ARECA NUT SUSTAINABLE DEVELOPMENT STRATEGY BASED ON LAND SUITABILITY EVALUATION IN NORTH MOLLO SUBDISTRICT, SOUTH CENTRAL TIMOR REGENCY

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ABSTRACT

Areca nut is one of the main commodities in North Mollo subdistrict, TTS Regency, it has high economic value and environmental services, so that the areca nut plants are sustainable. It is necessary to empower community and land use planning based on the criteria of plant growth (biogeophysics), the aspect of spatial (spatial planning), land availability and socioeconomic. This study aimed to determine the evaluation of areca nut suitability based on the physical condition of the land. The methodology used in this study includes biophysical variables with land suitability analysis based on the Food and Agriculture Organization (FAO) land evaluation procedure, and areca nut development strategies developed through SWOT analysis. Based on the map of the suitability of areca land, S1 class area covers 43.15%, S2 class area 31.93%), S3 class area 16.87%) and class N area 8.05%. The areca development strategy based on the SWOT analysis is an opportunity strength (SO) strategy, in which this strategy utilizes the forces and opportunities to develop areca nuts by developing existing vegetation through areca planting, and increasing the government's role in areca development thus increasing successful areca nut growth.

Keywords: areca nut, land suitability, environment, sustainability, north mollo.

INTRODUCTION

Areca nut is widely used by the community in Timor as commodity that connects to local culture and traditional values such as in North Molo subdistrict. This district has been known as one of the areca nut-producing areas in TTS Regency, whereby the areca growth and production is highly dependent on environmental conditions or land characteristics (biophysical, socioeconomic, and socio-cultural).

Based on the type of land issued by BPKH XIV 2018, North Mollo District is dominated by agricultural and plantation areas (36.19%). While other uses are vary, such as primary and secondary forests 34.05%, savannah grassland 23.14%, shrubs and vacant land 6.15%, and settlements 0.47%. According to (Basuki and Nulik, 2007) the soil condition in North Mollo District is dominated by Kambisol with an area of 13,973.96 ha (82.7%), Renzina land with an area of 1,423.11% ha (8.44%), Kambisol District with an area of 784.03

ha (4.65%), Alluvial land with an area of 636.24 ha (3.77%) and the rest are Mediterranean type haplik 72.88 ha (0.43%).

The topography in the TTS Regency is dominated by a slope of 15-25% (rather steep) which covers an area of 1,897 km^2 or 48.36% of the total area. The North Mollo District is located at an altitude of 1007 meters above sea level, with a topography dominated by a slope of 15-25% (rather steep) (BPDAS, 2012). In general, climatic conditions in North Mollo District, according to the Koppen climate classification system, include the Aw climate type (tropical wet and dry climate).

This area is the wettest mainland in (west) Timor with five dry and seven wet months. Rainfall ranges between 1500-2000 mm per year with the number of rainy days 100-150 days per year (BMKG, 2019). According to (Kalaiselvi et al, 2017) temperature does not matter for areca nut because this plant grows well in the tropical land with the average temperature is between $20\text{-}35^0$ C. These land characteristics appear to be related to the prevailing climatic conditions. In North Mollo District area classified as suitable for the growth and development of areca nut plants.

According to (Staples and Bevacqua, 2006) areca nut plants can grow at altitudes ranging from 1 meter to 1,400 meters above sea level, can flourish in tropical climates under the influence of sea conditions and grow optimally at an altitude of 900 meters above sea level. According to research (Sunil, Devadas, and George, 2011), it is argued that during the flowering stage from January to March, the increase in minimum temperature, relative humidity and rainfall had a positive effect on areca nut production while rainfall during the developmental stages from June and July adversely affected production.

The land suitability and climate in the environment is supported by the socio-cultural conditions of the community in North Mollo District. The tradition that is applied in Mollo community rules the areca nut as a must part in every community activity. But in reality the

people in North Mollo District have not made areca nut as a commodity that is prioritized for cultivation, even though areca nut has high economic value and environmental services as well as put as the basic needs for local people. The community has not been intensively cultivating areca nut and still relies on the plants that grow naturally. As a result, to meet the demand on areca nut, they imported this commodity from other regions. This study aimed to determine the evaluation of the areca nut plants suitability based on the land's physical condition.

MATERIALS AND METHODS

This research was conducted in North Mollo District, South Central Timor Regency in 2019.

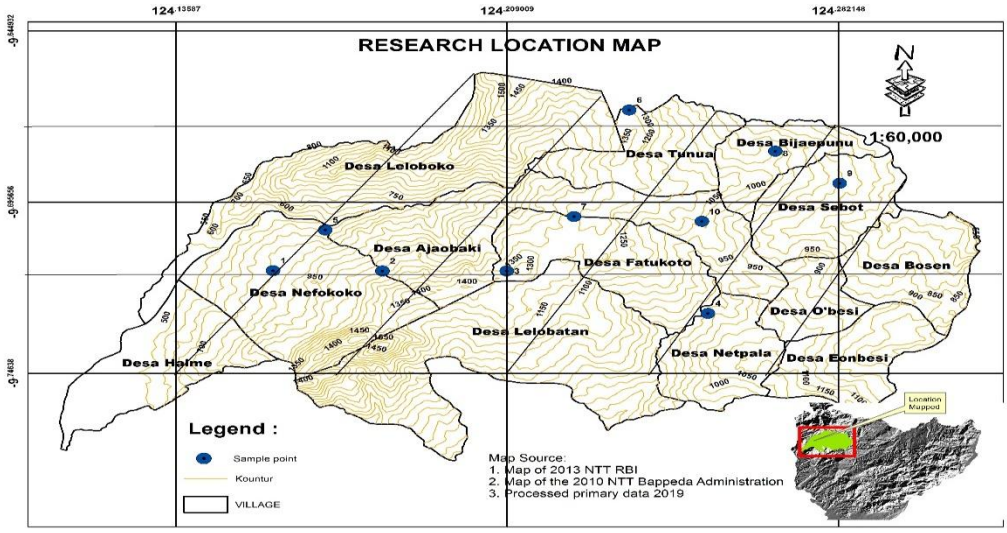

Figure 1 Research location. Source: Bappeda NTT administration map 2010 and data processed 2019

Evaluation of land suitability is carried out by matching methods of land characteristics and plantation commodity growth requirements (Djaenudin, H, H, & Hidayat, 2011). The material used in this study was *Areca catechu* LINN land, while tools used for collecting data are shovels, garden hoes , machetes, sample rings, iron bars, clear insulation, stationery, Global Positioning System (GPS), maps of soil types, slopes, land cover and land use, rainfall data for past five years. This study used primary data and it was collected

through direct observation using questionnaires, interviews and surveys. While secondary data gathered from various agencies related to the development of areca nut plants. Determination of the location of existing land, which has the potential for areca nut development, was carried out by field surveys, based on biophysical, economic, social and land availability aspects using existing land use maps, land map units, land maps, maps designation of forest area, administrative map, and suitability criteria for areca nut land. The sampling method used was stratified random sampling using 10 sample points in 3 strata. The selected height strata were: T1 = 750-1000 masl, T2 = 1000-1250 masl, and T3 = 1250-1500 masl. Land suitability analysis was done based on Food and Agriculture Organization land evaluation procedures (FAO, 1976). Data processing in each unit of land was linked (matching) with data on the requirements for areca nut plant growth. The land units were then categorized into: the appropriate order (S) or non-conforming (N), where the corresponding order consists of: Very Suitable class (S1), Fairly Sufficient (S2) or Marginal Conform (S3). SWOT analysis was employed to determine the areca nut development strategy.

RESULTS AND DISCUSSION

1. Land characteristics

Geographically, North Mollo District is located in Northern part of the Timor Tengah Selatan (TTS) regency. The land characteristics at the study site consisted of physical and chemical soil characteristics including soil texture, soil porosity, soil aggregate stability, soil reaction (pH), nitrogen, phosphorus, and potassium, which can be seen in Table 1 below:

Table 1 Physical and chemical characteristics of the soil at the study site

N0	Sample code (Village)	Organic matter	N total	P - available (ppm)	K – dd (cmol (+)/kg	PH	Porosity (%)	Aggregate Stability (EK = mgh) (Vilensky
		….%....						
	Strata I							
1	Nefokoko	4,28	0,31 S	53,57 ST	1,12 R	7,41 N	46,08 KB	2432,55

2	Nefokoko	3,70	0,27 S	43,45 ST	0,95 SR	7,43 N	60,59 P	1749,90
5	Nefokoko	2,88	0,22 S	31,74 T	0,77 SR	7,83 AA	42,15 KB	2693,59
9	Sebot	1,16	0,24 S	20,93 T	0,47 SR	8,18 AA	45,35 KB	2621,12
8	Bijaepunu	0,09	0,28 S	26,05 T	0,25 SR	8,11 AA	51,75 B	2360,04
	Strata II							
3	Fatukoto	1,91	0,18 R	20,78 S	0,62 SR	7,19 N	51,04 B	2305,33
7	Fatukoto	2,58	0,21 S	28,85 T	0,73 SR	5,11 M	51,54 B	2247,96
10	Ajaobaki	2,47	0,20 R	26,21 T	0,68 SR	5,02 M	53,54 B	2155,40
4	Netpala	2,36	0,21 S	27,58 T	0,73 SR	6,95 N	43,94 KB	2631,73
	Strata III							
6	Tunua	4,36	0,30 S	51,11 ST	1,07 R	6,74 N	54,30 B	2025,65

Source: processed primary data 2019 and (Hardjowigeno, 2010)

Notes :

SR	Very low	SM	Very sour	SP	Very porous
R	Low	M	Sour	P	Porous
S	Sedang	AM	Rather sour	B	well
T	High	N	Neutral	KB	Poorly
ST	Very high	AA	Somewhat alkaline	J	Poor
		A	Alkaline	SJ	Very ugly

The table 1 shows that the soil texture was dominated by fine texture in the form of clay, and sandy clay. Soil porosity at the research location started from poor in Nefokoko, Sebot and Netpala villages, good porosity was found in Fatukoto Ajaobaki, Tunua and axle villages in Nefokoko Village. The stability of the soil aggregate was quite diverse, namely in each unit of land ranging from 1749.90, the lowest was found in Nefokoko Village and the highest was 2693.59 in Nefokoko Village. Land reaction (soil pH) showed that soil pH in the study area varied greatly from acidity (5.02) in Ajaobaki Village to somewhat alkaline (8.18) in Sebot Village. Nitrogen content in research sites was quite diverse, each unit of land ranges from 0.18%, the lowest was in Fatukoto Village and the highest was 0.31% in Nefokoko Village or low to moderate. The availability of Phosphorus (P) levels of P2O5 were all included in the low category of 20.78 found in Fatukoto Village to very high at 53.57 in Nefokoko Village, but different for each unit of land. This difference occurred due to the fact that Phosphorus content in the soil was generally low and varies according to soil type, where younger soils were usually higher than old soils. Potassium (K) in a very low K2O levels of

0.25 were found in Bijaepunu Village and a low of 1.12 were found in Nefokoko Village or generally for all land units at the study site. According to research results (Mawii et al., 2017) the areca nut plantations have the ability to restore the soil to its original condition both the physical and chemical properties of the soil so that it can improve areca production in a sustainable manner.

2. The areca nut's land suitability

The actual land suitability classification is a grouping system of which based on the characteristics of the land available at the time without considering the inputs needed. The parameters for determining land suitability classes in North Mollo District are listed in the following table 2.

Table 2. Parameters for determining land suitability classes in North Mollo Sub-District

	Data values in land units									
Land Characteristics	1	2	3	4	5	6	7	8	9	10
Temperature (tc)										
Average Temperature (^{0}C)	20-27	20-27	20-25	20-28	23-28	18-24	20-27	20-26	20-27	20-28
Place height (mdpl)	764	950	1150	1050	754	1300	1010	938	871	1070
Slope (%)	8.-15	15-25	15-25	8.-15	8.-15	>40	8.-15	15-25	15-25	15-25
water availability (wa)										
Rainfall (mm)	1590-2308									
Oxygen availability (oa)										
Porosity (%)	46,08	60,59	51,04	43,94	42,15	54,30	51,54	51,75	45,35	53,54
Rooting Media (rc)										
Texture	Sandy loam									
Nutrient retention (na)										
pH H2O	7,41	7,43	7,19	6,95	7,83	6,74	5,11	8,11	8,18	5,02
C-organic (%)	4,28	3,70	1,91	2,36	2,88	4,36	2,58	1,09	1,16	2,47
nutrient availability (na)										
N- Total(%)	0,31	0,27	0,18	0,21	0,22	0,30	0,21	0,28	0,24	0,20
P2O5 (ppm)	53,57	43,45	20,78	27,58	31,74	51,11	28,85	26,05	20,93	26,21
K (cmol/kg)	1,12	0,95	0,62	0,73	0,77	1,07	0,73	0,25	0,47	0,68
Suitability class	S1	S1	S3	S2	S3	N	S1	S1	S1	S2

Source: processed primary data (2019)

Based on the guidelines (Djaenudin et al., 2011) the selected commodity must be in accordance with biophysical conditions, and economically profitable to be cultivated, as well

as the application of land management technology for each region based on the characteristics of the land and its environment. The choice of area based on soil and environmental characteristics (zones of land units). It will greatly helpful to areas, where a technology package that has been assembled for certain physical environmental conditions, can be applied. One commodity developed could be sustainable if the land used for its development was treated and managed appropriately.

Determination of potential locations for areca nut development in North Mollo District (Table 2) was based on biophysical aspects and land availability by integrating various thematic maps and using GIS. Spatially analyzed the actual land suitability of areca nut plants as displayed in figure 2.

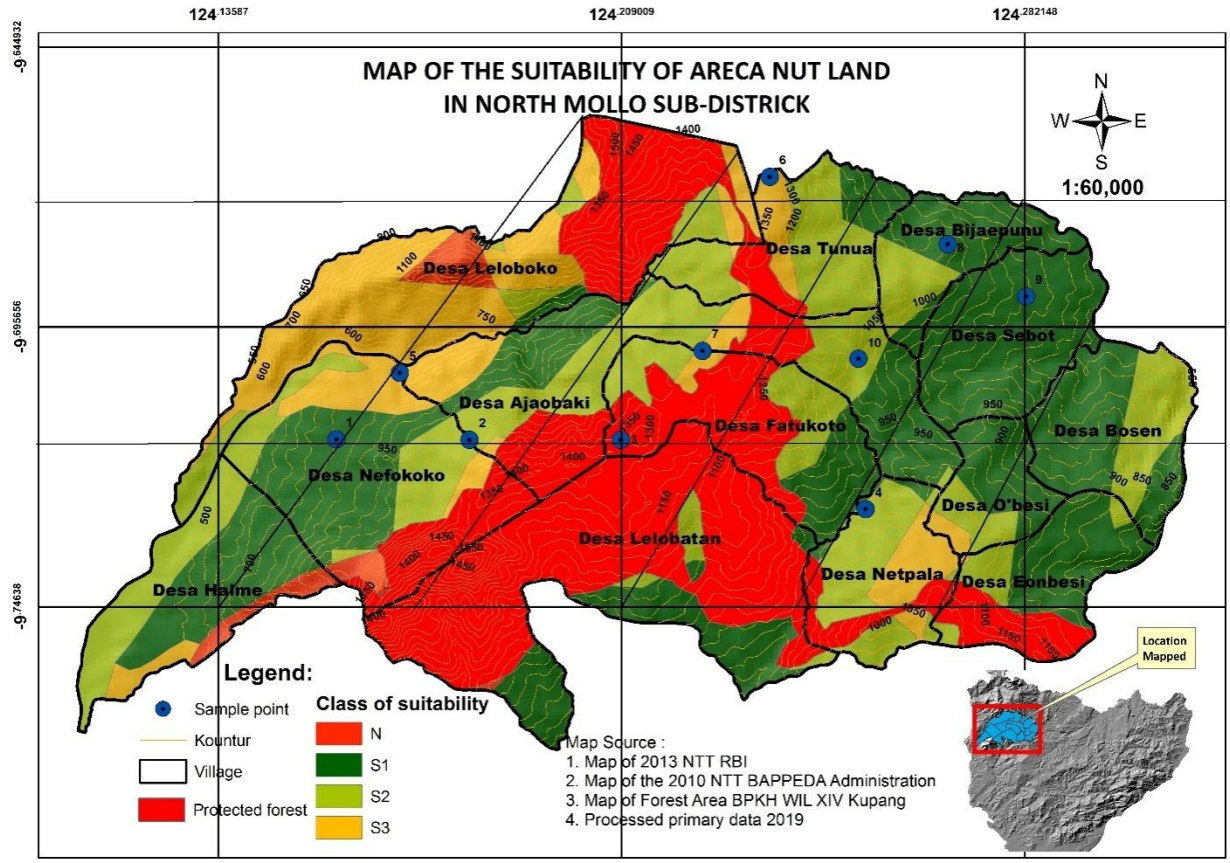

Figure 2 Map of the actual land suitability of areca nuts in North Mollo subdistrict.
Source: processed primary data (2019)

Matching results were illustrated in the form of mapping, therefore the area of each suitability class was obtained. In this case, S1 class with an area of 4079.12 ha or 43.15%, S2 with an area of 3017.98 ha or 31.93%, S3 with an area of 1594.94 ha or 16.87% and N with

an area of 760.52 ha or 8.05% of the total area of North Mollo District. The area distribution according to village in each land suitability class for areca nut development in North Mollo subdistrict is described in Table 3:

Table 3 Land Extensions Based on land suitability classes at the village level

No	Village	Class of Suitability (ha)				Total Area (ha)
		S1	S2	S3	N	
1	Ajaobaki	341.04	18.26	29.09	0.00	388.39
2	Bijaepunu	454.40	182.87	0.00	0.00	637.27
3	Bosen	592.50	311.30	0.00	0.00	903.80
4	Eonbesi	54.17	179.22	3.65	0.00	237.04
5	Fatukoto	34.90	363.51	549.15	0.00	947.56
6	Iusmollo	6.88	177.24	322.84	0.91	507.87
7	Kokfeu	507.82	367.36	0.08	41.67	916.92
8	Lelobatan	433.71	888.95	256.41	508.62	2087.70
9	Leloboko	21.21	127.30	117.91	128.38	394.81
10	Nefokoko	2.85	38.07	193.46	80.94	315.32
11	Sebot	960.29	0.01	0.00	0.00	960.31
12	Netpala	7.95	117.70	25.93	0.00	151.58
13	Obesi	62.71	107.31	38.75	0.00	208.78
14	Taiftob	190.70	45.53	0.00	0.00	236.22
15	Tomanat	101.53	0.00	0.00	0.00	101.53
16	Tunua	129.02	0.36	38.85	0.00	168.24
17	Tofen	177.45	6.27	0.00	0.00	183.72
18	Halme	0.00	86.70	18.82	0.00	105.52
	Total	**4079.12**	**3017.98**	**1594.94**	**760.52**	**9452.57**

Source: processed primary data (2019)

According to the results of adjustments to areca nut growing conditions and land characteristics in North Mollo District, land suitability could be classified as S1 (very suitable), S2 (quite appropriate), S3 (marginal appropriate). The Sub-grade level of suitability N (not suitable) in order to obtain a limiting factor (nutrient retention (na), slope of land or altitude). The efforts to improve the limiting factor were conducted in the hope that the actual land suitability class can become a potential land suitability class. From the limiting factors, fertilization was done as a way to manipulate the land, such as adding K fertilizer, for

example KCl, N fertilizer for example Urea, and P fertilizer for example SP-36 or compound fertilizer that is able to provide nutrients N, P (Supriayadi, Santoso, & Amzeri, 2009).

Efforts to improve the limiting factor of land slope or slope were improved through mechanization in the form of planting parallel to the contour line if the land's slope is <30% and efforts to make improvements must pay attention to ecological and economic aspects, meaning that if the land limiting factors can be overcome then the constraints must be taken into account whether the cultivation of these areca crops can still provide benefits (Hardjowigeno and Widiatmaka, 2017). This is in line with research conducted by (Nasrul, B. & Anom., 2000) where the improvement effort must look at the economic aspects, where the capital or investment and technology provided compared to the value of production produced, still provides benefits.

3. Sustainable areca nut development strategies

The strategy of decision-making process is always related to the development's mission, goals, strategies, and policies (strengths, weaknesses, opportunities, and threats) in the current conditions (Rangkuti, 2015). Based on the internal factor(s) analysis, external factors and the SWOT analysis diagram bellow, a SWOT analysis matrix was developed to determine the areca development strategy in North Mollo subdistrict, as presented in table 4:

Table 4. Matrix of Development Strategy

	Strengthness	**Weaknesses**
	1. Land availability and good fertility and high N content 2. High rainfall so water is good for areca nut plants 3. Optimal temperature for areca plant growth 4. Plant diversity is good at the tree level and natural stands are still found 5. Development of areca nut has the potential to provide high economic benefits and environmental services	1. Low nutrient retention 2. Steep slope conditions 3. Areca nut production is still low 4. Areca nut has not been developed optimally by the community because community knowledge about areca nut cultivation is still low
Opportunities	**Strategi S O**	**Strategi W O**

1. Community interest is high in developing areca nut plants 2. Land suitable for areca nut development	1. Develop existing plants by increasing areca nut cultivation 2. Increasing the role of government in areca nut development	1. Making narrow trenches 2. Intercropping and terracing planting patterns 3. The government and the community are more active in promoting the importance of planting areca nut
Threats	**Strategi S T**	**Strategi W T**
1. Negative impacts on the community that can damage the areca nut ecosystem 2. There is no government program that supports the development of areca nut plants	1. Providing environmental education or conservation to the community 2. Collaborative efforts between the government and the community in developing programs	1. Applying appropriate conservation technology in land use 2. Encouraging the development of natural resource management and the environment, especially the type of areca nut 3. Increase community knowledge about areca nut cultivation through counseling and training by relevant agencies.

Source: processed primary data (2019)

Tabel 4 shows that the resulting strategy is expected to assist in the development of areca nut in Mollo Utara District. One of the expected strategies is the strength opportunity (SO) strategy, in which this strategy utilizes the strength and opportunity to develop areca nuts through developing existing plants, planting areca nuts, and increasing the role of the government in developing areca nuts. In this case, the active role of the community is needed as long as the areca nut is still an important part of the socio-cultural tradition commodity among North Mollo District.

Another expected strategy is the weakness opportunity (WO) strategy that utilizes weaknesses to achieve opportunities. This strategy emphasizes deeper land management, making narrow trenches, the application of intercropping and terracing planting patterns and the activeness of the government and the community in terms of socialization of the importance of areca nut plants. While the ST (Strength Threats) strategy utilizes the power by suppressing the threats that can be made, namely making regulations on forest conversion, providing environmental education or conservation to the community, collaborative efforts between the government and the community in developing programs. The alternative

weakness threats (WT) strategy can be done through the application of appropriate conservation technology in land use, encouraging the development of natural resource management and the environment, especially the type of areca nut and increasing community knowledge about areca nut cultivation through counseling and training by relevant agencies.

CONCLUSION

North Mollo subdistrict is potential for developing areca nut commodities based on regional potential, land characteristics, and growing conditions. Its land suitability for areca nut consisted of S1 class (4079.12 ha or 43.15%), S2 class (3017.98 ha or 31.93%), S3 class (1594.94 ha or 16.87%) and N class (760.52 ha or 8, 05%). The limiting factors for areca nut land suitability were nutrient retention (na), land slope or altitude. Efforts to improve the limiting factor need to be carried out so that the actual land suitability class can be a potential land suitability class and productivity can be increased. The areca nut development strategy based on SWOT analysis in North Mollo District was a strength opportunity (SO) strategy.

RECOMMENDATION

The cultivation of areca nut plants could be done in the form of small-scale plantations or gardens. Furthermore, for developing this kind of plant into a more productive result, there are two points that must be paid for attention; they are environmental aspects such as carrying capacity and land quality. Furthermore, it is also necessary to consider the areca nut commodity market factors, especially related to the feasibility of prices and derivative products of the areca nut in developing economic aspects of such commodity. In addition to this, the factor of human resources (HR), related to community motivation regarding the cultivation, production and marketing of betel commodities are also important to be improved. Community empowerment should be carried out through adequate training and

counseling by local governments. The location for areca nut development also needs to be followed up with more detailed land use planning before its implementation, at least with the actual conditions become potential with more detailed scale.

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