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# RELEASE OF IMPROVED MUTANT VARIETIES OF RICE MUNGBEAN AND SOYBEAN

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ABSTRACT

Rice is the staple food for almost all of the Indonesian people, whereas legumes i.e. soybean, peanut and mungbean are important supplement food. Increasing food crop production is the main programme of National Agriculture Development due to population increase. Although national production and productivity of food crops has increased in the last two decades, the rate of increase is much less than demand, making import food from other countries a necessity. Although improving variety is not an absolute thing to increase productivity, it gives important contribution in increasing the production. Mutation breeding activities in the Centre for Research and Development of Isotopes and Radiation Technology, National Nuclear Energy Agency, had been carried out in rice, mungbean and soybean. Mutation breeding in rice started in 1972 and 5 low land and 1 upland rice varieties i.e. Atomita 1, Atomita 2, Atomita 3, Atomita 4 , Cilosari lowland rice varieties, and Situgintung upland varietyhad been officially released. Soybean mutation breeding activities started in 1980 resulting on releasing officially of 3 soybean varieties i.e. Muria, Tengger and Meratus; whereas mungbean mutation breeding activities started in 1983, and up to now only 1 variety, i.e Camar mungbean variety had been officially released. Another upland rice variety named Danau Atas was also derived from irradiated Seratus Malam upland rice variety, was officially released from the Central Research Institute for Food Crops, Agency for Agricultural Research and Development.

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## INTRODUCTION

Rice is the staple food for almost all of Indonesian people, whereas legume i.e. soybean and mungbean are important secondary crops for supplement food, especially for food diversity.

In Indonesia rice is grown in areas up to 1,800 meters above sea level, during the wet and the rainy season. Up to now more than 11,871 local and 103 improved varieties have been listed (Table 1). Due to population increase, increasing food crop production is the main programme of National Agriculture Development. Rice consumption rate per person since 1990 up to 1996 decreased from 118.00 to 111.48 kg, it showing that food diversification occurred from rice to non rice. It was predicted that rice consumption in 1998 will be 109.66 kg per person (1).

The national rice demand, in fact, is more than national rice production, while the harvesting area is mostly stable from year to year; causing increasing the rice import (Table 2) (2). Java island (56.46 %) is the main region for rice production, followed South Sulawesi (7 %) and North Sumatra (6.51 %).

Soybean and mungbean are secondary crops, important for their high nutrition value. The importance of these crops especially for food diversification and food supplement when climatic stress ( drought) take place.

Soybean have been included in the National Food Programme since 1984 due to high protein content, fat, vitamin and minerals for increasing nutritious food in people diet. The areal harvested is about 1.3 million hectares, and the productivity is about 1.1 ton per hectare. Most soybean production are used for direct consumption processed in forms, such as tempe (fermented bean), beancurd (tofu), and soya souce, feed stock and also for industrial raw material. Tempe and beancurd are very popular in Indonesia.

Mungbean usually used as vegetables (bean sprout/ 30 %), baby's food, porridge, cakes, feed stock and industrial raw material (cosmetics). Mungbean porridge is popular dish for breakfast. Although mungbean is rich in vitamin (especially B1 vitamin), the farmers are reluctant to grow it due to having low yied.

The importance of these crops is indicated by their increasing demand over the last decade. In 1987 a total of 1.4 million tons of soybean, 0.[illegible] million tons of groundnut, 0.3 million tons of mungbean and 0.2 other grain legumes were consumed as food and feed stock ,and also used as row material for local industry. Projected demand by the year 2000, both as food and feed stocks, are even greater, is estimated at 3.1 million tons of soybean, 1.9 million tons of groundnut and 0.6 million tons of mungbean (3).

The national soybean and mungbean demand, in fact, in more than their production. For solving this problem, imported legumes from other countries is the only way. Soybean and mungbean import was increased every year (Table 3, 4) (2). Soybean import in 1996 up to 1998, was reach about 700,000 tons a year, or more than 49%, whereas mungbean import in 1998 was more than 50% of the total production. Although improving variety is not the only way to increase the productivity, it gives an important contribution in increasing the production.

## RICE MUTATION BREEDING

Rice mutation breeding activities in the Centre for Research and Development of Isotopes and Radiation Technology, National Nuclear Energy Agency, was initiated in 1967 after instalation of the first $^{60}$Co-irradiation facility at the Centre for Research and Development of Isotopes and Radiation Technology.

Intensive work on rice mutation breeding programme in Indonesia was initiated in 1972, in attempt to improve protein content of rice grain. This research activity was carried out under the IAEA Research Coordination Programmes (4). Pelita I/1 and IR-5 rice varieties were used as the materials. Dry seed were irradiated at 0.2 – 0.5 kGy for Pelita I/1 and 0.2 – 0.3 kGy for IR-5 rice variety. Selection for high protein content was conducted in $M_2$ and $M_3$ generation respectively. Numbers of high protein mutant lines were identified, however none of them was submitted for release as a new variety. The rice seed protein content was much influenced by environmental factors, such as heterogenity of soil fertility, amount of applied nitrogen fertilizer etc. (5). Three early maturing rice mutant lines have been selected, however these mutant lines did not meet the requirement for release as a new variety due damage by brown planthopper and bacterial leaf blight, that was the main pest and disease for rice respectively at that time.

The rice mutant lines no. 627/4 – 214/PsJ and 627/10 – 3/PsJ were submitted for official release, however only the first mutant line no 627/4 – 214/PsJ was officially approved as a new variety Atomita 1 in 1982. This rice variety has good grain quality, early maturing, high yielding, resistant to brown planthopper biotype 1 and green leafhopper. However it was not resistant to brown planthopper biotype 2. There for, this variety was not grown widely, since its release due to endemic situation of brown planthopper biotype 2 in the field (6). In 1983, the mutant no 627 – 5/PsJ was released as a new variety named Atomita 2. This variety has better grain quality, resistant to brown planthopper biotype 1 and tolerance to salinity. This Atomita 2 rice variety has become a valuable source of salinity tolerance. This variety has been successfully used for hybridization in Vietnam. Variety "GB" had been developed by crossing of IR-42 with Atomita 2 which was released in Vietnam in 1986 (7).

For improving their resistance to brown planthopper rice variety Atomita 1 and rice mutant lines no 627/10 – 3/PsJ were irradiated with 0.2 and 0.3 kGy of gamma rays as a result, one resistant mutant line no 1066-E/PsJ was released as new variety Atomita 3 in 1990. This variety has a good grain quality and high yielding potential however this variety was not quite acceptable for farmers due to its rather late in maturity.

One early maturing rice mutant line no. Obs-208/PsJ was developed from gamma irradiated Cisadane rice variety, has been officially released as Atomita 4 rice variety in 1991. This variety has been popular to farmers because of its resistance to brown planthopper biotype 2, good cooking quality and more earlier in maturity time as compared with the original variety, Cisadane.

In upland rice, Seratus Malam rice variety had also been treated with 0.1; 0.2; 0.3; 0.4 and 0.5 kGy of gamma rays in 1982. Screening was carried out for their resistance to blast disease and brown planthopper. Among selected mutant lines there was one mutant line no. MG – 4/PsJ has been released as a new variety, Situgintung, in 1992. This variety performed high yield, resistant to blast disease and brown planthopper biotype 1 and 2. Semidwarf mutant no. SM – 268/PsJ, which was selected from 0.2 kGy treatment of irradiated Seratus Malam variety, had been crossed with IR 36. Selection was done for earlyness, and one of the selected mutants was mutant line no. Obs – 1647/PsJ. This mutant line was resistant to brown planthopper biotype 1 and 2, and also resistance to bacterial leaf blight, high yield potential, had been officially released as Cilosari rice variety in 1996. This variety is suitable for irrigated areas or lowland condition in Indonesia (9), and it is very popular to farmers, especially in West Nusa Tenggara and Bengkulu province.

Mutation breeding in upland rice was also carried out at the Bogor Research Institute for Food Crops, by irradiating Seratus Malam variety. In 1988 this institute had released Danau Atas upland rice mutant variety. Yield tria of some rice prommissing mutant lines are listed in Table 6.

Planted areas of some rice varieties are listed in table , whereas some rice mutant varieties are listed in table 6 respectively. Among the rice mutant varieties, Atomita 4 and Cilosari seems to be the most popular rice varieties planted in the field by the farmers. Yield trial of some promissing rice mutant lines was listed in Table 7.

## SOYBEAN MUTATION BREEDING

Mutation breeding activities on soybean was started in late 1979, and intensified afterwards through the IAEA Regional Project on Grain Legume Improvement and the UNDP Country Project. These activities had produced a new variety, named Muria, which was released in 1987. This variety has high yield and shorter plant stature compared to that of the original variety Orba. Muria soybean variety have been planted in the area about 1965 Ha (0.46%) in the dry season and about 30 Ha (0.01%) in wet season 1997. Further activities in soybean mutation breeding had stressed on the development of early maturing times (70 days) to meet the need for varieties that are suitable for the rice-rice-grain legume cropping pattern under irrigated lowland conditions. Guntur, Orba, Tidar and Wilis soybean varieties were irradiated with gamma rays at dosages of 0.1 – 0.3 kGy. One of the soybean mutant lines, no 71/PsJ had been released as a new soybean variety, named Tengger, in 199 . This variety has maturity time, about 70-73 days, and moderately resistance to *Phakopsora pachyrizi*. Another early maturing soybean mutant line, no 157/PsJ, had been released in 1998 as a new variety, named Meratus. This variety derived from gamma irradiated of Orba variety, at dosage 0.2 kGy.

In addition to select for earlyness, laboratory and green house screening for aluminum tolerance had also been applied to mutant lines developed from the irradiation. Several mutant lines had been identified as Al tolerant, i.e no. 21; 23; 23D (7), however these mutant lines did not meet the requirement for release as a new variety due to having low yield potential. For improving yield potential and maintaining their tolerance to Al toxicity, these mutant lines were crossed with some other soybean mutant line. Some high yield and tolerance to Al toxicity had developed on these activities, i.e. mutant line no. GH -7-Batan, GH-55-Batan and GH-58-Batan. Yield trial of some promissing soybean mutant lines are listed in Table 8.

## MUNGBEAN MUTATION BREEDING

Mungbean mutation breeding activities in the Center for Research and Development of Isotop and Radiation Technology, National Nuclear Energy Agency, started about 1980, by studying radiosensitivity and variation dosages to find out the optimum dose. Further intensive work on mutation breeding started in 1983, by using gamma irradiation at dosages of 0.1 – 0.4 kGy to induce mutation. Bhakti and Manyar mungbean varieties were used as experiment materials. The main objective of the activities were:

- synchronize in maturity time
- high yield potential
- resistance to *Cercospora* leaf spot.

Many morphological change appeared in some mutant lines derived from irradiated Manyar variety, i.e. changing in pod color and shape, grain color and shape and also leaf color and shape. Mutant line no. MI-5 has smaller seed, higher yield and more earlier/synchronize in maturity compared to that of the original variety, i.e. Manyar variety. This mutant line had been officially released as Camar variety in 1991. Camar mungbean variety is tolerance to *Cercospora leaf spot.*

Mutation breeding for shade tolerance started in 1994 by irradiating Merak, Walet and Gelatik mungbean varieties, with gamma rays and fast neutron, at dosages of 0.1 – 0.4 kGy and 0.01 – 0.03 kGy respectively. The objective of this programme was to increase the areal harvested, by planting shade tolerance varieties among the plantation crops. Some mutant lines had been selected viz. mutant lines no. PsJ-B-II-5, PsJ-B-II-15, PsJ-S-31, PsJ-CT26, CT 8 and PsJ 21-90 were identified as tolerance to shade. Yield trial of some mungbean promissing mutant line are listed in Table 9.

Drought resistance programme was started this year by gamma rays irradiation of 3 mungbean mutant lines, which were indicated resistance to drought, viz. mutant lines no. PsJ-19-91, WI-5 and MI-45, with dosage of 0.15, 0.25 and 0.35 KGy. Drought resistance will be tested among M2 and M3 generation. Selection for drought will also be carried out upon irradiated callus.

Some mutant varieties developed in the Centre for Research and Development of Isotopes and Radiation, National Nuclear Energy Agency are listed in Table 10.

## MAJOR CONSTRAINS OF PRODUCTION :

- Decreasing of fertile soil to grow rice, which is about 20,000 Ha a year, in Java island for non agriculture purposes.
- Emerging of new biotype/phytotype of pest and desease due to continuous planting only a certain commercial variety.
- Most of the farmers still produce the local variety which usually have low yield potential.

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Table 1 : Number of released rice varieties

NUMBER OF RELEASED RICE VARIETY

| RICE | PERIOD | | | | | |
|---|---|---|---|---|---|---|
| | 69-73 | 74-78 | 79-83 | 84-88 | 89-93 | 94-96 |
| SAWAH L.L. | 3 | 4 | 14 | 11 | 9 | 6 |
| SAWAH H.L. | 0 | 3 | 1 | 1 | 1 | 0 |
| SAWAH T.W. | 0 | 0 | 2 | 4 | 2 | 0 |
| UP LAND | 0 | 2 | 3 | 6 | 4 | 0 |
| INTRODUCTION | 1 | 8 | 3 | 6 | 6 | 0 |

TOTAL RELEASED RICE VARIETY = 103

Table (2). Development of rice areal harvested, production an l rice imported

| Year | Areal harvested (ha) | Production (ton) | Imported (ton/%) |
|---|---|---|---|
| 1991 | 10281597 | 44688247 | 190572 / 0.43% |
| 1992 | 11103317 | 48240009 | 621070 / 1.29% |
| 1993 | 11012800 | 48181087 | 32437 / 0.07% |
| 1994 | 10733830 | 46641524 | 636856 / 1.37% |
| 1995 | 11438764 | 49744140 | 1819226 / 3.66% |
| 1996 | 11569729 | 51101206 | 2149758 / 4.21% |
| 1997 | 11365523 | 49568170 | 2190511 / 4.42% |
| 1998 | 11889619 | 52914744 | 2170619 / 4.10% |

Table (3). Development of soybean areal harvested, productti in and soybean imported.

| Year | Areal harvested (ha) | Production (ton) | Imported (ton/%) |
|---|---|---|---|
| 1991 | 1368199 | 1555453 | 631038 / 40.57% |
| 1992 | 1665706 | 1869713 | 687550 / 36.77% |
| 1993 | 1470206 | 1708528 | 700156 / 40.98% |
| 1994 | 1406918 | 1564847 | 628159 / 40.14% |
| 1995 | 1477432 | 1680007 | 496888 / 29.58% |
| 1996 | 1279286 | 1517181 | 743532 / 49.01% |
| 1997 | 1265853 | 1373049 | 732745 / 53.37% |
| 1998 | 1300501 | 1547263 | 723501 / 46.76% |

Table (4). Development of mungbean areal harvested, production and soybean imported.

| Year | Areal harvested (ha) | Production (ton) | Imported (ton/%) |
|---|---|---|---|
| 1991 | 301267 | 237447 | 21094 / 8.88% |
| 1992 | 393073 | 326750 | 15593 / 4.77% |
| 1993 | 404673 | 357991 | 31687 / 8.85% |
| 1994 | 292095 | 283886 | 73191 / 25.78% |
| 1995 | 361115 | 325342 | 68235 / 20.97% |
| 1996 | 338404 | 308330 | 109738 / 35.59% |
| 1997 | 395538 | 359644 | 157803 / 43.88% |
| 1998 | 400984 | 387312 | 208631 / 53.87% |

Table (8) : Yield potential of some soybean promissing mutant lines, tolerance to Al toxicity.

| No. | Mutant lines/ variety | Yield* ( ton/ Ha ) |
|---|---|---|
| 1. | GH-7- Batan | 2.[illegible]57 |
| 2. | GH-58-Batan | 2.[illegible]74 |
| 3. | GH-55-Batan | 2.[illegible]56 |
| 4. | Wilis (C) | 1.[illegible]61 |

* Yield rate of some soybean mutant lines, tested from 6 loc[illegible]tions

Table (9). Agronomic characters of some promissing mungbe[illegible]n mutant lines, at dry season 1997, tested from 3 locations.

| No | Mutant line/variety | Plant height (cm) | Maturity ti[illegible]e (days) | Yield (ton/Ha) |
|---|---|---|---|---|
| 1 | PsJ-19-90 | 49.65 | 70.48 | 1.514 |
| 2 | PsJ-21-90 | 54.39 | 71.67 | 1.385 |
| 3 | PsJ-S-30 | 54.36 | 70.60 | 1.410 |
| 4 | PsJ-S-31 | 54.12 | 72.83 | 1.508 |
| 5 | PsJ-S-32 | 55.39 | 70.75 | 1.508 |
| 6 | PsJ-B-II-5 | 60.34 | 71.65 | 1.457 |
| 7 | Walet (c) | 61.79 | 72.00 | 1.401 |