MORPHOLOGICAL, PHYSIOLOGICAL AND AGRONOMIC CHARACTERISTICS OF CASSAVA SUPERIOR VARIETY OF COASTAL LANDS

Amarullah

Department of Agrotechnology Faculty of Agriculture, University of Borneo Tarakan

amarullah70@gmail.com

Abstract. Additional information on morphological, physiological and agronomic performance for different cassava genotypes will support decision making for genetic resource selection, cultivation techniques and development of the desired crops for water-limited conditions such as coastal or coastal land. The purpose of this study was to evaluate the morphological, physiological and agronomic characters of eight cassava genotypes, namely Adira-1, Adira-4, Malang-4, Malang-6, UJ-3, UJ-5, Singgah and Ketan grown in the environment. dry land on coastal lands during high accumulation of root storage during mid 2018-2019. The study used a completely randomized design (RCD) with one factor and five replications. Morphological characteristics (plant height, stem diameter, number and shape of branches) were observed during growth. Physiological characters (leaf area index), chlorophyll content and photosynthetic activity) were observed 180 days after planting. The agronomic characteristics associated with tuber yield were observed at harvest. The results showed that cassava in coastal land had morphological characters (stem 277.78 cm high, 3.09 cm in diameter, varied branches), physiological characters (LAI = 3.85, leaf chlorophyll content = 1.29 mg g^-1 with high photosynthetic activity), agronomic character (tuber yield 11.09 t / ha, dry weight 8.65%, 0.74). There is a positive relationship between several parameters in morphological and physiological characters on the agronomic characters related to the yield of cassava. All superior cassava varieties showed better performance compared to local glutinous rice varieties. Malang-4 and Malang-6 varieties produced tuber weights with dry matter and high yield harvest index (13.65 kg / plant + 8.69% + 0.77 and 13.81 kg / plant + 8.68% + 0.77)

Keywords: Characteristics, Superior Varieties, Cassava dan Coastal

1. Introduction

Cassava (Manihot esculenta Crantz) is an important world economic commodity, developing both in tropical and subtropical areas [1,2, 3]. Cassava can be used as an alternative food substitute for rice, [4] due to its superiority compared to other crops, because all parts of the plant can be used. Apart from energy sources producing carbohydrates [5], alcohol, detergents, biofuels, textiles and also for animal feed and other pharmaceutical products [6, 7, 8, 9]. However, it is also important as a source of industrial raw materials and a contributor to food safety [10,11].

Apart from being related to nutrition and economy [11], the conditions of “drought, war and famine” because it can be planted on dry soil are not fertile and harvested when needed as food reserves [12], it is even more resistant to climate change than other crops [13].
Globally, cassava production reached 277.1 million tonnes (productivity 23 t / ha) with Nigeria being the largest producer followed by Thailand and Indonesia [14]. Global yield of cassava is still lower at 11.6 t / ha [15], still much lower than its potential (80 t / ha), but better agricultural practices can help reduce yield gaps and reach 60 t / ha [16, 17].

The increase in yield, quality and sustainability of cassava commodity is important for food security, consumption needs and other interests related to the human population that will increase twofold by 2050 [18]. Improvement efforts are very important, considering the planted area has increased but yields are still low. This condition is due to the lack of water for some farmers cultivating in rainfed conditions, so that during the planting period there is water pressure and decreased productivity [18,19]. According to [20], the low yield of cassava is due to a lack of well-adapted varieties to different conditions, inadequate cultivation practices and the use of low quality planting material [21].

In response to this, variety selection becomes important [22] by identifying new varieties to replace varieties that have lost their good qualities. In this context, [23] found genotypic characters with high potential in different environments to be better.

Cassava can be widely adapted from hot climates (tropical), lowlands to high (altitude 2,500 meters above sea level). The ideal climate is an area with an air temperature of at least 10oC, humidity (Rh) 60-65%, rainfall 700-1,500 mm / year, an open place and gets 10 hours of sunshine / day. Areas with dry climates or low rainfall have a negative effect on cassava production, namely fibrous, woody tubers, low production and prone to pests. Conversely, in wet climates or high rainfall, plant growth tends to be vegetative and susceptible to fungi [24]. Cassava grows continuously, with periods of growth and storage of carbohydrates alternating in the tuber [25]. Adaptability to various types of soil (including marginal), climate, drought tolerant [26], can be considered development.

Selection of varieties with high yield potential and reduction of varieties with lower yields in conditions of water shortage is an alternative strategy to solve the problem in a sustainable manner because high yielding varieties are closely related to yield potential. According to [25], one of the main components in production technology and as an entry point for increasing the productivity of cassava is the use of superior varieties.

In the selection of varieties used criteria for tuber yield, harvest index, and starch content at the final harvest [27], although tuber yields and components vary between varieties [28, 29, 30] Cassava does not require special conditions to grow and is relatively easy to cultivate. Each variety is characterized by its morphological and physiological characteristics which are the result of the interaction between genetics and the environment [30]. Morphological, physiological and agronomic characters cause differences in photosynthetic activity which can affect the yield of cassava [31]. [32] found a positive relationship between net photosynthesis (Pn) and dry weight of cassava tubers grown in rainfed conditions, and the dry period. These three characteristics support the efficiency of selecting high productivity cassava varieties and for further breeding programs. Cassava varieties are generally distinguished from one another based on morphological characteristics such as leaf, stem and tuber color [33]. Productivity is related to photosynthetic ability. That is why, the process of photosynthesis is important to promote growth, development and yield [31]. Therefore, it is necessary to explore the morphological, physiological and agronomic characteristics of the superior varieties of cassava products associated with dry conditions during the high accumulation of cassava roots storage in rainfed conditions in coastal lands. Given the adaptability of superior varieties, it is necessary to test them in coastal areas that have dry climates with sandy soil conditions so that water availability is low. In addition, the adaptability of cassava growing on the coast needs to be seen from the side of morphological, physiological and agronomic characters that can be used as a benchmark.

The novelty of this research lies in a new local variety, namely Singgah with high yield potential and the location of the research is on coastal land which has not been widely cultivated due to dry, high conditions, low temperature and fertility. The results of this study are expected to be indicative of superior varieties that can be developed in coastal lands with high tuber yields. The creativity in this research examines the three characters of superior varieties and the technical depth of
cultivation techniques in dry climates of the coast. The low yield of tubers is suggested to be improved through cultivation techniques with the addition of various organic materials both as mulch to maintain moisture and fertilization to increase soil fertility.

This information will support the decision making to select recommended varieties suitable for development in coastal drought conditions. Good sources of information can help increase the success of the new genotype being released. The aim of this study was to evaluate the morphological, physiological and agronomical results of eight different genotypes of cassava grown under dry environment during high storage root formation

2. Research Methodology

2.1. Time and Place of Research

This research was conducted in Tarakan North Kalimantan from February to September 2019. in the Experimental Garden of the Faculty of Agriculture, University of Borneo Tarakan

2.2. Research Design

The research process: starting from land preparation and planting media, planting, observation, observation of supporting data (soil and climate) measurement, harvesting, and data processing, such us in Image 1). Six genotypes of superior varieties of cassava (Adira 1, Adira 4, Malang 4, Malang 6, UJ 3, UJ 5), one potential superior variety (Singgah) and one local commercial variety (glutinous rice) were evaluated for their morphological, physiological and agronomic characters. rainfed on coastal land in Tarakan, North Kalimantan province, Indonesia, Altitude ± 12 m above sea level, from March 2018 to March 2019. Alluvial soil type with sandy clay texture. Climate data (rainfall and temperature are obtained from the statistical headquarters for the City of Tarakan, shown in Table 1 below

Image 1: Research Flowchart
Table 1: Rainfall and temperature figures at the experimental site during 2018/2019 growing season

| Month         | Rainfall (mm) | Temperature (°C) | Min. | Max. |
|---------------|---------------|------------------|------|------|
| April, 2018   | 105.9         | 21.4             | 30.4 |      |
| May, 2018     | 92.0          | 21.3             | 29.0 |      |
| June, 2018    | 206.5         | 21.7             | 28.5 |      |
| July, 2018    | 103.7         | 20.9             | 30.0 |      |
| August, 2018  | 10.2          | 21.8             | 31.8 |      |
| September, 2018 | 56.7      | 22.1             | 32.1 |      |
| October, 2018 | 163.6         | 20.5             | 33.2 |      |
| November, 2018| 21.6          | 18.4             | 34.2 |      |
| December, 2018| 0.0           | 21.1             | 35.8 |      |
| January, 2019 | 302.0         | 24.5             | 30.7 |      |
| February, 2019| 88.0          | 24.8             | 31.7 |      |
| March, 2019   | 422.0         | 24.5             | 30.7 |      |
| Total         | 1572.2        | 263.00           | 371.90 | |
| Rate          | 131.02        | 21.9             | 30.99 | |

BPS Tarakan City (2018/2019)

Table 2: Soil chemical and physical properties of study site

| Chemical property | Level |
|-------------------|-------|
| pH                | 5.42  |
| Organic carbon (%)| 1.24  |
| Organic matter (%)| 2.10  |
| Nitrogen (%)      | 0.04  |
| Phosphorus ppm    | 5.86  |
| Calcium           | 5.98  |
| Magnesium         | 1.62  |
| EXC Acidity (Al + H) | 3.17 |
| CEC (Cmol/kg/Me/100g) | 5.86 |

| Soil separates (%) | % Composition |
|-------------------|---------------|
| Sand              | 72.68         |
| Silt              | 18.84         |
| Clay              | 08.48         |
| Texture           | Sandy loam    |

FPUBT Soil Science Laboratory (2019)

The study used a randomized block design (RBD) with 1 factor, namely cassava varieties with five replications. Individual plot sizes are 102 m² with a distance between plots of 1 m. The land used was 4080 m². The land preparation was carried out following standard procedures for the cassava experiment including preparing the soil surface. Plant material in the form of cassava stems from parent plants 12 months after planting were cut as 20 cm long stem cuttings containing 7-12 buds and soaked in 25% thiamethoxam with a water rate of 4 g per 20 L of water, for 5-10 minutes to remove flea flour stuck to the pieces. Eight cuttings of cassava varieties were inserted into the ridge of the soil (beds) (2/3 of the length is buried). A distance of 1 m between rows and 1 m between plants in rows was made. A total of 510 stem cuttings per treatment. Irrigation was carried out during the first month after planting to facilitate uniform population of the crop, and the plants were then allowed to grow in rainfed conditions until the final harvest. Weed control manuals were carried out to avoid competition. Basic fertilizer using organic fertilizer derived from chicken manure was given a week after processing the soil as much as 2 kg / m². Further fertilizers using inorganic fertilizers in the form of urea, S36 and KCl as much as 200, 100 and 100 kg/ha were applied twice, namely one and three months after planting.

2.3. Research Implementation

The implementation of field research followed the standard practice of cassava cultivation. Before tillage, the land was given dolomite 1.8 tons / ha in 2-3 weeks before planting to increase soil pH. Manure is given one week before planting at a rate of 15 tons / ha. Manure was given by spread evenly...
over the beds, then stirring with soil. TSP fertilizer with a dose of 200 kg / ha is given with manure, while urea fertilizer is 200 kg / ha and KCl fertilizer is 150 kg / ha given twice, half part at 3 days before planting and the other half at 3-4 weeks after planting. Planting was carried out vertically by immersing the seedlings in the ground up to about three quarters of a part, with a distance between plants 1 m x 1 m. Plant maintenance included activities; water supply, replanting of non-growing plants, weeding, weeding to loosen soil and control pests and diseases.

2.4. Observation
The plant's morphological characteristics were obtained by observing various parameters such as Stem growth by measuring plant height (cm) and stem diameter (cm), plant height was measured at the main stem starting from ± 10 cm from the ground to the tip of the highest shoot using a tape / measuring stick (if the main stem is more than one, then the average is calculated), while the stem diameter (cm) is measured measuring the circumference of the stem using a measuring tape. The formula for finding the diameter is d = circumference / π (π is the radius = 3.14).
The number of books was counted where the petiole grows. The branch angle is known by measuring the angle of the first level branch using a protractor and the number of branches is known by counting the number of branches formed.

Physiological characters were known by observing:
1. Leaf area; observed using a leaf area meter on the leaves of 3 sample plants, calculated according to [34].
2. Leaf greenness was determined by using the Chlorophyll Meter SPAD 502 Minolta tool. Measurements were made on 3 sample plants for each treatment on the third leaf from the top that had opened perfectly using a leaf clamp and the number that appears is the greenish value of the leaves.
3. Leaf chlorophyll levels were carried out on perfect leaves in 3 clumps of plants. Measurements were made of chlorophyll a, b and total content. by taking 1 gram of fresh leaves, then mashing it in a mortar and then adding 20 ml of 80% acetone. After stirring, the solution was filtered using Whatman 41 filter paper. Measurement of chlorophyll using the Spectronic 21D Spectrophotometer, absorbance at wavelengths 663 and 645 nm. To get chlorophyll a, b and total as follows:
   Chlorophyll a = 12,7 x A_{663} -2,69 x A_{645} x 20 ml 
                  1000 x 1 g
   Chlorophyll b = 22,9 x A_{645} – 4,68 x A_{663} x 20 ml 
                   1000 x 1 g
   Chlorophyll total = 20,2 x A_{645} + 8,02 x A_{663} x 20 ml 
                     1000 x 1 g
4. Photosynthetic activity, transpiration, stomatal conductivity, relative humidity of leaf cells, leaf surface temperature and leaf cell temperature, leaf cell H2O and CO2 content were measured by means of Photosynthetic analyzer type Li COR 6400. aged 8 MAP.

The agronomical characteristics related to the production of cassava were obtained by calculating the observed data from the yield component parameters of the fresh cassava tubers at the end of the study at the time of harvesting the plants aged 9 bst, including:
1. The number of tubers, count all the tubers that have been perfectly formed by pulling out the sample tree slowly so that all roots are included.
2. Tuber length, measured all the tubers that have been fully formed by pulling out the sample tree slowly so that all roots are included.
3. Tuber diameter, observed by measuring the circumference of the middle tuber with a measuring tape, then calculated the width of the radius of the stem circumference.
4. Fresh weight of tubers, done by weighing all the tubers pulling out the sample tree slowly so that all roots are included.
5. Dry matter (DM) and starch content were observed and calculated at harvest by the method of Kawano. Estimation of DM and cassava starch content was based on the principle of a linear relationship between specific gravity and DM and starch content. The percentage of BK = 158.3x - 142, while the starch content = 112.1x - 106.4; where x is the specific gravity. Specific gravity is measured by weighing the tuber sample weighing 3-5 kg (Wa), then the sample is weighed in water (Ww). The specific gravity of cassava can be calculated using the equation:

\[ \text{Specific Gravity} = \frac{\text{Wa} - \text{Ww}}{\text{Wa}} \]

Specific gravity is measured by weighing the tuber sample weighing 3-5 kg (Wa), then the sample is weighed in water (Ww). The specific gravity of cassava can be calculated using the equation:

\[ \text{Specific Gravity} = \frac{\text{Wa} - \text{Ww}}{\text{Wa}} \]

Six plants from an area of 4 m² were harvested per treatment and then the weight out of the tubers was measured and then converted to kilograms (kg) per hectare then tonnes per hectare. Fresh tuber yield (t/ha) was calculated by dividing the weight of tubers harvested in kg based on the number of plants harvested per area and multiplied by 10,000. The yield of fresh tubers was oven dried until constant weight and dry root weight were measured. The total shoot dry weight was added to the total root dry weight to obtain the total dry matter yield. Tuber yield per hectare was calculated as follows:

\[ \text{Yield per hectare (t/ha)} = \frac{\text{yield per plot (kg)} \times 10,000 \text{m}^2}{6 \text{m}^2 (\text{net plot size}) \times 1000 (\text{kg/t})} \]

where 1 hectare (ha) = 10,000m² and 1 ton (t) = 1000 kg. For the dry matter content of the tubers, the tubers of each plant are peeled and cut into small pieces and weighed until fresh, put in an oven and dried at 105°C for 24 hours. After that it was weighed again to find out the dry weigh

\[ \text{DM\%} = \frac{\text{tuber dry weight (g)}}{\text{tuber fresh weight (g)}} \times 100\% \]

2.5. Data analysis
Analysis of variance (ANOVA) was carried out for all plant traits by following the RCBD model. Comparison of means was done based on Duncan's multiple range test (DMRT). All statistical analyzes were performed by following Gomez and Gomez [24] procedures and by using the SAS Statistics program [25]

3. Result and Discussion
This research has been carried out under field conditions in the coastal area. Rainfall data during the study from meteorological and geophysical agencies obtained an average rainfall of 131.02 mm / month. To be able to produce optimally, cassava requires rainfall of 150-200 mm at the age of 1-3 months, 250-300 mm at the age of 4-7 months, and 100-150 mm in the phase before and at harvest (Wargiono et al., 2006). The above rainfall is still in the condition that superior varieties of cassava are still feasible to be developed in coastal areas. The mean annual temperature ranges from 21.9 to 30.99°C.) minimum and maximum annual mean precipitation of 131,02 mm, respectively.

The soil type of the study area is alluvial with a texture of sandy loam. Table 3 shows that the soil in the research area shows slightly acidic conditions (pH 5.4) so that it still allows cassava plants to adapt and live optimally because cassava is able to live at a pH of 4.5-8. Macro nutrients N, P, and K are needed in sufficient quantities during growth, but because they are low, especially N, they can limit the growth of cassava plants. Table 3 also shows that the organic matter & organic C are classified as low so that in this study, 2 times organic fertilizer derived from chicken manure was given (measuring ½ kg / plant). The results of the analysis show that the soil with the composition of the soil texture fraction includes sandy loam. The high sand fraction is still in accordance with the requirements for cultivating cassava plants, namely sandy to clay, but efforts are needed to provide inorganic and organic fertilizers to meet the nutrient needs of the plant during its growth period. Evaluation of the morphological characteristics 10 months after planting (Table 3) showed that each variety showed variations in its morphological characteristics.
Table 3. Morphological Characters Varieties of Cassava with Wet Treatment

| Variable observation          | Adira1         | Adira4         | Malang4         | Malang6         | UJ4          | UJ5          | Singgah        | Ketan          |
|------------------------------|----------------|----------------|-----------------|-----------------|--------------|--------------|----------------|----------------|
| Height Plant (cm)            | 269.78ab       | 293.04ab       | 272.34a         | 274.23b         | 248.44c      | 241.26c      | 307.80a        | 295.33ab       |
| Stem Diameter (cm)           | 112.42b        | 142.44b        | 16.78a          | 16.90a          | 112.08b      | 110.43b      | 120.82b        | 138.27b        |
| Stem Number                  | 3.20b          | 3.20b          | 3.53a           | 3.56a           | 2.74c        | 2.72c        | 2.66cd         | 3.02bc         |
| Total Node Number            | 144.04b        | 142.44b        | 161.90a         | 163.90a         | 112.03b      | 110.43b      | 120.82b        | 138.27b        |
| Total Branch Number          | 2.62b          | 2.60b          | 4.34a           | 4.33a           | 1.82d        | 1.76d        | 2.33c          | 2.13c          |
| The shape of the branches    | 35-60°         | 35-60°         | Cylindrical,    | Cylindrical,    | Open,        | Open,        | Open,          | Cylindrical,   |
| The angle of the branches    | Umbrella,       | Umbrella,       | lateral branches | lateral branches | decumbent or | decumbent or | decumbent or    | Compact,       |

Note: Same letters in the same column are not significantly different at 5% DMRT

Based on agronomic characteristics data in Table 3. It can be seen that each variety shows a different character. Plant height, number of segments, stem diameter and number of primary branches are significant at the 1% level of confidence, while the length of the segment is significant at the 5% level. Malang-4 and Malang-6 varieties have more dominant agronomic traits and are different from other varieties even though the plant height is under the Ketan, Adira-1 and Adira-4 varieties, while cassava UJ-3, UJ-5 and Ketan varieties have a tendency for agronomic characters to be smaller and different from other varieties. The results of the identification of branch shapes and branch tilt angle turned out to cassava varieties have different shapes and angle.

High productivity of cassava can be seen from the production of crop tubers in planting area units. Cassava production is related to the morphological and agronomic characteristics during growth.

Further analysis of the DMRT test showed significant differences between the five varieties for all tuber responses.

Table 4. Physiological Characteristic varieties of cassava plant

| Variable observation          | Adira1         | Adira4         | Malang4         | Malang6         | UJ4          | UJ5          | Singgah        | Ketan          |
|------------------------------|----------------|----------------|-----------------|-----------------|--------------|--------------|----------------|----------------|
| The density of stomata (mm²)  | 92.67ab        | 93.78ab        | 73.68b          | 73.89bc         | 66.22c       | 66.22c       | 110.78a        | 68.56c         |
| Stomatal aperture width (μm) | 8.42c          | 8.46c          | 12.82a          | 12.67a          | 8.38c        | 8.38c        | 10.36b         | 6.07d          |
| Conductivity stomata (mol H₂O m⁻³) | 0.17a        | 0.17a          | 0.16a           | 0.16a           | 0.17a        | 0.17a        | 0.21a          | 0.29a          |
| The content of H₂O (mmol/mol) | 35.64b        | 35.41b         | 36.49b          | 36.49b          | 37.99a       | 37.99a       | 36.45ab        | 36.54ab        |
| The CO₂ content of the cell (mole/mmol⁻¹) | 303.54a       | 305.24a        | 304.37a         | 304.37a         | 310.87a      | 310.87a      | 306.19a        | 35.40a         |
| Total chlorophyll (mg g⁻¹)   | 1.03c          | 1.01c          | 1.08b           | 1.08b           | 1.04c        | 1.04c        | 0.95d          | 1.14a          |
| Activities of transpiration (mmol H₂O m⁻³) | 3.27a        | 3.36a          | 3.21a           | 3.18a           | 2.91a        | 2.91a        | 4.19a          | 3.97a          |
| The rate of photosynthesis (mole CO₂ m⁻³) | 42.12ab    | 42.53ab        | 146.48a         | 144.33a         | 141.33a      | 141.33ab     | 140.00ab       | 155.00b        |

Note. Same letters in the same column are not significantly different at 5% DMRT

Cassava varieties Singgah, Adira-1 and Adira-4 which are included in the bronze variety have the highest ILD and are significantly different from other tested varieties. This is in line with [43] and [42] which states that superior varieties of cassava have a high leaf area index. Table 5 shows that the
cassava varieties Malang-6 and Ketane have greener leaves containing high total chlorophyll. Chlorophyll can accommodate light which is absorbed by other pigments through photosynthesis of cassava leaves, there is chlorophyll pigment which is sensitive to light in the form of chlorophyll a (green blue) and b (green yellow) pigments. The main function of chlorophyll is to absorb and utilize solar energy, trigger the fixation of CO$_2$ into carbohydrates and provide energy for plants.

There was no difference in the conductivity of stomata, transpiration rate and the CO$_2$ content of cells but there were differences in the density and width of stomata, H$_2$O content, total chlorophyll content and photosynthesis rate among cassava varieties studied (Table 4). Singgah local varieties have the highest density of stomata although not significantly different from the density of stomata varieties Adira-1 and Adira-4. Stomata widest occur in Malang-4 and Malang-6 superior varieties and significantly different from other varieties, while the narrowest on local varieties Ketan. Ketan local varieties have the highest total chlorophyll content and significantly different from the varieties Adira-1, Adira-4, Malang-4, Malang-6 UJ-3 and UJ-5, but local varieties Singgah has the lowest chlorophyll content between varieties studied. Local varieties of cassava photosynthesis rate equal Singgah varieties Adira-1, Adira-4, UJ-3 and UJ-5, although slightly slower than varieties Malang-4 and Malang 6 but faster than the local varieties Ketan.

The H$_2$O content of cassava varieties UJ-5 higher and significantly different from the varieties of Adira-1 and Adira-4, but did not differ with varieties Malang-4, Malang-6, Singgah and Ketan. The concentration of CO$_2$, stomatal conductivity and transpiration of leaves, although not significantly different between the varieties, but there is a relationship between the three. Cassava varieties Ketan has higher total chlorophyll content and was different from the four other varieties but has a density of stomata narrowest tenuous invitation, otherwise cassava varieties Singgah generated total chlorophyll content of at least but it has the most stomata and meetings. Malang-6 cassava variety produces enough chlorophyll content and has a number and density of stomata were in fact have the widest stomata.

Cassava varieties Ketan has higher total chlorophyll content and is different from the seven other varieties but has a dense stomata. On the other hand, cassava varieties Singgah generate total chlorophyll content of at least but it has the most stomata and meetings. Malang-6 cassava varieties produce enough chlorophyll content and density of stomata were in fact have the widest stomata. Leaf chlorophyll content directly affects the transmission and distribution of energy absorption of light and the photosynthetic efficiency is directly affected by photosynthetic leaf [35]. The density of stomata of the leaves is negatively correlated with leaf chlorophyll. Conditions of water shortages and high light intensity during plant growth resulted in different responses to the varieties of cassava plant. Therefore, the cassava was modified in term of leaf anatomy as stomata as density became higher due to surrounding cells that are smaller in size and leaf that tend to be thicker [36].

Transpiration process is influenced by a variety of internal factors such as the size of the leaves, the thickness of the leaves, the thickness of the wax layer, and the shape and location of the stomata and external such as; light radiation, temperature, humidity, light, wind and soil water content. Selin was also influenced by the potential gradient between soil water, tissues and atmosphere, as well as the presence of toxic substances in the environment. Transpiration rate of has a positive relationship with the conductivity of stomata (Table 4). More details can be seen that the rate of transpiration has a higher correlation with stomatal density compared to the width of stomata. The rate of diffusion of water vapor through the stomata or transpiration is affected by the conductivity of stomata. Stomata conductivity in turn is influenced by the density and width of openings or stomata. The opening of the stomata is affected by CO$_2$, light, humidity, temperature, wind, leaf water potential and photosynthesis rate. Rate of water loss control mechanisms control the rate of metabolism, structural adaptation of leaves reduces the rate of water loss, including arranging the conductivity of stomata. Although there is no real correlation between transpiration and H$_2$O levels of cells, it is known that the higher the transpiration, the lower the levels of H$_2$O cells. Transpiration is the actual transportation and is the evaporation of water from the plant body. The process of loss of water in the form of liquids, vapours or gases from plant tissues is mostly through stomata. The more rate of water loss, the more water...
content remaining in the plant body. Increased water levels affect cell turgor cover, length and width increase over changes in light intensity and cell cover curved outwards consequently formed cracks and porous open so the stomata open. Stomata conductivity plays a role in the speed control mechanism of transpiration and water loss on the process control network. Transpiration controls body fluids, absorption and transport of water, minerals and tissue temperature. Transpiration occurs through stomata, cuticle and lenticels. Stomata negatively correlated to CO₂ content, but positively correlated and very significant effect on the rate of photosynthesis. CO₂ and O₂ gas exchange that occurs in the leaves is strongly influenced by the open and closing of stomata. Therefore, the conductivity of stomata influences the pace and outcome photosynthesis, as shown in Table 2. The rate of the cassava plant photosynthesis is affected by the width of stomata and CO₂ concentration. Photosynthesis depends on a constant flow of CO₂ and the ins and outs of cell O₂, CO₂ and O₂ concentrations of cells and stomatal opening [37]. The low water potential causes stomatal closure and reduce leaf conductivity, impeding photosynthesis and transpiration and usually tie leaf temperature increases. The content of H₂O positively correlated to the rate of photosynthesis. The process of photosynthesis resulted in CO₂ levels in the cell decreased. According to [38], that the decrease in stomatal CO₂ concentration in the diffusion limitation effect on photosynthesis. Cassava needs CO₂ for photosynthesis thus high rate of CO₂ will also increase the rate of photosynthesis and it is apparent at Singgah varieties which is slightly faster than Ketan local varieties. It was confirmed by [38] that by reducing the CO₂ concentration resulting in the limitation of diffusion process which in turn lowering photosynthesis rate. Differences in the rate of photosynthesis between varieties strengthen the research Mahon et al. and Tan that the photosynthesis rate ranges from 15-45 mg CO₂ dn-2 hour-1. Stomatal conductivity is the ability to be able to pass gas CO₂, O₂, H₂O and other gases. High and low values of stomatal conductivity can be a limiting factor for the photosynthesis process associated with CO₂ absorption that occurs in the leaves at noon [39].

Theoretically conductivity should have affected joint stomata density and width of stomata, but the data of this study showed there was no such relationship. This occurs because the varieties Singgah, Adira-1 and Adira-4 that have a high density of stomata, stomata tend to have a medium width. However, varieties Malang-4 and Malang-6 which has the widest stomata, has a density of stomata which includes the lower middle class. Because the two are mutually weakened the determinant variables resulted in stomatal conductivity did not differ between varieties and have no contact with one another.

Table 5. Average values for number of tubers/plants, length of tubers/plant, diameter of tubers/plant, tuber yield per plot, total tuber yield per hectare, and percent of dry matter content of four cassava varieties cultivated

| Variable observation | Adira1 | Adira4 | Malang4 | Malang6 | UJ3 | UJ5 | Singgah | Ketan |
|----------------------|--------|--------|---------|---------|-----|-----|---------|-------|
| Number of tubers/plants (kg) | 9.23d | 9.11d | 9.13d | 9.53d | 10.46b | 9.63d | 9.67d | 10.22c |
| Length of tubers/plant (cm) | 42.07c | 40.77c | 63.94b | 46.48b | 35.45d | 34.87d | 52.77b | 6.09d |
| Diameter of tubers/plant (cm) | 9.63a | 9.59a | 8.67b | 8.74b | 7.18d | 7.12d | 7.75c | 6.09d |
| Weight/tuber (g) | 998.28b | 992.98b | 1028.95a | 1033.95a | 787.33c | 777.33c | 1053.02a | 605.77d |
| Weight Tuber/Plant (kg) | 12.01c | 11.11c | 13.65a | 13.81a | 9.88d | 9.64d | 11.98b | 6.62c |
| Total tuber yield /ha (kg) | 12.01c | 11.11c | 13.65a | 13.81a | 9.88d | 9.64d | 11.98b | 6.62c |
| Dry matter content of tubers (%) | 8.61d | 8.59d | 8.69a | 8.68a | 8.65b | 8.64b | 8.62c | 8.69a |
| Harvest Index | 0.76a | 0.76a | 0.77a | 0.75a | 0.76a | 0.76a | 0.58c |

Note. Same letters in the same column are not significantly different at 5% DMRT

There is a correlation between the length of the segment and the results which find an inverse relationship between the length of the segment and the result. This finding is supported, where various cassava with the shortest segment length in Malang-4 and Malang-6, gives the highest yield, on the other hand the UJ-3 and UJ-5 variety has the longest segment length with the least number of segments producing the lowest tuber. cassava varieties with stems that continue to produce long and longer segments have fewer tubers per plant. Larger numbers of the main branches found in the Singgah variety have long segments but the long main branching produces high yields. There are
growing habits of cassava that produce a greater number of tubers than the main branch. The difference in yield of cassava tubers is determined by several factors, such as the number of tubers, tubers length and tuber weight. The number and size of the tuber diameter are the main yield components that contribute to an increase in cassava.

Cassava dry matter from this research is still below the level of cassava dry matter in general. This is because the harvest and measurement of dry matter is done when the plant is still 9 months old, even though the cassava varieties of Adira-1, Adira-4, Malang-4, malang-6, UJ-3, UJ-5 and Singgah are still not yet fully mature. The content of dried cassava is influenced by a number of factors such as plant age, season, and various planting locations. The dry matter content of cassava varieties is in the high value range, ranging from 10.7% to 57.2%, with an average of 34.7%. Various varieties that produced the highest tuber weights in this study had the lowest dry matter content. There are also varieties which have significantly lower tuber weights showing lower with high dry matter.

4. Conclusion
The results showed that cassava in coastal land had morphological characters (stem 277.78 cm high, 3.09 cm in diameter, varied branches), physiological characters (LAI = 3.85, leaf chlorophyll content = 1.29 mg g⁻¹ with high photosynthetic activity), agronomic character (tuber yield 11.09 t / ha, dry weight 8.65%, 0.74). There is a positive relationship between several parameters in morphological and physiological characters on the yield of cassava. All superior cassava varieties showed better performance compared to local Ketan varieties. Malang-4 and Malang-6 varieties produced tuber weights with dry matter and high yield index (13.65 kg / plant + 8.69% + 0.77 and 13.81 kg / plant + 8.68% + 0.77).

5. References
[1] El-Sharkawy, M.A. Cassava biology and physiology. Plant Mol. Biol. 2003, 53, 621–641.
[2] Howeler, R.; Lutaladio, N.; Thomas, G. Save and Grow: Cassava—A Guide to Sustainable Production Intensification; Food and Agriculture Organization: Rome, Italy, 2013.
[3] Wongnoi. S. P. Banterng . N. Vorasoot . S. Jogloy.and P. Theerakulpisut. 2020. Physiology, Growth and Yield of Di_erent Cassava
[4] Murtiana Caniago, Dewi Indriyani Roslim, dan Herman. 2014., Deskripsi Karakter Morfologi Ubi Kayu (Manihot esculenta Crantz) Juray Dari Kabupaten Rokan Hulu. JOM FMIPA Volume 1 No. 2.
[5] Buhari AK. 2017. Profitability of cassava (Manihot esculenta) production in Kebbi state. Ambit Journal of Agricultural Research 2:85-93.
[6] Siroth, K.; Piyachomkwan, K.; Wanlapatit, S.; Nivitchanyong, S. 2010. The promise of a technology revolution in cassava bioethanol: Thai practice to the world practice. Fuel, 89, 1333–1338.
[7] Anyanwu, C.N.; Ibeto, C.N.; Ezeooha, S.L.; Ogbaru, N.J. Sustainability of cassava (Manihot esculenta Crantz) as industrial feedstock, energy and food crop in Nigeria. Renew. Energ. 2015, 81, 745–752.
[8] Bhuiyan, M.M.; Iji, P.A. Energy value of cassava products in broiler chicken diets with or without enzyme supplementation. Asian Austral. J. Anim. 2015, 28, 1317–1326.
[9] Tonukari, N.; Ezedom, T.; Enuma, C.C.; Sakpa, S.O.; Awioroko, O.J.; Eraga, L.; Odiyoma, E. White gold:Cassava as an industrial base. Am. J. Plant Sci. 2015, 6, 972–979.
[10] Ambang Z., Akoa A., Bekolo, J. Nantia, L. Nyobe et Ongono Y.S.B. Tolérance de quelques cultivars de manioc (Manihot esculenta Crantz) et de l’espèce sauvage (Manihot glaziovii) à la mosaïque virale africaine et à la cercosporiose du manioc. Tropicicultura, 2007; 25(3):140-145. Anonyme. FAOSTAT
[11] Heu A1., Ngome Ajebeson F.2, Maho Yalen J.E3.,Ngoh Dooh J.P4., Mboussi S.B1., Kone S.A.N.1, Ambang Z 2018. Ijrsrn.Human; Vol. 9 (4): 1-20.
[12] Shackelford , G.E, N R. Haddaway, H. O. Usieta, P. Pypers, S. O. Petrovan & W.J. Sutherland. 2018. Cassava farming practices and their agricultural and environmental impacts: a systematic map protocol. Environmental Evidence volume 7, Article number: 30
[13] Mupakati, T. Tanyanyiwa, V.I., 2017, ‘Cassava production as a climate change adaptation strategy in Chilonga Ward, Chiredzi District, Zimbabwe’, Jambá: Journal of Disaster Risk Studies 9(1), a348. https://doi.org/10.4102/jamba.v9i1.348
[14] FAO. Statistics Databases: Production; FAO: Rome, Italy, 2017; Available online: http://www.fao.org/faostat/en/#data/QC (accessed on 15 January 2019).
[15] Jarvis A, Ramirez-Villegas J, Campo BVH, Navarro-Racines C. Is cassava the answer to African climate change adaptation Tropical Plant Biology.2012;5:9–29.
[16] FAO. FAOSTAT Database. Rome: Food and Agriculture Organization of the United Nations (FAO); 2018. http://www.fao.org/faostat/.
[17] Kinctché K, Hauser S, Mahungu NM, Ndonga A, Lukombo S, Nhano N. 2017. Cassava yield loss in farmer fields was mainly caused by low soil fertility and suboptimal management practices in two provinces of the Democratic Republic of Congo. Eur J Agron. 7:89:107–23.
[18] Fermont AM, van Asten PJA, Tittonell P, van Wijk MT, Giller KE. Closing the cassava yield gap: an analysis from smallholder farms in East Africa. Field Crops Res. 2009;112:24–36.
[19] A. I. Malik. P. Kongsil, V. A Nguyên, W. Ou, Sholihi, P. Sreen. MN Sheela, L. A. B. López-Lavalle, Y. Utsumi, C. Lu, P. Kittipadakul, H. Ceballos, , M. S. Gomez, P. Aiemnaka, R. Labarta, S. Chen, S. Amawan, S. Sok, L. Youabee1, M. Seki, H. Tokunaga, W. Wang., K. Li, L. H. Hâm and M. Ishitani. 2018. Cassava breeding and agronomy in Asia: 50 years of history and future directions. Breeding Science Preview doi: 10.1270/jsbbs.18180
[20] G Lopes AC, Viana AES, Matsomoto SN, Cardoso Júnior N dos S, São José AR (2010). Complementação da irrigação e épocas de colheita de mandioca cv. coqueiro no Planalto de Conquista, BA. Ciência e agrotecnologia 34(3):579-587.
[21] Oliveira SL de, Coelho EF, Nogueira CCP (2006). Irrigação. In: Aspectos Socioeconômicos e Agronômicos da Mandioca. Editor: Luciano da Silva Souza... [et al]. Cruz das Almas: Embrapa mandioca e fruticultura tropical. pp. 292-300
[22] Apea-Bah, I. Oduro, W. O. Ellis, and O. Safo-Kantanka, “Factor analysis and age at harvest effect on the quality of flour from four cassava varieties,” World Journal of Dairy and Food Sciences, vol. 6, no. 1, pp. 43–54, 2011.
[23] T. Mulualem and B. Ayenew, “Cassava (Manihot esculenta crantz) varieties and harvesting stages influenced yield and yield related components,” Journal of Natural Sciences Research, vol. 2, no. 10, pp. 122–128, 2012.
[24] Thamrin, M, A. Mardhiyah dan S.E. Marpaung. 2013. Analisis Usahatani Ubi Kayu (Manihot utilissima). Agrim, April 2013 Volume 18 No 1
[25] J. B. M.Rawung , R.Indrasti and B. Bakrie. 2018. Sustainable Agricultural Bioindustry Development: Integration of Cassava Cultivation with Beef Cattle Husbandry in North Sulawesi Province. International Journal of Environment, Agriculture and Biotechnology (IJEA) Vol-3, Issue-4, Jul-Aug- 2018 http://dx.doi.org/10.22161/ijeb/3.4.26
[26] J. P. Aryal, T. B. Sapkota, R. Khurana, A. K.Chhetri, D. B. Rahut & M. L. Jat .2019. Climate change and agriculture in South Asia: adaptation options in smallholder production systems,. Environment, Development and Sustainability. Vol 22, pages: 5045–5075.
[27] FW. M. Giménez, S. L.R. Sanabria, G. D. V. Britez, S.B. Pérez, D. S. Cohene, J. A. V. Duarte, V. B. Pérez, L. P. P. Lopes and N. D.L. Duarte 2020. Yield of different varieties of cassava (Manihot esculenta Crantz) in different harvest intervals. A.Journal of Agricultural Research. Vol. 14(34), pp. 1892-1896, November, 2019 DOI: 10.5897/AJAR2019.14344
[28] A. E. Agahiu, K. P. Batyier, and R. O. Ogbuji, “Correlation analysis of tuber yield and yield related characters in two cassava (Manihot esculenta Crantz) morphological-types grown
under nine weed management systems in the Guinea savanna zone of Nigeria,” Journal of Applied Biosciences, vol. 48, pp. 3316–3321, 2011.

[29] M. S. A. Fakir, M. H. R. Talukder, M. G. Mostafa, and M. S. Rahman. 2011, “De-branching effect on growth and yield in cassava,” Journal of Agroforestry and Environment, vol. 5:1, .

[30] G. Benti and G. Degefa, 2017. Performance evaluation and palatability taste of cassava varieties in Fedis and babile districts, eastern Ethiopia , Int. Journal of Current Research, 9, (04)

[31] Misganaw C.D. and W. D. Bayou. 2020. Tuber Yield and Yield Component Performance of Cassava Varieties in Fafen District, Ethiopia. International Journal of Agronomy Volume 2020, Article ID 5836452, 6 pages https://doi.org/10.1155/2020/5836452

[32] Putri. D.I, Sunyoto, E.Yuliadi, and S. D. Utomo, “Karakter Agronomi Klon-klon F1 Ubikayu (Manihot sculentra Crantz) Keturunan Tetua Betina UJ-3, CMM 25-27, Dan Mentik Urang,” J. Agrotek Tropika Vol.1 No. 1:1-7, Januari 2013.

[33] Amarullah , D. Indradewa , P. Yudono & B. H. dan Sunarminto, 2016. Photosynthetic Activity of Superior Varieties and Local Cassava (Manihot esculenta Crantz) Indonesia. Journal of Agricultural Science; Vol. 8, No. 8; 2016. doi:10.5539/jas.v8n8p194

[34] De Tafur, S.M.; El-Sharkawy, M.A.; Calle, F. Photosynthesis and yield performance of cassava in seasonally dry and semi-arid environments. Photosynthetica 1997, 33, 249–257.

[35] Amarullah. 2020. Evaluation of quality and variety of Indonesian cassava (Manihot esculenta Crantz). Int. J. Agril. Res. Innov. Tech. 10(1): 108-116, June 2020. https://doi.org/10.3329/ijarit.v10i1.48102

[36] Gardner, F.P., R.B. Pearce, and R.L. Mitchell. 2008. Physiology of Crop Plants (Fisiologi Tanaman Budidaya. Alih Bahasa: Herawati Susilo). Universitas Indonesia Press, Jakarta

[37] Hau, X., Li, R., Jia, Z., & Han, Q. 2013. Rotational tillage improve photosynthesis of winter wheat during reproductive growth stages in a semiarid region. Agronomy Journal, 105, 215-221. http://dx.doi.org/10.2134/agronj2012.0201

[38] Pompeili, M. F., Martins, S. C. V., Celin, E. F., Venterlla, M. C., & DaMatta, F. M. 2010. Influence of ordinary epidermal cells and stomata on the leaf plasticity of plant grown under full-sun and shady condition. Braz. J. Biol., 70(4), 1083-1088. http://dx.doi.org/10.1590/S1519-69842010000500025

[39] Messinger, S. M. 2006. Evidence for involvement of photosynthetic processes in the stomatal response to CO2. Plant Physiol., 140(2), 771-7708. http://dx.doi.org/10.1104/pp.105.073676

[40] Nazar, R., Umar, S., Khan, N. N., & Sareer, O. 2015. Salicylic acid supplementation improves photosynthesis and growth in mustard through changes in proline accumulation and ethylene formation under drought stress. South African Journal of Botany, 98(2015), 84-94. http://dx.doi.org/10.1016/j.sajb.2015.02.005

[41] DeMatta, F. M., Ronchi, C. P., Maestri, M., & Barros, R. S. 2007. Ecophysiology of Coffee Growth and Production. Braz. J. Plant Physiol, 19(4), 485-510. http://dx.doi.org/10.1016/j.sajb.2015.02.005

[42] Adeniji, O.T.P, E.Odo. P.E and B. Ibrahim..2011. Genetic relationships and selection indices for cassava root yield in Adamawa state. Nigeria. Afric. Journal of Agricultural Research 6 (13): 2931-2934.

[43] Lahai, M.T, I, J. Ekanayake and J, P.C. Koroma. 2013. Influence of canopy structure on yiled of cassava cultivars at various topossequences of an inland valley agro-ecosystem. Journal of Agricultural Biotechnology and Sustainable Development. 5 (3): 36-47. Doi: 10-5897/JABSD10.006.