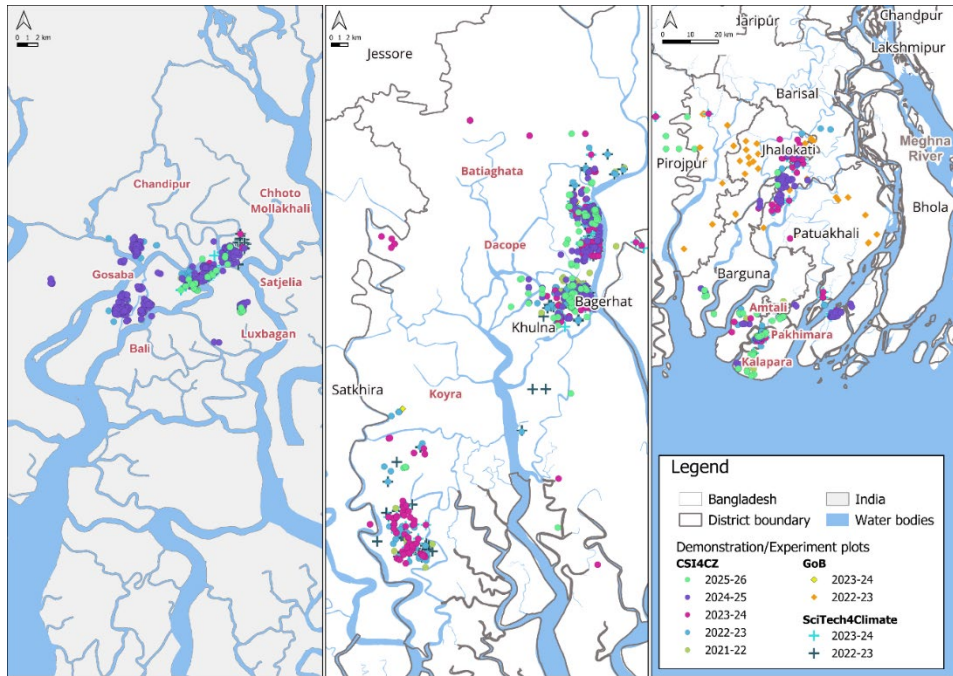


Socio-economic assessment and value chain analysis



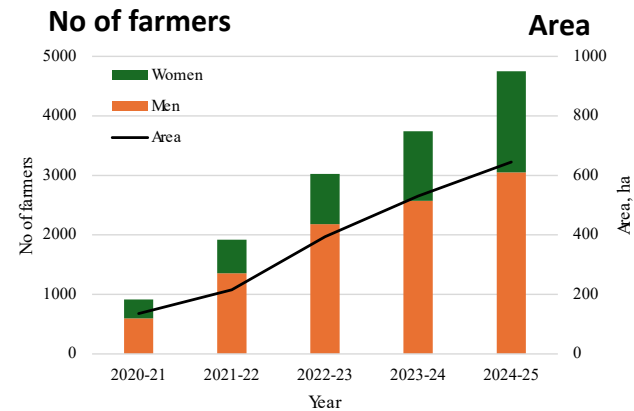
Expansion of demonstration area

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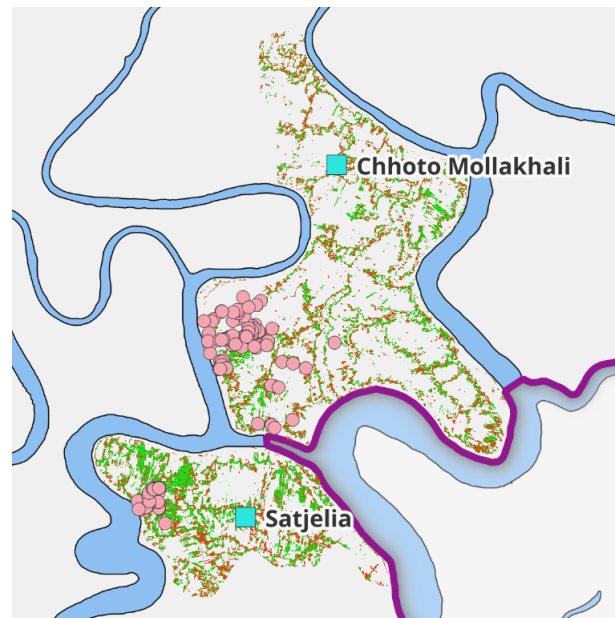
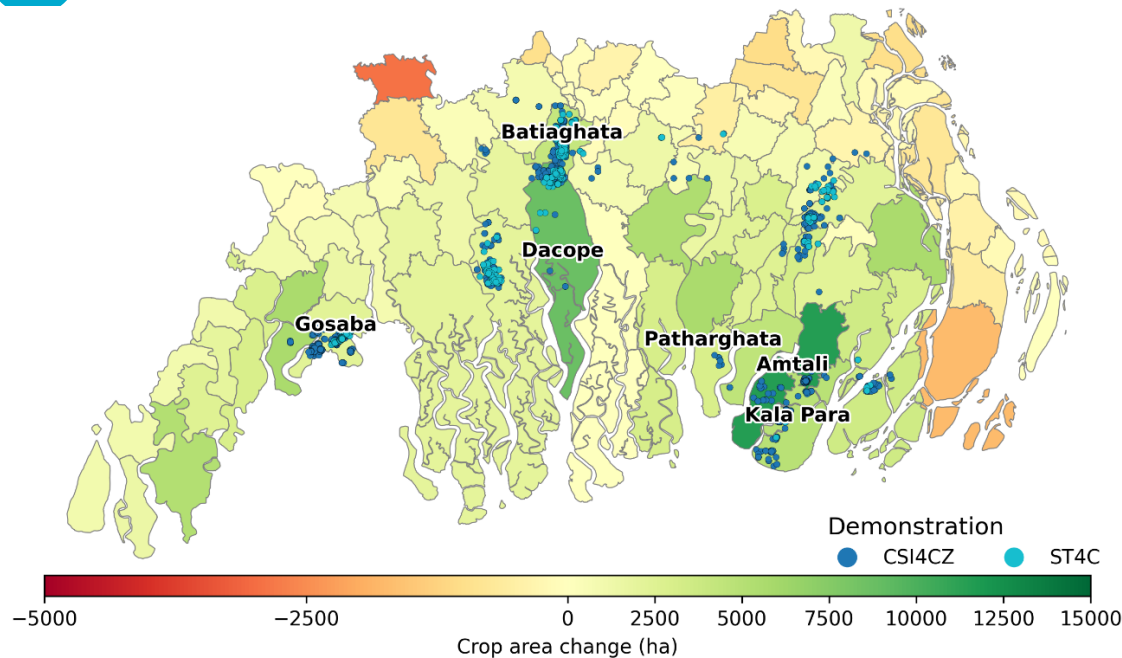
- **West Bengal** – Gosaba, Bali, Chandipur, Satjelia, Chhoto Mollakhali, Luxbagan
- **Khulna** – Dacope, Batiaghata, Koyra
- **Patuakhali** – Amtali, Kalapara, Taltoli, Patharghata
- Increasing number of sites within each location

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- No of farmers increased from 913 (2020-21) to 4,751 (2024-25)
- Total (2nd Phase) – Area- 2,324 ha, Farmers – 17,229, 36% women headed

RS images show increase in dry season area



ZT potato in two islands at Gosaba, WB

- Higher increase in area in the project in the project sites and surrounding areas
- In Dacope, cropped area increased from 663 ha in 2018–2019 to 9,381 ha in 2024–2025, 1,383 ha/year.
- In Gosaba (West Bengal), cropped area expanded from 4,827 ha to 7,149 ha, 413 ha per year



Economic and social impacts

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- Measurable improvements across human, social, natural, physical, and financial capital
- Directly improved the food security and livelihoods of 17,229 farmers (31% women)
- Over 5 years produced 4,500 tonnes of extra rice from demonstration plots - food security for 6,000 people per year over five years
- Empowered women, increased women's knowledge, technical skills, confidence, and decision-making capacity



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Capacity buildings

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Farmers

- 61 training and Field Day events involving 7,739 farmers (36 % women) (last 5 years)
- 25,168 farmers (42% women) participated in other events (last 5 years)

Scientists, PhD and MS fellows

- 7 JAF PhD from Bangladesh in Australia
- 10 KGF PhD fellows in Bangladesh
- 10 PhD, 26 (Phase-2) MS student in India
- Formal and informal training for the scientists, participation in international conferences, and symposium
- Opportunities for scientists to spent 6-8 weeks at CSIRO and Murdoch University



Farmers training



Field Day



Training at Murdoch Uni,
2023



DuelEM Training at
BARI, Jul 2025



ACIAR Symposium, Can Tho, Mar 2024

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Over 100 Journal articles and 5 Book Chapters published on wide range of topics

Impacts in Australia

- Use of optical remote sensing work to characterise cropping dynamics in the Murray–Darling Basin
- ECa methodology used to interpret wheat trial results in Australia
- Significant contribution to APSIM: adoption for complex coastal salinity environment, development of grass pea, potato, Aus rice models

Global impacts

- Scaling of ZT potato by CIP in Bangladesh, India, Cambodia, Africa (Kenya, Malawi) and Latin America (Peru) in non-saline, water-scarce area
- Mekong Institute – project to scale in Southeast Asia



Photo 1: Zero tillage Potato Cultivation in Fallow Land, Pankhal, Dacope. Credit: Md. Monower Hossain

Adoption and non-adoption of Potato Production through Zero Tillage with Rice Straw Mulch (PZTM) in coastal Bangladesh

Adoption and nonadoption of minimum tillage potato cultivation resulting from mechanized rice farming in Vietnam

Nozomi Kawarazuka¹, Trang Bui¹ and Ha Trang Phung²

¹Regenerative Agriculture, International Potato Center, Hanoi, Vietnam and ²Formerly Crop Improvement, International Potato Center, Hanoi, Vietnam



Contents lists available at ScienceDirect

Journal of Agriculture and Food Research

journal homepage: www.sciencedirect.com/journal/journal-of-agriculture-and-food-research



Potato production under zero tillage with rice straw mulching as a promissory technology to diversify rice-based systems in Southwest Coastal Bangladesh

David A. Ramirez^{a,*}, M. Monower Hossain^b, E.H.M. Shofur Rahman^c, Carlos Mestanza^{a,d}, Javier Rinza^a, Johan Ninanya^{a,d}, Felipe de Mendiburu^d, Hildo Loayza^a, Marcel Gatto^{e,f}, Jan F. Kreuz^a

CIP papers and brochure



Communication and Dissemination

- Organized workshops for the stakeholders and policy makers
- 11 episodes (~25 min each) of TV program in national TV channels in Bangladesh
- 1 episode (~25 min) in Indian national Bangla channel (Doordarshan)
- Many TV interviews of local scientists
- **Shushilan song and dance drama** - live performance to communicate the technologies to the farmers
- 6 ACIAR blogposts with 5-6 min video
- International (USA) journalist visited project site and published [articles and podcast](#)
- 50 Newspaper articles in Bangladesh and India (over the last 5 years)





Achievements

- Featured in Australia-India Roadmap
- Minister of Agriculture in Bangladesh visited project sites in 2020, 2022
- Workshop with Minister of Agriculture, West Bengal
- Land and Water - **Effective Communication of Science Award 2021**
- Agriculture and Food –**Impact Award 2024**
- ACIAR Commission visit to Bangladesh – Feb 2023
- AHC India – visit West Bengal, 2022
- Additional funding from DFAT, the GoB for out-scaling and canal reexcavation



Deputy Aus High Commissioner and Consul General visit



ACIAR Commission visit, Feb 2023



Lessons Learnt

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- The Coastal zone has long been characterised as a wicked environment with intractable limitations
- Needed integrated/transdisciplinary research to crack
- True collaboration with Australian partners, training, ongoing access to data and tools
- Technologies developed and tested in the farmers' field
- Provide a framework for testing of technologies, for out-scaling, and for prioritisation of investments
- Relevance to other mega-deltas – Mekong, Indus, etc.
- Focused on crop - Important to broadening the scope to encompass other aspects of livelihoods – livestock, aquaculture, drinking water availability, salinity related health issues

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Thank you

Environment

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