Annex 3

Presentation Summaries of
FNCA 2021 Online Workshop on Mutation Breeding Project

January 18th – February 1, 2022

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

Finally about 15 advanced promising mutant lines are selected form carbon ion beam and gamma induced population of B11 and Lombur rice land races. Two promising lines sent for regional/multiplication trials. Most of them are selected for higher yield, early & late maturity, lodging resistant, draught tolerant and suitable for cultivation in rain feed condition, photoperiod insensitive, bold grain and also long grain and fine grain. Most of them are suitable for both cultivation in Aus and Aman seasons.

China (Prof. Shu Qingyao, Zhejiang University)

- Breeding New Rice Varieties for Sustainable Agriculture under Climate Change -

Our rice mutation breeding project has been focused on (i) development of new rice mutants with the potential to become new rice varieties, (ii) identification of mutant genes underlying mutated traits, (iii) establishment of protocols for mutant screening, and (iv) promotion of new mutant rice varieties for commercial production. During the past year, mutation techniques have been deployed together with other molecular and biotechnological methods (anther culture, genomic editing, molecular marker assisted selection, etc.) for the development of conventional and hybrid rice varieties.

The main achievement of the past year includes the following: (1) Several putative mutant lines were developed from commercial rice varieties for fast grain-filling, with enhanced tolerance to a herbicide that can kill weedy rice; (2) Jiang-liang-you 7901, a nationally registered hybrid rice, with an early maturing mutant as its female line, are being grown in several provinces and showed great promise for further expansion. (3) A gain-of-function mutant gene was cloned and elucidated for the *xantha* suppressor trait. (4) Dissection of structural variations (SVs) induced by ion beams was performed using next generation sequencing (NGS). The characteristics of SVs were investigated for two indica and two japonica rice mutagenized by Ar, Ne and C ion beams, and the nature of structural variations were investigated in detail.

Indonesia (Dr. Winda Puspitasari, Research Organization for Nuclear Energy)

- Soybean Improvement through Induced Mutations and Related Biotechnology -

Soybean mutation breeding in Indonesia is carried out to increase national soybean production to fulfil high demand of soybean for food and industry. One strategy that can be

conducted to increase national soybean production is by expanding the planting area, including marginal land that has low fertility. To overcome the drawbacks from marginal land, several strategies can be selected, such as improving soil conditions or by using superior varieties adaptive to such soil conditions. Therefore, soybean mutation breeding in BATAN aims to obtain superior varieties with high yields, tolerant to abiotic stress (drought prone areas and acid soil) and have good seed quality by using induced mutation combined with related biotechnology.

In recent years, BATAN has succeeded in releasing several new high-yielding soybean varieties, namely Kemuning 1 and Kemuning 2 (released in 2019) which have drought stress tolerance, Sugentan 1 and Sugentan 2 (released in 2021) with early maturity trait of 68 and 69 days, and in the early of 2022, 1 new variety named Detara will be released, which is black soybean with high yields and large seeds.

Different kind of specific trait of soybean varieties will provide opportunities for farmers to select the suitable one for their environmental conditions and their preference to increase soybean production continuously. In addition, research of soybean breeding is important to be conducted in order to support increasing of national soybean production and to increase soybean resilience to climate change.

Japan (Dr. Hase Yoshihiro, National Institutes for Quantum Science and Technology)

- Progress report on the mutant screening of rice for salt tolerance -

Stress tolerance of crop plants is an important issue to promote the sustainable agriculture under climate change. Mutant isolation and the functional analysis of the responsible genes is a powerful tool to provide new genetic resources to develop stress-tolerant plants. Here, we tried to screen salt-sensitive/tolerant mutants from the mutagenized population of BRRIdhan47, which is one of the most salt-tolerant varieties developed in Bangladesh.

First, we performed the mutant screening for salt-sensitive mutants. The seeds of BRRIdhan47 were mutagenized with 60 Gy of 320-MeV carbon ions, and the M_2 population was grown by a hydroponic culture. A net increase of fresh weight under normal growth condition was measured for each plant. Then, NaCl was added to the culture solution and a net increase of fresh weight under salinity condition (EC: ~800 mS/m) was measured. The putative salt-sensitive mutants were selected based on the ratio between the fresh weight under normal and salinity conditions. Unfortunately, we have not yet obtained any salt-sensitive mutants, whose phenotype were confirmed in M3 generation so far. However, we obtained a stable mutant line that shows severe withering of the leaf tip. Interestingly, this mutant line shows slightly higher tolerance under salinity condition in terms of the control ratio. This mutant line has a homozygous 2-bp deletion in the gene on chromosome 1. Further physiological and genetic experiments will be done to characterize the function of

the responsible gene.

Also, we performed the mutant screening for salt-tolerant mutants. The M_2 population was grown by a hydroponic culture, and the salinity was gradually increased up to 2,000 mS/m, which corresponds to the half strength of sea water. A putative salt-tolerant mutant was obtained, and the phenotype will be confirmed in the following generation.

Korea (Prof. Kang Si-Yong, Kongju National University)

- Ion beam breeding research for development of useful crop genetic resources -

It has been suggested that ion beams with high liner energy transfer (LET) and high relative biological effectiveness (RBE) induce higher mutation frequency and spectrum than low LET radiations (gamma and x rays). The KOMAC (Korea Multi-Purpose Accelerator Complex) under the KAERI was constructed in Gyeongju in 2013 and then has been provide 45 MeV and 100 MeV proton beam irradiation service. The KAERI research group started wide researches for setting the irradiation condition of 100 MeV proton beam of the KOMAC for mutation breeding. Two research papers related to proton beam breeding conducted by our research team were published in two international journals in 2021. The heavy ion beam (200 MeV) of Rare Isotope Accelerator (RAON) has been constructed at the Institute of Basic Science in Daejeon, Korea. In near future, many applications in the plant mutation breeding will be done using the proton and heavy ion beam with high LET. In this presentation, I would like to introduce some research status of plant mutation breeding using proton beam irradiation in Korea.

(Article-1) Sang Hoon Kim, Sun Young Kim, Jaihyunk Ryu, Yeong Deuk Jo, Hong-Il Choi, Jin-Baek Kim, and Si-Yong Kang (2021) Suggested doses of proton ions and gamma-rays for mutation induction in 20 plant species. International Journal of Radiation Biology 97(11): 1624-1629.

Abstract: Proton ions are expected to be used as a discriminative radiation source to induce different kinds of mutations than those produced by c-rays and carbon ions; however, there is little systemic information about radiosensitivity in plants. We analyzed the LD30, LD50, and RD50 values in response to proton ions and c-rays using 20 plant species. Plant seeds were irradiated, and growth responses were measured one month after planting, except for cymbidium, for which in vitro rhizomes were irradiated. The rhizomes were analyzed at six and nine months after subculturing. Resistance to proton ions and c-rays was observed in Chinese cabbage, watermelon, and melon, while Japanese atractylodes, naked barley, and lentil were susceptible. Plants belonging to the Brassicaceae and Cucurbitaceae families were highly resistant to radiation, and plants belonging to the Compositae and Poaceae families were highly susceptible. In addition, plants with genome sizes greater than 8,000 Mbp were highly sensitive to radiation, but there was no clear relationship between

radiosensitivity and genome size in plants with genomes smaller than 2,500 Mbp. The biological effectiveness of proton ions was greater than that of c-rays in 16 plant species, indicating that they could be used as a discriminative radiation source to induce mutations compared with c-rays.

(Article-2) Sang Woo Lee, Yu-Jeong Kwon, Inwoo Baek, Hong-Il Choi, Joon-Woo Ahn, Jin-Baek Kim, Si-Yong Kang, Sang Hoon Kim and Yeong Deuk Jo (2021) Mutagenic Effect of Proton Beams Characterized by Phenotypic Analysis and Whole Genome Sequencing in Arabidopsis. Frontiers in Plant Science 12: Article 752108. doi: 10.3389/fpls.2021.752108

Abstract: Protons may have contributed to the evolution of plants as a major component of cosmic-rays and also have been used for mutagenesis in plants. Although the mutagenic effect of protons has been well-characterized in animals, no comprehensive phenotypic and genomic analyses has been reported in plants. Here, we investigated the phenotypes and whole genome sequences of Arabidopsis M2 lines derived by irradiation with proton beams and gamma-rays, to determine unique characteristics of proton beams in mutagenesis. We found that mutation frequency was dependent on the irradiation doses of both proton beams and gamma-rays. On the basis of the relationship between survival and mutation rates, we hypothesized that there may be a mutation rate threshold for survived individuals after irradiation. There were no significant differences between the total mutation rates in groups derived using proton beam or gamma-ray irradiation at doses that had similar impacts on survival rate. However, proton beam irradiation resulted in a broader mutant phenotype spectrum than gamma ray irradiation, and proton beams generated more DNA structural variations (SVs) than gamma-rays. The most frequent SV was inversion. Most of the inversion junctions contained sequences with micro-homology and were associated with the deletion of only a few nucleotides, which implies that preferential use of micro-homology in non homologous end joining was likely to be responsible for the SVs. These results show that protons, as particles with low linear energy transfer (LET), have unique characteristics in mutagenesis that partially overlap with those of low-LET gamma-rays and high-LET heavy ions in different respects.

Malaysia (Dr. Sobri Bin Hussein, Malaysian Nuclear Agency)

Malaysia's National Agrofood Policy (NAP 2.0) was formulated with a special focus on improving the food production sector including rice, and strengthening country food supply and food security. Even though Malaysia is still depending on imported rice to fulfil consumer's demand, rice industry has always been a national priority based on its strategic importance as a staple food commodity. Nevertheless, the rice industry in Malaysia is hampered by several challenges such as global climate change, flash flooding, rising prices of pesticides, unauthorized seeds, rapid development in rural area, lacking new variety,

insufficient certified and high-quality seeds, emerging of major diseases such as Bacterial Panicle Blight (BPB), Leaf Blast, drought season, decreasing of planting area, lost interest of the farmers due to high cost of rice production and many others. Apart from that, according to the local newspapers, currently, farmers are facing huge problem with the flash flood and plant disease caused by brown planthopper. Thus, the NAP had highlighted that local rice production should be increased to ensure the country's demand in the future. FNCA project is one of the initiatives that supported the objectives of NAP as, improving the rice genotype via induced mutation is crucial to broaden the genetic diversity of rice in Malaysia. Furthermore, this technique is suitable in developing new rice variety since stable populations can be achieved faster compared to the conventional technique.

According to the farmer's association in Sekinchan Selangor, NMR152 consistently produced between 7-10 t/ha in granary area as compared to 4.6 t/ha produced by other varieties within the same planting areas. The yield is significantly higher as compared to the national average yield that is only 3.5 t/ha. Observation from 2020 until 2021 showed that NMR152 is highly stable in flash flood areas in Kedah, Perak, Malacca and Selangor, whereby the data showed that 90% recovery was observed after the flash flood. Meanwhile, according to the farmers in northern part of Peninsular Malaysia, the production cost for rice mutant can be reduced up to 40% mainly due to the reduction in fertilizer and pesticide usage. Additionally, several local verification trials (LVT) were also conducted from the Northern part until the Southern part of Peninsular Malaysia between the year 2020 to 2021. The data obtained from Kedah and Selangor revealed that NMR 191 constantly produced between 7-9 t/ha in granary area as compared to 4 t/ha (average) produced by other varieties within the same planting areas. Based on the record from the certified seed company, HMN (M) Sdn Bhd, the total area that planted with mutant rice in Peninsular Malaysia is around 24,600 ha.

As for disease screening, the selected mutant line has been further assessed by Malaysian Agricultural Research and Development Institute (MARDI). The two seasons' data revealed that NMR 151 and NMR 152 were categorized as moderately resistant (MR) for foliar blast. Meanwhile, MINT3 was moderately susceptible to foliar blast. For panicle blast, NMR151 and NMR152 were resistant (R) while MINT3 was moderately resistant (MR) to panicle blast. For sheath blight, NMR 151, NMR 152 and MINT3 were recorded as moderately resistant (MR). For bacterial leaf blight (BLB), NMR151 was moderately susceptible, and both NMR152 and MINT3 were moderately resistant in main season 2019/2020. Nevertheless, different results were recorded during the off season of 2020, in which NMR151 and NMR152 were susceptible and MINT3 was moderately susceptible. The difference between the seasons is expected as BLB disease has high response to different climates.

On 29 Jan 2021, the Malaysia's Ministry of Agriculture and Food Industries (MAFI) have certified NMR152 as national new rice variety after NMR152 undergone the strict technical evaluation by the technical committee BKKIPB (Ref no: MDI/PR/JKTBKKIPB/P/2021(14)). Due to the great reputation and high demand from the farmers, NMR152 was officially launched by the honorable Prime Minister of Malaysia on 20 November 2021. With the launching, the mutant rice variety - NMR 152, is now officially named after the name of the 9th Prime Minister of Malaysia as 'IS21'. Moving forward, Malaysia Nuclear Agency will continue with its efforts in obtaining the approval and registration of other potential mutant lines (NMR151 and NMR191) as the national new rice variety. As a conclusion, the project has addressed the national agenda and policy in generating new rice varieties and thus, increase the well-being and livelihood of the farmers. Malaysian Nuclear Agency has successfully developed, commercialized and disseminate the new mutant rice seeds to farmers throughout Malaysia.

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

Mongolia is experiencing dramatic climate change. Last 70 years the absolute air temperature raised by 2.1^{0}C and the precipitation decreased in Mongolia. By the year 2020 the average air temperature will raise by 2.2-3.0^{0}C and in further 25 years warming will intensify by two times and evaporation increase by seven to ten times. Due to the above changes the yield potential of existing plant varieties reduced due to climate change, the cropping zone boundaries has been changing towards North, pest and disease distribution, frequency increased and soil erosion and degradation increased, respectively.

The wheat is dominant crop and cultivated in about 80% of agricultural land in Mongolia. In Mongolia, the breeding of high potential wheat varieties was always major subject in breeding program. During 50 years of study the over 90 cereals crop varieties developed including 72 varieties of spring wheat, nine-durum wheat, four of oats and 2 common millet varieties. Among them a new spring wheat varieties Orkhon, Khalkh Gol –1, Darkhan-34, Darkhan-74, Darkhan-144, Darkhan-131 and the barley variety Alag-Erdene, Burkhant-1 and common millet Burgaltai are officially certified and commercialized. Barley is second cultivar planting after wheat in Mongolia. Mostly used for animal feed, brewing beer and human consumption. Soybean is relatively new crop for Mongolian farmers with very rapid expansion the rotation system. However, all soybean varieties cultivated in Mongolia are from foreign origin because no local breeding activities took place before. There we need to develop short duration varieties adapted Mongolian condition.

The application of mutation breeding technique in Mongolia has conducted since 1970s at the Institute of Plant and Agricultural Science (IPAS). The mutation breeding mainly focuses on the development of new mutant wheat varieties and barley, rapeseed and rice

mutant on enhancement of wheat genetic diversity for breeding.

Purpose of the Project:

Improvement of major crops productivity and drought tolerance through application of mutation technique combined biotechnology and marker assisted selection following tasks identified:

- Enhancement of genetic diversity in wheat, barley through application of mutation techniques
- Development of high yielding, drought tolerance, disease resistant wheat and barley varieties

Project Progress Report

Objective in 2021

- Planted M1 generation of wheat, which has treated by ion beam treatment in 2-3 different doses.
- Evaluation and screening M2-M4 generation in the field condition.
- Screening and selection of advanced mutant lines of wheat and barley with improved mutant traits through field on the yield performance and drought tolerance and disease resistance.

Project progress

Wheat: The improved new mutagen source for mutation breeding of Mongolia, such as ion beam (He 50MeV, Carbon 320 MeV) mutagen. Totally, 1917 rows of 60 progenies planted in M2-M4 for the breeding initial materials. In 2021, the ion beam treatment applied at the Department of Radiation-Applied Biology Research, National Institutes for Quantum and Radiological Science and Technology Japan. According to the biometrical measurements taken in the M_2 generation, the growth period of Darkhan-144 15Gy dose variant was 3 days earlier than control, in Omskaya-36 100Gy was 2 day earlier than control. Yield increased by 25.0g in the 100Gy dose (helium ion beam treatment) of Omskaya-36 variety. Other mutant progenies could not pass control by yield. 100Gy dose of Omskaya-36 variety productive stem is higher than control. Seed number per spike of Toboliskaya 125Gy variant increased by 6. According to the biometrical measurements taken in the M_3 generation, the growth period of 20Gy dose of Omskaya-36 variety was 2 days earlier than control, other mutant progenies were similar to control. Plant height is fluctuated 83-111 cm. All doses of ion beam treatment of Toboliskaya variety plant height reduced by 7-16 cm. Productive stem number of Darkhan-144 20Gy variant was higher (by 12) than control. Also yield of this progeny was high (by 14 g higher than control). In 20Gy dose of Toboliskaya variety seed number per spike was higher than control and seed weight per spike also higher than control variety. The 363 spikes 42 plants and 95 rows selected by the spike form, maturity, and stress tolerance and transferred to the next level study. In 2021, at the agronomy trail we

are studied 10 mutant lines of early, mid and mid-late maturity. AL-647, AL-649 mutant lines matured by 5 days earlier than check variety Darkhan-144 and gave higher yield by 0.4-3.1 t/ha. In the yield trial, two mutant lines including early maturity Darkhan-225 and mid maturity variety Darkhan-234. The 1000 kernel weight and seed volume weight of mutant advanced line Darkhan-225 were higher than control Darkhan-131 variety. Mid late maturity mutant advanced line Darkhan-234 were high 1000 kernel weight than control Darkhan-34 variety.

Barley: In 2021, in the initial material field investigated 258 mutant progenies of M1-M3 generation. In the yield trail investigated 2 barley mutant lines. Mutant line of malting barley MB-412/6 gave 3.2ton/ha grain yield, it has 1.2 ton/ha higher than parent Burkhant-1 variety. Mutant lines food barley MB-178/1 gave 2.1ton/ha grain yield, it has 0.6 ton/ha higher than parent Alag erdene variety.

Future Work plan in 2022

- Continue screening and selection of advanced mutant lines with improved mutant traits through field test. Evaluation the promising mutants for improved traits and drought tolerance
- Demonstration and dissemination of the released mutant variety
- Drought screening of advanced mutant lines using PEG6000 by index of some germinating and root traits

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

- Enhancing Flood Resilience of the Philippine Rice Variety NSIC Rc222 through Induced Mutation -

One of the most devastating effects of climate change is the occurrence of strong typhoons causing severe flash floods in low-lying areas. These floods submerge rice fields in the area incurring yield reduction of about 50% to 80%. Rice varieties with tolerance to submergence is one of the long-term solutions to address this problem in submergence-prone rice ecosystem. NSIC Rc222 is a popular rice variety in the Philippines because of its high yielding ability of 8 tha^{-1} up to 12 tha^{-1}, however it has poor eating quality because of its high amylose content and gelatinization temperature, rendering its cooked rice hard. The Philippine Rice Research Institute utilized induced mutation technique to improve the survival of NSIC Rc222 under complete submergence. The objective of the study is to develop a rice variety with tolerance to submergence in the background of a high yielding rice variety. The breeding strategy generated 13 mutant lines with enhanced survival under complete submergence and higher yield under submergence in comparison to the original NSIC Rc222. These mutant lines are also resistant to rice tungro disease, tolerance to salinity and drought stress at seedling stage, and reduced amylose content and gelatinization

temperature, improving its cooked rice to tender. The line will be entered to the National Cooperative Test on 2022 wet season, for on-site testing, and hopefully by 2024, the lines will be approved as new varieties and will be available to the farmers, for cultivation and commercialization in submergence-prone rice ecosystem.

Thailand (Mr. Apichart Noenplab, Rice Department)

- Thai rice improvement for flood tolerance through electron beam-induced mutation -

Abstract

Seventy hundred twenty (720) lines of nine parents/varieties (4,500 lines) are mutant rice lines. The lines are submergence tolerant line under artificial ponds flood submerge (4 times) during M_4 to M_7. The period of submerge is about 10 to 14 days at vegetative stage rice. The range of percent plant survival after de-submerge is about 10 to 100%. This is significantly higher than susceptible check/parents (0%). While comparing to tolerant check (FR13A), the survival rate is about 95-100%. A twenty-two elite lines were experimented On-Station Yield Trial (paddy field). The average yield is about 3,002 kg/ha and nine lines had yielded more than parent (ck.). RD31-B-390-3-4B brought highest yield (3,870 kg/ha), and its maturity age is 121 days. The average plant stature is 124 cm. Its grain is long and slender shape with 11.05 mm. in length, 2.73 mm. in width and 2.13 mm. in thickness. Its grain has moderate chalkiness (1.58) with high amylose content (28.23%). The agronomic traits of the line are similar to parent (RD31). However, the line can survive (tolerance) under artificial flood submerge. Moreover, the rest of the submergence lines are growing on yield trial and seed maintaining for future experiments.

Introduction

The flood risk area of rice growing of Thailand is approximately 62,246 h. (Chinucha *et al.,* 2014). The pattern of flooding could be divided into 2 types of flood. The first is pro-long deep flooding and the second is flash flood, which features a short period flooding (1-2 weeks). While deep water flood is fairly predictable, flash flood is extremely unpredictable and may occur at any stage of rice growth especially at vegetative period. Thus, submergence tolerance in rice is highly desirable and expected to enhance food security.

Objective: To induce mutation in rice for flood tolerance through electron beam

Methods: Evaluation/selection for submergence tolerance in rice. The method consists of 3 steps of testing line, susceptible check (IR42) and tolerant check (FR13A)

1) Sowing/broadcasting seed by pre-germinate seed.
2) Plant density/height is measured at 25-30 days old seedling, then start to submergence, check water depth daily and maintain water (150 cm. depths) to completely submerge the plants.
3) Observe IR42 from day 7 or day 12 of submergence. Start to de-submergence after the

plants become soft with 70% to 80% injury. Later, score of plant survival and plants recovery.

Results

Four thousand five hundred (4,500) rice lines of nine parents were screened for submergence tolerance in rice. The experiment was screened during M_4 to M_7 generations. The result shows the decrease in the amount of submergence tolerant lines from 1717, 1410, 1013 and 720 lines respectively. However, in M_7, two hundred twenty-three (223) lines had shown 50 to 85% of plant survival, which is less than FR13A (tolerant check) 95 to 100% and the parents were failed to recover. Twenty-two elite lines were selected to conduct On-station Yield Trial (paddy field). Nine lines had yielded more than parent (3,005 kg/ha). RD31-B-390-3-4B had highest yield (3,872 kg/ha) and its maturity age is 121 days. The average of plant stature is 124 cm and its grain is long and slender shape. Brown rice shape is slender with 7.55 mm in length, 2.34 mm in width and 1.83 mm in thickness. Its grain has moderate chalkiness (1.58) with high amylose content (28.23%).

Conclusion

The study found seventy hundred twenty (720) lines are submergence tolerant rice lines. The percentage of plant recover during M_4-M_7 is about 10-100% (artificial pond flood submerge). Nine lines had yielded more than parent (ck.). Furthermore, RD31-B-390-3-4B had highest yield (3,872 kg/ha). As the amount of submergence tolerant rice lines were decreased, the evaluation of submergence tolerance needs further studies, particularly study of the genetic control of the mutant rice lines.

Table 1 The survival number and percent plant recovery of mutant rice lines (M_4 to M_7) from submerged tolerance screening

		M_4		M_5		M_6		M_7		Range
No	Parents	No.	%	No.	%	No.	%	No.	%	(%)
1	SPR1	291	25-95	262	10-80	186	10-80	132	10-80	10-95
2	SPR60	255	50-95	185	10-80	66	10-80	63	10-50	10-95
3	PSL2	169	50-95	87	20-80	46	10-60	43	10-60	10-95
4	PTT1	22	50-98	19	40-80	14	10-50	10	10-50	10-98
5	CNT1	53	50-95	53	20-80	34	10-60	29	10-60	10-95
6	RD47	192	10-95	191	10-90	181	10-80	77	10-80	10-95
7	RD49	317	50-95	299	10-90	249	10-80	167	10-80	10-95
8	RD23	98	20-95	74	10-80	59	10-80	39	10-80	10-95
9	RD31	320	10-100	240	50-95	178	10-80	160	10-80	10-100
Total/lines		*1,717*		*1,410*		*1,013*		*720*		

*FR13A 95-100% of plant survival, IRRI Standard Evaluation System for Rice, 2014

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

- Improving Rice and Peanut Varieties through Cobalt-60 Gamma Irradiation in Vietnam -

The orientation in breeding of new mutant varieties (rice and soybean) in Vietnam are high yield and quality; wide adaptation, easily cultivation; short growth duration; tolerant to most important biotic and abiotic stresses in climate change condition. From 2008 to 2019, by gamma rays, Vietnam has released 13 new mutant varieties (11 rice and 02 soybean). In this, rice outstanding variety is Khang dan Mutant, released in 2008 with characters high yield, good tolerant to pest and disease cover about 400,00ha/year. DT39 Quelam released in 2013 has quality, high protein, yield and resistant to leaf blight. DT80 released in 2017 is the quality, BLB resistance variety. On soybean, the DT2008 is outstanding variety with the highest yield and tolerance ability in soybean breeding history, special in drought and diseases tolerance. Beside that, the first time, by the mutation method, Vietnam have a black soybean variety DT2008DB have almost characteristics the same DT2008 and content high nutrition and omega,... excellent in food use.

In 2021, our project, with the state's support budget, has focused on creating mutant varieties on peanuts and rice. Specifically, for peanuts, through screening from generations M2 to M5, 27 promising mutant lines were selected from 5 original varieties; With rice, from generation M2 to M4, 35 lines were selected from VTNA6 and 47 lines from ST20.

In Future Work Plan, the project has not ended and we will continue screening to select new varieties, and in 2022, we continue to irradiate on peanuts, oranges and soybeans.