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MEKONG SUSTAINABLE RICE

Message from the Project Leader

Dr Jaquie Mitchell

Following on from our successful mid-term review, the team has continued to work hard to progress their respective activities. In this newsletter you can read about: the significant work being conducted in Australia to improve tolerance to foliar disease for tropical production; the investigation by the AGU team of the applicability of the Paddy Vision for rapid assessment of fresh paddy quality for rice growers in the Mekong Delta; the excellent molecular training workshop delivered by UQ at CLRRI to share the latest in molecular analysis tools to improve efficiency in rice breeding; the positive feedback from the farmers field day and workshop led by CTU team promoting

Australian Centre for International Agricultural Research | Australian Aid | SunRice Group | Viet Nam National University Ho Chi Minh City | Đại Học Cần Thơ | Viện Lúa Đồng Bằng Sông Cửu Long CLRRI | The University Of Queensland Australia — Create Change

sustainable rice production of DS1 in Kien Giang; and the pre-breeding activity conducted by UQ to improve disease resistance and aerobic adaptation via the import of novel genetic material from IRRI and CIAT.

Amongst the hive of activity, I was privileged to attend in person, the ACIAR hybrid brown bag session in September at the Australian Embassy in Hanoi, to highlight the wonderful achievements and impact our project is having on the ground contributing to improved livelihoods of Mekong rice farmers. After the welcome remark by the Australian Ambassador to Vietnam HE Andrew Goledzinowski, Dr Todd Sanderson, ACIAR Research Program Manager, Social Systems opened the session which focused on ACIAR-funded projects supporting the sustainable development of Vietnam's rice sector. The four ACIAR-funded projects briefly introduced were:

- Supporting greenhouse gas inventories and targeted rice mitigation options for Vietnam (CLIM/2019/150) delivered by Tran Van The
- Support policymakers and farmers in green agriculture reform: rice production in Vietnam (SSS/2024/107) delivered by Long Chu
- Planning and establishing a sustainable smallholder rice chain in the Mekong Delta (AGB/2019/153) delivered by Jaquie Mitchell
- Farmer options for crops under saline conditions in the Mekong River Delta, Vietnam (SLAM/2018/144) delivered by Chau Minh Koi

The ACIAR hybrid session was attended in person by ACIAR team & ACIAR research partners, relevant Embassy teams: Development; Economic; Agriculture; Aus4Innovation team; and CG. Ms Thu Ha from SNV (managing the TRVC project funded by DFAT) and media representatives, as well as a number of online participants including our RPM David Shearer. Challenging big picture questions were raised and it was determined that a longer session was required to discuss and capitalise on the learnings of each project and the synergies and opportunities that coming together can offer.

I then enjoyed a quick trip to the Mekong Delta (MD) with a field visit at CLRRI, where I also met with key team leaders to ensure that all is on track as we head towards project completion, only 15 months left! One significant output to note was that our next annual meeting will be held in the MD in May 2025 (please put it in your calendar).

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The other important point to mention at this time, is that I would like to sincerely thank Dr Bin Ho for his commitment and leadership as in-country project coordinator and on behalf of all project members I wish him all the very best in his new role as Deputy DARD of AG province. We are fortunate that Dr Binh Ho will continue to be involved in our project as an expert advisor with the AGU team. I would also like to take this opportunity to welcome our projects new in-country coordinator AGU's Vice Rector Dr Tri (Nguyen Huu Tri). Dr Tri is an expert in economics and business administration, and I am sure his experience will be of significant benefit to our project.

This quick trip to Vietnam provided me with confidence that our work on the ground is having significant impact and our learnings can contribute to the Vietnamese government 1 million ha project. I encourage you to ensure that we are capturing our learning and stories such as that recently highlighted in the ACIAR in Vietnam August 2024 publication as some of these are truly remarkable and contributing to positive change for both smallholder farmers and other stakeholders that are engaging in this market-led high quality export value chain.

I hope you enjoy the read and celebrate the great efforts made by the team and appreciate the impact that the collective effort is producing.

Photo
A farmer examines rice crops during the Farmers' Field Day at Hiep Loi Cooperative, highlighting sustainable practices from the DS1 rice production model.

Significance of Tolerance to Foliar Disease for Australian Tropical Production

Rice Research Australia Pty Ltd

Historical incidents of bacterial leaf blight and rice blast have hampered commercial lowland rice production in tropical Australia, due to poor tolerance of commercial varieties (Photo 1a). Selecting for a durable source of varietal tolerance and pre-emptive breeding using molecular markers has in part identified the suitability of future varieties for lowland culture, but the movement to aerobic production in tropical Australia (Photo 1b) has highlighted the need for tolerance to Brown Spot (*Bipolaris oryzae*) and Rhizoctonia, also known as Sheath Blight (*Rhizoctonia solani*) (Photo 2).

(1a)

Photo
(1a) Purpose built blast nurseries in Northern Territory in which mid-season drainage was utilised to exacerbate blast incidence on sensitive varieties under lowland production.

(2a)

(2b)

Photo
Rhizoctonia (2a) and brown leaf spot (2b) reduce the current photosynthate available to developing grain, resulting in remobilization of stored assimilate in the stems causing lodged crops.

(1b)

Photo
(1b) Multi-environment trials under aerobic condition for which lodging and grain yield is assessed.

Before ascending to multi-environment evaluation, new varieties need to demonstrate either a low disease rating for these pathogens or compensatory morphology characteristics (short stature or thick stems) to mitigate grain yield losses due to lodging. To this end varieties with thick stems, short stature or erect leaves, have tolerated these foliar diseases adequately to not incur lodging.

To assess disease tolerance two multi-environmental trials (MET) were conducted in 2022 and 2024 in Mackay, Queensland. Pre-breeding lines had lower blast incidence compared to the commercial check Topaz in 2024 and comparable or lower brown spot and Rhizoctonia responses across years compared to Doongara and Topaz (Table). It's envisaged greater tolerance in future varieties for aerobic production for tropical Australia will be from a combination of conventional selection on morphological characteristics through field phenotyping in disease nurseries coupled with marker assisted selection for known disease genes. A new cohort of 30 introductions from CIAT are currently being evaluated for tolerance to Rhizoctonia and Brown leaf spot in this season's (2025) disease nurseries, with the hope of identifying future donor material.

Table
Disease incidence of Panicle blast, brown spot and Rhizoctonia (lower values are best) in Mackay, North Queensland of MET trials in 2022 and 2024.

Variety	Panicle blast		Brown spot		Rhizoctonia	
	2022	2024	2022	2024	2022	2024
Doongara	NA	1.0	6.3	1.0	5.6	1.3
Topaz	NA	4.3	3.3	1.0	2.7	1.0
V017	NA	1.3	3.1	1.0	2.4	1.7
YRF210	NA	1.7	3.6	2.0	1.4	1.7
MSD22=10-18	NA	1.7	4.3	1.3	2.2	1.3
MSC16n=08-12		2.3		1.7		2.7
Mean		2.1	4.1	1.3	2.9	1.6
Standard Error of Differences	NA	0.3	1.1	0.2	1.3	0.3

Investigating the Applicability of a Novel Technology (PaddyVision) for Rapid Assessment of Fresh Paddy Quality for Rice Growers in the Mekong Delta Region

An Giang University

Annually, the Mekong Delta produces approximately 24 millions of tons of paddy rice during harvest season, million tons of rice paddy are transported to milling factories by boats. Each rice boat typically carries 40-90 tons. This results in a substantial number of boats arriving at factories during harvest. Quality control personnel must collect and analyse samples from each boat, a process taking approximately 1.5 hours per sample. This creates a significant workload and time investment in quality assessment, leading to delays in payment, boat congestion, and post-harvest rice loss. To address this issue, the PaddyVision device was designed and manufactured for rapid analysis of fresh paddy rice quality. Developed by the SunRice Group in Australia, it is the first of its kind in Australia and globally. The device utilises image analysis technology to quickly measure several quality parameters in fresh paddy rice, particularly the percentage of broken grains and immature green grains. PaddyVision enables rapid rice quality determination within 5 minutes, significantly reducing assessment time.

Photo
Collecting fresh paddy samples directly from the boat for quality assessment and prepare samples for analysis using PaddyVision.

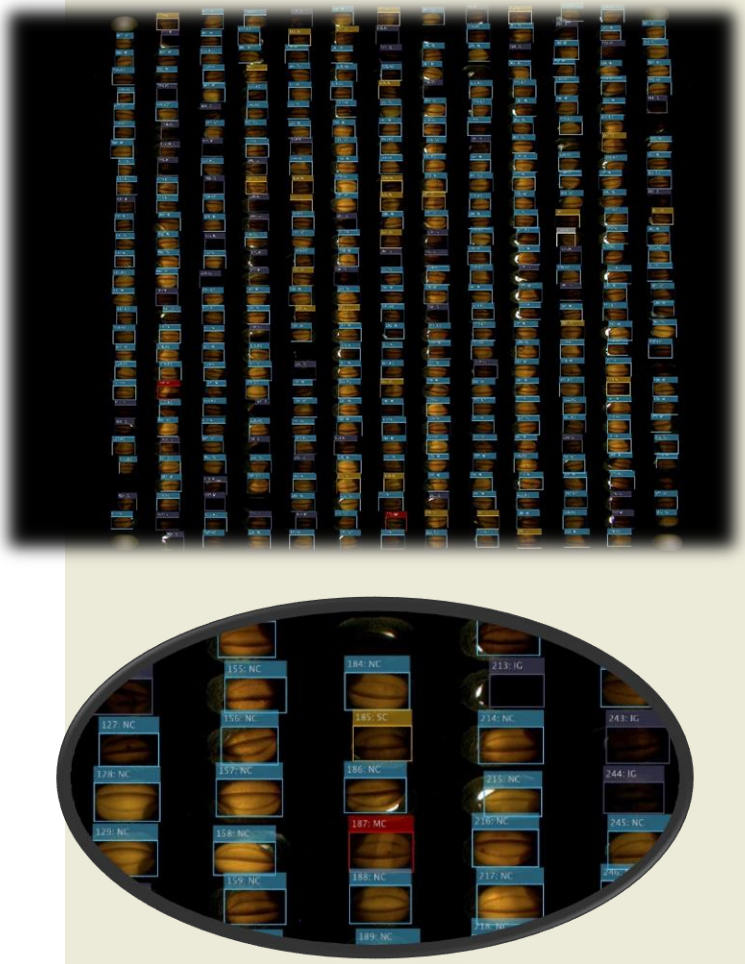


Photo
Results of image analysis inside fresh paddy grains using PaddyVision.

The SunRice Group has conducted successful trials of PaddyVision in Australia. However, due to differences in rice varieties, cultivation practices, and grain lengths between Australia and Vietnam, along with the presence of both fresh and dry paddy rice in the Mekong Delta compared to only fresh paddy in Australia, further research is necessary to evaluate the device's accuracy under Vietnamese conditions. Ms Ngan Tran, a bachelor student in food science of An Giang University conducted research to compare and contrast testing results of PaddyVision with traditional methods. The collected data provides an important database to calibrate PaddyVision for application in the Mekong delta. Three popular rice varieties including DT8, DS1 and OM18 were collected at four different provinces which are An Giang, Dong Thap, Hau Giang and Kien Giang. These are top provinces of rice production in the Mekong Delta. Paddy in the same batch can be cracked and immature, these are two very important criteria to evaluate rice quality.

The research indicates that the PaddyVision could accurately determine cracking degree of fresh paddy of all three varieties. With the immature ratio, the PaddyVision give higher results than traditional method, therefore it may need further adjustment to improve accuracy. On the other hand, dried paddy of long grain paddy could be affected on accuracy of the PaddyVision as the PaddyVision was originally designed for medium grain varieties. The researched data was exploited to adjust the PaddyVision to improve the accuracy for long grain paddy. In this way, PaddyVision could be widely use to manage rice paddy quality in the Mekong Delta in the near future.

The PaddyVision device represents a significant step forward in rice quality assessment by significantly reducing analysis time and improving efficiency compared to traditional methods. While initial trials in Australia have been successful, further research in the Mekong Delta is needed to address differences in rice varieties and processing conditions. Adapting the device based on local data will improve its accuracy, ultimately streamlining quality control processes and reducing issues such as post-harvest delays and losses in the region.

Applying Molecular Analysis Tools to Improve Efficiency in Rice Breeding

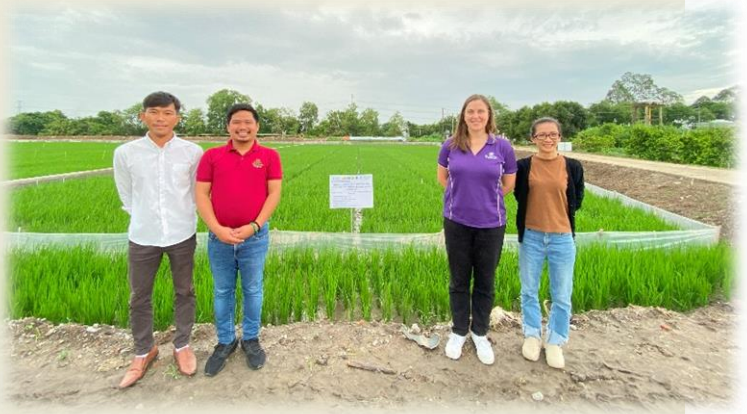
Cuu Long Delta Rice Research Institute

As we face the growing challenges of climate change, food security, and sustainable agriculture, it is imperative to leverage molecular tools to enhance crop traits, improve yield, and ensure resilience. The molecular training workshop was held from July 16-19, 2024, at CLRRI organised by the University of Queensland, with the participation of 27 researchers and experts including 22 from CLRRI, 2 from CTU, 1 from Lao PDR, and 2 from UQ. The workshop aimed to provide a platform for experts, and researchers to share insights, discuss innovative approaches, and explore how molecular biology can drive the development of superior crop varieties as well as the effective use of molecular biology tools in plant breeding.

(a)

(b)

(c)



Photo

(a) Participants practice using bioinformatics tools in next-generation sequencing through galaxy. (b) Participants of the workshop with UQ trainers. (c) Experts and researchers visit rice experimental field at CLRRI.

The workshop comprised both theoretical and practical sessions focusing on various topics essential for modern rice breeding. Participants engaged in next-generation sequencing analysis through Galaxy, learned about linkage map generation using R/qtl, and explored QTL identification through linkage mapping. Other topics included the development of molecular markers (KASP marker), review of molecular and cell biology, genome-wide association analysis, how to design primers for SNPs, insertion-deletion markers (gel-based) etc. Theoretical discussions provided a strong foundation, while practical sessions allowed participants to apply these techniques hands-on. The integration of molecular biology tools in breeding programs is pivotal for enhancing rice varieties to withstand both biotic and environmental stress and improve yield. The training workshop's comprehensive approach facilitated a deep understanding of these methodologies, equipping attendees with the knowledge to advance their research and breeding efforts.

At the conclusion of the training workshop, feedback indicated high satisfaction among participants regarding the quality of expertise shared and the knowledge exchanged. This event highlighted the importance of continued collaboration and education in molecular biology to meet the evolving challenges in rice breeding and ensure sustainable agricultural production.

Farmers' Field Day Promotes Sustainable Rice Production in Kien Giang

Mekong Delta Development Research Institute, Can Tho University

The "DS1 Rice Production Model Complying with aspects of Sustainable Rice Platform (SRP) Standards" event called Farmers' Field Day took place at the Hiep Loi Cooperative, My Hiep Son Commune, Hon Dat District marking a major step toward sustainable rice farming in the Summer-Autumn 2024 crop. The meeting attracted around 40 participants, including local farmers, government officials, extension workers, and researchers, and students from Can Tho University.

The workshop focused on evaluating the DS1 rice model, which applied aspects of SRP standards, at the farm of Farmer Mr Trinh Thanh Danh. Discussions centered around the benefits and challenges of SRP practices versus conventional farming.

Attendees toured experimental fields cultivated using SRP techniques, receiving guidance on critical practices such as seeding density, fertiliser application, pest control, and water management. A key focus was on rice straw management and emissions reduction, aligned with the province's push for high-quality, low-emission rice production.

Photo
Participants visited and self-evaluated the experimental rice fields during the meeting.

At the workshop, A Kien Giang Agricultural Extension Center representative outlined the province's agricultural strategy, tracing its evolution from 3 reductions (seeds, pesticides, fertilisers) 3 gains (yield, quality, and economic efficiency) in 2005 to 1 must do (use certified seed), five reductions (seeds, water, fertiliers, pesticides, and post-harvest losses) in 2012, and SRP in 2017. The strategy aims to lower input costs, boost rice quality, reduce emissions, and increase profits from rice and carbon credits. Additionally, a Plant Protection Sub-Department official highlighted the province's plan to execute 1 million hectares program of rice' high-quality, low-emission rice for export. Particularly, farmers from within and outside the project networked and exchanged insights on SRP rice farming standards.

The workshop concluded with a field assessment, where 95% of attendees rated the SRP model as "good." Despite positive results, challenges such as unstable rice prices, pest outbreaks, and climate issues persist. Suggested solutions include synchronised sowing, enhanced technical training, improved infrastructure, and stronger supplier-buyer links.

All participants expressed their readiness to transition from conventional farming practices to SRP (including Alternate Wetting and Drying-AWD, and Maximum Residue Level-MRL standards), signalling strong support for advancing sustainable rice production across Kien Giang and the wider Mekong Delta.

Photo
Participants shared their evaluation on the advantages of SRP rice fields.

Future Proofing the Australian Rice Industry

The University of Queensland

In order to develop tropically adapted long grain rice varieties suitable for northern Australian aerobic production and future proof the Australian industry, fifty lines have been imported with novel resistance and tolerance to biotic and abiotic stressors.

Although rice blast (*Pyricularia oryzae*) is endemic to northern Australia (Figure 3), the importance of incorporating disease resistance into Australian cultivars has been demonstrated with a recent outbreak of rice blast in the Northern Rivers, NSW. Lanoiselet (2016) reported that the most relevant resistant genes against Australian blast isolates are Pita-2 and Pi40. With Pi54 known to have broad spectrum resistance internationally, although its response to Australian isolates is unknown (Rai et al. 2011; Vasudevan et al. 2015).

Photo
Panicle blast observed in Mackay, Northern Queensland.

To future proof the Australian industry imported germplasm has been received from the International Center for Tropical Agriculture (CIAT) and the International Rice Research Institute (IRRI) and is either in or has passed through post-entry quarantine (Figure 1). The CIAT germplasm include aerobically adapted japonica and indica lines that have disease tolerance. Different races of blast exist internationally and despite these lines being resistant to Colombian isolates, it is unknown how well they will perform against Australian isolates. These lines have recently been genotyped and contain up to three blast resistant genes, Pita-2, Pi40 and/or Pi54, as well as aerobic adaptation tolerant markers. To expediate the usefulness of this germplasm crosses were made to local Australian germplasm in post-entry quarantine, with several F1's identified as containing Pita-2, Pi40 and other aerobic adaptation traits. CIAT lines identified with the pyramided blast resistant genes will be further utilised in crossing with the current high yield breeding lines.

The imported IRRI lines have novel resistance and tolerance to both biotic and abiotic stress, this includes gall midge, brown plant hopper, tungro disease, yellow mottle virus, sheath blight and Xa7 bacterial leaf blight resistance and salinity tolerance and tropically adapted japonica lines, and lines with stable high yield potential. Incorporation of the genetics from this diverse germplasm is to future proof the Australian rice industry against possible incursions due to northern Australia's proximity to Southeast Asia.

The next step is evaluating the newly imported germplasm under field conditions and further utilisation in the pre-breeding activities to improve Australian relevant germplasm.

Photo
Inspecting imported CIAT lines in post-entry quarantine.

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