PRODUCTIVITY OF HAIRY WATER LILY (Nhymphaea pubescens Will.) SEEDS IN SOUTH KALIMANTAN'S BACKSWAMPS BASED ON LINEAR MODEL

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ABSTRACT

The study on the productivity of water lily seeds in South Kalimantan's backswamps using Wageningen method and the interview with middle traders could give more information about water lily as food commodity. Rainfall pattern in Tabalong, Hulu Sungai Utara (HSU) and Hulu Sungai Selatan (HSS) regencies is like U letter. U type is sensitive with Monsoon. This Monsoon area is affected by easterly wind and local wind. When the sun is at the south side in October to March, the Monsoon moves from west to south east, and in the other way around in April to September, the wind moves from south east to west. In April, the height of water level in some different areas was the same. The highest water level was in Paharangan subdistrict that could reach more than 100 cm and the lowest was in Hambuku subdistrict, about 80 cm. Based on the interview with middle traders, it was found out that in Hambuku subdistrict and its surrounding area, there was about 1.0 to 1.7 t/ha of water lily seeds each period. In Ampukung, Hambuku and Paharangan subdistricts, the water lily seeds were about 1.121 t/ha, 1.057 t/ha and 0.653 t/ha, respectively. If the paddy fields in Tabalong, HSU and HST regencies are 10,683 ha, 21,2252 ha, and 18,763 ha, respectively, those areas potentially can yield about 11,976.661 t/ha, 224,456.2 t/ha and 12,254.6778 t/ha. Whereas, based on radiation (Rg), the photosynthetically active radiation on very clear days (Ac), in cal cm-2 day-1, and daily gross photosynthesis rate of crop canopies on very clear days (bc) in kg ha-1 day-1 for Pm = 20 kg CH2O ha-1 hr-1, it showed that the yield of hairy water lily seeds in Ampukung, Hambuku and Paharangan subdistricts was 1.1560 t/ha, 1.1425 t/ha and 1.1021 t/ha, respectively. Hairy water lily naturally grows with seeds in soil and water in paddy field, so it can grow, develop, and produce seeds. Therefore, agronomical technique is important for further study.

Keywords: hairy water lily, Wageningen, yield potential.

INTRODUCTION

South Kalimantan has swamp areas of about 800,000 ha, but only about 390,240 ha (48.78%) has been utilized for paddy field. Half of those areas, about 55,125.5 ha (0.67%), is in Hulu Sungai Utara Regency and only about 34,445.0 ha is used for paddy field (BPS, 2010).

Generally, South Kalimantan swamps can be categorized into three types, namely tidal swamp, monotonous swamp and backswamp. The types of swamps in Hulu Sungai Utara Regency is backswamp and monotonous swamp where many waterplants like hairy water lily can grow. According to Fuaddi (1966) hairy water lily is abundant in Hulu Sungai Utara Regency, mainly at Alabio polder area. Hairy water lily is also abundant in Danau Panggang and its surrounding area.

The swamps in South Kalimantan are suitable for hairy water lily because water lily is best grown in the area with the temperatures of 20oC – 30oC (Stodola, 1987). When the swamp is filled with water, some of fish start spawning and some of other water plants also grow, such as water spinach (Ipoemea aquatica), water hyacinth (Eichornia crassipes), lotus (Lotus sp) dan water lily (Nymphaea pubescens Wild.).

Hairy water lily (Nymphaea pubescens Wild.) is known by the community around the swamp as the source of food. The parts of the plant that can be used as the sources of food are seed, tuber and flower. Usually this crop is abundant around Panggang and Bangkau lakes.

The hairy water lily is an aquatic plant having erect perennial rhizomes or rootstocks that anchor it to the mud in the bottom. The rhizomes produce slender stolons. Its leave blades are round above the water and heart-shaped below 15–26 (–50) cm, papery, abaxially densely pubescent. Some of the leaves that emerge rise slightly above the water held by their stem in lotus fashion, but most of them just float on the surface. The floating leaves have undy edges that make a crenellate effect.

The hairy water lily is also commercialized as an aquarium plant. The underwater leaves of this species have a handsome appearance that is appreciated by aquarists who often remove the floating leaves to keep it as a fully subaquatic plant. The flowers are quite large, about 15 cm in diameter when fully open. They tend to close during the daytime and open wide at night.

Hairy water lily has tuber and strength root up to 1 m long. The leaves of hairy water lily float up to water. The leaves are dark green upside, but red-violet downside. The leaf is egg-shaped about 4 – 12 cm in diameter and the leaf side is folded. The leaf also has petiole (Stodola, 1987).

The hairy water lily can flower saveral times in a year. The flowers arise up to water and blossom at around 18.00-19.00 pm, and then it is closed tomorrow morning before midday. The flower will make a round fruit with a diameter of about 4-12 cm. The seeds are brown-black in colour, which are stored in the fruit. They have pericarps so they can be separated from fruit. The seeds can be cooked like rice. It has astringent and brown colour.

In Philippines and Indian, hairy water lily seeds can be made as bread flour (Sastrapradja & Bimantoro, 1981). Fuaddi (1996) said that the hairy water lily seeds contain carbohidrate at about 78.13%.

The maximum yield can be predicted based on the climatic conditions during the crop growth, the amount of radiation that can be received and the crop capacity to convert energy to photosintat and to distribute it to the crop organ. The length of the crop growth until the crop can be harvested will be determined by the total radiation received, which can determine the crop yield.

If the availability of water is enough for the crop requirement, the crop yield will be determined by nutrition and pest and desease. Therefore, crops will give the maximum yield (Ym) depending on the environmental conditions. In this case, the maximum yield (Ym) will be determined by genetic potential and crop's capability to adapt with climatic condition.

The climatic factors that can effect the crop growth and the yield are temperature and intercepted radition. Generally, temperature determines the crop development and effect the rate of crop development and the crop growth periods. The corn for example, at temperature of 25-30^{0}C can be harvested in 100 days. However, at a temperature of 20^{0}C it can be harvested in 150 days and even more than 250 days if the temperature reaches 15^{0}C (Doorenboss & Kassam, 1988).

Photosynthesis produces the source of assimilates which plants use for growth. The rate of photosynthesis is influenced by both radiation and temperature, but plants also have an obigatory development pattern in time and space, which must be met if the photosyntetic assimalates are to be converted into economically useful yields of satisfatory quantity and quality (FAO, 1978). The development sequence of crop growth in relation to the crop phenelogy is influenced by climatic factors, particularly the temperature and day length. In general, temperature determines the rate of growth and development. In some cases, temperature may determine whether a particular development process will begin or not. Low temperature can cause problems through delay in flowering and fruit setting. On the other hand, low night temperature during the ripening period will favour saturation and can lead to high yields. The day-length plays an important role in determining the time of flowering of photoperiodic sensitive crops. A good example is a deep water rice, which will only flower after the dark period has exceeded a specific length. Therefore, the temperature regime and the photoperiodic regime during a certain length of growing period govern the selection of the crop to be cultivated. When the climatic phenological requirements are met, both temperature and radiation set a limit to crop prduction or, in other words, determine the potential net biomass production.

Information about hairy water lily seeds is needed to develop its potentioal as food comodity from wetland. Therefore, the estimation of hairy water lily seeds with linier model like agro-ecological zone (AEZ) is needed to figure out how many seeds are available as the food commodity.

MATERIALS AND METHODS

1. Methods

The net biomass production (B_n) is different from gross biomass production (B_g) and respiration loss (R):

$$B_n = B_g - R$$

The rate of net biomass production (b_n) is similarly related to the rate of gross biomass production (b_g) and the rate of respiration (r):

$$b_n = b_g - r$$

The maximum rate of net biomass production (b_{nm}) is reached when the crop fully covers the ground surface. If the growth per unit time is plotted againt time, the resulting curve has the shape of a normal distribution curve. It is assumed here that seasonal average rate of net biomass production (b_{na}) is half the maximum crop growth rate (0.5 b_{nm}). This means that net biomass production for crop of N days is:

$$B_n = 0.5 b_{nm} x\ N$$

In order to calculate b_{nm} we need to know the maximum rate of gross biomass production (b_{gm}) and the respiration rate, r_m. Hairy water lily is C3 species that operates optimally at temperatures of 25-30^{0}C.

De Wit (1965) has calculated the amount of photosynthetically active radiation (PAR) on perfectly clear days at different latitude for each month of the year (A_c). On a totally overcast day PAR = 0.2 A_c. If we also assume that PAR = 0.5 R_g (R_g = total short wave radiation), the fraction (F) of the day-time when the sky is overcast is then decribed as:

$$F = {(A_c - 0.5\ R_g)}/{0.8\ A_c}$$

De Wit (1965) has also calculated the maximum rate of gross biomass production by a crop when the leaf index (LAI) equals 5, on perfectly clear days (b_c) and on totally overcast days (b_0), given that P_m (the maximum rate of leaf photosynthesis at light saturation is 20 kg CH_2O $ha^{-1}hr^{-1}$. The values for A_c, b_c and b_0 are given in Appendix II, Table 1 (FAO, 1979). It is now possible to calculate the actual rate of maximum gross biomass production (b_{gm}):

$$b_{gm} = F x b_0 + (1 - F) x\ b_c$$

We have seen that the maximum rate of CO_2 exchange (P_m) depends both on temperature and the photosynthetic pathway of the crop species. Based on Figure Relationships between maximum leaf photosynthesis rate and the temperature for crop groups I, II, III, and IV (FAO, 1979), the value of P_m can be found if the actual day-time temperature and the crop adaptability group is known. If P_m is more than 20 kg CH_2O $ha^{-1}hr^{-1}$, the the value of bgm from equation should be increased; if P_m is less than 20 kg CH_2O $ha^{-1}hr^{-1}$ then bm should be decreased. The amount of increase and decrease respectively are given by then following formulas:

$$b_{gm}{}^{+} = 0.005 y\ x\ F\ x\ b_0 + 0.002\ x\ y\ x\ (1 - F) x\ bc$$

$$b_{gm}{}^{-} = 0.005 y\ x\ F\ x\ b_0 + 0.001\ x\ y\ x\ (1 - F) x\ bc$$

In which y = $y = \left({(P_m - 20)}/{20}\right)$

If P_m is greater then 20 kg CH_2O $ha^{-1}hr^{-1}$, and LAI = 5

$$b_{gm}{}^{+} = F\ x\ b_0\big(1 + 0.025(P_m - 20)\big) + bc\big(1 + 0.01(P_m - 20)\big)$$

If P_m is less than 20 kg CH_2O $ha^{-1}hr^{-1}$, and LAI = 5

$$b_{gm}{}^{-} = F\ x\ b_0\big(1 + 0.025(20 - P_m)\big) + bc\big(1 + 0.01(20 - P_m)\big)$$

The following relationship has been established to calculate r_m:

$$r_m = k b_{gm} + c B_m$$

In which k = 0.28, independent of crop species and temperature,

$$c_t = c_{30}(0.004 + 0.0019\ T_{mean}{}^2)$$

It was found that the maintenance respiration constant "c" was dependent on both crop species and mean temperature. At 30^{0}C for non-legume is 0.0108.

The cumulative net biomass (B_m) is equivalent to half the net biomass at the point of inflexion, then B_m = 0.5 B_n. The net biomass for a crop of N days is:

$$B_m = 0.25 b_{nm}\ x\ N$$

Then,

$$b_{nm} = b_{gm} - \big(k b_{gm} + c_t B_m\big)\ or\ b_{nm} = 0.78\ b_{gm} - c_t B_m$$

So,

$$b_{nm} = {0.78\ b_{gm}}/{(1 + 0.25\ c_t N)}$$

The final equation is needed to calculate the net biomass production, given that LAI at the time of maximum gross biomass production rate is 5, then read as follows:

$$B_n = {0.36\ b_{gm}}/{(N^{-1} + 0.25\ c_t)}$$

In order to calculate the net biomass production of the actual maximum LAI, the result should be multiplied by the reduction factor R_{LAI}:

$$B_{n(actual\ LAI)} = R_{LAI} x B_{n(LAI=5)}$$

The yield biomass (B_y) can be calculated if the harvest index (Hi) is known, which is the fraction of the net biomass of the crop that is economically useful:

$$B_y = H_i x B_n$$

For the validation of the yield biomass (B_y) we made a plot of 10 x 10 m^2 in width.

2. Materials

The tools used in the study were scale, meter/gauge and office tools.

3. Site and Time Research

The study was conducted in three regencies that have backswamps, namely Tabalong (Kelua subdistrict), Hulu Sungai Utara (Sungai Pandai subdistrict) and Hulu Sungai Selatan (Daha Utara subdistrict).

Sample plot was made to get primer data. The sample plot area was a wet rice field of 1 hectare dominated by hairy water lily. The width of plot was 1 hectar divided into 10 of 10 m^2 small plot. From each plot, 5 sample crops were taken.

The seed production per clump was observed every week for 10 weeks. The environment parameter was the sea water level, and some growth parameters were length of crop (cm), total leaf per clump (leave), total flower per clump (item), total fruit per clump (item), total harvested fruit per clump (item), seed weight (g) and seed weight per crop (g).

RESULTS AND DISCUSSION

1. Hairy water lily's Environment

1.1. Climate

The climate in thestudy areas was presented in Table 1, 2 and 3. The rainfall pattern in Tabalong, HSU and HSS regencies have U shape. That type is very sensitive be affected by Monsoon wind. Those areas are very affected by easterly passat wind and southeast passat wind, as well as local wind. If the sun in south from equator in October to March, Monsoon wind moves from western to southeast. On the contrary, in April to September, the wind will move from southest to western.

Ampukung area has A climate type with Q value =10.2% or this area is very wet with tropical rainforest according Schmidth – Ferguson (1951) classification and has C1 climate type according to Oldeman (1980) classification system or in one year paddy in this area can be cultivated one time and two times, crops planted as 2d crop in dry season. The annual rainfall is about 2,527.2 mm and evapotranpiration 1,354.4 mm or 3.71 mm/day.

Hambuku area has C climate type with Q value =52.9% or approximately wet with a rainforest that has vegetation with leaf down at dry season according to Schmidth-Ferguson (1951) classification and has C2 climate type according to Oldeman (1980) classification system or in one year this area can cultivate paddy one time and crops planted as 2d crop in dry season must be planted carefully. The annual rainfall is about 2,436.1 mm and evapotranpiration 1,230.4 mm or 3.4 mm/day.

Paharangan area has B climate type with Q value =32.4% or this area is wet with still tropical rainforest according to Schmidth – Ferguson (1951) classification and has C2 climate type according to Oldeman (1980) classification system or in one year this area can cultivate paddy one time and crops planted as 2d crop in dry season must be planted carefully. The annual rainfall is about 2,311.8 mm and evapotranpiration 1,230.4 mm or 3.4 mm/day.

Table 1. Climatic Elements in Tabalong Regency

Month	Climatic Element								
	Rainfall	Rain Day	Atmospheric Pressure	Relative Humidity	Air Temperature	Evapotranpiration, ET_O	Wind Velocity and Direction		Time of Sunshine
	(mm)	(hh)	(mb)[1)]	(%)	(^oC)	(mm)[2)]	(knot)	o [1)]	(%)
January	300,8	16,3	1006,9	90,5	26,4	111,0	1,3	BL	42,8
February	224,9	14,6	1006,3	90,9	26,9	98,3	2,0	BL	36,4
March	298,6	16,1	1006,5	87,0	27,7	115,6	2,1	BL	37,4
April	238,1	15,9	1006,2	90,1	28,8	111,0	3,6	BL	41,0
May	178,7	10,9	1006,0	90,1	27,8	120,9	2,5	BBD	57,0
June	181,0	11,1	1007,1	84,6	27,9	104,7	1,4	BBD	53,4

July	98,0	7,9	1007,0	90,4	27,2	120,0	2,3	BD	62,1
August	102,9	7,6	1007,8	90,5	27,3	128,0	2,3	S	61,4
September	129,3	8,9	1007,3	89,5	28,5	122,4	1,9	SBD	50,9
October	148,8	11,7	1006,9	90,6	27,5	122,1	1,7	SBD	49,2
November	298,2	14,6	1006,2	90,6	26,8	98,7	2,1	BBD	35,7
December	379,9	20,6	1006,0	91,9	27,5	101,7	4,2	BBD	33,5
Total	2579,1	156				1354,4			
Average			1006,7	89,7	27,5		2,3		46,7
STD (%)	9,75	3,39	0,18	0,00	0,00		0,00		0,00

Source: Data is calculated from Tabalong in Figures (1990-2011)
1) BMKG Banjarbaru Station (2004-2007)
2) Data is estimated according Penman-Montheith

Table 2. Climatic Elements in Hulu Sungai Utara Regency

Month	Climatic								
	Rainfall	day of rain	Air Pressure	Air Moisture	Air Temperature	Evapotranspiration	Wind		Length of sunshine
	(mm)	(hh)	(mb)1)	(%)	(°C)	(mm)2)	(knot)	o 1)	(%)
January	295,0	18,8	1009,9	87,8	26,0	105,9	4,3	B	39,6
February	276,2	16,1	1010,1	87,4	26,1	96,2	3,8	BD	37,3
Mart	326,0	18,9	1009,9	88,3	26,3	112,0	3,7	BD	43,9
April	262,7	16,0	1009,7	88,6	26,4	113,6	3,8	BL	56,2
May	168,8	11,4	1009,9	88,4	26,8	110,1	4,1	TL	55,0
June	96,5	8,7	1010,3	86,4	26,6	106,6	3,8	T	59,4
July	62,3	8,3	1010,8	86,1	26,7	113,3	3,8	T	59,8
August	53,8	5,9	1011,1	84,5	27,0	127,5	4,4	T	64,3
September	69,3	8,9	1010,8	85,2	27,1	116,6	4,7	Tg	50,4
October	189,1	12,6	1010,5	85,9	26,6	123,6	4,2	Tg	53,8
November	257,2	18,4	1009,8	88,2	26,1	106,1	4,2	B	44,6
December	379,3	22,3	1010,1	88,2	25,9	98,8	4,0	B	33,9
Total	2436,1	166				1330			
Average			1010,3	87,1	26,5		4,1		49,8
STD	5,7	5,7	100,0	0,6	0,1		0,0		9,3

Source: Data is calculated from SMPK Pantai Hambawang, HST Regency (2001-2010)
1) BMKG Banjarbaru Station, Banjarbaru Regency (2004-2007)

Table 3. Climatic Elements in Hulu Sungai Selatan Regency

Month	Climatic Element								
	Rainfall	Rain Day	Atmospheric Pressure	Relative Humidity	Air Temperature	Evapotranpiration, ET_O	Wind Velocity and Direction		Time of Sunshine
	(mm)	(hh)	(mb)1)	(%)	(°C)		(knot)	o 1)	(%)
January	295,0	18,8	1009,9	87,8	26,0	105,9	4,3	B	39,6
February	276,2	16,1	1010,1	87,4	26,1	96,2	3,8	BD	37,3
Mart	326,0	18,9	1009,9	88,3	26,3	112,0	3,7	BD	43,9
April	262,7	16,0	1009,7	88,6	26,4	113,6	3,8	BL	56,2
May	168,8	11,4	1009,9	88,4	26,8	110,1	4,1	TL	55,0
June	96,5	8,7	1010,3	86,4	26,6	106,6	3,8	T	59,4
July	62,3	8,3	1010,8	86,1	26,7	113,3	3,8	T	59,8
August	53,8	5,9	1011,1	84,5	27,0	127,5	4,4	T	64,3
September	69,3	8,9	1010,8	85,2	27,1	116,6	4,7	Tg	50,4
October	189,1	12,6	1010,5	85,9	26,6	123,6	4,2	Tg	53,8
November	257,2	18,4	1009,8	88,2	26,1	106,1	4,2	B	44,6
December	379,3	22,3	1010,1	88,2	25,9	98,8	4,0	B	33,9
Total	2436,1	166				1330			
Average			1010,3	87,1	26,5		4,1		49,8
STD	5,7	5,7	100,0	0,6	0,1	0,0	0,0		9,3

Source: Data processing from PHTPH (Pest Management Control)_Raya River HSS Regency (2000-2009)
1) BMKG Banjarbaru Station (2004-2007)

1.2. Water Level

The water level at the study area was relative the same in April. The highest water level was more than 100 cm at Paharangan subdistrict and the lowest about 80 cm at Hambuku subdistrict. After May, water begins to subside, so the hairy water lily seeds can be harvested and the preparation for paddy field can be started (**Figure 1**).

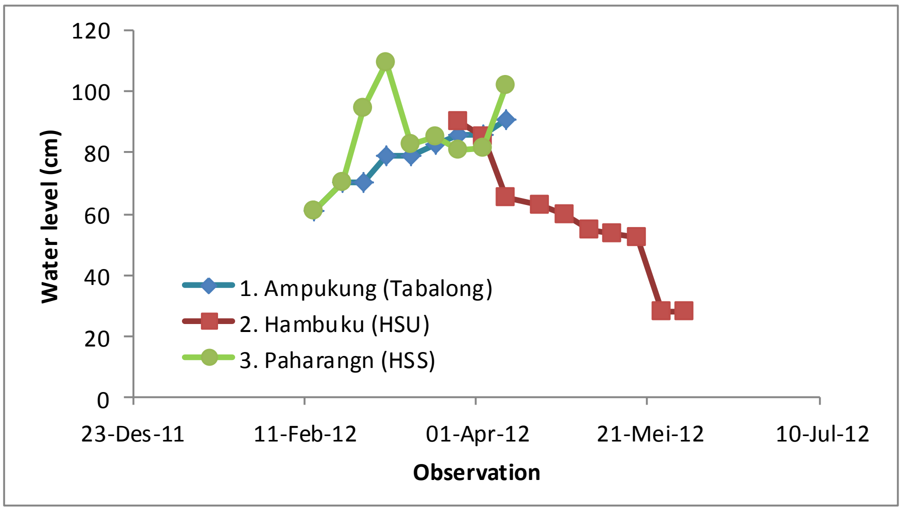

Figure 1. Water level fluctuation in study area

1.3. Growth of Hairy Water Lily Seeds

The hairy water lily seeds were about 0.9–1.3 t/ha. The highest yield was at Ampukung subdistrict because the temperature at Ampukung (about 27.5°C) was higher than the other areas, and the lowest yield was at Paharangan subdistrict. The higher temperature can make hairy water lily's evapotranspiration higher. The higher evapotranspiration can make photosynthesis better.

The highest yield is not determined by water level Table 1). It estimated that the high water level increased the vegetative growth. In Hambuku, Ampukung, and Paharangan subdistricts, the water level was 57.9 cm, 78.2 cm, and 85.3 cm, respectively, while the respective crop length was 73.4 cm, 85.8 cm, and 109.4 cm. This indicates that the highest water level can make plants grow taller.

Table 1. Water level, Growth and Yield

No	Parameter	Unit	Area Study					
			Ampukung (Tabalong)	SE	Hambuku (HSU)	SE	Paharangan (HSS)	SE
1	Water level	cm	78,18	0,81	57,94	0,07	85,28	0,24
2	Plant hight per cluster	cm	85,79	0,81	73,37	0,06	109,41	0,24
3	Total leaf per cluster	helai	2,44	0,04	18,27	0,09	19,50	0,24
4	Total flowers per cluster	buah	2,28	0,04	1,00	0,00	2,38	0,24
5	Total fruit per cluster	buah	2,13	0,04	2,84	0,03	1,81	0,24
6	Total harvested fruit per cluster	buah	0,83	0,01	2,00	0,00	0,91	0,24
7	Harvested fruit weight per cluster	g	213,61	5,24	252,00	2,87	307,14	0,24
8	Dry fruit weight per plant	g	25,63	0,45	22,03	0,18	18,28	0,24
9	Dry fruit weight per m^2	g	128,13	2,27	110,17	0,89	91,42	0,24
10	Dry fruit weight per hektare	t	1,28	#REF!	1,10	0,00	0,91	0,24
11	Dry fruit weight per hektare (Model)	t	1,12	0,00	1,06	0,00	0,65	0,00

1.4. Estimation of Hairy water lily's yield based on linear Model

1.4.1. Hairy water lily's yield based on field observation

Based on the field observation, the hairy water lily seeds harvested in Ampukung, Hambuku and Paharangan were 1.121 t, 1.057 t and 0.653 t, respectively. The potential paddy fields that can be cultivated for hairy water lily in Tabalong, HSU and HST regencies were about 10,683 ha, 21,2252 ha, and 18,763 ha, respectively. It shows that each zone has the potential to produce about 11,976.661 t/ha, 224,456.2 t/ha and 12,254.6778 t/ha.

1.4.2. Hairy water lily's yield based on linear model (Agroecological Zone, AEZ)

Table 2. Based on radiation (R_g), photosyntetically active radiation on very clear days (A_c), in cal cm^{-2} day^{-1}, and daily gross photosynthesis rate of crop canopies on very clear days (b_c) in kg ha^{-1} day-1 fot Pm = 20 kg CH_2O ha^{-1} hr^{-1}, so the yield of

The parameters used to estimate the yield based on agroecological zone (AEZ) are presented in hairy water lily seeds in Ampukung, Hambuku and Paharangan subdistrict was 1.1560 t/ha, 1.1425 t/ha and 1.1021 t/ha, respectively, see Figure 2.

Table 2. Estimation of Yield Biomass Parameter

Paharangan subdistrict

Bulan	Rg	Ac	bc	bo	Tr	Tmak	Tmin	Tsh	N
	cal/cm^2/day				°C				
Januari	312	347,95	417,25	221,4	27,45	30,8	24,1	29,2	12,1
Februri	354	360,4	424,55	226,7	27,65	31,25	24,05	29,7	12,1
Maret	344	368	429	230	27,5	31	24	30,6	12,1
Rata-rata	336,7	358,8	423,6	226,0	27,5	31,0	23,7	29,8	12,1

Hambuku subdistrict

Bulan	Rg	Ac	bc	bo	Tr	Tmak	Tmin	Tsh	N
	cal/cm^2/day				°C				
Februari	354	360,4	424,55	226,7	27,1	31,0	23,2	29,2	12,1
Maret	344	368	429	230	27,2	31,3	23,2	29,7	12,1
April	420	364,4	426,55	227,7	27,1	31,3	22,9	30,6	12,1
Rata-rata	372,7	364,3	426,7	228,1	27,2	31,2	23,1	29,8	12,1

Ampukung subdistrict

Bulan	Rg	Ac	bc	bo	Tr	Tmak	Tmin	Tsh	N
	cal/cm^2/day				°C				
Maret	344	368	429	230	26,5	30	23	29,2	12,1
April	420	364,4	426,55	227,7	27,0	30	24	29,7	12,1
Mei	401	355,8	416,95	221,55	26,5	29	24	30,6	12,1
Rata-rata	388,3	362,7	424,2	226,4	26,7	29,7	23,7	29,8	12,1

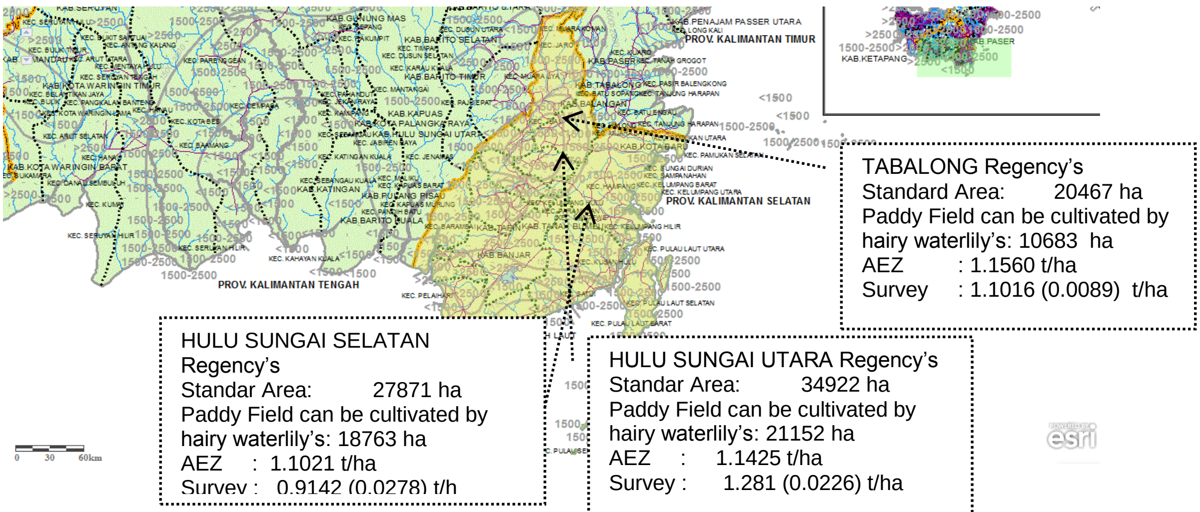

Figure 2. Hairy water lily's yield based on AEZ model and observation in Ampukung, Hambuku and Paharangan subdistricts.

The validation between AEZ model and observation data shows no significant difference. It means that the model linier of AEZ can be used to predict hairy water lily's yield. The area with highest radiation has highest yield.

CONCLUSION

Vegetative growth of hairy water lily is determined by the water level. If the vegetative growth is higher than the generative, the seeds could be less. The linear model of agroecologycal zone predicts the yield based on radiation. The model predicted that the maximum yield was in the area having highest radiation; therefore, Ampukung subdistrict had the highest yield, followed by Hambuku and Paharangan.The hairy water lily's growth is naturally with rhizomes in the soil of paddy field. If the water level is high, the hairy water lily can grow, develop, and yield. Therefore, the agronomy of hairy water lily should be investigated to increase its productivity.

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