

Development of High Yielding Variety to Support Coconut Replanting in Indonesia

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Introduction

The coconut plantations can be found in almost all the 34 provinces of Indonesia. The three largest area which constitute 75% of total coconut area are Sumatera (32.0%) followed by Java (27.0%) and Sulawesi (21.0%). The main coconut products exported are coconut oil, desiccated coconut, and copra meal. In the last 10 years there is increase in demand of other coconut products which includes food and non-food coconut products, such as: VCO, Nata de coco, coconut water, tender coconut, coconut milk, coco fiber, cocopeat, briquette, etc.

The main problem in coconut development is low productivity, because of old and senile palms. The implementation of coconut replanting and development program are lower than the target, because of the limited budget and non-availability of quality seedlings. The average copra production at the farmers level is only 1.2 ton/ha/year. The coconut breeding in Indonesia had succeeded to produce several kinds of tall, dwarf and hybrid varieties with high productivity of copra and nuts. The potential productivity of coconut tall varieties can reach 3.0-3.5 ton copra/ha/ year and 4.0-5.0 ton copra/ha/ year for hybrid varieties. The production of fruit is 12,000-15,000 nuts/ha/year for Tall type, and more than 20,000 nuts/palm/year for hybrid and dwarf varieties. But the resources of these varieties of Tall, Hybrid and Dwarf are limited, because these coconut seed gardens are not maintained properly. For more than 40 years, the Indonesian government is focusing on development of oil palm cultivation. In 2020 the total area under oil palm is reported around 14 million ha, larger than coconut area that is only 3.6 million ha.

The Indonesian Palma Crops Research Institute, ICERD-IAARD is implementing a short and medium

strategy for production of the good and quality coconut planting material, through the technology of mass selection, local tall and dwarf variety having high production quality has been selected from each block and recommended for mass multiplication to produce high yielding tall and dwarf in each region or province.

Coconut breeding development in Indonesia

In early 1970 there was decline in the productivity of coconut, while the demand for cooking oil increased. To overcome this problem, the government has implemented various programs to increase area under coconut and production of copra through coconut replanting program. In order to fulfil the needs of hybrid coconut seeds in quick and large quantities, the government had introduced PB121(Malayan Yellow Dwarf x West African Tall) hybrid from Cote d'Ivoire. In addition, hybrid coconut seed gardens were established in 11 provinces with an area of 1,856 hectares. Type of coconut hybrid generated is NIWA hybrid (Nias Yellow Dwarf x West Africa Tall). Besides importing hybrid variety, the Indonesian government through the Agency for Agricultural Research and Development has collected a local hybrid coconut, namely KHINA hybrid.

The breeding program in Indonesia launched in the past (1970-1990) with the objective to produce large scale superior quality planting material with the characteristics of high yield of copra and early bearing of fruits (Liyanage,1974). To achieve this objective crossed breeding method has been selected with hybridization to assemble various types of hybrid coconut of dwarf x tall.

1. Hybridization of Dwarf x Tall Coconut Crossing of dwarf x tall has been started since 1975. The local



Figure 1. KHINA-1 hybrid coconut

hybrid coconut can produce 4-5 tons copra/ha/year. The three types of hybrid coconut are KHINA1 (Nias Yellow Dwarf x Tenga Tall), KHINA2 (Nias Yellow Dwarf x Bali Tall) and KHINA 3 (Nias Yellow Dwarf x Palu Tall) and was released by the Ministry of Agriculture in 1984. The KHINA hybrid started its first flowering at the age of 3-4 years. The average copra production is 4 tons/ha/year, with the highest production up to 5 tons/ha/year. Copra oil content is 64%-65%. Average weight of copra is around 300g/nut so require 3-4 nuts to get one (1) kg of copra.

The coconut farmers are generally not using fertilizers in coconut plantations. As a result, the fruit size of hybrid coconut became small, and getting low production. Coconut farmers were very disappointed, because the imported hybrid coconut, namely PB121 is susceptible to bud rot disease caused by *Phytophthora palmivora*, and less tolerant to drought in addition to low production. KHINA hybrid (Figure 1) shown better performance compared to the PB121 hybrid, in production as well as resistance to disease. But the coconut farmers were not interested to take hybrid coconut under the program. Survey of

coconut plantation in the North Sulawesi showed that 98% of coconut farmers choose tall type under replanting program of coconut. Rethinam, et.al, (2002) reported that 94.44% of coconut farmers in Indonesia prefer to take high yielding local tall and local hybrid for use in development program. 93% of the total coconut area in Indonesia is covered with tall coconut variety. After that the IPCRI continued to release the KHINA-4 (Raja Brown Dwarf x Mapanget tall) and KHINA-5 (Bali Yellow Dwarf x Mapanget tall). The purpose of releasing these two coconut hybrids was that it required less inputs i.e. 50% compared to KHINA-1, 2 and 3 around 3 kg (Urea+SP36+KCl) per palm/year. The potential production with medium input get around 3.0-3.5 ton copra/ha/year.

Farmers generally prefer tall variety of coconut with the following reasons: (1) Tall coconut does not require intensive maintenance, (2) More tolerant to drought and bud rot disease, (3) The seednuts/seedlings are cheaper, (4) Farmers have not had a good experience with hybrid coconut. In recent year experienced more demands for hybrid coconut seednuts, especially from private plantation owners. Research started during 2012 for the new hybrid variety and successfully completed and released in



Figure 2. Hand pollination to produce coconut hybrid



Figure 3. Local tall coconut

2019 with the name HENGNIU. The variety starts bearing fruit at the age of 3 year and the copra production potentially reach 4 tons/ha/year.

2. Development and Replanting Program Using High Yielding Local Tall

Based on the experience and the acceptance by the coconut farmers, during 1990-2000 under the coconut breeding program the government has decided to produce tall coconut varieties having high content of copra. Increasing the productivity of tall coconut can be done through mass selection. Mass selection based on the weight of nut to improve the yield of next generation. Selection of 5%, the best mother palm will provide the 14.4% increase followed by selection of 10% and 15% provided 10.1% and 7.9% respectively. Selection of Mapanget tall, which produced 45-50 kg copra/palm/year, is better than other tall varieties such as: Tenga tall, Bali tall and Palu tall.

The total coconut area is distributed in 34 Provinces of Indonesia. In 2016, the total coconut area was 3.6 Mha with production of about 3.2 MMT copra equivalent. The main coconut Provinces, covering more than 200,000 ha are Riau Province (628,582 ha), followed by East Java Province (288,120 ha), North Sulawesi Province (268,973 ha), Central Java Province (234,651 ha) and North Maluku Province (210,107 ha). Out of the total area about 580,000 ha area is occupied with old and senile palms which is 15% of the total area. To increase the coconut productivity for sustainable coconut industry, replanting the old and senile coconut palms for which good planting materials is needed.

One of the sources for coconut seedling program is to identify High Yielding Block (HYB) and Coconut Mother Palm (CMP) in each Province and Regents. For identification of HYB and selection of CMP the Standardization finalized in the Coconut National Meeting held during July 2005 at Denpasar, Bali was considered. Some of the HYB criteria identified are location easy to reach, palms of 15-60 years age, mostly uniform morphology, average production > 70nuts/palm/year, free from pests and diseases. The CMP is selected individually from the HYB population, and maximum selected is 15%. Some of the CMP criteria identified are shape of crown is to be Spherical or Semi-spherical, number of green-leaf > 29 leaf, petiole short, width and vigour, production > 7 nuts/ bunch are considered during the selection of the seednut, and seedling before planting in the field.

The total of HYB have been identified until 2009 in an increase of 2,212 ha. The good of SMP have been selected from each HYB, and maximum selection is 15%. From these total HYB can produce 1,647,250 seednuts and can be used for replanting 8,236 ha every year. This capacity of HYB is lower than the requirement and it needs to be replanted 100,000 ha per year as macro programme of government.

The largest of HYB is in East Java Province with total area of 1,100 ha. The maximum number of SMP and coconut farmers belongs to East Java Province. It shows the location of HYB, for example in Sumenep Regent, Gapura District (Andulang Village), Panggul District (Wonocolo Village) and Tugu District (Prambon Village). The total number of SMP is 264 palms, and all these palms are belonging to 32 coconut farmers. The total SMP in East Java have been

Table 1. High Yielding Tall Coconut Variety

| No. | Varieties | Origin | Characteristic of yield and fruit component | | | | | | Re- leased year |
|-----|-------------------|--|---|------------------------|-------------------------------|--------------------------------------|------------------|-----------------------------------|-----------------------|
| | | | Number of bunch/ palm/years | Fruit weight (g) | Number of nuts/ bunches | Number of nuts/ palm/ years | Copra/ nut(g) | Oil content of copra (%) | |
| 1. | Mapanget tall | North Minahasa region, North Sulawesi Province | 13 | | 90 | | 250 | 63 | 2004 |
| 2. | Tenga tall | South Minahasa region, North Sulawesi Province | 13 | 2,500 | 6 | 75 | 250 | 69 | 2004 |
| 3. | Bali tall | Bali Province | 13 | | 6 | 75 | 290 | 66 | 2004 |
| 4. | Palu tall | Donggala region, Central Sulawesi | 13 | | 6 | 75 | 250 | 69 | 2004 |
| 5. | Sawarna tall | Lebak region, West Java Province | 14 | | 8 | 75 | 275 | 66 | 2006 |
| 6. | Sikka tall | Sikka, Flores, East Nusa Tenggara Province | 13 | | 7 | 90 | 250 | 64 | 2007 |
| 7. | Jepara tall | Jepara region, Central Java | 14 | | 8 | 80 | 233 | 62 | 2008 |
| 8. | Kima Atas tall | Manado city, North Sulawesi | 16 | | 10 | 100 | 220 | 62 | 2008 |
| 9. | Lubuk Pakam tall | Lubuk Pakam region, North Sumatera | 14 | | 9 | 75 | 248 | 60 | 2008 |
| 10. | Banyuwangi tall | Banyuwangi region, East Java province | 14 | | 8 | 80 | 270 | 63 | 2008 |
| 11. | Bojong Bulat tall | Banyuwangi region, East Java province | 12 | | 8 | 98 | 220 | 68 | 2008 |
| 12. | Molowahu tall | Kulonprogo region, Jogyakarta | 14 | | 9 | 110 | 225 | 67 | 2009 |
| 13. | Lubuk Kramat tall | Gorontalo region, Goron- talo Province | 13 | | 8 | 100 | 220 | 65 | 2009 |
| 14. | Adonara tall | Boalemo region, Goron- talo Province | 14 | 2,000 | 9 | 95 | 250 | 66 | 2012 |
| 15. | BuolST-1 tall | East Flores region, East Nusa Tenggara Province | 13 | 1,518 | 10 | 139 | 240 | 61 | 2013 |
| 16. | Mastutin tall | Buol region, Central Sulawesi | 13 | 2,170 | 9 | 133 | 240 | 62 | 2015 |
| 17. | Sri Gemilang tall | Labuhan Mapin, South Sulawesi Province | 13 | 1,800 | 9 | 116 | 244 | 64 | 2017 |
| 18. | Lampanah tall | Indra Giri region, Riau Province | 13 | 1,525 | 9 | 138 | 224 | 67 | 2017 |
| 19. | Bido tall | Aceh Besar region, Aceh Province | 14 | 2,500 | 9 | 133 | 320 | 58 | 2017 |
| 20. | Babasal tall | Morotai Island region, North Maluku | 13 | 1,795 | 10 | 128 | 210 | 61 | 2018 |
| 21. | Selayar tall | Banggai region, Central Sulawesi Province | 13 | 2,135 | 9 | 119 | 272 | 60 | 2018 |
| 22. | NuiSua tall | Selayar Island Region, South Sulawesi Province | 14 | 1,450 | 9 | 126 | 211 | 61 | 2019 |
| 23. | Zabal tall | Sula Island region, North Maluku | 13 | 2,026 | 9 | 123 | 252 | 64 | 2019 |
| 24. | Gambut tall | Tanjung Jabung Timur region, Jambi Province | 14 | 1,981 | 8 | 128 | 235 | 60 | 2019 |

Source: IPCRI Manado



Figure 4 Bali tall palm in Bali Island and Bali tall fruit

identified and selected 4,495 palms, since 2005 to 2009. These HYB and SMP will be used as source of seednuts for supporting the replanting programme in East Java. The other advantage of using the local tall are usually more adaptive to environment, and tolerant to pests and diseases compared to introducing the coconut seedlings from other location.

3. Release of High Yielding Tall Coconut Variety During the year 2000-2008, IPCRI have released 10 high yielding tall varieties. The results showed that some varieties of tall coconut have a high yield potential and these varieties are proposed to release. The coconut varieties that are recommended as the high yielding varieties are Mapanget tall, Tenga tall, Bali tall, Palu tall, and Sawarna tall (Table 1). The copra production of these five varieties are between 2.2-3.5 ton/ha/year, higher than the average national production, i.e. 1.0-1.5 ton/ha/year. Coconut Mapanget tall, Tenga tall, Bali successfully released 24 high yielding tall coconut varieties until 2020. The potential yield of these tall varieties is more than 3.0-ton copra/ha/year. The high yielding varieties can be very well utilized for replanting old and senile coconut palm to increase the production and productivity, and to improve coconut farmers' income. Tall and Palu tall have been released in 2004, coconut Sawarna tall released in 2006 by the Ministry of Agriculture. While five other coconut varieties have been released in the year 2008. Out of this superior coconut varieties have been recommended to use as source of good planting materials under replanting program of coconut.

Until 2020, the IPCRI has released 24 high yielding tall coconut varieties from some Regions and Provinces of Indonesia, which is producing copra



more than 3.0 ton/ha/year (Table 1). Some of the high yielding tall varieties are Bojong Bulat tall from Yogyakarta; Molowahu tall from Gorontalo; Adonara from Flores, East Nusa Tenggara; Sawarna tall from West Java ; Lubuk Pakam tall from North Sumatera; Mastutin tall from South Sulawesi; Buol tall from Central Sulawesi; Lampanah tall from Aceh; Bido tall from North Maluku; and Zabak tall from Jambi, etc.

Conclusion

Coconut productivity can be improved optimally by using improved seed, improved cultural practices, and breeding activities. The breeding program includes: selection, evaluation, and utilization of coconut germplasm. The selected good accession, can be released as high yielding variety. Several coconut varieties of tall type and dwarf type have been released as commercial seed nuts by Indonesian Palma Crops Research Institute (IPCRI) for more than 40 years. The IPCRI-IAARD

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