Annex 3

Presentation Summaries of
FNCA 2023 Workshop on Mutation Breeding Project

September 26th - 28th, 2023
Takasaki and Fuchu, Japan

Bangladesh (Dr. A.N.K Mamun, Bangladesh Atomic Energy Commission)

BINA dhan 25 is a mutant of very popular widely cultivated rice in Bangladesh named BRRI dhan 29. It was developed through 40 Gy carbon ion beam irradiation under FNCA project at QST, Takasaki, Japan. It was officially released for cultivation on January 18, 2022. In grain, the amount of amylose content is 25.1% and protein content is 6.6%. Rice is white, neat, and tasty so the market price is high and it is suitable for export. It is early mature, day neutral, high yield (7.14 to 8.50 t/ha) and long grain fine Boro rice. It can cultivate relatively low fertilizer and low irrigation system. This variety was developed with the co-operation of FNCA, IAEA/RCA and BINA. Application is made for the official release as a variety namely "Lal Atom dhan 1" using carbon ion beam irradiation of indigenous rice land race B-11. It was developed through 50 Gy carbon ion beam irradiation under FNCA project at QST, Takasaki, Japan. It is early mature, day neutral, high yield (7.8 to 8.0 t/ha) with high amylose (26.6%) and high protein (8.9%) content Boro rice. Lal Atom dhan 1 was evaluated with the popular rice variety BRRI dhan 88 in 10 different agro-ecological regions and the variety showed better yield and other agronomical traits. This variety is being developed with the co-operation of FNCA, IAEA/RCA and Lal Teer Seed Ltd.

Indonesia (Dr. Winda Puspitasari, National Research and Innovation Agency)

Generally, farmers in Indonesia plant soybeans in the dry season using a rice-rice-soybean cropping pattern. Drought stress can reduce potential yield of soybeans by up to 50%, therefore developing drought-tolerant soybeans is very important. This research was conducted to evaluate the tolerance of soybean mutant lines to drought stress. The result showed that drought stress by applying 40% irrigation can cause a reduction in plant growth as indicated by a significant decrease in plant height compared to full irrigation. Five soybean mutant lines showed a higher stress tolerance index (STI) compared to the tolerant checks, especially in seed weight STI, which shows that these mutant lines have the potential to be developed into drought stress tolerant mutant lines.

Japan (Prof. Nakai Hirokazu, Shizuoka University)

Cross and mutation breeding of rice for adaptability to nature farming (low input sustainable agriculture) have been conducted in 19 places across Japan from Okinawa to Hokkaido in these about 18 years. One of the results of the cross breeding combined with the induced mutations in Hokkaido is presented. The AK49 breeding line, which is of higher

yield in nature farming, was obtained from cross combination of Asahi and Kamenoo of representative native varieties of Japan. However, this line was found to be fluctuated for yield from year to year because of it being late heading. Then, seeds of AK49 were irradiated by gamma-rays of 200Gy with breeding purpose for earlier heading. The mutant lines, AK-3(early heading) and AK-31(middle heading) were obtained through selection tests in the nature farming fields in Hokkaido. These three lines (AK 49, AK49-3and AK49-31) are to be taken steps for official registration of new rice variety. Up to now, more than 10 new varieties adaptable to nature farming were taken steps for official registration of new variety from the 9 breeding places. Also, importance of the new varieties for future agricultural systems was discussed.

Malaysia (Mr. Faiz Bin Ahmad, Malaysian Nuclear Agency)

Ion beam irradiation has big impacts on developing climate-resilient rice in Malaysia. Fourteen potential mutant lines have been developed from ion beam irradiation of the traditional variety PS2 and the mutant genotype MA03. These mutants showed early maturity traits and high yields. Furthermore, 10 early maturity and submergence tolerance F3 rice lines from crossing mutant cultivar NMR152 with mega variety MR220CL2 have been developed. Multilocation trials (MLT) and local verification trials (LVT) of mutant variety NMR151 showed stable yields around 4.90–5.09 ton/ha across all locations. A memorandum of agreement (MOA) between Nuclear Malaysia and seed-certified company Pertama Padi (M) Sdn Bhd will be signed in 2023 for commercializing mutant cultivar NMR152 and disseminating it on a large scale to farmers.

Mongolia (Dr. Bayarsukh Noov, Institute of Plant and Agricultural Science)

Mongolia successfully applied the different mutagen sources such as ion beam (He 50 MeV, Carbon 320 MeV), X-ray and chemicals applied for mutation induction for wheat and barley. Thanks to our colleague from the Department of Quantum-Applied Biosciences, National Institutes for Quantum Science and Technology Japan for great help for irradiation our seed materials during project implementation period. We would like to request Japan to continue this service to member countries.

In 2019-2023, totally 11838 progenies of wheat mutant lines in M1-M4 have been planted in the respective breeding plots and field observation, data collection is in progress during crop duration. In the yield trial, totally 4 new mutant varieties including early variety Darkhan-225, mid maturity variety Darkhan-229, Darkhan-234 and mid late maturity variety Darkhan-222 have been tested in 4 replications and evaluated for green traits, quality and resistance to disease and pests. The mutant wheat variety Darkhan-222 transferred to the State variety test for further release.

The Philippines (Mr. Christopher C. Cabusora, Philippine Rice Research Institute)

Induced mutation activities of the Philippines' breeding program for adverse ecosystem has developed numerous mutant varieties adapted to saline and rainfed-drought prone ecosystems. This year, large scale basic seed production of these varieties has commenced in preparation for the forecasted El Niño phenomenon to occur this year until the second quarter of 2024. In line with this, PhilRice has partnered with local government units and branch stations to establish technology demonstration of these mutant varieties in regions with saline and rainfed-drought prone rice areas.

Thailand (Dr. Prakobkit Dangthaisong, Rice Department)

Rice improvement for acid sulfate soil tolerance was conducted from 2020 to 2023. Mutation rice breeding began from Khlong Luang Rice Research Center, and 23 elite rice lines were treated with gamma ray at 300 Gy at Thailand Institute of Nuclear Technology in dry season 2020. Mutant progenies of M1 to M2 were planted and selected at farmer's field in Nakhon Nayok province (soil pH 4.52) in wet season 2020 and dry season 2021. The 548 mutant lines from M2 (23 parents) were selected and distributed for four locations to generate for M3 mutant progenies in wet season 2021. The results showed that 237 mutant lines of M3 were selected by Khlong Luang Rice Research Center, in addition 399, 511 and 630 lines were selected from Chachoengsao Rice Research Center, Pathum Thani Rice Research Center and Phatthalung Rice Research Renter, respectively. The 237 mutant lines of M3 were planted to generate for M4 at Khlong Luang Rice Research Center in wet season 2022 and selected 133 lines (rice yield varied from 3,900 to 5,500 kg/ha) with good performance of plant type, 85 lines of them found *badh2* (aromatic) and *wx* (waxy), these elite lines will promote for observation process in dry season 2023 and then intra-station yield in wet season 2023.

Vietnam (Dr. Le Duc Thao, Agricultural Genetics Institute)

We started a new mutation breeding project to improve some key crops such as soybean, groundnut from 2022. In 2023, we continue to screen in M2 for soybean and peanut.

In regards to soybean, gamma-ray irradiation of dry seeds induced many different variations on soybean varieties in the M1 and M2 generations such as stem shape (curved stem, flat stem...), branch shape (early branching, symmetrical branching...), leaf shape, hair color on main stem. We found some beneficial variations for breeding such as upright stem shape, many first-level branches, many fruits, early ripening and so on.

In regards to peanut, in the M2 generation, phenotypic variations were most frequently observed after irradiation with highest dose 350 Gy in all studied peanut varieties. Variations observed in experimental peanut varieties were albino, leaflet variation,

branching variation, short plant variation, tall tree variation, sterile variation, late ripening. Testing new peanut varieties showed that, the varieties L14-180/2, L27-220/2, L27-250/3, L29-200/4 had a higher yield than L14 from 5.2 - 14.5%, and are promising varieties for production and application. We are completing documents and procedures to release variety L27-220/2 in October 2023.