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PRODUCTION OF HIGH-YIELDING COCONUT VARIETIES BY THE DEPARTMENT OF AGRICULTURE SABAH, MALAYSIA

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Abstract

The coconut [*Cocos nucifera* (*C. nucifera*) L.] is an important fruit tree in the world, providing food for millions of people, especially in the tropical and subtropical regions and with its many uses it is often called the "tree of life". Coconut is one of the oldest industrial crops planted in Sabah. Coconut cultivation was initiated by the British Chartered Company in the 1880s, during their earliest period of governance in Sabah. Coconut planting has slowly become popular in recent years as there has been a 13.5% increase in the cultivated area from 2013 to 2023. The Department of Agriculture Sabah (DOA Sabah) is the main government agency in Sabah in coconut research, providing technical advisory services and producing coconut commercial planting material. Genetic material is the foundation for the setting up of a breeding program. DOA Sabah has produced and released four high-yielding varieties, i.e., MAWA, Aromatic Green Dwarf (AROD), MATAG, and Tacunan Green Dwarf (TACD), based on their yield potential and utilization. MAWA was recommended for fresh kernel and copra. MATAG is high-yielding and early in maturity with round, large fruit. It was distributed to farmers for replanting and rejuvenating coconut areas since the 8th Malaysia Plan. AROD was launched for tender coconut production, quality aromatic virgin coconut oil (VCO), and as a food ingredient due to its fragrance. TACD was recommended for commercial planting due to its large fruit size, precocity, and short palm height. The rearing of coconut seedlings in a well-maintained nursery facilitates efficient selection of normal uniform seedlings. Coconuts are propagated by seed nuts. The seed nut is sown in germination bed with saw dust as sowing media. Seed nuts will germinate in 2 to 3 months after sowing. Seedlings with 8 to 10 leaves are ready for field planting at about 7 - 8 months old.

Keywords**:** Coconut, Aromatic Green Dwarf, MATAG, Tacunan

1. INTRODUCTION

The coconut [*Cocos nucifera* (*C. nucifera*) L.] is an important fruit tree in the world, providing food for millions of people, especially in the tropical and subtropical regions and with its many uses it is often called the "tree of life". At any one time a coconut palm has 12 different crops of nuts on it, from opening flower to ripe nut (DebMandal and Mandal, 2010).

The coconut palm is subdivided into two morphological types: tall and dwarf. Tall is cross-pollinating, heterozygous, has a long lifespan and matures slowly. Dwarf cultivar, on the other hand, is self-pollinating, homozygous and mature faster than tall cultivar. Dwarfs are typically found near human settlements and contain traits that reflect human selection, such as slow trunk growth and self-pollination. This is in contrast to tall types, which lack self-pollination and domesticated characteristics (Arumugam and Hatta, 2022).

Coconut is one of the oldest industrial crops planted in Sabah. Coconut cultivation was initiated by the British Chartered Company in the 1880s, during their earliest period of governance in Sabah. District officers encouraged nomadic coastal dwellers to settle down by planting coconuts (Ramanathan and Ng, 1971). The coconut land use has been changed drastically to oil palm and cocoa due to its low economic return in the past four decades since the 1970s. However, coconut planting has slowly become popular in recent years, as there has been a 13.5% increase in the cultivated area from 2013 (17,286 ha) to 2023 (19,047 ha) (Figure 1).

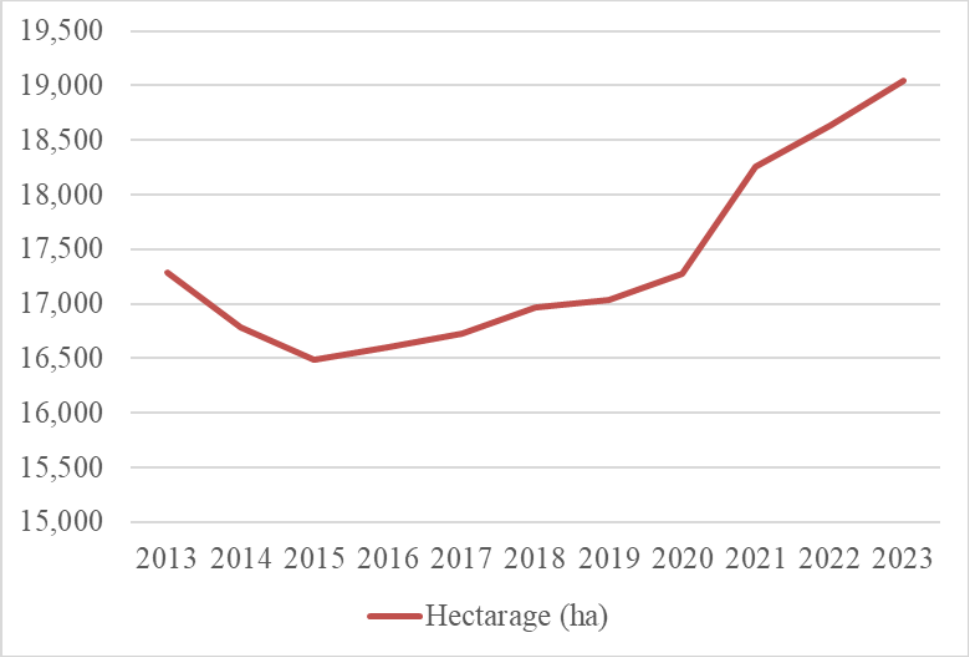

Figure 1. Hectarage (ha) of coconut cultivation in Sabah from 2013 to 2023

Currently, oil palm has the largest area cultivated in Sabah, followed by rubber, paddy, and coconut. The largest area planted with coconut is in the Kudat Division which constitutes about 52% of the coconut area followed by the Tawau Division with about 33% of coconut growing area (Table 1). Of the total coconut area, 93% are under smallholder's management, 5% are

under the management of the private estates and 2% owned by the government schemes or agencies.

Table 1: Hectarage of Coconut by Districts, Sabah 2023

District/Division	Planted area (ha)
Tawau	1,143.4
Semporna	3,113.3
Lahad Datu	1,863.5
Kunak	87.0
TAWAU DIVISION	**6,207.2**
Sandakan	722.3
Kinabatangan	132.5
Tongod	3.6
Beluran	179.5
Telupid	6.0
SANDAKAN DIVISION	**1,051.9**
Kudat	3,663.2
Matunggong	1,209.1
Pitas	3,464.6
Kota Marudu	1,542.4
KUDAT DIVISION	**9,879.3**
Kota Belud	443.2
Ranau	50.0
Tuaran	161.8
Kota Kinabalu	5.0
Penampang	6.5
Putatan	2.4
Papar	68.0
WEST COAST DIVISION	**736.9**
Beaufort	422.9
Sipitang	270.2
Kuala Penyu	415.2
Tenom	12.4
Keningau	38.2
Sook	5.0
Tambunan	6.8
Nabawan	1.0
INTERIOR DIVISION	**1,171.7**
SABAH	**19,047.0**

*source: Department of Agriculture (DOA) Sabah Crop hectarage

Malaysia has 79,412 ha of land cultivated with coconut in 2023. It covers 19,047 of ha in Sabah. Sabah ranks first in term of hectarage with fruit production about 3.3 t/ha which is lower than the

national production capacity at 7.9 t/ha (Table 2). On the other hand, the state remains as net exporter of coconut (RM 34 million) (Third Sabah Agricultural Policy (DPNS3), 2017 – 2026).

Table 2: Planted Area and Production of Coconut by State, Malaysia, 2023

State	Planted area (ha)	Harvested area (ha)	Total production (t)	Production per unit area (t/ha)
Johor	11,032.28	8,713.98	125,449.82	11.4
Kedah	1,765.75	1,736.88	34,241.15	19.4
Kelantan	10,278.17	9,390.96	75,961.36	7.4
Melaka	3,351.19	2,898.68	27,457.90	8.2
Negeri Sembilan	1,582.42	1,454.48	17,810.35	11.3
Pahang	3,667.93	3,162.43	27,016.45	7.4
Perak	7,405.5	7,343.88	88,982.17	12.0
Perlis	561	561	6,732.00	12.0
Pulau Pinang	28	19.3	112	4.0
Selangor	8,082.50	8,082.50	121,237.50	15.0
Terengganu	2,458.21	2,107.90	17,338.28	7.1
Peninsular Malaysia	**50,212.95**	**67,595.69**	**542,338.98**	**10.8**
Sabah	**19,047.00**	**15,718.50**	**62,063.80**	**3.3**
Sarawak	10,099.60	6,362.10	18,846.43	1.9
W. P. Labuan	52.4	43.10	413.52	7.9
MALAYSIA	**79,411.95**	**75,150.7**	**623,662.73**	**7.9**

*source: Industrial Crops Statistics Malaysia 2023, Department of Agriculture Malaysia

The Department of Agriculture Sabah (DOA Sabah) is the main government agency in Sabah in coconut research, providing technical advisory services, and is also recognized as one of Malaysia's coconut commercial planting material producers. The main coconut seed garden in Sabah was established in Stesen Kelapa Menumbok (SKM). In the meantime, Agriculture Research Centre Ulu Dusun (ARCUD), Sandakan, is responsible for producing high-quality foundation materials for the establishment of seed gardens (Shaftang, 2023).

This paper reviews the production of high-yielding coconut varieties by the Department of Agriculture Sabah.

2. MATERIALS AND METHODS

The selection of high-yielding coconut varieties includes assessing coconut genetic materials and on-farm trials through farmers' participatory programs. Genetic material assessment usually takes years due to coconut being a perennial crop. Genetic materials received from aboard need to be planted in an isolated area for quarantine purposes. They will be evaluated once they have shown good progress in growth and adaptation to the local conditions. Varieties with good economic potential will be launched and endorsed by the Department. Good coconut nursery management is vital in optimizing coconut planting material production.

2.1 Assessment and Selection of Coconut Genetic Materials

Genetic material is the foundation for the setting up of a breeding program. DOA Sabah has initiated the coconut germplasm collection program since 1975. The earliest cultivars collected were Sabah Tall (SBT), followed by the introduction of various coconut cultivars from abroad and Peninsular Malaysia. The Sabah Tall cultivar was planted at Manjang Agriculture Experimental Station (MAES) in 1976, followed by the planting of Cameroon Red Dwarf (CRD) and other dwarf cultivars at ARCUD in 1981. In 1995, the coconut conservation program was extended to Sg. Koyah Agriculture Experimental Station (SKAES) in Kinabatangan District (Nancy Shaftang & Au Wai Fong, 2018).

Nine tall and six dwarfs of highly promising populations were crossed and evaluated in the hybrid trial since the 80s. Most hybrids produced a high number of fruits, but fruit size varied depending on the parental material. Hybrid coconuts such as MAWA and MATAG are suitable to grow for the production of mature coconut because of their high and precocious yields (Nancy and Au, 2018). MAWA is a hybrid between Malayan Yellow/Red Dwarf (MYD/MRD) and West African Tall (WAT). It is early bearing and has vigorous growth. MAWA was recommended for fresh kernel and copra. MATAG, on the other hand, is a hybrid between Malayan Yellow/Red Dwarf (MYD/MRD) and Tagnanan Tall (TAGT). This hybrid is high-yielding and early in maturity with round, large fruit.

Hybrid coconut planting materials production is expensive due to manpower and input for emasculation, pollen collection and assisted pollination. Hence, it is crucial to breed pure line to save the cost of planting material. Utilization of selected dwarf coconut variety is a good option due to its uniformity and precocity. Pure seed nuts could be obtained under isolated seed gardens without assisted pollination.

Hence, apart from the hybrid program, DOA Sabah has also assessed one tall and two dwarfs with important characters, i.e., Sabah Tall (SBT), Aromatic Green Dwarf (AROD), and Tacunan Green Dwarf (TACD). Sabah Tall, also called by the locals as Pinggan-Pinggan Tall or Kudat Tall, is a typical example of tall coconut in Sabah. It is well adapted to local conditions. In 1997, the AROD was launched for tender coconut production, quality aromatic virgin coconut oil (VCO), and as a food ingredient due to its fragrance. TACD was launched in 2012 for commercial planting due to its large fruit size, precocity, and short palm height (Nancy Shaftang & Au Wai Fong, 2018). The yield components of these recommended varieties are shown in Table 3.

Table 3: Yield Components / Parameters of Coconut Varieties, Sabah

Variety	Fruit / palm / year	No of fruit / ha	Fresh meat (g) / fruit	Fresh meat (m.t./ha/ year)	VCO (ml) / fruit	Est. VCO liter/ ha/year
Sabah Tall (SBT) (143 palms/ha)	45	6,435	556	3.58	85	547
MAWA (MYD X WAT) (180 palms/ha)	80	14,400	347	5.00	80	1,152
MATAG (MYD X TAGT) (180 palms/ha)	107	19,260	481	9.26	88	1,695
Pandan (AROD) (272 palms/ha)	94	25,568	251	6.42	60	1,534
Tacunan (TACD) (236 palms/ha)	92	21,712	460	9.99	80	1,737
Average		17,475	419	7	79	1,374

*Source: Nancy Shaftang & Au Wai Fong, 2018

2.2 Seed Nuts Harvesting and Nursery Management

Coconuts are propagated by seed nuts or coconut fruits. The coconut fruit takes more or less 12 months to ripen from the time of pollination. However, 11-month-old nuts are considered physiologically mature and can be harvested. These nuts can be easily identified when the husk of one or two nuts in the bunch start turning brown (Santos *et al*, 1992).

Palms were selected as parent plants starting at five years old for dwarf varieties (AROD, TACD, MYD/MRD) and eight years old for tall varieties (TAGT, SBT), with consistent fruit production.

The seed nut was sown in germination bed with saw dust as sowing media. Seed nuts would germinate in 2 to 3 months after sowing. Seedlings with 8 to 10 leaves are ready for field planting at about 7 - 8 months old. Temporary shade that provides 50% - 75% light transmission was used to protect the seedlings from scorching.

The seedlings were transplanted into polybags if it was not possible to plant the smaller seedlings. Polybags of 40 cm x 45 cm and 0.15 mm gauge were used for hybrid or dwarf cultivar seedlings, and 45 cm x 55 cm and 0.2 mm gauge for tall cultivar seedlings. In the nursery, the polybags were allocated at a triangular spacing of 60 cm. Fertilizers were applied to the seedlings

in the polybags at 7 months after germination. Fertilizer such as compound or mixture NPK of 12:12:17:2 was applied at the rate of 30 g per seedling per month.

All diseased and stunted seedlings were rejected when inspecting the nursery, and before field planting. Adequate watering was also provided. Spray was necessary to control pests and disease.

3. RESULTS AND DISCUSSION

The Department commenced production of West African Tall (WAT) pollen for MAWA hybrid coconut in 1985. However, the production of MAWA seedlings was terminated in 2001 as the Department recommended a new source of coconut variety for planting. Production of MATAG planting material was started by the Department in 1999. MATAG was distributed to farmers for replanting and rejuvenating coconut areas since the 8th Malaysia Plan (2001-2005) (Nancy and Au, 2018). AROD and TACD were mass-produced in 1997 and 2012, respectively. To date, DOA Sabah is the sole genuine producer of MATAG coconuts in Sabah.

3.1 MATAG Hybrid Coconut

DOA Sabah, through ARCUD and SKM, has established TAGT and MYD/MRD seed gardens, respectively. ARCUD utilized 20 TAGT palms as pollen sources. The pollen was processed and tested for viability before being dispatched to SKM for cross-pollination with MYD/MRD. Only pollen with more than 20% viability will be kept and used in the field. SKM has a total area of 420 ha and was planted with MYD/MRD in stages from 1981 to 2012 for MATAG coconut hybrid production. It has a production capacity of 35,000 MATAG coconut seedlings per year.

The number of MATAG seedlings produced by DOA Sabah from 2001 to 2022 is 534,670, which could cater to the development of 2,970 ha of coconut farms in the State. In Sabah, MATAG is mainly planted in the Kudat Division because of environmental factors, especially rainfall. Area in the northern part of Sabah typically received less rain compared to other parts of the state. MATAG is known to be relatively tolerant to drought season due to tall characteristics from the father palm (TAGT), which is suitable for growing in dry areas.

3.2 Aromatic Green Dwarf (AROD) Coconut

Aromatic Green Dwarf (AROD), locally known as Pandan Coconut, was introduced to Sabah in 1985. The origin of this coconut was from Thailand. The immature nuts of AROD are deep green with aromatic sweet meat and water. DOA Sabah has established AROD coconut seed gardens in ARCUD and SKM. The fields are isolated at least 400 meters from other coconut varieties to keep their purity. It can produce 80 to 120 nuts per palm per year under local conditions. A nut contains 510 ml water with sugar content between 5.5 to 7.0%.

The number of AROD seedlings produced by DOA Sabah from 1997 to 2022 is 788,954, which could cater to the development of 2,900 ha of coconut farms in the State. Pandan coconut is the

most popular coconut planted in the West Coast Division of Sabah. The demand for Pandan tender coconut is exceptionally high during festive seasons. The price per tender nut can reach up to RM5.00. West Coast, being the center of tourist attractions in Sabah, has a strategic location for marketing.

3.3 Tacunan Green Dwarf (TACD) Coconut

Tacunan Green Dwarf (TACD) was introduced to Sabah by the department in 1980 as a germplasm collection from the Philippine. It has an average nut production of 50 to 90 nuts per palm per year in ARCUD. Matured nut contained 460 g fresh albumin (meat) and 247 g copra. The inflorescence of the TACD has a very typical cone shape, which makes the variety easier to identify (Bourdeix *et al*. 2005). DOA Sabah has established TACD coconut seed gardens in ARCUD and SKM. ARCUD is the main producer of TACD with the average capacity of 5,000 seed nuts per month.

The number of TACD seedlings produced by DOA Sabah from 2012 to 2022 is 96,982, which could cater to the development of 411 ha of coconut farms in the State. Currently, the Sandakan Division has the highest Tacunan hectarage in Sabah. Apart from ARC Ulu Dusun, private companies have also planted Tacunan on a big scale to meet the demand for planting materials and downstream processing. Although Tacunan is the youngest variety launched by the Department, it has sought significant interest from industry players as its yield performance and fruit characteristics are comparable to those of MATAG.

3.4 Challenges and Recommendation

Environment, biodiversity, and climate change have become increasingly important issues in recent years. They have impacted the production and the emergence of new pests and diseases around the globe. The major coconut insect pests in Sabah are Rhinoceros beetles (*Oryctes rhinoceros*) and Coconut leaf-eating beetles, particularly *Plesispa reichei*. To mitigate these issues, the Department has advocated and trained coconut plantations to practice the Good Agricultural Practices (myGAP) to ensure the sustainability of their plantation production.

Many uses or products can be developed from each portion of each stage of coconut development. The full potential of downstream production in Sabah has yet to be achieved due to the lack of investment in processing. Future processing plants need to practice product quality control and comply with international standards, e.g., GMP, HACCP (Hazard Analysis and Critical Control Points), and Halal certificates, to enhance the competitiveness of the local producers, manufacturers, traders, and entrepreneurs. However, it is estimated that the factory requires at least 45,000 nuts daily, depending on the mill size and range of products, to optimize the return on investment.

4. CONCLUSION

The production of high-quality coconut planting materials is essential to supporting the coconut industry in Sabah. Through continuous breeding programs, the development of high-yielding varieties, and good nursery management, DOA Sabah can continue to provide substantial

agricultural benefits to the state. The rearing of coconut seedlings in a well-maintained nursery facilitates efficient selection of normal uniform seedlings. It permits equal and unbiased application of treatment and evaluation. Care must be taken in choosing the seedlings to start a plantation since plantings will be in the field for many years.

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