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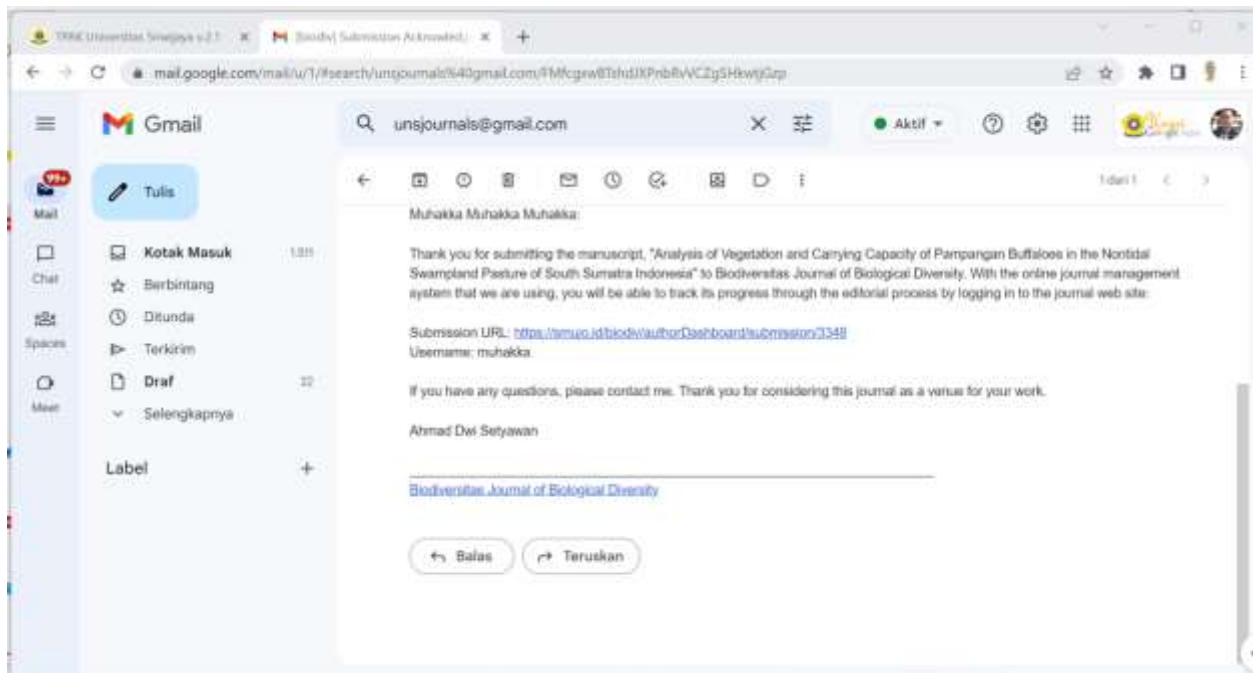
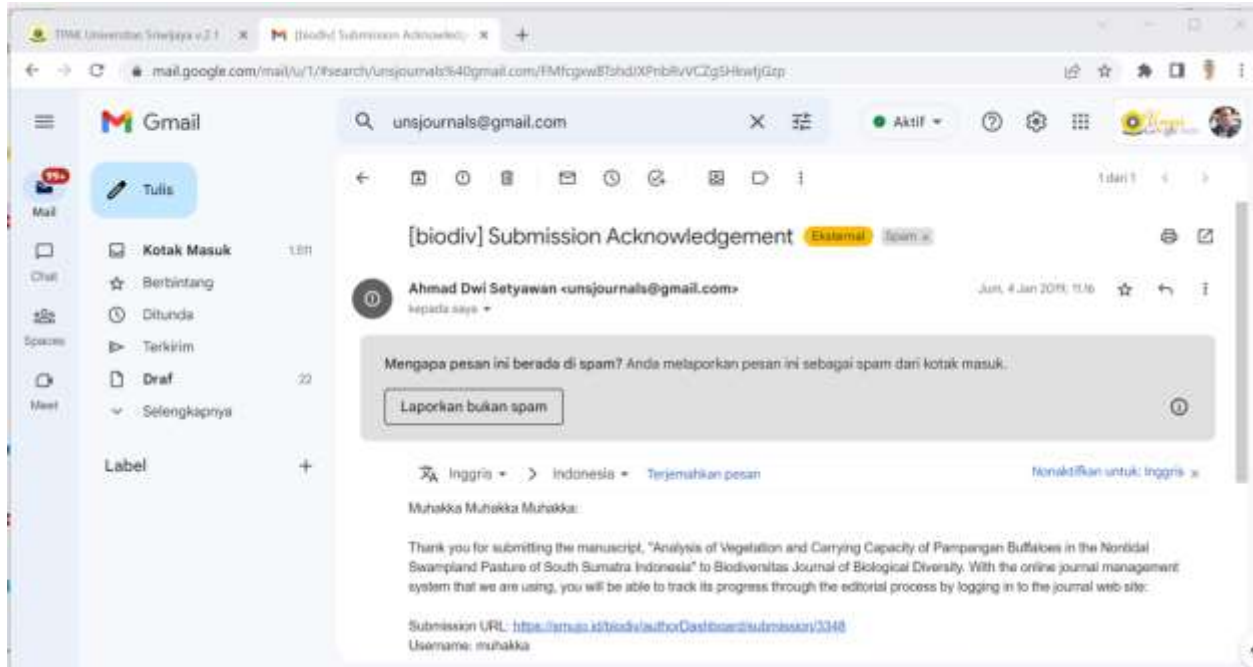
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and its carrying capacity for Pampangan buffalo pasture.

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COVERING LETTER

Dear **Editor-in-Chief**,

I herewith enclosed a research article,

Title:

Analysis of Vegetation and Carrying Capacity of Pampangan Buffaloes in the Nontidal Swampland Pasture of South Sumatra Indonesia

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MUHAKKA

Analysis of Vegetation and Carrying Capacity of Pampangan Buffaloes in the Nontidal Swampland Pasture of South Sumatra Indonesia

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Abstract. This study aimed to analyze the vegetation and carrying capacity of Pampangan buffalo in the swampland pasture. The methods of collecting the data used measurements and direct observation in the field covering identification of forage species and production. The measurement of forage production used methods of Halls. There were totally 50 observation points on the swampland. The forage in the quadrant was cut and weighed. The results of the study found 19 species of forage swamp potential as Pampangan buffalo feed. The highest important value index of Purun tikus (*E.dulcis*) was 89.71% and Kumpai padi (*O.rupifogon*) was 54.08%. The production of fresh forage and dry matter in the wet season in Pulau Layang was 6.90tons.ha⁻¹.year⁻¹ and 1.27tons.ha⁻¹.year⁻¹ consecutively, whereas in Rambutan Village they were 3.68tons.ha⁻¹.year⁻¹ and 0.91tons.ha⁻¹.year⁻¹ successively. The production of fresh forage and dry matter in the dry season in Pulau Layang was 4.86tons.ha⁻¹.year⁻¹ and 0.99tons.ha⁻¹.year⁻¹ consecutively, while in Rambutan they were 2.52tons.ha⁻¹.year⁻¹ and 0.71tons.ha⁻¹.year⁻¹ successively. The pasture carrying capacity of swampland of Pulau Layang village in the wet season was 3.66AU.ha⁻¹.year⁻¹ and in the dry season it was 2.85AU.ha⁻¹.year⁻¹, while in Rambutan village it was 2.61AU.ha⁻¹.year⁻¹ and 2.04AU.ha⁻¹.year⁻¹. There were six species of forage with high production, namely Kumpai tembaga, Kumpai padi, Kumpai minyak, Are bolong, Bento rayap and Purun tikus.

Key words: Pampangan buffalo, Analysis of vegetation, Carrying capacity, Pasture, Nontidal Swampland

INTRODUCTION

Nontidal Swampland is a suboptimal land and the availability is very extensive in Indonesia. The area of nontidal swampland is about 13.27 million Ha, and only 4 million ha was developed. The public and the private sector managed 2.6 million ha and 1.3 million Ha developed by government assistance (Statistic Center Bureau, 2010, Mulyani and Sarwani, 2013). It consists of 3.0 million ha of deep swampland; 6.07 million ha of middle swampland and 4.2 million ha of shallow swampland scattered in Sumatra, Kalimantan and Papua islands. Nontidal swampland in South Sumatra cover highest area in Sumatra reaching 2.98 million ha, with only 298,189 ha has been developed (Statistic Center Bureau South Sumatra, 2014).

Pampangan buffaloes are the ones of the potential germplasm of South Sumatra Province widely found in Pulau Layang Village of Ogan Komering Ilir and Rambutan Village of Banyuasin which are generally extensively maintained (Muhakka et al., 2013). In addition to being taken for their meat, they also produce milk to be processed into traditional food (*Gulo Puan*). The buffalo population in South Sumatra in 2014 was 33,369 buffaloes and the number decreased compared to that in 2012 to be 34,866 buffaloes (4.29%) (Statistics of South Sumatra Animal Husbandry, 2014). There are three factors causing a decline in the buffalo livestock population, namely (1) the availability of fluctuating natural forage amount, (2) the quality of nutritional forage of swamp lowland was low, and (3) the grazing pasture decreased (BPTP South Sumatra, 2011). The low productivity of buffaloes (growth and milk production) resulted from the consumed rations which could not meet the needs of food substances; this was characterized by low protein content and high crude fiber and low digestibility. However, the buffaloes have several advantages and their roles can be enhanced especially through food and genetic improvement (Talib et al., 2014). The buffaloes have their own advantages compared to cows. They can survive particularly if the existing feed has low quality (Diwyanto and Handiwirawan 2006; Yasin, 2013).

One strategy that can be done to maintain and improve the ability of the level of productivity of pampangan buffaloes is by conducting a study of forage vegetation in swamp lowland, through analysis of vegetation and carrying capacity of pasture. The study of vegetation analysis and pasture carrying capacity at the present time is limited to the dry land such as in Wulan Gitrang Subdistrict, East Flores, whose carrying capacity are 0.42 AU.ha⁻¹.year⁻¹ on coffee plantation area and 0.38 AU.ha⁻¹.year⁻¹ on grassland area (Kleden et al., 2015). The carrying capacity of livestock storage

52 under the auspices of preproduction of rubber plants is 0.14 AU. ha⁻¹.year⁻¹, while rubber production plants can only
 53 accommodate 0.06 AU. ha⁻¹.year⁻¹ (Pramana et al., 2015).
 54 This study aimed to analyze swamp forage vegetation and the carrying capacity of Pampangan buffalo pasture in
 55 the swampland of South Sumatra.

56 MATERIALS AND METHODS

57 This research was carried out in Pulau Layang Village of Pampangan Subdistrict of Ogan Komering Ilir District and
 58 Rambutan Village of Rambutan Subdistrict of Banyuasin District of South Sumatra from April to September 2017. The
 59 method used a survey method and measurements and direct observations on swamp lowland which was commonly used as
 60 pasture by farmers taken as samples. The data of livestock population were collected from related agencies and
 61 institutions.

62 The data were collected using measurements and direct observations in the field including forage vegetation species,
 63 the amount of production, forage quality (natural grass and legume), and soil fertility. The method used a quadratic method
 64 with the placement of plots by using purposive sampling with a plot size of 1x1m and the number of plots of 50 plots in
 65 swamp lowland (Kleden et al., 2015). Then, each observation plot recorded the species of forage vegetation, the number of
 66 individuals of each species, and collected all species of forage vegetation. The collection was labeled hanging and each
 67 species of forage vegetation was photographed with a digital camera. The revoked vegetation from each plot was separated
 68 according to each species and dried to calculate the dominant value. The unknown species of vegetation was collected,
 69 given 70% alcohol, oven-baked, and identified.

70 The variables to be measured and observed in this study were as follows:

71 **Vegetation Analysis**

72 The collected data were analyzed quantitatively (Utami et al., 2007) as follows:

73 a. Density

74 Density is the number of individuals of a species of certain location formulated as follows:

$$75 \text{ Density} = \frac{\text{The species number}}{\text{The total area of the sample plots}}$$

79 b. Relative Density

80 Relative density is a percentage of density of a species toward density of all species which is formulated as follows:

$$81 \text{ Relative Density} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100\%$$

85 c. Frequency

86 Frequency is the comparison of the number of sample plots having a species and the number of sample plots which
 87 were made, formulated as follows:

$$88 \text{ Frequency} = \frac{\text{The number of plots having a species}}{\text{The number of all observed plots}}$$

92 d. Relative Frequency

93 Relative Frequency is a frequency percentage of a species toward the number of frequency of all species, formulated as
 94 follows:

$$95 \text{ Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100\%$$

98 e. Important Value Index (IVI)

99 This value indicates the dominance of a species in a particular area formulated as follows:

$$100 \text{ IVI} = \text{Relative Density} + \text{Relative Frequency}$$

101 **Forage Production**

102 The measurement of forage production adopted the *Halls* method (in Kleden et al., 2015) which used a 1m x 1m
 103 quadratic frame by sampling construction (Sutaryo, 2009). A total of 50 observation points were conducted in a grazing
 104 area on swamp lowland often used by farmers/ranchers. The placement of squared frame for each observation point was
 105 based on random numbers. The average forage production was calculated using the following formula:

$$106 \text{ X} = \frac{\sum x_i}{n}$$

109 Where: X = The existing average forage biomass production
 110 $\sum xi$ = The amount of forage biomass production at each observation
 111 n = The amount of observation
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113 Pasture Carrying Capacity

114 The amount of carrying capacity was found out by estimating the consumption of dry matter/Animal Unit (AU). The
 115 carrying capacity was calculated for each species of forage. The calculation adopted the Purnomo's formula (2006).
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$$117 \text{ Carrying Capacity} = \frac{\text{Cumulative Production} \times \text{proper use factor (\%)}}{\text{Animal needs (kg DM/AU/day)} \times 360 \text{ days}}$$

$$121 \text{ Cumulative Forage Production} = \left[\left(\frac{hk}{ik} \times pk \right) + \left(\frac{hp}{ip} \times pp \right) + \left(\frac{hh}{ih} \times ph \right) \right]$$

124 Remarks:

- 125 hk : Number of days in the dry season (90 days)
- 126 hp : Number of days in the transition season (120 days)
- 127 hh : Number of days in the wet season (150 days)
- 128 ik : Cutting intervals in the dry season (50 days)
- 129 ip : Cutting intervals in the transition season (30 days)
- 130 ih : Cutting intervals in the wet season (40 days)
- 131 pk : Biomass production in the dry season
- 132 pp : Biomass production in the transition season
- 133 ph : Biomass production in the wet season
- 134 puf: Proper Use Factor 68%.
- 135 kt : Animal Need 6,25 kg Dry Matter AU⁻¹day⁻¹

137 Data Analysis

138 The data of the carrying capacity of pasture were obtained from the total needs of livestock by referring to the total
 139 forage production. The carrying capacity data were analyzed by comparing forage production with the number of livestock
 140 available to find out the ratio of the two illustrating the number of buffaloes that could be developed in the study area using
 141 the following formulations: (a). AUp/AUt < 1 : if the number of livestock being grazed in swamp lowlands is greater than
 142 the amount of feed available, (b). AUp/AUt = 1 : If there is a balance between the amount of forage available and the
 143 number of livestock being grazed. (c). AUp/AUt > 1 : If the number of livestock being grazed is less than the amount of
 144 food available in the pasture. Remarks: AUp and AUt are animal units for feed and animal unit for livestock successively
 145 (Kleden *et al.*, 2015).

146 RESULTS AND DISCUSSION

147 Results

148 Species of Forage Vegetation

149 Forage vegetation of swamp lowland in Pampangan buffalo pasture had 19 forage species potential to be used as
 150 buffalo feed covering 17 grass species (*gramineae*) and 2 legume species (*leguminosa*) (Table 1).
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Table 1. Species of forage vegetation of swampy lowland of Pampangan buffalo pasture.

No.	Local Name	Latin Name	Village		Remarks
			P	R	
1	Purun tikus	<i>Eleocharis dulcis</i>	+	+	DP
2	Kumpai padi	<i>Oryza rupifogon</i>	+	+	DP
3	Kumpai tembaga	<i>Hymenachne acutigluma</i>	+	+	DP
4	Bento rayap	<i>Leersia hexandra</i>	+	+	DP
5	Kumpai minyak	<i>Hymenachne amplexicaulis</i>	+	+	DP
6	Pasiran / Kerak maling	<i>Digitaria fuscescens</i>	+	+	DP
7	Are bolong	<i>Polygonum barbatum L.</i>	+	-	DNP
8	Kumpai merah	<i>Hymenachne sp.</i>	+	-	NDP
9	Kasuran	<i>Cyperus digitatus</i>	-	+	NDP
10	Apit-apit	<i>Cyperus chephalotes Vahl</i>	+	-	NDP
11	Telepuk Gajah	<i>Nymphaea lotus</i>	+	-	NDP
12	Telepuk Padi	<i>Nymphaea adorata Aiton</i>	+	-	NDP
13	Kangkung merah	<i>Ipomoea aquatica Forsk.</i>	+	-	NDP
14	Tapak dara	<i>Catharanthus roseus (L.) Don</i>	+	-	NDP
15	Eceng gondok	<i>Eichhornia crassipes</i>	+	-	NDP
16	Kemon air	<i>Neptunia olerancia</i>	+	-	NDP
17	Mutiara	<i>Sesbania exasperata</i>	-	+	NDP
18	Cecengkehan	<i>Ludwigia hyssopifolia</i>	+	-	ND
19	Berondong	<i>Rhynchospora corymbosa. L</i>	-	+	ND

167	Remarks:	P	: Pulau Layang Village	NDP	: Not Dominant Palatabel
168		R	: Rambutan Village	ND	: Not Dominant
169		DP	: Dominant, Palatabel	+	: Available
170		DNP	: Dominant Not Palatabel	-	: Unavailable

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Analysis of Forage Vegetation

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Analysis of forage vegetation of swamp lowland of Pampangan buffalo pastures in the wet and dry seasons in Pulau Layang Village of Pampangan Sudistrict and Rambutan Village of Banyuasin Subdistrict (Tables 2 and 3).

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Table 2. Density Value, Relative Density, Frequency, Relative Frequency, and Index of Important Value of Swamp Lowland Forage Vegetation of Pampangan Buffalo Pasture during the Wet and Dry Seasons in Pulau Layang Village.

No.	Local Name	Wet Season					Dry Season				
		D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
1	Kemon air	0,56	17,500	0,32	19,512	37,012	0,38	20,000	0,24	19,048	39,048
2	Are bolong	0,54	16,875	0,26	15,854	32,729	0,28	14,737	0,20	15,873	30,610
3	Eceng gondok	0,48	15,000	0,20	12,195	27,195	0,18	9,474	0,08	6,349	15,823
4	Kumpai merah	0,46	14,375	0,18	10,976	25,351	0,20	10,526	0,12	9,524	20,050
5	Kumpai tembaga	0,22	6,875	0,12	7,317	14,192	0,12	6,316	0,12	9,524	15,840
6	Purun tikus	0,16	5,000	0,14	8,537	13,537	-	-	-	-	-
7	Kumpai minyak	0,20	6,250	0,10	6,098	12,348	0,14	7,368	0,08	6,349	13,717
8	Kumpai padi	0,18	5,625	0,08	4,878	10,503	-	-	-	-	-
9	Cecengkehan	0,18	5,625	0,06	3,659	9,284	0,16	8,421	0,08	6,349	14,770
10	Tapak dara	0,08	2,500	0,06	3,659	6,159	-	-	-	-	-
11	Bento rayap	0,06	1,875	0,04	2,439	4,314	0,12	6,316	0,10	7,936	14,252
12	Kangkung merah	0,04	1,250	0,04	2,439	3,689	-	-	-	-	-
13	Telepuk Gajah	0,02	0,625	0,02	1,220	1,845	-	-	-	-	-
14	Telepuk Padi	0,02	0,625	0,02	1,220	1,845	-	-	-	-	-
15	Apit-apit	-	-	-	-	-	0,16	8,421	0,12	9,524	17,945
16	Kerak Maling	-	-	-	-	-	0,16	8,421	0,12	9,524	17,945
TOTAL		3,2	100	1,64	100	200	1,9	100	1,26	100	200

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Remarks:	D	= Density
	RD	= Relative Density
	F	= Frequency
	RF	= Relative Frequency
	IVI	= Important Value Index

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Table 3. Density Value, Relative Density, Frequency, Relative Frequency, and Index of Important Value of Swamp Lowland Forage Vegetation of Pampangan Buffalo Pasture during the Wet and Dry Seasons in Rambutan Village.

No.	Local Name	Wet Season					Dry Season				
		D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
1	Purun tikus	1,68	34,426	0,74	36,634	71,060	1,00	44,248	0,62	44,928	89,176 ¹
2	Kerak Maling	1,10	22,541	0,40	19,802	42,343	0,40	1,770	0,22	15,942	17,712 ³
3	Kumpai padi	0,80	16,393	0,40	19,802	36,195	0,60	26,549	0,38	27,536	54,085 ²
4	Kasuran	0,88	18,033	0,30	14,851	32,884	0,12	5,310	0,06	4,348	9,658 ⁴
5	Mutiara	0,20	4,098	0,06	2,970	7,068	-	-	-	-	-
6	Berondong	0,08	1,639	0,04	1,980	3,619	0,04	1,770	0,02	1,449	3,219 ⁶
7	Bento rayap	0,06	1,230	0,04	1,980	3,210	0,04	1,770	0,04	2,899	4,659 ⁵
8	Kumpai minyak	0,04	0,820	0,02	0,990	1,810	0,04	1,770	0,02	1,449	3,219 ⁷
9	Kumpai tembaga	0,04	0,820	0,02	0,990	1,810	0,02	0,885	0,02	1,449	2,334 ⁸
TOTAL		4,88	100	2,02	100	200	2,26	100	1,38	100	200

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Remarks: D = Density
RD = Relative Density
F = Frequency
RF = Relative Frequency
IVI = Important Value Index

Forage Production

Production of vegetation fresh forage of swamp lowland in the two study locations on the average was 6.90 tons.ha⁻¹.year⁻¹ in the pasture area of Pulau Layang Village of Pampangan Subdistrict of Ogan Komering Ilir District (Table 4) and 3.68 tons.ha⁻¹.year⁻¹ in the pasture area of Rambutan Village of Rambutan Subdistrict of Banyuasin District (Table 5).

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Table 4. Fresh Weight Production, Dry Matter Production, and Forage Carrying Capacity of Swamp Lowland in the Wet and Dry Seasons in Pulau Layang Village of Ogan Komering Ilir.

No.	Local Name	Wet Season			Dry Season		
		FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
1	Purun tikus	12.640	2.664,5	7,69	-	-	-
2	Kumpai padi	12.960	2.225,2	6,42	-	-	-
3	Telepuk Gajah	9.800	1.983,5	5,72	-	-	-
4	Are bolong	7.180	1.651,4	4,77	5.290	1.244,74 ³	3,59
5	Kumpai tembaga	6.700	1.352,7	3,90	7.480	1.632,54 ¹	4,71
6	Telepuk Padi	7.500	1.286,3	3,71	-	-	-
7	Bento rayap	4.740	1.232,4	3,56	5.290	1.385,45 ²	4,00
8	Kumpai merah	7.040	1.151,7	3,32	5.720	975,83 ⁵	2,82
9	Eceng gondok	5.940	1.097,7	3,17	4.700	830,49 ⁶	2,40
10	Tapak dara	7.530	977,4	2,82	-	-	-
11	Kumpai minyak	6.650	790,0	2,28	5.990	729,58 ⁸	2,11
12	Kangkung merah	4.020	604,6	1,75	-	-	-
13	Kemon air	1.910	394,8	1,14	2.870	607,01 ⁹	1,75
14	Cecengkehan	1.980	346,9	1,00	4.290	777,35 ⁷	2,24
15	Apit-apit	-	-	-	4.580	1.145,00 ⁴	3,30
16	Kerak Maling	-	-	-	2.420	537,97 ¹⁰	1,55
Average		6.899	1.268,51	3,66	4.863	986,60	2,85

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Pasture Carrying Capacity

The carrying capacity of Pampangan buffaloes in the swamp lowland pasture of Pulau Layang Village was 3.66 AU.ha⁻¹.year⁻¹ during the wet season and 2.85 AU.ha⁻¹.year⁻¹ in the dry season (Table 4). The carrying capacity of Pampangan buffaloes in the swamp lowland pasture of Rambutan Village was 2.61 AU.ha⁻¹.year⁻¹ in the wet season it was 2.04 AU.ha⁻¹.year⁻¹ in the dry season (Table 5).

Table 5. Fresh Weight Production, Dry Matter Production, and Forage Carrying Capacity of Swamp Lowland in the Wet and Dry Seasons in Rambutan Village of Banyuasin.

No.	Local Name	Wet Season			Dry Season		
		FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ . year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ . year ⁻¹)
1	Kumpai tembaga	8.540	3.139,3	9,06	5.900	2.181,82	6,29
2	Kumpai padi	4.690	1.462,8	4,22	4.420	1.421,03	4,10
3	Bento rayap	4.380	1.138,8	3,29	3.380	917,67	2,65
4	Purun tikus	4.370	921,2	2,66	1.700	376,21	1,09
5	Kumpai minyak	4.860	577,4	1,67	3.200	489,28	1,41
6	Berondong	1.510	441,8	1,28	250	77,88	0,22
7	Kasuran	2.590	248,9	0,72	240	28,61	0,08
8	Mutiara	1.360	111,5	0,32	-	-	-
9	Kerak Maling	790	108,0	0,31	1.100	152,79	0,44
Average		3.676,67	905,52	2,61	2.523,75	705,66	2,04

211 Discussion

212 Species of Forage Vegetation

213 There are dominant and palatable species of swamp lowland forage vegetation having potential as buffalo feed,
 214 namely Kumpai padi grass (*O. rupifogon*), Kumpai tembaga (*H. acutigluma*), and Kumpai minyak (*H. amplexicaulis*), not
 215 dominant and palatable such as Kumpai merah (*Hymenachne sp*) and Kemon air (*N. olerancia*); dominant and non
 216 palatable grass species (buffalo doesn't like it) namely Are bolong (*P. Barbatum. L*). Yet, this grass species would be eaten
 217 by the buffaloes if there were no other species to be eaten (Table 1).

218 Ali et al. (2012) conducting a study on swamp land vegetation found 25 species, Rohaeni et al. (2005) found 24
 219 species in South Kalimantan, and Camarao and Rodrigues Filho (2001) only found 7 species. In Gowa District, there were
 220 15 vegetation species on the natural grasslands consisting of 12 vegetation species classified as palatable forage (7 grasses
 221 and 5 legumes) and 3 non palatable species. All of these vegetation species are of natural grass fields with local species.
 222 Based on the number of species encountered (15 species), it can be said that the natural pasture of Gowa District is quite
 223 good (Rinduwati et al., 2016). In Sota Village pasture there found 33 vegetation species consisting of 61% grass, 3%
 224 legume and other plants 36% (Praptiwi et al., 2017); 22 forage species (Abdullah et al., 2017), 40 forage species consisting
 225 of 82 – 87% forage grass, 1% legume and forage consumable by livestock, and 12 - 17% those inedible by livestock (Yoku
 226 et al., 2015). The composition of feed forage in Tobelo Subdistrict pasture is 58.33% grass, 25% legume, and 16.67%
 227 other forage (Matulesy and Kastanja, 2013; Eoh, 2014). The species diversity at different heights is influenced by the
 228 season where the wet season increases the availability of water needed by plants for growth, especially the grass species
 229 (Kumalasari and Sunardi, 2015).

230 Analysis of Forage Vegetation

231 The analysis results of the vegetation of Pulau Layang Village during the wet season having the highest relative
 232 density, relative frequency, and Important Value Index (IVI) were Kemon air (*N. olerancia*) having 0.56 density, 17.5%
 233 relative density, 0.32 frequency, 19.512% relative frequency, and 37.01% Important Value Index, followed by 32.72% Are
 234 bolong (*P. barbatum L*) and 27.19% Eceng gondok (*E. crassipes*), while the lowest value was Telepuk padi (*N. adorata*
 235 Aiton) and Telepuk gajah (*N. lotus*) which was 1.84% each. The highest relative density, relative frequency and
 236 importance value index in the dry season were Kemon air (*N. olerancia*) which was 39.04%, followed by Are bolong (*P.*
 237 *barbatum L*) 30.61% and Kumpai merah (*Hymenachne sp.*) 20.05%, while the lowest value was Kumpai padi (*O.*
 238 *rupifogon*) which was 13.71% (Table 2). Those results also showed that in Pulau Layang Village there was a difference in
 239 the amount of vegetation between the wet and dry seasons. In the wet season there were 14 forage vegetation species and
 240 in the dry season there were only 10 forage vegetation species. Meanwhile, Apit-apit (*C. chephalotes Vahl*) and Kerak
 241 maling (*D. fuscescens*) were not found in the wet season. Likewise, in the dry season, Purun tikus (*E. dulcis*), Kumpai padi
 242 (*O. rupifogon*), Tapak darah (*C. roseus L. Don*), Kangkung merah (*I. aquatica Forsk*), and Telepuk padi (*N. adorata*
 243 Aiton) were not found. The results show that there were some vegetation species tolerant of water and some others were
 244 not. In other words, those tolerant of water would survive and those which were not would die.

245 The Important Value Index (IVI) differences of the swamp lowland forage vegetation might have resulted from the
 246 competition of each species of vegetation to obtain nutrients in the soil and sunlight, as well as the influencing factors of
 247 the wet and dry seasons. This is in accordance with the results of Parmadi JC et al. (2016) reporting that the IVI
 248 differences of each vegetation species were due to the their competition to obtain nutrients and sunlight. In addition to
 249 nutrients and sun, there are other influencing factors of vegetation density and tides. Variations of the species and amount
 250 of vegetation indicate that even though one research location has the same age, yet the environmental conditions result in
 251 different vegetation (Syarifuddin, 2011). The vegetation species having the highest IVI were Kemon air and Are bolong
 252 (37.01 and 32.73%). This shows that the vegetation species of Kemon air and Are bolong are the most dominant ones
 253

254 among other vegetation species. A vegetation species is said to be dominant in an area if it has a percentage of more than
255 20% of the total individuals and co-dominant if the percentage ranges from 10% to 20% (Suveltri et al., 2014).

256 The analysis results of the vegetation of Rambutan Village during the wet season having the highest relative density,
257 relative frequency, and Important Value Index were Purun tikus (*E. dulcis*) 71.06%, Kerak maling (*D. fuscescens*) 42.34%,
258 and Kumpai padi (*O. rupifogon*) 36.19%. The lowest value ones were Kumpai tembaga (*H. acutigluma*) and Kumpai
259 minyak (*H. amplexicaulis*) 1.81% each. The highest relative density, relative frequency, and important value index in the
260 dry season were Purun tikus (*E. dulcis*) 89.71%, Kumpai padi (*O. rupifogon*) 54.08%, and Kerak maling (*D. fuscescens*)
261 17.71%. The lowest value was Kumpai tembaga (*H. acutigluma*) 2.33% (Table 3). The highest density of swamp forage
262 vegetation might have resulted from its adaptation and development ability in accordance with the environment. This is in
263 accordance with the study result conducted by Oktaviani et al. (2015) that the plant vegetation had the highest density
264 because this vegetation matched the environment to grow and reproduce under the conditions of land whose soil and water
265 contained low pH. As for the plants having the lowest density, it might have been due to the unsuitable environmental and
266 land factors for the plants to grow and breed, particularly the pH of the water and the soil was low in acid (Samin et al.,
267 2016). The results also show that in Rambutan Village there was a difference in the amount of vegetation between the wet
268 and dry seasons. In wet season there were 9 species of forage vegetation, while in the dry season there were only 8 species
269 of forage vegetation. In the dry season there was no legume Mutiara (*S. exasperate*). This shows that the legume
270 Mutiara (*S. exasperate*) could not bear the drought and as a result it would die in the dry season.

271 Forage Production

272 The high production of vegetation for swamp lowland in Pampangan Subdistrict compared to that in Rambutan
273 Subdistrict might have resulted from the soil fertility of the pasture area of Pampangan Subdistrict which was more fertile
274 than that of Rambutan Subdistrict. The analysis results showed that the C-Organic, N-total and P-available analysis (Bray
275 I) were higher than those in the Rambutan District. The high fertility of the land was thought that the most pasture of Pulau
276 Layang Village was the rice fields and always given fertilizer. Unlike the pasture of Pampangan Subdistrict, the pasture of
277 Rambutan Village was only used for the grazing buffaloes without any use of fertilizer. The provision of manure and
278 bioslurry fertilizer can increase the production and forage quality of 4.75 tons and 4.36 tons respectively. (Suarna dan
279 Budiasa 2016; Jeffery et al., 2018).

281 The results of the research in the pasture area of Pampangan Subdistrict, Ogan Komering Ilir was 6.90 tons ha⁻¹.year⁻¹
282 which was lower than that of Kleden et al. (2015) reporting that the production of natural grass in coffee and grassland
283 areas of Wulanggitang Subdistrict, East Flores District was 7.664 tons.ha⁻¹.year⁻¹ and 6.98 tons.ha⁻¹.year⁻¹ respectively.
284 This result was higher than that of Se'u et al. (2015) reporting that the grass production in real conditions in South Central
285 Timor District was only 0.15-0.39 tons.ha⁻¹.year⁻¹.

286 The production of fresh forage swamp lowland pastures of Pulau Layang Village in the wet season was 6,899 kg.ha⁻¹.
287 year⁻¹ and the production of the dry matter was 1,268.51 kg.ha⁻¹.year⁻¹, while in the dry season the fresh production was
288 4,863 kg.ha⁻¹.year⁻¹ and the dry matter production was 986.60 kg.ha⁻¹.year⁻¹ (Table 4). This result was higher than those
289 conducted by (Rinduwati et al., 2016; Omokanye et al., 2018; Se'u et al., 2015) stating that the average fresh production of
290 pasture of Gowa District in the wet season was 5,350 kg.ha⁻¹. year⁻¹ and in the dry season was 1,390 kg.ha⁻¹.year⁻¹. But
291 those results were lower than the study of Abdullah et al., (2017) who reported that forage production was 8,029.1 kg.ha⁻¹.
292 year⁻¹ in the wet season and 5,422.9 kg.ha⁻¹. year⁻¹ in the dry season. The pasture forage production of Sabana Timur
293 Barat on the average ranged from 0.61 to 4.33 tons.ha⁻¹.year⁻¹. The lowest production occurred at the peak of the dry
294 season in October and the highest in April (Manu, 2013; Damry, 2009). The forage production of *Pennisetum*
295 *purpuphoides* was 70.4 ton.ha⁻¹, *Setaria sphasielata* 44.8 tons.ha⁻¹, *Brachiaria sp* 44.7 tons.ha⁻¹, *Pennisetum purpureum*
296 44.6 tons.ha⁻¹, and *Panicum maximum* 15,6 tons.ha⁻¹ (Jarmani and Haryanto, 2015). The different amounts of production
297 might have resulted from the differences in vegetation species, types of pasture, and methods used. There are various
298 methods for estimating forage production, but many are inaccurate when used with certain animal feed plant species.
299 Therefore, it is very important to find out the use and limited techniques of measuring forage production (Edvan et al.,
300 2016; Badgery et al., 2017).

301 There were 5 swamp lowland forage species having high fresh production in the wet season in Pulau Layang Village,
302 namely Kumpai padi (*O. rupifogon*) 12,960 kg.ha⁻¹.year⁻¹, followed by Purun tikus (*E. dulcis*), Telepuk gajah (*N. lotus*),
303 Are bolong (*P. barbatum* L) and Telepuk padi (*N. adorata* Aiton), and the lowest one was Kemon air (*N. olerancia*) 1,910
304 kg.ha⁻¹.year⁻¹. In the dry season the highest fresh production was Kumpai tembaga (*H. acutigluma*) as many as 7,480
305 kg.ha⁻¹.year⁻¹, followed by Kumpai minyak (*H. amplexicaulis*), Kumpai merah (*Hymenachne sp.*), Are bolong (*P.*
306 *barbatum* L) and Bento rayap (*L. hexandra*), and the lowest one was Kemon air (*N. olerancia*) of only 2,870 kg.ha⁻¹.year⁻¹.
307 The highest dry matter production in the wet season was Purun tikus (*E. dulcis*) as many as 2,664.5 kg.ha⁻¹.year⁻¹, followed
308 by Kumpai padi (*O. rupifogon*), Telepuk gajah (*N. lotus*), Are bolong (*P. barbatum* L), and Kumpai tembaga (*H.*
309 *acutigluma*), and the lowest one was Cecengkehan (*L. hyssopifolia*). In the dry season the highest dry matter production
310 was Kumpai tembaga (*H. acutigluma*) as many as 7,480 kg.ha⁻¹.year⁻¹, followed by Bento rayap (*L. hexandra*), Are bolong
311 (*P. barbatum* L), Apit-apit (*C. chephalotes* Vahl) and Kumpai merah (*Hymenachne sp.*), and the lowest one was Kerak
312 maling (*D. fuscescens*) as many as 2,420 kg.ha⁻¹.year⁻¹ (Table 4).

313 The fresh production of swamp lowland pasture of Rambutan Village during the wet season was 3,676.67 kg.ha⁻¹.year⁻¹ and the dry matter production was 905.52 kg.ha⁻¹.year⁻¹, whereas in the dry season the fresh production was
 314 2,523.75 kg.ha⁻¹.year⁻¹ and the dry matter production was 705.66 kg.ha⁻¹.year⁻¹ (Table 5). This results were higher than
 315 those of the study conducted by (Purwantari et al. 2015; Praptiwi et al., 2017) reporting that the average availability of the
 316 forage on palmoil plantations on pasture areas was 1,455.5 kg.ha⁻¹. year⁻¹, but it was lower than the those of the study
 317 conducted by Rinduwati et al., (2016) stating that the production of pasture fresh forage in Gowa District during the wet
 318 season was on the average 5,350 kg.ha⁻¹. year⁻¹, but it was lower than that in the dry season of only 1,390 kg.ha⁻¹.year⁻¹.
 319 The forage production of preproduction rubber plantation was 732.90 kg.ha⁻¹.year⁻¹ and at the time of production it was
 320 only 317.83 kg. ha⁻¹.year⁻¹ (Pramana et al., 2015).

322 There were 5 species of swamp lowland forage having the highest fresh and dry matter production during the wet
 323 season, namely Kumpai tembaga (*H. acutigluma*) producing 8,540 kg.ha⁻¹.year⁻¹ and 3,139.3 kg. ha⁻¹.year⁻¹ each, followed
 324 by Kumpai padi (*O. rupifogon*), Bento rayap (*L. hexandra*), Purun tikus (*E. dulcis*), and Kumpai minyak (*H.*
 325 *amplexicaulis*), and the lowest one was Kerak maling (*D. fuscescens*) of 790 kg.ha⁻¹. year⁻¹ and 108.0 kg.ha⁻¹.year⁻¹. In the
 326 dry season, the highest fresh and dry matter production was Kumpai tembaga (*H. acutigluma*) of 5,900 kg.ha⁻¹.year⁻¹ and
 327 2,181.82 kg.ha⁻¹.year⁻¹, followed by Kumpai padi (*O. rupifogon*), Bento rayap (*L. hexandra*), Kumpai minyak (*H.*
 328 *amplexicaulis*), and Purun tikus (*E. dulcis*), and the lowest one was Kasuran (*C. digitatus*) of 240 kg.ha⁻¹.year⁻¹ and 11.92
 329 kg.ha⁻¹.year⁻¹ respectively (Table 5). The results of this study were still higher than those conducted by Rostini et al. (2014)
 330 stating that the highest grass production of *Hymenachne amplexicaulis* Haes was 1,032 kg DM.ha⁻¹.harvest⁻¹ in the high
 331 tide season and 518.3 kg DM.ha⁻¹.harvest⁻¹ in the low tide season, where the dry matter production ranged from 43.8 to
 332 1.032 kg DM.ha⁻¹.harvest⁻¹ in the high tide season and from 38.5 to 752.8kg DM.ha⁻¹.year⁻¹.harvest⁻¹ in the low tide season.
 333

334 Pasture Carrying Capacity

335 The carrying capacity is an analysis of the ability of pasture areas or grass farming to accommodate a number of
 336 livestock so that the need for grass for one-year-animal feed is sufficient. Calculating forage carrying capacity of swamp
 337 lowland forage is based on the amount of forage supplied on a pasture for livestock needs for one year which is stated in
 338 Animal Unit (AU) per hectare. According to Purnomo (2006), the calculation of carrying capacity is based on the formula
 339 of:

$$341 \text{ Carrying Capacity} = \frac{\text{Cumulative Production} \times \text{proper use factor (\%)}}{\text{Animal Need (kg DM/AU/day)} \times 360 \text{ days}}$$

345 The carrying capacity for Pampangan buffaloes on the swamp lowland pasture of Pulau Layang Village in the wet
 346 season was 3.66 AU.ha⁻¹.year⁻¹ and 2.85 AU.ha⁻¹.year⁻¹ during the dry season (Table 4). The results of this study
 347 corresponded to those of the study conducted by Rostini et al. (2014) stated that the carrying capacity of swamp lowland
 348 plants in South Kalimantan was 2.91 AU. ha⁻¹.year⁻¹. These results were higher than those of the study conducted by Seu et
 349 al., (2015) reporting that the carrying capacity of grass in real conditions in South Central Timor District was only 0.24 -
 350 0.63 AU.ha⁻¹.year⁻¹, and average carrying capacity of natural pastures of Gowa District was 0.88 AU.ha⁻¹.year⁻¹ (Rinduwati
 351 et al., 2016) and the capacity of pasture in Poso District 0.63 AU.ha⁻¹.year⁻¹ (Damry, 2009; Daru et al., 2014). The carrying
 352 capacity of pasture of Sota Village, Merauke District, was still relatively small (Praptiwi et al., 2017). The carrying
 353 capacity of pasture in Kelei and Didiri Villages of Poso Districts was 0.96 and 1.12 AU.ha⁻¹.year⁻¹ (Karti et al., 2015).
 354 The pasture performance of the *Brachuaria humidicola* (Rendle) was 2.31 AU.ha⁻¹.year⁻¹ (Anis et al., 2014). Abdullah et
 355 al., (2017) reported that the carrying capacities of forage in the wet and dry seasons in Pakistan were 24 AU. ha⁻¹.year⁻¹
 356 and 16 AU.ha⁻¹.year⁻¹. The high carrying capacity is related to the high forage production, management of forage
 357 development and selection of good species. The management and strategy carried out to increase forage production require
 358 stockbreeder-farmer innovative training facilitated to have knowledge of breeding and it should supported by the
 359 government and private companies to make a program about the importance of forage to increase ruminant livestock
 360 production (Nigus, 2017 ; Omokanye et al., 2018). In the pasture condition having one species of swamp forage, the
 361 highest carrying capacity in the wet season was Purun tikus (*E. dulcis*) as much as 7.69 AU.ha⁻¹.year⁻¹, and then followed
 362 by Kumpai padi (*O. rupifogon*) 6.42 AU.ha⁻¹.year⁻¹, Telepuk gajah (*N. lotus*) 5.72 AU.ha⁻¹.year⁻¹, Are bolong (*P.*
 363 *barbatum* L) 4.77 AU.ha⁻¹.year⁻¹ and Kumpai tembaga (*H. acutigluma*) 3.90 AU.ha⁻¹.year⁻¹ consecutively, and the lowest
 364 one was Cecengkehan (*L. hyssopifolia*) 1.00 AU.ha⁻¹.year⁻¹. In the dry season the highest carrying capacity was Kumpai
 365 tembaga (*H. acutigluma*) as much as 4.71 AU.ha⁻¹.year⁻¹, and then it was followed by Bento rayap (*L. hexandra*) as much
 366 as 4.00 AU.ha⁻¹.year⁻¹, Are bolong (*P. barbatum* L) 3.59 AU.ha⁻¹.year⁻¹, Apit-apit (*C. chephalotes* Vahl) 3.30 AU.ha⁻¹.year⁻¹
 367 and Kumpai merah (*Hymenachne sp.*) 2.82 ha⁻¹.year⁻¹, whereas the lowest one was Kerak maling (*D. fuscescens*) as much
 368 as 1.55 AU.ha⁻¹.year⁻¹ (Table 4).

369 The carrying capacity of Pampangan buffalo pasture of the swamp lowland of Rambutan Village during the wet
 370 season was 2.61 AU.ha⁻¹.year⁻¹ and in the dry season it was 2.04 AU.ha⁻¹.year⁻¹ (Table 5). This result was lower than those
 371 of the study conducted by Muhajirin et al. (2017) stating that the carrying capacity of Padang Mengatas BPTU was 5
 372 AU.ha⁻¹.year⁻¹ in the wet season and 3.18 AU.ha⁻¹.year⁻¹ in the dry season. There was a decrease in the dry material

373 production during the dry season because the water condition in swamp lowland alleviated. The decreased swamp water
374 condition resulted in a decrease of photosynthesis and automatically the production of the dry matter decreased. Water is
375 the main ingredient needed in photosynthesis. The disruption of metabolic processes in plants will affect plant production.
376 Plant dry weight depicts the accumulation of organic compounds that are successfully synthesized by the plants from
377 inorganic compounds, especially water and CO₂ (Lakitan, 1995). Water shortages will have a negative effect on plant
378 growth resulting in decreased production (Jun-Feng et al., 2010; Taiz and Zeiger 2002).

379 When the pasture condition had one species of swamp forage, the highest carrying capacity in the wet season
380 consecutively included Kumpai tembaga (*H. acutigluma*) of 9.06 AU.ha⁻¹.year⁻¹, Kumpai padi (*O. rupifogon*) 4.22 AU.ha⁻¹.
381 year⁻¹, Bento rayap (*L. hexandra*) 3.29 AU.ha⁻¹.year⁻¹, Purun tikus (*E. dulcis*) 2.66 AU. ha⁻¹.year⁻¹, and Kumpai minyak
382 (*H. amplexicaulis*) 1.67 AU.ha⁻¹.year⁻¹. While the lowest one was Kerak maling (*D. fuscescens*) as much as 0.31 AU.ha⁻¹.
383 year⁻¹. During the dry season the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) as much as 6.29 AU.ha⁻¹.
384 year⁻¹, and then followed by Kumpai padi (*O. rupifogon*) as much as 4.10 AU.ha⁻¹.year⁻¹, Bento rayap (*L. hexandra*) 2.65
385 AU.ha⁻¹.year⁻¹, Kumpai minyak (*H. amplexicaulis*) 1.41 AU.ha⁻¹.year⁻¹, and Purun tikus (*E. dulcis*) 1.09 AU.ha⁻¹.year⁻¹.
386 While the lowest one was Kasuran (*C. digitatus*) as much as 0.08 AU.ha⁻¹.year⁻¹ (Table 5). These results indicate that the
387 carrying capacity is very influential with the type of feed plan. In addition the most important thing is also cattle grazing
388 system. Livestock grazing must be regulated to avoid over-grazing. The amount of grazing livestock depends on the
389 carrying capacity of the pasture (Salendu and Elly, 2014; Cheng et al., 2017; Hashemi, 2017).

390 The results of this study indicated that the forage availability was still sufficient to meet feed requirements for
391 Pampangan buffaloes. The population of Pampangan buffaloes of Pulau Layang Village was 487 buffaloes with a grazing
392 area of 500 ha with an average carrying capacity of 3.14 AU. ha⁻¹.year⁻¹. While the number of Pampangan buffaloes of
393 Rambutan Village was 1.735 buffaloes with a pasture area of 1,203 ha and an average carrying capacity of 2.45 AU.ha⁻¹.
394 year⁻¹. It is projected that there is still a need for additional buffalo cattle as much as 0.31 AU.ha⁻¹.year⁻¹ in Pulau Layang
395 Village and 0.59 AU.ha⁻¹.year⁻¹ in Rambutan Village.

396 Based on the results of the study, the following is the conclusion:

- 397 1. There were 19 species of swamp lowland forage vegetation found to have the potential to feed the Pampangan buffaloes
398 in South Sumatra.
- 399 2. Important Value Index (IVI) is strongly influenced by grazing locations and seasons. The high IVI were Kemon air (*N.*
400 *olerancia*) and Are bolong (*P. barbatum* L) in Pulau Layang Village. In Rambutan Village, the high IVI were Purun
401 tikus (*E. dulcis*), Kerak maling (*D. fuscescens*), and Kumpai padi (*O. rupifogon*).
- 402 3. In Pulau Layang Village, the fresh forage and dry matter production of forage vegetation swamp lowland pasture in the
403 wet season were 6.90 and 1.27 tons.ha⁻¹.year⁻¹, while in Rambutan Village they were 3.68 tons.ha⁻¹.year⁻¹ and 0.91
404 ton.ha⁻¹.year⁻¹ dry consecutively. The fresh forage production and dry matter production in the dry season in Pulau
405 Layang Village were 4.86 and 0.99 tons.ha⁻¹.year⁻¹, while in Rambutan Village they were 2.52 tons.ha⁻¹.year⁻¹ and 0.71
406 tons.ha⁻¹.year⁻¹ consecutively.
- 407 4. The carrying capacity of swamp lowland pasture in the wet season in Pulau Layang Village was 3.66 AU.ha⁻¹.year⁻¹
408 and in the dry season it was 2.85 AU.ha⁻¹.year⁻¹. In Rambutan Village in the wet season it was 2.61 AU.ha⁻¹.year⁻¹ and
409 in the dry season it was 2.04 AU.ha⁻¹.year⁻¹. Therefore, on the average the carrying capacity of the swamp lowland
410 pasture in South Sumatra was 2.79 AU.ha⁻¹.year⁻¹.
- 411 5. The forage availability is still sufficient to meet the need for animal feed, and it is projected that there is still a need for
412 additional buffalo cattle for 0.31 AU.ha⁻¹.year⁻¹ in Pulau Layang Village and 0.59 AU.ha⁻¹.year⁻¹ in Rambutan Village.
- 413 6. The highest forage production in the wet season in Pulau Layang Village was Purun tikus, followed by, Kumpai padi,
414 Telepuk gajah, Are bolong, Kumpai tembaga, while in the dry season the highest one was Kumpai tembaga, followed
415 by Bento rayap, Are bolong, Apit-apit and Kumpai merah. In Rambutan Village the highest forage production in the
416 wet and dry seasons were Kumpai tembaga, Kumpai padi, Bento rayap, Kumpai minyak, and Purun tikus.

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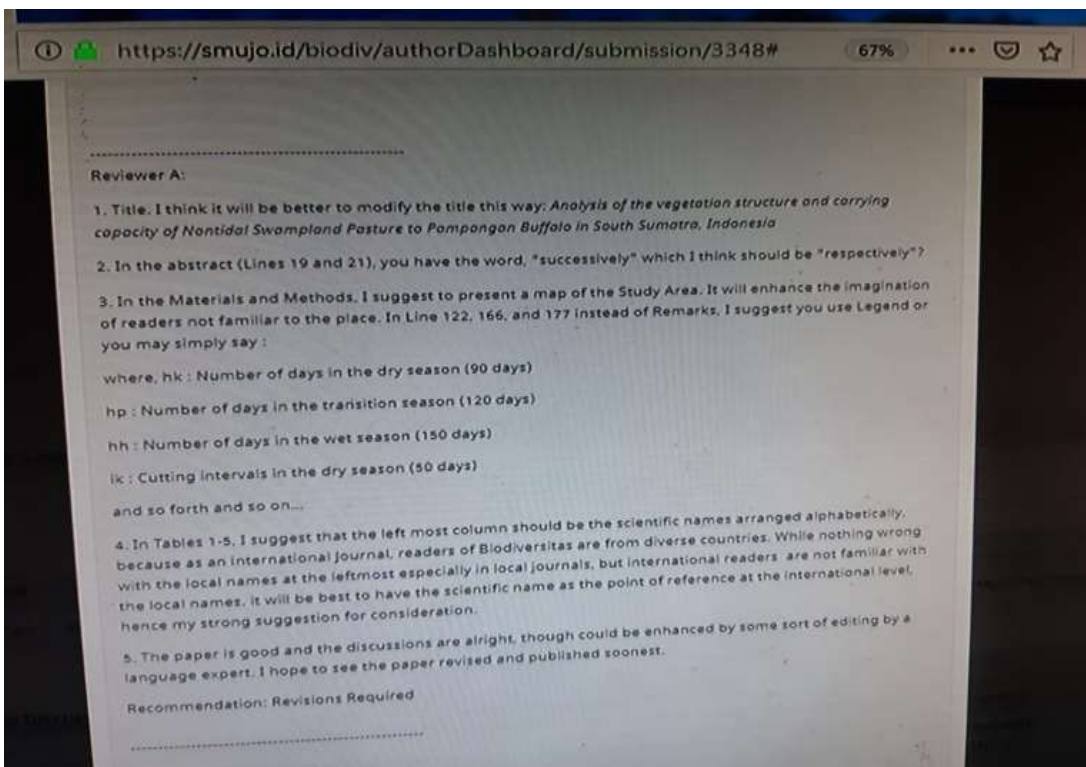
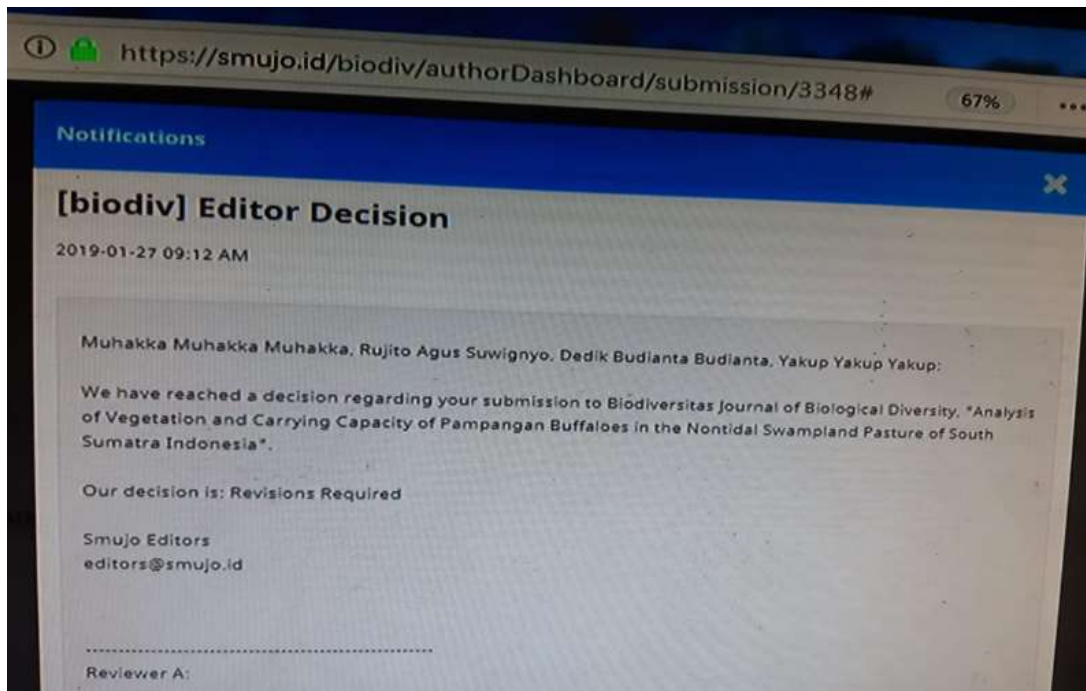
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**2. Bukti Konfirmasi Review dan
Hasil Review Pertama
(27 Januari 2019)**



Analysis of the Vegetation Structure and Carrying Capacity of Nontidal Swampland Pasture to Pampangan Buffalo in South Sumatra, Indonesia

Abstract. This study aimed to analyze the vegetation and carrying capacity of Pampangan buffalo in the swampland pasture. The methods of collecting the data used measurements and direct observation in the field covering identification of forage species and production. The measurement of forage production used methods of Halls. There were totally 50 observation points on the swampland. The forage in the quadrant was cut and weighed. The results of the study found 19 species of forage swamp potential as Pampangan buffalo feed. The highest important value index of Purun tikus (*E.dulcis*) was 89.71% and Kumpai padi (*O.rupifogon*) was 54.08%. The production of fresh forage and dry matter in the wet season in Pulau Layang was 6.90tons.ha⁻¹.year⁻¹ and 1.27tons.ha⁻¹.year⁻¹ consecutively, whereas in Rambutan Village they were 3.68tons.ha⁻¹.year⁻¹ and 0.91tons.ha⁻¹.year⁻¹ respectively. The production of fresh forage and dry matter in the dry season in Pulau Layang was 4.86tons.ha⁻¹.year⁻¹ and 0.99tons.ha⁻¹.year⁻¹ consecutively, while in Rambutan they were 2.52tons.ha⁻¹.year⁻¹ and 0.71tons.ha⁻¹.year⁻¹ respectively. The pasture carrying capacity of swampland of Pulau Layang village in the wet season was 3.66AU.ha⁻¹.year⁻¹ and in the dry season it was 2.85AU.ha⁻¹.year⁻¹, while in Rambutan village it was 2.61AU.ha⁻¹.year⁻¹ and 2.04AU.ha⁻¹.year⁻¹. There were six species of forage with high production, namely Kumpai tembaga, Kumpai padi, Kumpai minyak, Are bolong, Bento rayap and Purun tikus.

Key words: Pampangan buffalo, Analysis of vegetation, Carrying capacity, Pasture, Nontidal Swampland

INTRODUCTION

Nontidal Swampland is a suboptimal land and the availability is very extensive in Indonesia. The area of nontidal swampland is about 13.27 million Ha, and only 4 million ha was developed. The public and the private sector managed 2.6 million ha and 1.3 million Ha developed by government assistance (Statistic Center Bureau, 2010, Mulyani and Sarwani, 2013). It consists of 3.0 million ha of deep swampland; 6.07 million ha of middle swampland and 4.2 million ha of shallow swampland scattered in Sumatra, Kalimantan and Papua islands. Nontidal swampland in South Sumatra cover highest area in Sumatra reaching 2.98 million ha, with only 298,189 ha has been developed (Statistic Center Bureau South Sumatra, 2014).

Pampangan buffaloes are the ones of the potential germplasm of South Sumatra Province widely found in Pulau Layang Village of Ogan Komering Ilir and Rambutan Village of Banyuasin which are generally extensively maintained (Muhakka et al., 2013). In addition to being taken for their meat, they also produce milk to be processed into traditional food (*Gulo Puan*). The buffalo population in South Sumatra in 2014 was 33,369 buffaloes and the number decreased compared to that in 2012 to be 34,866 buffaloes (4.29%) (Statistics of South Sumatra Animal Husbandry, 2014). There are three factors causing a decline in the buffalo livestock population, namely (1) the availability of fluctuating natural forage amount, (2) the quality of nutritional forage of swamp lowland was low, and (3) the grazing pasture decreased (BPTP South Sumatra, 2011). The low productivity of buffaloes (growth and milk production) resulted from the consumed rations which could not meet the needs of food substances; this was characterized by low protein content and high crude fiber and low digestibility. However, the buffaloes have several advantages and their roles can be enhanced especially through food and genetic improvement (Talib et al., 2014). The buffaloes have their own advantages compared to cows. They can survive particularly if the existing feed has low quality (Diwyanto and Handiwirawan 2006; Yasin, 2013).

One strategy that can be done to maintain and improve the ability of the level of productivity of pampangan buffaloes is by conducting a study of forage vegetation in swamp lowland, through analysis of vegetation and carrying capacity of pasture. The study of vegetation analysis and pasture carrying capacity at the present time is limited to the dry land such as in Wulan Gitrang Subdistrict, East Flores, whose carrying capacity are 0.42 AU.ha⁻¹.year⁻¹ on coffee plantation area and

51 0.38 AU.ha⁻¹.year⁻¹ on grassland area (Kleden et al., 2015). The carrying capacity of livestock storage under the auspices
52 of preproduction of rubber plants is 0.14 AU. ha⁻¹.year⁻¹, while rubber production plants can only accommodate 0.06 AU.
53 ha⁻¹.year⁻¹ (Pramana et al., 2015).

54 This study aimed to analyze swamp forage vegetation and the carrying capacity of Pampangan buffalo pasture in the
55 swampland of South Sumatra.

56 MATERIALS AND METHODS

57 This research was carried out in Pulau Layang Village of Pampangan Subdistrict of Ogan Komering Ilir District and
58 Rambutan Village of Rambutan Subdistrict of Banyuasin District of South Sumatra from April to September 2017. The
59 method used a survey method and measurements and direct observations on swamp lowland which was commonly used as
60 pasture by farmers taken as samples. The data of livestock population were collected from related agencies and
61 institutions.

62 The data were collected using measurements and direct observations in the field including forage vegetation species,
63 the amount of production, forage quality (natural grass and legume), and soil fertility. The method used a quadratic method
64 with the placement of plots by using purposive sampling with a plot size of 1x1m and the number of plots of 50 plots in
65 swamp lowland (Kleden et al., 2015). Then, each observation plot recorded the species of forage vegetation, the number of
66 individuals of each species, and collected all species of forage vegetation. The collection was labeled hanging and each
67 species of forage vegetation was photographed with a digital camera. The revoked vegetation from each plot was separated
68 according to each species and dried to calculate the dominant value. The unknown species of vegetation was collected,
69 given 70% alcohol, oven-baked, and identified.

70
71 The variables to be measured and observed in this study were as follows:

72 **Vegetation Analysis**

73 The collected data were analyzed quantitatively (Utami et al., 2007) as follows:

74 a. Density

75 Density is the number of individuals of a species of certain location formulated as follows:

$$76 \text{Density} = \frac{\text{The species number}}{\text{The total area of the sample plots}}$$

80 b. Relative Density

81 Relative density is a percentage of density of a species toward density of all species which is formulated as follows:

$$82 \text{Relative Density} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100\%$$

86 c. Frequency

87 Frequency is the comparison of the number of sample plots having a species and the number of sample plots which
88 were made, formulated as follows:

$$89 \text{Frequency} = \frac{\text{The number of plots having a species}}{\text{The number of all observed plots}}$$

93 d. Relative Frequency

94 Relative Frequency is a frequency percentage of a species toward the number of frequency of all species, formulated as
95 follows:

$$96 \text{Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100\%$$

99 e. Important Value Index (IVI)

100 This value indicates the dominance of a species in a particular area formulated as follows:

$$101 \text{IVI} = \text{Relative Density} + \text{Relative Frequency}$$

102 **Forage Production**

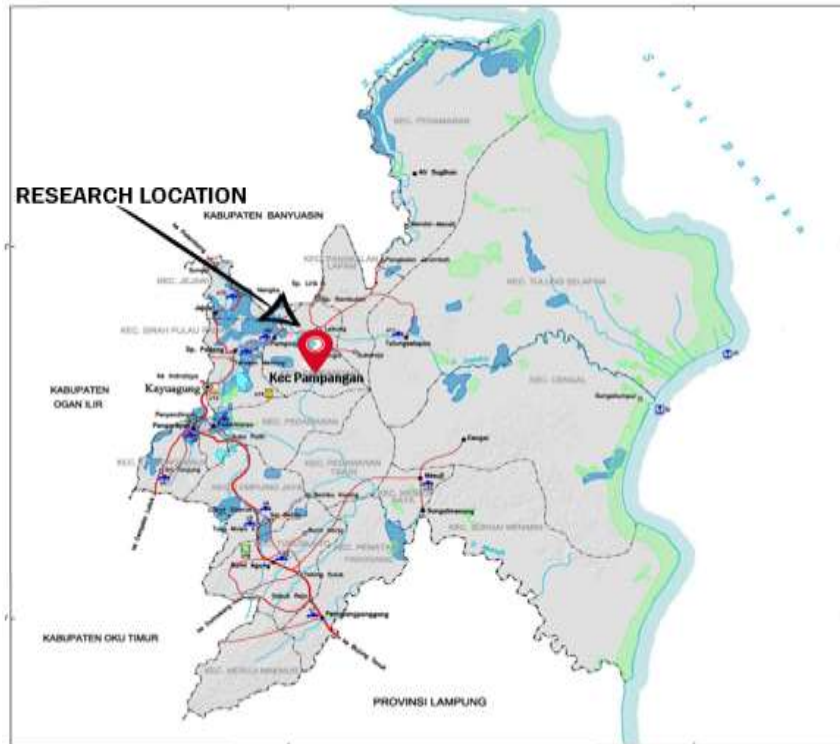
103 The measurement of forage production adopted the *Halls* method (in Kleden et al., 2015) which used a 1m x 1m
104 quadratic frame by sampling construction (Sutaryo, 2009). A total of 50 observation points were conducted in a grazing
105 area on swamp lowland often used by farmers/ranchers. The placement of squared frame for each observation point was
106 based on random numbers. The average forage production was calculated using the following formula:

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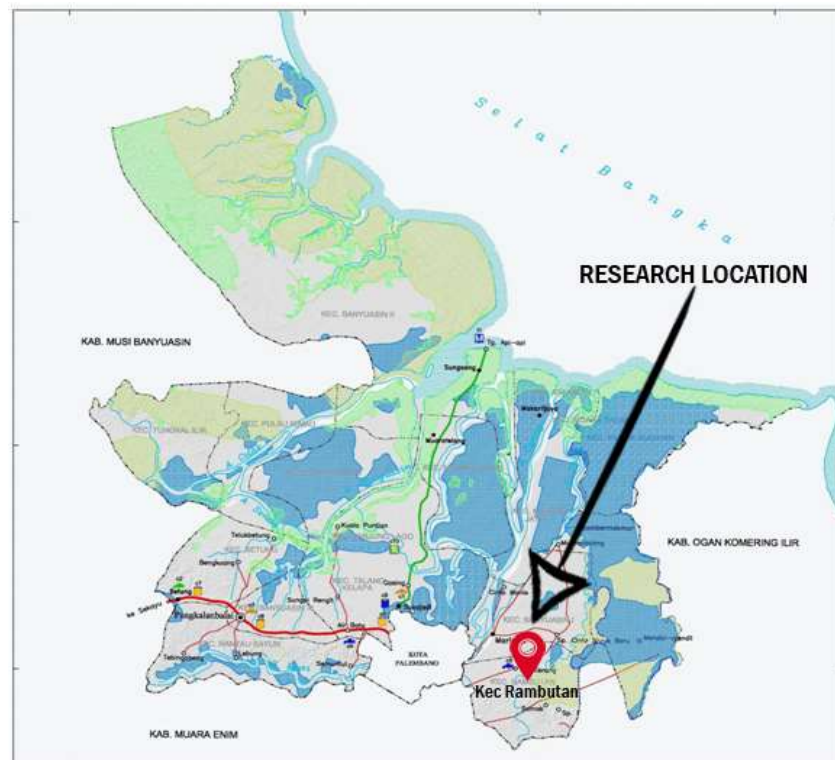
$$X = \frac{\sum xi}{n}$$

Where: X = The existing average forage biomass production
 $\sum xi$ = The amount of forage biomass production at each observation
n = The amount of observation



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Figure 1. Research location : Pulau Layang Village, Pampangan sub-district, Ogan Komering Ilir District



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Figure 2. Research location : Rambutan Village, Rambutan sub-district , Banyuasin District

121 **Pasture Carrying Capacity**

122 The amount of carrying capacity was found out by estimating the consumption of dry matter/Animal Unit (AU). The
123 carrying capacity was calculated for each species of forage. The calculation adopted the Purnomo's formula (2006).

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$$\text{Carrying Capacity} = \frac{\text{Cumulative Production} \times \text{proper use factor (\%)}}{\text{Animal needs (kg DM/AU/day)} \times 360 \text{ days}}$$

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$$\text{Cumulative Forage Production} = \left[\left(\frac{\text{hk}}{\text{ik}} \times \text{pk} \right) + \left(\frac{\text{hp}}{\text{ip}} \times \text{pp} \right) + \left(\frac{\text{hh}}{\text{ih}} \times \text{ph} \right) \right]$$

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132 Where:

- 133 hk : Number of days in the dry season (90 days)
134 hp : Number of days in the transition season (120 days)
135 hh : Number of days in the wet season (150 days)
136 ik : Cutting intervals in the dry season (50 days)
137 ip : Cutting intervals in the transition season (30 days)
138 ih : Cutting intervals in the wet season (40 days)
139 pk : Biomass production in the dry season
140 pp : Biomass production in the transition season
141 ph : Biomass production in the wet season
142 puf: Proper Use Factor 68%.
143 kt : Animal Need 6,25 kg Dry Matter AU⁻¹day⁻¹

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145 **Data Analysis**

146 The data of the carrying capacity of pasture were obtained from the total needs of livestock by referring to the total
147 forage production. The carrying capacity data were analyzed by comparing forage production with the number of livestock
148 available to find out the ratio of the two illustrating the number of buffaloes that could be developed in the study area using
149 the following formulations: (a). AUp/AUt < 1 : if the number of livestock being grazed in swamp lowlands is greater than
150 the amount of feed available, (b). AUp/AUt = 1 : If there is a balance between the amount of forage available and the
151 number of livestock being grazed. (c). AUp/AUt > 1 : If the number of livestock being grazed is less than the amount of
152 food available in the pasture. Remarks: AUp and AUt are animal units for feed and animal unit for livestock successively
153 (Kleden *et al.*, 2015).

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178 **Results**179 **Species of Forage Vegetation**

180 Forage vegetation of swamp lowland in Pampangan buffalo pasture had 19 forage species potential to be used as
 181 buffalo feed covering 17 grass species (*gramineae*) and 2 legume species (*leguminosa*) (Table 1).

182

183 **Table 1.** Species of forage vegetation of swampy lowland of Pampangan buffalo pasture

184

Latin Name	Local Name	Village		Remarks
		P	R	
<i>Catharanthus roseus</i> (L.) Don	Tapak dara	+	-	NDP
<i>Cyperus chephalotes</i> Vahl	Apit-apit	+	-	NDP
<i>Cyperus digitatus</i>	Kasuran	-	+	NDP
<i>Digitaria fuscescens</i>	Pasiran / Kerak maling	+	+	DP
<i>Eichhornia crassipes</i>	Eceng gondok	+	-	NDP
<i>Eleocharis dulcis</i>	Purun tikus	+	+	DP
<i>Hymenachne acutigluma</i>	Kumpai tembaga	+	+	DP
<i>Hymenachne amplexicaulis</i>	Kumpai minyak	+	+	DP
<i>Hymenachne sp.</i>	Kumpai merah	+	-	NDP
<i>Ipomoea aquatica</i> Forsk.	Kangkung merah	+	-	NDP
<i>Leersia hexandra</i>	Bento rayap	+	+	DP
<i>Ludwigia hyssopifolia</i>	Cecengkehan	+	-	ND
<i>Neptunia olerancia</i>	Kemon air	+	-	NDP
<i>Nymphaea adorata</i> Aiton	Telepuk Padi	+	-	NDP
<i>Nymphaea lotus</i>	Telepuk Gajah	+	-	NDP
<i>Oryza rupifogon</i>	Kumpai padi	+	+	DP
<i>Polygonum barbatum</i> L)	Are bolong	+	-	DNP
<i>Rhynchospora corymbosa</i> . L	Berondong	-	+	ND
<i>Sesbania exasperata</i>	Mutiara	-	+	NDP

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Where: P : Pulau Layang Village NDP : Not Dominant Palatabel

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R : Rambutan Village ND : Not Dominant

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DP : Dominant, Palatabel + : Available

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DNP : Dominant Not Palatabel - : Unavailable

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190 **Analysis of Forage Vegetation**

191 Analysis of forage vegetation of swamp lowland of Pampangan buffalo pastures in the wet and dry seasons in
 192 Pulau Layang Village of Pampangan Sudistrict and Rambutan Village of Banyuasin Subdistrict (Tables 2 and 3).

193 **Table 2.** Density Value, Relative Density, Frequency, Relative Frequency, and Index of Important Value of Swamp Lowland Forage
 194 Vegetation of Pampangan Buffalo Pasture during the Wet and Dry Seasons in Pulau Layang Village.

Latin Name	Wet Season					Dry Season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Catharanthus roseus</i> (L.) Don	0,08	2,500	0,06	3,659	6,159	-	-	-	-	-
<i>Cyperus chephalotes</i> Vahl	-	-	-	-	-	0,16	8,421	0,12	9,524	17,945
<i>Digitaria fuscescens</i>	-	-	-	-	-	0,16	8,421	0,12	9,524	17,945
<i>Eichhornia crassipes</i>	0,48	15,000	0,20	12,195	27,195	0,18	9,474	0,08	6,349	15,823
<i>Eleocharis dulcis</i>	0,16	5,000	0,14	8,537	13,537	-	-	-	-	-
<i>Hymenachne acutigluma</i>	0,22	6,875	0,12	7,317	14,192	0,12	6,316	0,12	9,524	15,840
<i>Hymenachne amplexicaulis</i>	0,20	6,250	0,10	6,098	12,348	0,14	7,368	0,08	6,349	13,717
<i>Hymenachne sp.</i>	0,46	14,375	0,18	10,976	25,351	0,20	10,526	0,12	9,524	20,050
<i>Ipomoea aquatica</i> Forsk.	0,04	1,250	0,04	2,439	3,689	-	-	-	-	-
<i>Leersia hexandra</i>	0,06	1,875	0,04	2,439	4,314	0,12	6,316	0,10	7,936	14,252
<i>Ludwigia hyssopifolia</i>	0,18	5,625	0,06	3,659	9,284	0,16	8,421	0,08	6,349	14,770
<i>Neptunia olerancia</i>	0,56	17,500	0,32	19,512	37,012	0,38	20,000	0,24	19,048	39,048
<i>Nymphaea adorata</i> Aiton	0,02	0,625	0,02	1,220	1,845	-	-	-	-	-
<i>Nymphaea lotus</i>	0,02	0,625	0,02	1,220	1,845	-	-	-	-	-
<i>Oryza rupifogon</i>	0,18	5,625	0,08	4,878	10,503	-	-	-	-	-
<i>Polygonum barbatum</i> L)	0,54	16,875	0,26	15,854	32,729	0,28	14,737	0,20	15,873	30,610
TOTAL	3,2	100	1,64	100	200	1,9	100	1,26	100	200

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Where: D = Density

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RD = Relative Density

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F = Frequency

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RF = Relative Frequency

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IVI = Important Value Index

200 **Table 3.** Density Value, Relative Density, Frequency, Relative Frequency, and Index of Important Value of Swamp Lowland Forage
 201 Vegetation of Pampangan Buffalo Pasture during the Wet and Dry Seasons in Rambutan Village.

Latin Name	Wet Season					Dry Season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Cyperus digitatus</i>	0,88	18,033	0,30	14,851	32,884	0,12	5,310	0,06	4,348	9,658 ⁴
<i>Eleocharis dulcis</i>	1,68	34,426	0,74	36,634	71,060	1,00	44,248	0,62	44,928	89,176 ¹
<i>Digitaria fuscescens</i>	1,10	22,541	0,40	19,802	42,343	0,40	1,770	0,22	15,942	17,712 ³
<i>Hymenachne acutigluma</i>	0,04	0,820	0,02	0,990	1,810	0,02	0,885	0,02	1,449	2,334 ⁸
<i>Hymenachne amplexicaulis</i>	0,04	0,820	0,02	0,990	1,810	0,04	1,770	0,02	1,449	3,219 ⁷
<i>Leersia hexandra</i>	0,06	1,230	0,04	1,980	3,210	0,04	1,770	0,04	2,899	4,659 ⁵
<i>Oryza rufifogon</i>	0,80	16,393	0,40	19,802	36,195	0,60	26,549	0,38	27,536	54,085 ²
<i>Rhynchospora corymbosa. L</i>	0,08	1,639	0,04	1,980	3,619	0,04	1,770	0,02	1,449	3,219 ⁶
<i>Sesbania exasperata</i>	0,20	4,098	0,06	2,970	7,068	-	-	-	-	-
TOTAL	4,88	100	2,02	100	200	2,26	100	1,38	100	200

202 Where: D = Density
 203 RD = Relative Density
 204 F = Frequency
 205 RF = Relative Frequency
 206 IVI = Important Value Index
 207

208 Forage Production

209 Production of vegetation fresh forage of swamp lowland in the two study locations on the average was 6.90 tons.ha⁻¹.year⁻¹ in the pasture area of Pulau Layang Village of Pampangan Subdistrict of Ogan Komering Ilir District (Table 4)
 210 and 3.68 tons.ha⁻¹.year⁻¹ in the pasture area of Rambutan Village of Rambutan Subdistrict of Banyuasin District (Table 5).
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 212

213 **Table 4.** Fresh Weight Production, Dry Matter Production, and Forage Carrying Capacity of Swamp Lowland in the Wet and Dry
 214 Seasons in Pulau Layang Village of Ogan Komering Ilir.

Latin Name	Wet Season			Dry Season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Catharanthus roseus</i> (L.) Don	7.530	977,4	2,82	-	-	-
<i>Cyperus chepalotes</i> Vahl	-	-	-	4.580	1.145,00 ⁴	3,30
<i>Digitaria fuscescens</i>	-	-	-	2.420	537,97 ¹⁰	1,55
<i>Eichhornia crassipes</i>	5.940	1.097,7	3,17	4.700	830,49 ⁶	2,40
<i>Eleocharis dulcis</i>	12.640	2.664,5	7,69	-	-	-
<i>Hymenachne acutigluma</i>	6.700	1.352,7	3,90	7.480	1.632,54 ¹	4,71
<i>Hymenachne amplexicaulis</i>	6.650	790,0	2,28	5.990	729,58 ⁸	2,11
<i>Hymenachne sp.</i>	7.040	1.151,7	3,32	5.720	975,83 ⁵	2,82
<i>Ipomoea aquatica</i> Forsk.	4.020	604,6	1,75	-	-	-
<i>Leersia hexandra</i>	4.740	1.232,4	3,56	5.290	1.385,45 ²	4,00
<i>Ludwigia hyssopifolia</i>	1.980	346,9	1,00	4.290	777,35 ⁷	2,24
<i>Neptunia olerancia</i>	1.910	394,8	1,14	2.870	607,01 ⁹	1,75
<i>Nymphaea adorata</i> Aiton	7.500	1.286,3	3,71	-	-	-
<i>Nymphaea lotus</i>	9.800	1.983,5	5,72	-	-	-
<i>Oryza rufifogon</i>	12.960	2.225,2	6,42	-	-	-
<i>Polygonum barbatum</i> L)	7.180	1.651,4	4,77	5.290	1.244,74 ³	3,59
Average	6.899	1.268,51	3,66	4.863	986,60	2,85

215 Pasture Carrying Capacity

216 The carrying capacity of Pampangan buffaloes in the swamp lowland pasture of Pulau Layang Village was 3.66
 217 AU.ha⁻¹.year⁻¹ during the wet season and 2.85 AU.ha⁻¹.year⁻¹ in the dry season (Table 4). The carrying capacity of
 218 Pampangan buffaloes in the swamp lowland pasture of Rambutan Village was 2.61 AU.ha⁻¹.year⁻¹ in the wet season it was
 219 2.04 AU.ha⁻¹.year⁻¹ in the dry season (Table 5).
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Table 5. Fresh Weight Production, Dry Matter Production, and Forage Carrying Capacity of Swamp Lowland in the Wet and Dry Seasons in Rambutan Village of Banyuasin.

Latin Name	Wet Season			Dry Season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ . year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ . year ⁻¹)
<i>Cyperus digitatus</i>	2.590	248,9	0,72	240	28,61	0,08
<i>Digitaria fuscescens</i>	790	108,0	0,31	1.100	152,79	0,44
<i>Eleocharis dulcis</i>	4.370	921,2	2,66	1.700	376,21	1,09
<i>Hymenachne acutigluma</i>	8.540	3.139,3	9,06	5.900	2.181,82	6,29
<i>Hymenachne amplexicaulis</i>	4.860	577,4	1,67	3.200	489,28	1,41
<i>Oryza rufifogon</i>	4.690	1.462,8	4,22	4.420	1.421,03	4,10
<i>Rhynchospora corymbosa. L</i>	1.510	441,8	1,28	250	77,88	0,22
<i>Sesbania exasperata</i>	1.360	111,5	0,32	-	-	-
Average	3.676,67	905,52	2,61	2.523,75	705,66	2,04

233 **Discussion**

234 **Species of Forage Vegetation**

235 There are dominant and palatable species of swamp lowland forage vegetation having potential as buffalo feed, namely
236 Kumpai padi grass (*O. rufifogon*), Kumpai tembaga (*H. acutigluma*), and Kumpai minyak (*H. amplexicaulis*), not
237 dominant and palatable such as Kumpai merah (*Hymenachne sp*) and Kemon air (*N. olerancia*); dominant and non
238 palatable grass species (buffalo doesn't like it) namely Are bolong (*P. Barbatum. L*). Yet, this grass species would be eaten
239 by the buffaloes if there were no other species to be eaten (Table 1).

240 Ali et al. (2012) conducting a study on swamp land vegetation found 25 species, Rohaeni et al. (2005) found 24 species
241 in South Kalimantan, and Camarao and Rodrigues Filho (2001) only found 7 species. In Gowa District, there were 15
242 vegetation species on the natural grasslands consisting of 12 vegetation species classified as palatable forage (7 grasses
243 and 5 legumes) and 3 non palatable species. All of these vegetation species are of natural grass fields with local species.
244 Based on the number of species encountered (15 species), it can be said that the natural pasture of Gowa District is quite
245 good (Rinduwati et al., 2016). In Sota Village pasture there found 33 vegetation species consisting of 61% grass, 3%
246 legume and other plants 36% (Praptiwi et al., 2017); 22 forage species (Abdullah et al., 2017), 40 forage species consisting
247 of 82 – 87% forage grass, 1% legume and forage consumable by livestock, and 12 - 17% those inedible by livestock (Yoku
248 et al., 2015). The composition of feed forage in Tobelo Subdistrict pasture is 58.33% grass, 25% legume, and 16.67%
249 other forage (Matulesy and Kastanja, 2013; Eoh, 2014). The species diversity at different heights is influenced by the
250 season where the wet season increases the availability of water needed by plants for growth, especially the grass species
251 (Kumalasari and Sunardi, 2015).

252
253 **Analysis of Forage Vegetation**

254 The analysis results of the vegetation of Pulau Layang Village during the wet season having the highest relative
255 density, relative frequency, and Important Value Index (IVI) were Kemon air (*N. olerancia*) having 0.56 density, 17.5%
256 relative density, 0.32 frequency, 19.512% relative frequency, and 37.01% Important Value Index, followed by 32.72% Are
257 bolong (*P. barbatum L*) and 27.19% Eceng gondok (*E. crassipes*), while the lowest value was Telepuk padi (*N. adorata*
258 Aiton) and Telepuk gajah (*N. lotus*) which was 1.84% each. The highest relative density, relative frequency and
259 importance value index in the dry season were Kemon air (*N. olerancia*) which was 39.04%, followed by Are bolong (*P.*
260 *barbatum L*) 30.61% and Kumpai merah (*Hymenachne sp.*) 20.05%, while the lowest value was Kumpai padi (*O.*
261 *rufifogon*) which was 13.71% (Table 2). Those results also showed that in Pulau Layang Village there was a difference in
262 the amount of vegetation between the wet and dry seasons. In the wet season there were 14 forage vegetation species and
263 in the dry season there were only 10 forage vegetation species. Meanwhile, Apit-apit (*C. chephalotes Vahl*) and Kerak
264 maling (*D. fuscescens*) were not found in the wet season. Likewise, in the dry season, Purun tikus (*E. dulcis*), Kumpai padi
265 (*O. rufifogon*), Tapak darah (*C. roseus L. Don*), Kangkung merah (*I. aquatica Forsk*), and Telepuk padi (*N. adorata*
266 Aiton) were not found. The results show that there were some vegetation species tolerant of water and some others were
267 not. In other words, those tolerant of water would survive and those which were not would die.

268 The Important Value Index (IVI) differences of the swamp lowland forage vegetation might have resulted from the
269 competition of each species of vegetation to obtain nutrients in the soil and sunlight, as well as the influencing factors of
270 the wet and dry seasons. This is in accordance with the results of Parmadi JC et al. (2016) reporting that the IVI
271 differences of each vegetation species were due to the their competition to obtain nutrients and sunlight. In addition to
272 nutrients and sun, there are other influencing factors of vegetation density and tides. Variations of the species and amount
273 of vegetation indicate that even though one research location has the same age, yet the environmental conditions result in
274 different vegetation (Syarifuddin, 2011). The vegetation species having the highest IVI were Kemon air and Are bolong
275 (37.01 and 32.73%). This shows that the vegetation species of Kemon air and Are bolong are the most dominant ones
276 among other vegetation species. A vegetation species is said to be dominant in an area if it has a percentage of more than
277 20% of the total individuals and co-dominant if the percentage ranges from 10% to 20% (Suveltri et al., 2014).

278 The analysis results of the vegetation of Rambutan Village during the wet season having the highest relative density,
279 relative frequency, and Important Value Index were Purun tikus (*E. dulcis*) 71.06%, Kerak maling (*D. fuscescens*) 42.34%,
280 and Kumpai padi (*O. rupifogon*) 36.19%. The lowest value ones were Kumpai tembaga (*H. acutigluma*) and Kumpai
281 minyak (*H. amplexicaulis*) 1.81% each. The highest relative density, relative frequency, and important value index in the
282 dry season were Purun tikus (*E. dulcis*) 89.71%, Kumpai padi (*O. rupifogon*) 54.08%, and Kerak maling (*D. fuscescens*)
283 17.71%. The lowest value was Kumpai tembaga (*H. acutigluma*) 2.33% (Table 3). The highest density of swamp forage
284 vegetation might have resulted from its adaptation and development ability in accordance with the environment. This is in
285 accordance with the study result conducted by Oktaviani et al. (2015) that the plant vegetation had the highest density
286 because this vegetation matched the environment to grow and reproduce under the conditions of land whose soil and water
287 contained low pH. As for the plants having the lowest density, it might have been due to the unsuitable environmental and
288 land factors for the plants to grow and breed, particularly the pH of the water and the soil was low in acid (Samin et al.,
289 2016). The results also show that in Rambutan Village there was a difference in the amount of vegetation between the wet
290 and dry seasons. In wet season there were 9 species of forage vegetation, while in the dry season there were only 8 species
291 of forage vegetation. In the dry season there was no legume Mutiara (*S. exasperate*). This shows that the legume
292 Mutiara (*S. exasperate*) could not bear the drought and as a result it would die in the dry season.

293 Forage Production

294 The high production of vegetation for swamp lowland in Pampang Subdistrict compared to that in Rambutan
295 Subdistrict might have resulted from the soil fertility of the pasture area of Pampang Subdistrict which was more fertile
296 than that of Rambutan Subdistrict. The analysis results showed that the C-Organic, N-total and P-available analysis (Bray
297 I) were higher than those in the Rambutan District. The high fertility of the land was thought that the most pasture of Pulau
298 Layang Village was the rice fields and always given fertilizer. Unlike the pasture of Pampang Subdistrict, the pasture of
299 Rambutan Village was only used for the grazing buffaloes without any use of fertilizer. The provision of manure and
300 bioslurry fertilizer can increase the production and forage quality of 4.75 tons and 4.36 tons respectively. (Suarna dan
301 Budiasa 2016; Jeffery et al., 2018).

302 The results of the research in the pasture area of Pampang Subdistrict, Ogan Komering Ilir was 6.90 tons ha⁻¹.year⁻¹
303 which was lower than that of Kleden et al. (2015) reporting that the production of natural grass in coffee and grassland
304 areas of Wulanggintang Subdistrict, East Flores District was 7.664 tons.ha⁻¹.year⁻¹ and 6.98 tons.ha⁻¹.year⁻¹ respectively.
305 This result was higher than that of Se'u et al. (2015) reporting that the grass production in real conditions in South Central
306 Timor District was only 0.15-0.39 tons.ha⁻¹.year⁻¹.

307 The production of fresh forage swamp lowland pastures of Pulau Layang Village in the wet season was 6.899 kg.ha⁻¹.year⁻¹
308 and the production of the dry matter was 1,268.51 kg.ha⁻¹.year⁻¹, while in the dry season the fresh production was
309 4,863 kg.ha⁻¹.year⁻¹ and the dry matter production was 986.60 kg.ha⁻¹.year⁻¹ (Table 4). This result was higher than those
310 conducted by (Rinduwati et al., 2016; Omokanye et al., 2018; Se'u et al., 2015) stating that the average fresh production of
311 pasture of Gowa District in the wet season was 5,350 kg.ha⁻¹. year⁻¹ and in the dry season was 1,390 kg.ha⁻¹.year⁻¹. But
312 those results were lower than the study of Abdullah et al., (2017) who reported that forage production was 8,029.1 kg.ha⁻¹.year⁻¹
313 in the wet season and 5,422.9 kg.ha⁻¹. year⁻¹ in the dry season. The pasture forage production of Sabana Timur
314 Barat on the average ranged from 0.61 to 4.33 tons.ha⁻¹.year⁻¹. The lowest production occurred at the peak of the dry
315 season in October and the highest in April (Manu, 2013; Damry, 2009). The forage production of *Pennisetum*
316 *purpuphoides* was 70.4 ton.ha⁻¹, *Setaria sphasielata* 44.8 tons.ha⁻¹, *Brachiaria sp* 44.7 tons.ha⁻¹, *Pennisetum purpureum*
317 44.6 tons.ha⁻¹, and *Panicum maximum* 15.6 tons.ha⁻¹ (Jarmani and Haryanto, 2015). The different amounts of production
318 might have resulted from the differences in vegetation species, types of pasture, and methods used. There are various
319 methods for estimating forage production, but many are inaccurate when used with certain animal feed plant species.
320 Therefore, it is very important to find out the use and limited techniques of measuring forage production (Edvan et al.,
321 2016; Badgery et al., 2017).

322 There were 5 swamp lowland forage species having high fresh production in the wet season in Pulau Layang Village,
323 namely Kumpai padi (*O. rupifogon*) 12,960 kg.ha⁻¹.year⁻¹, followed by Purun tikus (*E. dulcis*), Telepuk gajah (*N. lotus*),
324 Are bolong (*P. barbatum* L) and Telepuk padi (*N. adorata* Aiton), and the lowest one was Kemon air (*N. olerancia*) 1,910
325 kg.ha⁻¹.year⁻¹. In the dry season the highest fresh production was Kumpai tembaga (*H. acutigluma*) as many as 7,480
326 kg.ha⁻¹.year⁻¹, followed by Kumpai minyak (*H. amplexicaulis*), Kumpai merah (*Hymenachne sp.*), Are bolong (*P.*
327 *barbatum* L) and Bento rayap (*L. hexandra*), and the lowest one was Kemon air (*N. olerancia*) of only 2.870 kg.ha⁻¹.year⁻¹.
328 The highest dry matter production in the wet season was Purun tikus (*E. dulcis*) as many as 2,664.5 kg.ha⁻¹.year⁻¹, followed
329 by Kumpai padi (*O. rupifogon*), Telepuk gajah (*N. lotus*), Are bolong (*P. barbatum* L), and Kumpai tembaga (*H.*
330 *acutigluma*), and the lowest one was Cecengkehan (*L. hyssopifolia*). In the dry season the highest dry matter production
331 was Kumpai tembaga (*H. acutigluma*) as many as 7.480 kg.ha⁻¹.year⁻¹, followed by Bento rayap (*L. hexandra*), Are bolong
332 (*P. barbatum* L), Apit-apit (*C. chephalotes* Vahl) and Kumpai merah (*Hymenachne sp.*), and the lowest one was Kerak
333 maling (*D. fuscescens*) as many as 2,420 kg.ha⁻¹.year⁻¹ (Table 4).

334 The fresh production of swamp lowland pasture of Rambutan Village during the wet season was 3,676.67 kg.ha⁻¹.year⁻¹
335 and the dry matter production was 905.52 kg.ha⁻¹.year⁻¹, whereas in the dry season the fresh production was 2,523.75
336 kg.ha⁻¹.year⁻¹ and the dry matter production was 705.66 kg.ha⁻¹.year⁻¹ (Table 5). This results were higher than those of the
337

study conducted by (Purwantari et al. 2015; Praptiwi et al., 2017) reporting that the average availability of the forage on palm oil plantations on pasture areas was 1,455.5 kg.ha⁻¹. year⁻¹, but it was lower than those of the study conducted by Rinduwati et al., (2016) stating that the production of pasture fresh forage in Gowa District during the wet season was on the average 5,350 kg.ha⁻¹. year⁻¹, but it was lower than that in the dry season of only 1,390 kg.ha⁻¹.year⁻¹. The forage production of preproduction rubber plantation was 732.90 kg.ha⁻¹.year⁻¹ and at the time of production it was only 317.83 kg. ha⁻¹.year⁻¹ (Pramana et al., 2015).

There were 5 species of swamp lowland forage having the highest fresh and dry matter production during the wet season, namely Kumpai tembaga (*H. acutigluma*) producing 8,540 kg.ha⁻¹.year⁻¹ and 3,139.3 kg. ha⁻¹.year⁻¹ each, followed by Kumpai padi (*O. rupifogon*), Bento rayap (*L. hexandra*), Purun tikus (*E. dulcis*), and Kumpai minyak (*H. amplexicaulis*), and the lowest one was Kerak maling (*D. fuscescens*) of 790 kg.ha⁻¹. year⁻¹ and 108.0 kg.ha⁻¹.year⁻¹. In the dry season, the highest fresh and dry matter production was Kumpai tembaga (*H. acutigluma*) of 5,900 kg.ha⁻¹.year⁻¹ and 2,181.82 kg.ha⁻¹.year⁻¹, followed by Kumpai padi (*O. rupifogon*), Bento rayap (*L. hexandra*), Kumpai minyak (*H. amplexicaulis*), and Purun tikus (*E. dulcis*), and the lowest one was Kasuran (*C. digitatus*) of 240 kg.ha⁻¹.year⁻¹ and 11.92 kg.ha⁻¹.year⁻¹ respectively (Table 5). The results of this study were still higher than those conducted by Rostini et al. (2014) stating that the highest grass production of *Hymenachne amplexicaulis* Haes was 1,032 kg DM.ha⁻¹.harvest⁻¹ in the high tide season and 518.3 kg DM.ha⁻¹.harvest⁻¹ in the low tide season, where the dry matter production ranged from 43.8 to 1.032 kg DM.ha⁻¹.harvest⁻¹ in the high tide season and from 38.5 to 752.8kg DM.ha⁻¹.year⁻¹.harvest⁻¹ in the low tide season.

Pasture Carrying Capacity

The carrying capacity is an analysis of the ability of pasture areas or grass farming to accommodate a number of livestock so that the need for grass for one-year-animal feed is sufficient. Calculating forage carrying capacity of swamp lowland forage is based on the amount of forage supplied on a pasture for livestock needs for one year which is stated in Animal Unit (AU) per hectare. According to Purnomo (2006), the calculation of carrying capacity is based on the formula of:

$$\text{Carrying Capacity} = \frac{\text{Cumulative Production} \times \text{proper use factor (\%)}}{\text{Animal Need (kg DM/AU/day)} \times 360 \text{ days}}$$

The carrying capacity for Pampangan buffaloes on the swamp lowland pasture of Pulau Layang Village in the wet season was 3.66 AU.ha⁻¹.year⁻¹ and 2.85 AU.ha⁻¹.year⁻¹ during the dry season (Table 4). The results of this study corresponded to those of the study conducted by Rostini et al. (2014) stated that the carrying capacity of swamp lowland plants in South Kalimantan was 2.91 AU. ha⁻¹.year⁻¹. These results were higher than those of the study conducted by Seu et al., (2015) reporting that the carrying capacity of grass in real conditions in South Central Timor District was only 0.24 - 0.63 AU.ha⁻¹.year⁻¹, and average carrying capacity of natural pastures of Gowa District was 0.88 AU.ha⁻¹.year⁻¹ (Rinduwati et al., 2016) and the capacity of pasture in Poso District 0.63 AU.ha⁻¹.year⁻¹ (Damry, 2009; Daru et al., 2014). The carrying capacity of pasture of Sota Village, Merauke District, was still relatively small (Praptiwi et al., 2017). The carrying capacity of pasture in Kelei and Didiri Villages of Poso Districts was 0.96 and 1.12 AU.ha⁻¹.year⁻¹ (Karti et al., 2015). The pasture performance of the *Brachuararia humidicola* (Rendle) was 2.31 AU.ha⁻¹.year⁻¹ (Anis et al., 2014). Abdullah et al., (2017) reported that the carrying capacities of forage in the wet and dry seasons in Pakistan were 24 AU. ha⁻¹.year⁻¹ and 16 AU.ha⁻¹.year⁻¹. The high carrying capacity is related to the high forage production, management of forage development and selection of good species. The management and strategy carried out to increase forage production require stockbreeder-farmer innovative training facilitated to have knowledge of breeding and it should be supported by the government and private companies to make a program about the importance of forage to increase ruminant livestock production (Nigus, 2017 ; Omokanye et al., 2018). In the pasture condition having one species of swamp forage, the highest carrying capacity in the wet season was Purun tikus (*E. dulcis*) as much as 7.69 AU.ha⁻¹.year⁻¹, and then followed by Kumpai padi (*O. rupifogon*) 6.42 AU.ha⁻¹.year⁻¹, Telepuk gajah (*N. lotus*) 5.72 AU.ha⁻¹.year⁻¹, Are bolong (*P. barbatum* L) 4.77 AU.ha⁻¹.year⁻¹ and Kumpai tembaga (*H. acutigluma*) 3.90 AU.ha⁻¹.year⁻¹ consecutively, and the lowest one was Cecengkehan (*L. hyssopifolia*) 1.00 AU.ha⁻¹.year⁻¹. In the dry season the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) as much as 4.71 AU.ha⁻¹.year⁻¹, and then it was followed by Bento rayap (*L. hexandra*) as much as 4.00 AU.ha⁻¹.year⁻¹, Are bolong (*P. barbatum* L) 3.59 AU.ha⁻¹.year⁻¹, Apit-apit (*C. chephalotes* Vahl) 3.30 AU.ha⁻¹.year⁻¹ and Kumpai merah (*Hymenachne sp.*) 2.82 ha⁻¹.year⁻¹, whereas the lowest one was Kerak maling (*D. fuscescens*) as much as 1.55 AU.ha⁻¹.year⁻¹ (Table 4).

The carrying capacity of Pampangan buffalo pasture of the swamp lowland of Rambutan Village during the wet season was 2.61 AU.ha⁻¹.year⁻¹ and in the dry season it was 2.04 AU.ha⁻¹.year⁻¹ (Table 5). This result was lower than those of the study conducted by Muhajirin et al. (2017) stating that the carrying capacity of Padang Mengatas BPTU was 5 AU.ha⁻¹.year⁻¹ in the wet season and 3.18 AU.ha⁻¹.year⁻¹ in the dry season. There was a decrease in the dry material production during the dry season because the water condition in swamp lowland alleviated. The decreased swamp water condition resulted in a decrease of photosynthesis and automatically the production of the dry matter decreased. Water is the main ingredient needed in photosynthesis. The disruption of metabolic processes in plants will affect plant production. Plant dry

398 weight depicts the accumulation of organic compounds that are successfully synthesized by the plants from inorganic
399 compounds, especially water and CO₂ (Lakitan, 1995). Water shortages will have a negative effect on plant growth
400 resulting in decreased production (Jun-Feng et al., 2010; Taiz and Zeiger 2002).

401 When the pasture condition had one species of swamp forage, the highest carrying capacity in the wet season
402 consecutively included Kumpai tembaga (*H. acutigluma*) of 9.06 AU.ha⁻¹.year⁻¹, Kumpai padi (*O. rupifogon*) 4.22 AU.ha⁻¹.year⁻¹,
403 Bento rayap (*L. hexandra*) 3.29 AU.ha⁻¹.year⁻¹, Purun tikus (*E. dulcis*) 2.66 AU. ha⁻¹.year⁻¹, and Kumpai minyak
404 (*H. amplexicaulis*) 1.67 AU.ha⁻¹.year⁻¹. While the lowest one was Kerak maling (*D. fuscescens*) as much as 0.31 AU.ha⁻¹.year⁻¹.
405 During the dry season the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) as much as 6.29 AU.ha⁻¹.year⁻¹,
406 and then followed by Kumpai padi (*O. rupifogon*) as much as 4.10 AU.ha⁻¹.year⁻¹, Bento rayap (*L. hexandra*) 2.65
407 AU.ha⁻¹.year⁻¹, Kumpai minyak (*H. amplexicaulis*) 1.41 AU.ha⁻¹.year⁻¹, and Purun tikus (*E. dulcis*) 1.09 AU.ha⁻¹.year⁻¹.
408 While the lowest one was Kasuran (*C. digitatus*) as much as 0.08 AU.ha⁻¹.year⁻¹ (Table 5). These results indicate that the
409 carrying capacity is very influential with the type of feed plan. In addition the most important thing is also cattle grazing
410 system. Livestock grazing must be regulated to avoid over-grazing. The amount of grazing livestock depends on the
411 carrying capacity of the pasture (Salendu and Elly, 2014; Cheng et al., 2017; Hashemi, 2017).

412 The results of this study indicated that the forage availability was still sufficient to meet feed requirements for
413 Pampangan buffaloes. The population of Pampangan buffaloes of Pulau Layang Village was 487 buffaloes with a grazing
414 area of 500 ha with an average carrying capacity of 3.14 AU. ha⁻¹.year⁻¹. While the number of Pampangan buffaloes of
415 Rambutan Village was 1.735 buffaloes with a pasture area of 1,203 ha and an average carrying capacity of 2.45 AU.ha⁻¹.year⁻¹.
416 It is projected that there is still a need for additional buffalo cattle as much as 0.31 AU.ha⁻¹.year⁻¹ in Pulau Layang
417 Village and 0.59 AU.ha⁻¹.year⁻¹ in Rambutan Village.

418 Based on the results of the study, the following is the conclusion:

- 419 1. There were 19 species of swamp lowland forage vegetation found to have the potential to feed the Pampangan buffaloes
420 in South Sumatra.
- 421 2. Important Value Index (IVI) is strongly influenced by grazing locations and seasons. The high IVI were Kemon air (*N.*
422 *olerancia*) and Are bolong (*P. barbatum* L) in Pulau Layang Village. In Rambutan Village, the high IVI were Purun
423 tikus (*E. dulcis*), Kerak maling (*D. fuscescens*), and Kumpai padi (*O. rupifogon*).
- 424 3. In Pulau Layang Village, the fresh forage and dry matter production of forage vegetation swamp lowland pasture in the
425 wet season were 6.90 and 1.27 tons.ha⁻¹.year⁻¹, while in Rambutan Village they were 3.68 tons.ha⁻¹.year⁻¹ and 0.91
426 ton.ha⁻¹.year⁻¹ dry consecutively. The fresh forage production and dry matter production in the dry season in Pulau
427 Layang Village were 4.86 and 0.99 tons.ha⁻¹.year⁻¹, while in Rambutan Village they were 2.52 tons.ha⁻¹.year⁻¹ and 0.71
428 tons.ha⁻¹.year⁻¹ consecutively.
- 429 4. The carrying capacity of swamp lowland pasture in the wet season in Pulau Layang Village was 3.66 AU.ha⁻¹.year⁻¹
430 and in the dry season it was 2.85 AU.ha⁻¹.year⁻¹. In Rambutan Village in the wet season it was 2.61 AU.ha⁻¹.year⁻¹ and
431 in the dry season it was 2.04 AU.ha⁻¹.year⁻¹. Therefore, on the average the carrying capacity of the swamp lowland
432 pasture in South Sumatra was 2.79 AU.ha⁻¹.year⁻¹.
- 433 5. The forage availability is still sufficient to meet the need for animal feed, and it is projected that there is still a need for
434 additional buffalo cattle for 0.31 AU.ha⁻¹.year⁻¹ in Pulau Layang Village and 0.59 AU.ha⁻¹.year⁻¹ in Rambutan Village.
- 435 6. The highest forage production in the wet season in Pulau Layang Village was Purun tikus, followed by, Kumpai padi,
436 Telepuk gajah, Are bolong, Kumpai tembaga, while in the dry season the highest one was Kumpai tembaga, followed
437 by Bento rayap, Are bolong, Apit-apit and Kumpai merah. In Rambutan Village the highest forage production in the
438 wet and dry seasons were Kumpai tembaga, Kumpai padi, Bento rayap, Kumpai minyak, and Purun tikus.

439 ACKNOWLEDGEMENTS

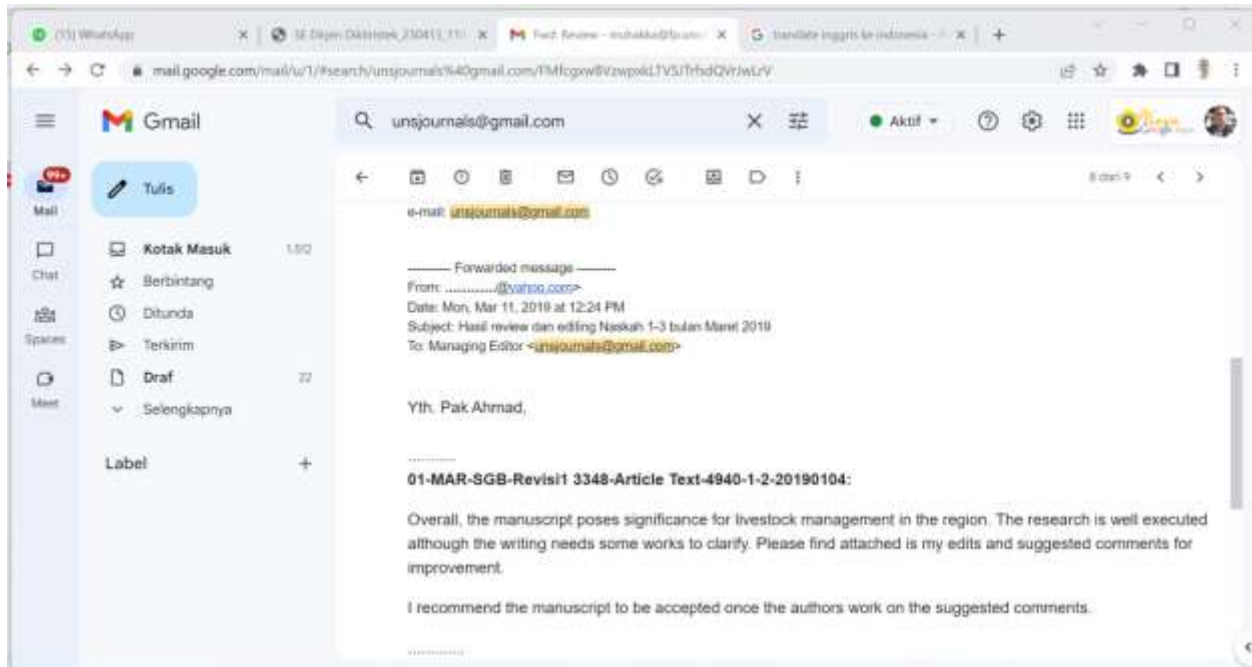
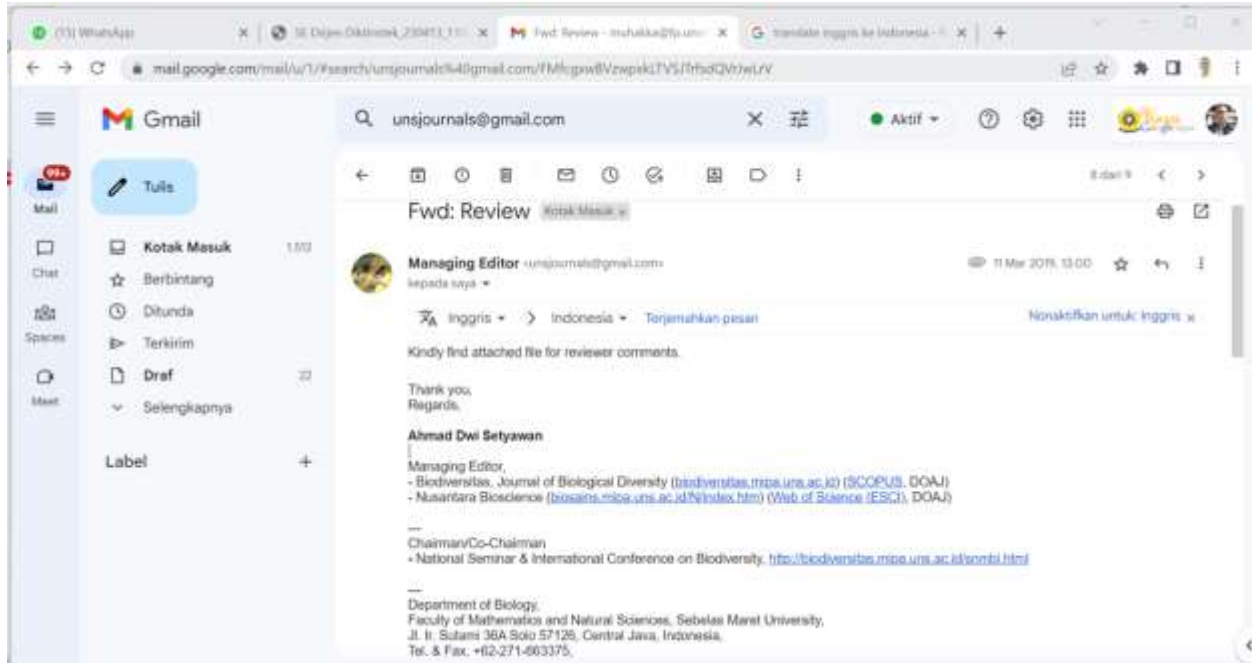
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**3. Bukti Konfirmasi Submit Revisi Pertama,
Respon kepada Reviewer, dan Artikel
yang Diresubmit (11 Maret 2019)**



Analysis of the Vegetation analysis Structure of non-tidal swampland in South Sumatra, Indonesia and its cCarrying cCapacity of Nontidal Swamplandfor Pampangan buffalo pPasture- to Pampangan Buffalo in South Sumatra, Indonesia

Abstract. ~~This study aimed to analyze the vegetation structure of non-tidal swampland in Pulau Layang village, Ogan Komering Ilir District and Rambutan village, Banyuasin District, South Sumatera and to examine its carrying capacity of for Pampangan buffalo in the swampland pasture. The methods used of collecting were by the combination of direct observation, survey using plot sampling with total 50 observation plots, and data used measurements to determine and direct observation in the field covering identification of forage species and production. The measurement of forage production used using Halls methods of Halls. There were totally 50 observation points on the swampland. The forage in the quadrant was cut and weighed. The results of the study show that found there 19 forage species were in two studied areas which are of forage swamp potential as Pampangan buffalo feed. Species with the highest important V-value index of were Purun tikus (*E. dulcis*) was with 89.71% and Kumpai padi (*O. rufipogon*) with 54.08%. The production of fresh forage and dry matter in the wet season in Pulau Layang was 6.90 tons·ha⁻¹·year⁻¹ and 1.27 tons·ha⁻¹·year⁻¹ consecutively, respectively, whereas in Rambutan Village they were 3.68 tons·ha⁻¹·year⁻¹ and 0.91 tons·ha⁻¹·year⁻¹, respectively. The production of fresh forage and dry matter in the dry season in Pulau Layang was 4.86 tons·ha⁻¹·year⁻¹ and 0.99 tons·ha⁻¹·year⁻¹, respectively consecutively, while in Rambutan they were 2.52 tons·ha⁻¹·year⁻¹ and 0.71 tons·ha⁻¹·year⁻¹, respectively. The pasture carrying capacity of swampland of in Pulau Layang village in the wet season was 3.66 AU (Animal Unit)·ha⁻¹·year⁻¹ and in the dry season it was 2.85 AU·ha⁻¹·year⁻¹, while in Rambutan village it was 2.61 AU·ha⁻¹·year⁻¹ and 2.04 AU·ha⁻¹·year⁻¹, respectively. There were six species of forage with high production, namely Kumpai tembaga, Kumpai padi, Kumpai minyak, Are bolong, Bento rayap and Purun tikus, [...]~~

Key words: Pampangan buffalo, ~~Analysis of~~ vegetation analysis, cCarrying capacity, pPasture, nNon-tidal sSwampland and

INTRODUCTION

Non-tidal swampland is often considered as a suboptimal land despite its and the availability is very extensive in Indonesia. The total extent of non-tidal swampland is about 13.27 million ha, consisting of 3.0 million ha of deep swampland, 6.07 million ha of swampland with medium deep and 4.2 million ha of shallow swampland, and is distributed in Sumatra, Kalimantan and Papua. Nonetheless, there is, and only 4 million ha of them have been developed with. The public and the private sector managed 2.6 million ha and while 1.3 million ha are developed by government assistance (Indonesian Statistic Center Bureau Agency, 2010; Mulyani and Sarwani, 2013). At provincial level, it consists of 3.0 million ha of deep swampland, 6.07 million ha of middle swampland and 4.2 million ha of shallow swampland scattered in Sumatra, Kalimantan and Papua islands. Non-tidal swampland in South Sumatra covers the most extensive highest area in Sumatra, reaching 2.98 million ha but, with only 298,189 ha that has been developed (Statistics Agency Center Bureau of South Sumatra, 2014).

Pampangan buffaloes are the ones of the potential germplasm of South Sumatra Province which is widely found and extensively farmed in Pulau Layang Village, of Ogan Komering Ilir District and Rambutan Village, of Banyuasin District which are generally extensively maintained (Muhakka et al., 2013). In addition to being taken farmed for their meat, the buffalo they also produce milk to be processed into traditional food (named Gulo Puan). The buffalo population in South Sumatra in 2014 was 33,369 buffaloes, and the number decreasing 4.29% than compared to that in 2012 to be with 34,865 buffaloes (4.29%) (Statistics of South Sumatra Animal Husbandry, 2014). There are three factors causing the decline in the buffalo livestock population, namely: (1) the fluctuated availability of fluctuating natural forage amount, (2) low the quality of nutritional forage of lowland swamp lowland was low swamp, and (3) decreasing extent of the grazing pasture

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Commented [A4]: Please mention the Latin names instead of local name as local name might be different across place.

Commented [A5]: Please add one or two sentences as concluding remarks stating the implication of the results of this study on livestock management in the region.

50 ~~land decreased~~ (BPTP South Sumatra, 2011). The low productivity of ~~the buffaloes~~ ~~in term of~~ (growth and milk production
51 ~~is) resulted from~~ ~~caused by~~ the consumed rations ~~which~~ could not meet the needs ~~for of~~ food substances ~~which~~ ~~;- this was~~
52 characterized by low protein content, ~~and~~ high crude fiber, and low digestibility. However, the buffaloes have several
53 advantages and their ~~roles~~ ~~productivity~~ can be enhanced especially through food and genetic improvement (Talib et al.,
54 2014). The buffaloes have ~~their own~~ advantages compared to cows ~~in which~~ ~~-F~~ they can survive particularly ~~if~~ ~~when the~~
55 ~~existing available~~ feed has low quality (Diwyanto and Handiwirawan 2006; Yasin, 2013).

56 One strategy that can be done to maintain and improve ~~the ability of~~ the level of productivity of ~~p~~Pampangan buffaloes
57 is by ~~conducting a~~ ~~studying~~ ~~their of~~ forage ~~vegetation~~ in lowland swamp ~~by analyzing the~~ ~~lowland~~ ~~through analysis of~~
58 vegetation and carrying capacity of pasture. ~~The s~~ ~~studies~~ ~~on~~ vegetation analysis and pasture carrying capacity ~~at the~~
59 ~~present time up to date~~ ~~are is only~~ limited to ~~the~~ dry land ~~areas~~, such as in Wulan Gitrang Sub-district, East Flores ~~which~~
60 ~~show~~, whose carrying capacity ~~are of~~ 0.42 AU.ha⁻¹.year⁻¹ on coffee plantation ~~area~~ and 0.38 AU.ha⁻¹.year⁻¹ on grassland ~~area~~
61 (Kleden et al., 2015). ~~Another study investigating~~ The carrying capacity of livestock ~~storage forage under~~ ~~during~~ the auspices
62 ~~of~~ preproduction of rubber ~~plants~~ ~~(juvenile plants)~~ is 0.14 AU. ha⁻¹.year⁻¹, while ~~during~~ rubber production (~~mature plants~~)
63 ~~plants~~ can only accommodate 0.06 AU. ha⁻¹.year⁻¹ (Pramana et al., 2015).

64 ~~This study aims to analyze vegetation structure of non-tidal swampland in South Sumatera and examine its carrying~~
65 ~~capacity for Pampangan buffalo pasture~~ ~~This study aimed to analyze swamp forage vegetation and the carrying capacity of~~
66 ~~Pampangan buffalo pasture in the swampland of South Sumatera.~~

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67 MATERIALS AND METHODS

68 This research was carried out in Pulau Layang ~~v~~Village, ~~of~~ Pampangan Sub-district, ~~of~~ Ogan Komering Ilir District
69 and Rambutan ~~v~~Village, ~~of~~ Rambutan Sub-district, ~~of~~ Banyuasin District, ~~of~~ South Sumatra from April to September 2017.
70 The methods used ~~were the combination of~~ a survey, ~~method and~~ measurements, and direct observations ~~on samples of~~ ~~on~~
71 swamp ~~lowland~~ ~~which was commonly used as pasture by farmers taken as samples~~. The ~~d~~Data of livestock population
72 ~~were~~ collected from related agencies and institutions.

73 ~~Field~~ The data were collected using ~~direct observations and~~ measurements ~~and direct observations in the field~~ including
74 forage vegetation species, ~~the~~ amount of production, forage quality (natural grasses and legumes), and soil fertility. ~~Purposive~~
75 ~~sampling was~~ ~~The method used~~ ~~conducted by making a~~ quadratic method with the placement of plots ~~by using purposive~~
76 ~~sampling with a plot size of 1x1m~~ ~~each plot~~ and ~~with the number total number~~ of plots was ~~of~~ 50 plots in swamp lowland
77 (Kleden et al., 2015). ~~Then~~, ~~In~~ each observation plot, ~~the name and individual number of forage~~ ~~recorded the species of~~
78 ~~forage vegetation, the number of individuals of each species were recorded~~. The plant specimens ~~were~~, and collected ~~all~~
79 ~~species of forage vegetation~~. The collection ~~was and~~ labeled ~~with hanging and~~ each species of forage vegetation was
80 photographed ~~with a~~ digital camera. The ~~revoked~~ ~~vegetation~~ ~~collected specimens~~ from each plot ~~were~~ separated according
81 to each species and dried to calculate the dominant value. The unknown species ~~of vegetation~~ was collected ~~for herbaria~~,
82 ~~being given treated with~~ 70% alcohol, oven ~~baked~~ ~~dried~~, and identified.

Commented [A6]: In addition to the map of research location, please add photograph(s) showing the landscape to give insight to readers non-tidal swamp looks like.

Commented [A7]: Please be consistent in using terminology if you refer to the same thing.

Commented [A8]: Please clarify what do you means with dominant value?

Commented [A9]: Please describe how you identify the plant. For example: either employing a botanist or sending the specimen to competent institutions (e.g. LIPI), or simply using reference book.

84 The variables ~~to be analyzed~~ ~~measured and observed~~ in this study ~~are~~ as follows:

85 Vegetation Analysis

86 The collected data were analyzed quantitatively (Utami et al., 2007) as follows:

87 a. Density

88 Density is the number of individuals of a species ~~per area extent and of certain location~~ formulated as follows:

$$89 \text{Density} = \frac{\text{The species nNumber of individual of a species}}{\text{The Total area extent of the sample plots}}$$

90 b. Relative Density

91 Relative density is ~~a percentage of density of a species toward density of all spe~~ ~~the density of a species~~ ~~as a percent of~~
92 ~~total plant density which is and~~ formulated as follows:

$$93 \text{Relative Density} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100\%$$

94 c. Frequency

95 Frequency is ~~the comparison of~~ the number of sample plots having a species ~~in a and given total~~ the number of sample
96 plots ~~which were made, and~~ formulated as follows:

$$97 \text{Frequency} = \frac{\text{The nNumber of plots having a species}}{\text{The nNumber of all observed plots}}$$

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d. Relative Frequency

Relative Frequency is ~~a the~~ frequency of a species as a percentage of a species toward the number of total frequency of all species ~~and~~ formulated as follows:

$$\text{Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100\%$$

e. Important Value Index (IVI)

This value indicates the dominance of a species in a particular area ~~and~~ formulated as follows:

$$\text{IVI} = \text{Relative Density} + \text{Relative Frequency}$$

Forage Production

~~The m~~Measurement of forage production adopted the *Halls* method (~~m~~Kleden et al., 2015) ~~which usinged~~ a 1m x 1m quadratic frame ~~by sampling construction~~ (Sutaryo, 2009). A total of 50 observation points were ~~conducted done~~ in a grazing area ~~ofen~~ swamp lowland ~~often that frequently~~ used by farmers/ranchers. ~~The squared frame for each observation point was randomly placed~~ ~~The placement of squared frame for each observation point was based on random numbers~~. The average forage production was calculated using the following formula:

$$X = \frac{\sum xi}{n}$$

Where: X = The existing average of forage biomass production
 $\sum xi$ = The amount of forage biomass production at each observation
n = The amount of observation



Figure 1. Research location : Pulau Layang Village, Pampangan sub-district, Ogan Komereng Ilir District

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Commented [A11]: Please create single Figure showing the map of Sumatra island and maps of research location (i.e. merge Figure 1 and Figure 2 into one map) and put in earlier part of the Method when you describing study location.



Figure 2. Research location : Rambutan Village, Rambutan sub-district , Banyuasin District

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Pasture Carrying Capacity

The carrying capacity is an analysis of the ability of pasture areas or grass farming to accommodate a number of livestock so that the need for grass for one-year-animal feed is sufficient. Calculating forage carrying capacity of swamp lowland forage is based on the amount of forage supplied on a pasture for livestock needs for one year which is stated in Animal Unit (AU) per hectare. The amount of carrying capacity was found out by estimating the consumption of dry matter/Animal Unit (AU). The carrying capacity was calculated for each species of forage. The calculation adopted the Purnomo's formula developed by Purnomo (2006).

$$\text{Carrying Capacity} = \frac{\text{Cumulative Production} \times \text{proper use factor (\%)}}{\text{Animal needs (kg DM/AU/day)} \times 360 \text{ days}}$$

$$\text{Cumulative Forage Production} = \left[\left(\frac{hk}{ik} \times pk \right) + \left(\frac{hp}{ip} \times pp \right) + \left(\frac{hh}{ih} \times ph \right) \right]$$

Where:

- hk : Number of days in the dry season (90 days)
- hp : Number of days in the transition season (120 days)
- hh : Number of days in the wet season (150 days)
- ik : Cutting intervals in the dry season (50 days)
- ip : Cutting intervals in the transition season (30 days)
- ih : Cutting intervals in the wet season (40 days)
- pk : Biomass production in the dry season
- pp : Biomass production in the transition season
- ph : Biomass production in the wet season
- puf: Proper Use Factor 68%.
- kt : Animal Need 6,25 kg Dry Matter AU⁻¹day⁻¹

Data Analysis

The data of the carrying capacity of pasture were obtained from the total needs of livestock by referring to the total forage production. The carrying capacity data were analyzed by comparing forage production with to the number of livestock available which result into find out the a ratio that informs of the two illustrating the number of buffaloes that could be developed in the study area. Three possible ratios using the following formulations are: (a)- AU_p/AU_t < 1- means: if the

171 number of livestock being grazed in swamp lowlands is greater than the amount of feed available; (b) $AUp/AUt = 1$
 172 means: If there is a balance between the amount of forage available and the number of livestock being grazed; (c)
 173 $AUp/AUt > 1$ means: If the number of livestock being grazed is less than the amount of food available in the pasture. AU
 174 is animal unit equivalents with Remarks: AUp and AUt are animal units for feed and animal unit for livestock, successively,
 175 respectively (Kleden *et al.*, 2015).
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199 RESULTS AND DISCUSSION

200 Results

201 Species of Forage Vegetation Forage species

202 In the research areas, there were 19 forage species potential to be used as Pampangan buffalo feed, covering 17 grass
 203 species (*Gramineae*) and 2 legume species (*Leguminosae*) (Table 1). Forage vegetation of swamp lowland in Pampangan
 204 buffalo pasture had 19 forage species potential to be used as buffalo feed covering 17 grass species (*gramineae*) and 2
 205 legume species (*leguminosa*) (Table 1).

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206
 207 **Table 1.** Species of Forage species in the studied areas of Pampangan buffalo pasture in non-tidal vegetation of swampy lowland of
 208 Pampangan buffalo pasture
 209

Latin Name	Local Name	Village		Remarks
		P	R	
<i>Catharanthus roseus</i> (L.) Don	Tapak dara	+	-	NDP
<i>Cyperus cephalotes</i> Vahl	Apit-apit	+	-	NDP
<i>Cyperus digitatus</i>	Kasuran	-	+	NDP
<i>Digitaria fuscescens</i>	Pasiran / Kerak maling	+	+	DP
<i>Eichhornia crassipes</i>	Eceng gondok	+	-	NDP
<i>Eleocharis dulcis</i>	Purun tikus	+	+	DP
<i>Hymenachne acutigluma</i>	Kumpai tembaga	+	+	DP
<i>Hymenachne amplexicaulis</i>	Kumpai minyak	+	+	DP
<i>Hymenachne sp.</i>	Kumpai merah	+	-	NDP
<i>Ipomoea aquatica</i> Forsk.	Kangkung merah	+	-	NDP
<i>Leersia hexandra</i>	Bento rayap	+	+	DP
<i>Ludwigia hyssopifolia</i>	Cecengkehan	+	-	ND
<i>Neptunia oleracea</i>	Kemon air	+	-	NDP
<i>Nymphaea odorata</i> Aiton	Telepuk Padi	+	-	NDP
<i>Nymphaea lotus</i>	Telepuk Gajah	+	-	NDP
<i>Oryza rufipogon</i>	Kumpai padi	+	+	DP
<i>Polygonum barbatum</i> L.	Are bolong	+	-	DNP
<i>Rhynchospora corymbosa</i> L.	Berondong	-	+	ND

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210	<i>Sesbania exasperata</i>	Mutiara	-	+	NDP
211	Where: P	: Pulau Layang v Village	NDP	: Not Dominant, Palatable s	
212	R	: Rambutan v Village	ND	: Not Dominant, Not Palatable s	
213	DP	: Dominant, Palatable	+	: AvailablePresent	
214	DNP	: Dominant, Not Palatable	-	: UnavailableAbsent	

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215 **Analysis of Forage Vegetation**

216 The results of Analysis of forage-vegetation analysis of forage species of at Pampangan buffalo pastures in swamp

217 lowland of Pampangan buffalo pastures induring the wet and dry seasons in Pulau Layang ~~v~~Village of Pampangan Sudistrict

218 and Rambutan ~~v~~Village are presented in of Banyuasin Subdistrict (Tables 2 and 3, respectively).

220 **Table 2.** Density-Value, Relative Density, Frequency, Relative Frequency, and Important Value Index of Important Value of Swamp

221 Lowland Forage species-Vegetation of at Pampangan bBuffalo pPasture during the Wwet and dDry Sseasons in Pulau Layang ~~v~~Village.

Latin Name	Wet Season					Dry Season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Catharanthus roseus</i> (L.) Don	0,08	2,500	0,06	3,659	6,159	-	-	-	-	-
<i>Cyperus cephalotes</i> Vahl	-	-	-	-	-	0,16	8,421	0,12	9,524	17,945
<i>Digitaria fuscescens</i>	-	-	-	-	-	0,16	8,421	0,12	9,524	17,945
<i>Eichhornia crassipes</i>	0,48	15,000	0,20	12,195	27,195	0,18	9,474	0,08	6,349	15,823
<i>Eleocharis dulcis</i>	0,16	5,000	0,14	8,537	13,537	-	-	-	-	-
<i>Hymenachne acutigluma</i>	0,22	6,875	0,12	7,317	14,192	0,12	6,316	0,12	9,524	15,840
<i>Hymenachne amplexicaulis</i>	0,20	6,250	0,10	6,098	12,348	0,14	7,368	0,08	6,349	13,717
<i>Hymenachne sp.</i>	0,46	14,375	0,18	10,976	25,351	0,20	10,526	0,12	9,524	20,050
<i>Ipomoea aquatica</i> Forsk.	0,04	1,250	0,04	2,439	3,689	-	-	-	-	-
<i>Leersia hexandra</i>	0,06	1,875	0,04	2,439	4,314	0,12	6,316	0,10	7,936	14,252
<i>Ludwigia hyssopifolia</i>	0,18	5,625	0,06	3,659	9,284	0,16	8,421	0,08	6,349	14,770
<i>Neptunia oleracica</i>	0,56	17,500	0,32	19,512	37,012	0,38	20,000	0,24	19,048	39,048
<i>Nymphaea odorata</i> Aiton	0,02	0,625	0,02	1,220	1,845	-	-	-	-	-
<i>Nymphaea lotus</i>	0,02	0,625	0,02	1,220	1,845	-	-	-	-	-
<i>Oryza rufipifogon</i>	0,18	5,625	0,08	4,878	10,503	-	-	-	-	-
<i>Polygonum barbatum</i> L.)	0,54	16,875	0,26	15,854	32,729	0,28	14,737	0,20	15,873	30,610
TOTAL	3,2	100	1,64	100	200	1,9	100	1,26	100	200

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222 Where: D = Density

223 RD = Relative Density

224 F = Frequency

225 RF = Relative Frequency

226 IVI = Important Value Index

227 **Table 3.** Density, Relative Density, Frequency, Relative Frequency, and Important Value Index of forage species at Pampangan buffalo

228 pasture during wet and dry seasons inDensity-Value, Relative Density, Frequency, Relative Frequency, and Index of Important Value of

229 Swamp Lowland Forage-Vegetation of Pampangan Buffalo Pasture during the Wet and Dry Seasons in Rambutan ~~v~~Village.

Latin Name	Wet Season					Dry Season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Cyperus digitatus</i>	0,88	18,033	0,30	14,851	32,884	0,12	5,310	0,06	4,348	9,658 ⁴
<i>Eleocharis dulcis</i>	1,68	34,426	0,74	36,634	71,060	1,00	44,248	0,62	44,928	89,176 ¹
<i>Digitaria fuscescens</i>	1,10	22,541	0,40	19,802	42,343	0,40	1,770	0,22	15,942	17,712 ³
<i>Hymenachne acutigluma</i>	0,04	0,820	0,02	0,990	1,810	0,02	0,885	0,02	1,449	2,334 ⁸
<i>Hymenachne amplexicaulis</i>	0,04	0,820	0,02	0,990	1,810	0,04	1,770	0,02	1,449	3,219 ⁷
<i>Leersia hexandra</i>	0,06	1,230	0,04	1,980	3,210	0,04	1,770	0,04	2,899	4,659 ⁵
<i>Oryza rufipifogon</i>	0,80	16,393	0,40	19,802	36,195	0,60	26,549	0,38	27,536	54,085 ²
<i>Rhynchospora corymbosa</i> L	0,08	1,639	0,04	1,980	3,619	0,04	1,770	0,02	1,449	3,219 ⁶
<i>Sesbania exasperata</i>	0,20	4,098	0,06	2,970	7,068	-	-	-	-	-
TOTAL	4,88	100	2,02	100	200	2,26	100	1,38	100	200

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230 Where: D = Density

231 RD = Relative Density

232 F = Frequency

233 RF = Relative Frequency

234 IVI = Important Value Index

236 **Forage Production**

237 The average Pproduction of fresh forage-vegetation fresh forage- of swamp lowland in-atthe two study locations on-the

238 average-wasas 6.90 tons.ha⁻¹.year⁻¹ in the pasture-area-of Pulau Layang ~~v~~Village, of Pampangan Sub-district, of Ogan

239 Komering Ilir District -(Table 4) and 3.68 tons.ha⁻¹.year⁻¹ in the pasture-area-of Rambutan ~~v~~Village, of Rambutan Sub-

240 district, of Banyuasin District (Table 5).

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Table 4. Fresh wWeight pProduction, dDry mMatter pProduction, and fForage cCarrying cCapacity of sSwamp lLowland in the Wwet and dDry sSeasons in Pulau Layang vVillage, of Ogan Komering Ilir.

Latin Name	Wet Season			Dry Season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Catharanthus roseus</i> (L.) Don	7.530	977,4	2,82	-	-	-
<i>Cyperus chephalotes</i> Vahl	-	-	-	4.580	1.145,00 ⁴	3,30
<i>Digitaria fuscescens</i>	-	-	-	2.420	537,97 ¹⁰	1,55
<i>Eichhornia crassipes</i>	5.940	1.097,7	3,17	4.700	830,49 ⁶	2,40
<i>Eleocharis dulcis</i>	12.640	2.664,5	7,69	-	-	-
<i>Hymenachne acutigluma</i>	6.700	1.352,7	3,90	7.480	1.632,54 ¹	4,71
<i>Hymenachne amplexicaulis</i>	6.650	790,0	2,28	5.990	729,58 ⁸	2,11
<i>Hymenachne sp.</i>	7.040	1.151,7	3,32	5.720	975,83 ⁵	2,82
<i>Ipomoea aquatica</i> Forsk.	4.020	604,6	1,75	-	-	-
<i>Leersia hexandra</i>	4.740	1.232,4	3,56	5.290	1.385,45 ²	4,00
<i>Ludwigia hyssopifolia</i>	1.980	346,9	1,00	4.290	777,35 ⁷	2,24
<i>Neptunia olerancia</i>	1.910	394,8	1,14	2.870	607,01 ⁹	1,75
<i>Nymphaea uadorata</i> Aiton	7.500	1.286,3	3,71	-	-	-
<i>Nymphaea lotus</i>	9.800	1.983,5	5,72	-	-	-
<i>Oryza rupifogon</i>	12.960	2.225,2	6,42	-	-	-
<i>Polygonum barbatum</i> L.)	7.180	1.651,4	4,77	5.290	1.244,74 ³	3,59
Average	6.899	1.268,51	3,66	4.863	986,60	2,85

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Pasture Carrying Capacity

The carrying capacity of ~~swamp lowland for Pampangan buffalo pasture in Pulau Layang village~~ Pampangan buffaloes in the ~~swamp lowland pasture of Pulau Layang Village~~ was 3.66 AU.ha⁻¹.year⁻¹ during the wet season and 2.85 AU.ha⁻¹.year⁻¹ in the dry season (Table 4). The carrying capacity of ~~swamp lowland for Pampangan buffaloes in the swamp lowland pasture in of Rambutan vVillage~~ was 2.61 AU.ha⁻¹.year⁻¹ in the wet season ~~it and was~~ 2.04 AU.ha⁻¹.year⁻¹ in the dry season (Table 5).

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Table 5. Fresh weight production, dry matter production, and forage carrying capacity of swamp lowland in wet and dry seasons in Fresh Weight Production, Dry Matter Production, and Forage Carrying Capacity of Swamp Lowland in the Wet and Dry Seasons in Rambutan vVillage, of Banyuasin.

Latin Name	Wet Season			Dry Season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Cyperus digitatus</i>	2.590	248,9	0,72	240	28,61	0,08
<i>Digitaria fuscescens</i>	790	108,0	0,31	1.100	152,79	0,44
<i>Eleocharis dulcis</i>	4.370	921,2	2,66	1.700	376,21	1,09
<i>Hymenachne acutigluma</i>	8.540	3.139,3	9,06	5.900	2.181,82	6,29
<i>Hymenachne amplexicaulis</i>	4.860	577,4	1,67	3.200	489,28	1,41
<i>Oryza rupifogon</i>	4.690	1.462,8	4,22	4.420	1.421,03	4,10
<i>Rhynchospora corymbosa</i> L.)	1.510	441,8	1,28	250	77,88	0,22
<i>Sesbania exasperata</i>	1.360	111,5	0,32	-	-	-
Average	3.676,67	905,52	2,61	2.523,75	705,66	2,04

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Discussion

Diversity of forage Species of Forage Vegetation

There are dominant and palatable ~~forage vegetation~~ species of ~~in~~ swamp lowland ~~forage vegetation~~ having potential as buffalo feed, namely Kumpai padi grass (*O. ru~~p~~ifogon*), Kumpai tembaga (*H. acutigluma*), and Kumpai minyak (*H. amplexicaulis*), not dominant and palatable such as Kumpai merah (*Hymenachne sp*) and Kemon air (*N. olera~~n~~cia*).

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269 dominant and non palatable grass species (buffalo doesn't like it) namely Are bolong (*P. bBarbatum*: L). Yet, this grass
270 species would be eaten by the buffaloes if there were no other forage species to be eaten (Table 1).
271 Ali et al. (2012) conducted a study on swamp land vegetation and found 25 species, while Rohaeni et al. (2005) found
272 24 species in South Kalimantan, and Camarao and Rodrigues Filho (2001) only found 7 species. In Gowa District, there
273 were 15 vegetation species on found on the natural grasslands consisting of 12 vegetation species classified as palatable
274 forage (7 grasses and 5 legumes) and 3 non palatable species, all of them are native species (Rinduwati et al., 2016). All of
275 these vegetation species are of natural grass fields with local species. Based on the number of species encountered (15
276 species), it can be said that the natural pasture in of Gowa District is quite good (Rinduwati et al., 2016). Other studies show
277 high diversity of forage species. In Sota Village pasture there found 33 vegetation species in Sota village, consisting of 61%
278 grass, 3% legume and other plants 36% (Praptiwi et al., 2017); 22 forage species (Abdullah et al., 2017), 40 forage species
279 consisting of 82 – 87% forage grass, 1% legume and forage consumable by livestock, and 12 - 17% those in not edible by
280 livestock (Yoku et al., 2015). In Tobelo Sub-district, The composition of feed forage in Tobelo Subdistrict pasture is
281 consisted of 58.33% grass, 25% legume, and 16.67% other forage (Matulesy and Kstanja, 2013; Eoh, 2014). The sSpecies
282 diversity at different heights is influenced by the season in which where the wet season increases the availability of water
283 needed by plants for growth, especially the grass species, resulting in higher diversity (Kumalasari and Sunardi, 2015).

285 Analysis of Forage yVegetation

286 In Pulau Layang village, The analysis results of the vegetation of Pulau Layang Village during the wet season, species
287 with having the highest relative density, relative frequency, and Important Value Index (IVI) were Kemon air (*N. olerancia*)
288 having 0.56 density, 17.5% relative density, 0.32 frequency, 19.512% relative frequency, and 37.01% Important Value
289 Index, followed by 32.72% Are bolong (*P. barbatum* L) and 27.19% Eceng gondok (*E. crassipes*), while the lowest value
290 was Telepuk padi (*N. odorata* Aiton) and Telepuk gajah (*N. lotus*) which was 1.84% each. During the dry season, The
291 highest relative density, relative frequency and IVI importance value index in the dry season were Kemon air (*N. olerancia*)
292 which was with 39.04%, followed by Are bolong (*P. barbatum* L) 30.61% and Kumpai merah (*Hymenachne* sp.) 20.05%,
293 while the lowest value was Kumpai padi (*O. rufipogon*) which was with 13.71% (Table 2). Those results also showed that
294 in Pulau Layang Village there was a difference in the amount of vegetation between the wet and dry seasons. In the wet
295 season there were 14 forage vegetation species and in the dry season there were only 10 forage vegetation species.
296 Meanwhile, Apit apit (*C. cephalotes* Vahl) and Kerak maling (*D. fuscescens*) were not found in the wet season. Likewise,
297 in the dry season, Purun tikus (*E. dulcis*), Kumpai padi (*O. rufipogon*), Tapak darah (*C. roseus* L. Don), Kangkung merah
298 (*I. aquatica* Forsk), and Telepuk padi (*N. odorata* Aiton) were not found. The results show that there were some vegetation
299 species tolerant of water and some others were not.

300 In Rambutan village, during the wet season, species with the highest Important Value Index (IVI) were Purun tikus (*E.*
301 *dulcis*) with 71.06%, Kerak maling (*D. fuscescens*) 42.34%, and Kumpai padi (*O. rufipogon*) 36.19%. The lowest value were
302 Kumpai tembaga (*H. acutigluma*) and Kumpai minyak (*H. amplexicaulis*) 1.81% each. In the dry season, the highest IVI
303 were Purun tikus (*E. dulcis*) 89.71%, Kumpai padi (*O. rufipogon*) 54.08%, and Kerak maling (*D. fuscescens*) 17.71%. The
304 lowest value was Kumpai tembaga (*H. acutigluma*) 2.33% (Table 3).

305 The results also showed that there was a difference in the species richness between the wet and dry seasons. In Pulau
306 Layang Village in the wet season there were 14 forage species and in the dry season there were only 10 forage species. While
307 Apit apit (*C. cephalotes* Vahl) and Kerak maling (*D. fuscescens*) were not found in the wet season, Purun tikus (*E. dulcis*),
308 Kumpai padi (*O. rufipogon*), Tapak darah (*C. roseus* L. Don), Kangkung merah (*I. aquatica* Forsk), and Telepuk padi (*N.*
309 *odorata* Aiton) were not found in the dry season. In Rambutan village, in wet season there were 9 forage species, while in
310 the dry season there were only 8 species. In the dry season there was no legume Mutiara (*S. exasperate*), indicating that this
311 species could not bear the drought and as a result it would die in the dry season. These results suggest that there are some
312 species that tolerant to water while some others were not. On the other hand, some species are tolerant to drought, while
313 some others are not.

314 In other words, those tolerant of water would survive and those which were not would die.

315 The Important Value Index (IVI) differences of the swamp lowland forage vegetation among species might have be
316 resulted from caused by the competition of each species of vegetation to in obtaining soil nutrients in the soil and sunlight,
317 as well as the influencing climatic factors of the wet and dry seasons. This is in accordance with the results of as also stated
318 by Parmadi JC et al. (2016) reporting that the IVI differences of each vegetation species were due to the their competition
319 to obtain nutrients and sunlight. In addition to nutrients and sun, there are other influencing factors of namely vegetation
320 density and tides. The variations of their species diversity and composition and amount of vegetation indicates that even
321 though aone research location has the same age, yet the environmental conditions could result in different vegetation
322 (Syarifuddin, 2011). In Pulau Layang village, The vegetation species having the highest IVI were Kemon air and Are bolong
323 (37.01 and 32.73%) while in Rambutan village were Purun tikus, Kerak maling and Kumpai padi (71.06%, 42.34%, and
324 36.19%), indicating that. This shows that the vegetation species of Kemon air and Are bolong they are the most dominant
325 ones species among other vegetation species. A vegetation species is said considered to be dominant in an area if it has a
326 percentage IVI of more than 20% of the total individuals all species and co-dominant if the percentage ranges from 10% to
327 20% (Suveltri et al., 2014).

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The analysis results of the vegetation of Rambutan Village during the wet season having the highest relative density, relative frequency, and Important Value Index were Purun tikus (*E. dulcis*) 71.06%, Kerak maling (*D. fuscescens*) 42.34%, and Kumpai padi (*O. rufipogon*) 36.19%. The lowest value ones were Kumpai tembaga (*H. acutigluma*) and Kumpai minyak (*H. amplexicaulis*) 1.81% each. The highest relative density, relative frequency, and important value index in the dry season were Purun tikus (*E. dulcis*) 89.71%, Kumpai padi (*O. rufipogon*) 54.08%, and Kerak maling (*D. fuscescens*) 17.71%. The lowest value was Kumpai tembaga (*H. acutigluma*) 2.33% (Table 3). The highest species density of swamp forage vegetation in swamp ecosystem might have resulted from its adaptation and development ability in accordance with the environment. This is in accordance with the study result conducted by Oktaviani et al. (2015) that the plants vegetation had the with the highest density because can this vegetation adapt to match the environment to grow and reproduce under the conditions of land whose soil and water contained low pH in water and soil. In contrast, as for the plants having with the lowest density, it might have been due to be caused by the unsuitable environmental and land factors for the plants to grow and breed, particularly in the acidic the pH of the water and the soil was low in acid (Samin et al., 2016). The results also show that in Rambutan Village there was a difference in the amount of vegetation between the wet and dry seasons. In wet season there were 9 species of forage vegetation, while in the dry season there were only 8 species of forage vegetation. In the dry season there was no legume Mutiara (*S. exasperate*). This shows that the legume Mutiara (*S. exasperate*) could not bear the drought and as a result it would die in the dry season.

Forage pPProduction

The high production of vegetation for swamp lowland in Pampangan Subdistrict compared to that in Rambutan Subdistrict might have resulted from the soil fertility of the pasture area of Pampangan Subdistrict which was more fertile than that of Rambutan Subdistrict. The analysis results showed that the C-Organic, N-total and P-available analysis (Bras I) were higher than those in the Rambutan District. The high fertility of the land was thought that the most pasture of Pulau Layang Village was the rice fields and always given fertilizer. Unlike the pasture of Pampangan Subdistrict, the pasture of Rambutan Village was only used for the grazing buffaloes without any use of fertilizer. The provision of manure and bioslurry fertilizer can increase the production and forage quality of 4.75 tons and 4.36 tons respectively. (Suarna dan Budiasa 2016; Jeffery et al., 2018).

The results of the research in the pasture area of Pampangan Subdistrict, Ogan Komering Lir was 6.90 tons $\text{ha}^{-1}\cdot\text{year}^{-1}$ which was lower than that of Kleden et al. (2015) reporting that the production of natural grass in coffee and grassland areas of Wulanggintang Subdistrict, East Flores District was 7.664 tons $\text{ha}^{-1}\cdot\text{year}^{-1}$ and 6.98 tons $\text{ha}^{-1}\cdot\text{year}^{-1}$ respectively. This result was higher than that of Se'u et al. (2015) reporting that the grass production in real conditions in South Central Timor District was only 0.15-0.39 tons $\text{ha}^{-1}\cdot\text{year}^{-1}$.

The production of fresh forage swamp lowland at pastures in of Pulau Layang Village in the wet season was 6.899 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$ and the production of the dry matter was 1,268.51 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$, while in the dry season the fresh production of fresh forage was 4,863 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$ and the dry matter production was 986.60 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$ (Table 4). This result is was higher than those conducted by (Rinduwati et al., 2016; Omokanye et al., 2018; Se'u et al., 2015) stating that the average fresh production of pasture in of Gowa District in the wet season was 5,350 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$ and in the dry season was 1,390 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$. But those the results of this study were lower than the study of by Abdullah et al., (2017) who reported that forage production was 8,029.1 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$ in the wet season and 5,422.9 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$ in the dry season. The forage production of pasture forage production in of Sabana Timur Barat on the average ranged from 0.61 to 4.33 tons $\text{ha}^{-1}\cdot\text{year}^{-1}$.

The lowest production usually occurs at the peak of the dry season in October and the highest occurs in April (Manu, 2013; Damry, 2009). The forage production of *Pennisetum purpureoides* was 70.4 ton ha^{-1} , *Setaria sphacelata* 44.8 tons ha^{-1} , *Brachiaria sp* 44.7 tons ha^{-1} , *Pennisetum purpureum* 44.6 tons ha^{-1} , and *Panicum maximum* 15.6 tons ha^{-1} (Jarman and Haryanto, 2015). The different amounts of production might have resulted from the differences in vegetation species, types of pasture, and methods used. There are various methods for estimating forage production, but many are inaccurate when used with applied to certain animal feed plant species. Therefore, it is very important to find out the use and understand the limitations of the techniques used of to measuring forage production (Edvan et al., 2016; Badgery et al., 2017).

In Pulau Layang village, there were 5 forage species swamp lowland forage species having high fresh production in the wet season in Pulau Layang Village, namely Kumpai padi (*O. rufipogon*) with 12,960 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$, followed by Purun tikus (*E. dulcis*), Telepek gajah (*N. lotus*), Are bolong (*P. barbatum* L) and Telepek padi (*N. odorata* Aiton), and the lowest one was Kemon air (*N. olerancia*) with 1,910 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$. In the dry season the highest fresh production was Kumpai tembaga (*H. acutigluma*) as many as with 7,480 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$, followed by Kumpai minyak (*H. amplexicaulis*), Kumpai merah (*Hymenachne* sp.), Are bolong (*P. barbatum* L) and Bento rayap (*L. hexandra*), and the lowest one was Kemon air (*N. olerancia*) of with only 2,870 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$. The highest dry matter production in the wet season was Purun tikus (*E. dulcis*) as many as with 2,664.5 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$, followed by Kumpai padi (*O. rufipogon*), Telepek gajah (*N. lotus*), Are bolong (*P. barbatum* L), and Kumpai tembaga (*H. acutigluma*), and the lowest one was Cecengkehan (*L. hyssopifolia*). In the dry season the highest dry matter production was Kumpai tembaga (*H. acutigluma*) as many as with 7,480 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$, followed by Bento rayap (*L. hexandra*), Are bolong (*P. barbatum* L), Apit-apit (*C. chepalotes* Vahl) and Kumpai merah (*Hymenachne* sp.), and the lowest one was Kerak maling (*D. fuscescens*) as many as with 2,420 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$ (Table 4).

In Rambutan village, the fresh the production of fresh forage swamp lowland pasture of Rambutan Village during the wet season was 3,676.67 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$ and the dry matter production was 905.52 kg $\text{ha}^{-1}\cdot\text{year}^{-1}$, whereas in the dry season

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388 the fresh production was 2,523.75 kg·ha⁻¹·year⁻¹ and the dry matter production was 705.66 kg·ha⁻¹·year⁻¹ (Table 5). These
389 results were higher than those of the study conducted by (Purwantari et al. (2015); and Praptiwi et al. (2017) who reported
390 that the average availability of the forage on palm oil plantations on pasture areas was 1,455.5 kg·ha⁻¹·year⁻¹; but it was
391 lower than the those of the study conducted by Rinduwati et al., (2016) stating that the production of pasture fresh forage
392 in Gowa District during the wet season was on the average 5,350 kg·ha⁻¹·year⁻¹, but it was lower than that in the dry season
393 of only 1,390 kg·ha⁻¹·year⁻¹. The forage production of during preproduction of rubber plantation was 732.90 kg·ha⁻¹·year⁻¹
394 and at the time of production it was only 317.83 kg·ha⁻¹·year⁻¹ (Pramana et al., 2015).

395 In Rambutan village, during the wet season there were 5 forage species of swamp lowland forage having the highest
396 fresh and dry matter production during the wet season, namely Kumpai tembaga (*H. acutigluma*) producing 8,540 kg·ha⁻¹
397 ·year⁻¹ and 3,139.3 kg·ha⁻¹·year⁻¹ each respectively, followed by Kumpai padi (*O. rupestris*), Bento rayap (*L. hexandra*),
398 Purun tikus (*E. dulcis*), and Kumpai minyak (*H. amplexicaulis*), and the lowest one was Kerak maling (*D. fuscescens*) of
399 with 790 kg·ha⁻¹·year⁻¹ and 108.0 kg·ha⁻¹·year⁻¹, respectively. In the dry season, the highest fresh and dry matter production
400 was Kumpai tembaga (*H. acutigluma*) of 5,900 kg·ha⁻¹·year⁻¹ and 2,181.82 kg·ha⁻¹·year⁻¹, followed by Kumpai padi (*O.*
401 *rupestris*), Bento rayap (*L. hexandra*), Kumpai minyak (*H. amplexicaulis*), and Purun tikus (*E. dulcis*), and the lowest
402 one was Kasuran (*C. digitatus*) with of 240 kg·ha⁻¹·year⁻¹ and 11.92 kg·ha⁻¹·year⁻¹, respectively (Table 5). The results of
403 this study were still higher than those conducted by Rostini et al. (2014) stating that the highest grass fresh forage production
404 of grass *Hymenachne amplexicaulis* Haes was 1,032 kg DM·ha⁻¹·harvest⁻¹ in the high tide season and 518.3 kg DM·ha⁻¹
405 ·harvest⁻¹ in the low tide season, where the dry matter production ranged from 43.8 to 1.032 kg DM·ha⁻¹·harvest⁻¹ in the
406 high tide season and from 38.5 to 752.8 kg DM·ha⁻¹·harvest⁻¹ in the low tide season.

407 The higher production of forage in Pampangan Sub-district compared to that in Rambutan Sub-district might be caused
408 by higher soil fertility of the pasture area in Pampangan. The result of soil analysis showed that the C-Organic, N-total and
409 P-available in Pampangan (Bray I) were higher than those in Rambutan which might be related to the fact that most pasture
410 in Pulau Layang village (Pampangan) are rice fields which are always given fertilizer. This differs with pasture in Rambutan
411 village which is only used for grazing without any use of fertilizer. The provision of manure and bioslurry fertilizer can
412 increase the production and forage quality of 4.75 tons and 4.36 tons, respectively (Suarna dan Budiasa 2016; Jeffery et al.,
413 2018).

414 415 416 Pasture Carrying Capacity

417 In Pulau Layang village, the carrying capacity is an analysis of the ability of pasture areas or grass farming to
418 accommodate a number of livestock so that the need for grass for one year animal feed is sufficient. Calculating forage
419 carrying capacity of swamp lowland forage is based on the amount of forage supplied on a pasture for livestock needs for
420 one year which is stated in Animal Unit (AU) per hectare. According to Purnomo (2006), the calculation of carrying capacity
421 is based on the formula of:

$$\text{Carrying Capacity} = \frac{\text{Cumulative Production} \times \text{proper use factor (\%)}}{\text{Animal Need (kg DM/AU/day)} \times 360 \text{ days}}$$

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427 The carrying capacity for Pampangan buffaloes pasture on the swamp lowland pasture of Pulau Layang Village in the
428 wet season was 3.66 AU·ha⁻¹·year⁻¹ and 2.85 AU·ha⁻¹·year⁻¹ during the dry season (Table 4). In Rambutan village, the
429 carrying capacity for Pampangan buffalo pasture in the wet season was 2.61 AU·ha⁻¹·year⁻¹ and in the dry season was 2.04
430 AU·ha⁻¹·year⁻¹ (Table 5). The results of this study corresponded to those of the study conducted by Rostini et al. (2014)
431 which found stated that the carrying capacity of swamp lowland plants in South Kalimantan was 2.91 AU·ha⁻¹·year⁻¹. These
432 results were higher than those of the study conducted by Seu et al., (2015) reporting that the carrying capacity of grass in
433 real conditions in South Central Timor District was only 0.24 - 0.63 AU·ha⁻¹·year⁻¹, and average carrying capacity of natural
434 pastures of Gowa District was 0.88 AU·ha⁻¹·year⁻¹ (Rinduwati et al., 2016) and the capacity of pasture in Poso District 0.63
435 AU·ha⁻¹·year⁻¹ (Damry, 2009; Daru et al., 2014). The carrying capacity of pasture of Sota Village, Merauke District, was
436 still relatively small (Praptiwi et al., 2017). The carrying capacity of pasture in Kelei and Didiri Villages of Poso Districts
437 was 0.96 and 1.12 AU·ha⁻¹·year⁻¹ (Karti et al., 2015). The pasture performance of the *Brachiaria humidicola* (Rendle) was
438 2.31 AU·ha⁻¹·year⁻¹ (Anis et al., 2014). Abdullah et al., (2017) reported that the carrying capacities of forage in the wet and
439 dry seasons in Pakistan were 24 AU·ha⁻¹·year⁻¹ and 16 AU·ha⁻¹·year⁻¹.

440 These results were higher than in grass land in South Central Timor District with only 0.24 - 0.63 AU·ha⁻¹·year⁻¹ (Seu et
441 al., 2015), in natural pastures of Gowa District with 0.88 AU·ha⁻¹·year⁻¹ (Rinduwati et al., 2016), in pasture in Poso District
442 with 0.63 AU·ha⁻¹·year⁻¹ (Damry, 2009; Daru et al., 2014), in Kelei and Didiri villages of Poso Districts with 0.96 and 1.12
443 AU·ha⁻¹·year⁻¹ (Karti et al., 2015), and the pasture of *Brachiaria humidicola* (Rendle) with 2.31 AU·ha⁻¹·year⁻¹ (Anis et al.,
444 2014). However, these results were lower than the study conducted by Muhajirin et al. (2017) stating that the carrying
445 capacity of Padang Mengatas BPTU was 5 AU·ha⁻¹·year⁻¹ in the wet season and 3.18 AU·ha⁻¹·year⁻¹ in the dry season. Even,
446 Abdullah et al., (2017) reported very high carrying capacity of forage in Pakistan with 24 AU·ha⁻¹·year⁻¹ and 16 AU·ha⁻¹
447 year⁻¹ in the wet and dry seasons, respectively.

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448 There is a decrease in the dry material production during the dry season because the water condition in swamp lowland
449 is reduced. Decrease in swamp water level resulted in the decrease of photosynthesis which affect the production of the dry
450 matter. Water is the main ingredient needed in photosynthesis. The disruption of metabolic processes in plants will affect
451 plant production. Plant dry weight depicts the accumulation of organic compounds that are successfully synthesized by the
452 plants from inorganic compounds, especially water and CO₂ (Lakitan, 1995). Water shortages will have a negative effect on
453 plant growth resulting in decreased production (Jun-Feng et al., 2010; Taiz and Zeiger 2002).

454 The high carrying capacity is related to the high forage production, forage management of forage development and
455 selection of good species. The management and strategy carried out to increase forage production require innovative
456 facilitation and training to stockbreeders and farmers innovative training facilitated to have to increase their knowledge.
457 These efforts of breeding and it should be supported by the government and private companies a develop to make a programs
458 regarding about the importance of forage to increase ruminant livestock production (Nigus, 2017; Omokanye et al.,
459 2018).

460 In Pulau Layang village. In a the pasture condition assumed to have one forage species of swamp forage, the highest
461 carrying capacity in the wet season was Purun tikus (*E. dulcis*) as much as with 7.69 AU_{ha}⁻¹.year⁻¹, and then followed by
462 Kumpai padi (*O. rufipogon*) with 6.42 AU_{ha}⁻¹.year⁻¹, Telepek gajah (*N. lotus*) with 5.72 AU_{ha}⁻¹.year⁻¹, Are bolong (*P.*
463 *barbatum* L) with 4.77 AU_{ha}⁻¹.year⁻¹ and Kumpai tembaga (*H. acutigluma*) with 3.90 AU_{ha}⁻¹.year⁻¹,
464 respectively consecutively, and the lowest one was Cecengkehan (*L. hyssopifolia*) with 1.00 AU_{ha}⁻¹.year⁻¹. In the dry
465 season, the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) as much as with 4.71 AU_{ha}⁻¹.year⁻¹, and then
466 it was followed by Bento rayap (*L. hexandra*) as much as with 4.00 AU_{ha}⁻¹.year⁻¹, Are bolong (*P. barbatum* L) with 3.59
467 AU_{ha}⁻¹.year⁻¹, Apit-apit (*C. chephalotes* Vahl) with 3.30 AU_{ha}⁻¹.year⁻¹ and Kumpai merah (*Hymenachne* sp.) with 2.82
468 AU_{ha}⁻¹.year⁻¹, whereas the lowest one was Kerak maling (*D. fuscescens*) as much as with 1.55 AU_{ha}⁻¹.year⁻¹ (Table 4).

469 The carrying capacity of Pampangan buffalo pasture of the swamp lowland of Rambutan Village during the wet season
470 was 2.61 AU_{ha}⁻¹.year⁻¹ and in the dry season it was 2.04 AU_{ha}⁻¹.year⁻¹ (Table 5). This result was lower than those of the
471 study conducted by Muhajirin et al. (2017) stating that the carrying capacity of Padang Mengatas BPTU was 5 AU_{ha}⁻¹.year⁻¹
472 in the wet season and 3.18 AU_{ha}⁻¹.year⁻¹ in the dry season. There was a decrease in the dry material production during
473 the dry season because the water condition in swamp lowland alleviated. The decreased swamp water condition resulted in
474 a decrease of photosynthesis and automatically the production of the dry matter decreased. Water is the main ingredient
475 needed in photosynthesis. The disruption of metabolic processes in plants will affect plant production. Plant dry weight
476 depicts the accumulation of organic compounds that are successfully synthesized by the plants from inorganic compounds,
477 especially water and CO₂ (Lakitan, 1995). Water shortages will have a negative effect on plant growth resulting in decreased
478 production (Jun-Feng et al., 2010; Taiz and Zeiger 2002).

479 When the pasture in Rambutan village, assuming that the pasture condition had had one forage species of swamp forage,
480 the highest carrying capacity in the wet season consecutively included was Kumpai tembaga (*H. acutigluma*) with of 9.06
481 AU_{ha}⁻¹.year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 4.22 AU_{ha}⁻¹.year⁻¹, Bento rayap (*L. hexandra*) with 3.29
482 AU_{ha}⁻¹.year⁻¹, Purun tikus (*E. dulcis*) 2.66 with AU_{ha}⁻¹.year⁻¹, and Kumpai minyak (*H. amplexicaulis*) with 1.67 AU_{ha}⁻¹.year⁻¹.
483 While the lowest one was Kerak maling (*D. fuscescens*) as much as with 0.31 AU_{ha}⁻¹.year⁻¹. During the dry
484 season the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) as much as with 6.29 AU_{ha}⁻¹.year⁻¹, and then
485 followed by Kumpai padi (*O. rufipogon*) as much as with 4.10 AU_{ha}⁻¹.year⁻¹, Bento rayap (*L. hexandra*) with 2.65 AU_{ha}⁻¹.year⁻¹,
486 Kumpai minyak (*H. amplexicaulis*) with 1.41 AU_{ha}⁻¹.year⁻¹, and Purun tikus (*E. dulcis*) with 1.09 AU_{ha}⁻¹.year⁻¹.
487 While the lowest one was Kasuran (*C. digitatus*) as much as with 0.08 AU_{ha}⁻¹.year⁻¹ (Table 5). These results
488 indicate that the carrying capacity is very influential with the type of feed plan. In addition, the most other important thing is
489 also cattle grazing system in which livestock grazing must be regulated to avoid over-grazing as the amount of grazing
490 livestock depends on the carrying capacity of the pasture (Salendu and Elly, 2014; Cheng et al., 2017; Hashemi, 2017).

491 The results of this study indicated that the forage availability was still sufficient to meet feed requirements for
492 Pampangan buffaloes. The population of Pampangan buffaloes of in Pulau Layang Village was 487 buffaloes with a grazing
493 area of 500 ha with an average carrying capacity of 3.14 AU_{ha}⁻¹.year⁻¹. While the number of Pampangan buffaloes of
494 Rambutan Village was 1.735 buffaloes with a pasture area of 1,203 ha and an average carrying capacity of 2.45 AU_{ha}⁻¹.year⁻¹.
495 It is projected estimated that there is still a need for can be additional buffalo cattle as much as 0.31 AU_{ha}⁻¹.year⁻¹
496 in Pulau Layang Village and 0.59 AU_{ha}⁻¹.year⁻¹ in Rambutan Village.

497 Based on the results of the study, the following is the conclusion:

498 1. There were 19 forage species of swamp lowland forage vegetation found to have the potential to as feeding source of
499 the Pampangan buffaloes in South Sumatra. The importance of species indicated by

500 2. Important Value Index (IVI) is strongly influenced by grazing locations and seasons. The most important species The
501 high IVI were Kemon air (*N. oleracea*) and Are bolong (*P. barbatum* L) in Pulau Layang Village and Purun tikus (*E.*
502 *dulcis*), Kerak maling (*D. fuscescens*), and Kumpai padi (*O. rufipogon*) in Rambutan Village, the high IVI were Purun
503 tikus (*E. dulcis*), Kerak maling (*D. fuscescens*), and Kumpai padi (*O. rufipogon*).

504 3. In Pulau Layang Village, the fresh forage and dry matter production of forage vegetation swamp lowland
505 pasture in the wet season were 6.90 and 1.27 tons_{ha}⁻¹.year⁻¹, while in Rambutan Village they were 3.68 tons_{ha}⁻¹.year⁻¹
506 and 0.91 ton_{ha}⁻¹.year⁻¹ dry consecutively, respectively. The fresh forage production and dry matter production in the dry

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season in Pulau Layang Village were 4.86 and 0.99 tons \cdot ha⁻¹ \cdot year⁻¹, while in Rambutan Village they were 2.52 tons \cdot ha⁻¹ \cdot year⁻¹ and 0.71 tons \cdot ha⁻¹ \cdot year⁻¹, respectively consecutively.

4. The carrying capacity of swamp lowland pasture in the wet season in Pulau Layang Village was 3.66 AU \cdot ha⁻¹ \cdot year⁻¹ and in the dry season it was 2.85 AU \cdot ha⁻¹ \cdot year⁻¹. In Rambutan Village in the wet season it was 2.61 AU \cdot ha⁻¹ \cdot year⁻¹ and in the dry season it was 2.04 AU \cdot ha⁻¹ \cdot year⁻¹. Therefore, on the average the carrying capacity of the swamp lowland pasture in South Sumatra was 2.79 AU \cdot ha⁻¹ \cdot year⁻¹. As such,

5. The forage availability is still sufficient to meet the need for animal feed, and it is projected-estimated the areas can be that there is still a need for additional added buffalo cattle for of 0.31 AU \cdot ha⁻¹ \cdot year⁻¹ in Pulau Layang Village and 0.59 AU \cdot ha⁻¹ \cdot year⁻¹ in Rambutan Village.

6. The highest forage production in the wet season in Pulau Layang Village was Purun tikus, followed by, Kumpai padi, Telepak gajah, Are bolong, Kumpai tembaga, while in the dry season the highest one was Kumpai tembaga, followed by Bento rayap, Are bolong, Apit apit and Kumpai merah. In Rambutan Village the highest forage production in the wet and dry seasons were Kumpai tembaga, Kumpai padi, Bento rayap, Kumpai minyak, and Purun tikus.

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**4. Bukti konfirmasi submit revisi kedua,
respon kepada reviewer, dan artikel
yang diresubmit (19 Maret 2019)**

Analysis of the Vegetation analysis Structure of non-tidal swampland in South Sumatra, Indonesia and its cCarrying cCapacity of Nontidal Swamplandfor Pampangan buffalo pPasture to Pampangan Buffalo in South Sumatra, Indonesia

Abstract. In Indonesia non-tidal swampland area is 13.27 million ha, only 4 million ha has been developed with details of 2.6 million ha that managed by the public and the private sector and 1.3 million ha with government assistance. This study aimed to analyze the vegetation structure of non-tidal swampland in Pulau Layang village, Ogan Komering Ilir District and Rambutan village, Banyuasin District, South Sumatera and to examine its carrying capacity of for Pampangan buffalo in the swampland pasture. The methods used of collecting were by the combination of direct observation, survey using plot sampling with total 50 observation plots, and data used measurements to determine and direct observation in the field covering identification of forage species and production. The measurement of forage production used using Halls methods of Halls. There were totally 50 observation points on the swampland. The forage in the quadrant was cut and weighed. The results of the study show that found there 19 forage species were in two studied areas which are of forage swampland potential as Pampangan buffalo feed. Species with the highest important V-value index of were Purun tikus (*Eleocharis dulcis*) was with 89.71% and Kumpai padi (*Oryza rufipogon*) with 54.08%. The production of fresh forage and dry matter in the wet season in Pulau Layang was 6.90 tons \cdot ha $^{-1}$ \cdot year $^{-1}$ and 1.27 tons \cdot ha $^{-1}$ \cdot year $^{-1}$ consecutively, respectively, whereas in Rambutan Village they were 3.68 tons \cdot ha $^{-1}$ \cdot year $^{-1}$ and 0.91 tons \cdot ha $^{-1}$ \cdot year $^{-1}$, respectively. The production of fresh forage and dry matter in the dry season in Pulau Layang was 4.86 tons \cdot ha $^{-1}$ \cdot year $^{-1}$ and 0.99 tons \cdot ha $^{-1}$ \cdot year $^{-1}$, respectively, while in Rambutan they were 2.52 tons \cdot ha $^{-1}$ \cdot year $^{-1}$ and 0.71 tons \cdot ha $^{-1}$ \cdot year $^{-1}$, respectively. The pasture carrying capacity of swampland of in Pulau Layang village in the wet season was 3.66 AU (Animal Unit) \cdot ha $^{-1}$ \cdot year $^{-1}$ and in the dry season it was 2.85 AU \cdot ha $^{-1}$ \cdot year $^{-1}$, while in Rambutan village it was 2.61 AU \cdot ha $^{-1}$ \cdot year $^{-1}$ and 2.04 AU \cdot ha $^{-1}$ \cdot year $^{-1}$, respectively. There were six species of forage with high production, namely Kumpai tembaga (*Hymenachne acutigluma*), Kumpai padi (*Oryza rufipogon*), Kumpai minyak (*Hymenachne amplexicaulis*), Are bolong (*Polygonum barbatum* L), Bento rayap (*Leersia hexandra*) and Purun tikus (*Eleocharis dulcis*). It is estimated that there still can be added buffalo cattle as much as 0.31 AU ha $^{-1}$ year $^{-1}$ in Pulau Layang village so 155 buffaloes and 0.59 AU ha $^{-1}$ year $^{-1}$ in Rambutan village. 709 buffaloes

Key words: Pampangan buffalo, Analysis of vegetation analysis, cCarrying capacity, pPasture, nNon-tidal sSwamplandland

INTRODUCTION

Non-tidal swampland is often considered as a suboptimal land despite its availability is very extensive in Indonesia. The total extent of non-tidal swampland is about 13.27 million ha, consisting of 3.0 million ha of deep swampland, 6.07 million ha of swampland with medium deep and 4.20 million ha of shallow swampland, and is distributed in Sumatra, Kalimantan and Papua. Nonetheless, there is, and only 4 million ha of them has been developed with the public and the private sectors managed 2.60 million ha and while 1.3 million ha are developed by government assistance (Indonesian Statistic Center-Bureau Agency, 2010; Mulyani and Sarwani, 2013). At provincial level, it consists of 3.0 million ha of deep swampland; 6.07 million ha of middle swampland and 4.2 million ha of shallow swampland scattered in Sumatra, Kalimantan and Papua islands. Non-tidal swampland in South Sumatra covers the most extensive highest area in Sumatra, reaching 2.98 million ha but, with only 298,189 ha that has been developed (Statistics Agency-Center-Bureau of South Sumatra, 2014).

Pampangan buffaloes is are the ones of the potential germplasm of South Sumatra Province which is widely found and extensively farmed in Pulau Layang Village, of Ogan Komering Ilir District and Rambutan Village, of Banyuasin District

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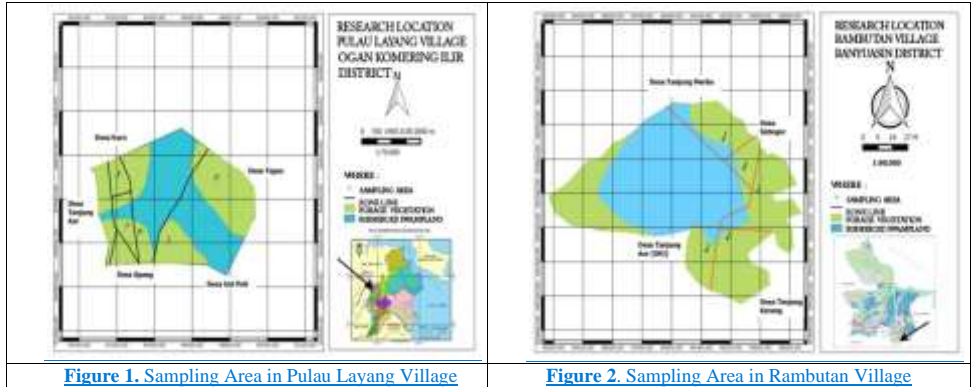
50 which are generally extensively maintained (Muhakka et al., 2013). In addition to being taken farmed for their meat, the
 51 buffalo~~hey~~ also produce milk to be processed into traditional food (named *Gulo Puan*). The buffalo population in South
 52 Sumatra in 2014 was 33,369 buffaloes, and the number decreasing 4.29% than compared to that in 2012 to be with 34,866
 53 buffaloes (4.29%) (Statistics of South Sumatra Animal Husbandry, 2014). There are three factors causing the decline in the
 54 the buffalo livestock population, namely: (1) the fluctuated availability of fluctuating natural forage amount, (2) low the
 55 quality of nutritional forage of lowland swamp lowland was low swamp, and (3) decreasing extent of the grazing pasture
 56 land decreased (BPTP South Sumatra, 2011). The low productivity of the buffaloes in term of (growth and milk production
 57 is) resulted from caused by the consumed rations which could not meet the needs for of food substances which ; this was
 58 characterized by low protein content, and high crude fiber, and low digestibility. However, the buffaloes have several
 59 advantages and their roles productivity can be enhanced especially through food and genetic improvement (Talib et al.,
 60 2014). The buffaloes have their own advantages compared to cows in which ; they can survive particularly if when the
 61 existing available feed has low quality (Diyanto and Handiwirawan 2006; Yasin, 2013).

62 One strategy that can be done to maintain and improve the ability of the level of productivity of Pampangan buffaloes
 63 is by conducting a studying their of foragee vegetation in lowland swamp by analyzing the lowland, through analysis of
 64 vegetation and carrying capacity of pasture. The studies onf vegetation analysis and pasture carrying capacity at the
 65 present time up to date are is only limited to the dry land areas, such as in Wulan Gitrang Sub-district, East Flores which
 66 show, whose carrying capacity are of 0.42 AU.ha⁻¹.year⁻¹ on coffee plantation area and 0.38 AU.ha⁻¹.year⁻¹ on grassland area
 67 (Kleden et al., 2015). Another study investigating The carrying capacity of livestock storage forage under during the auspices
 68 of preproduction of rubber plants (juvenile plants) is 0.14 AU.ha⁻¹.year⁻¹, while during rubber production (mature plants)
 69 plants can only accommodate 0.06 AU.ha⁻¹.year⁻¹ (Pramana et al., 2015).

70 This study aims to analyze vegetation structure of non-tidal swampland in South Sumatera and examine its carrying
 71 capacity for Pampangan buffalo pasture This study aimed to analyze swamp forage vegetation and the carrying capacity of
 72 Pampangan buffalo pasture in the swampland of South Sumatra.

73 **MATERIALS AND METHODS**

74 This research was carried out in Pulau Layang Village, of Pampangan Sub-district, of Ogan Komering Ilir District
 75 and Rambutan Village, of Rambutan Sub-district, of Banyuasin District, of South Sumatra from April to September 2017.
 76 The methods used were the combination of a survey, method and measurements, and direct observations on samples of on
 77 swampland lowland which was commonly used as pasture by farmers taken as samples. The data of livestock population
 78 were were collected from related agencies and institutions.



81 Field The data were collected using direct observations and measurements and direct observations in the field including
 82 forage vegetation species, the amount of production, forage quality (natural grasses and legumes), and soil fertility. Purposive
 83 sampling was The method used conducted by making a quadratic method with the placement of plots by using purposive
 84 sampling with a plot size of 1x1m each plot and with the number total number of plots was of 50 plots in swamp lowland
 85 (Kleden et al., 2015). Then, In each observation plot, the name and individual number of forage recorded the species of
 86 forage vegetation, the number of individuals of each species were recorded. The plant specimens were, and collected all
 87 species of forage vegetation. The collection was and labeled with hanging and each species of forage vegetation was
 88 photographed with a digital camera. The revoked vegetation collected specimens from each plot were as separated according
 89 to each species and dried to calculate the dominant value. Dominant value is a value that more important than other values.

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90 . The unknown species of vegetation was collected for herbaria, being given treated with 70% alcohol, oven-baked dried,
91 and identified. ~~the plant is identified by employing a botanist and using reference book.~~

92 The variables ~~to be analyzed~~ measured and observed in this study ~~are~~ were as follows:

95 Vegetation Analysis

96 The collected data were analyzed quantitatively (Utami et al., 2007) as follows:

97 a. Density

98 Density is the number of individuals of a species ~~per area extent and of certain location~~ formulated as follows:

$$99 \text{ Density} = \frac{\text{The species n} \text{Number of individual of a species}}{\text{The Total area extent of the sample plots}}$$

104 b. Relative Density

105 Relative density is ~~a percentage of density of a species toward density of all spe~~ the density of a species as a percent of
106 ~~total plant density which is~~ and formulated as follows:

$$107 \text{ Relative Density} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100\%$$

111 c. Frequency

112 Frequency is ~~the comparison of~~ the number of sample plots having a species ~~in a and given total~~ the number of sample
113 plots ~~which were made, and~~ formulated as follows:

$$114 \text{ Frequency} = \frac{\text{The n} \text{Number of plots having a species}}{\text{The n} \text{Number of all observed plots}}$$

118 d. Relative Frequency

119 Relative Frequency is ~~a the~~ frequency of a species as a percentage of a species toward the number of total frequency of
120 all species ~~and~~; formulated as follows:

$$121 \text{ Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100\%$$

124 e. Important Value Index (IVI)

125 This value indicates the dominance of a species in a particular area ~~and~~ formulated as follows:

$$126 \text{ IVI} = \text{Relative Density} + \text{Relative Frequency}$$

128 Forage Production

129 ~~The m~~ Measurement of forage production adopted the *Halls* method (~~in~~ Kleden et al., 2015) ~~which used~~ a 1m x 1m
130 quadratic frame ~~by sampling construction~~ (Sutaryo, 2009). A total of 50 observation points were ~~conducted done~~ in a grazing
131 area ~~of on~~ swamp ~~and lowland~~ often that frequently used by farmers/ranchers. ~~The squared frame for each observation point~~
132 ~~was randomly placed~~ The placement of squared frame for each observation point was based on random numbers. The average
133 forage production was calculated using the following formula:

$$134 X = \frac{\sum xi}{n}$$

135 Where: X = The existing average of forage biomass production
136 $\sum xi$ = The amount of forage biomass production at each observation
137 n = The amount of observation

Commented [A11]: Please describe how you identify the plant. For example: either employing a botanist or sending the specimen to competent institutions (e.g. LIPI), or simply using reference book.

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Commented [A12]: Please be consistent. Do you refer the same thing with non-tidal as you mentioned in previous parts including in the Title?

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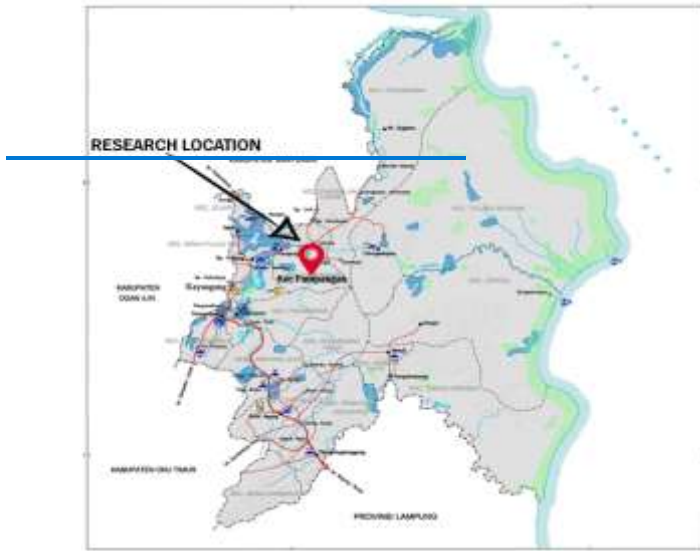


Figure 1. Research location : Pulau Layang Village, Pampangan sub-district, Ogan Komering Ilir District

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Figure 3. Research location in South Sumatera, Indonesia.

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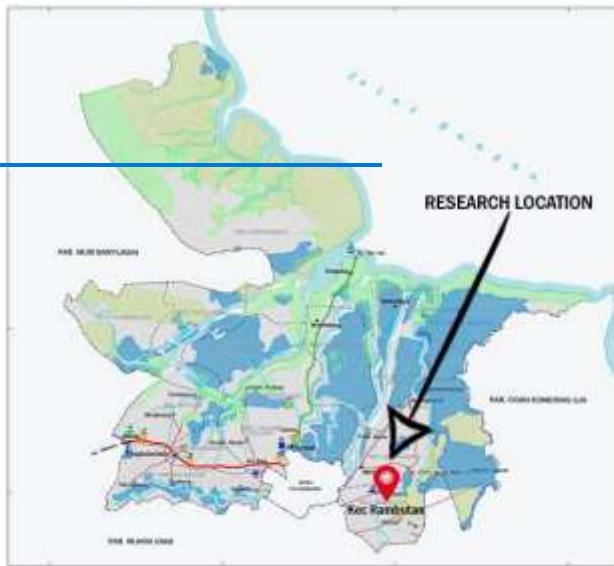


Figure 2. Research location : Rambutan Village, Rambutan sub-district, Banyuasin District

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Pasture Carrying Capacity

The carrying capacity is an analysis of the ability of pasture areas or grass farming to accommodate a number of livestock so that the need for grass for one-year-animal feed is sufficient. Calculating forage carrying capacity of swamp lowland forage is based on the amount of forage supplied on a pasture for livestock needs for one year which is stated in Animal Unit (AU) per hectare. The amount of carrying capacity was found out by estimating the consumption of dry matter/Animal Unit (AU). The carrying capacity was calculated for each species of forage. The calculation adopted the Purnomo's formula developed by Purnomo (2006).

$$\text{Carrying Capacity} = \frac{\text{Cumulative Production} \times \text{proper use factor (\%)}}{\text{Animal needs (kg DM/AU/day)} \times 360 \text{ days}}$$

$$\text{Cumulative Forage Production} = \left[\left(\frac{hk}{ik} \times pk \right) + \left(\frac{hp}{ip} \times pp \right) + \left(\frac{hh}{ih} \times ph \right) \right]$$

Where:

- hk : Number of days in the dry season (90 days)
- hp : Number of days in the transition season (120 days)
- hh : Number of days in the wet season (150 days)
- ik : Cutting intervals in the dry season (50 days)
- ip : Cutting intervals in the transition season (30 days)
- ih : Cutting intervals in the wet season (40 days)
- pk : Biomass production in the dry season
- pp : Biomass production in the transition season
- ph : Biomass production in the wet season
- puf: Proper Use Factor 68%.
- kt : Animal Need 6,25 kg Dry Matter AU⁻¹day⁻¹

Data Analysis

The data of the carrying capacity of pasture were obtained from the total needs of livestock by referring to the total forage production. The carrying capacity data were analyzed by comparing forage production with to the number of livestock available which result into find out the a ratio that informs of the two illustrating the number of buffaloes that could be developed in the study area. Three possible ratios using the following formulations are: (a)- AU_p/AU_t < 1 - means: if the

186 number of livestock ~~being grazed~~ in swamp ~~land~~ ~~lowlands~~ is greater than the amount of feed available; (b) AUp/AUt =
 187 1- ~~means~~; If there is a balance between the amount of forage available and the number of livestock ~~being grazed~~; (c)
 188 AUp/AUt > 1- ~~means~~; If the number of livestock ~~being grazed~~ is less than the amount of food available in the pasture. ~~AU~~
 189 ~~is animal unit equivalents with~~ ~~Remarks~~: AUp and AUt are animal units for feed and animal unit for livestock, ~~successively~~
 190 ~~respectively~~ (Kleden *et al.*, 2015).

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214 RESULTS AND DISCUSSION

215 Results

216 ~~Species of Forage Vegetation~~ Forage species

217 In the research areas, there were 19 forage species potential to be used as Pampangan buffalo feed, covering 17 grass
 218 species (*Gramineae*) and 2 legume species (*Leguminosae*) (Table 1). Forage vegetation of swamp lowland in Pampangan
 219 buffalo pasture had 19 forage species potential to be used as buffalo feed covering 17 grass species (*gramineae*) and 2
 220 legume species (*leguminosa*) (Table 1).

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221 **Table 1.** ~~Species of Forage species in the studied areas of Pampangan buffalo pasture in non-tidal vegetation of swampy lowland land of~~
 222 ~~Pampangan buffalo pasture~~

Latin Name	Local Name	Village		Remarks
		P	R	
<i>Catharanthus roseus</i> (L.) Don	Tapak dara	+	-	NDP
<i>Cyperus cephalotes</i> Vahl	Apit-apit	+	-	NDP
<i>Cyperus digitatus</i>	Kasuran	-	+	NDP
<i>Digitaria fuscescens</i>	Pasiran / Kerak maling	+	+	DP
<i>Eichhornia crassipes</i>	Eceng gondok	+	-	NDP
<i>Eleocharis dulcis</i>	Purun tikus	+	+	DP
<i>Hymenachne acutigluma</i>	Kumpai tembaga	+	+	DP
<i>Hymenachne amplexicaulis</i>	Kumpai minyak	+	+	DP
<i>Hymenachne sp.</i>	Kumpai merah	+	-	NDP
<i>Ipomoea aquatica</i> Forsk.	Kangkung merah	+	-	NDP
<i>Leersia hexandra</i>	Bento rayap	+	+	DP
<i>Ludwigia hyssopifolia</i>	Cecengkehan	+	-	ND
<i>Neptunia oleracea</i>	Kemon air	+	-	NDP
<i>Nymphaea odorata</i> Aiton	Telepuk Padi	+	-	NDP
<i>Nymphaea lotus</i>	Telepuk Gajah	+	-	NDP
<i>Oryza rufipogon</i>	Kumpai padi	+	+	DP
<i>Polygonum barbatum</i> L.	Are bolong	+	-	DNP
<i>Rhynchospora corymbosa</i> L.	Berondong	-	+	ND

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225	<i>Sesbania exasperata</i>	Mutiara	-	+	NDP
226	Where: P	: Pulau Layang vVillage	NDP	: Not Dominant, Palatable	
227	R	: Rambutan vVillage	ND	: Not Dominant, Not Palatable?	
228	DP	: Dominant, Palatable	+	: Available Present	
229	DNP	: Dominant, Not Palatable	-	: Unavailable Absent	

230 Dominant means a type of forages that always appears in sampling and have high production.

231 **Analysis of Forage Vegetation**

232 The results of Analysis of forage-vegetation analysis of forage species of at Pampangan buffalo pastures in swamp
 233 lowland of Pampangan buffalo pastures during the wet and dry seasons in Pulau Layang vVillage of Pampangan Sudistrict
 234 and Rambutan vVillage are presented in of Banyuasin Subdistrict (Tables 2 and 3, respectively).

235 **Table 2.** Density Value, Relative Density, Frequency, Relative Frequency, and Important Value Index of Important Value of Swamp
 236 Lowland Forage species Vegetation of at Pampangan bBuffalo pPasture during the Wet and dDry Sseasons in Pulau Layang vVillage.

Latin Name	Wet Season					Dry Season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Catharanthus roseus</i> (L.) Don	0,08	2,500	0,06	3,659	6,159	-	-	-	-	-
<i>Cyperus cephalotes</i> Vahl	-	-	-	-	-	0,16	8,421	0,12	9,524	17,945
<i>Digitaria fuscescens</i>	-	-	-	-	-	0,16	8,421	0,12	9,524	17,945
<i>Eichhornia crassipes</i>	0,48	15,000	0,20	12,195	27,195	0,18	9,474	0,08	6,349	15,823
<i>Eleocharis dulcis</i>	0,16	5,000	0,14	8,537	13,537	-	-	-	-	-
<i>Hymenachne acutigluma</i>	0,22	6,875	0,12	7,317	14,192	0,12	6,316	0,12	9,524	15,840
<i>Hymenachne amplexicaulis</i>	0,20	6,250	0,10	6,098	12,348	0,14	7,368	0,08	6,349	13,777
<i>Hymenachne sp.</i>	0,46	14,375	0,18	10,976	25,351	0,20	10,526	0,12	9,524	20,050
<i>Ipomoea aquatica</i> Forsk.	0,04	1,250	0,04	2,439	3,689	-	-	-	-	-
<i>Leersia hexandra</i>	0,06	1,875	0,04	2,439	4,314	0,12	6,316	0,10	7,936	14,252
<i>Ludwigia hyssopifolia</i>	0,18	5,625	0,06	3,659	9,284	0,16	8,421	0,08	6,349	14,770
<i>Neptunia oleracea</i>	0,56	17,500	0,32	19,512	37,012	0,38	20,000	0,24	19,048	39,048
<i>Nymphaea odorata</i> Aiton	0,02	0,625	0,02	1,220	1,845	-	-	-	-	-
<i>Nymphaea lotus</i>	0,02	0,625	0,02	1,220	1,845	-	-	-	-	-
<i>Oryza rufipogon</i>	0,18	5,625	0,08	4,878	10,503	-	-	-	-	-
<i>Polygonum barbatum</i> L.	0,54	16,875	0,26	15,854	32,729	0,28	14,737	0,20	15,873	30,610
TOTAL	3,2	100	1,64	100	200	1,90	100	1,26	100	200

238 Where: D = Density
 239 RD = Relative Density
 240 F = Frequency
 241 RF = Relative Frequency
 242 IVI = Important Value Index

243 **Table 3.** Density, Relative Density, Frequency, Relative Frequency, and Important Value Index of forage species at Pampangan buffalo
 244 pasture during wet and dry seasons in Density Value, Relative Density, Frequency, Relative Frequency, and Index of Important Value of
 245 Swamp Lowland Forage Vegetation of Pampangan Buffalo Pasture during the Wet and Dry Seasons in Rambutan vVillage.

Latin Name	Wet Season					Dry Season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Cyperus digitatus</i>	0,88	18,033	0,30	14,851	32,884	0,12	5,310	0,06	4,348	9,654
<i>Eleocharis dulcis</i>	1,68	34,426	0,74	36,634	71,060	1,00	44,248	0,62	44,928	89,176
<i>Digitaria fuscescens</i>	1,10	22,541	0,40	19,802	42,343	0,40	1,770	0,22	15,942	17,712
<i>Hymenachne acutigluma</i>	0,04	0,820	0,02	0,990	1,810	0,02	0,885	0,02	1,449	2,334
<i>Hymenachne amplexicaulis</i>	0,04	0,820	0,02	0,990	1,810	0,04	1,770	0,02	1,449	3,219
<i>Leersia hexandra</i>	0,06	1,230	0,04	1,980	3,210	0,04	1,770	0,04	2,899	4,659
<i>Oryza rufipogon</i>	0,80	16,393	0,40	19,802	36,195	0,60	26,549	0,38	27,536	54,082
<i>Rhynchospora corymbosa</i> L.	0,08	1,639	0,04	1,980	3,619	0,04	1,770	0,02	1,449	3,219
<i>Sesbania exasperata</i>	0,20	4,098	0,06	2,970	7,068	-	-	-	-	-
TOTAL	4,88	100	2,02	100	200	2,26	100	1,38	100	200

246 Where: D = Density
 247 RD = Relative Density
 248 F = Frequency
 249 RF = Relative Frequency
 250 IVI = Important Value Index

251 **Forage Production**

252 The average Pproduction of fresh forage vegetation fresh forage of swamp lowland in-atthe two study locations on the
 253 average wasas 6.90 tons.ha¹.year¹ in the pasture area of Pulau Layang vVillage, of Pampangan Sub-district, of Ogan
 254

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Komerling Ilir District (Table 4) and 3.68 tons.ha⁻¹.year⁻¹ in the pasture area of Rambutan Village, of Rambutan Sub-district, of Banyuasin District (Table 5).

Table 4. Fresh Weight Production (FWP), Dry Matter Production (DMP), and Forage Carrying Capacity (CC) of Swamp Lowland in the Wet and Dry Seasons in Pulau Layang Village, of Ogan Komerling Ilir.

Latin Name	Wet Season			Dry Season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Catharanthus roseus</i> (L.) Don	7.530	977,40	2,82	-	-	-
<i>Cyperus cephalotes</i> Vahl	-	-	-	4.580	1.145,00 ⁴	3,30
<i>Digitaria fuscescens</i>	-	-	-	2.420	537,97 ¹⁰	1,55
<i>Eichhornia crassipes</i>	5.940	1.097,70	3,17	4.700	830,49 ⁶	2,40
<i>Eleocharis dulcis</i>	12.640	2.664,50	7,69	-	-	-
<i>Hymenachne acutigluma</i>	6.700	1.352,70	3,90	7.480	1.632,54 ¹	4,71
<i>Hymenachne amplexicaulis</i>	6.650	790,00	2,28	5.990	729,58 ⁸	2,11
<i>Hymenachne sp.</i>	7.040	1.151,70	3,32	5.720	975,83 ⁵	2,82
<i>Ipomoea aquatica</i> Forsk.	4.020	604,60	1,75	-	-	-
<i>Leersia hexandra</i>	4.740	1.232,40	3,56	5.290	1.385,45 ²	4,00
<i>Ludwigia hyssopifolia</i>	1.980	346,90	1,00	4.290	777,35 ⁷	2,24
<i>Neptunia oleracea</i>	1.910	394,80	1,14	2.870	607,01 ⁹	1,75
<i>Nymphaea odorata</i> Aiton	7.500	1.286,30	3,71	-	-	-
<i>Nymphaea lotus</i>	9.800	1.983,50	5,72	-	-	-
<i>Oryza rufipogon</i>	12.960	2.225,20	6,42	-	-	-
<i>Polygonum barbatum</i> L.	7.180	1.651,40	4,77	5.290	1.244,74 ³	3,59
Average	6.899	1.268,51	3,66	4.863	986,60	2,85

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Pasture Carrying Capacity

The carrying capacity of swamp lowland for Pampangan buffalo pasture in Pulau Layang village Pampangan buffaloes in the swamp lowland pasture of Pulau Layang Village was 3.66 AU.ha⁻¹.year⁻¹ during the wet season and 2.85 AU.ha⁻¹.year⁻¹ in the dry season (Table 4). The carrying capacity of swamp lowland for Pampangan buffaloes in the swamp lowland pasture in of Rambutan Village was 2.61 AU.ha⁻¹.year⁻¹ in the wet season it and was 2.04 AU.ha⁻¹.year⁻¹ in the dry season (Table 5).

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Table 5. Fresh weight production (FWP), dry matter production (DMP), and forage carrying capacity (CC) of swamp lowland in wet and dry seasons in Fresh Weight Production, Dry Matter Production, and Forage Carrying Capacity of Swamp Lowland in the Wet and Dry Seasons in Rambutan Village, of Banyuasin.

Latin Name	Wet Season			Dry Season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Cyperus digitatus</i>	2.590	248,90	0,72	240	28,61	0,08
<i>Digitaria fuscescens</i>	790	108,00	0,31	1.100	152,79	0,44
<i>Eleocharis dulcis</i>	4.370	921,20	2,66	1.700	376,21	1,09
<i>Hymenachne acutigluma</i>	8.540	3.139,30	9,06	5.900	2.181,82	6,29
<i>Hymenachne amplexicaulis</i>	4.860	577,40	1,67	3.200	489,28	1,41
<i>Oryza rufipogon</i>	4.690	1.462,80	4,22	4.420	1.421,03	4,10
<i>Rhynchospora corymbosa</i> L.	1.510	441,80	1,28	250	77,88	0,22
<i>Sesbania exasperata</i>	1.360	111,50	0,32	-	-	-
Average	3.676,67	905,52	2,61	2.523,75	705,66	2,04

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Discussion

Diversity of forage Species of Forage Vegetation

283 There are dominant and palatable forage vegetation species of-in swamp lowland forage-vegetation having potential as
284 buffalo feed, namely Kumpai padi grass (*O. rufipogon*), Kumpai tembaga (*H. acutigluma*), and Kumpai minyak (*H.*
285 *amplexicaulis*), not dominant and palatable such as Kumpai merah (*Hymenachne* sp) and Kemon air (*N. olerancia*);
286 dominant and non palatable grass species (buffalo doesn't like it) namely Are bolong (*P. barbatum* L). Yet, this grass
287 species would be eaten by the buffaloes if there were no other forage species to be eaten (Table 1). The results of this study
288 are different from the results of research conducted by other people before, the fundamental difference is the existence of
289 differences in internal factors (forage vegetation) and external factors (environment). This research was carried out on
290 swampland while research carried out by others was mostly on dry land or on tidal land. With the difference in place of
291 study, the number, types of forage vegetation that are available will also be different. Besides that there is also a difference
292 about the production of forages and the carrying capacity of pasture. The renewal of this research is that there is currently
293 no discussion about the analysis of vegetation and the carrying capacity of pasture grazing on swampland.

295 Ali et al. (2012) conducted a study on swamp land vegetation and found 25 species in Pampang sub-district, while
296 Rohaeni et al. (2005) found 24 species in South Kalimantan, and Camarao and Rodrigues Filho (2001) only found 7 species
297 in Brazil. In Gowa District, there were 15 vegetation species on found on the natural grasslands consisting of 12 vegetation
298 species classified as palatable forage (7 grasses and 5 legumes) and 3 non palatable species, all of them are native species
299 (Rinduwati et al., 2016). All of these vegetation species are of natural grass fields with local species. Based on the number
300 of species encountered (15 species), it can be said that the natural pasture in Gowa District is quite good (Rinduwati et al.,
301 2016). Other studies show high diversity of forage species: in Sota Village pasture there found 33 vegetation species in Sota
302 village in Marauke, consisting of 61% grass, 3% legume and other plants 36% (Praptiwi et al., 2017); 22 forage species in
303 Pakistan (Abdullah et al., 2017), 40 forage species consisting of 82 – 87% forage grass, 1% legume and forage consumable
304 by livestock, and 12 - 17% those innot edible by livestock in West Papua (Yoku et al., 2015). In Tobelo Sub-district, The
305 composition of feed-forage in Tobelo Sub-district pasture is consisted of 58.33% grass, 25% legume, and 16.67% other forage
306 (Matulesy and Kastanja, 2013; Eoh, 2014). The species diversity at different heights is influenced by the season in which
307 where the wet season increases the availability of water needed by plants for growth, especially the grass species, resulting
308 in higher diversity (Kumalasari and Sunardi, 2015).

310 Analysis of Forage rVegetation

311 In Pulau Layang village, The analysis results of the vegetation of Pulau Layang Village during the wet season, species
312 with having the highest relative density, relative frequency, and Important Value Index (IVI) were Kemon air (*N. olerancia*)
313 having 0.56 density, 17.5% relative density, 0.32 frequency, 19.512% relative frequency, and 37.01% Important Value
314 Index, followed by 32.72% Are bolong (*P. barbatum* L) and 27.19% Eceng gondok (*E. crassipes*), while the lowest value
315 was Telepek padi (*N. odorata* Aiton) and Telepek gajah (*N. lotus*) which was 1.84% each. During the dry season, The
316 highest relative density, relative frequency and IVI importance value index in the dry season were Kemon air (*N. olerancia*)
317 which was with 39.04%, followed by Are bolong (*P. barbatum* L) 30.61% and Kumpai merah (*Hymenachne* sp.) 20.05%,
318 while the lowest value was Kumpai padi (*O. rufipogon*) which was with 13.71% (Table 2). Those results also showed that
319 in Pulau Layang Village there was a difference in the amount of vegetation between the wet and dry seasons. In the wet
320 season there were 14 forage vegetation species and in the dry season there were only 10 forage vegetation species.
321 Meanwhile, Apit-apit (*C. chephalotes* Vahl) and Kerak maling (*D. fuscescens*) were not found in the wet season. Likewise,
322 in the dry season, Purun tikus (*E. dulcis*), Kumpai padi (*O. rufipogon*), Tapak darah (*C. roseus* L. Don), Kangkung merah
323 (*I. aquatica* Forsk), and Telepek padi (*N. odorata* Aiton) were not found. The results show that there were some vegetation
324 species tolerant of water and some others were not.

325 In Rambutan village, during the wet season, species with the highest Important Value Index (IVI) were Purun tikus (*E.*
326 *dulcis*) with 71.06%, Kerak maling (*D. fuscescens*) 42.34%, and Kumpai padi (*O. rufipogon*) 36.19%. The lowest value were
327 Kumpai tembaga (*H. acutigluma*) and Kumpai minyak (*H. amplexicaulis*) 1.81% each. In the dry season, the highest IVI
328 were Purun tikus (*E. dulcis*) 89.71%, Kumpai padi (*O. rufipogon*) 54.08%, and Kerak maling (*D. fuscescens*) 17.71%. The
329 lowest value was Kumpai tembaga (*H. acutigluma*) 2.33% (Table 3).

330 The results also showed that there was a difference in the species richness between the wet and dry seasons. In Pulau
331 Layang Village in the wet season there were 14 forage species and in the dry season there were only 10 forage species. While
332 Apit-apit (*C. chephalotes* Vahl) and Kerak maling (*D. fuscescens*) were not found in the wet season, Purun tikus (*E. dulcis*),
333 Kumpai padi (*O. rufipogon*), Tapak darah (*C. roseus* L. Don), Kangkung merah (*I. aquatica* Forsk), and Telepek padi (*N.*
334 *odorata* Aiton) were not found in the dry season. In Rambutan village, in wet season there were 9 forage species, while in
335 the dry season there were only 8 species. In the dry season there was no legume Mutiara (*S. exasperate*), indicating that this
336 species could not bear the drought and as a result it would die in the dry season. These results suggest that there are some
337 species that tolerant to water while some others were not. On the other hand, some species are tolerant to drought, while
338 some others are not.

339 In other words, those tolerant of water would survive and those which were not would die.

340 The Important Value Index (IVI) differences of the swamp lowland forage vegetation among species might have be
341 resulted from caused by the competition of each species of vegetation to in obtaining soil nutrients in the soil and sunlight,
342 as well as the influencing climatic factors of the wet and dry seasons. This is in accordance with the results of as also stated

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343 by Parmadi JC et al. (2016) reporting that the IVI differences of each vegetation species were due to their competition
344 to obtain nutrients and sunlight. In addition to nutrients and sun, there are other influencing factors of namely vegetation
345 density and ~~hides~~. The variations of the species diversity and composition and amount of vegetation indicates that even
346 though ~~one~~ research location has the same age, yet the environmental conditions could result in different vegetation
347 (Syarifuddin, 2011). In Pulau Layang village, The vegetation species having the highest IVI were Kemon air and Are bolong
348 (37.01 and 32.73%) while in Rambutan village were Purun tikus, Kerak maling and Kumpai padi (71.06%, 42.34%, and
349 36.19%), indicating that. This shows that the vegetation species of Kemon air and Are bolong they are the most dominant
350 ones species among other vegetation species. A vegetation species is said considered to be dominant in an area if it has a
351 percentage IVI of more than 20% of the total individuals all species and co-dominant if the percentage ranges from 10% to
352 20% (Suveltri et al., 2014).

353 The analysis results of the vegetation of Rambutan Village during the wet season having the highest relative density,
354 relative frequency, and Important Value Index were Purun tikus (*E. dulcis*) 71.06%, Kerak maling (*D. fuscescens*) 42.34%,
355 and Kumpai padi (*O. rufipogon*) 36.19%. The lowest value ones were Kumpai tembaga (*H. acutigluma*) and Kumpai minyak
356 (*H. amplexicaulis*) 1.81% each. The highest relative density, relative frequency, and important value index in the dry season
357 were Purun tikus (*E. dulcis*) 89.71%, Kumpai padi (*O. rufipogon*) 54.08%, and Kerak maling (*D. fuscescens*) 17.71%. The
358 lowest value was Kumpai tembaga (*H. acutigluma*) 2.33% (Table 3). The highest species density of swamp forage vegetation
359 in swamp ecosystem might have resulted from its adaptation and development ability in accordance with the environment.
360 This is in accordance with strengthen the study result conducted by Oktaviani et al. (2015) that the plants vegetation had
361 the with the highest density because can this vegetation adapt to matched the environment to grow and reproduce under the
362 conditions of land whose soil and water contained low pH in water and soil. In contrast, As for the plants having with
363 the lowest density, it might have been due to be caused by the unsuitable environmental and land factors for the plants to grow
364 and breed, particularly in the acidic the pH of the water and the soil was low in acid. (Samin et al., 2016). The results also
365 show that in Rambutan Village there was a difference in the amount of vegetation between the wet and dry seasons. In wet
366 season there were 9 species of forage vegetation, while in the dry season there were only 8 species of forage vegetation. In
367 the dry season there was no legume Mutiara (*S. exasperate*). This shows that the legume Mutiara (*S. exasperate*) could not
368 bear the drought and as a result it would die in the dry season.

370 Forage pProduction

371 The high production of vegetation for swamp lowland in Pampangan Subdistrict compared to that in Rambutan
372 Subdistrict might have resulted from the soil fertility of the pasture area of Pampangan Subdistrict which was more fertile
373 than that of Rambutan Subdistrict. The analysis results showed that the C-Organic, N-total and P-available analysis (Bray
374 I) were higher than those in the Rambutan District. The high fertility of the land was thought that the most pasture of Pulau
375 Layang Village was the rice fields and always given fertilizer. Unlike the pasture of Pampangan Subdistrict, the pasture of
376 Rambutan Village was only used for the grazing buffaloes without any use of fertilizer. The provision of manure and bioslurry
377 fertilizer can increase the production and forage quality of 4.75 tons and 4.36 tons respectively. (Suarna dan Budiasa 2016;
378 Jeffery et al., 2018).

379 The results of the research in the pasture area of Pampangan Subdistrict, Ogan Komering Ilir was 6.90 tons ha⁻¹.year⁻¹
380 which was lower than that of Kleden et al. (2015) reporting that the production of natural grass in coffee and grassland areas
381 of Wulanggintang Subdistrict, East Flores District was 7.664 tons.ha⁻¹.year⁻¹ and 6.98 tons.ha⁻¹.year⁻¹ respectively. This result
382 was higher than that of Se'u et al. (2015) reporting that the grass production in real conditions in South Central Timor District
383 was only 0.15-0.39 tons.ha⁻¹.year⁻¹.

384 The production of fresh forage swamp lowland at pastures in of Pulau Layang vVillage in the wet season was 6.899 kg
385 .ha⁻¹.year⁻¹ and the production of the dry matter was 1,268.51 kg .ha⁻¹.year⁻¹, while in the dry season the fresh production of
386 fresh forage was 4,863 kg .ha⁻¹.year⁻¹ and the dry matter production was 986.60 kg .ha⁻¹.year⁻¹ (Table 4). This result is was
387 higher than those conducted by in Canada (Rinduwati et al., 2016; (Omokanye et al., 2018) and in Timor Tengah Selatan
388 District (Se'u et al., 2015), stating that the average fresh production of pasture in of Gowa District in the wet season was
389 5,350 kg .ha⁻¹. year⁻¹ and in the dry season was 1,390 kg .ha⁻¹.year⁻¹ (Rinduwati et al., 2016). But those the results of this
390 study were lower than the study of by Abdullah et al., (2017) in Pakistan who reported that forage production was 8,029.1
391 kg .ha⁻¹.year⁻¹ in the wet season and 5,422.9 kg .ha⁻¹. year⁻¹ in the dry season. The forage production of pasture forage
392 production in of Sabana Timur Barat on the average ranged from 0.61 to 4.33 tons .ha⁻¹.year⁻¹ (Manu, 2013).

393 The lowest production usually occurs red at the peak of the dry season in October and the highest occurs in April (Manu,
394 2013; Damry, 2009). The forage production of *Pennisetum purpupoides* was 70.4 ton .ha⁻¹.year⁻¹, *Setaria sphaesieta* 44.8
395 tons .ha⁻¹.year⁻¹, *Brachiaria sp* 44.7 tons .ha⁻¹.year⁻¹, *Pennisetum purpureum* 44.6 tons .ha⁻¹.year⁻¹, and *Panicum maximum* 15,6
396 tons .ha⁻¹.year⁻¹ (Jarmani and Haryanto, 2015). The different amounts of production might have resulted from the differences
397 in vegetation species, types of pasture, and methods used. There are various methods for estimating forage production, but
398 many are inaccurate when used with applied to certain animal feed plant species. Therefore, it is very important to find out
399 the use and understand the limitations of ted techniques used of to measuring forage production (Edvan et al., 2016;
400 Badgery et al., 2017).

401 In Pulau Layang village, there were 5 forage species swamp lowland forage species having high fresh production in the
402 wet season in Pulau Layang Village, namely Kumpai padi (*O. rufipogon*) with 12,960 kg .ha⁻¹.year⁻¹, followed by Purun

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403 tikus (*E. dulcis*), Telepuk gajah (*N. lotus*), Are bolong (*P. barbatum* L) and Telepuk padi (*N. odorata* Aiton), and the lowest
404 one was Kemon air (*N. olerancia*) with 1,910 kg_·ha⁻¹·year⁻¹. In the dry season the highest fresh production was Kumpai
405 tembaga (*H. acutigluma*) as many as with 7,480 kg_·ha⁻¹·year⁻¹, followed by Kumpai minyak (*H. amplexicaulis*), Kumpai
406 merah (*Hymenachne* sp.), Are bolong (*P. barbatum* L) and Bento rayap (*L. hexandra*), and the lowest one was Kemon air
407 (*N. olerancia*) of with only 2,870 kg_·ha⁻¹·year⁻¹. The highest dry matter production in the wet season was Purun tikus (*E.*
408 *dulcis*) as many as with 2,664.5 kg_·ha⁻¹·year⁻¹, followed by Kumpai padi (*O. rufipogon*), Telepuk gajah (*N. lotus*), Are
409 bolong (*P. barbatum* L), and Kumpai tembaga (*H. acutigluma*), and the lowest one was Cecengkehan (*L. hyssopifolia*). In
410 the dry season the highest dry matter production was Kumpai tembaga (*H. acutigluma*) as many as with 7,480 kg_·ha⁻¹·year⁻¹
411 ¹, followed by Bento rayap (*L. hexandra*), Are bolong (*P. barbatum* L), Apit-apit (*C. chephalotes* Vahl) and Kumpai merah
412 (*Hymenachne* sp.), and the lowest one was Kerak maling (*D. fuscescens*) as many as with 2,420 kg_·ha⁻¹·year⁻¹ (Table 4).

413 In Rambutan village, the production of fresh forage swamp lowland pasture of Rambutan Village during the
414 wet season was 3,676.67 kg_·ha⁻¹·year⁻¹ and the dry matter production was 905.52 kg_·ha⁻¹·year⁻¹, whereas in the dry season
415 the fresh production was 2,523.75 kg_·ha⁻¹·year⁻¹ and the dry matter production was 705.66 kg_·ha⁻¹·year⁻¹ (Table 5). These
416 results were higher than those of the study conducted by (Purwantari et al. (2015); and Praptiwi et al., (2017) who reported
417 that the average availability of the forage on palm oil plantations on pasture areas was 1,455.5 kg_·ha⁻¹·year⁻¹, but it was
418 lower than the those of the study conducted by Rinduwati et al., (2016) stating that the production of pasture fresh forage
419 in Gowa District during the wet season was on the average 5,350 kg_·ha⁻¹·year⁻¹, but it was lower than that in the dry season
420 of only 1,390 kg_·ha⁻¹·year⁻¹. The forage production of during preproduction of rubber plantation was 732.90 kg_·ha⁻¹·year⁻¹
421 and at the time of production it was only 317.83 kg_·ha⁻¹·year⁻¹ (Pramana et al., 2015).

422 In Rambutan village, during the wet season there were 5 forage species of swamp lowland forage having the highest
423 fresh and dry matter production during the wet season, namely Kumpai tembaga (*H. acutigluma*) producing 8,540 kg_·ha⁻¹
424 ·year⁻¹ and 3,139.3 kg_·ha⁻¹·year⁻¹ each respectively, followed by Kumpai padi (*O. rufipogon*), Bento rayap (*L. hexandra*),
425 Purun tikus (*E. dulcis*), and Kumpai minyak (*H. amplexicaulis*), and the lowest one was Kerak maling (*D. fuscescens*) of
426 with 790 kg_·ha⁻¹·year⁻¹ and 108.0 kg_·ha⁻¹·year⁻¹, respectively. In the dry season, the highest fresh and dry matter production
427 was Kumpai tembaga (*H. acutigluma*) of 5,900 kg_·ha⁻¹·year⁻¹ and 2,181.82 kg_·ha⁻¹·year⁻¹, followed by Kumpai padi (*O.*
428 *rufipogon*), Bento rayap (*L. hexandra*), Kumpai minyak (*H. amplexicaulis*), and Purun tikus (*E. dulcis*), and the lowest
429 one was Kasuran (*C. digitatus*) with of 240 kg_·ha⁻¹·year⁻¹ and 11.92 kg_·ha⁻¹·year⁻¹, respectively (Table 5). The results of
430 this study were still higher than those conducted by Rostini et al. (2014) stating that the highest grass fresh forage
431 of grass *Hymenachne amplexicaulis* Haes was 1,032 kg DM_·ha⁻¹·harvest⁻¹ in the high tide season and 518.3 kg DM_·ha⁻¹
432 ·harvest⁻¹ in the low tide season, where the dry matter production ranged from 43.8 to 1.032 kg DM_·ha⁻¹·harvest⁻¹ in the
433 high tide season and from 38.5 to 752.8 kg DM_·ha⁻¹·harvest⁻¹ in the low tide season.

434 The higher production of forage in Pampangan Sub-district compared to that in Rambutan Sub-district might be caused
435 by higher soil fertility of the pasture area in Pampangan. The result of soil analysis showed that the C-Organic, N-total and
436 P-available in Pampangan (Bray D) were higher than those in Rambutan which might be related to the fact that most pasture
437 in Pulau Layang village (Pampangan) are rice fields which are always given fertilizer. This differs with pasture in Rambutan
438 village which is only used for grazing without any use of fertilizer. The provision of manure and bioslurry fertilizer can
439 increase the production and forage quality of 4.75 tons and 4.36 tons, respectively (Suarna dan Budiasa 2016; Jeffery et al.,
440 2018).

443 Pasture Carrying Capacity

444 In Pulau Layang village, the carrying capacity is an analysis of the ability of pasture areas or grass farming to
445 accommodate a number of livestock so that the need for grass for one-year animal feed is sufficient. Calculating forage
446 carrying capacity of swamp lowland forage is based on the amount of forage supplied on a pasture for livestock needs for
447 one year which is stated in Animal Unit (AU) per hectare. According to Purnomo (2006), the calculation of carrying capacity
448 is based on the formula of:

$$449 \text{ Carrying Capacity} = \frac{450 \text{ Cumulative Production} \times \text{proper use factor} (\%)}{451 \text{ Animal Need (kg DM/AU/day)} \times 360 \text{ days}}$$

452 The carrying capacity for Pampangan buffaloes pasture on the swamp lowland pasture of Pulau Layang Village in the
453 wet season was 3.66 AU_·ha⁻¹·year⁻¹ and 2.85 AU_·ha⁻¹·year⁻¹ during the dry season (Table 4). In Rambutan village, the
454 carrying capacity for Pampangan buffalo pasture in the wet season was 2.61 AU_·ha⁻¹·year⁻¹ and in the dry season was 2.04
455 AU_·ha⁻¹·year⁻¹ (Table 5). The results of this study corresponded to those of the study conducted by Rostini et al. (2014)
456 which found stated that the carrying capacity of swamp lowland plants in South Kalimantan was 2.91 AU_·ha⁻¹·year⁻¹. These
457 results were higher than those of the study conducted by Seu et al., (2015) reporting that the carrying capacity of grass in
458 real conditions in South-Central Timor District was only 0.24–0.63 AU_·ha⁻¹·year⁻¹, and average carrying capacity of natural
459 pastures of Gowa District was 0.88 AU_·ha⁻¹·year⁻¹ (Rinduwati et al., 2016) and the capacity of pasture in Poso District 0.63
460 AU_·ha⁻¹·year⁻¹ (Damry, 2009; Daru et al., 2014). The carrying capacity of pasture of Sota Village, Merauke District, was

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463 still relatively small (Praptiwi et al., 2017). The carrying capacity of pasture in Kelei and Didiri Villages of Poso Districts
464 was 0.96 and 1.12 AU.ha⁻¹.year⁻¹ (Karti et al., 2015). The pasture performance of the *Brachyaria humidicola* (Rendle) was
465 2.31 AU.ha⁻¹.year⁻¹ (Anis et al., 2014). Abdullah et al., (2017) reported that the carrying capacities of forage in the wet and
466 dry seasons in Pakistan were 24 AU.ha⁻¹.year⁻¹ and 16 AU.ha⁻¹.year⁻¹.

467 These results were higher than in grass land in South Central Timor District with only 0.24 - 0.63 AU ha⁻¹ year⁻¹ (Seu et
468 al., 2015), in natural pastures of Gowa District with 0.88 AU ha⁻¹ year⁻¹ (Rinduwati et al., 2016), in pasture in Poso District
469 with 0.63 AU ha⁻¹ year⁻¹ (Damry, 2009; Daru et al., 2014), in Kelei and Didiri villages of Poso Districts with 0.96 and 1.12
470 AU ha⁻¹ year⁻¹ (Karti et al., 2015), and the pasture of *Brachyaria humidicola* (Rendle) with 2.31 AU ha⁻¹ year⁻¹ (Anis et al.,
471 2014). However, these results were lower than the study conducted by Muhajirin et al. (2017) stating that the carrying
472 capacity of Padang Mengatas BPTU was 5 AU ha⁻¹ year⁻¹ in the wet season and 3.18 AU ha⁻¹ year⁻¹ in the dry season. Even,
473 Abdullah et al., (2017) reported very high carrying capacity of forage in Pakistan with 24 AU ha⁻¹ year⁻¹ and 16 AU ha⁻¹
474 year⁻¹ in the wet and dry seasons, respectively.

475 There is a decrease in the dry material production during the dry season because the water condition in swamp lowland
476 is reduced. Decrease in swamp water level resulted in the decrease of photosynthesis which affect the production of the dry
477 matter. Water is the main ingredient needed in photosynthesis. The disruption of metabolic processes in plants will affect
478 plant production. Plant dry weight depicts the accumulation of organic compounds that are successfully synthesized by the
479 plants from inorganic compounds, especially water and CO₂ (Lakitan, 1995). Water shortages will have a negative effect on
480 plant growth resulting in decreased production (Jun-Feng et al., 2010; Taiz and Zeiger 2002).

481 The high carrying capacity is related to the high forage production, forage management of forage development and
482 selection of good species. The management and strategy carried out to increase forage production require innovative
483 facilitation and training to stockbreeders and farmers innovative training facilitated to have to increase their knowledge.
484 These efforts of breeding and it should be supported by the government and private companies develop to make a program
485 regarding about the importance of forage to increase ruminant livestock production (Nigus, 2017; Omokanye et al.,
486 2018).

487 In Pulau Layang village. In a the pasture condition assumed to have one forage species of swamp forage, the highest
488 carrying capacity in the wet season was Purun tikus (*E. dulcis*) as much as with 7.69 AU.ha⁻¹.year⁻¹, and then followed by
489 Kumpai padi (*O. rufipogon*) with 6.42 AU.ha⁻¹.year⁻¹, Telepek gajah (*N. lotus*) with 5.72 AU.ha⁻¹.year⁻¹, Are bolong (*P.*
490 *barbatum* L) with 4.77 AU.ha⁻¹.year⁻¹ and Kumpai tembaga (*H. acutigluma*) with 3.90 AU.ha⁻¹.year⁻¹,
491 respectively consecutively, and the lowest one was Cecengkehan (*L. hyssopifolia*) with 1.00 AU.ha⁻¹.year⁻¹. In the dry
492 season, the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) as much as with 4.71 AU.ha⁻¹.year⁻¹, and then
493 it was followed by Bento rayap (*L. hexandra*) as much as with 4.00 AU.ha⁻¹.year⁻¹, Are bolong (*P. barbatum* L) with 3.59
494 AU.ha⁻¹.year⁻¹, Apit-apit (*C. chepalotes* Vahl) with 3.30 AU.ha⁻¹.year⁻¹ and Kumpai merah (*Hymenachne* sp.) with 2.82
495 AU.ha⁻¹.year⁻¹, whereas the lowest one was Kerak maling (*D. fuscescens*) as much as with 1.55 AU.ha⁻¹.year⁻¹ (Table 4).

496 The carrying capacity of Pampangan buffalo pasture of the swamp lowland of Rambutan Village during the wet season
497 was 2.61 AU.ha⁻¹.year⁻¹ and in the dry season it was 2.04 AU.ha⁻¹.year⁻¹ (Table 5). This result was lower than those of the
498 study conducted by Muhajirin et al. (2017) stating that the carrying capacity of Padang Mengatas BPTU was 5 AU.ha⁻¹.year⁻¹
499 in the wet season and 3.18 AU.ha⁻¹.year⁻¹ in the dry season. There was a decrease in the dry material production during
500 the dry season because the water condition in swamp lowland alleviated. The decreased swamp water condition resulted in
501 a decrease of photosynthesis and automatically the production of the dry matter decreased. Water is the main ingredient
502 needed in photosynthesis. The disruption of metabolic processes in plants will affect plant production. Plant dry weight
503 depicts the accumulation of organic compounds that are successfully synthesized by the plants from inorganic compounds,
504 especially water and CO₂ (Lakitan, 1995). Water shortages will have a negative effect on plant growth resulting in decreased
505 production (Jun-Feng et al., 2010; Taiz and Zeiger 2002).

506 When the pasture in Rambutan village, assuming that the pasture condition had had one forage species of swamp forage,
507 the highest carrying capacity in the wet season consecutively included was Kumpai tembaga (*H. acutigluma*) with of 9.06
508 AU.ha⁻¹.year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 4.22 AU.ha⁻¹.year⁻¹, Bento rayap (*L. hexandra*) with 3.29
509 AU.ha⁻¹.year⁻¹, Purun tikus (*E. dulcis*) 2.66 with AU.ha⁻¹.year⁻¹, and Kumpai minyak (*H. amplexicaulis*) with 1.67 AU
510 ha⁻¹.year⁻¹. While the lowest one was Kerak maling (*D. fuscescens*) as much as with 0.31 AU.ha⁻¹.year⁻¹. During the dry
511 season the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) as much as with 6.29 AU.ha⁻¹.year⁻¹, and then
512 followed by Kumpai padi (*O. rufipogon*) as much as with 4.10 AU.ha⁻¹.year⁻¹, Bento rayap (*L. hexandra*) with 2.65 AU.
513 ha⁻¹.year⁻¹, Kumpai minyak (*H. amplexicaulis*) with 1.41 AU.ha⁻¹.year⁻¹, and Purun tikus (*E. dulcis*) with 1.09 AU.ha⁻¹
514 .year⁻¹. While the lowest one was Kasuran (*C. digitatus*) as much as with 0.08 AU.ha⁻¹.year⁻¹ (Table 5). These results
515 indicate that the carrying capacity is very influential with the type of feed plan. In addition, the most other important thing is
516 also cattle grazing system in which livestock grazing must be regulated to avoid over-grazing as. The amount of grazing
517 livestock depends on the carrying capacity of the pasture (Salendu and Elly, 2014; Cheng et al., 2017; Hashemi, 2017).

518 The results of this study indicated that the forage availability was is still sufficient to meet feed requirements for
519 Pampangan buffaloes. The population of Pampangan buffaloes of in Pulau Layang village was 487 buffaloes with a grazing
520 area of 500 ha with and an average carrying capacity of 3.14 AU.ha⁻¹.year⁻¹. While the number of Pampangan buffaloes of
521 Rambutan village was 1.735 buffaloes with a pasture area of 1,203 ha and an average carrying capacity of 2.45 AU.ha⁻¹

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522 -year⁻¹. It is projected-estimated that there-is still a-need-for-can be additional buffalo cattle as much as 0.31 AU .ha⁻¹ .year⁻¹
 523 ¹ in Pulau Layang vVillage so 155 buffaloes and 0.59 AU .ha⁻¹ .year⁻¹ in Rambutan vVillage .709 buffaloes
 524 Based on the results of the study, the following is the In conclusion :-
 525 1. There were 19 forage species of swamp lowland forage vegetation found to have the potential to-as feeding source of
 526 the Pampangan buffaloes in South Sumatra. The importance of species indicated by
 527 2. Important Value Index (IVI) is strongly influenced by grazing locations and seasons. The most important species-The
 528 high IVI were Kemon air (*N. olerancia*) and Are bolong (*P. barbatum* L) in Pulau Layang vVillage and- Purun tikus (*E.*
 529 *dulcis*), Kerak maling (*D. fuscescens*), and Kumpai padi (*O. rufipogon*) in Rambutan Village. -the high IVI were Purun
 530 tikus (*E. dulcis*), Kerak maling (*D. fuscescens*), and Kumpai padi (*O. rufipogon*);
 531 3. In In Pulau Layang vVillage, the fresh forage and dry matter production of forage vegetation swamp lowland
 532 pasture in the wet season were 6.90 and 1.27 tons .ha⁻¹ .year⁻¹, while in Rambutan vVillage they were 3.68 tons .ha⁻¹ .year⁻¹
 533 and 0.91 ton .ha⁻¹ .year⁻¹ dry consecutively, respectively. The fresh forage production and dry matter production in the dry
 534 season in Pulau Layang vVillage were 4.86 and 0.99 tons .ha⁻¹ .year⁻¹, while in Rambutan vVillage they were 2.52 tons .ha⁻¹
 535 .year⁻¹ and 0.71 tons .ha⁻¹ .year⁻¹, respectively consecutively.
 536 4. The carrying capacity of swamp lowland pasture in the wet season in Pulau Layang Village was 3.66 AU.ha⁻¹.year⁻¹
 537 and in the dry season it was 2.85 AU.ha⁻¹.year⁻¹. In Rambutan Village in the wet season it was 2.61 AU.ha⁻¹.year⁻¹ and in the
 538 dry season it was 2.04 AU.ha⁻¹.year⁻¹. Therefore, On the average the carrying capacity of the swamp lowland pasture in
 539 South Sumatra was 2.79 AU.ha⁻¹.year⁻¹. As such,
 540 5. The forage availability is still sufficient to meet the need for animal feed, and it is projected-estimated the areas can be
 541 that there is still a need for additional added buffalo cattle for of 0.31 AU .ha⁻¹ .year⁻¹ in Pulau Layang vVillage and 0.59 AU
 542 .ha⁻¹ .year⁻¹ in Rambutan vVillage.
 543 6. The highest forage production in the wet season in Pulau Layang Village was Purun tikus, followed by, Kumpai padi,
 544 Telepuk gajah, Are bolong, Kumpai tembaga, while in the dry season the highest one was Kumpai tembaga, followed by
 545 Bento rayap, Are bolong, Apit apit and Kumpai merah. In Rambutan Village the highest forage production in the wet
 546 and dry seasons were Kumpai tembaga, Kumpai padi, Bento rayap, Kumpai minyak, and Purun tikus.

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634

**5. Bukti konfirmasi submit revisi ketiga,
respon kepada reviewer, dan artikel
yang diresubmit (23 Maret 2019)**

Vegetation analysis of non-tidal swampland in South Sumatra, Indonesia and its carrying capacity for Pampangan buffalo pasture

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Abstract. Muhakka, Agussuwignyo R, Budianta D, Yakup. 2019. Vegetation analysis of non-tidal swampland in South Sumatra, Indonesia and its carrying capacity for Pampangan buffalo pasture. *Biodiversitas* 20: xxxx. In Indonesia, non-tidal swampland area is 13.27 million ha, only 4 million ha has been developed with details of 2.6 million ha that managed by the public and the private sector and 1.3 million ha with government assistance. This study aims to analyze vegetation structure of non-tidal swampland in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin District, South Sumatera and to examine its carrying capacity for Pampangan buffalo pasture. Methods used were by the combination of direct observation, survey using plot sampling with total 50 observation plots, and measurements to determine forage production using Halls method. The results show that there 19 forage species were in two studied areas which are potential as Pampangan buffalo feed. Species with the highest Important Value Index were Purun tikus (*Eleocharis dulcis*) with 89.71% and Kumpai padi (*Oryza rufipogon*) with 54.08%. The production of fresh forage and dry matter in the wet season in Pulau Layang was 6.90 tons ha⁻¹ year⁻¹ and 1.27 tons ha⁻¹ year⁻¹, respectively, whereas in Rambutan they were 3.68 tons ha⁻¹ year⁻¹ and 0.91 tons ha⁻¹ year⁻¹, respectively. The production of fresh forage and dry matter in the dry season in Pulau Layang was 4.86 tons ha⁻¹ year⁻¹ and 0.99 tons ha⁻¹ year⁻¹, respectively, while in Rambutan they were 2.52 tons ha⁻¹ year⁻¹ and 0.71 tons ha⁻¹ year⁻¹, respectively. The pasture carrying capacity in Pulau Layang in the wet season was 3.66 AU (Animal Unit) ha⁻¹ year⁻¹ and in the dry season, it was 2.85 AU ha⁻¹ year⁻¹, while in Rambutan Village it was 2.61 AU ha⁻¹ year⁻¹ and 2.04 AU ha⁻¹ year⁻¹, respectively. There were six species of forage with high production, namely Kumpai tembaga (*Hymenachne acutigluma*) Kumpai padi (*Oryza rufipogon*), Kumpai minyak (*Hymenachne amplexicaulis*), Are bolong (*Polygonum barbatum* L), Bento rayap (*Leersia hexandra*) and Purun tikus (*Eleocharis dulcis*). It is estimated that there still can be added buffalo cattle as much as 0.31 AU ha⁻¹ year⁻¹ in Pulau Layang Village so 155 buffaloes and 0.59 AU ha⁻¹ year⁻¹ in Rambutan Village. 709 buffaloes

Keywords: Pampangan buffalo, vegetation analysis, carrying capacity, pasture, non-tidal swampland

INTRODUCTION

Non-tidal swampland is often considered as suboptimal land despite its availability is very extensive in Indonesia. The total extent of non-tidal swampland is about 13.27 million ha, consisting of 3.0 million ha of deep swampland, 6.07 million ha of swampland with medium deep and 4.20 million ha of shallow swampland, and is distributed in Sumatra, Kalimantan, and Papua. Nonetheless, there is only 4 million ha of them have been developed with public and private sectors manage 2.60 million ha while 1.3 million ha are developed by government assistance (Indonesian Statistic Agency 2010; Mulyani and Sarwani 2013). At provincial level, non-tidal swampland in South Sumatra covers the most extensive area in Sumatra, reaching 2.98 million ha but only 298,189 ha that has been developed (Statistics Agency of South Sumatra 2014).

Pampangan buffalo is potential germplasm of South Sumatra Province which is widely found and extensively farmed in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin District

(Muhakka et al. 2013). In addition to being farmed for their meat, the buffalo also produce milk to be processed into traditional food named *Gulo Puan*. Buffalo population in South Sumatra in 2014 was 33,369 buffaloes, decreasing 4.29% than that in 2012 with 34,866 buffaloes (Statistics of South Sumatra Animal Husbandry 2014). There are three factors causing the decline in the buffalo livestock population, namely: (1) fluctuated availability of natural forage, (2) low quality of nutritional forage of lowland swamp, and (3) decreasing extent of grazing pasture land (BPTP South Sumatra 2011). The low productivity of the buffaloes in term of growth and milk production is caused by the consumed rations could not meet the needs for food substances which characterized by low protein content, high crude fiber, and low digestibility. However, the buffaloes have several advantages and their productivity can be enhanced especially through food and genetic improvement (Talib et al. 2014). The buffaloes have advantages compared to cows in which they can survive particularly when available feed has low quality (Diwyanto and Handiwirawan 2006; Yasin 2013).

One strategy that can be done to maintain and improve the level of productivity of Pampangan buffalo is by studying their forage in lowland swamp by analyzing the vegetation and carrying capacity of pasture. Studies on vegetation analysis and pasture carrying capacity up to date are only limited to dry land areas, such as in Wulan Gitrang Sub-district, East Flores which show carrying capacity of $0.42 \text{ AU} \cdot \text{ha}^{-1} \cdot \text{year}^{-1}$ on coffee plantation and $0.38 \text{ AU} \cdot \text{ha}^{-1} \cdot \text{year}^{-1}$ on grassland (Kleden et al. 2015). Another study investigating carrying capacity of livestock forage during preproduction of rubber (juvenile plants) is $0.14 \text{ AU} \cdot \text{ha}^{-1} \cdot \text{year}^{-1}$, while during rubber production (mature plants) can only accommodate $0.06 \text{ AU} \cdot \text{ha}^{-1} \cdot \text{year}^{-1}$ (Pramana et al. 2015).

This study aims to analyze vegetation structure of non-tidal swampland in South Sumatera and examine its carrying capacity for Pampangan buffalo pasture.

MATERIALS AND METHODS

This research was carried out in Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District, South Sumatera and Rambutan Village, Rambutan Sub-district, Banyuasin District, South Sumatera from April to September 2017. The methods used were the combination of survey, measurements, and direct observations on samples of swampland commonly used as pasture by farmers. Data of livestock population were collected from related agencies and institutions.

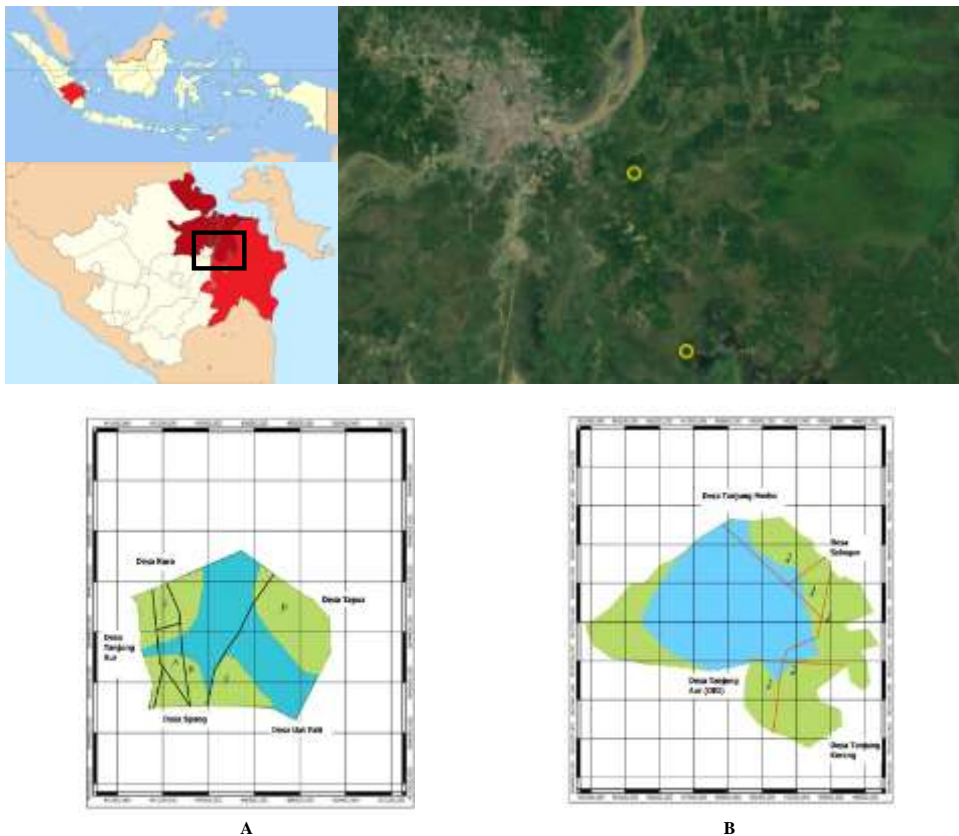


Figure 1. Research location in South Sumatera, Indonesia. A. Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District, South Sumatera, B. Rambutan Village, Rambutan Sub-district, Banyuasin District, South Sumatera

Field data were collected using direct observations and measurements including forage vegetation species, amount of production, forage quality (natural grasses and legumes), and soil fertility. Purposive sampling was conducted by making quadratic plots with size of 1x1m each plot and with total number of plots was 50 (Kleden et al. 2015). In each observation plot, the name and individual number of forage species were recorded. The plant specimens were collected and labeled with each species was photographed with digital camera. The collected specimens from each plot were separated according to each species and dried to calculate the dominant value. Dominant value is a value that more important than other values. . The unknown species was collected for herbaria, being treated with 70% alcohol, oven-dried, and identified the plant is identified by employing a botanist and using reference book.

Vegetation analysis

The collected data were analyzed quantitatively (Utami et al. 2007) as follows:

Density

Density is the number of individual of a species per area extent and formulated as follows:

$$\text{Density} = \frac{\text{Number of individual of a species}}{\text{Total extent of sample plots}}$$

Relative Density

Relative density is the density of a species as a percent of total plant density and formulated as follows:

$$\text{Relative Density} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100\%$$

Frequency

Frequency is the number of sample plots having a species in a given total number of sample plots and formulated as follows:

$$\text{Frequency} = \frac{\text{Number of plots having a species}}{\text{Number of all observed plots}}$$

Relative Frequency

Relative Frequency is the frequency of a species as a percent of total frequency of all species and formulated as follows:

$$\text{Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100\%$$

Important Value Index (IVI)

This value indicates the dominance of a species in a particular area and formulated as follows:

$$\text{IVI} = \text{Relative Density} + \text{Relative Frequency}$$

Forage production

Measurement on forage production adopted the *Halls* method (Kleden et al. 2015) using a 1m x 1m quadratic frame (Sutaryo 2009). A total of 50 observation points were done in grazing area of swampland lowland—that frequently used by farmers/ranchers. The squared frame for each observation point was randomly placed. The average forage production was calculated using the following formula:

$$X = \sum xi/n$$

Where:

X = The existing average of forage biomass production
 $\sum xi$ = The amount of forage biomass production at each observation
 n = The amount of observation

Pasture carrying capacity

The carrying capacity is the ability of pasture areas or grass farming to accommodate a number of livestock so that the need for grass for one-year-animal feed is sufficient. Calculating forage carrying capacity of swamp lowland forage is based on the amount of forage supplied on pasture for livestock needs for one year which is stated in Animal Unit (AU) per hectare. The carrying capacity was calculated for each species of forage. The calculation adopted formula developed by Purnomo (2006).

$$\text{Carrying capacity} = \frac{\text{Cumulative Production} \times \text{proper use factor (\%)}}{\text{Animal needs (kg DM/AU/day)} \times 360 \text{ days}}$$

$$\text{Cumulative Forage Production} = [(hk/ik \times pk) + (hp/ip \times pp) + (hh/ih \times ph)]$$

Where:

hk : Number of days in the dry season (90 days)
 hp : Number of days in the transition season (120 days)
 hh : Number of days in the wet season (150 days)
 ik : Cutting intervals in the dry season (50 days)
 ip : Cutting intervals in the transition season (30 days)
 ih : Cutting intervals in the wet season (40 days)
 pk : Biomass production in the dry season
 pp : Biomass production in the transition season
 ph : Biomass production in the wet season
 puf: Proper use factor 68%.
 kt : Animal need 6,25 kg dry matter AU⁻¹day⁻¹

Data analysis

Carrying capacity was analyzed by comparing forage production to the number of livestock available which result in a ratio that informs the number of buffaloes that could be developed in the study area. Three possible ratios are: (i) AUp/AUt < 1 means the number of livestock grazing in swampland lowlands is greater than the amount of feed available; (ii) AUp/AUt =1 means there is a balance between the amount of forage available and the number of livestock; c) AUp/AUt > 1 means the number of livestock is less than the amount of food available in the pasture. AU is animal unit equivalents with AUp and AUt are animal units for feed and animal unit for livestock, respectively (Kleden et al. 2015).

RESULTS AND DISCUSSION

Forage species

In the research areas, there were 19 forage species potential to be used as Pampangan buffalo feed, covering 17 grass species (Gramineae) and 2 legume species (Leguminosae) (Table 1).

Analysis of forage vegetation

The results of vegetation analysis of forage species at Pampangan buffalo pastures in swamp lowland during wet

and dry seasons in Pulau Layang Village and Rambutan Village are presented in Tables 2 and 3, respectively.

Forage production

The average production of fresh forage vegetation of swamp lowland at two study locations was 6.90 tons.ha⁻¹.year⁻¹ in Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District (Table 4) and 3.68 tons.ha⁻¹.year⁻¹ in Rambutan Village, Rambutan Sub-district, Banyuasin District (Table 5).

Table 1. Forage species in the studied areas of Pampangan buffalo pasture in non-tidal swampland

Latin name	Local name	Village		Remarks
		P	R	
<i>Catharanthus roseus</i> (L.) Don	Tapak dara	+	-	NDP
<i>Cyperus cephalotes</i> Vahl	Apit-apit	+	-	NDP
<i>Cyperus digitatus</i>	Kasuran	-	+	NDP
<i>Digitaria fuscescens</i>	Pasiran / Kerak maling	+	+	DP
<i>Eichhornia crassipes</i>	Eceng gondok	+	-	NDP
<i>Eleocharis dulcis</i>	Purun tikus	+	+	DP
<i>Hymenachne acutigluma</i>	Kumpai tembaga	+	+	DP
<i>Hymenachne amplexicaulis</i>	Kumpai minyak	+	+	DP
<i>Hymenachne sp.</i>	Kumpai merah	+	-	NDP
<i>Ipomoea aquatica</i> Forsk.	Kangkung merah	+	-	NDP
<i>Leersia hexandra</i>	Bento rayap	+	+	DP
<i>Ludwigia hyssopifolia</i>	Cecengkehan	+	-	ND
<i>Neptunia oleracea</i>	Kemon air	+	-	NDP
<i>Nymphaea odorata</i> Aiton	Telepuk Padi	+	-	NDP
<i>Nymphaea lotus</i>	Telepuk Gajah	+	-	NDP
<i>Oryza rufipogon</i>	Kumpai padi	+	+	DP
<i>Polygonum barbatum</i> L.	Are bolong	+	-	DNP
<i>Rhynchospora corymbosa</i> L.	Berondong	-	+	ND
<i>Sesbania exasperata</i>	Mutiara	-	+	NDP

Note: P: Pulau Layang Village, R: Rambutan Village, DP: Dominant, Palatable, DNP: Dominant, Not Palatable, NDP: Not Dominant, Palatable ND: Not Dominant, Not Palatable; +: Present, -: Absent. Dominant means a type of forages that always appears in sampling and have high production.

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Table 2. Density, Relative Density, Frequency, Relative Frequency, and Important Value Index of forage species at Pampangan buffalo pasture during wet and dry seasons in Pulau Layang Village

Latin name	Wet Season					Dry Season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Catharanthus roseus</i> (L.) Don	0,08	2,50	0,06	3,65	6,15	-	-	-	-	-
<i>Cyperus cephalotes</i> Vahl	-	-	-	-	-	0,16	8,42	0,12	9,52	17,94
<i>Digitaria fuscescens</i>	-	-	-	-	-	0,16	8,42	0,12	9,52	17,94
<i>Eichhornia crassipes</i>	0,48	15,00	0,20	12,19	27,19	0,18	9,47	0,08	6,34	15,82
<i>Eleocharis dulcis</i>	0,16	5,00	0,14	8,53	13,53	-	-	-	-	-
<i>Hymenachne acutigluma</i>	0,22	6,87	0,12	7,31	14,19	0,12	6,31	0,12	9,52	15,84
<i>Hymenachne amplexicaulis</i>	0,20	6,25	0,10	6,09	12,34	0,14	7,36	0,08	6,34	13,71
<i>Hymenachne sp.</i>	0,46	14,37	0,18	10,97	25,35	0,20	10,52	0,12	9,52	20,05
<i>Ipomoea aquatica</i> Forsk.	0,04	1,25	0,04	2,43	3,68	-	-	-	-	-
<i>Leersia hexandra</i>	0,06	1,87	0,04	2,43	4,31	0,12	6,31	0,10	7,93	14,25
<i>Ludwigia hyssopifolia</i>	0,18	5,62	0,06	3,65	9,28	0,16	8,42	0,08	6,34	14,77
<i>Neptunia oleracea</i>	0,56	17,50	0,32	19,51	37,01	0,38	20,00	0,24	19,04	39,04
<i>Nymphaea odorata</i> Aiton	0,02	0,62	0,02	1,22	1,84	-	-	-	-	-
<i>Nymphaea lotus</i>	0,02	0,62	0,02	1,22	1,84	-	-	-	-	-
<i>Oryza rufipogon</i>	0,18	5,62	0,08	4,87	10,50	-	-	-	-	-
<i>Polygonum barbatum</i> L.	0,54	16,87	0,26	15,85	32,72	0,28	14,73	0,20	15,87	30,61
Total	3,2	100	1,64	100	200	1,90	100	1,26	100	200

Note: D = Density, RD = Relative Density, F = Frequency, RF = Relative Frequency, IVI = Important Value Index

Table 3. Density, Relative Density, Frequency, Relative Frequency, and Important Value Index of forage species at Pampangan buffalo pasture during wet and dry seasons in Rambutan Village

Latin name	Wet Season					Dry Season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Cyperus digitatus</i>	0,88	18,03	0,30	14,85	32,88	0,12	5,31	0,06	4,34	9,65 ⁴
<i>Eleocharis dulcis</i>	1,68	34,42	0,74	36,63	71,06	1,00	44,24	0,62	44,92	89,17 ¹
<i>Digitaria fuscescens</i>	1,10	22,54	0,40	19,80	42,34	0,40	1,77	0,22	15,94	17,71 ³
<i>Hymenachne acutigluma</i>	0,04	0,82	0,02	0,99	1,81	0,02	0,88	0,02	1,44	2,33 ⁸
<i>Hymenachne amplexicaulis</i>	0,04	0,82	0,02	0,99	1,81	0,04	1,77	0,02	1,44	3,21 ⁷
<i>Leersia hexandra</i>	0,06	1,23	0,04	1,98	3,21	0,04	1,77	0,04	2,89	4,65 ⁵
<i>Oryza rufipogon</i>	0,80	16,39	0,40	19,80	36,19	0,60	26,54	0,38	27,53	54,08 ²
<i>Rhynchospora corymbosa</i> L.	0,08	1,63	0,04	1,98	3,61	0,04	1,77	0,02	1,44	3,21 ⁶
<i>Sesbania exasperata</i>	0,20	4,09	0,06	2,97	7,06	-	-	-	-	-
Total	4,88	100	2,02	100	200	2,26	100	1,38	100	200

Note: D = Density, RD = Relative Density, F = Frequency, RF = Relative Frequency, IVI = Important Value Index

Table 4. Fresh weight production (FWP), dry matter production (DMP), and forage carrying capacity (CC) of swamp lowland in wet and dry seasons in Pulau Layang Village, Ogan Komering Ilir.

Latin name	Wet Season			Dry Season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Catharanthus roseus</i> (L.) Don	7.530	977,40	2,82	-	-	-
<i>Cyperus cephalotes</i> Vahl	-	-	-	4.580	1.145,00 ⁴	3,30
<i>Digitaria fuscescens</i>	-	-	-	2.420	537,97 ¹⁰	1,55
<i>Eichhornia crassipes</i>	5.940	1.097,70	3,17	4.700	830,49 ⁶	2,40
<i>Eleocharis dulcis</i>	12.640	2.664,50	7,69	-	-	-
<i>Hymenachne acutigluma</i>	6.700	1.352,70	3,90	7.480	1.632,54 ¹	4,71
<i>Hymenachne amplexicaulis</i>	6.650	790,00	2,28	5.990	729,58 ⁸	2,11
<i>Hymenachne sp.</i>	7.040	1.151,70	3,32	5.720	975,83 ⁵	2,82
<i>Ipomoea aquatica</i> Forsk.	4.020	604,60	1,75	-	-	-
<i>Leersia hexandra</i>	4.740	1.232,40	3,56	5.290	1.385,45 ²	4,00
<i>Ludwigia hyssopifolia</i>	1.980	346,90	1,00	4.290	777,35 ⁷	2,24
<i>Neptunia oleracea</i>	1.910	394,80	1,14	2.870	607,01 ⁹	1,75
<i>Nymphaea odorata</i> Aiton	7.500	1.286,30	3,71	-	-	-
<i>Nymphaea lotus</i>	9.800	1.983,50	5,72	-	-	-
<i>Oryza rufipogon</i>	12.960	2.225,20	6,42	-	-	-
<i>Polygonum barbatum</i> L.	7.180	1.651,40	4,77	5.290	1.244,74 ³	3,59
Average	6.899	1.268,51	3,66	4.863	986,60	2,85

Table 5. Fresh weight production (FWP), dry matter production (DMP), and forage carrying capacity (CC) of swamp lowland in wet and dry seasons in Rambutan Village, Banyuasin.

Latin Name	Wet Season			Dry Season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Cyperus digitatus</i>	2.590	248,90	0,72	240	28,61	0,08
<i>Digitaria fuscescens</i>	790	108,00	0,31	1.100	152,79	0,44
<i>Eleocharis dulcis</i>	4.370	921,20	2,66	1.700	376,21	1,09
<i>Hymenachne acutigluma</i>	8.540	3.139,30	9,06	5.900	2.181,82	6,29
<i>Hymenachne amplexicaulis</i>	4.860	577,40	1,67	3.200	489,28	1,41
<i>Oryza rufipogon</i>	4.690	1.462,80	4,22	4.420	1.421,03	4,10
<i>Rhynchospora corymbosa</i> L.	1.510	441,80	1,28	250	77,88	0,22
<i>Sesbania exasperata</i>	1.360	111,50	0,32	-	-	-
Average	3.676,67	905,52	2,61	2.523,75	705,66	2,04

Pasture carrying capacity

The carrying capacity of swamp lowland for Pampangan buffalo pasture in Pulau Layang Village was 3.66 AU.ha⁻¹.year⁻¹ during the wet season and 2.85 AU.ha⁻¹.year⁻¹ in the dry season (Table 4).

The carrying capacity of swamp lowland for Pampangan buffalo pasture in Rambutan Village was 2.61 AU.ha⁻¹.year⁻¹ in the wet season and 2.04 AU.ha⁻¹.year⁻¹ in the dry season (Table 5).

Discussion

Diversity of forage species

There are dominant and palatable forage vegetation species in swamp lowland having potential as buffalo feed, namely Kumpai padi grass (*O. rufipogon*), Kumpai tembaga (*H. acutigluma*), and Kumpai minyak (*H. amplexicaulis*), not dominant and palatable such as Kumpai merah (*Hymenachne* sp) and Kemon air (*N. oleracea*); dominant and non palatable grass species (buffalo doesn't like it) namely Are bolong (*P. barbatum* L). Yet, this grass species would be eaten by the buffaloes if there were no other forage species to be eaten (Table 1). The results of this study are different from the results of research conducted by other people before, the fundamental difference is the existence of differences in internal factors (forage vegetation) and external factors (environment). This research was carried out on swampland while research carried out by others was mostly on dry land or on tidal land. With the difference in place of study, the number, types of forage vegetation that are available will also be different. Besides that, there is also a difference in the production of forages and the carrying capacity of pasture. The renewal of this research is that there is currently no discussion about the analysis of vegetation and the carrying capacity of pasture grazing on swampland.

Ali et al. (2012) conducted a study on swampland vegetation and found 25 species in Pampangan sub-district, while Rohaeni et al. (2005) found 24 species in South Kalimantan, and Camarao and Rodrigues Filho (2001) only found 7 species in Brazil. In Gowa District, there were 15 species found on natural grasslands consisting of 12 species classified as palatable forage (7 kinds of grass and 5 legumes) and 3 non palatable species, all of them are native species (Rinduwati et al. 2016). Based on the number of species encountered (15 species), it can be said that the natural pasture in Gowa District is quite good. Other studies show high diversity of forage species: 33 species in Sota village in Merauke, consisting of 61% grass, 3% legume and other plants 36% (Praptiwi et al. 2017); 22 forage species in Pakistan (Abdullah et al. 2017), 40 forage species consisting of 82 – 87% forage grass, 1% legume and forage consumable by livestock, and 12 - 17% those not edible by livestock in West Papua (Yoku et al. 2015). In Tobelo Sub-district, forage pasture consisted of 58.33% grass, 25% legume, and 16.67% other forage (Matulesy and Kastanja 2013; Eoh 2014). Species diversity is influenced by season in which the wet season increases the availability of water needed by plants for growth, especially the grass species, resulting in higher diversity (Kumalasari and Sunardi 2015).

Analysis of forage vegetation

In Pulau Layang Village, during the wet season, species with the highest Important Value Index (IVI) were Kemon air (*N. oleracea*) having 37.01% Important Value Index, followed by 32.72% Are bolong (*P. barbatum* L) and 27.19% Eceng gondok (*E. crassipes*), while the lowest value was Telepuk padi (*N. odorata* Aiton) and Telepuk gajah (*N. lotus*) which was 1.84% each. During the dry season, the highest IVI were Kemon air (*N. oleracea*) with

39.04%, followed by Are bolong (*P. barbatum* L) 30.61% and Kumpai merah (*Hymenachne* sp.) 20.05%, while the lowest value was Kumpai padi (*O. rufipogon*) with 13.71% (Table 2).

In Rambutan Village, during the wet season, species with the highest Important Value Index (IVI) were Purun tikus (*E. dulcis*) with 71.06%, Kerak maling (*D. fuscescens*) 42.34%, and Kumpai padi (*O. rufipogon*) 36.19%. The lowest values were Kumpai tembaga (*H. acutigluma*) and Kumpai minyak (*H. amplexicaulis*) 1.81% each. In the dry season, the highest IVI were Purun tikus (*E. dulcis*) 89.71%, Kumpai padi (*O. rufipogon*) 54.08%, and Kerak maling (*D. fuscescens*) 17.71%. The lowest value was Kumpai tembaga (*H. acutigluma*) 2.33% (Table 3).

The results also showed that there was a difference in the species richness between the wet and dry seasons. In Pulau Layang Village in the wet season there were 14 forage species and in the dry season, there were only 10 forage species. While Apit-apit (*C. cephalotes* Vahl) and Kerak maling (*D. fuscescens*) were not found in the wet season, Purun tikus (*E. dulcis*), Kumpai padi (*O. rufipogon*), Tapak darah (*C. roseus* L. Don), Kangkung merah (*I. aquatica* Forsk), and Telepuk padi (*N. odorata* Aiton) were not found in the dry season. In Rambutan Village, in wet season there were 9 forage species, while in the dry season there were only 8 species. In the dry season there was no legume Mutiara (*S. exasperate*), indicating that this species could not bear the drought and as a result, it would die in the dry season. These results suggest that there are some species that tolerant to water while some others were not. On the other hand, some species are tolerant to drought, while some others are not.

The Important Value Index (IVI) differences among species might be caused by the competition of each species in obtaining soil nutrients and sunlight, as well as climatic factors of the wet and dry seasons as also stated by Parmadi et al. (2016). In addition, there are other influencing factors namely vegetation density. The variation in species diversity and composition indicates that even though a research location has the same age, yet the environmental conditions could result in different vegetation (Syarifuddin 2011). In Pulau Layang Village, species having the highest IVI were Kemon air and Are bolong (37.01 and 32.73%) while in Rambutan Village were Purun tikus, Kerak maling and Kumpai padi (71.06%, 42.34%, and 36.19%), indicating that they are the most dominant species among other. A species is considered to be dominant in an area if it has IVI of more than 20% of all species and co-dominant if the percentage ranges from 10% to 20% (Suveltri et al. 2014).

The highest species density of forage vegetation in swamp ecosystem might have resulted from its adaptation and development ability in accordance with environment. This strengthens the study conducted by Oktaviani et al. (2015) that plants with the highest density can adapt to the environment to grow and reproduce under the conditions of low pH in water and soil. In contrast, plants with the lowest density might be caused by the unsuitable environmental

factors for the plants to grow and breed, particularly in the acidic water and soil (Samin et al. 2016).

Forage production

The production of fresh forage at pastures in Pulau Layang Village in the wet season was 6.899 kg ha⁻¹ year⁻¹ and the production of the dry matter was 1,268.51 kg ha⁻¹ year⁻¹, while in the dry season the production of fresh forage was 4,863 kg ha⁻¹ year⁻¹ and the dry matter production was 986.60 kg ha⁻¹ year⁻¹ (Table 4). This result is higher than those conducted in Canada (Omokanye et al. 2018) and in Timor Tengah Selatan District (Se'u et al. 2015) stating that the average fresh production of pasture in Gowa District in the wet season was 5,350 kg ha⁻¹ year⁻¹ and in the dry season was 1,390 kg ha⁻¹ year⁻¹ (Rinduwati et al. 2016). But the results of this study were lower than the study by Abdullah et al. (2017) in Pakistan who reported that forage production was 8,029.1 kg ha⁻¹ year⁻¹ in the wet season and 5,422.9 kg ha⁻¹ year⁻¹ in the dry season. The forage production of pasture in Sabana Timur Barat on the average ranged from 0.61 to 4.33 tons ha⁻¹ year⁻¹ (Manu 2013).

The lowest production usually occurs at the peak of dry season in October and the highest occurs in April (Manu 2013; Damry 2009). The forage production of *Pennisetum purpureoides* was 70.4 tons ha⁻¹ year⁻¹, *Setaria sphaesolata* 44.8 tons ha⁻¹ year⁻¹, *Brachiaria sp* 44.7 tons ha⁻¹ year⁻¹, *Pennisetum purpureum* 44.6 tons ha⁻¹ year⁻¹, and *Panicum maximum* 15.6 tons ha⁻¹ year⁻¹ (Jarmani and Haryanto 2015). The different amounts of production might have resulted from the differences in vegetation species, types of pasture, and methods used. There are various methods for estimating forage production, but many are inaccurate when applied to certain animal feed plant species. Therefore, it is very important to understand the limitations of technique used to measure forage production (Edvan et al. 2016; Badgery et al. 2017).

In Pulau Layang Village, there were 5 forage species having high fresh production in the wet season, namely Kumpai padi (*O. rufipogon*) with 12,960 kg ha⁻¹ year⁻¹, followed by Purun tikus (*E. dulcis*), Telepek gajah (*N. lotus*), Are bolong (*P. barbatum* L) and Telepek padi (*N. odorata* Aiton), and the lowest one was Kemon air (*N. olerancia*) with 1,910 kg ha⁻¹ year⁻¹. In the dry season the highest fresh production was Kumpai tembaga (*H. acutigluma*) with 7,480 kg ha⁻¹ year⁻¹, followed by Kumpai minyak (*H. amplexicaulis*), Kumpai merah (*Hymenachne* sp.), Are bolong (*P. barbatum* L) and Bento rayap (*L. hexandra*), and the lowest one was Kemon air (*N. oleracea*) with only 2,870 kg ha⁻¹ year⁻¹. The highest dry matter production in the wet season was Purun tikus (*E. dulcis*) with 2,664.5 kg ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*), Telepek gajah (*N. lotus*), Are bolong (*P. barbatum* L), and Kumpai tembaga (*H. acutigluma*), and the lowest was Cecengkehan (*L. hyssoifolia*). In the dry season the highest dry matter production was Kumpai tembaga (*H. acutigluma*) with 7,480 kg ha⁻¹ year⁻¹, followed by Bento rayap (*L. hexandra*), Are bolong (*P. barbatum* L), Apit-apit (*C. cephalotes* Vahl) and Kumpai

merah (*Hymenachne* sp.), and the lowest was Kerak maling (*D. fuscescens*) with 2,420 kg ha⁻¹ year⁻¹ (Table 4).

In Rambutan Village, the production of fresh forage during the wet season was 3,676.67 kg ha⁻¹ year⁻¹ and the dry matter production was 905.52 kg ha⁻¹ year⁻¹, whereas in the dry season the fresh produce was 2,523.75 kg ha⁻¹ year⁻¹ and the dry matter production was 705.66 kg ha⁻¹ year⁻¹ (Table 5). These results were higher than those of the study conducted by Purwantari et al. (2015) and Praptiwi et al. (2017) who reported that the average availability of forage on palm oil plantation was 1,455.5 kg ha⁻¹ year⁻¹. The forage production during preproduction of rubber plantation was 732.90 kg ha⁻¹ year⁻¹ and at the time of production, it was only 317.83 kg ha⁻¹ year⁻¹ (Pramana et al. 2015).

In Rambutan Village, during the wet season there were 5 forage species having the highest fresh and dry matter production, namely Kumpai tembaga (*H. acutigluma*) producing 8,540 kg ha⁻¹ year⁻¹ and 3,139.3 kg ha⁻¹ year⁻¹ respectively, followed by Kumpai padi (*O. rufipogon*), Bento rayap (*L. hexandra*), Purun tikus (*E. dulcis*), and Kumpai minyak (*H. amplexicaulis*), and the lowest one was Kerak maling (*D. fuscescens*) with 790 kg ha⁻¹ year⁻¹ and 108.0 kg ha⁻¹ year⁻¹, respectively. In the dry season, the highest fresh and dry matter production was Kumpai tembaga (*H. acutigluma*) of 5,900 kg ha⁻¹ year⁻¹ and 2,181.82 kg ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*), Bento rayap (*L. hexandra*), Kumpai minyak (*H. amplexicaulis*), and Purun tikus (*E. dulcis*), and the lowest one was Kasuran (*C. digitatus*) with 240 kg ha⁻¹ year⁻¹ and 11.92 kg ha⁻¹ year⁻¹, respectively (Table 5). The results of this study were still higher than those conducted by Rostini et al. (2014) stating that the highest fresh forage production of grass *Hymenachne amplexicaulis* Haes was 1,032 kg DM ha⁻¹ harvest⁻¹ in the high tide season and 518.3 kg DM ha⁻¹ harvest⁻¹ in the low tide season, where the dry matter production ranged from 43.8 to 1,032 kg DM ha⁻¹ harvest⁻¹ in the high tide season and from 38.5 to 752.8 kg DM ha⁻¹ year⁻¹ harvest⁻¹ in the low tide season.

The higher production of forage in Pampangan Sub-district compared to that in Rambutan Sub-district might be caused by higher soil fertility of the pasture area in Pampangan. The result of soil analysis showed that the C-Organic, N-total, and P-available in Pampangan (Bray I) were higher than those in Rambutan which might be related to the fact that most pasture in Pulau Layang Village (Pampangan) are rice fields which are always given fertilizer. This differs with pasture in Rambutan Village which is only used for grazing without any use of fertilizer. The provision of manure and bioslurry fertilizer can increase the production and forage quality of 4.75 tons and 4.36 tons, respectively (Suarna dan Budiasa 2016; Jeffery et al. 2018).

Pasture carrying capacity

In Pulau Layang Village, the carrying capacity for Pampangan buffaloes pasture on the swamp lowland in the wet season was 3.66 AU ha⁻¹ year⁻¹ and 2.85 AU ha⁻¹ year⁻¹ during the dry season (Table 4). In Rambutan Village, the carrying capacity for Pampangan buffalo pasture in the wet

season was 2.61 AU ha⁻¹ year⁻¹ and in the dry season was 2.04 AU ha⁻¹ year⁻¹ (Table 5). The results of this study correspond to study conducted by Rostini et al. (2014) which found the carrying capacity of swamp lowland in South Kalimantan was 2.91 AU ha⁻¹ year⁻¹.

These results were higher than in grassland in South Central Timor District with only 0.24 - 0.63 AU ha⁻¹ year⁻¹ (Seu et al. 2015), in natural pastures of Gowa District with 0.88 AU ha⁻¹ year⁻¹ (Rinduwati et al. 2016), in pasture in Poso District with 0.63 AU ha⁻¹ year⁻¹ (Damry 2009; Daru et al. 2014), in Kelei and Didiri villages of Poso Districts with 0.96 and 1.12 AU ha⁻¹ year⁻¹ (Karti et al. 2015). However, these results were lower than the study conducted by Muhajirin et al. (2017) stating that the carrying capacity of Padang Mengatas BPTU was 5 AU ha⁻¹ year⁻¹ in the wet season and 3.18 AU ha⁻¹ year⁻¹ in the dry season. Even, Abdullah et al. (2017) reported very high carrying capacity of forage in Pakistan with 24 AU ha⁻¹ year⁻¹ and 16 AU ha⁻¹ year⁻¹ in the wet and dry seasons, respectively.

There is a decrease in dry material produced during the dry season because the water condition in swamp lowland is reduced. Decrease in swamp water level resulted in the decrease of photosynthesis which affects the production of the dry matter. Water is the main ingredient needed in photosynthesis. The disruption of metabolic processes in plants will affect plant production. Plant dry weight depicts the accumulation of organic compounds that are successfully synthesized by the plants from inorganic compounds, especially water and CO₂ (Lakitan 1995). Water shortages will have a negative effect on plant growth resulting in decreased production (Jun-Feng et al. 2010; Taiz and Zeiger 2002).

The high carrying capacity is related to the high forage production, forage management and selection of good species. Management and strategy to increase forage production require innovative facilitation and training to stockbreeders and farmers to increase their knowledge. These efforts should be supported by government and private companies develop programs regarding the importance of forage in increasing ruminant livestock production (Nigus 2017; Omokanye et al. 2018).

In Pulau Layang Village, in a pasture condition assumed to have one forage species, the highest carrying capacity in the wet season was Purun tikus (*E. dulcis*) with 7.69 AU ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 6.42 AU ha⁻¹ year⁻¹, Telepek gajah (*N. lotus*) with 5.72 AU ha⁻¹ year⁻¹, Are bolong (*P. barbatum* L) with 4.77 AU ha⁻¹ year⁻¹ and Kumpai tembaga (*H. acutigluma*) with 3.90 AU ha⁻¹ year⁻¹, respectively, and the lowest was Cecengkehan (*L. hyssopifolia*) with 1.00 AU ha⁻¹ year⁻¹. In the dry season, the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) with 4.71 AU ha⁻¹ year⁻¹, followed by Bento rayap (*L. hexandra*) with 4.00 AU ha⁻¹ year⁻¹, Are bolong (*P. barbatum* L) with 3.59 AU ha⁻¹ year⁻¹, Apit-apit (*C. cephalotes* Vahl) with 3.30 AU ha⁻¹ year⁻¹ and Kumpai merah (*Hymenachne* sp.) with 2.82 AU ha⁻¹ year⁻¹, whereas the lowest was Kerak maling (*D. fuscescens*) with 1.55 AU ha⁻¹ year⁻¹ (Table 4).

In Rambutan Village, assuming that the pasture had one forage species, the highest carrying capacity in the wet season was Kumpai tembaga (*H. acutigluma*) with 9.06 AU ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 4.22 AU ha⁻¹ year⁻¹, Bento rayap (*L. hexandra*) with 3.29 AU ha⁻¹ year⁻¹, Purun tikus (*E. dulcis*) 2.66 with AU ha⁻¹ year⁻¹, and Kumpai minyak (*H. amplexicaulis*) with 1.67 AU ha⁻¹ year⁻¹, while the lowest was Kerak maling (*D. fuscescens*) with 0.31 AU ha⁻¹ year⁻¹. During the dry season the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) with 6.29 AU ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 4.10 AU ha⁻¹ year⁻¹, Bento rayap (*L. hexandra*) with 2.65 AU ha⁻¹ year⁻¹, Kumpai minyak (*H. amplexicaulis*) with 1.41 AU ha⁻¹ year⁻¹, and Purun tikus (*E. dulcis*) with 1.09 AU ha⁻¹ year⁻¹, while the lowest was Kasuran (*C. digitatus*) with 0.08 AU ha⁻¹ year⁻¹ (Table 5). These results indicate that the carrying capacity is very influential with the type of feed plan. In addition, another important thing is cattle grazing system in which livestock grazing must be regulated to avoid over-grazing as the amount of grazing livestock depends on the carrying capacity of the pasture (Salendu and Elly 2014; Cheng et al. 2017; Hashemi 2017).

The results of this study indicated that forage availability is still sufficient to meet feed requirements for Pampangan buffaloes. The population of Pampangan buffaloes in Pulau Layang Village was 487 buffaloes with a grazing area of 500 ha and average carrying capacity of 3.14 AU ha⁻¹ year⁻¹. While the number of Pampangan buffaloes of Rambutan Village was 1.735 buffaloes with a pasture area of 1,203 ha and average carrying capacity of 2.45 AU ha⁻¹ year⁻¹. It is estimated that there still can be added buffalo cattle as much as 0.31 AU ha⁻¹ year⁻¹ in Pulau Layang Village so 155 buffaloes and 0.59 AU ha⁻¹ year⁻¹ in Rambutan Village 709 buffaloes

In conclusion, there were 19 forage species to have the potential as feeding source of Pampangan buffaloes in South Sumatra. The importance of species indicated by IVI is strongly influenced by grazing locations and seasons. The most important species were Kemon air (*N. oleracea*) and Are bolong (*P. barbatum* L) in Pulau Layang Village and Purun tikus (*E. dulcis*), Kerak maling (*D. fuscescens*), and Kumpai padi (*O. rufipogon*) in Rambutan Village. In Pulau Layang Village, the fresh forage and dry matter production in the wet season were 6.90 and 1.27 tons ha⁻¹ year⁻¹, while in Rambutan Village they were 3.68 tons ha⁻¹ year⁻¹ and 0.91 ton ha⁻¹ year⁻¹, respectively. The fresh forage production and dry matter production in the dry season in Pulau Layang Village were 4.86 and 0.99 tons ha⁻¹ year⁻¹, while in Rambutan Village were 2.52 tons ha⁻¹ year⁻¹ and 0.71 tons ha⁻¹ year⁻¹, respectively. On the average the carrying capacity of the swamp lowland pasture in South Sumatra was 2.79 AU.ha⁻¹.year⁻¹. As such, forage availability is still sufficient to meet the need for animal feed, and it is estimated the areas can be added buffalo cattle of 0.31 AU ha⁻¹ year⁻¹ in Pulau Layang Village and 0.59 AU ha⁻¹ year⁻¹ in Rambutan Village.

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Vegetation analysis of non-tidal swampland in South Sumatra, Indonesia and its carrying capacity for Pampangan buffalo pasture

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Abstract. Muhakka, Agussuwignyo R, Budianta D, Yakup. 2019. Vegetation analysis of non-tidal swampland in South Sumatra, Indonesia and its carrying capacity for Pampangan buffalo pasture. *Biodiversitas* 20: xxxx. In Indonesia, non-tidal swampland area is 13.27 million ha, only 4 million ha has been developed with details of 2.6 million ha that managed by the public and the private sector and 1.3 million ha with government assistance. This study aims to analyze vegetation structure of non-tidal swampland in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin District, South Sumatera and to examine its carrying capacity for Pampangan buffalo pasture. Methods used were by the combination of direct observation, survey using plot sampling with total 50 observation plots, and measurements to determine forage production using Halls method. The results show that there 19 forage species were in two studied areas which are potential as Pampangan buffalo feed. Species with the highest Important Value Index were Purun tikus (*Eleocharis dulcis*) with 89.71% and Kumpai padi (*Oryza rufipogon*) with 54.08%. The production of fresh forage and dry matter in the wet season in Pulau Layang was 6.90 tons ha⁻¹ year⁻¹ and 1.27 tons ha⁻¹ year⁻¹, respectively, whereas in Rambutan they were 3.68 tons ha⁻¹ year⁻¹ and 0.91 tons ha⁻¹ year⁻¹, respectively. The production of fresh forage and dry matter in the dry season in Pulau Layang was 4.86 tons ha⁻¹ year⁻¹ and 0.99 tons ha⁻¹ year⁻¹, respectively, while in Rambutan they were 2.52 tons ha⁻¹ year⁻¹ and 0.71 tons ha⁻¹ year⁻¹, respectively. The pasture carrying capacity in Pulau Layang in the wet season was 3.66 AU (Animal Unit) ha⁻¹ year⁻¹ and in the dry season, it was 2.85 AU ha⁻¹ year⁻¹, while in Rambutan Village it was 2.61 AU ha⁻¹ year⁻¹ and 2.04 AU ha⁻¹ year⁻¹, respectively. There were six species of forage with high production, namely Kumpai tembaga (*Hymenachne acutigluma*) Kumpai padi (*Oryza rufipogon*), Kumpai minyak (*Hymenachne amplexicaulis*), Are bolong (*Polygonum barbatum* L), Bento rayap (*Leersia hexandra*) and Purun tikus (*Eleocharis dulcis*). It is estimated that there still can be added buffalo cattle as much as 0.31 AU ha⁻¹ year⁻¹ in Pulau Layang Village so 155 buffaloes and 0.59 AU ha⁻¹ year⁻¹ in Rambutan Village. 709 buffaloes

Keywords: Pampangan buffalo, vegetation analysis, carrying capacity, pasture, non-tidal swampland

INTRODUCTION

Non-tidal swampland is often considered as suboptimal land despite its availability is very extensive in Indonesia. The total extent of non-tidal swampland is about 13.27 million ha, consisting of 3.0 million ha of deep swampland, 6.07 million ha of swampland with medium deep and 4.20 million ha of shallow swampland, and is distributed in Sumatra, Kalimantan, and Papua. Nonetheless, there is only 4 million ha of them have been developed with public and private sectors manage 2.60 million ha while 1.3 million ha are developed by government assistance (Indonesian Statistic Agency 2010; Mulyani and Sarwani 2013). At provincial level, non-tidal swampland in South Sumatra covers the most extensive area in Sumatra, reaching 2.98 million ha but only 298,189 ha that has been developed (Statistics Agency of South Sumatra 2014).

Pampangan buffalo is potential germplasm of South Sumatra Province which is widely found and extensively farmed in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin District

(Muhakka et al. 2013). In addition to being farmed for their meat, the buffalo also produce milk to be processed into traditional food named *Gulo Puan*. Buffalo population in South Sumatra in 2014 was 33,369 buffaloes, decreasing 4.29% than that in 2012 with 34,866 buffaloes (Statistics of South Sumatra Animal Husbandry 2014). There are three factors causing the decline in the buffalo livestock population, namely: (1) fluctuated availability of natural forage, (2) low quality of nutritional forage of lowland swamp, and (3) decreasing extent of grazing pasture land (BPTP South Sumatra 2011). The low productivity of the buffaloes in term of growth and milk production is caused by the consumed rations could not meet the needs for food substances which characterized by low protein content, high crude fiber, and low digestibility. However, the buffaloes have several advantages and their productivity can be enhanced especially through food and genetic improvement (Talib et al. 2014). The buffaloes have advantages compared to cows in which they can survive particularly when available feed has low quality (Diwyanto and Handiwirawan 2006; Yasin 2013).

One strategy that can be done to maintain and improve the level of productivity of Pampangan buffalo is by studying their forage in lowland swamp by analyzing the vegetation and carrying capacity of pasture. Studies on vegetation analysis and pasture carrying capacity up to date are only limited to dry land areas, such as in Wulan Gitrang Sub-district, East Flores which show carrying capacity of $0.42 \text{ AU}\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$ on coffee plantation and $0.38 \text{ AU}\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$ on grassland (Kleden et al. 2015). Another study investigating carrying capacity of livestock forage during preproduction of rubber (juvenile plants) is $0.14 \text{ AU}\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$, while during rubber production (mature plants) can only accommodate $0.06 \text{ AU}\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$ (Pramana et al. 2015).

This study aims to analyze vegetation structure of non-tidal swampland in South Sumatera and examine its carrying capacity for Pampangan buffalo pasture.

MATERIALS AND METHODS

This research was carried out in Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District, South Sumatera and Rambutan Village, Rambutan Sub-district, Banyuasin District, South Sumatera from April to September 2017. The methods used were the combination of survey, measurements, and direct observations on samples of swampland commonly used as pasture by farmers. Data of livestock population were collected from related agencies and institutions.

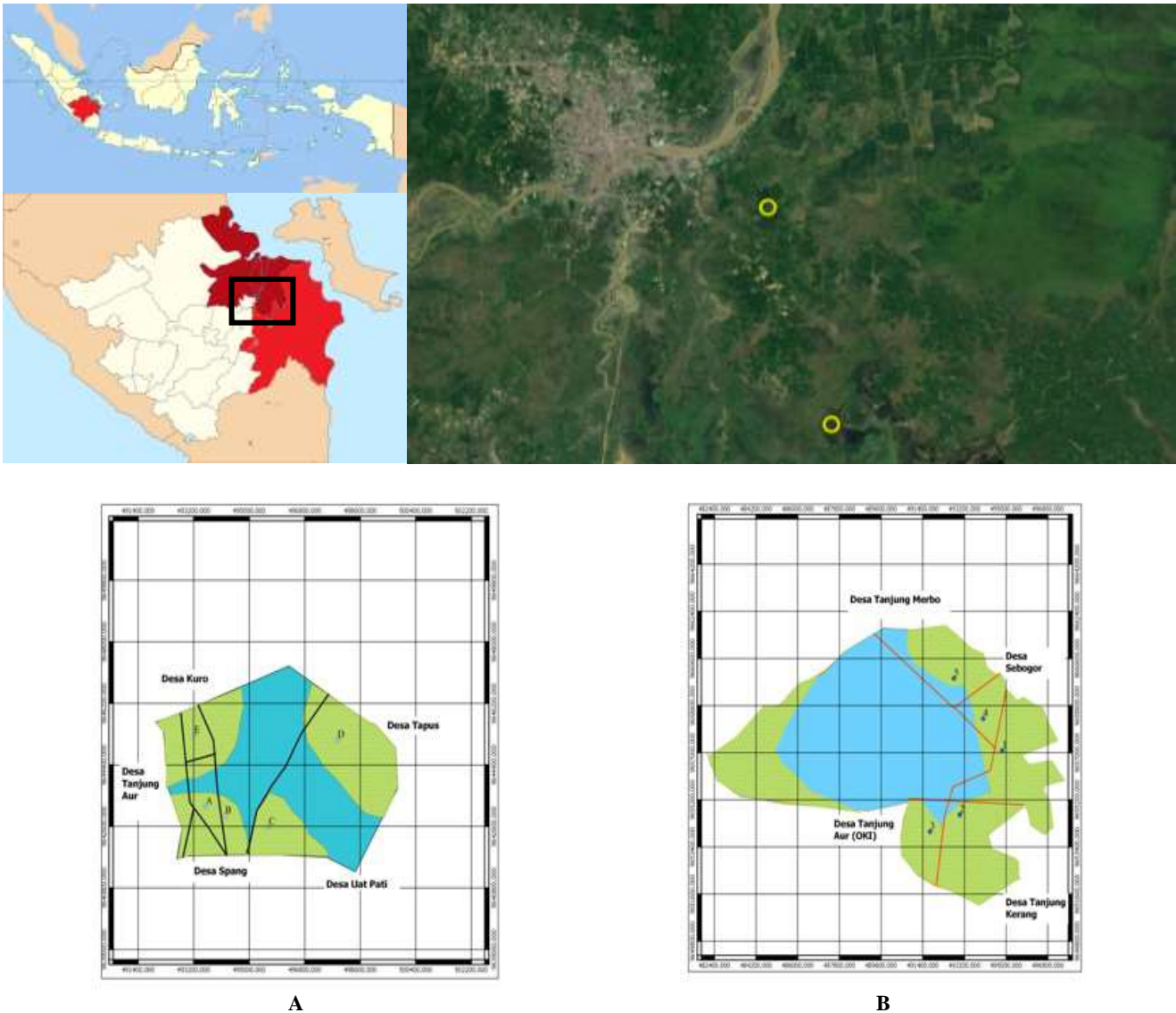


Figure 1. Research location in South Sumatera, Indonesia. A. Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District, South Sumatera, B. Rambutan Village, Rambutan Sub-district, Banyuasin District, South Sumatera

Field data were collected using direct observations and measurements including forage vegetation species, amount of production, forage quality (natural grasses and legumes), and soil fertility. Purposive sampling was conducted by making quadratic plots with size of 1x1m each plot and with total number of plots was 50 (Kleden et al. 2015). In each observation plot, the name and individual number of forage species were recorded. The plant specimens were collected and labeled with each species was photographed with digital camera. The collected specimens from each plot were separated according to each species and dried to calculate the dominant value. Dominant value is a value that more important than other values. The unknown species was collected for herbaria, being treated with 70% alcohol, oven-dried, and identified the plant is identified by employing a botanist and using reference book.

Vegetation analysis

The collected data were analyzed quantitatively (Utami et al. 2007) as follows:

Density

Density is the number of individual of a species per area extent and formulated as follows:

$$\text{Density} = \frac{\text{Number of individual of a species}}{\text{Total extent of sample plots}}$$

Relative Density

Relative density is the density of a species as a percent of total plant density and formulated as follows:

$$\text{Relative Density} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100\%$$

Frequency

Frequency is the number of sample plots having a species in a given total number of sample plots and formulated as follows:

$$\text{Frequency} = \frac{\text{Number of plots having a species}}{\text{Number of all observed plots}}$$

Relative Frequency

Relative Frequency is the frequency of a species as a percent of total frequency of all species and formulated as follows:

$$\text{Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100\%$$

Important Value Index (IVI)

This value indicates the dominance of a species in a particular area and formulated as follows:

$$\text{IVI} = \text{Relative Density} + \text{Relative Frequency}$$

Forage production

Measurement on forage production adopted the *Halls* method (Kleden et al. 2015) using a 1m x 1m quadratic frame (Sutaryo 2009). A total of 50 observation points were done in grazing area of swampland ~~lowland~~ that frequently used by farmers/ranchers. The squared frame for each observation point was randomly placed. The average forage production was calculated using the following formula:

$$X = \sum xi/n$$

Where:

X = The existing average of forage biomass production

$\sum xi$ = The amount of forage biomass production at each observation

n = The amount of observation

Pasture carrying capacity

The carrying capacity is the ability of pasture areas or grass farming to accommodate a number of livestock so that the need for grass for one-year-animal feed is sufficient. Calculating forage carrying capacity of swamp lowland forage is based on the amount of forage supplied on pasture for livestock needs for one year which is stated in Animal Unit (AU) per hectare. The carrying capacity was calculated for each species of forage. The calculation adopted formula developed by Purnomo (2006).

$$\text{Carrying capacity} = \frac{\text{Cumulative Production} \times \text{proper use factor (\%)}}{\text{Animal needs (kg DM/AU/day)} \times 360 \text{ days}}$$

$$\text{Cumulative Forage Production} = [(hk/ik \times pk) + (hp/ip \times pp) + (hh/ih \times ph)]$$

Where:

hk : Number of days in the dry season (90 days)

hp : Number of days in the transition season (120 days)

hh : Number of days in the wet season (150 days)

ik : Cutting intervals in the dry season (50 days)

ip : Cutting intervals in the transition season (30 days)

ih : Cutting intervals in the wet season (40 days)

pk : Biomass production in the dry season

pp : Biomass production in the transition season

ph : Biomass production in the wet season

puf: Proper use factor 68%.

kt : Animal need 6,25 kg dry matter AU⁻¹day⁻¹

Data analysis

Carrying capacity was analyzed by comparing forage production to the number of livestock available which result in a ratio that informs the number of buffaloes that could be developed in the study area. Three possible ratios are: (i) AUp/AUt < 1 means the number of livestock grazing in swampland ~~lowlands~~ is greater than the amount of feed available; (ii) AUp/AUt =1 means there is a balance between the amount of forage available and the number of livestock; c) AUp/AUt > 1 means the number of livestock is less than the amount of food available in the pasture. AU is animal unit equivalents with AUp and AUt are animal units for feed and animal unit for livestock, respectively (Kleden et al. 2015).

RESULTS AND DISCUSSION

Forage species

In the research areas, there were 19 forage species potential to be used as Pampangan buffalo feed, covering 17 grass species (Gramineae) and 2 legume species (Leguminosae) (Table 1).

Analysis of forage vegetation

The results of vegetation analysis of forage species at Pampangan buffalo pastures in swamp lowland during wet

and dry seasons in Pulau Layang Village and Rambutan Village are presented in Tables 2 and 3, respectively.

Forage production

The average production of fresh forage vegetation of swamp lowland at two study locations was 6.90 tons.ha⁻¹.year⁻¹ in Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District (Table 4) and 3.68 tons.ha⁻¹.year⁻¹ in Rambutan Village, Rambutan Sub-district, Banyuasin District (Table 5).

Table 1. Forage species in the studied areas of Pampangan buffalo pasture in non-tidal swampland

Latin name	Local name	Village		Remarks
		P	R	
<i>Catharanthus roseus</i>	Tapak dara	+	-	NDP
<i>Cyperus cephalotes</i>	Apit-apit	+	-	NDP
<i>Cyperus digitatus</i>	Kasuran	-	+	NDP
<i>Digitaria fuscescens</i>	Pasiran / Kerak maling	+	+	DP
<i>Eichhornia crassipes</i>	Eceng gondok	+	-	NDP
<i>Eleocharis dulcis</i>	Purun tikus	+	+	DP
<i>Hymenachne acutigluma</i>	Kumpai tembaga	+	+	DP
<i>Hymenachne amplexicaulis</i>	Kumpai minyak	+	+	DP
<i>Hymenachne sp.</i>	Kumpai merah	+	-	NDP
<i>Ipomoea aquatica</i>	Kangkung merah	+	-	NDP
<i>Leersia hexandra</i>	Bento rayap	+	+	DP
<i>Ludwigia hyssopifolia</i>	Cecengkehan	+	-	ND
<i>Neptunia oleracea</i>	Kemon air	+	-	NDP
<i>Nymphaea odorata</i> Aiton	Telepuk Padi	+	-	NDP
<i>Nymphaea lotus</i>	Telepuk Gajah	+	-	NDP
<i>Oryza rufipogon</i>	Kumpai padi	+	+	DP
<i>Polygonum barbatum</i>	Are bolong	+	-	DNP
<i>Rhynchospora corymbosa</i>	Berondong	-	+	ND
<i>Sesbania exasperata</i>	Mutiara	-	+	NDP

Note: P: Pulau Layang Village, R: Rambutan Village, DP: Dominant, Palatable, DNP: Dominant, Not Palatable, NDP: Not Dominant, Palatable ND : Not Dominant, Not Palatable means forages that is not liked by buffaloes to eat swampland. Dominand means a type of forages that always appears in sampling and have high production.

Table 2. Density, Relative Density, Frequency, Relative Frequency, and Important Value Index of forage species at Pampangan buffalo pasture during wet and dry seasons in Pulau Layang Village

Latin name	Wet Season					Dry Season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Catharanthus roseus</i>	0,08	2,50	0,06	3,65	6,15	-	-	-	-	-
<i>Cyperus cephalotes</i>	-	-	-	-	-	0,16	8,42	0,12	9,52	17,94
<i>Digitaria fuscescens</i>	-	-	-	-	-	0,16	8,42	0,12	9,52	17,94
<i>Eichhornia crassipes</i>	0,48	15,00	0,20	12,19	27,19	0,18	9,47	0,08	6,34	15,82
<i>Eleocharis dulcis</i>	0,16	5,00	0,14	8,53	13,53	-	-	-	-	-
<i>Hymenachne acutigluma</i>	0,22	6,87	0,12	7,31	14,19	0,12	6,31	0,12	9,52	15,84
<i>Hymenachne amplexicaulis</i>	0,20	6,25	0,10	6,09	12,34	0,14	7,36	0,08	6,34	13,71
<i>Hymenachne sp.</i>	0,46	14,37	0,18	10,97	25,35	0,20	10,52	0,12	9,52	20,05
<i>Ipomoea aquatica</i>	0,04	1,25	0,04	2,43	3,68	-	-	-	-	-
<i>Leersia hexandra</i>	0,06	1,87	0,04	2,43	4,31	0,12	6,31	0,10	7,93	14,25
<i>Ludwigia hyssopifolia</i>	0,18	5,62	0,06	3,65	9,28	0,16	8,42	0,08	6,34	14,77
<i>Neptunia oleracea</i>	0,56	17,50	0,32	19,51	37,01	0,38	20,00	0,24	19,04	39,04
<i>Nymphaea odorata</i>	0,02	0,62	0,02	1,22	1,84	-	-	-	-	-
<i>Nymphaea lotus</i>	0,02	0,62	0,02	1,22	1,84	-	-	-	-	-
<i>Oryza rufipogon</i>	0,18	5,62	0,08	4,87	10,50	-	-	-	-	-
<i>Polygonum barbatum</i>	0,54	16,87	0,26	15,85	32,72	0,28	14,73	0,20	15,87	30,61
Total	3,2	100	1,64	100	200	1,90	100	1,26	100	200

Note: D = Density, RD = Relative Density, F = Frequency, RF = Relative Frequency, IVI = Important Value Index

Table 3. Density, Relative Density, Frequency, Relative Frequency, and Important Value Index of forage species at Pampangan buffalo pasture during wet and dry seasons in Rambutan Village

Latin name	Wet Season					Dry Season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Cyperus digitatus</i>	0,88	18,03	0,30	14,85	32,88	0,12	5,31	0,06	4,34	9,65 ⁴
<i>Eleocharis dulcis</i>	1,68	34,42	0,74	36,63	71,06	1,00	44,24	0,62	44,92	89,17 ¹
<i>Digitaria fuscescens</i>	1,10	22,54	0,40	19,80	42,34	0,40	1,77	0,22	15,94	17,71 ³
<i>Hymenachne acutigluma</i>	0,04	0,82	0,02	0,99	1,81	0,02	0,88	0,02	1,44	2,33 ⁸
<i>Hymenachne amplexicaulis</i>	0,04	0,82	0,02	0,99	1,81	0,04	1,77	0,02	1,44	3,21 ⁷
<i>Leersia hexandra</i>	0,06	1,23	0,04	1,98	3,21	0,04	1,77	0,04	2,89	4,65 ⁵
<i>Oryza rufipogon</i>	0,80	16,39	0,40	19,80	36,19	0,60	26,54	0,38	27,53	54,08 ²
<i>Rhynchospora corymbosa</i>	0,08	1,63	0,04	1,98	3,61	0,04	1,77	0,02	1,44	3,21 ⁶
<i>Sesbania exasperata</i>	0,20	4,09	0,06	2,97	7,06	-	-	-	-	-
Total	4,88	100	2,02	100	200	2,26	100	1,38	100	200

Note: D = Density, RD = Relative Density, F = Frequency, RF = Relative Frequency, IVI = Important Value Index

Table 4. Fresh weight production (FWP), dry matter production (DMP), and forage carrying capacity (CC) of swamp lowland in wet and dry seasons in Pulau Layang Village, Ogan Komering Ilir.

Latin name	Wet Season			Dry Season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Catharanthus roseus</i>	7.530	977,40	2,82	-	-	-
<i>Cyperus cephalotes</i>	-	-	-	4.580	1.145,00 ⁴	3,30
<i>Digitaria fuscescens</i>	-	-	-	2.420	537,97 ¹⁰	1,55
<i>Eichhornia crassipes</i>	5.940	1.097,70	3,17	4.700	830,49 ⁶	2,40
<i>Eleocharis dulcis</i>	12.640	2.664,50	7,69	-	-	-
<i>Hymenachne acutigluma</i>	6.700	1.352,70	3,90	7.480	1.632,54 ¹	4,71
<i>Hymenachne amplexicaulis</i>	6.650	790,00	2,28	5.990	729,58 ⁸	2,11
<i>Hymenachne sp.</i>	7.040	1.151,70	3,32	5.720	975,83 ⁵	2,82
<i>Ipomoea aquatica</i>	4.020	604,60	1,75	-	-	-
<i>Leersia hexandra</i>	4.740	1.232,40	3,56	5.290	1.385,45 ²	4,00
<i>Ludwigia hyssopifolia</i>	1.980	346,90	1,00	4.290	777,35 ⁷	2,24
<i>Neptunia oleracea</i>	1.910	394,80	1,14	2.870	607,01 ⁹	1,75
<i>Nymphaea odorata</i>	7.500	1.286,30	3,71	-	-	-
<i>Nymphaea lotus</i>	9.800	1.983,50	5,72	-	-	-
<i>Oryza rufipogon</i>	12.960	2.225,20	6,42	-	-	-
<i>Polygonum barbatum</i>	7.180	1.651,40	4,77	5.290	1.244,74 ³	3,59
Average	6.899	1.268,51	3,66	4.863	986,60	2,85

Table 5. Fresh weight production (FWP), dry matter production (DMP), and forage carrying capacity (CC) of swamp lowland in wet and dry seasons in Rambutan Village, Banyuasin.

Latin Name	Wet Season			Dry Season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Cyperus digitatus</i>	2.590	248,90	0,72	240	28,61	0,08
<i>Digitaria fuscescens</i>	790	108,00	0,31	1.100	152,79	0,44
<i>Eleocharis dulcis</i>	4.370	921,20	2,66	1.700	376,21	1,09
<i>Hymenachne acutigluma</i>	8.540	3.139,30	9,06	5.900	2.181,82	6,29
<i>Hymenachne amplexicaulis</i>	4.860	577,40	1,67	3.200	489,28	1,41
<i>Oryza rufipogon</i>	4.690	1.462,80	4,22	4.420	1.421,03	4,10
<i>Rhynchospora corymbosa</i>	1.510	441,80	1,28	250	77,88	0,22
<i>Sesbania exasperata</i>	1.360	111,50	0,32	-	-	-
Average	3.676,67	905,52	2,61	2.523,75	705,66	2,04

Pasture carrying capacity

The carrying capacity of swamp lowland for Pampangan buffalo pasture in Pulau Layang Village was 3.66 AU.ha⁻¹.year⁻¹ during the wet season and 2.85 AU.ha⁻¹.year⁻¹ in the dry season (Table 4). The carrying capacity of swamp lowland for Pampangan buffalo pasture in Rambutan Village was 2.61 AU.ha⁻¹.year⁻¹ in the wet season and 2.04 AU.ha⁻¹.year⁻¹ in the dry season (Table 5).

¹.year⁻¹ in the dry season (Table 4). The carrying capacity of swamp lowland for Pampangan buffalo pasture in Rambutan Village was 2.61 AU.ha⁻¹.year⁻¹ in the wet season and 2.04 AU.ha⁻¹.year⁻¹ in the dry season (Table 5).

Discussion

Diversity of forage species

There are dominant and palatable forage vegetation species in swamp lowland having potential as buffalo feed, namely Kumpai padi grass (*O. rufipogon*), Kumpai tembaga (*H. acutigluma*), and Kumpai minyak (*H. amplexicaulis*), not dominant and palatable such as Kumpai merah (*Hymenachne* sp) and Kemon air (*N. oleracea*); dominant and non palatable grass species (buffalo doesn't like it) namely Are bolong (*P. barbatum* L). Yet, this grass species would be eaten by the buffaloes if there were no other forage species to be eaten (Table 1). The results of this study are different from the results of research conducted by other people before, the fundamental difference is the existence of differences in internal factors (forage vegetation) and external factors (environment). This research was carried out on swampland while research carried out by others was mostly on dry land or on tidal land. With the difference in place of study, the number, types of forage vegetation that are available will also be different. Besides that, there is also a difference in the production of forages and the carrying capacity of pasture. The renewal of this research is that there is currently no discussion about the analysis of vegetation and the carrying capacity of pasture grazing on swampland.

Ali et al. (2012) conducted a study on swampland vegetation and found 25 species in Pampang sub-district, while Rohaeni et al. (2005) found 24 species in South Kalimantan, and Camarao and Rodrigues Filho (2001) only found 7 species in Brazil. In Gowa District, there were 15 species found on natural grasslands consisting of 12 species classified as palatable forage (7 kinds of grass and 5 legumes) and 3 non palatable species, all of them are native species (Rinduwati et al. 2016). Based on the number of species encountered (15 species), it can be said that the natural pasture in Gowa District is quite good. Other studies show high diversity of forage species: 33 species in Sota village in Merauke, consisting of 61% grass, 3% legume and other plants 36% (Praptiwi et al. 2017); 22 forage species in Pakistan (Abdullah et al. 2017), 40 forage species consisting of 82 – 87% forage grass, 1% legume and forage consumable by livestock, and 12 - 17% those not edible by livestock in West Papua (Yoku et al. 2015). In Tobelo Sub-district, forage pasture consisted of 58.33% grass, 25% legume, and 16.67% other forage (Matulesy and Kastanja 2013; Eoh 2014). Species diversity is influenced by season in which the wet season increases the availability of water needed by plants for growth, especially the grass species, resulting in higher diversity (Kumalasari and Sunardi 2015).

Analysis of forage vegetation

In Pulau Layang Village, during the wet season, species with the highest Important Value Index (IVI) were Kemon air (*N. oleracea*) having 37.01% Important Value Index, followed by 32.72% Are bolong (*P. barbatum* L) and 27.19% Eceng gondok (*E. crassipes*), while the lowest value was Telepuk padi (*N. odorata* Aiton) and Telepuk gajah (*N. lotus*) which was 1.84% each. During the dry season, the highest IVI were Kemon air (*N. oleracea*) with

39.04%, followed by Are bolong (*P. barbatum* L) 30.61% and Kumpai merah (*Hymenachne* sp.) 20.05%, while the lowest value was Kumpai padi (*O. rufipogon*) with 13.71% (Table 2).

In Rambutan Village, during the wet season, species with the highest Important Value Index (IVI) were Purun tikus (*E. dulcis*) with 71.06%, Kerak maling (*D. fuscescens*) 42.34%, and Kumpai padi (*O. rufipogon*) 36.19%. The lowest values were Kumpai tembaga (*H. acutigluma*) and Kumpai minyak (*H. amplexicaulis*) 1.81% each. In the dry season, the highest IVI were Purun tikus (*E. dulcis*) 89.71%, Kumpai padi (*O. rufipogon*) 54.08%, and Kerak maling (*D. fuscescens*) 17.71%. The lowest value was Kumpai tembaga (*H. acutigluma*) 2.33% (Table 3).

The results also showed that there was a difference in the species richness between the wet and dry seasons. In Pulau Layang Village in the wet season there were 14 forage species and in the dry season, there were only 10 forage species. While Apit-apit (*C. cephalotes* Vahl) and Kerak maling (*D. fuscescens*) were not found in the wet season, Purun tikus (*E. dulcis*), Kumpai padi (*O. rufipogon*), Tapak darah (*C. roseus* L. Don), Kangkung merah (*I. aquatica* Forsk), and Telepuk padi (*N. odorata* Aiton) were not found in the dry season. In Rambutan Village, in wet season there were 9 forage species, while in the dry season there were only 8 species. In the dry season there was no legume Mutiara (*S. exasperate*), indicating that this species could not bear the drought and as a result, it would die in the dry season. These results suggest that there are some species that tolerant to water while some others were not. On the other hand, some species are tolerant to drought, while some others are not.

The Important Value Index (IVI) differences among species might be caused by the competition of each species in obtaining soil nutrients and sunlight, as well as climatic factors of the wet and dry seasons as also stated by Parmadi et al. (2016). In addition, there are other influencing factors namely vegetation density. The variation in species diversity and composition indicates that even though a research location has the same age, yet the environmental conditions could result in different vegetation (Syarifuddin 2011). In Pulau Layang Village, species having the highest IVI were Kemon air and Are bolong (37.01 and 32.73%) while in Rambutan Village were Purun tikus, Kerak maling and Kumpai padi (71.06%, 42.34%, and 36.19%), indicating that they are the most dominant species among other. A species is considered to be dominant in an area if it has IVI of more than 20% of all species and co-dominant if the percentage ranges from 10% to 20% (Suveltri et al. 2014).

The highest species density of forage vegetation in swamp ecosystem might have resulted from its adaptation and development ability in accordance with environment. This strengthens the study conducted by Oktaviani et al. (2015) that plants with the highest density can adapt to the environment to grow and reproduce under the conditions of low pH in water and soil. In contrast, plants with the lowest density might be caused by the unsuitable environmental

factors for the plants to grow and breed, particularly in the acidic water and soil (Samin et al. 2016).

Forage production

The production of fresh forage at pastures in Pulau Layang Village in the wet season was 6,899 kg ha⁻¹ year⁻¹ and the production of the dry matter was 1,268.51 kg ha⁻¹ year⁻¹, while in the dry season the production of fresh forage was 4,863 kg ha⁻¹ year⁻¹ and the dry matter production was 986.60 kg ha⁻¹ year⁻¹ (Table 4). This result is higher than those conducted in Canada (Omokanye et al. 2018) and in Timor Tengah Selatan District (Se'u et al. 2015) stating that the average fresh production of pasture in Gowa District in the wet season was 5,350 kg ha⁻¹ year⁻¹ and in the dry season was 1,390 kg ha⁻¹ year⁻¹ (Rinduwati et al. 2016). But the results of this study were lower than the study by Abdullah et al. (2017) in Pakistan who reported that forage production was 8,029.1 kg ha⁻¹ year⁻¹ in the wet season and 5,422.9 kg ha⁻¹ year⁻¹ in the dry season. The forage production of pasture in Sabana Timur Barat on the average ranged from 0.61 to 4.33 tons ha⁻¹ year⁻¹ (Manu 2013).

The lowest production usually occurs at the peak of dry season in October and the highest occurs in April (Manu 2013; Damry 2009). The forage production of *Pennisetum purpuphoides* was 70.4 ton ha⁻¹ year⁻¹, *Setaria sphasielata* 44.8 tons ha⁻¹ year⁻¹, *Brachiaria sp* 44.7 tons ha⁻¹ year⁻¹, *Pennisetum purpureum* 44.6 tons ha⁻¹ year⁻¹, and *Panicum maximum* 15.6 tons ha⁻¹ year⁻¹ (Jarmani and Haryanto 2015). The different amounts of production might have resulted from the differences in vegetation species, types of pasture, and methods used. There are various methods for estimating forage production, but many are inaccurate when applied to certain animal feed plant species. Therefore, it is very important to understand the limitations of technique used to measure forage production (Edvan et al. 2016; Badgery et al. 2017).

In Pulau Layang Village, there were 5 forage species having high fresh production in the wet season, namely Kumpai padi (*O. rufipogon*) with 12,960 kg ha⁻¹ year⁻¹, followed by Purun tikus (*E. dulcis*), Telepuk gajah (*N. lotus*), Are bolong (*P. barbatum* L) and Telepuk padi (*N. odorata* Aiton), and the lowest one was Kemon air (*N. olerancia*) with 1,910 kg ha⁻¹ year⁻¹. In the dry season the highest fresh production was Kumpai tembaga (*H. acutigluma*) with 7,480 kg ha⁻¹ year⁻¹, followed by Kumpai minyak (*H. amplexicaulis*), Kumpai merah (*Hymenachne* sp.), Are bolong (*P. barbatum* L) and Bento rayap (*L. hexandra*), and the lowest one was Kemon air (*N. oleracea*) with only 2,870 kg ha⁻¹ year⁻¹. The highest dry matter production in the wet season was Purun tikus (*E. dulcis*) with 2,664.5 kg ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*), Telepuk gajah (*N. lotus*), Are bolong (*P. barbatum* L), and Kumpai tembaga (*H. acutigluma*), and the lowest was Cecengkehan (*L. hyssopifolia*). In the dry season the highest dry matter production was Kumpai tembaga (*H. acutigluma*) with 7,480 kg ha⁻¹ year⁻¹, followed by Bento rayap (*L. hexandra*), Are bolong (*P. barbatum* L), Apit-apit (*C. cephalotes* Vahl) and Kumpai

merah (*Hymenachne* sp.), and the lowest was Kerak maling (*D. fuscescens*) with 2,420 kg ha⁻¹ year⁻¹ (Table 4).

In Rambutan Village, the production of fresh forage during the wet season was 3,676.67 kg ha⁻¹ year⁻¹ and the dry matter production was 905.52 kg ha⁻¹ year⁻¹, whereas in the dry season the fresh produce was 2,523.75 kg ha⁻¹ year⁻¹ and the dry matter production was 705.66 kg ha⁻¹ year⁻¹ (Table 5). These results were higher than those of the study conducted by Purwantari et al. (2015) and Praptiwi et al. (2017) who reported that the average availability of forage on palm oil plantation was 1,455.5 kg ha⁻¹ year⁻¹. The forage production during preproduction of rubber plantation was 732.90 kg ha⁻¹ year⁻¹ and at the time of production, it was only 317.83 kg ha⁻¹ year⁻¹ (Pramana et al. 2015).

In Rambutan Village, during the wet season there were 5 forage species having the highest fresh and dry matter production, namely Kumpai tembaga (*H. acutigluma*) producing 8,540 kg ha⁻¹ year⁻¹ and 3,139.3 kg ha⁻¹ year⁻¹ respectively, followed by Kumpai padi (*O. rufipogon*), Bento rayap (*L. hexandra*), Purun tikus (*E. dulcis*), and Kumpai minyak (*H. amplexicaulis*), and the lowest one was Kerak maling (*D. fuscescens*) with 790 kg ha⁻¹ year⁻¹ and 108.0 kg ha⁻¹ year⁻¹, respectively. In the dry season, the highest fresh and dry matter production was Kumpai tembaga (*H. acutigluma*) of 5,900 kg ha⁻¹ year⁻¹ and 2,181.82 kg ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*), Bento rayap (*L. hexandra*), Kumpai minyak (*H. amplexicaulis*), and Purun tikus (*E. dulcis*), and the lowest one was Kasuran (*C. digitatus*) with 240 kg ha⁻¹ year⁻¹ and 11.92 kg ha⁻¹ year⁻¹, respectively (Table 5). The results of this study were still higher than those conducted by Rostini et al. (2014) stating that the highest fresh forage production of grass *Hymenachne amplexicaulis* Haes was 1,032 kg DM ha⁻¹ harvest⁻¹ in the high tide season and 518.3 kg DM ha⁻¹ harvest⁻¹ in the low tide season, where the dry matter production ranged from 43.8 to 1,032 kg DM ha⁻¹ harvest⁻¹ in the high tide season and from 38.5 to 752.8 kg DM ha⁻¹ harvest⁻¹ in the low tide season.

The higher production of forage in Pampangan Sub-district compared to that in Rambutan Sub-district might be caused by higher soil fertility of the pasture area in Pampangan. The result of soil analysis showed that the C-Organic, N-total, and P-available in Pampangan (Bray I) were higher than those in Rambutan which might be related to the fact that most pasture in Pulau Layang Village (Pampangan) are rice fields which are always given fertilizer. This differs with pasture in Rambutan Village which is only used for grazing without any use of fertilizer. The provision of manure and bioslurry fertilizer can increase the production and forage quality of 4.75 tons and 4.36 tons, respectively (Suarna dan Budiasa 2016; Jeffery et al. 2018).

Pasture carrying capacity

In Pulau Layang Village, the carrying capacity for Pampangan buffaloes pasture on the swamp lowland in the wet season was 3.66 AU ha⁻¹ year⁻¹ and 2.85 AU ha⁻¹ year⁻¹ during the dry season (Table 4). In Rambutan Village, the carrying capacity for Pampangan buffalo pasture in the wet

season was 2.61 AU ha⁻¹ year⁻¹ and in the dry season was 2.04 AU ha⁻¹ year⁻¹ (Table 5). The results of this study correspond to study conducted by Rostini et al. (2014) which found the carrying capacity of swamp lowland in South Kalimantan was 2.91 AU ha⁻¹ year⁻¹.

These results were higher than in grassland in South Central Timor District with only 0.24 - 0.63 AU ha⁻¹ year⁻¹ (Seu et al. 2015), in natural pastures of Gowa District with 0.88 AU ha⁻¹ year⁻¹ (Rinduwati et al. 2016), in pasture in Poso District with 0.63 AU ha⁻¹ year⁻¹ (Damry 2009; Daru et al. 2014), in Kelei and Didiri villages of Poso Districts with 0.96 and 1.12 AU ha⁻¹ year⁻¹ (Karti et al. 2015). However, these results were lower than the study conducted by Muhajirin et al. (2017) stating that the carrying capacity of Padang Mengatas BPTU was 5 AU ha⁻¹ year⁻¹ in the wet season and 3.18 AU ha⁻¹ year⁻¹ in the dry season. Even, Abdullah et al. (2017) reported very high carrying capacity of forage in Pakistan with 24 AU ha⁻¹ year⁻¹ and 16 AU ha⁻¹ year⁻¹ in the wet and dry seasons, respectively.

There is a decrease in dry material produced during the dry season because the water condition in swamp lowland is reduced. Decrease in swamp water level resulted in the decrease of photosynthesis which affects the production of the dry matter. Water is the main ingredient needed in photosynthesis. The disruption of metabolic processes in plants will affect plant production. Plant dry weight depicts the accumulation of organic compounds that are successfully synthesized by the plants from inorganic compounds, especially water and CO₂ (Lakitan 1995). Water shortages will have a negative effect on plant growth resulting in decreased production (Jun-Feng et al. 2010; Taiz and Zeiger 2002).

The high carrying capacity is related to the high forage production, forage management and selection of good species. Management and strategy to increase forage production require innovative facilitation and training to stockbreeders and farmers to increase their knowledge. These efforts should be supported by government and private companies develop programs regarding the importance of forage in increasing ruminant livestock production (Nigus 2017; Omokanye et al. 2018).

In Pulau Layang Village, in a pasture condition assumed to have one forage species, the highest carrying capacity in the wet season was Purun tikus (*E. dulcis*) with 7.69 AU ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 6.42 AU ha⁻¹ year⁻¹, Telepuk gajah (*N. lotus*) with 5.72 AU ha⁻¹ year⁻¹, Are bolong (*P. barbatum* L) with 4.77 AU ha⁻¹ year⁻¹ and Kumpai tembaga (*H. acutigluma*) with 3.90 AU ha⁻¹ year⁻¹, respectively, and the lowest was Cecengkehan (*L. hyssopifolia*) with 1.00 AU ha⁻¹ year⁻¹. In the dry season, the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) with 4.71 AU ha⁻¹ year⁻¹, followed by Bento rayap (*L. hexandra*) with 4.00 AU ha⁻¹ year⁻¹, Are bolong (*P. barbatum* L) with 3.59 AU ha⁻¹ year⁻¹, Apit-apit (*C. cephalotes* Vahl) with 3.30 AU ha⁻¹ year⁻¹ and Kumpai merah (*Hymenachne* sp.) with 2.82 AU ha⁻¹ year⁻¹, whereas the lowest was Kerak maling (*D. fuscescens*) with 1.55 AU ha⁻¹ year⁻¹ (Table 4).

In Rambutan Village, assuming that the pasture had one forage species, the highest carrying capacity in the wet season was Kumpai tembaga (*H. acutigluma*) with 9.06 AU ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 4.22 AU ha⁻¹ year⁻¹, Bento rayap (*L. hexandra*) with 3.29 AU ha⁻¹ year⁻¹, Purun tikus (*E. dulcis*) 2.66 with AU ha⁻¹ year⁻¹, and Kumpai minyak (*H. amplexicaulis*) with 1.67 AU ha⁻¹ year⁻¹, while the lowest was Kerak maling (*D. fuscescens*) with 0.31 AU ha⁻¹ year⁻¹. During the dry season the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) with 6.29 AU ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 4.10 AU ha⁻¹ year⁻¹, Bento rayap (*L. hexandra*) with 2.65 AU ha⁻¹ year⁻¹, Kumpai minyak (*H. amplexicaulis*) with 1.41 AU ha⁻¹ year⁻¹, and Purun tikus (*E. dulcis*) with 1.09 AU ha⁻¹ year⁻¹, while the lowest was Kasuran (*C. digitatus*) with 0.08 AU ha⁻¹ year⁻¹ (Table 5). These results indicate that the carrying capacity is very influential with the type of feed plan. In addition, another important thing is cattle grazing system in which livestock grazing must be regulated to avoid over-grazing as the amount of grazing livestock depends on the carrying capacity of the pasture (Salendu and Elly 2014; Cheng et al. 2017; Hashemi 2017).

The results of this study indicated that forage availability is still sufficient to meet feed requirements for Pampangan buffaloes. The population of Pampangan buffaloes in Pulau Layang Village was 487 buffaloes with a grazing area of 500 ha and average carrying capacity of 3.14 AU ha⁻¹ year⁻¹. While the number of Pampangan buffaloes of Rambutan Village was 1.735 buffaloes with a pasture area of 1,203 ha and average carrying capacity of 2.45 AU ha⁻¹ year⁻¹. It is estimated that there still can be added buffalo cattle as much as 0.31 AU ha⁻¹ year⁻¹ in Pulau Layang Village so 155 buffaloes and 0.59 AU ha⁻¹ year⁻¹ in Rambutan Village 709 buffaloes

In conclusion, there were 19 forage species to have the potential as feeding source of Pampangan buffaloes in South Sumatra. The importance of species indicated by IVI is strongly influenced by grazing locations and seasons. The most important species were Kemon air (*N. oleracea*) and Are bolong (*P. barbatum* L) in Pulau Layang Village and Purun tikus (*E. dulcis*), Kerak maling (*D. fuscescens*), and Kumpai padi (*O. rufipogon*) in Rambutan Village. In Pulau Layang Village, the fresh forage and dry matter production in the wet season were 6.90 and 1.27 tons ha⁻¹ year⁻¹, while in Rambutan Village they were 3.68 tons ha⁻¹ year⁻¹ and 0.91 ton ha⁻¹ year⁻¹, respectively. The fresh forage production and dry matter production in the dry season in Pulau Layang Village were 4.86 and 0.99 tons ha⁻¹ year⁻¹, while in Rambutan Village were 2.52 tons ha⁻¹ year⁻¹ and 0.71 tons ha⁻¹ year⁻¹, respectively. On the average the carrying capacity of the swamp lowland pasture in South Sumatra was 2.79 AU.ha⁻¹.year⁻¹. As such, forage availability is still sufficient to meet the need for animal feed, and it is estimated the areas can be added buffalo cattle of 0.31 AU ha⁻¹ year⁻¹ in Pulau Layang Village and 0.59 AU ha⁻¹ year⁻¹ in Rambutan Village.

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Vegetation analysis of non-tidal swampland in South Sumatra, Indonesia and its carrying capacity for Pampangan buffalo pasture

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Abstract. Muhakka, Agussuwignyo R, Budianta D, Yakup. 2019. Vegetation analysis of non-tidal swampland in South Sumatra, Indonesia and its carrying capacity for Pampangan buffalo pasture. *Biodiversitas* 20: 1069-1078. In Indonesia, non-tidal swampland area is 13.27 million ha, only 4 million ha has been developed with details of 2.6 million ha that managed by the public and the private sector and 1.3 million ha with government assistance. This study aims to analyze vegetation structure of non-tidal swampland in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin District, South Sumatera and to examine its carrying capacity for Pampangan buffalo pasture. Methods used were by the combination of direct observation, survey using plot sampling with total 50 observation plots, and measurements to determine forage production using Halls method. The results show that there 19 forage species were in two studied areas which are potential as Pampangan buffalo feed. Species with the highest Important Value Index were Purun tikus (*Eleocharis dulcis*) with 89.71% and Kumpai padi (*Oryza rufipogon*) with 54.08%. The production of fresh forage and dry matter in the wet season in Pulau Layang was 6.90 tons ha⁻¹ year⁻¹ and 1.27 tons ha⁻¹ year⁻¹, respectively, whereas in Rambutan they were 3.68 tons ha⁻¹ year⁻¹ and 0.91 tons ha⁻¹ year⁻¹, respectively. The production of fresh forage and dry matter in the dry season in Pulau Layang was 4.86 tons ha⁻¹ year⁻¹ and 0.99 tons ha⁻¹ year⁻¹, respectively, while in Rambutan they were 2.52 tons ha⁻¹ year⁻¹ and 0.71 tons ha⁻¹ year⁻¹, respectively. The pasture carrying capacity in Pulau Layang in the wet season was 3.66 AU (Animal Unit) ha⁻¹ year⁻¹ and in the dry season, it was 2.85 AU ha⁻¹ year⁻¹, while in Rambutan Village it was 2.61 AU ha⁻¹ year⁻¹ and 2.04 AU ha⁻¹ year⁻¹, respectively. There were six species of forage with high production, namely Kumpai tembaga (*Hymenachne acutigluma*) Kumpai padi (*Oryza rufipogon*), Kumpai minyak (*Hymenachne amplexicaulis*), Are bolong (*Polygonum barbatum* L), Bento rayap (*Leersia hexandra*) and Purun tikus (*Eleocharis dulcis*). It is estimated that there still can be added buffalo cattle as much as 0.31 AU ha⁻¹ year⁻¹ in Pulau Layang Village so 155 buffaloes and 0.59 AU ha⁻¹ year⁻¹ in Rambutan Village. 709 buffaloes

Keywords: Pampangan buffalo, vegetation analysis, carrying capacity, pasture, non-tidal swampland

INTRODUCTION

Non-tidal swampland is often considered as suboptimal land despite its availability is very extensive in Indonesia. The total extent of non-tidal swampland is about 13.27 million ha, consisting of 3.0 million ha of deep swampland, 6.07 million ha of swampland with medium deep and 4.20 million ha of shallow swampland, and is distributed in Sumatra, Kalimantan, and Papua. Nonetheless, there is only 4 million ha of them have been developed with public and private sectors manage 2.60 million ha while 1.3 million ha are developed by government assistance (BPS 2010; Mulyani and Sarwani 2013). At provincial level, non-tidal swampland in South Sumatra covers the most extensive area in Sumatra, reaching 2.98 million ha but only 298,189 ha that has been developed (BPS 2014).

Pampangan buffalo is potential germplasm of South Sumatra Province which is widely found and extensively farmed in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin District (Muhakka et al. 2013). In addition to being farmed for their

meat, the buffalo also produce milk to be processed into traditional food named *Gulo Puan*. Buffalo population in South Sumatra in 2014 was 33,369 buffaloes, decreasing 4.29% than that in 2012 with 34,866 buffaloes (South Sumatra Province Animal Husbandry Office 2014). There are three factors causing the decline in the buffalo livestock population, namely: (i) fluctuated availability of natural forage, (ii) low quality of nutritional forage of lowland swamp, and (iii) decreasing extent of grazing pasture land (BPTP South Sumatra 2011). The low productivity of the buffaloes in term of growth and milk production is caused by the consumed rations could not meet the needs for food substances which characterized by low protein content, high crude fiber, and low digestibility. However, the buffaloes have several advantages and their productivity can be enhanced especially through food and genetic improvement (Talib et al. 2014). The buffaloes have advantages compared to cows in which they can survive particularly when available feed has low quality (Diwyanto and Handiwirawan 2006; Yasin 2013).

One strategy that can be done to maintain and improve the level of productivity of Pampangan buffalo is by studying their forage in lowland swamp by analyzing the vegetation and carrying capacity of pasture. Studies on vegetation analysis and pasture carrying capacity up to date are only limited to dry land areas, such as in Wulan Gitrang Sub-district, East Flores which show carrying capacity of $0.42 \text{ AU}\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$ on coffee plantation and $0.38 \text{ AU}\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$ on grassland (Kleden et al. 2015). Another study investigating carrying capacity of livestock forage during preproduction of rubber (juvenile plants) is $0.14 \text{ AU}\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$, while during rubber production (mature plants) can only accommodate $0.06 \text{ AU}\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$ (Pramana et al. 2015).

This study aims to analyze vegetation structure of non-tidal swampland in South Sumatera and examine its carrying capacity for Pampangan buffalo pasture.

MATERIALS AND METHODS

This research was carried out in Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District, South Sumatra and Rambutan Village, Rambutan Sub-district, Banyuasin District, South Sumatra from April to September 2017. The methods used were the combination of survey, measurements, and direct observations on samples of swampland commonly used as pasture by farmers. Data of livestock population were collected from related agencies and institutions.

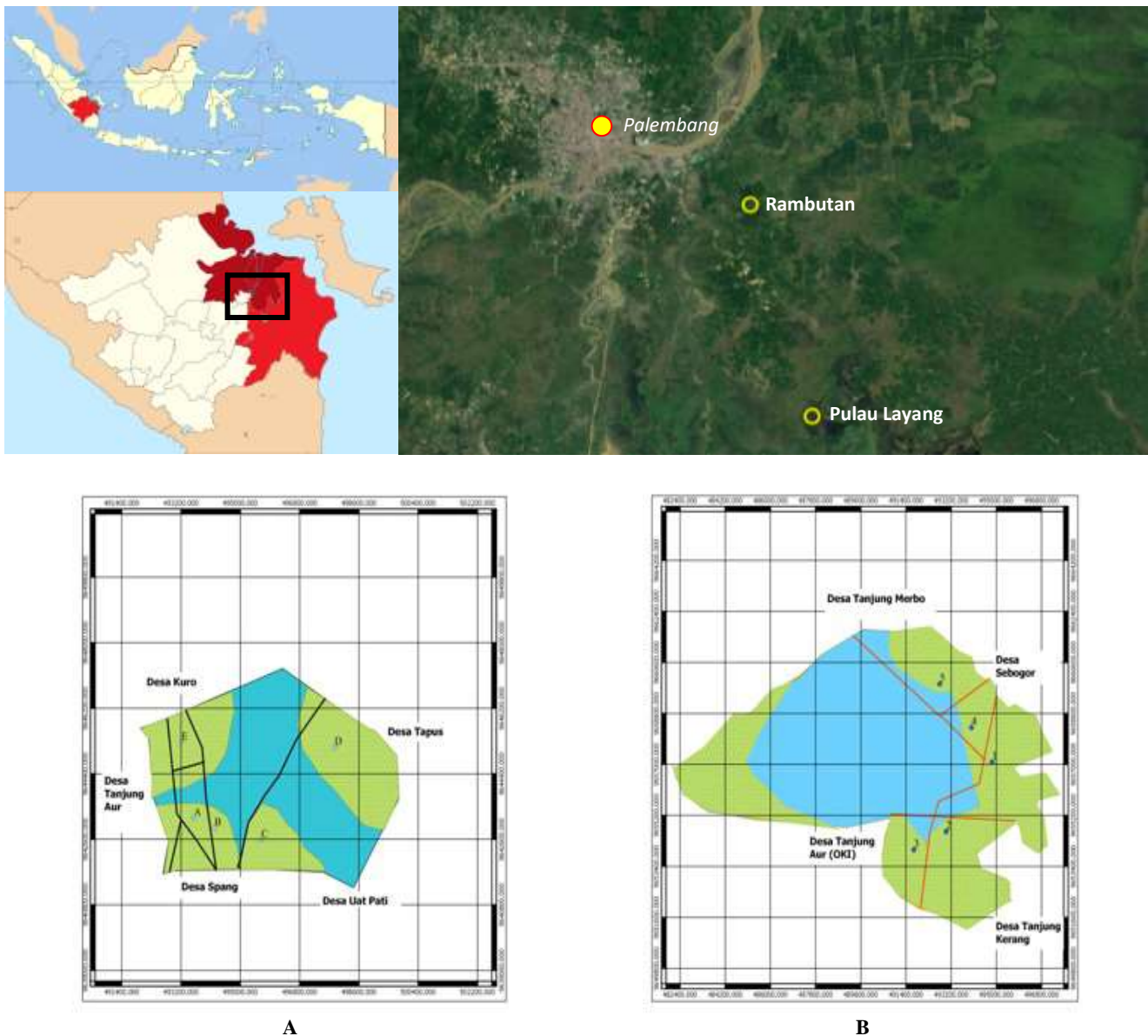


Figure 1. Research location in South Sumatera, Indonesia. A. Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District, South Sumatra. B. Rambutan Village, Rambutan Sub-district, Banyuasin District, South Sumatra

Field data were collected using direct observations and measurements including forage vegetation species, amount of production, forage quality (natural grasses and legumes), and soil fertility. Purposive sampling was conducted by making quadratic plots with size of 1x1m each plot and with total number of plots was 50 (Kleden et al. 2015). In each observation plot, the name and individual number of forage species were recorded. The plant specimens were collected and labeled with each species was photographed with digital camera. The collected specimens from each plot were separated according to each species and dried to calculate the dominant value. Dominant value is a value that more important than other values. The unknown species was collected for herbaria, being treated with 70% alcohol, oven-dried, and identified the plant is identified by employing a botanist and using reference book.

Vegetation analysis

The collected data were analyzed quantitatively (Utami et al. 2007) as follows:

Density

Density is the number of individual of a species per area extent and formulated as follows:

$$\text{Density} = \frac{\text{Number of individual of a species}}{\text{Total extent of sample plots}}$$

Relative density

Relative density is the density of a species as a percent of total plant density and formulated as follows:

$$\text{Relative density} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100\%$$

Frequency

Frequency is the number of sample plots having a species in a given total number of sample plots and formulated as follows:

$$\text{Frequency} = \frac{\text{Number of plots having a species}}{\text{Number of all observed plots}}$$

Relative frequency

Relative Frequency is the frequency of a species as a percent of total frequency of all species and formulated as follows:

$$\text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100\%$$

Important Value Index (IVI)

This value indicates the dominance of a species in a particular area and formulated as follows:

$$\text{IVI} = \text{Relative Density} + \text{Relative Frequency}$$

Forage production

Measurement on forage production adopted the *Halls* method (Kleden et al. 2015) using a 1m x 1m quadratic frame (Sutaryo 2009). A total of 50 observation points were done in grazing area of swampland lowland that frequently used by farmers/ranchers. The squared frame for each observation point was randomly placed. The average forage production was calculated using the following formula:

$$X = \sum xi/n$$

Where:

X : The existing average of forage biomass production

$\sum xi$: The amount of forage biomass production at each observation

n : The amount of observation

Pasture carrying capacity

The carrying capacity is the ability of pasture areas or grass farming to accommodate a number of livestock so that the need for grass for one-year-animal feed is sufficient. Calculating forage carrying capacity of swamp lowland forage is based on the amount of forage supplied on pasture for livestock needs for one year which is stated in Animal Unit (AU) per hectare. The carrying capacity was calculated for each species of forage. The calculation adopted formula developed by Purnomo (2006).

$$\text{Carrying capacity} = \frac{\text{Cumulative production} \times \text{proper use factor (\%)}}{\text{Animal needs (kg DM/AU/day)} \times 360 \text{ days}}$$

$$\text{Cumulative Forage Production} = [(hk/ik \times pk) + (hp/ip \times pp) + (hh/ih \times ph)]$$

Where:

hk : Number of days in the dry season (90 days)

hp : Number of days in the transition season (120 days)

hh : Number of days in the wet season (150 days)

ik : Cutting intervals in the dry season (50 days)

ip : Cutting intervals in the transition season (30 days)

ih : Cutting intervals in the wet season (40 days)

pk : Biomass production in the dry season

pp : Biomass production in the transition season

ph : Biomass production in the wet season

puf: Proper use factor 68%.

kt : Animal need 6,25 kg dry matter AU⁻¹day⁻¹

Data analysis

Carrying capacity was analyzed by comparing forage production to the number of livestock available which result in a ratio that informs the number of buffaloes that could be developed in the study area. Three possible ratios are: (i) AUp/AUt < 1 means the number of livestock grazing in swampland is greater than the amount of feed available; (ii) AUp/AUt =1 means there is a balance between the amount of forage available and the number of livestock; (iii) AUp/AUt > 1 means the number of livestock is less than the amount of food available in the pasture. AU is animal unit equivalents with AUp and AUt are animal units for feed and animal unit for livestock, respectively (Kleden et al. 2015).

RESULTS AND DISCUSSION

Forage species

In the research areas, there were 19 forage species potential to be used as Pampangan buffalo feed, covering 17 grass species (Gramineae) and 2 legume species (Leguminosae) (Table 1).

Analysis of forage vegetation

The results of vegetation analysis of forage species at Pampangan buffalo pastures in swamp lowland during wet

and dry seasons in Pulau Layang Village and Rambutan Village are presented in Tables 2 and 3, respectively.

Forage production

The average production of fresh forage vegetation of swamp lowland at two study locations was 6.90 tons.ha⁻¹.year⁻¹ in Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District (Table 4) and 3.68 tons.ha⁻¹.year⁻¹ in Rambutan Village, Rambutan Sub-district, Banyuasin District (Table 5).

Table 1. Forage species in the studied areas of Pampangan buffalo pasture in non-tidal swampland of South Sumatra, Indonesia

Latin name	Local name	Village		Remarks
		P	R	
<i>Catharanthus roseus</i>	Tapak dara	+	-	NDP
<i>Cyperus cephalotes</i>	Apit-apit	+	-	NDP
<i>Cyperus digitatus</i>	Kasuran	-	+	NDP
<i>Digitaria fuscescens</i>	Pasiran/Kerak maling	+	+	DP
<i>Eichhornia crassipes</i>	Eceng gondok	+	-	NDP
<i>Eleocharis dulcis</i>	Purun tikus	+	+	DP
<i>Hymenachne acutigluma</i>	Kumpai tembaga	+	+	DP
<i>Hymenachne amplexicaulis</i>	Kumpai minyak	+	+	DP
<i>Hymenachne sp.</i>	Kumpai merah	+	-	NDP
<i>Ipomoea aquatica</i>	Kangkung merah	+	-	NDP
<i>Leersia hexandra</i>	Bento rayap	+	+	DP
<i>Ludwigia hyssopifolia</i>	Cecengkehan	+	-	ND
<i>Neptunia oleracea</i>	Kemon air	+	-	NDP
<i>Nymphaea lotus</i>	Telepuk Gajah	+	-	NDP
<i>Nymphaea odorata</i>	Telepuk Padi	+	-	NDP
<i>Oryza rufipogon</i>	Kumpai padi	+	+	DP
<i>Polygonum barbatum</i>	Are bolong	+	-	DNP
<i>Rhynchospora corymbosa</i>	Berondong	-	+	ND
<i>Sesbania exasperata</i>	Mutiara	-	+	NDP

Note: P: Pulau Layang Village, R: Rambutan Village, DP: Dominant, Palatable, DNP: Dominant, Not Palatable, NDP: Not Dominant, Palatable ND : Not Dominant, Not Palatable means forages that is not liked by buffaloes to eat swampland. + : Present, -: Absent. Dominand means a type of forages that always appears in sampling and have high production.

Table 2. Density, relative density, frequency, relative frequency, and important value index of forage species at Pampangan buffalo pasture during wet and dry seasons in Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District, South Sumatra, Indonesia

Latin name	Wet season					Dry season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Catharanthus roseus</i>	0.08	2.50	0.06	3.65	6.15	-	-	-	-	-
<i>Cyperus cephalotes</i>	-	-	-	-	-	0.16	8.42	0.12	9.52	17.94
<i>Digitaria fuscescens</i>	-	-	-	-	-	0.16	8.42	0.12	9.52	17.94
<i>Eichhornia crassipes</i>	0.48	15.00	0.20	12.19	27.19	0.18	9.47	0.08	6.34	15.82
<i>Eleocharis dulcis</i>	0.16	5.00	0.14	8.53	13.53	-	-	-	-	-
<i>Hymenachne acutigluma</i>	0.22	6.87	0.12	7.31	14.19	0.12	6.31	0.12	9.52	15.84
<i>Hymenachne amplexicaulis</i>	0.20	6.25	0.10	6.09	12.34	0.14	7.36	0.08	6.34	13.71
<i>Hymenachne sp.</i>	0.46	14.37	0.18	10.97	25.35	0.20	10.52	0.12	9.52	20.05
<i>Ipomoea aquatica</i>	0.04	1.25	0.04	2.43	3.68	-	-	-	-	-
<i>Leersia hexandra</i>	0.06	1.87	0.04	2.43	4.31	0.12	6.31	0.10	7.93	14.25
<i>Ludwigia hyssopifolia</i>	0.18	5.62	0.06	3.65	9.28	0.16	8.42	0.08	6.34	14.77
<i>Neptunia oleracea</i>	0.56	17.50	0.32	19.51	37.01	0.38	20.00	0.24	19.04	39.04
<i>Nymphaea lotus</i>	0.02	0.62	0.02	1.22	1.84	-	-	-	-	-
<i>Nymphaea odorata</i>	0.02	0.62	0.02	1.22	1.84	-	-	-	-	-
<i>Oryza rufipogon</i>	0.18	5.62	0.08	4.87	10.50	-	-	-	-	-
<i>Polygonum barbatum</i>	0.54	16.87	0.26	15.85	32.72	0.28	14.73	0.20	15.87	30.61
Total	3.2	100	1.64	100	200	1.90	100	1.26	100	200

Note: D = Density, RD = Relative Density, F = Frequency, RF = Relative Frequency, IVI = Important Value Index

Table 3. Density, Relative Density, Frequency, Relative Frequency, and Important Value Index of forage species at Pampangan buffalo pasture during wet and dry seasons in Rambutan Village, Rambutan Sub-district, Banyuasin District, South Sumatra, Indonesia

Latin name	Wet season					Dry season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Cyperus digitatus</i>	0.88	18.03	0.30	14.85	32.88	0.12	5.31	0.06	4.34	9.65 ⁴
<i>Digitaria fuscescens</i>	1.10	22.54	0.40	19.80	42.34	0.40	1.77	0.22	15.94	17.71 ³
<i>Eleocharis dulcis</i>	1.68	34.42	0.74	36.63	71.06	1.00	44.24	0.62	44.92	89.17 ¹
<i>Hymenachne acutigluma</i>	0.04	0.82	0.02	0.99	1.81	0.02	0.88	0.02	1.44	2.33 ⁸
<i>Hymenachne amplexicaulis</i>	0.04	0.82	0.02	0.99	1.81	0.04	1.77	0.02	1.44	3.21 ⁷
<i>Leersia hexandra</i>	0.06	1.23	0.04	1.98	3.21	0.04	1.77	0.04	2.89	4.65 ⁵
<i>Oryza rufipogon</i>	0.80	16.39	0.40	19.80	36.19	0.60	26.54	0.38	27.53	54.08 ²
<i>Rhynchospora corymbosa</i>	0.08	1.63	0.04	1.98	3.61	0.04	1.77	0.02	1.44	3.21 ⁶
<i>Sesbania exasperata</i>	0.20	4.09	0.06	2.97	7.06	-	-	-	-	-
Total	4.88	100	2.02	100	200	2.26	100	1.38	100	200

Note: D = Density, RD = Relative Density, F = Frequency, RF = Relative Frequency, IVI = Important Value Index

Table 4. Fresh weight production (FWP), dry matter production (DMP), and forage carrying capacity (CC) of swamp lowland in wet and dry seasons in Pulau Layang Village, Ogan Komering Ilir.

Latin name	Wet season			Dry season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Catharanthus roseus</i>	7,530	977.40	2.82	-	-	-
<i>Cyperus cephalotes</i>	-	-	-	4,580	1,145.00 ⁴	3.30
<i>Digitaria fuscescens</i>	-	-	-	2,420	537.97 ¹⁰	1.55
<i>Eichhornia crassipes</i>	5,940	1,097.70	3.17	4,700	830.49 ⁶	2.40
<i>Eleocharis dulcis</i>	12,640	2,664.50	7.69	-	-	-
<i>Hymenachne acutigluma</i>	6,700	1,352.70	3.90	7,480	1,632.54 ¹	4.71
<i>Hymenachne amplexicaulis</i>	6,650	790.00	2.28	5,990	729.58 ⁸	2.11
<i>Hymenachne sp.</i>	7,040	1,151.70	3.32	5,720	975.83 ⁵	2.82
<i>Ipomoea aquatica</i>	4,020	604.60	1.75	-	-	-
<i>Leersia hexandra</i>	4,740	1,232.40	3.56	5,290	1,385.45 ²	4.00
<i>Ludwigia hyssopifolia</i>	1,980	346.90	1.00	4,290	777.35 ⁷	2.24
<i>Neptunia oleracea</i>	1,910	394.80	1.14	2,870	607.01 ⁹	1.75
<i>Nymphaea lotus</i>	9,800	1,983.50	5.72	-	-	-
<i>Nymphaea odorata</i>	7,500	1,286.30	3.71	-	-	-
<i>Oryza rufipogon</i>	12,960	2,225.20	6.42	-	-	-
<i>Polygonum barbatum</i>	7,180	1,651.40	4.77	5,290	1,244.74 ³	3.59
Average	6,899	1,268.51	3.66	4,863	986.60	2.85

Table 5. Fresh weight production (FWP), dry matter production (DMP), and forage carrying capacity (CC) of swamp lowland in wet and dry seasons in Rambutan Village, Banyuasin.

Latin name	Wet season			Dry season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Cyperus digitatus</i>	2,590	248.90	0.72	240	28.61	0.08
<i>Digitaria fuscescens</i>	790	108.00	0.31	1,100	152.79	0.44
<i>Eleocharis dulcis</i>	4,370	921.20	2.66	1,700	376.21	1.09
<i>Hymenachne acutigluma</i>	8,540	3,139.30	9.06	5,900	2,181.82	6.29
<i>Hymenachne amplexicaulis</i>	4,860	577.40	1.67	3,200	489.28	1.41
<i>Oryza rufipogon</i>	4,690	1,462.80	4.22	4,420	1,421.03	4.10
<i>Rhynchospora corymbosa</i>	1,510	441.80	1.28	250	77.88	0.22
<i>Sesbania exasperata</i>	1,360	111.50	0.32	-	-	-
Average	3,676.67	905.52	2.61	2,523.75	705.66	2.04

Pasture carrying capacity

The carrying capacity of swamp lowland for Pampangan buffalo pasture in Pulau Layang Village was 3.66 AU.ha⁻¹.year⁻¹ during the wet season and 2.85 AU.ha⁻¹.year⁻¹ in the dry season (Table 4). The carrying capacity of swamp lowland for Pampangan buffalo pasture in Rambutan Village was 2.61 AU.ha⁻¹.year⁻¹ in the wet season and 2.04 AU.ha⁻¹.year⁻¹ in the dry season (Table 5).

¹.year⁻¹ in the dry season (Table 4). The carrying capacity of swamp lowland for Pampangan buffalo pasture in Rambutan Village was 2.61 AU.ha⁻¹.year⁻¹ in the wet season and 2.04 AU.ha⁻¹.year⁻¹ in the dry season (Table 5).

Discussion

Diversity of forage species

There are dominant and palatable forage vegetation species in swamp lowland having potential as buffalo feed, namely Kumpai padi grass (*O. rufipogon*), Kumpai tembaga (*H. acutigluma*), and Kumpai minyak (*H. amplexicaulis*), not dominant and palatable such as Kumpai merah (*Hymenachne* sp) and Kemon air (*N. oleracea*); dominant and non palatable grass species (buffalo doesn't like it) namely Are bolong (*P. barbatum*). Yet, this grass species would be eaten by the buffaloes if there were no other forage species to be eaten (Table 1). The results of this study are different from the results of research conducted by other people before, the fundamental difference is the existence of differences in internal factors (forage vegetation) and external factors (environment). This research was carried out on swampland while research carried out by others was mostly on dry land or on tidal land. With the difference in place of study, the number, types of forage vegetation that are available will also be different. Besides that, there is also a difference in the production of forages and the carrying capacity of pasture. The renewal of this research is that there is currently no discussion about the analysis of vegetation and the carrying capacity of pasture grazing on swampland.

Ali et al. (2012) conducted a study on swampland vegetation and found 25 species in Pampang sub-district, while Rohaeni et al. (2005) found 24 species in South Kalimantan, and Camarao and Rodrigues Filho (2001) only found 7 species in Brazil. In Gowa District, there were 15 species found on natural grasslands consisting of 12 species classified as palatable forage (7 kinds of grass and 5 legumes) and 3 non palatable species, all of them are native species (Rinduwati et al. 2016). Based on the number of species encountered (15 species), it can be said that the natural pasture in Gowa District is quite good. Other studies show high diversity of forage species: 33 species in Sota village in Merauke, consisting of 61% grass, 3% legume and other plants 36% (Praptiwi et al. 2017); 22 forage species in Pakistan (Abdullah et al. 2017), 40 forage species consisting of 82-87% forage grass, 1% legume and forage consumable by livestock, and 12-17% those not edible by livestock in West Papua (Yoku et al. 2015). In Tobelo Sub-district, forage pasture consisted of 58.33% grass, 25% legume, and 16.67% other forage (Matulesy and Kastanja 2013; Eoh 2014). Species diversity is influenced by season in which the wet season increases the availability of water needed by plants for growth, especially the grass species, resulting in higher diversity (Kumalasari and Sunardi 2015).

Analysis of forage vegetation

In Pulau Layang Village, during the wet season, species with the highest Important Value Index (IVI) were Kemon air (*N. oleracea*) having 37.01% Important Value Index, followed by 32.72% Are bolong (*P. barbatum* L) and 27.19% Eceng gondok (*E. crassipes*), while the lowest value was Telepuk padi (*N. odorata* Aiton) and Telepuk gajah (*N. lotus*) which was 1.84% each. During the dry season, the highest IVI were Kemon air (*N. oleracea*) with

39.04%, followed by Are bolong (*P. barbatum* L) 30.61% and Kumpai merah (*Hymenachne* sp.) 20.05%, while the lowest value was Kumpai padi (*O. rufipogon*) with 13.71% (Table 2).

In Rambutan Village, during the wet season, species with the highest Important Value Index (IVI) were Purun tikus (*E. dulcis*) with 71.06%, Kerak maling (*D. fuscescens*) 42.34%, and Kumpai padi (*O. rufipogon*) 36.19%. The lowest values were Kumpai tembaga (*H. acutigluma*) and Kumpai minyak (*H. amplexicaulis*) 1.81% each. In the dry season, the highest IVI were Purun tikus (*E. dulcis*) 89.71%, Kumpai padi (*O. rufipogon*) 54.08%, and Kerak maling (*D. fuscescens*) 17.71%. The lowest value was Kumpai tembaga (*H. acutigluma*) 2.33% (Table 3).

The results also showed that there was a difference in the species richness between the wet and dry seasons. In Pulau Layang Village in the wet season there were 14 forage species and in the dry season, there were only 10 forage species. While Apit-apit (*C. cephalotes* Vahl) and Kerak maling (*D. fuscescens*) were not found in the wet season, Purun tikus (*E. dulcis*), Kumpai padi (*O. rufipogon*), Tapak darah (*C. roseus* L. Don), Kangkung merah (*I. aquatica* Forsk), and Telepuk padi (*N. odorata* Aiton) were not found in the dry season. In Rambutan Village, in wet season there were 9 forage species, while in the dry season there were only 8 species. In the dry season there was no legume Mutiara (*S. exasperate*), indicating that this species could not bear the drought and as a result, it would die in the dry season. These results suggest that there are some species that tolerant to water while some others were not. On the other hand, some species are tolerant to drought, while some others are not.

The Important Value Index (IVI) differences among species might be caused by the competition of each species in obtaining soil nutrients and sunlight, as well as climatic factors of the wet and dry seasons as also stated by Parmadi et al. (2016). In addition, there are other influencing factors namely vegetation density. The variation in species diversity and composition indicates that even though a research location has the same age, yet the environmental conditions could result in different vegetation (Syarifuddin 2011). In Pulau Layang Village, species having the highest IVI were Kemon air and Are bolong (37.01 and 32.73%) while in Rambutan Village were Purun tikus, Kerak maling and Kumpai padi (71.06%, 42.34%, and 36.19%), indicating that they are the most dominant species among other. A species is considered to be dominant in an area if it has IVI of more than 20% of all species and co-dominant if the percentage ranges from 10% to 20% (Suveltri et al. 2014).

The highest species density of forage vegetation in swamp ecosystem might have resulted from its adaptation and development ability in accordance with environment. This strengthens the study conducted by Oktaviani et al. (2015) that plants with the highest density can adapt to the environment to grow and reproduce under the conditions of low pH in water and soil. In contrast, plants with the lowest density might be caused by the unsuitable environmental

factors for the plants to grow and breed, particularly in the acidic water and soil (Samin et al. 2016).

Forage production

The production of fresh forage at pastures in Pulau Layang Village in the wet season was 6,899 kg ha⁻¹ year⁻¹ and the production of the dry matter was 1,268.51 kg ha⁻¹ year⁻¹, while in the dry season the production of fresh forage was 4,863 kg ha⁻¹ year⁻¹ and the dry matter production was 986.60 kg ha⁻¹ year⁻¹ (Table 4). This result is higher than those conducted in Canada (Omokanye et al. 2018) and in Timor Tengah Selatan District (Se'u et al. 2015) stating that the average fresh production of pasture in Gowa District in the wet season was 5,350 kg ha⁻¹ year⁻¹ and in the dry season was 1,390 kg ha⁻¹ year⁻¹ (Rinduwati et al. 2016). But the results of this study were lower than the study by Abdullah et al. (2017) in Pakistan who reported that forage production was 8,029.1 kg ha⁻¹ year⁻¹ in the wet season and 5,422.9 kg ha⁻¹ year⁻¹ in the dry season. The forage production of pasture in Sabana Timur Barat on the average ranged from 0.61 to 4.33 tons ha⁻¹ year⁻¹ (Manu 2013).

The lowest production usually occurs at the peak of dry season in October and the highest occurs in April (Manu 2013; Damry 2009). The forage production of *Pennisetum purpuphoides* was 70.4 ton ha⁻¹ year⁻¹, *Setaria sphasielata* 44.8 tons ha⁻¹ year⁻¹, *Brachiaria sp* 44.7 tons ha⁻¹ year⁻¹, *Pennisetum purpureum* 44.6 tons ha⁻¹ year⁻¹, and *Panicum maximum* 15.6 tons ha⁻¹ year⁻¹ (Jarmani and Haryanto 2015). The different amounts of production might have resulted from the differences in vegetation species, types of pasture, and methods used. There are various methods for estimating forage production, but many are inaccurate when applied to certain animal feed plant species. Therefore, it is very important to understand the limitations of technique used to measure forage production (Edvan et al. 2016; Badgery et al. 2017).

In Pulau Layang Village, there were 5 forage species having high fresh production in the wet season, namely Kumpai padi (*O. rufipogon*) with 12,960 kg ha⁻¹ year⁻¹, followed by Purun tikus (*E. dulcis*), Telepuk gajah (*N. lotus*), Are bolong (*P. barbatum* L) and Telepuk padi (*N. odorata* Aiton), and the lowest one was Kemon air (*N. olerancia*) with 1,910 kg ha⁻¹ year⁻¹. In the dry season the highest fresh production was Kumpai tembaga (*H. acutigluma*) with 7,480 kg ha⁻¹ year⁻¹, followed by Kumpai minyak (*H. amplexicaulis*), Kumpai merah (*Hymenachne* sp.), Are bolong (*P. barbatum* L) and Bento rayap (*L. hexandra*), and the lowest one was Kemon air (*N. oleracea*) with only 2,870 kg ha⁻¹ year⁻¹. The highest dry matter production in the wet season was Purun tikus (*E. dulcis*) with 2,664.5 kg ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*), Telepuk gajah (*N. lotus*), Are bolong (*P. barbatum* L), and Kumpai tembaga (*H. acutigluma*), and the lowest was Cecengkehan (*L. hyssopifolia*). In the dry season the highest dry matter production was Kumpai tembaga (*H. acutigluma*) with 7,480 kg ha⁻¹ year⁻¹, followed by Bento rayap (*L. hexandra*), Are bolong (*P. barbatum* L), Apit-apit (*C. cephalotes* Vahl) and Kumpai

merah (*Hymenachne* sp.), and the lowest was Kerak maling (*D. fuscescens*) with 2,420 kg ha⁻¹ year⁻¹ (Table 4).

In Rambutan Village, the production of fresh forage during the wet season was 3,676.67 kg ha⁻¹ year⁻¹ and the dry matter production was 905.52 kg ha⁻¹ year⁻¹, whereas in the dry season the fresh produce was 2,523.75 kg ha⁻¹ year⁻¹ and the dry matter production was 705.66 kg ha⁻¹ year⁻¹ (Table 5). These results were higher than those of the study conducted by Purwantari et al. (2015) and Praptiwi et al. (2017) who reported that the average availability of forage on palm oil plantation was 1,455.5 kg ha⁻¹ year⁻¹. The forage production during preproduction of rubber plantation was 732.90 kg ha⁻¹ year⁻¹ and at the time of production, it was only 317.83 kg ha⁻¹ year⁻¹ (Pramana et al. 2015).

In Rambutan Village, during the wet season there were 5 forage species having the highest fresh and dry matter production, namely Kumpai tembaga (*H. acutigluma*) producing 8,540 kg ha⁻¹ year⁻¹ and 3,139.3 kg ha⁻¹ year⁻¹ respectively, followed by Kumpai padi (*O. rufipogon*), Bento rayap (*L. hexandra*), Purun tikus (*E. dulcis*), and Kumpai minyak (*H. amplexicaulis*), and the lowest one was Kerak maling (*D. fuscescens*) with 790 kg ha⁻¹ year⁻¹ and 108.0 kg ha⁻¹ year⁻¹, respectively. In the dry season, the highest fresh and dry matter production was Kumpai tembaga (*H. acutigluma*) of 5,900 kg ha⁻¹ year⁻¹ and 2,181.82 kg ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*), Bento rayap (*L. hexandra*), Kumpai minyak (*H. amplexicaulis*), and Purun tikus (*E. dulcis*), and the lowest one was Kasuran (*C. digitatus*) with 240 kg ha⁻¹ year⁻¹ and 11.92 kg ha⁻¹ year⁻¹, respectively (Table 5). The results of this study were still higher than those conducted by Rostini et al. (2014) stating that the highest fresh forage production of grass *Hymenachne amplexicaulis* Haes was 1,032 kg DM ha⁻¹ harvest⁻¹ in the high tide season and 518.3 kg DM ha⁻¹ harvest⁻¹ in the low tide season, where the dry matter production ranged from 43.8 to 1,032 kg DM ha⁻¹ harvest⁻¹ in the high tide season and from 38.5 to 752.8 kg DM ha⁻¹ harvest⁻¹ in the low tide season.

The higher production of forage in Pampangan Sub-district compared to that in Rambutan Sub-district might be caused by higher soil fertility of the pasture area in Pampangan. The result of soil analysis showed that the C-Organic, N-total, and P-available in Pampangan (Bray I) were higher than those in Rambutan which might be related to the fact that most pasture in Pulau Layang Village (Pampangan) are rice fields which are always given fertilizer. This differs with pasture in Rambutan Village which is only used for grazing without any use of fertilizer. The provision of manure and bioslurry fertilizer can increase the production and forage quality of 4.75 tons and 4.36 tons, respectively (Suarna and Budiasa 2016; Jeffery et al. 2018).

Pasture carrying capacity

In Pulau Layang Village, the carrying capacity for Pampangan buffaloes pasture on the swamp lowland in the wet season was 3.66 AU ha⁻¹ year⁻¹ and 2.85 AU ha⁻¹ year⁻¹ during the dry season (Table 4). In Rambutan Village, the carrying capacity for Pampangan buffalo pasture in the wet

season was 2.61 AU ha⁻¹ year⁻¹ and in the dry season was 2.04 AU ha⁻¹ year⁻¹ (Table 5). The results of this study correspond to study conducted by Rostini et al. (2014) which found the carrying capacity of swamp lowland in South Kalimantan was 2.91 AU ha⁻¹ year⁻¹.

These results were higher than in grassland in South Central Timor District with only 0.24-0.63 AU ha⁻¹ year⁻¹ (Seu et al. 2015), in natural pastures of Gowa District with 0.88 AU ha⁻¹ year⁻¹ (Rinduwati et al. 2016), in pasture in Poso District with 0.63 AU ha⁻¹ year⁻¹ (Damry 2009; Daru et al. 2014), in Kelei and Didiri villages of Poso Districts with 0.96 and 1.12 AU ha⁻¹ year⁻¹ (Karti et al. 2015). However, these results were lower than the study conducted by Muhajirin et al. (2017) stating that the carrying capacity of Padang Mengatas BPTU was 5 AU ha⁻¹ year⁻¹ in the wet season and 3.18 AU ha⁻¹ year⁻¹ in the dry season. Even, Abdullah et al. (2017) reported very high carrying capacity of forage in Pakistan with 24 AU ha⁻¹ year⁻¹ and 16 AU ha⁻¹ year⁻¹ in the wet and dry seasons, respectively.

There is a decrease in dry material produced during the dry season because the water condition in swamp lowland is reduced. Decrease in swamp water level resulted in the decrease of photosynthesis which affects the production of the dry matter. Water is the main ingredient needed in photosynthesis. The disruption of metabolic processes in plants will affect plant production. Plant dry weight depicts the accumulation of organic compounds that are successfully synthesized by the plants from inorganic compounds, especially water and CO₂ (Lakitan 1995). Water shortages will have a negative effect on plant growth resulting in decreased production (Jun-Feng et al. 2010; Taiz and Zeiger 2002).

The high carrying capacity is related to the high forage production, forage management and selection of good species. Management and strategy to increase forage production require innovative facilitation and training to stockbreeders and farmers to increase their knowledge. These efforts should be supported by government and private companies develop programs regarding the importance of forage in increasing ruminant livestock production (Nigus 2017; Omokanye et al. 2018).

In Pulau Layang Village, in a pasture condition assumed to have one forage species, the highest carrying capacity in the wet season was Purun tikus (*E. dulcis*) with 7.69 AU ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 6.42 AU ha⁻¹ year⁻¹, Telepuk gajah (*N. lotus*) with 5.72 AU ha⁻¹ year⁻¹, Are bolong (*P. barbatum* L) with 4.77 AU ha⁻¹ year⁻¹ and Kumpai tembaga (*H. acutigluma*) with 3.90 AU ha⁻¹ year⁻¹, respectively, and the lowest was Cecengkehan (*L. hyssopifolia*) with 1.00 AU ha⁻¹ year⁻¹. In the dry season, the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) with 4.71 AU ha⁻¹ year⁻¹, followed by Bento rayap (*L. hexandra*) with 4.00 AU ha⁻¹ year⁻¹, Are bolong (*P. barbatum* L) with 3.59 AU ha⁻¹ year⁻¹, Apit-apit (*C. cephalotes* Vahl) with 3.30 AU ha⁻¹ year⁻¹ and Kumpai merah (*Hymenachne* sp.) with 2.82 AU ha⁻¹ year⁻¹, whereas the lowest was Kerak maling (*D. fuscescens*) with 1.55 AU ha⁻¹ year⁻¹ (Table 4).

In Rambutan Village, assuming that the pasture had one forage species, the highest carrying capacity in the wet season was Kumpai tembaga (*H. acutigluma*) with 9.06 AU ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 4.22 AU ha⁻¹ year⁻¹, Bento rayap (*L. hexandra*) with 3.29 AU ha⁻¹ year⁻¹, Purun tikus (*E. dulcis*) 2.66 with AU ha⁻¹ year⁻¹, and Kumpai minyak (*H. amplexicaulis*) with 1.67 AU ha⁻¹ year⁻¹, while the lowest was Kerak maling (*D. fuscescens*) with 0.31 AU ha⁻¹ year⁻¹. During the dry season the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) with 6.29 AU ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 4.10 AU ha⁻¹ year⁻¹, Bento rayap (*L. hexandra*) with 2.65 AU ha⁻¹ year⁻¹, Kumpai minyak (*H. amplexicaulis*) with 1.41 AU ha⁻¹ year⁻¹, and Purun tikus (*E. dulcis*) with 1.09 AU ha⁻¹ year⁻¹, while the lowest was Kasuran (*C. digitatus*) with 0.08 AU ha⁻¹ year⁻¹ (Table 5). These results indicate that the carrying capacity is very influential with the type of feed plan. In addition, another important thing is cattle grazing system in which livestock grazing must be regulated to avoid over-grazing as the amount of grazing livestock depends on the carrying capacity of the pasture (Salendu and Elly 2014; Cheng et al. 2017; Hashemi 2017).

The results of this study indicated that forage availability is still sufficient to meet feed requirements for Pampangan buffaloes. The population of Pampangan buffaloes in Pulau Layang Village was 487 buffaloes with a grazing area of 500 ha and average carrying capacity of 3.14 AU ha⁻¹ year⁻¹. While the number of Pampangan buffaloes of Rambutan Village was 1.735 buffaloes with a pasture area of 1,203 ha and average carrying capacity of 2.45 AU ha⁻¹ year⁻¹. It is estimated that there still can be added buffalo cattle as much as 0.31 AU ha⁻¹ year⁻¹ in Pulau Layang Village so 155 buffaloes and 0.59 AU ha⁻¹ year⁻¹ in Rambutan Village 709 buffaloes

In conclusion, there were 19 forage species to have the potential as feeding source of Pampangan buffaloes in South Sumatra. The importance of species indicated by IVI is strongly influenced by grazing locations and seasons. The most important species were Kemon air (*N. oleracea*) and Are bolong (*P. barbatum* L) in Pulau Layang Village and Purun tikus (*E. dulcis*), Kerak maling (*D. fuscescens*), and Kumpai padi (*O. rufipogon*) in Rambutan Village. In Pulau Layang Village, the fresh forage and dry matter production in the wet season were 6.90 and 1.27 tons ha⁻¹ year⁻¹, while in Rambutan Village they were 3.68 tons ha⁻¹ year⁻¹ and 0.91 ton ha⁻¹ year⁻¹, respectively. The fresh forage production and dry matter production in the dry season in Pulau Layang Village were 4.86 and 0.99 tons ha⁻¹ year⁻¹, while in Rambutan Village were 2.52 tons ha⁻¹ year⁻¹ and 0.71 tons ha⁻¹ year⁻¹, respectively. On the average the carrying capacity of the swamp lowland pasture in South Sumatra was 2.79 AU.ha⁻¹.year⁻¹. As such, forage availability is still sufficient to meet the need for animal feed, and it is estimated the areas can be added buffalo cattle of 0.31 AU ha⁻¹ year⁻¹ in Pulau Layang Village and 0.59 AU ha⁻¹ year⁻¹ in Rambutan Village.

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Vegetation analysis of non-tidal swampland in South Sumatra, Indonesia and its carrying capacity for Pampangan buffalo pasture

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Abstract. Muhakka, Suwignyo RA, Budianta D, Yakup. 2019. Vegetation analysis of non-tidal swampland in South Sumatra, Indonesia and its carrying capacity for Pampangan buffalo pasture. *Biodiversitas* 20: 1077-1086. In Indonesia, non-tidal swampland area is 13.27 million ha, only 4 million ha has been developed with details of 2.6 million ha that managed by the public and the private sector and 1.3 million ha with government assistance. This study aims to analyze vegetation structure of non-tidal swampland in Pulau Layang Village, Ogan Komering Ilir District, South Sumatra, Indonesia and Rambutan Village, Banyuasin District, South Sumatra, Indonesia and to examine its carrying capacity for Pampangan buffalo pasture. Methods used were by the combination of direct observation, survey using plot sampling with total 50 observation plots, and measurements to determine forage production using Halls method. The results show that there 19 forage species were in two studied areas which are potential as Pampangan buffalo feed. Species with the highest Important Value Index were Purun tikus (*Eleocharis dulcis*) with 89.71% and Kumpai padi (*Oryza rufipogon*) with 54.08%. The production of fresh forage and dry matter in the wet season in Pulau Layang was 6.90 tons ha⁻¹ year⁻¹ and 1.27 tons ha⁻¹ year⁻¹, respectively, whereas in Rambutan they were 3.68 tons ha⁻¹ year⁻¹ and 0.91 tons ha⁻¹ year⁻¹, respectively. The production of fresh forage and dry matter in the dry season in Pulau Layang was 4.86 tons ha⁻¹ year⁻¹ and 0.99 tons ha⁻¹ year⁻¹, respectively, while in Rambutan they were 2.52 tons ha⁻¹ year⁻¹ and 0.71 tons ha⁻¹ year⁻¹, respectively. The pasture carrying capacity in Pulau Layang in the wet season was 3.66 AU (Animal Unit) ha⁻¹ year⁻¹ and in the dry season, it was 2.85 AU ha⁻¹ year⁻¹, while in Rambutan Village it was 2.61 AU ha⁻¹ year⁻¹ and 2.04 AU ha⁻¹ year⁻¹, respectively. There were six species of forage with high production, namely Kumpai tembaga (*Hymenachne acutigluma*) Kumpai padi (*Oryza rufipogon*), Kumpai minyak (*Hymenachne amplexicaulis*), Are bolong (*Polygonum barbatum* L), Bento rayap (*Leersia hexandra*) and Purun tikus (*Eleocharis dulcis*). It is estimated that there still can be added buffalo cattle as much as 0.31 AU ha⁻¹ year⁻¹ in Pulau Layang Village so 155 buffaloes and 0.59 AU ha⁻¹ year⁻¹ in Rambutan Village. 709 buffaloes

Keywords: Pampangan buffalo, vegetation analysis, carrying capacity, pasture, non-tidal swampland

INTRODUCTION

Non-tidal swampland is often considered as suboptimal land despite its availability is very extensive in Indonesia. The total extent of non-tidal swampland is about 13.27 million ha, consisting of 3.0 million ha of deep swampland, 6.07 million ha of swampland with medium deep and 4.20 million ha of shallow swampland, and is distributed in Sumatra, Kalimantan, and Papua. Nonetheless, there is only 4 million ha of them have been developed with public and private sectors manage 2.60 million ha while 1.3 million ha are developed by government assistance (BPS 2010; Mulyani and Sarwani 2013). At provincial level, non-tidal swampland in South Sumatra covers the most extensive area in Sumatra, reaching 2.98 million ha but only 298,189 ha that has been developed (BPS 2014).

Pampangan buffalo is potential germplasm of South Sumatra Province which is widely found and extensively farmed in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin District (Muhakka et al. 2013). In addition to being farmed for their

meat, the buffalo also produce milk to be processed into traditional food named *Gulo Puan*. Buffalo population in South Sumatra in 2014 was 33,369 buffaloes, decreasing 4.29% than that in 2012 with 34,866 buffaloes (South Sumatra Province Animal Husbandry Office 2014). There are three factors causing the decline in the buffalo livestock population, namely: (i) fluctuated availability of natural forage, (ii) low quality of nutritional forage of lowland swamp, and (iii) decreasing extent of grazing pasture land (BPTP South Sumatra 2011). The low productivity of the buffaloes in term of growth and milk production is caused by the consumed rations could not meet the needs for food substances which characterized by low protein content, high crude fiber, and low digestibility. However, the buffaloes have several advantages and their productivity can be enhanced especially through food and genetic improvement (Talib et al. 2014). The buffaloes have advantages compared to cows in which they can survive particularly when available feed has low quality (Diwyanto and Handiwirawan 2006; Yasin 2013).

One strategy that can be done to maintain and improve the level of productivity of Pampangan buffalo is by studying their forage in lowland swamp by analyzing the vegetation and carrying capacity of pasture. Studies on vegetation analysis and pasture carrying capacity up to date are only limited to dry land areas, such as in Wulan Gitrang Sub-district, East Flores which show carrying capacity of $0.42 \text{ AU}\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$ on coffee plantation and $0.38 \text{ AU}\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$ on grassland (Kleden et al. 2015). Another study investigating carrying capacity of livestock forage during preproduction of rubber (juvenile plants) is $0.14 \text{ AU}\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$, while during rubber production (mature plants) can only accommodate $0.06 \text{ AU}\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$ (Pramana et al. 2015).

This study aims to analyze vegetation structure of non-tidal swampland in South Sumatra and examine its carrying capacity for Pampangan buffalo pasture.

MATERIALS AND METHODS

This research was carried out in Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District, South Sumatra and Rambutan Village, Rambutan Sub-district, Banyuasin District, South Sumatra from April to September 2017. The methods used were the combination of survey, measurements, and direct observations on samples of swampland commonly used as pasture by farmers. Data of livestock population were collected from related agencies and institutions.

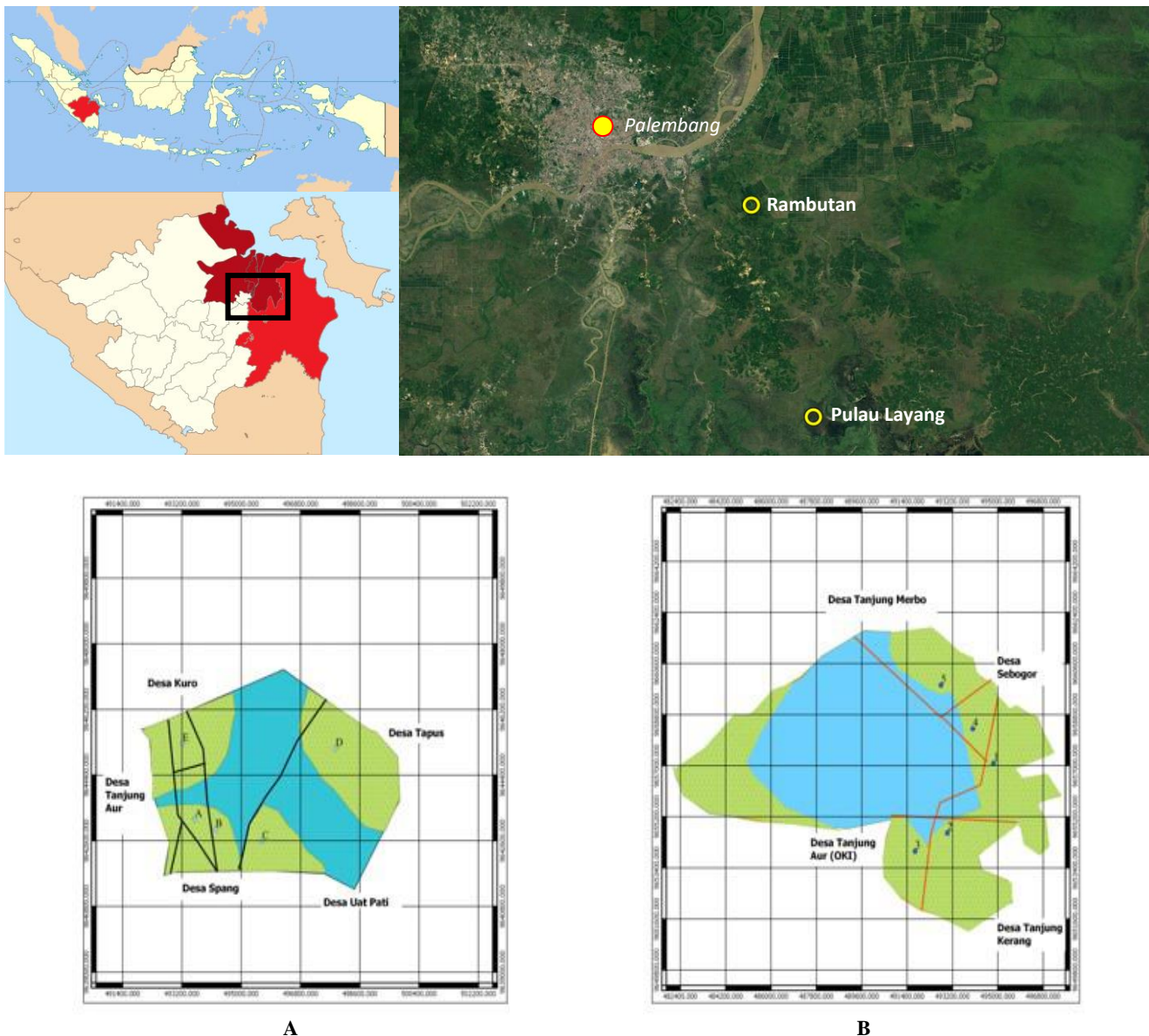


Figure 1. Research location in South Sumatra, Indonesia. A. Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District, South Sumatra. B. Rambutan Village, Rambutan Sub-district, Banyuasin District, South Sumatra

Field data were collected using direct observations and measurements including forage vegetation species, amount of production, forage quality (natural grasses and legumes), and soil fertility. Purposive sampling was conducted by making quadratic plots with size of 1x1m each plot and with total number of plots was 50 (Kleden et al. 2015). In each observation plot, the name and individual number of forage species were recorded. The plant specimens were collected and labeled with each species was photographed with digital camera. The collected specimens from each plot were separated according to each species and dried to calculate the dominant value. Dominant value is a value that more important than other values. The unknown species was collected for herbaria, being treated with 70% alcohol, oven-dried, and identified the plant is identified by employing a botanist and using reference book.

Vegetation analysis

The collected data were analyzed quantitatively (Utami et al. 2007) as follows:

Density

Density is the number of individual of a species per area extent and formulated as follows:

$$\text{Density} = \frac{\text{Number of individual of a species}}{\text{Total extent of sample plots}}$$

Relative density

Relative density is the density of a species as a percent of total plant density and formulated as follows:

$$\text{Relative density} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100\%$$

Frequency

Frequency is the number of sample plots having a species in a given total number of sample plots and formulated as follows:

$$\text{Frequency} = \frac{\text{Number of plots having a species}}{\text{Number of all observed plots}}$$

Relative frequency

Relative Frequency is the frequency of a species as a percent of total frequency of all species and formulated as follows:

$$\text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100\%$$

Important Value Index (IVI)

This value indicates the dominance of a species in a particular area and formulated as follows:

$$\text{IVI} = \text{Relative Density} + \text{Relative Frequency}$$

Forage production

Measurement on forage production adopted the *Halls* method (Kleden et al. 2015) using a 1m x 1m quadratic frame (Sutaryo 2009). A total of 50 observation points were done in grazing area of swampland lowland that frequently used by farmers/ranchers. The squared frame for each observation point was randomly placed. The average forage production was calculated using the following formula:

$$X = \sum xi/n$$

Where:

X : The existing average of forage biomass production

$\sum xi$: The amount of forage biomass production at each observation

n : The amount of observation

Pasture carrying capacity

The carrying capacity is the ability of pasture areas or grass farming to accommodate a number of livestock so that the need for grass for one-year-animal feed is sufficient. Calculating forage carrying capacity of swamp lowland forage is based on the amount of forage supplied on pasture for livestock needs for one year which is stated in Animal Unit (AU) per hectare. The carrying capacity was calculated for each species of forage. The calculation adopted formula developed by Purnomo (2006).

$$\text{Carrying capacity} = \frac{\text{Cumulative production} \times \text{proper use factor (\%)}}{\text{Animal needs (kg DM/AU/day)} \times 360 \text{ days}}$$

$$\text{Cumulative Forage Production} = [(hk/ik \times pk) + (hp/ip \times pp) + (hh/ih \times ph)]$$

Where:

hk : Number of days in the dry season (90 days)

hp : Number of days in the transition season (120 days)

hh : Number of days in the wet season (150 days)

ik : Cutting intervals in the dry season (50 days)

ip : Cutting intervals in the transition season (30 days)

ih : Cutting intervals in the wet season (40 days)

pk : Biomass production in the dry season

pp : Biomass production in the transition season

ph : Biomass production in the wet season

puf: Proper use factor 68%.

kt : Animal need 6,25 kg dry matter AU⁻¹day⁻¹

Data analysis

Carrying capacity was analyzed by comparing forage production to the number of livestock available which result in a ratio that informs the number of buffaloes that could be developed in the study area. Three possible ratios are: (i) AUp/AUt < 1 means the number of livestock grazing in swampland is greater than the amount of feed available; (ii) AUp/AUt =1 means there is a balance between the amount of forage available and the number of livestock; (iii) AUp/AUt > 1 means the number of livestock is less than the amount of food available in the pasture. AU is animal unit equivalents with AUp and AUt are animal units for feed and animal unit for livestock, respectively (Kleden et al. 2015).

RESULTS AND DISCUSSION

Forage species

In the research areas, there were 19 forage species potential to be used as Pampangan buffalo feed, covering 17 grass species (Gramineae) and 2 legume species (Leguminosae) (Table 1).

Analysis of forage vegetation

The results of vegetation analysis of forage species at Pampangan buffalo pastures in swamp lowland during wet

and dry seasons in Pulau Layang Village and Rambutan Village are presented in Tables 2 and 3, respectively.

Forage production

The average production of fresh forage vegetation of swamp lowland at two study locations was 6.90 tons.ha⁻¹.year⁻¹ in Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District (Table 4) and 3.68 tons.ha⁻¹.year⁻¹ in Rambutan Village, Rambutan Sub-district, Banyuasin District (Table 5).

Table 1. Forage species in the studied areas of Pampangan buffalo pasture in non-tidal swampland of South Sumatra, Indonesia

Latin name	Local name	Village		Remarks
		P	R	
<i>Catharanthus roseus</i>	Tapak dara	+	-	NDP
<i>Cyperus cephalotes</i>	Apit-apit	+	-	NDP
<i>Cyperus digitatus</i>	Kasuran	-	+	NDP
<i>Digitaria fuscescens</i>	Pasiran/Kerak maling	+	+	DP
<i>Eichhornia crassipes</i>	Eceng gondok	+	-	NDP
<i>Eleocharis dulcis</i>	Purun tikus	+	+	DP
<i>Hymenachne acutigluma</i>	Kumpai tembaga	+	+	DP
<i>Hymenachne amplexicaulis</i>	Kumpai minyak	+	+	DP
<i>Hymenachne sp.</i>	Kumpai merah	+	-	NDP
<i>Ipomoea aquatica</i>	Kangkung merah	+	-	NDP
<i>Leersia hexandra</i>	Bento rayap	+	+	DP
<i>Ludwigia hyssopifolia</i>	Cecengkehan	+	-	ND
<i>Neptunia oleracea</i>	Kemon air	+	-	NDP
<i>Nymphaea lotus</i>	Telepuk Gajah	+	-	NDP
<i>Nymphaea odorata</i>	Telepuk Padi	+	-	NDP
<i>Oryza rufipogon</i>	Kumpai padi	+	+	DP
<i>Polygonum barbatum</i>	Are bolong	+	-	DNP
<i>Rhynchospora corymbosa</i>	Berondong	-	+	ND
<i>Sesbania exasperata</i>	Mutiara	-	+	NDP

Note: P: Pulau Layang Village, R: Rambutan Village, DP: Dominant, Palatable, DNP: Dominant, Not Palatable, NDP: Not Dominant, Palatable ND : Not Dominant, Not Palatable means forages that is not liked by buffaloes to eat swampland. +: Present, -: Absent. Dominand means a type of forages that always appears in sampling and have high production.

Table 2. Density, relative density, frequency, relative frequency, and important value index of forage species at Pampangan buffalo pasture during wet and dry seasons in Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District, South Sumatra, Indonesia

Latin name	Wet season					Dry season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Catharanthus roseus</i>	0.08	2.50	0.06	3.65	6.15	-	-	-	-	-
<i>Cyperus cephalotes</i>	-	-	-	-	-	0.16	8.42	0.12	9.52	17.94
<i>Digitaria fuscescens</i>	-	-	-	-	-	0.16	8.42	0.12	9.52	17.94
<i>Eichhornia crassipes</i>	0.48	15.00	0.20	12.19	27.19	0.18	9.47	0.08	6.34	15.82
<i>Eleocharis dulcis</i>	0.16	5.00	0.14	8.53	13.53	-	-	-	-	-
<i>Hymenachne acutigluma</i>	0.22	6.87	0.12	7.31	14.19	0.12	6.31	0.12	9.52	15.84
<i>Hymenachne amplexicaulis</i>	0.20	6.25	0.10	6.09	12.34	0.14	7.36	0.08	6.34	13.71
<i>Hymenachne sp.</i>	0.46	14.37	0.18	10.97	25.35	0.20	10.52	0.12	9.52	20.05
<i>Ipomoea aquatica</i>	0.04	1.25	0.04	2.43	3.68	-	-	-	-	-
<i>Leersia hexandra</i>	0.06	1.87	0.04	2.43	4.31	0.12	6.31	0.10	7.93	14.25
<i>Ludwigia hyssopifolia</i>	0.18	5.62	0.06	3.65	9.28	0.16	8.42	0.08	6.34	14.77
<i>Neptunia oleracea</i>	0.56	17.50	0.32	19.51	37.01	0.38	20.00	0.24	19.04	39.04
<i>Nymphaea lotus</i>	0.02	0.62	0.02	1.22	1.84	-	-	-	-	-
<i>Nymphaea odorata</i>	0.02	0.62	0.02	1.22	1.84	-	-	-	-	-
<i>Oryza rufipogon</i>	0.18	5.62	0.08	4.87	10.50	-	-	-	-	-
<i>Polygonum barbatum</i>	0.54	16.87	0.26	15.85	32.72	0.28	14.73	0.20	15.87	30.61
Total	3.2	100	1.64	100	200	1.90	100	1.26	100	200

Note: D = Density, RD = Relative Density, F = Frequency, RF = Relative Frequency, IVI = Important Value Index

Table 3. Density, Relative Density, Frequency, Relative Frequency, and Important Value Index of forage species at Pampangan buffalo pasture during wet and dry seasons in Rambutan Village, Rambutan Sub-district, Banyuasin District, South Sumatra, Indonesia

Latin name	Wet season					Dry season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
<i>Cyperus digitatus</i>	0.88	18.03	0.30	14.85	32.88	0.12	5.31	0.06	4.34	9.65 ⁴
<i>Digitaria fuscescens</i>	1.10	22.54	0.40	19.80	42.34	0.40	1.77	0.22	15.94	17.71 ³
<i>Eleocharis dulcis</i>	1.68	34.42	0.74	36.63	71.06	1.00	44.24	0.62	44.92	89.17 ¹
<i>Hymenachne acutigluma</i>	0.04	0.82	0.02	0.99	1.81	0.02	0.88	0.02	1.44	2.33 ⁸
<i>Hymenachne amplexicaulis</i>	0.04	0.82	0.02	0.99	1.81	0.04	1.77	0.02	1.44	3.21 ⁷
<i>Leersia hexandra</i>	0.06	1.23	0.04	1.98	3.21	0.04	1.77	0.04	2.89	4.65 ⁵
<i>Oryza rufipogon</i>	0.80	16.39	0.40	19.80	36.19	0.60	26.54	0.38	27.53	54.08 ²
<i>Rhynchospora corymbosa</i>	0.08	1.63	0.04	1.98	3.61	0.04	1.77	0.02	1.44	3.21 ⁶
<i>Sesbania exasperata</i>	0.20	4.09	0.06	2.97	7.06	-	-	-	-	-
Total	4.88	100	2.02	100	200	2.26	100	1.38	100	200

Note: D = Density, RD = Relative Density, F = Frequency, RF = Relative Frequency, IVI = Important Value Index

Table 4. Fresh weight production (FWP), dry matter production (DMP), and forage carrying capacity (CC) of swamp lowland in wet and dry seasons in Pulau Layang Village, Ogan Komering Ilir.

Latin name	Wet season			Dry season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Catharanthus roseus</i>	7,530	977.40	2.82	-	-	-
<i>Cyperus cephalotes</i>	-	-	-	4,580	1,145.00 ⁴	3.30
<i>Digitaria fuscescens</i>	-	-	-	2,420	537.97 ¹⁰	1.55
<i>Eichhornia crassipes</i>	5,940	1,097.70	3.17	4,700	830.49 ⁶	2.40
<i>Eleocharis dulcis</i>	12,640	2,664.50	7.69	-	-	-
<i>Hymenachne acutigluma</i>	6,700	1,352.70	3.90	7,480	1,632.54 ¹	4.71
<i>Hymenachne amplexicaulis</i>	6,650	790.00	2.28	5,990	729.58 ⁸	2.11
<i>Hymenachne sp.</i>	7,040	1,151.70	3.32	5,720	975.83 ⁵	2.82
<i>Ipomoea aquatica</i>	4,020	604.60	1.75	-	-	-
<i>Leersia hexandra</i>	4,740	1,232.40	3.56	5,290	1,385.45 ²	4.00
<i>Ludwigia hyssopifolia</i>	1,980	346.90	1.00	4,290	777.35 ⁷	2.24
<i>Neptunia oleracea</i>	1,910	394.80	1.14	2,870	607.01 ⁹	1.75
<i>Nymphaea lotus</i>	9,800	1,983.50	5.72	-	-	-
<i>Nymphaea odorata</i>	7,500	1,286.30	3.71	-	-	-
<i>Oryza rufipogon</i>	12,960	2,225.20	6.42	-	-	-
<i>Polygonum barbatum</i>	7,180	1,651.40	4.77	5,290	1,244.74 ³	3.59
Average	6,899	1,268.51	3.66	4,863	986.60	2.85

Table 5. Fresh weight production (FWP), dry matter production (DMP), and forage carrying capacity (CC) of swamp lowland in wet and dry seasons in Rambutan Village, Banyuasin.

Latin name	Wet season			Dry season		
	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)	FWP (kg)	DMP (kg)	CC (AU.ha ⁻¹ .year ⁻¹)
<i>Cyperus digitatus</i>	2,590	248.90	0.72	240	28.61	0.08
<i>Digitaria fuscescens</i>	790	108.00	0.31	1,100	152.79	0.44
<i>Eleocharis dulcis</i>	4,370	921.20	2.66	1,700	376.21	1.09
<i>Hymenachne acutigluma</i>	8,540	3,139.30	9.06	5,900	2,181.82	6.29
<i>Hymenachne amplexicaulis</i>	4,860	577.40	1.67	3,200	489.28	1.41
<i>Oryza rufipogon</i>	4,690	1,462.80	4.22	4,420	1,421.03	4.10
<i>Rhynchospora corymbosa</i>	1,510	441.80	1.28	250	77.88	0.22
<i>Sesbania exasperata</i>	1,360	111.50	0.32	-	-	-
Average	3,676.67	905.52	2.61	2,523.75	705.66	2.04

Pasture carrying capacity

The carrying capacity of swamp lowland for Pampangan buffalo pasture in Pulau Layang Village was 3.66 AU.ha⁻¹.year⁻¹ during the wet season and 2.85 AU.ha⁻¹.year⁻¹ in the dry season (Table 4). The carrying capacity of swamp lowland for Pampangan buffalo pasture in Rambutan Village was 2.61 AU.ha⁻¹.year⁻¹ in the wet season and 2.04 AU.ha⁻¹.year⁻¹ in the dry season (Table 5).

The carrying capacity of swamp lowland for Pampangan buffalo pasture in Rambutan Village was 2.61 AU.ha⁻¹.year⁻¹ in the wet season and 2.04 AU.ha⁻¹.year⁻¹ in the dry season (Table 5).

Discussion

Diversity of forage species

There are dominant and palatable forage vegetation species in swamp lowland having potential as buffalo feed, namely Kumpai padi grass (*O. rufipogon*), Kumpai tembaga (*H. acutigluma*), and Kumpai minyak (*H. amplexicaulis*), not dominant and palatable such as Kumpai merah (*Hymenachne* sp) and Kemon air (*N. oleracea*); dominant and non palatable grass species (buffalo doesn't like it) namely Are bolong (*P. barbatum*). Yet, this grass species would be eaten by the buffaloes if there were no other forage species to be eaten (Table 1). The results of this study are different from the results of research conducted by other people before, the fundamental difference is the existence of differences in internal factors (forage vegetation) and external factors (environment). This research was carried out on swampland while research carried out by others was mostly on dry land or on tidal land. With the difference in place of study, the number, types of forage vegetation that are available will also be different. Besides that, there is also a difference in the production of forages and the carrying capacity of pasture. The renewal of this research is that there is currently no discussion about the analysis of vegetation and the carrying capacity of pasture grazing on swampland.

Ali et al. (2012) conducted a study on swampland vegetation and found 25 species in Pampang sub-district, while Rohaeni et al. (2005) found 24 species in South Kalimantan, and Camarao and Rodrigues Filho (2001) only found 7 species in Brazil. In Gowa District, there were 15 species found on natural grasslands consisting of 12 species classified as palatable forage (7 kinds of grass and 5 legumes) and 3 non palatable species, all of them are native species (Rinduwati et al. 2016). Based on the number of species encountered (15 species), it can be said that the natural pasture in Gowa District is quite good. Other studies show high diversity of forage species: 33 species in Sota village in Merauke, consisting of 61% grass, 3% legume and other plants 36% (Praptiwi et al. 2017); 22 forage species in Pakistan (Abdullah et al. 2017), 40 forage species consisting of 82-87% forage grass, 1% legume and forage consumable by livestock, and 12-17% those not edible by livestock in West Papua (Yoku et al. 2015). In Tobelo Sub-district, forage pasture consisted of 58.33% grass, 25% legume, and 16.67% other forage (Matulesy and Kastanja 2013; Eoh 2014). Species diversity is influenced by season in which the wet season increases the availability of water needed by plants for growth, especially the grass species, resulting in higher diversity (Kumalasari and Sunardi 2015).

Analysis of forage vegetation

In Pulau Layang Village, during the wet season, species with the highest Important Value Index (IVI) were Kemon air (*N. oleracea*) having 37.01% Important Value Index, followed by 32.72% Are bolong (*P. barbatum* L) and 27.19% Eceng gondok (*E. crassipes*), while the lowest value was Telepuk padi (*N. odorata* Aiton) and Telepuk gajah (*N. lotus*) which was 1.84% each. During the dry season, the highest IVI were Kemon air (*N. oleracea*) with

39.04%, followed by Are bolong (*P. barbatum* L) 30.61% and Kumpai merah (*Hymenachne* sp.) 20.05%, while the lowest value was Kumpai padi (*O. rufipogon*) with 13.71% (Table 2).

In Rambutan Village, during the wet season, species with the highest Important Value Index (IVI) were Purun tikus (*E. dulcis*) with 71.06%, Kerak maling (*D. fuscescens*) 42.34%, and Kumpai padi (*O. rufipogon*) 36.19%. The lowest values were Kumpai tembaga (*H. acutigluma*) and Kumpai minyak (*H. amplexicaulis*) 1.81% each. In the dry season, the highest IVI were Purun tikus (*E. dulcis*) 89.71%, Kumpai padi (*O. rufipogon*) 54.08%, and Kerak maling (*D. fuscescens*) 17.71%. The lowest value was Kumpai tembaga (*H. acutigluma*) 2.33% (Table 3).

The results also showed that there was a difference in the species richness between the wet and dry seasons. In Pulau Layang Village in the wet season there were 14 forage species and in the dry season, there were only 10 forage species. While Apit-apit (*C. cephalotes* Vahl) and Kerak maling (*D. fuscescens*) were not found in the wet season, Purun tikus (*E. dulcis*), Kumpai padi (*O. rufipogon*), Tapak darah (*C. roseus* L. Don), Kangkung merah (*I. aquatica* Forsk), and Telepuk padi (*N. odorata* Aiton) were not found in the dry season. In Rambutan Village, in wet season there were 9 forage species, while in the dry season there were only 8 species. In the dry season there was no legume Mutiara (*S. exasperate*), indicating that this species could not bear the drought and as a result, it would die in the dry season. These results suggest that there are some species that tolerant to water while some others were not. On the other hand, some species are tolerant to drought, while some others are not.

The Important Value Index (IVI) differences among species might be caused by the competition of each species in obtaining soil nutrients and sunlight, as well as climatic factors of the wet and dry seasons as also stated by Parmadi et al. (2016). In addition, there are other influencing factors namely vegetation density. The variation in species diversity and composition indicates that even though a research location has the same age, yet the environmental conditions could result in different vegetation (Syarifuddin 2011). In Pulau Layang Village, species having the highest IVI were Kemon air and Are bolong (37.01 and 32.73%) while in Rambutan Village were Purun tikus, Kerak maling and Kumpai padi (71.06%, 42.34%, and 36.19%), indicating that they are the most dominant species among other. A species is considered to be dominant in an area if it has IVI of more than 20% of all species and co-dominant if the percentage ranges from 10% to 20% (Suveltri et al. 2014).

The highest species density of forage vegetation in swamp ecosystem might have resulted from its adaptation and development ability in accordance with environment. This strengthens the study conducted by Oktaviani et al. (2015) that plants with the highest density can adapt to the environment to grow and reproduce under the conditions of low pH in water and soil. In contrast, plants with the lowest density might be caused by the unsuitable environmental

factors for the plants to grow and breed, particularly in the acidic water and soil (Samin et al. 2016).

Forage production

The production of fresh forage at pastures in Pulau Layang Village in the wet season was 6,899 kg ha⁻¹ year⁻¹ and the production of the dry matter was 1,268.51 kg ha⁻¹ year⁻¹, while in the dry season the production of fresh forage was 4,863 kg ha⁻¹ year⁻¹ and the dry matter production was 986.60 kg ha⁻¹ year⁻¹ (Table 4). This result is higher than those conducted in Canada (Omokanye et al. 2018) and in Timor Tengah Selatan District (Se'u et al. 2015) stating that the average fresh production of pasture in Gowa District in the wet season was 5,350 kg ha⁻¹ year⁻¹ and in the dry season was 1,390 kg ha⁻¹ year⁻¹ (Rinduwati et al. 2016). But the results of this study were lower than the study by Abdullah et al. (2017) in Pakistan who reported that forage production was 8,029.1 kg ha⁻¹ year⁻¹ in the wet season and 5,422.9 kg ha⁻¹ year⁻¹ in the dry season. The forage production of pasture in Sabana Timur Barat on the average ranged from 0.61 to 4.33 tons ha⁻¹ year⁻¹ (Manu 2013).

The lowest production usually occurs at the peak of dry season in October and the highest occurs in April (Manu 2013; Damry 2009). The forage production of *Pennisetum purpuphoides* was 70.4 ton ha⁻¹ year⁻¹, *Setaria sphasielata* 44.8 tons ha⁻¹ year⁻¹, *Brachiaria sp* 44.7 tons ha⁻¹ year⁻¹, *Pennisetum purpureum* 44.6 tons ha⁻¹ year⁻¹, and *Panicum maximum* 15.6 tons ha⁻¹ year⁻¹ (Jarmani and Haryanto 2015). The different amounts of production might have resulted from the differences in vegetation species, types of pasture, and methods used. There are various methods for estimating forage production, but many are inaccurate when applied to certain animal feed plant species. Therefore, it is very important to understand the limitations of technique used to measure forage production (Edvan et al. 2016; Badgery et al. 2017).

In Pulau Layang Village, there were 5 forage species having high fresh production in the wet season, namely Kumpai padi (*O. rufipogon*) with 12,960 kg ha⁻¹ year⁻¹, followed by Purun tikus (*E. dulcis*), Telepuk gajah (*N. lotus*), Are bolong (*P. barbatum* L) and Telepuk padi (*N. odorata* Aiton), and the lowest one was Kemon air (*N. olerancia*) with 1,910 kg ha⁻¹ year⁻¹. In the dry season the highest fresh production was Kumpai tembaga (*H. acutigluma*) with 7,480 kg ha⁻¹ year⁻¹, followed by Kumpai minyak (*H. amplexicaulis*), Kumpai merah (*Hymenachne* sp.), Are bolong (*P. barbatum* L) and Bento rayap (*L. hexandra*), and the lowest one was Kemon air (*N. oleracea*) with only 2,870 kg ha⁻¹ year⁻¹. The highest dry matter production in the wet season was Purun tikus (*E. dulcis*) with 2,664.5 kg ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*), Telepuk gajah (*N. lotus*), Are bolong (*P. barbatum* L), and Kumpai tembaga (*H. acutigluma*), and the lowest was Cecengkehan (*L. hyssopifolia*). In the dry season the highest dry matter production was Kumpai tembaga (*H. acutigluma*) with 7,480 kg ha⁻¹ year⁻¹, followed by Bento rayap (*L. hexandra*), Are bolong (*P. barbatum* L), Apit-apit (*C. cephalotes* Vahl) and Kumpai

merah (*Hymenachne* sp.), and the lowest was Kerak maling (*D. fuscescens*) with 2,420 kg ha⁻¹ year⁻¹ (Table 4).

In Rambutan Village, the production of fresh forage during the wet season was 3,676.67 kg ha⁻¹ year⁻¹ and the dry matter production was 905.52 kg ha⁻¹ year⁻¹, whereas in the dry season the fresh produce was 2,523.75 kg ha⁻¹ year⁻¹ and the dry matter production was 705.66 kg ha⁻¹ year⁻¹ (Table 5). These results were higher than those of the study conducted by Purwantari et al. (2015) and Praptiwi et al. (2017) who reported that the average availability of forage on palm oil plantation was 1,455.5 kg ha⁻¹ year⁻¹. The forage production during preproduction of rubber plantation was 732.90 kg ha⁻¹ year⁻¹ and at the time of production, it was only 317.83 kg ha⁻¹ year⁻¹ (Pramana et al. 2015).

In Rambutan Village, during the wet season there were 5 forage species having the highest fresh and dry matter production, namely Kumpai tembaga (*H. acutigluma*) producing 8,540 kg ha⁻¹ year⁻¹ and 3,139.3 kg ha⁻¹ year⁻¹ respectively, followed by Kumpai padi (*O. rufipogon*), Bento rayap (*L. hexandra*), Purun tikus (*E. dulcis*), and Kumpai minyak (*H. amplexicaulis*), and the lowest one was Kerak maling (*D. fuscescens*) with 790 kg ha⁻¹ year⁻¹ and 108.0 kg ha⁻¹ year⁻¹, respectively. In the dry season, the highest fresh and dry matter production was Kumpai tembaga (*H. acutigluma*) of 5,900 kg ha⁻¹ year⁻¹ and 2,181.82 kg ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*), Bento rayap (*L. hexandra*), Kumpai minyak (*H. amplexicaulis*), and Purun tikus (*E. dulcis*), and the lowest one was Kasuran (*C. digitatus*) with 240 kg ha⁻¹ year⁻¹ and 11.92 kg ha⁻¹ year⁻¹, respectively (Table 5). The results of this study were still higher than those conducted by Rostini et al. (2014) stating that the highest fresh forage production of grass *Hymenachne amplexicaulis* Haes was 1,032 kg DM ha⁻¹ harvest⁻¹ in the high tide season and 518.3 kg DM ha⁻¹ harvest⁻¹ in the low tide season, where the dry matter production ranged from 43.8 to 1,032 kg DM ha⁻¹ harvest⁻¹ in the high tide season and from 38.5 to 752.8 kg DM ha⁻¹ harvest⁻¹ in the low tide season.

The higher production of forage in Pampangan Sub-district compared to that in Rambutan Sub-district might be caused by higher soil fertility of the pasture area in Pampangan. The result of soil analysis showed that the C-Organic, N-total, and P-available in Pampangan (Bray I) were higher than those in Rambutan which might be related to the fact that most pasture in Pulau Layang Village (Pampangan) are rice fields which are always given fertilizer. This differs with pasture in Rambutan Village which is only used for grazing without any use of fertilizer. The provision of manure and bioslurry fertilizer can increase the production and forage quality of 4.75 tons and 4.36 tons, respectively (Suarna and Budiasa 2016; Jeffery et al. 2018).

Pasture carrying capacity

In Pulau Layang Village, the carrying capacity for Pampangan buffaloes pasture on the swamp lowland in the wet season was 3.66 AU ha⁻¹ year⁻¹ and 2.85 AU ha⁻¹ year⁻¹ during the dry season (Table 4). In Rambutan Village, the carrying capacity for Pampangan buffalo pasture in the wet

season was 2.61 AU ha⁻¹ year⁻¹ and in the dry season was 2.04 AU ha⁻¹ year⁻¹ (Table 5). The results of this study correspond to study conducted by Rostini et al. (2014) which found the carrying capacity of swamp lowland in South Kalimantan was 2.91 AU ha⁻¹ year⁻¹.

These results were higher than in grassland in South Central Timor District with only 0.24-0.63 AU ha⁻¹ year⁻¹ (Seu et al. 2015), in natural pastures of Gowa District with 0.88 AU ha⁻¹ year⁻¹ (Rinduwati et al. 2016), in pasture in Poso District with 0.63 AU ha⁻¹ year⁻¹ (Damry 2009; Daru et al. 2014), in Kelei and Didiri villages of Poso Districts with 0.96 and 1.12 AU ha⁻¹ year⁻¹ (Karti et al. 2015). However, these results were lower than the study conducted by Muhajirin et al. (2017) stating that the carrying capacity of Padang Mengatas BPTU was 5 AU ha⁻¹ year⁻¹ in the wet season and 3.18 AU ha⁻¹ year⁻¹ in the dry season. Even, Abdullah et al. (2017) reported very high carrying capacity of forage in Pakistan with 24 AU ha⁻¹ year⁻¹ and 16 AU ha⁻¹ year⁻¹ in the wet and dry seasons, respectively.

There is a decrease in dry material produced during the dry season because the water condition in swamp lowland is reduced. Decrease in swamp water level resulted in the decrease of photosynthesis which affects the production of the dry matter. Water is the main ingredient needed in photosynthesis. The disruption of metabolic processes in plants will affect plant production. Plant dry weight depicts the accumulation of organic compounds that are successfully synthesized by the plants from inorganic compounds, especially water and CO₂ (Lakitan 1995). Water shortages will have a negative effect on plant growth resulting in decreased production (Jun-Feng et al. 2010; Taiz and Zeiger 2002).

The high carrying capacity is related to the high forage production, forage management and selection of good species. Management and strategy to increase forage production require innovative facilitation and training to stockbreeders and farmers to increase their knowledge. These efforts should be supported by government and private companies develop programs regarding the importance of forage in increasing ruminant livestock production (Nigus 2017; Omokanye et al. 2018).

In Pulau Layang Village, in a pasture condition assumed to have one forage species, the highest carrying capacity in the wet season was Purun tikus (*E. dulcis*) with 7.69 AU ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 6.42 AU ha⁻¹ year⁻¹, Telepuk gajah (*N. lotus*) with 5.72 AU ha⁻¹ year⁻¹, Are bolong (*P. barbatum* L) with 4.77 AU ha⁻¹ year⁻¹ and Kumpai tembaga (*H. acutigluma*) with 3.90 AU ha⁻¹ year⁻¹, respectively, and the lowest was Cecengkehan (*L. hyssopifolia*) with 1.00 AU ha⁻¹ year⁻¹. In the dry season, the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) with 4.71 AU ha⁻¹ year⁻¹, followed by Bento rayap (*L. hexandra*) with 4.00 AU ha⁻¹ year⁻¹, Are bolong (*P. barbatum* L) with 3.59 AU ha⁻¹ year⁻¹, Apit-apit (*C. cephalotes* Vahl) with 3.30 AU ha⁻¹ year⁻¹ and Kumpai merah (*Hymenachne* sp.) with 2.82 AU ha⁻¹ year⁻¹, whereas the lowest was Kerak maling (*D. fuscescens*) with 1.55 AU ha⁻¹ year⁻¹ (Table 4).

In Rambutan Village, assuming that the pasture had one forage species, the highest carrying capacity in the wet season was Kumpai tembaga (*H. acutigluma*) with 9.06 AU ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 4.22 AU ha⁻¹ year⁻¹, Bento rayap (*L. hexandra*) with 3.29 AU ha⁻¹ year⁻¹, Purun tikus (*E. dulcis*) 2.66 with AU ha⁻¹ year⁻¹, and Kumpai minyak (*H. amplexicaulis*) with 1.67 AU ha⁻¹ year⁻¹, while the lowest was Kerak maling (*D. fuscescens*) with 0.31 AU ha⁻¹ year⁻¹. During the dry season the highest carrying capacity was Kumpai tembaga (*H. acutigluma*) with 6.29 AU ha⁻¹ year⁻¹, followed by Kumpai padi (*O. rufipogon*) with 4.10 AU ha⁻¹ year⁻¹, Bento rayap (*L. hexandra*) with 2.65 AU ha⁻¹ year⁻¹, Kumpai minyak (*H. amplexicaulis*) with 1.41 AU ha⁻¹ year⁻¹, and Purun tikus (*E. dulcis*) with 1.09 AU ha⁻¹ year⁻¹, while the lowest was Kasuran (*C. digitatus*) with 0.08 AU ha⁻¹ year⁻¹ (Table 5). These results indicate that the carrying capacity is very influential with the type of feed plan. In addition, another important thing is cattle grazing system in which livestock grazing must be regulated to avoid over-grazing as the amount of grazing livestock depends on the carrying capacity of the pasture (Salendu and Elly 2014; Cheng et al. 2017; Hashemi 2017).

The results of this study indicated that forage availability is still sufficient to meet feed requirements for Pampangan buffaloes. The population of Pampangan buffaloes in Pulau Layang Village was 487 buffaloes with a grazing area of 500 ha and average carrying capacity of 3.14 AU ha⁻¹ year⁻¹. While the number of Pampangan buffaloes of Rambutan Village was 1.735 buffaloes with a pasture area of 1,203 ha and average carrying capacity of 2.45 AU ha⁻¹ year⁻¹. It is estimated that there still can be added buffalo cattle as much as 0.31 AU ha⁻¹ year⁻¹ in Pulau Layang Village so 155 buffaloes and 0.59 AU ha⁻¹ year⁻¹ in Rambutan Village 709 buffaloes

In conclusion, there were 19 forage species to have the potential as feeding source of Pampangan buffaloes in South Sumatra. The importance of species indicated by IVI is strongly influenced by grazing locations and seasons. The most important species were Kemon air (*N. oleracea*) and Are bolong (*P. barbatum* L) in Pulau Layang Village and Purun tikus (*E. dulcis*), Kerak maling (*D. fuscescens*), and Kumpai padi (*O. rufipogon*) in Rambutan Village. In Pulau Layang Village, the fresh forage and dry matter production in the wet season were 6.90 and 1.27 tons ha⁻¹ year⁻¹, while in Rambutan Village they were 3.68 tons ha⁻¹ year⁻¹ and 0.91 ton ha⁻¹ year⁻¹, respectively. The fresh forage production and dry matter production in the dry season in Pulau Layang Village were 4.86 and 0.99 tons ha⁻¹ year⁻¹, while in Rambutan Village were 2.52 tons ha⁻¹ year⁻¹ and 0.71 tons ha⁻¹ year⁻¹, respectively. On the average the carrying capacity of the swamp lowland pasture in South Sumatra was 2.79 AU.ha⁻¹.year⁻¹. As such, forage availability is still sufficient to meet the need for animal feed, and it is estimated the areas can be added buffalo cattle of 0.31 AU ha⁻¹ year⁻¹ in Pulau Layang Village and 0.59 AU ha⁻¹ year⁻¹ in Rambutan Village.

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