NATURAL SUSTAINABILITY OF TODDY PALM (*Borassus flabellifer* L.) IN LINAMNUTU, TIMOR TENGAH SELATAN, NUSA TENGGARA TIMUR

(Sustainabilitas alami Lontar (Borassus flabellifer L.) di Desa Linamnutu, Timor Tengah Selatan, Nusa Tenggara Timur)

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Abstract

Borassus flabellifer usually known as Toddy palm or Lontar is a member of family Arecaceae, a kind of palms that highly distributed in Nusa Tenggara Timur Province. This palm is abundant and wellknown for its endless uses, such as for building material, cattle feed, and food for the people in Linamnutu. Therefore study on Toddy palm density, fertility, and its survivorship is necessary to reveal natural sustainability of Toddy Palm for future use. This study was done through field work in Linamnutu Village, Timor Tengah Selatan Regency, Nusa Tenggara Timur Province from June 19th to July 1st 2011. Six sampling sites were selected based on ALOS AVNIR-1 analyzed using ArcGIS 9.3 and ENVI 4.5. Results showed that density of Lontar in nature was 195 trees per hectare, while using remote sensing methods plant density was 221 trees per hectare in 4,332 hectare. Total lontar trees in the village are 845.885 trees. Seed survivorship is 0.34 %. The high density and number of trees in more than 50 % cover area is still enough for future needs of inhabitants in Linamnutu, even though for future economic subsistence, a local wisdom to culture Lontar seedlings was encouraged for the future prospect.

Keywords: Linamnutu, lontar, seed survivorship, sustainability, Toddy palm.

Abstrak

Borassus flabellifer yang dikenal sebagai Lontar (Toddy palm) adalah anggota famili Arecaceae, merupakan tumbuhan palma yang tersebar sangat baik di Propinsi Nusa Tenggara Timur. Tumbuhan palma ini sangat melimpah dan dikenal karena kegunaannya yang sangat tinggi, materi bahan bangunan, makanan ternak, dan juga sebagai makanan untuk penduduk di desa Linamnutu. Oleh karena itu penelitian tentang sustainabilitas alami, meliputi kerapatan tumbuhan, fertilitas dan nilai sintasannya sangat penting dikethaui untuk penggunaan di masa mendatang. Penelitian densitas Lontar ini dilaksanakan di desa Linamnutu, kecamatan Timor Tengah Selatan, NTT pada tanggal 19 Juni sampai dengan 1 Juli 2011 dari 6 lokasi yang dipilih menggunakan analisis citra ALOS AVNIR-2 yang diolah dengan software ArcGIS 9.3 dan ENVI 4.5. Hasil penelitian menunjukkan bahwa kerapatan Lontar di alam sebesar 195/ha, sementara menggunakan pendekatan NDVI diperoleh kerapatan 221/ha dengan luas wilayah 4.332 ha. Jumlah total pohon Lontar di desa Linamnutu adalah 845.885 buah dengan sintasan biji sebesar 0,34 %. Kerapatan pohon yang masih tinggi di lebih dari 50% luas wilayah masih memenuhi keperluan bahan bangunan di masa mendatang bagi penduduk desa Linamnutu. Meskipun demikian, untuk pemenuhan ekonomi keluarga secara swasembada, pemencaran semai Lontar untuk dibudidayakan perlu didorong untuk prospek yang lebih baik di masa mendatang.

***Kata kunci**: Linamnutu, lontar, sintasan biji, sustainabilitas, Toddy palm.*

INTRODUCTION

Toddy Palm (*Borassus flabellifer* L.) or so called Lontar, is an important local plant that supports villages life (brown sugar and building) (Jayusman, 2010). Local people in Linamnutu village mostly farmers, their local culture of self sufficiency is still being practiced in their daily consumption. Production concept of farmers both in agriculture and in horticulture is still in traditional way, this means they produce staple food that enough to cover their daily needs, they don't think production for infestation for the future. Based on this reality, management of Lontar orchard for brown sugar production is still far from business practices, such as seedling preparation that still depend on its natural fecundity, no fertilizer inputs, and there is no effort to improve their process in order to get better financial benefit. When population of the village increases, the needs for food and housing also increase, therefore ecological

study of Lontar, its natural fecundity has been studied.

Toddy palm (Fig 1) is one of family member of Arecaceae that grows in semi arid to humid area. This palm can grow about 15–30 m tall, with the average stem diameter of 60 cm. This plant is *dioecious* (it separates between male and female plants), with fruits are arranged in a stem of about 20 fruits in each stem (Morton, 1988). This palm originally came from Africa and its distribution spreads from India, Malaysia, Cambodia, and Indonesia (East Java, East Nusa Tenggara and South Sulawesi) (Ayarkwa, 1997; Anonymous, 2011).

Lontar leaves are greyish green color, fan shape, stiff, with diameter about 150 cm, and sticks out like finger. Leave petiole is 100 cm long, and each leaf has short leaf midrib, with spiny structure at its petiole's site. Lontar trees become mature from 12 to 20 years, and it lives up to 150 years, with mostly its age is about 80 years (Anonymous, 2011). Male flowers are always branching, while female flowers usually are not branching, with number of flowers about 20 – 30 hanging down from its stem, brown to dark brown color. Female flowers are

(a) (b) (c) (d)

Fig 1. (a) Lontar tree, (b) Lontar leaves, (c) Lontar fruit, (d) Lontar *seedling*.

Fig 2. Alos imagery of Linamnutu village in Timor Tengah Selatan, NTT.

white, groupped in a stem flower with a flower stalk of 50 cm long. Lontar is *iteroparous* or *pleonanthic* plant, that can produces fruits many times in its whole life (flowering 2-3 times in a year). Number of fruits ranges from 20-25 in its stem, with diameter between 7-20 cm (Bayton, 2007; Anonymous, 2011).

Since Lontar is vegetation that fit to grow in the dry habitat in Timor and this is one of two species whom Linamnutu inhabitants relied on for daily uses, with very low effort in cultivation, therefore study to reveal its natural sustainability (density, reproductive status, and seed survivorship) is very important

EXPERIMENTAL METHOD

Study sites

The field work of the research had been conducted from 19th June–to 1st July 2011. Linamnutu village is located in South Amanuban Sub regency, Timor Tengah Selatan Regency, Nusa Tenggara Timur (NTT). Linamnutu village is one out of 14 villages in Amanuban Selatan sub regency, located in coordinates of N 8889341, 17580, and S 629273, 91361. It is located in valley of Noelmina watershed, South East Timor, NTT. Linamnutu village map can be seen in Fig 2. Area of Linamnutu is 42.823 km^2, with the surrounding boundary of Mio, Seki, Sillu and Oeekam villages (Myers *et al*., 2010).

Linamnutu village consists of 3 sub-villages, those are: Oetaman, Hausunaf, and Linamnutu. Geografically these 3 sub-villages (Dusun) are separated from the other sub-villages. In total it has more than 9 RW dan 20 RT (Myers *et al*., 2010).

Sampling and vegetation analysis

Six sampling sites were selected from ALOS images of Linamnutu village 2008 and on site considerations. These study sites represent study areas from the high up to low land in terms of geomorphology, represented the whole Lontar orchad areas with coordinates of those sampling sites are presented in Table 1.

Six quadrat sampling plots of 30 x 30 m^2 size of each study sites were measured both trees and seedling densities, and tree stem diameter to estimate its age was measured at Diameter Breast Height (DBH) (Subagja, *et al*. 2009). Total count methods were used in seedling density within the study sites to predict its natural reproduction. Male and female plants in this areas were reccorded and detected from their flowers or its leave-scar spiral type.

Table 1. Coordinate of sampling sites.

Plot No	*East*	*North*
Plot1	629163	8889231
Plot2	629391	8888869
Plot3	629590	8888505
Plot4	630058	8889274
Plot5	629040	8889469
Plot6	629217	8889213

Trees density estimation using GIS

Spectral values of ALOS AVNIR-2 imagery with 10 m spatial resolution were analysed to estimate trees density using ArcGIS 9.3 and ENVI 4.5. To differentiate Lontar population, supervised grouping with maximum likelihood model was used (Sudiana and Diasmara, 2008).

Tree density estimation of an image analysis was represented by vegetation index values, using *Normalized Difference Vegetation Index* (NDVI) (Danoedoro, 1996), with the NDVI formulation as follows:

$$NDVI = \frac{near\ infrared\ band - red\ band}{near\ infrared\ band + red\ band} \quad (1)$$

NDVI values between 0 to 1 represented vegetation, while NDVI between -1 to 0 represented non-vegetation. The higher this values showed the higher the tree density (Danoedoro, 1996). These NDVI values and ground check measurements were then analysed its relations with the regression analysis.

Calculation of fecundity value

Fecundity was estimated through seeds survivorship (Tarumingkeng, 1994) calculated from the number of seedlings with various stages (number of open leaflets produced by seedlings) found in the diameter surrounding female plants, and average seeds density surounding the female plants. Lontar fecundity can be deducted from seeds that grow as seedlings underneath female trees. Number of seeds produced was calculated from fallen seeds under each female tree in the 2.5 m radius away from trees. Average seed density counted using triplicate of 0.5 x 0.5 m^2 quadratic plots for each tree of 5 trees in every study site.

RESULTS AND DISCUSSION

Plant density and its reproductive status

From the field survey, showed that average density of Lontar was 195 plants/ha with ratio between female to male plants was 0.46 (Table 2). Random measurement of stem diameter of 47 trees and 77 seedlings and their frequency were summarized in Table 3. Stem diameter is one character related to plant ages that can be measured

Table 2. Field density and vegetation index based on image pixel character (NDVI).

Plot	Number of plants		Total	Average density	NDVI
	Male	Female		(plants/ha)	(vegetation index)
Plot 1	7	6	13	541 – 722 (720)	0.088
Plot 2	5	5	10	833 - 1,042 (1040)	0.063
Plot 3	12	5	17	189	Outlier
Plot 4	3	3	6	67 (70)	0.115
Plot 5	10	15	25	278 (280)	0.215
Plot 6	6	7	13	144 (150)	0.305
Average			14	407	
				Ratio between female to total : 0.46	

Source : Data analysis.

Table 3. Stem diameter, frequency, and basal area.

Stem circle (cm)	Number of tree and seedling	Frequency (%)	Basal area (cm^2) of trees	
			Average	Total
<50 cm	5 + 77 = 81	71.7	1,516.2	7,581
50-59 cm	15	13.3	2,134.4	32,016
60-69 cm	12	10.6	3,262.6	39,154
70-79 cm	3	2.7	4,493.3	13,486
>80 cm	2	1.7	5,348.0	10,696

Source : Data analysis.

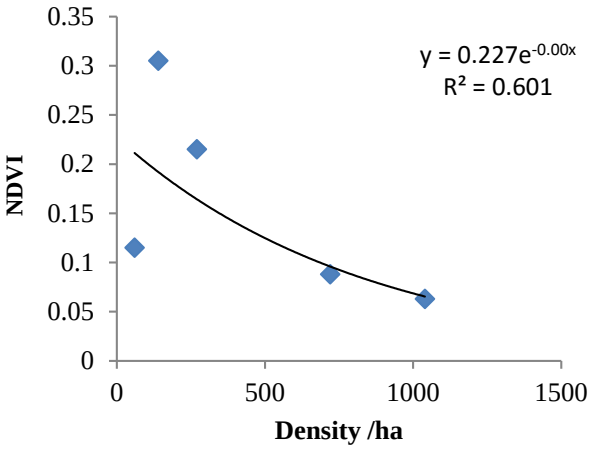

Fig 3. Regression curve between density of *B. flabellifer* L and NDVI.

in the field. This age structure reflected their reproductive status of the plant community (Barbour *et al*., 1987). Table 3 showed that Lontar plants with stem circle between 50 – 69 cm dominated from the field sites, this can be deducted that Lontar tree community in Linamnutu was still sustain as the young trees was in higher proportion (72.2%) (Table 3).

Plant Population Calculated from NDVI Index

Based on the plant density value of each sample plot sites, then vegetation index based on image pixel character (NDVI) of each sites were reccorded (Table 2). The regression analysis between plant density and NDVI (Fig 3.) then be used to estimate plant density and elaborate area from the satelite image through ENVI 4.5 *software*. Based on bandmath calculation using ENVI 4.5 software, estimated tree population from Linamnutu was shown in Table 4. Plant density calculated from software ranged from 12 to 658 trees per hectare. These densities, however was mixture between stand, sapling, and seedling, therefore corection in calculating should be taken (Sudiana and Diasmara, 2008; Sigit, personal comm.). Assuming that maximum tree density as a stand in one hectare is 256 trees, therefore bandmath value above 256 was corrected only 256 trees/ha (Table 4).

Regression analysis between tree density and NDVI values resulted regression function of $y= 0.227\ e^{-0.001x}$ with determinant coefisient of R^2 = 0,602 (Fig. 3). Estimated average tree density of Lontar calculated with software was 221 trees/ha. Trees density measured from the field sites showed that the real tree density of 195 trees/ha was lower than that of an estimated tree density (221 trees/ha) calculated using remote sensing method. This may happen due to that NDVI value was an estimation index that in regression function may not perform linearly, therefore scientific judgement to take correction factor as one consideration. Secondly, regression function formed in this case had coefficient of confidence of R^2 = 0,602, and thirdly, NDVI value produced from the computer image pixel that cannot differentiate between Lontar and Gewang (*Corypha utan*, Lamk.), similar canopy images between two species that grew in the same habitat might reflected as the same object (Sancayaningsih *et al*., 2012).

Tree density classification and estimated cover area dominated by Lontar trees in Linamnutu village

was presented in Table 5. It shows that 4332.05 ha and 18 % of the whole area in Linamnutu was dominated with Lontar tree. Among these, 47 % of this area is in the category of very dense (Table 5). Therefore the potency of Lontar was still good with the total number of Lontar was 845,885 trees in Linamnutu (Table 4).

Survivorship of Lontar Seeds

Lontar survivorship can be deducted from seeds that grow as seedlings underneath female trees. Number of seeds was calculated from each female tree in the radius of 2.5 m away from trees based on quadrat plots of 1 x 1 m^2 and ratio between female and male tree of 0.46; and seedlings with each leaves class were considered as survival of the seeds (Table 6).

Based on the total number of seedlings grow in all plots, that was 15.4, therefore fertility of Lontar seed was the number of survivors divided by the average of seeds produced (15.4/4480), equals to 0.34%. Seed dispersal for Lontar mostly due to animal dispersion (squirrel), however, this percentage is very low. In terms of plot area's fertility and plant productivity, there were only 2 of them are productive (Table 6) and produced more seedlings. This because of the environments among 6 study sites are different, as also that seed dispersal and fecundity often depend on the local environment (Schurr *et al*., 2008) and variation occurred between dry forest and wet forest (Howe and Kerckove,

Table 4. Calculated density of *B. flabellifer* using ENVI 4.5 *software* in Linamnutu.

No	Densitas (trees/hectare)	Number of pixel	Area (hectare)	Total number of trees
1	12	13,047	130.47	1,616
2	28	12,822	128.22	3,606
3	44	11,871	118.71	5,208
4	60	13,630	136.3	8,125
5	75	13,012	130.12	9,805
6	91	12,050	120.50	10,977
7	107	12,371	123.71	13,217
8	123	14,430	144.3	17,689
9	138	14,923	149.23	20,642
10	154	11,668	116.68	17,977
11	170	14,248	142.48	24,194
12	186	13,354	133.54	24,779
13	201	15,493	154.93	31,187
14	217	12,258	122.58	26,604
15	233	15,541	155.41	36,176
16	249	14,464	144.64	35,946
17	256	218,023	2,180.23	558,138
Total		433,205	4,332.05	**845,885**

Source : Data analysis.

Table 5. Classification of area covered by Lontar in Linamnutu based on ArcGIS 9.3, and ENVI 4.5 software calculation.

Classification	Density category (tree/ha)	Density (tree/ha)	Number of tree (%)	Estimated cover area (ha)	Cover area (%)
Very rare	<70	18554	2	513	11.86
Rare	71-130	51688	6	518	11.97
Fair	131-180	62813	7	408	9.43
Dense	181-250	190806	23	852	19.67
Very dense	>251	522025	62	2039	47.07

Source : Data analysis.

Table 6. Fecundity of *B. flabellifer* L. in Linamnutu.

Plot	Average seeds/m^2	Total seeds/tree	Total trees	No of seeds	Total seedlings of different leaves classes in each plot				
					<4 lvs	4 lvs	5 lvs	6 lvs	7 lvs
1	20.0	166	13	4796	40	0	1	0	1
2	19.5	162	10	3600	10	2	1	0	1
3	12.0	100	17	3778	1	0	3	0	0
4	12.5	104	25	5778	1	0	1	4	6
5	18.5	154	13	4449	3	1	1	0	0
Average	16.5	137		4480	11	0.6	1.4	0.8	1.6

Source : Data analysis.

1979). This means that survival of Lontar seed is still natural, and local people had not rejuvenated Lontar efficiently as also reported by Anonymous (1994). This natural survival of Lontar seed is able to be raised by giving such a moist environment to the mature seeds, this seedling culture technology should be trained to the local people (Tambunan, 2010) in order to rejuvenate Lontar orchard.

CONCLUSION

The high density and number of trees of Lontar in nature that was 195 trees per hectare, with the total trees of 845.9, and seed survivorship of 0.34%, this indicates that the future prospect of Lontar sustainability is still enough for inhabitants of Linamnutu village to use Lontar for daily consumption at least for 5 years. However, in terms of future needs for economic subsistence for people, with an estimation of human population increase, this must be a local wisdom to culture the Lontar seedlings in proper way supported by an effective government policy.

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