Zabak Tall as a potential coconut variety in tidal areas

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Abstract. A challenge still being faced at the coconut farmers’ level is the low productivity, which is only at an average of 1.2 tons of copra per hectare per year. Apart from being caused by old plant age, it is also caused by low-quality seeds. The types of superior coconut that are currently available are still limited, especially the tidal-specific varieties. The research was conducted in the Village of Tanjung Solok, East Tanjung Jabung Regency, Jambi Province, Indonesia, from 2015 to 2018, using an observational survey, which was aimed to find promising lines of coconut that suitable for the tidal areas. The observed characters include vegetative, generative, and fruit components. The analysis of the coefficient variance was carried out to determine the level of variance and production potential of the Zabak Tall coconut. Meanwhile, the yield stability was analyzed by observing the linearity of the production characters for three years. The results showed that the productivity of Zabak Tall is at about 3.09 tons of copra per hectare per year, which is stable for three years of observation and even tends to increase due to selection activities.

Keywords: superior coconut, seeds quality, specific land

1. Introduction
Indonesia has an extensive peatland area of 14.9 million hectares, so if it is used optimally, it would play an essential role in supporting self-sufficiency and national food security. The potential and distribution of tidal land in Jambi Province is 684,000 ha or 12 percent of the total area of Jambi province [1]. A total 252,983 ha of the land have been cleared and reclaimed, consisting of 211,962 ha of tidal swampland and 41,021 ha of lebak swampland (non-tidal). Tidal swamp land is located in 3 regencies, the widest is Tanjung Jabung Timur Regency 149,210 ha followed by Tanjung Jabung Barat (52,052) ha, and finally Muaro Jambi Regency 10,700 ha. In comparison, the lebak swampland is spread over five regencies, namely Muaro Jambi, Batang Tebo, Bungo, Merangin, and Kerinci. Reclamation was carried out more than 100 years ago by residents and ethnic Bugis. Usually, they make canals from the river that protrude into the so-called kongsi trench, then planted with various crops such as food crops, coconut, industrial plants, and medicines [2].

The development of tidal swampland is one of the efforts to answer the challenges of increasing agricultural production, which is more complicated. With proper processing through the application of appropriate technological innovations, tidal swampland has good prospects to be developed into productive agricultural land [3]. Tidal land can be developed as plantation and agricultural land considering low productivity, large land area, and low cropping index [4]. In addition, the food production patterns in tidal areas complement the pattern of food production in Java and the competition for land use for non-agricultural purposes. It is relatively low, and the availability of production technology for various commodities, also contribute to the tidal swampland potential. The potential for
tidal swampland is tremendous in several areas of Indonesia, namely in Sumatra 32.9%, Kalimantan 40.4%, Papua 21%, Sulawesi 5.7%, and the rest is distributed in several places [5].

Coconut (Cocos nucifera L.) is one of the primary plantation commodities in Tanjung Jabung Timur Regency, Jambi Province, which plays a vital role in the farmers’ economy. Most of the population (70%) earn a living in the agricultural sector, with the plantation sector as the main commodity. Therefore, the local government of Tanjung Jabung Timur Regency prioritizes economic development in the agricultural sector with plantation commodities as the main economic support, which can be seen from the size of the coconut plantation area and the number of farmers who depend on coconut for their livelihood. The coconut plantation area has the largest area in Tanjung Jabung Timur Regency, which is 58521 ha, followed by oil palm 33872 ha, areca nut 9095 ha, rubber 7768 ha, and coffee in fifth place 3323 ha [6].

This research collaborated among the Local Government of East Tanjung Jabung Regency the Indonesian Palm Crops Research Institute (IPCRI), and the Estate Crops Plantation Service Jambi Province. Activities begin with exploration, selection of High Yielding Blocks, and observations since 2015. The determination of High Yielding Block and selected mother palms on the population of Tall coconut in tidal land at East Tanjung Jabung Regency, to obtain a population that can be proposed as a source of seed development through the release of varieties program. The results of the evaluation of the tall coconut population in Tanjung Jabung Timur Regency found several populations that could be designated as High Yielding Block of coconut. From some of these Tall High Yielding Block, it was also found that the population of Zabak Tall coconuts has a high production potential, which is above 3.0 tons of copra/ha/year. Because of the potential of Zabak Tall coconut on tidal land in East Tanjung Jabung, it can be used in the tall coconut development program. The population has been evaluated and characterized to determine its potential and productivity stability since 2016.

One of the coconut problems at the farm level is the low productivity of coconut, which is on average 1.2 tons of copra per ha per year. It is because superior seeds have not been used as well as the application of optimal cultivation techniques by farmers. The types of superior tall coconut available today are still very limited, so that they have not been able to meet the need for seeds in the coconut development program. The need for tall coconut seeds has been met from farmers’ gardens, namely from High Yielding Blocks. The national superior varieties are still very limited in number that has been released by the Minister of Agriculture, have not been able to meet the need for seeds. Nationally, all high-yielding coconut varieties that the Minister of Agriculture has released generally have habitat on dry land, and only two high-yielding varieties of coconut have habitat on tidal land, namely Sri Gemilang Tall coconut from Indragiri Hilir district and Kelambi Ujung Kubu Tall coconut from Batubara Regency.

Utilization of local superior coconuts for specific tidal lands such as Zabak Tall coconut is expected to answer the challenge of the lack of availability of specific tidal palms that are adaptive on sub-optimal land and have high production potential. The objective of this study was to observe the potential of Zabak tall coconut as an excellent coconut variety to cultivate in tidal areas.

2. Materials and methods
The research was conducted using direct observation or observation method on Zabak Tall coconut populations at Tanjung Solok Village, Kuala Jambi District, East Tanjung Jabung Regency, Jambi Province, Indonesia. The activity was carried out for 4 years, starting in 2015 until 2018. The population of these two coconuts was planted in 1985 or has aged 36 Years.

The observation activities include observation of vegetative and generative characters and fruit components, determination of High Yielding Blocks and determination of Selected Mother Palms, testing of fruit component characteristics, and supporting data in the form of climate and soil data. The number of samples is 30 trees which are taken at random. Data on agronomic characters (vegetative, generative, and fruit components observed) were analyzed for the coefficient of variance with the help of MS. EXCEL. The stability of coconut production was assessed by observing the fruits component analysis for 3 years. Observations on characters agronomy are as follows:
2.1 Vegetative characteristics:
   a. The girth of a stem (cm), girth measurement at 1.5 m height from above the soil surface
   b. Length (cm) of a stem with 11 leaf scars, measured starting from the bottom of the first leaf scar to the bottom of the 11th leaf scar.
   c. Number of leaves, count all leaves with green color.
   d. Petiole length (cm), measured from to the most proximal leaflet.
   e. Petiole width (cm), measured as above.
   f. Petiole thickness (cm) measured at the insertion of the first leaflet.
   g. Rachis length (cm), measured from the base of the petiole to the tip.
   h. Number of leaflets, count on one side of the front with the first leaflet closest to the base.
   i. Leaflet length (cm), use four leaflets (two on each side) near the middle of the rachis and record the average of four measurements.
   j. Leaflet width (cm), use the same leaflets as above, and record average (at maximum width) of four measurements.

2.2 Generative characteristics
   a. Number of the bunch, count all the bunches in one tree.
   b. Number of fruits/bunch, count the fruit in every bunch at the 3 oldest bunches.
   c. Length of inflorescense (cm), measured from the base of the bunch stalk to the top of the spikelet.
   d. Length of the peduncle (cm), measured from the base of the bunch stalk to the top of the spikelet.
   e. Peduncle thickness (cm), measured near the base of the lowest spikelet.
   f. Width of the peduncle (cm), measured near the base of the lowest spikelet.
   g. The Number of spikelets, count all the spikelets.
   h. Number of female flowers/bunch, count all the female flowers in each spikelet.
   i. Number of fruits/year, by multiplying the number of fruit per bunches by the number of bunches.

2.3 Fruit component analysis
   a. Weight of fruits (g), weighed each fruit.
   b. The equatorial circumference of fruit, measured in a circle from the base of the fruit to the opposite end.
   c. Polar circumference of fruit, measured in a circle opposite to the measurement of fruit.
   d. Weight of unhusked fruit, the fruit is peeled, then weighed.
   e. Weight of endosperm, the endosperm is removed from the shell and then weighed.
   f. Endosperm thickness, measured using a caliper.

3. Results and discussions
   3.1 The characteristics of vegetative, generative, and the fruit components of Zabak Tallcoconut
   The analysis of the coefficient of variance for three years of observation for the vegetative, generative, and fruit components characters, almost all characters showed a value below 20 percent. This value indicated that the appearance of the plant is uniform.

   3.2 The variation of vegetative characters
   The analysis of the coefficient of variance showed that eleven vegetative characters analyzed for the coefficient of variance showed a uniform appearance, except for the length of the stem on 11 leaf scars (20.04 percent) and petiole thickness (35.29 percent). It illustrates that the characters of the stem length on 11 leaf scars and petiole thickness can be used as selection criteria for improving coconut populations in Zabak (Table 1). However, this criterion must have a close relationship with the yield so that if it is used as a selection criterion, it is effective. Miftahorrachman et al., 2019 identified that the characters
of the weight of endosperm, the number of fruits, and the number of coconut bunches in Kampung Laut (Zabak), which had a close and positive relationship with the yielding character, namely coconut meat production, while 13 characters others analyzed did not have a direct relationship with the character of coconut meat production [7].

According to Sivakumar et al., 2020, the improvement of results is only possible by selecting characters that have a relationship with yield [8]. Breeders usually use correlation analysis to find out the characters that are closely related to the yield so that it is easier for breeders to select various yield components [9]. However, in plant improvement, the selection is not effective if carried out directly on yield characters because these characters are polygenic and strongly influenced by the environment [10].

Table 1. Vegetative characters of Zabak Tall coconut.

| No | Characters                              | X  | SD  | CV  |
|----|----------------------------------------|----|-----|-----|
| 1  | Girth of a stem (cm)                    | 82.34 | 7.36 | 8.95 |
| 2  | Length of a stem at eleven leaf scars(cm) | 68.04 | 13.60 | 20.04 |
| 3  | Length of petiole (cm)                  | 117.00 | 9.32 | 7.92 |
| 4  | Petiole width (cm)                      | 6.91  | 0.56 | 8.06 |
| 5  | Petiole thickness (cm)                  | 2.87  | 1.01 | 35.29 |
| 6  | Length of rachis (m)                    | 398.00 | 23.25 | 5.84 |
| 7  | Number of leaflets                      | 108.00 | 10.55 | 9.77 |
| 8  | Width of leaflets (cm)                  | 5.40  | 0.80 | 14.86 |
| 9  | Length of leaflets (cm)                 | 116.40 | 16.35 | 14.05 |

| a  | Mean value                              |
|---|----------------------------------------|
| b  | Standard deviation                      |
| c  | Coefficient of variance                 |

3.3 The variance of generative characters

The results of the analysis of the variance of Zabak Tall coconut showed a uniform appearance. It is indicated by the value of the coefficient of variance, which is below 20 percent (Table 2). Therefore, the selection program can only be achieved by utilizing valid information about the correlation and the variance in the population [11]. In addition, the effectiveness of breeding programs can be developed through the genetic variance of the available plant populations [12].

Table 2. Generative characters of Zabak Tall coconut.

| No | Characters                              | X  | SD  | CV  |
|----|----------------------------------------|----|-----|-----|
| 1  | Number of bunches                      | 13.40 | 0.71 | 5.30 |
| 2  | Number of fruits per bunch             | 9.24  | 0.96 | 10.39 |
| 3  | Length of inflorescence (cm)           | 93.75 | 2.50 | 2.67 |
| 4  | Length of peduncle (cm)                | 40.00 | 1.00 | 2.50 |
| 5  | Peduncle thickness (cm)                | 3.95  | 0.50 | 12.66 |
| 6  | Width of peduncle (cm)                 | 3.80  | 0.60 | 15.79 |
| 7  | Number of spikelets                    | 27.00 | 2.50 | 9.26 |
| 8  | Number of female flowers per bunch     | 23.50 | 2.50 | 10.64 |
| 9  | Number of fruits per year              | 123.0 | 3.40 | 2.76 |

| a  | Mean value                              |
|---|----------------------------------------|
| b  | Standard deviation                      |
| c  | Coefficient of variance                 |
3.4 The variance of the fruit components of Zabak Tall coconut in three years observation

The appearance of the six components of Zabak Tall coconut during the 3 years of observation showed a reasonably uniform appearance with a coefficient of variance below 20 percent (Table 3). The average size of the Zabak Tall coconut is larger than the Babasal Tall, the Sri Gemilang Tall, and the Kelambi Ujung Kubu Tall, which have been released previously. Zabak Tall coconut has an average of 2026 grams per fruit compared to the weight of the Babasal Tall, Sri Gemilang Tall, and Kelambi Ujung Kubu Tall coconut, which only has 1975 grams, 1920 grams, and 1703 grams per fruit, respectively [13], [14], [15]. Likewise, the weight character of coconut meat in Zabak Tall is on average 504 grams per fruit, coconut meat in Babasal Tall weighs only 421 grams, Sri Gemilang Tall coconut 483 grams, Kelambu Ujung Kubu Tall coconut 461 grams.

| No | Characters                        | X  | SD  | CV  |
|----|-----------------------------------|----|-----|-----|
| 1  | Weight of fruit (g)               | 2026.17 | 396.92 | 19.59 |
| 2  | Equatorial circumference of fruit (cm) | 62.78 | 4.07 | 6.48 |
| 3  | Polar circumference of fruit (cm) | 67.33 | 4.45 | 6.61 |
| 4  | Weight of unhusked fruit (g)      | 1164.00 | 203.12 | 17.45 |
| 5  | Weight of endosperm (g)           | 504.67 | 67.47 | 13.37 |
| 6  | Endosperm thickness (g)           | 1.26 | 0.12 | 9.52 |

*a* Mean value  
*b* Standard deviation  
*c* Coefficient of variance

Figure 1. The appearance of Zabak Tall coconut: A. The population of Zabak Tall; B. The performance of the tree; C. The appearance of the dehusked fruit.

3.5 The impact of selection and stability of fruit components of Zabak Tall coconut in three years of observation

The stability of coconut production was assessed by observing the fruits component analysis for 3 years. The average character of the coconut production component in Zabak tends to increase due to individual selection in 2016 (Table 4), while the stability of the production component can be seen in Figure 1. The increase in the potential production impact of the selection results is seen significantly on the character of whole fruit weight in 2016, an average of only 1876 grams per fruit to 2026.17 grams/fruit in 2018. Likewise with the weight character of meat, in 2016, it was only 480.50 grams/fruit to 504.67 grams in 2018. This impacts the estimated production of coconut copra in Zabak Tall, from 2.98 tons of copra/year in 2016 to 3.09 tons of copra/ha in 2018.
The stability of Zabak Tall coconut production tend to increase in 3 years of observation (Figure 2). In addition, the character of the production components such as the number of bunches, was also showed an unstable appearance. However, the potential is above the initial potential data before selection (Table 3). The actual stability of the coconut production potential in the Zabak needs to be tested in several ecosystems. In addition, yield stability depends on plant characteristics such as resistance to environmental stress [16]. Other researchers explained that yield is a complex quantitative character strongly influenced by environmental fluctuations. The target of plant breeders will usually develop varieties with adaptability to a broad environment [17]. The yields are strongly influenced by the environment, which causes varying results, both in several years of planting in one location and in several locations even in different locations in several years of the growing season [18]. Other researchers found that progeny number 110 of oil palm was the most stable among the 6 progenies tested in three different locations [19].

Table 4. Potential of production characters of Zabak Tall coconut from 2016 to 2018.

| No | Characters                        | Year 2016 | Year 2017 | Year 2018 | Average |
|----|-----------------------------------|-----------|-----------|-----------|---------|
| 1  | Number of bunches                 | 12.20     | 14.20     | 13.67     | 13.40   |
| 2  | Number of fruits per bunch        | 8.02      | 9.76      | 9.94      | 9.24    |
| 3  | Number of fruit/palm/year         | 99.84     | 136.40    | 135.68    | 123.700 |
| 4  | Weight of fruit (g)               | 1876.00   | 1962.50   | 2240.00   | 2026.17 |
| 5  | Weight of nut (g)                 | 1187.67   | 1084.33   | 1220.00   | 1164.00 |
| 4  | Weight of endosperm/nut (g)       | 480.50    | 508.50    | 525.00    | 504.67  |
| 5  | Thick of endosperm (cm)           | 1.27      | 1.23      | 1.29      | 1.26    |
| 5  | Weight of copra (g)               | 242.00    | 262.50    | 260.00    | 252.25  |
| 6  | Copra production/palm per year (kg)| 26.98    | 31.08     | 31.00     | 29.00   |
| 7  | Copra production/ha/year (ton)    | 2.98      | 3.08      | 3.22      | 3.09    |

The stability of Zabak Tall coconut production tend to increase in 3 years of observation (Figure 2).

Figure 2. Stability of 6 production components of Zabak Tall coconut for 3 years observations.
Table 5. Rainfall data (mm) (year 2014 – 2018) in Kuala Jambi District

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Total |
|------|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-------|
| 2014 | 123 | 53  | 116 | 156 | 198 | 12  | 41  | 188 | 85   | 43  | 294 | 61  | 1105  |
| 2015 | 186 | 215 | 149 | 245 | 120 | 127 | 92  | 51  | 16   | 9   | 297 | 280 | 1210  |
| 2016 | 203 | 239 | 339 | 233 | 161 | 122 | 92  | 51  | 136  | 79  | 179 | 52  | 1671  |
| 2017 | 141 | 203 | 133 | 102 | 283 | 92  | 95  | 122 | 137  | 183 | 203 | 115 | 1491  |
| 2018 | 38  | 282 | 264 | 192 | 154 | 39  | 122 | 104 | 137  | 145 | 259 | 297 | 1477  |

Source: Meteorology Climatology and Geophysics Agency, Meteorological Station Class 1 Sultan Thaha Jambi.

The rainfall data in Kuala Jambi District shows that the rain is not evenly distributed throughout the year. In 2014-2018 there were about 2 - 7 dry months per year, with rainfall ranging from 1105 - 1671 mm per year (Table 5). Dry months (<130 mm) that were more than 3 consecutive months in 2014 occurred throughout January to March, then in 2015 from May to October, and in 2015 when El Nino occurred from January to February and June until October. However, climatic conditions, especially the uneven rainfall, did not affect productivity, especially the four production components as shown in Figure 1, except for the character of the number of bunches which tended to decline in 2018.

3.6 The quality of the fruit of Zabak Tall coconut

The analysis results of the dominant saturated fatty acids are lauric acid, namely lauric acid of 30.89 percent. The results of this analysis are much lower than the lauric acid content of Kelambi Ujung Kubu Tall coconut, which is 52.75 percent (Table 6). Likewise, the dominant unsaturated fatty acid content, namely oleic acid, is only 4.4 percent lower than the coconut oleic acid content in Kelambi Ujung Kubu Tall of 6.28 percent [15]. However, the analysis results of the fat and protein content of the coconut meat in Zabak are generally relatively high compared to other Tall coconuts that have been released previously (Table 7).

Table 6. Nutrients content of Zabak Tall coconut meat.

| Parameter          | Units  | Results | Testing methods             |
|--------------------|--------|---------|------------------------------|
| Water              | %      | 4.36    | SNI.01-2891-1992, point 5.1 |
| Protein (Nx6.25)   | %      | 8.60    | 18-8-31/MU/SMM-SIG, Kjeltec  |
| Fat                | %      | 64.74   | 18-8-5/MU/SMM-SIG, Weilbug   |
| Fatty acid composition |       |         |                              |
| Saturated fatty acid |       |         | 18-6-1/MU/SMM-SIG, GC       |
| Butyric (C4)       | %      | 0       |                              |
| Caproic (C6)       | %      | 0.39    |                              |
| Caprilic (C8)      | %      | 5.13    |                              |
| Capric (C10)       | %      | 4.18    |                              |
| Lauric (C12)       | %      | 30.89   |                              |
| Myristate (C14:0)  | %      | 10.96   |                              |
| Palmitic (C16:0)   | %      | 6.11    |                              |
| Stearic (C18:0)    | %      | 1.95    |                              |
| Unsaturated fatty acid |       |         | 18-6-1/MU/SMM-SIG, GC       |
| Oleic (C18:1)      | %      | 4.44    |                              |
| Linoleic (C18:2)   | %      | 1.07    |                              |
| Linolenic (C18:3)  | %      | -       |                              |
Fatty acid research started about 90 years ago but has intensified in recent years. The essential fatty acids (linoleic and α-linolenic) must come from food. Other fatty acids may come from food or may be synthesized. Fatty acids are major components of cell membrane structure, modulate gene transcription, function as cytokine precursors, and serve as energy sources for complex, interconnected systems. It is becoming increasingly clear that dietary fatty acids affect vital functions and human health. As the most substantial evidence for its effect is found on cardiovascular disease and mental health, many additional conditions are affected. Problematic changes in the fatty acid composition of the human diet have also occurred over the last century. This review summarizes the current understanding of the role of pervasive essential fatty acids and their metabolites in human health [20].

Table 7. Comparison of protein and lipid content of Zabak Tall coconut with others tall coconut.

| Variety          | Protein(%) | Fat(%) | Water content(%) | Source                             |
|------------------|------------|--------|------------------|------------------------------------|
| Zabak Tall       | 8.60       | 64.74  | 4.36             | This research                      |
| Sri Gemilang Tall| 8.96       | 65.19  | 1.70             | Pandin et al., 2017                |
| Mastutin Tall    | 8.95       | 61.88  | -                | Tenda et al., 2017                 |
| Kelambi Ujung Kubu Tall | 8.13   | 62.10  | -                | Mahayu et al., 2019               |
| Babasal Tall     | 8.13       | 61.08  | -                | Tenda, 2017                       |

3.7 Potential sources of coconut seeds of Zabak Tall
The Coconut High Yielding Blocks in Zabak is managed by the Jaya Farmers Group, Tanjung Solok Village, Kuala Jambi District, East Tanjung Jabung Regency, Indonesia. The number of Selected Mother Palms is 613 trees with a seed potential of 15,252 seeds per year, equivalent to the development of coconut plantations of 124 hectares/year. Expansion of coconut plantations of Zabak Tall in the future is vital considering the productivity of it, which is relatively high every year, namely 3.09 tons of copra/ha/year, and the availability of selected mother palms as a source of superior seeds.

4. Conclusions and suggestions
Zabak Tall coconut is suitable for development on tidal land considering that it has high production, which is 3.09 tons of copra per hectare per year. Compare to the other released tall coconut, it has high oil content which is 64.74 %, with a protein content of 8.60 %. Potential sources of coconut seeds in Zabak can supply the seed needs of 60,319 seeds or the equivalent of 301 hectares of coconut development every year.

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