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SHORT COMMUNICATION

A Blueprint for Tapping the Wild Relatives for Crop Improvement: A Success Story of CWR-derived Rice Candidate Varieties, Nông Dân 1 and Nông Dân 2 in Vietnam

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Crop wild relatives (CWR), the non-domesticated plants closely or distantly related to cultivated crops, have continued to evolve in natural habitats in response to diverse climatic conditions over thousands of years and thus carry potentially useful genes/alleles for adaptations to various environments. Utilizing these untapped sources of variation will help develop new climate-resilient cultivars that will ensure food security, economic stability, and environmental sustainability. Though the importance of CWR in improving the resilience of cultivated crops is well-known, their frequent utilization in breeding programs is hindered due to several technical challenges such as lack of precise data on the traits of breeder's interest, access to data and trait-specific germplasm, cross-incompatibility barriers, linkage drag, *etc.* (Sharma, 2017). Although there are different ways and means to overcome these challenges, most breeders are still reluctant to use CWR in breeding programs. This is because of the fear that the use of CWR will deteriorate their working collection and it will be difficult or will take many years to develop a variety if CWR is involved in the crossing program. Further, most breeders feel that pre-breeding lines derived from CWRs cannot be included in multi-location evaluation trials or released as a variety. Indeed, these lines can only be used as parents in crossing programs. Hence, there is an apprehension that the use of CWRs in breeding programs may lead to limited or no success in terms of variety development during the breeders' working span. While breeders are adopting modern tools and technologies to breed and develop desirable crop varieties in the shortest possible time and are using speed breeding platforms to enhance the genetic gain of crop cultivars, there is a fear among breeders that the use of CWRs will slow down this progress.

We would like to share the story of Nông Dân 1 (https://www.linkedin.com/posts/shivali-sharma-27362087_boldcwr-boldcwr-rice-activity-7248208405176197120-H2kI?) and Nông Dân 2 (Fig. 1), the CWR-derived elite lines recently registered for Plant Variety Protection (PVP) in Vietnam. These two lines have been recognized

as varieties in the informal system in Vietnam and referred to as candidate varieties hereafter in this article. The story of these two candidate varieties began over 10 years back under the project 'Enhancing utilization of crop wild relatives: Capturing genetic value from ancestral populations of wild rice' (2011–2016) within the framework of the CWR Project (https://cwr.croptrust.org/) that focussed on developing and evaluating introgression lines (IL) of *O. rufipogon* Griff. and *O. nivara* S. D. Sharma & Shastry. Under this project, a total of four accessions were selected from the International Rice Genebank Collection at the International Rice Research Institute (IRRI), originating from Bangladesh (IRGC 103837), China (IRGC 100916), Malaysia (IRGC 105491), and Papua New Guinea (IRGC 106276) as donors and the modern variety IRRI 154 (released in the Philippines under the commercial name NSiCRc 222) as recipient (Tin *et al*., 2021). The crosses were attempted at Cornell University, Ithaca, NY, USA. Using three backcrosses followed by selfing, four BC_3F_2 families were generated. These backcross families were shared with IRRI, Philippines, where they were evaluated for yield under both well-watered and drought conditions in IRRI's experimental farm at Los Baños in 2016. Based on yield data collected in 2016 at IRRI, a total of 200 BC_3F_{3B} lines were selected and shared with Can Tho University, Can Tho City, Vietnam, using the Standard Material Transfer Agreement (SMTA) in December 2018 for evaluation and use under the CWR Project (https://cwr.croptrust.org/). The lines were distributed to 13 seed clubs in eight provinces in the Mekong Delta region for participatory on-farm selection during the crop season from the December 2018 to May 2019 with technical support from the Mekong Delta Development Research Institute of the Can Tho University (MDI-CTU) (Tin *et al*., 2021). Based on the performance, high-yielding elite lines were selected for further multilocation evaluation by the seed clubs in diverse agro-ecologies across the Mekong Delta, North and Central Vietnam, under the Biodiversity for Opportunities, Livelihoods and Development (BOLD) Project (https://bold.croptrust.org/). The BOLD Project started in 2021 and builds on the success of the CWR Project. On-farm participatory evaluation of these lines by farmers across locations over seasons in Vietnam led to the identification of most promising high-yielding elite lines, which are at different stages of development. Of these, Nông Dân 1 and Nông Dân 2 (Fig. 1 and Fig. 2), two candidate varieties, are at the most advanced stage and are given the PVP Certificates based on their distinctness, uniformity, and stability (DUS) tests. Nông Dân 1 is derived from a cross between IRRI 154 and IRGC 106276, whereas Nông Dân 2 is derived from a cross between IRRI 154 and IRGC 100916 (Tin *et al*., 2021).

The BOLD Rice team dedicated the elite lines to the farmers, which is evident from their names. Nông dân is a Vietnamese term that translates to "Farmer" in English. These two candidate varieties have also been tested for their Value


BỘ NÔNG NGHIỆP & PHÁT TRIỂN NÔNG THÔN
CỤC TRỒNG TRỌT

CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập - Tự do - Hạnh phúc

BẰNG BẢO HỘ GIỐNG CÂY TRỒNG

SỐ BẰNG: 09.VN.2025

TÊN GIỐNG CÂY TRỒNG: Nông Dân 2

TÊN LOÀI CÂY TRỒNG: Lúa - *Oryza sativa* L.

CHỦ SỞ HỮU BẰNG BẢO HỘ: Trường Đại học Cần Thơ

TÁC GIẢ GIỐNG CÂY TRỒNG: Huỳnh Quang Tín, Nguyễn Hoàng Khải, Nguyễn Hữu Lợi, Nguyễn Hồng Cúc, Shivali Sharma, Benjamin Kilian

HIỆU LỰC CỦA BẰNG BẢO HỘ: 20 năm kể từ ngày cấp Bằng

Hà Nội, ngày 24 tháng 02 năm 2025

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Được quét bằng CamScanner

Fig. 1: Plant Variety Protection (PVP) certificate issued for Nông dân 2 in Vietnam

Fig. 2: Cultivation of Nông Dân 2 at the Seed Club in Hau Giang Province in Vietnam (Photo Credit: Huynh Quang Tin)

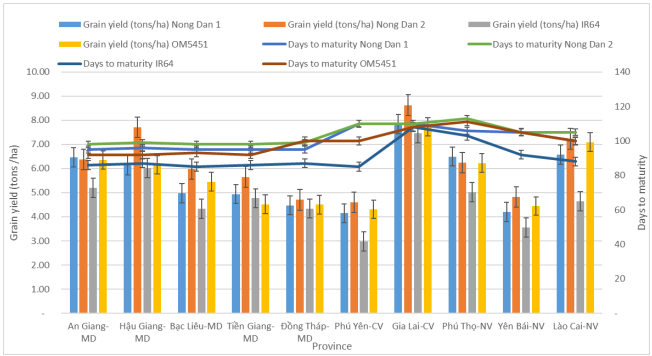

Fig. 3: Performance of Nông Dân 1, Nông Dân 2, and the popular check varieties, IR 64 and OM 5451, in 10 provinces across the Mekong Delta (MD), Central (CV), and North Vietnam (NV) over two seasons (May-October 2023 and November 2023-May 2024) in Vietnam

for Cultivation and Use (VCU), which assesses the suitability of a line for formal release and commercial cultivation based on different criteria. Nông Dân 1 and Nông Dân 2 are in the process of formal variety release in the Mekong Delta. Nông Dân 1 is preferred due to its high productivity and blast resistance, while Nông Dân 2 is preferred due to its good

eating quality and low amylose (~16%) content besides high yield (Fig. 2 and Fig. 3). Both candidate varieties have been selected by the farmers and are of short duration (ranging from 95-99 days in Mekong Delta and ~110 days in Central and North Vietnam) with excellent phenotypic acceptability, which makes them suitable for taking three crops in a year with wider adaptation across different agro-ecologies of Vietnam. Besides these two candidate varieties, additional farmer-preferred elite lines, namely Nông Dân 7, Nông Dân 20, Nông Dân 26 are at various stages of development in the Mekong Delta region of Vietnam. Nông Dân 7 is the most preferred line by the farmers in Gia Lai province in Central Vietnam. Though this line is still in the testing phase, nonetheless, it was grown over a 2.0 ha area for seed multiplication to meet the seed demand of the farmers in 2024. As the farmers are actively involved in the testing and decision-making process for selecting the best lines, it is hoped that the best elite line(s) released as a variety(ies) after the on-farm participatory selection process will have rapid large-scale adoption by the Vietnamese farmers. It will be interesting to study the impact of such varieties on rice production systems in Vietnam in due course.

This study clearly shows that CWRs can be utilized in developing new varieties if we follow a systematic and focused pre-breeding and breeding approach. Indeed, in this case, careful selection of donor and recipient parents followed by three cycles of backcrossing, selfing, and multi-location evaluation over the years with the active involvement of farmers starting from the early-stage evaluation and selection, as well as in the decision-making process led to the identification of promising elite lines having farmer-preferred traits.

This study also helps to address other important questions, such as: Who should be doing pre-breeding? Is it necessary for every breeding program to have a pre-breeding pipeline in place? As pre-breeding using unadapted germplasm, especially CWR, is a time-consuming and resource-demanding endeavour that also requires specialized skills on the part of breeders, especially when cross-incompatible CWR are involved in crossing, not every breeding program, especially in the National Agricultural Research System (NARS), can afford to invest in pre-breeding activities. Hence, it is important to identify a few advanced centers within the national programs that have the skills and resources to invest in crop-specific pre-breeding activities. Another approach could be to collaborate with advanced research institutes (ARIs) and/or CGIAR centres at the international level, who can generate and share the pre-breeding material, as was done in this study.

This study also highlights the importance of conserving pre-breeding lines in international genebanks that have the global responsibility of conserving and sharing the germplasm with global users using the SMTA of the International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA; in short, Treaty). Seeds of 1497 backcross inbred lines (IRGC 136300 to IRGC 137796) are available from the IRRI genebank. Nông Dân 1 is a selection from IRGC 137056, whereas Nông Dân 2 is a selection from IRGC 136992. Evaluation data on selected backcross inbred lines across locations and seasons in Vietnam are available in Germinate (https://germinate.hutton.ac.uk/cwr/rice/#/home). Success stories and impacts have been generated in other target crops besides rice under the CWR (https://cwr.croptrust.org) (Kilian *et al*., 2021) and BOLD (https://bold.croptrust.org) projects.

To harness the potential of CWRs using modern tools and technologies for developing climate-resilient varieties, it is important to attract young and passionate researchers with the required skill set for pre-breeding for germplasm development. Besides systematic and focused pre-breeding research efforts, long-term funding support is needed to harness the true potential of this important and unexploited diversity.

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