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# Land Characteristics and Their Relationship to Papua Nutmeg (*Myristica argentea* Warb.) Population in Fakfak Regency

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**Abstract**

Papua nutmegis an indigineous plant of Papua growing in all districts of Fakfak regency with relatively different distribution pattern. This study aims to find out the characteristics of land components (latitude, light intensity, humidity, soil chemical properties) and their relationship to population condition of Papua nutmeg in Fakfak regency, West Papua. This study was conducted for three months in TelukPattipi, West Fakfak, Kokas and Kramomongga districtswith survey technique. Observations were condudcted on growing pattern, agromorphological characteristics of nutmeg plant, and abiotic environmental factor of land components and micro wheather. Study findings indicate that distribution pattern and condition of nutmeg plants in each district were varied due to land characteristics difference. Density level, population, diameter, stem girth, and height of nutmeg plants in areas with latitude of 0-100 m are relatively higher compared to those of in areas with latitude of 100-500 m above sea level (m.a.s.l). Average C-organic, N-total and available P in areas with latitude of 100 to 500 m.a.s.l were higher compared to those in areas with latitude of 0 to 100 m.a.s.l. CationsExchangeCapacity (CEC) and pH at latitude of 100-500 m.a.s.l were higher compared to lower latitudes. Humidity tended to correlate positively canopy (R=0.143) and to plant height (R=0.869). Light factor indicated a significant positive correlation to canopy (R=0.903) and sapling growth (R=0.928), light intensity level correlated to canopy increase and sapling stage growth. N-total, available P, and exchaneable K correlated positively to the growth of stem diameter, stem girth, and height, except for canopy of nugmet plant. K-exchaneable correlated positively to stem diameter (0.930) and stem girth of nugmet plant (0.930).

**Keywords:** Nugmet, characteristics, land, population, Fakfak

## Introduction

Papua nutmeg (*Myristica argentea* Warb) is a leading commodity of Fakfak Regency in farming subsector because it has a very significant contribution to the local economy by supplying 6% of national production value. Data from FAO indicated that Indonesia contribute 70% of nutmeg oil and seeds needs woldwide, whereas Grenada contributes 25%. The remaining are supplied from India, Srilanka and Malaysia. Nutmeg production in Indonesia is in the third position worldwide (National Farming Statistics, 2012).

Local nutmeg or more popularly known as Papua nutmeg is an indigenous plant of Fakfak Regency and cultivated by almost majority of the local people. This type of nutmeg has different caracteristics compared to nutmegs from other regions such as Banda nutmeg (*Myristicafragrans*). Data from Regional Forestry and Estate Crops Office of Fakfak (2011), indicated that nutmeg plants have a better productivity compared to other crops plant such as coconut, coffee, cocoa, and clove. Forest area planted with nugmet plant, which is more commonly known as nugmet forest in Fakfak Regency, is 16,733 ha (UNIPA Team, 2013), with nugmet production of 3,688 tons.

Papua nutmegs in Fakfak Regency grow widely in forests owned by the local community. Nutmegs distribute from beach ecosystem to down hills and rocky area at latitude of 0 to 700 meter above sea level. Nutmegs distribute evenly in entire Fakfak area but with relatively different pattern and productivity. This has resulted in the use of beach nutmegs and mountain nutmegs terms among local people.

Soil is one of the abiotic envinroment component which highly determine the distribution of nutmeg population in Fafak Regency. Soil as an ecosystem component, together with other components, function as an ecological system. Therefore, the ecosystem of nutmeg farming can be differentiated into beach ecosystem and mountain ecosystem. Abiotic environment components such as physical and chemical properties of soil (light intensity, rainfall, humidity, and temperature) as ecosystem elements in farming in Fakfak Regency influence the distribution and productivity of plant. Until now, not much is known about the abiotic environment factors that influence the population condition of local nutmeg in Fakfak Regency. This study aims to find out the relationship between some of land components and population condition of nutmeg plant in Fakfak Regency, West Papua.

## Methodology

This study was conducted for three months, from October to December 2014. This study took place in Fakfak Regency that included West Fakfak, Kokas, Kramomongga, and TelukPattipi districts. Study locations in each district were selected purposively according to latitude of each district at the range of 0 to 100 m.a.s.l and 100 to 500 m.a.s.l. This study used a descriptive method with surveys. Surveys were conducted to find out and describe the condition of nutmeg population in its relationship to soil components and micro weather.

Sampling determination was conducted in serveral stages. The first stage was the selection of appropriate districts for purposive sampling. The selected districts for observation samples were West Fakfak, Kokas, Kramomongga, and TelukPatipi. The second stage was the selection of observation location in each district according to location latitude. In each district, observation locations were selected according latitude from sea level that included West Fakfak and TelukPattipi which were determined at latitude of 0-100 meters above sea leve, whereas the observation location in Kokas and Kramomongga districts were determined at latitude of 100-500 meters above sea level. Analysis of the chemical and physicalsoil properties using the method according to standard procedures.

**Data on population and distribution of nutmegs**

Data on population and distribution of nutmeg by district were interpreted from image maps, whereas the observations on growth level were conducted within the sample plots (3 sample plots). Plot measure in pole, sapling and seedling stages was 50 x 50 m, 25 x 25 m dan 5 x 5 m, respectively. Sample plots were adjusted according to path/transect in each location which were situated diagonally intersecting vertically the wind direction of East-West. Data on nutmeg population that were observed:

1. The number of nutmeg plants according to pole (>5m), sapling (2-5 m), and seedling (<2m) stage in each transect/path
2. Nutmeg plant density as determined by calculating the number of plant in pole, sapling, and seedling stage.
3. Nutmeg plant population in various growth level, calculated based on estimated nutmeg densitu per sample plot with nutmeg plant area based on image maps.
4. Ration between male and female nutmegs as determined by calculating the male and female nutmeg in each plot at each transect.

Data were collected from the population by creating sample plot based on color (tone) contained in the image (the distinguishing feature of nutmeg and non-nutmeg). Each of the tone strata samples depicting dense population and loose population were documented for their GPS positions and the real positions were determined in the field for locating the sample plot. Each of the population levels was divided in three sample plots (repetition) measuring 50 m x 50 m with path/transect method.

## Results and Discussion

**Population and Distribution of Nutmeg Plants**

Study findings indicated that the highest density at pole stage was observed in TelukPattipi District (11.23%), whereas at sapling stage the highest density was observed in Kokas (4.49%) and at seedling stage was observed in West Fakfak (8.34%). Land area and distribution of nutmeg plants in observation region based on interpretation results from Citra Alos data (2010) reached 16,733 ha. The largest nutmeg land was observed in Kramongmongga District, namely 4,067 ha (24.30%), followed by TelukPattipi District of 2.742 ha (16.39%). The highest nutmeg plant population was observed in West Fakfak regency (±2.106,151 trees), while the lowest population was observed in Kokas district (± 690,146 trees). Highest nutmeg population according to land latitude was observed at 0-100 m.a.s.l (± 1.518.611), whereas the lowest population was observed at latitude of 100-500 (1,332,209 individual trees). Data on density, population, male/female ratio, planting space, pala plants and population area in each district are presented in Table 1.

**Table 1:** Distribution of male/femala ratio, planting space, density, nutmeg plants area, populasi and land area based on location latitude

| Observation Variables | Tel. Pattipi | West Fakfak | Average | Kramong-mongga | Kokas | ssRata-rata |
|---|---|---|---|---|---|---|
| | (0 – 100 m dpl) | | | (100 – 500 m dpl) | | |
| Density persample plot (%) | | | | | | |
| Pole (50x50 $m^2$) | 2.81 | 1.14 | 1.98 | 1.71 | 2.75 | 1,43 |
| Sapling (25x25 $m^2$) | 4.02 | 3.10 | 3.56 | 2.81 | 4.49 | 2,96 |
| Seeding (5 x5$m^2$) | 18.84 | 15.76 | 17.30 | 15.76 | 12.64 | 15,76 |
| Population (per sample plot) | | | | | | |
| Pole (50x50 $m^2$) | 70.17 | 28.5 | 49.34 | 42.86 | 68.78 | 35,68 |
| Sapling (25x25 $m^2$) | 25.12 | 19.35 | 22.24 | 17.57 | 28.06 | 18,46 |
| Seeding (5 x5 $m^2$) | 4.71 | 3.94 | 4.33 | 3.94 | 3.16 | 3,94 |
| Male/Female Ratio (%) | 8.96/91.04 | 18.87/81.13 | 13.92/86.08 | 12.82/87.12 | 16.79/83,21 | 14,82/85,18 |
| Nutmeg Plants Area (ha)[1] | 2,742 | 2,123 | 2,433 | 4,067 | 2,038 | 3.095 |
| Planting Space ($m^2$) | 29.45 | 10.08 | 20.00 | 20.60 | 29.53 | 25,00 |
| Population | 931,070 | 2,106,151 | 1,518,611 | 1,974,272 | 690,146 | 1.332.209 |

[1] *Area according to interpretation from image maps, 2013.*

Determination of male to female nutmeg ratio was based on the flowers of the plant (male or female flowers). The type of new nutmeg plants can be determined after the plants is 5-7 years old (Purseglove, et. al., 1981).

The recommended nutmeg trees composition according to male to female ratio was 1: 10, meaning that in each 10 rows of female trees there are 1 male tree (Hadad and Syakir, 1992). Observation on nutmeg plant precentage according to its sex type in each district indicated the highest female to male plant ratio in TelukPattipi district (91.04%: 8.96%). This means that among 100 nutmeg plants in TelukPattipi area, about 90 plants were female and the remaining (about 8-9) were male plants. Whereas the highest average female to male ratio was observed at latitude of 100 m.a.s.l to 500 m.a.s.l (85.18%: 14.82%) (Tabel 1).

Planting space is one of the factors affecting the production capability of nutmeg plants. Plant production capability is affected by several factors such as canopy and plant ability in capturing sunlight for photosynthesis and competition for nutrients by roots. The ideal nutmeg planting space is 10x10 m (Gardner et. al., 1991; Deptan, 1986). Observation results indicated that the longest average planting space was found in Kokas and TelukPattipi district, reaching 29.53 $m^2$ (or about 5.43 m x 5.43 m) whereas the shortest planting space was found in West Fakfak (10.08 or about 3.28 m x 3.28 m). From the bservation results on planting space by location latitude, it can be shown that average planting space at latitude of 100-500 m.a.s.l (25.00 $m^2$) was higher compared to planting space at latitude of 0-100 m.a.s.l (20.00 $m^2$). This condition will have negative impact on maximum productivity results. A very densed nutmeg population results in competition in nutrient absorption, very limited sun light intensity causing suboptimal photosynthesis. This condition causes the maximum production can be achieved. With ideal planting space, the branches of the closely planted plants will not intercepting each other, and with this condition the capacity to reproduce will be maximal at adult age. Even though, the planting space in observation location had positive impact on land conservation principles. The densed nutmeg population can reduce the surface flow rate and increase infiltration rate.

Plant density affects also the agromorphological characters of nutmeg plant. Agromorphological character features are inter-related symptomps between growing components and measurement extension started by irreversible cell differentiation and related to anatomicaly and physiologically specialization (Haryadi, 1996). Observation results on agromorphological characteristics (stem diameter and girth, plant height and canopy) indicated that locations with lower latitude strata (0-100 m.a.s.l) tended to have a higher diameter, stem girth, and plant height (Table 2). The highest average plant diameter at latitude of 0-100 m.a.s.l was 24.13 cm, whereas the stem girth reached 75.77 cm, with average plant height reaching 17.22 m. Average canopy reached 613.97 cm lower than average canopy at latitude of 100-500 m.a.s.l. Nutmeg plant with largest diameter and stem girth was found in TelukPattipi district (24.53 cm and 77.03 cm), whereas the highest average highest plant height was found in West Fakfak (20.73 m) and the highest average canopy was found in Kokas district (781.42 cm).

**Table 2:** Micro Climate Conditions in Observation Locations

| Observation Variables | Tel. Pattipi | West Fakfak | Average | Kramong-mongga | Kokas | Average |
|---|---|---|---|---|---|---|
| | (0 – 100 m.a.s.l) | | | (100 – 500 m.a.s.l) | | |
| | Temperature ($^0$C) | | | | | |
| 6 | 25,75 | 25,00 | 25,38 | 23,83 | 23,60 | 23,72 |
| 9 | 31,43 | 26,50 | 28,97 | 30,20 | 28,83 | 29,52 |
| 12 | 32,70 | 27,67 | 30,19 | 32,40 | 35,00 | 33,70 |
| 15 | 31,64 | 27,33 | 29,49 | 31,20 | 28,67 | 29,94 |
| 18 | 30,78 | 26,67 | 28,73 | 27,20 | 26,60 | 26,90 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Average | 30,46 | 26,63 | 28,55 | 28,97 | 28,54 | 28,76 |
| | Humidity (%) | | | | | |
| 6 | 68,58 | 78,67 | 73,63 | 81,67 | 77,20 | 79,44 |
| 9 | 44,00 | 77,33 | 60,67 | 65,00 | 66,33 | 65,67 |
| 12 | 42,70 | 72,83 | 57,77 | 57,00 | 51,20 | 54,10 |
| 15 | 47,00 | 71,33 | 59,17 | 51,80 | 67,50 | 59,65 |
| 18 | 52,22 | 72,83 | 62,53 | 75,00 | 69,17 | 72,09 |
| Average | 50,90 | 74,60 | 62,75 | 66,09 | 66,28 | 66,19 |
| | Light Intensity (flux) | | | | | |
| 6 | 1,004,34 | 1,973,92 | 1,489,13 | 946,40 | 2,363 | 1,654,70 |
| 9 | 596,40 | 2,128,75 | 1,362,58 | 854,88 | 1,009 | 931,34 |
| 12 | 1,404,92 | 1,995,42 | 1,700,17 | 530,25 | 1,403 | 966,63 |
| 15 | 1,516,18 | 2,377,17 | 1,946,68 | 528,90 | 1,644 | 1,086,45 |
| 18 | 326,97 | 2,407,67 | 1,367,32 | 789,50 | 709 | 749,25 |
| Average | 969,76 | 2,176,58 | 1,573,17 | 729,99 | 1,425,17 | 1,077,58 |

*Source: Primary data, 2014.*

**Climate**

Analysis results on macro climate, when classified according to Köppen, indicated that the climate type in study locations was tropical rainy climate Af. Average temperature in the coolest month is still >18$^{o}$C and average rainfall at dry month is >60 mm. Agroclimate zone category of the study location, according to Oldeman, which are based on wet months number (>200 mm) and dry months (<100 mm), isAgroclimate Zone A (>9 months of wet and <2 dry months) (Handoko, 2005). Temperature in each month reached 25.63$^{o}$C. This condition is highly favorable for the growth and production of nutmeg plants. Temperature, humidity, rainy days number, rainfall, and sunlight exposure are environmental factors that have strong influence on nutmeg plant growth. Nutmeg plants commonly distribute in areas with temperature range of 18$^{o}$C-34$^{o}$C. In tropical areas, nutmeg plant will grow and reproduce well at optimum temperature of ± 20º-30ºC and need hot tropical climate with high rainfall ranging from ± 2,175-3,550 mm year$^{-1}$, without the presence of significant dry period (Deptan, 1986).

Temperature, humidity, and light intensity are the micro climate components that are interrelated and influence the plants growth (Noorhadi and Sudadi, 2003). In addition, temperatures correlate positively to radiation or sun light exposure intensity. Sun light exposure intensity affects also the land or air temperature in around the plant canopy. Temperature fluctuation around the plant is determined by sun light radiation, plants density, light distribution in plant canopy, and land moisture content.

Temperature plays an important role in plants growth. Plants growth becomes slowed down at certain temperature conditions and even terminated, because the enzymatic activities are controlled by temperature. Low temperatures cause the reduced respiration rate, and usually followed by the stopping of photosynthesis process. Lower temperatures in majority of plants can damage the stem tissues, younger leaves, flower bud and fruits. The extent of organ or tissue damage due to lower temperature depends on water condition, nutrient condition, morphology and physiological condition of the plants. In tropical plants, like nutmeg plants, the growth tends to be inhibited at temperature of 20$^{o}$C as shown by reduced growth rate toward temperature of 10$^{o}$C and die after lowering temperature under 10$^{o}$C (Gardner, et. al., 1991).

Observation results on temperature condition around the growing environment of nutmeg plants indicated that overall the daily average temperature reached 28.65$^{o}$C, with lowest average daily temperature in West Fakfa district (26.63$^{o}$C), whereas the highest temperature was found in Teluk Pattipi district (30.46$^{o}$C). The lowest humidity in observation area reached 50.90%, namely in Teluk Pattipi district, whereas the highest was in West Fakfak (74.60%). Handoko (2005) suggested that air humidity is inversely proportional to air temperature. The higher the air temperature, the smaller the air humidity. This was due to the fact that at high air temperature precipitation of water molecules caontained in the air will ensue, resulting the lowered water content in the air.

In addition to location latitude, canopy coverage of the plant also affects the temperature and humidity fluctuation. Observation results on plant canopy indicated that the average canopy in location with latitude of 100-500 m.a.s.l was 655.38 cm with micro climate reached 27.80$^{o}$C, whereas the observation locations at lower latitude (0-100 m.a.s.l) tended to be inhbited by nutmegs with relatively narrower average canopy (602.00 cm) with temperature condition reaching 28.55$^{o}$C. From the above conditions it can be explained that observation areas at higher latitude (100-500 m.a.s.l) with wider canopy growth tended to affect the low temperature, whereas the areas at lower latitude with relatively narrower canopy growth affected also the higher micro climate.

**Physical and Chemical Properties of Soil**

Analysis results on physical properties, particularly the texture, are presented in Table 3, whereas some of the soil chemical properties are presented in Table 4. Soil texture grade based on sand, dust, and clay composition can be classified into coarse texture, slightly coarse texture, moderate, slightly fine, and fine. Observation results indicated that clay soil texture almost predominated in all observation locations. The highest clay soil texture was observed in West Fakfak (66.82%), whereas the lowest was in TelukPattipi (56.75%). In addition to clay soil, sand and dust soil textures were also found in some locations but the levels were lower compared to clay texture.

**Table 3:** Soil texture in observation locations

| Physical Properties | Teluk Pattipi | West Fakfak | Average | Kramong-mongga | Kokas | Average |
|---|---|---|---|---|---|---|
| | (0 – 100 m.a.s.l) | | | (100 – 500 m.a.s.l) | | |
| Sand (%) | 2.83 | 7.53 | 5.18 | 8.79 | 0.86 | 4.83 |
| Dust (%) | 40.43 | 25.65 | 33.04 | 28.64 | 39.98 | 34.31 |
| Clay (%) | 56.75 | 66.82 | 61.79 | 62.57 | 59.17 | 60.87 |

*Source: Laboratory Analysis Results of Biotrop Soil (2013)*

**Table 4:** Chemical properties of soil in observation locations

| Chemical Properties of Soil | | Teluk Pattipi | West Fakfak | Average | Kramong-mongga | Kokas | Average |
|---|---|---|---|---|---|---|---|
| | | (0 – 100 m.a.s.l) | | | (100 – 500 m.a.s.l) | | |
| C-Org | % | 4,91 | 3,37 | 4,14 | 4,83 | 3,47 | 4,15 |
| N-Total | | 0,39 | 2,32 | 1,36 | 0,36 | 2,39 | 1,38 |
| P-Bray | | 12,11 | 14,78 | 13,45 | 12,77 | 14,68 | 13,73 |
| Ca | (me/100g) | 68,33 | 34,80 | 51,57 | 48,20 | 84,10 | 66,15 |
| Mg | | 3,63 | 4,97 | 4,30 | 3,84 | 7,56 | 5,70 |
| K | | 0,42 | 0,23 | 0,33 | 0,47 | 0,22 | 0,35 |
| Na | | 0,64 | 0,38 | 0,51 | 0,60 | 0,57 | 0,59 |
| KTK | | 50,06 | 41,60 | 45,83 | 50,57 | 77,90 | 64,24 |
| pH | | 6,98 | 6,04 | 6,51 | 6,73 | 7,53 | 7,13 |
| KB (%) | % | 98,07 | 95,45 | 96,76 | 100,00 | 100,00 | 100,00 |

*Source: Laboratory Analysis Results of Soil Biotrop (2013)*

Soil organic materials play important role in affecting the physical and chemical properties of soil. Organic material content in soil can be divided into two groups: humified materials, which is known as humic substance and unhumified materials or known as nonhumic substances. The first group is the end result of decompsition process of organic substances that are stable and withstand the biodegradation process, consisting of humic acid fraction, fulvic acid and humin, whereas the second group consisted of organic compounds such as carbohydrates, amino acid, peptide, fat, wax, lignin, nucleic acid, protein(Sanchez dan Pedro, 1992). Soil analysis results indicated that average C-organic content in observation location with latitude of 0-100 m.a.s.l or 100-500 m.a.s.l was relatively not different but varied widely between districts. The highest average C-organic content was found in TelukPattipi district (4.91%) and the lowest was found in Kokas district (3.47%). Base cations (Ca, Mg, K, and Na) in location with latitude of 0-100 m.a.s.l was relatively lower compared to locations at latitude of 100-500 m.a.s.l. The highest level was for Ca (66.15 cmol $kg^{-1}$) and the lowest was K (0.35 cmol $kg^{-1}$).

The component of soil chemical properties as an indicator of land fertility was Cation Exchange Capability. The highest cation exchange capability was found in observation location in each district locations. The highest cation exchange capability was found in Kokas (77.90 me/100g) whereas the lowest was in Kramongmongga district (41.60 me/100g).

**Relationship Between Variables**

The results of correlation test between nutmeg plant growth and micro climates (humidity, temperature, and light) in observation locations do not indicate significant correlation at significance level of P>0.05. Humidity tended to correlate positively to plant canopy and height with correlation value 0.143 and 0.869, respectively.

Whereas for diameter and stem girth, both tended to correlate negatively to humidity with correlation value-0.39 and-0.310, respectively. Correlation test results for temperature factors against stem diameter, stem girth, canopy and plant height, indicated that temperature correlate positively to diameter and stem girth with correlation value of 0.019 and 0.020, respectively. Whereas the temperature tended to correlate nevatively to canopy and plant height with correlation value of-0.182 and-0.970, respectively.

Humidity and temperature had a negative correlation, meaning that the increase in humidity tended to supress temperature to be lower (Handoko, 2005). Temperature and humidity are environmental factors that are interrelated and affect the nutmeg plant growth. Observation results on micro-humidity level indicated that the highest humidity occurred in West Fakfak district (74.60%), but the lowest temperature was also found in this district (26.63$^{o}$C). The opposite results were found in TelukPattipi districts with lowest humidity (50.90%) and with highest temperature (30.46$^{o}$C).

Light factor tended to indicate positive correlation to diameter growth (correlation value of 0.071) and stem girth (0.0761), canopy (0.903), except for plant height. This indicated that the high light exposure intensity had an effect on the increase in stem diameter, stem girth and canopy growth.

The results of correlation test for nutmeg growth variable and soil variables (N-total, available-P, and exchangeable-K) indicated that N-total correlated positively to stem diameter growth (R-0.103), stem girth (R-0.102), plant height (R=0.690), canopy (R-0.748), whereas the available-P tended to correlate negatively. This was due to the imbalance of N and P nutrients that resulted in interactive effect on growth and pala plant yields. K-exchangeable factor correlated positively to stem diameter (0.903), stem girth (0.930) and canopy (0.371), whereas it correlated negatively to plant height. The highest N-total concentration was found in Kokas and West Fakfak district, whereas the highest available-P was found in Kramongmongga and highest K-exchangeable in TelukPattipi. This indicated that nutmeg plant growth condition, particularly the diameter, stem girth and canopy, tended to be larger.

## Conclusion

Papua nutmegis an indigineous plant of Papua growing in all districts of Fakfak regency with relatively different distribution pattern. Light factor tended to indicate positive correlation to diameter growth (R-0.071) and stem girth (R=0.0761), canopy (R-0.903), except for plant height. This indicated that the high light exposure intensity had an effect on the increase in stem diameter, stem girth and canopy growth. Nitrogen-total correlated positively to stem diameter growth (R-0.103), stem girth (R-0.102), plant height (R=0.690), canopy (R-0.748),

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