BUKTI KORESPONDENSI

ARTIKEL JURNAL INTERNASIONAL BEREPUTASI

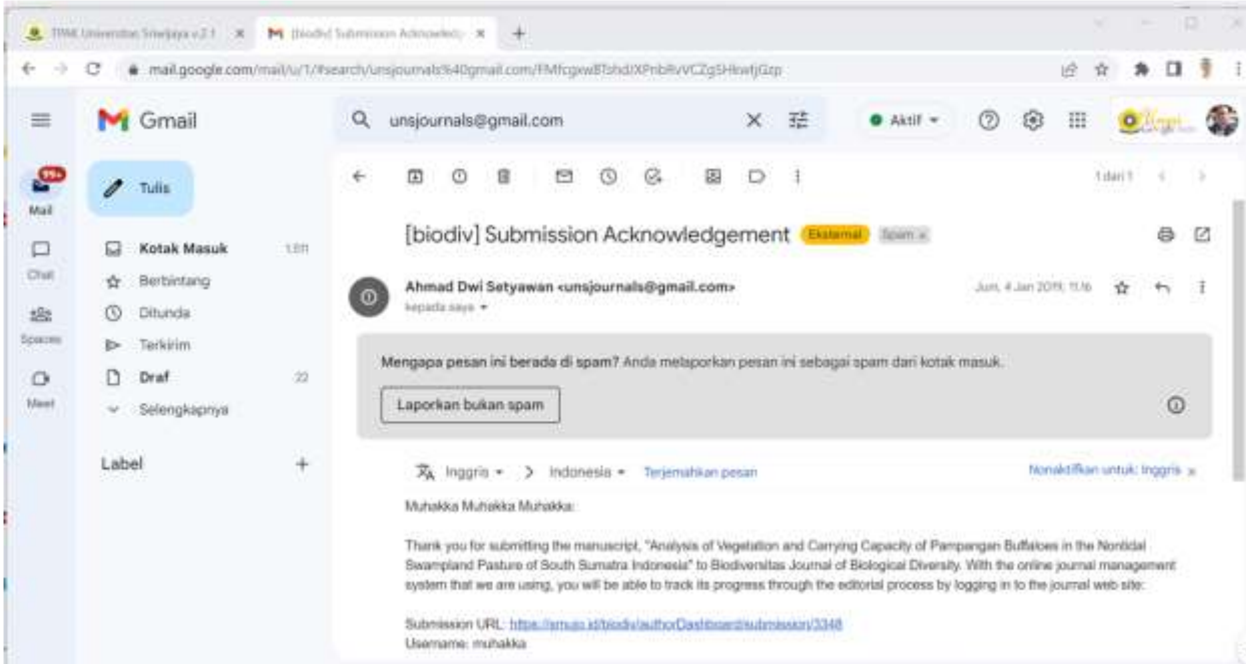
Judul Artikel : Vegetation analysis of non-tidal swampland in South Sumatra, Indonesia and its carrying capacity for Pampangan buffalo pasture.

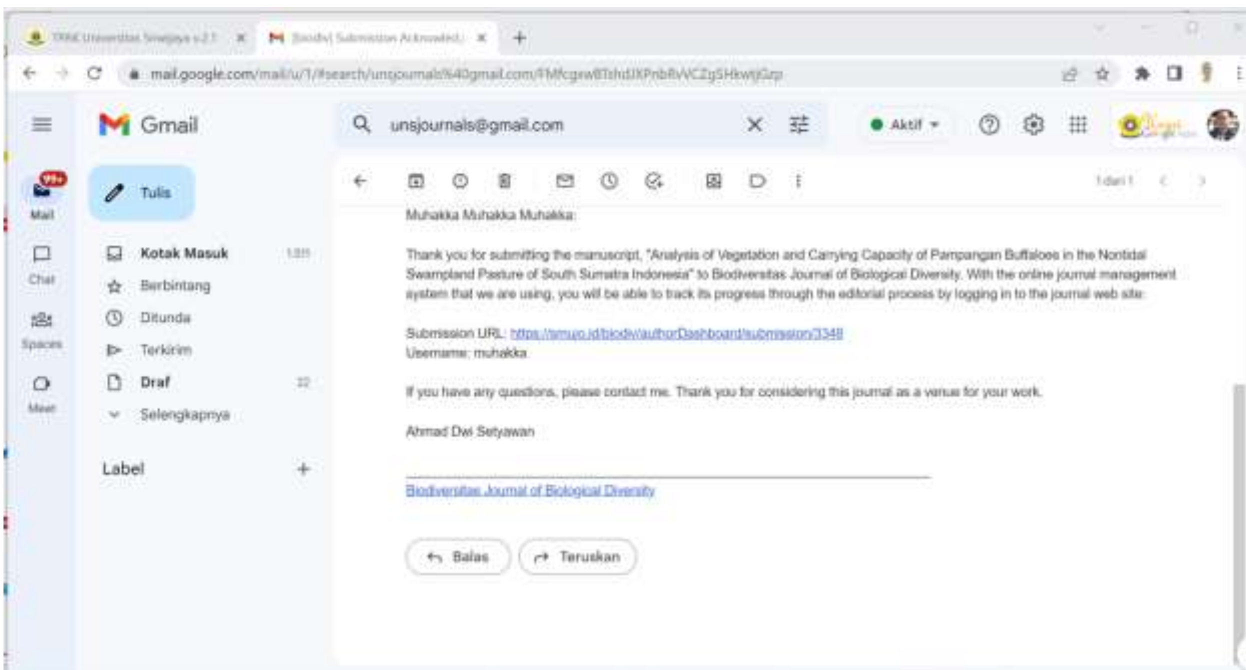
Jurnal : Biodiversitas, 2019 Volume 20 (4) : 1077-1086

Penulis :

No.	Perihal	Tanggal
1.	Bukti konfirmasi submit artikel dan artikel yang disubmit	4 Januari 2018
2.	Bukti konfirmasi review dan hasil review pertama	4 Januari 2019
3.	Bukti konfirmasi submit revisi pertama, respon kepada reviewer, dan artikel yang diresubmit	27 Januari 2019
4.	Bukti konfirmasi review dan hasil review kedua	11 Maret 2019
5.	Bukti konfirmasi submit revisi kedua, respon kepada reviewer, dan artikel yang diresubmit	19 Maret 2019
6.	Bukti konfirmasi submit revisi ketiga, respon kepada reviewer, dan artikel yang diresubmit	23 Maret 2019
7.	Bukti konfirmasi artikel accepted	23 Maret 2019
8.	Bukti konfirmasi artikel published online	1 April 2019

1.Bukti Konfirmasi Submit Artikel dan Artikel yang Disubmit (4 Januari 2019)


Gmail
unsjournals@gmail.com
Aktif
Tulis
Kotak Masuk
Berbintang
Ditunda
Terkirim
Draf
Selengkapnya
Label
[biodiv] Submission Acknowledgement
Eksternal
Ahmad Dwi Setyawan <unsjournals@gmail.com>
Mengapa pesan ini berada di spam? Anda melaporkan pesan ini sebagai spam dari kotak masuk.
Laporkan bukan spam
Inggris
Indonesia
Terjemahkan pesan
Nonaktifkan untuk: Inggris
Muhakka Muhakka Muhakka:
Thank you for submitting the manuscript, "Analysis of Vegetation and Carrying Capacity of Pampangan Buffaloes in the Nontidal Swampland Pasture of South Sumatra Indonesia" to Biodiversitas Journal of Biological Diversity. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:
Submission URL: https://smujo.id/biodiv/authorDashboard/submission/3348
Username: muhakka


Gmail
unsjournals@gmail.com
Aktif
Tulis
Kotak Masuk
Berbintang
Ditunda
Terkirim
Draf
Selengkapnya
Label
Muhakka Muhakka Muhakka:
Thank you for submitting the manuscript, "Analysis of Vegetation and Carrying Capacity of Pampangan Buffaloes in the Nontidal Swampland Pasture of South Sumatra Indonesia" to Biodiversitas Journal of Biological Diversity. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:
Submission URL: https://smujo.id/biodiv/authorDashboard/submission/3348
Username: muhakka
If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.
Ahmad Dwi Setyawan
Biodiversitas Journal of Biological Diversity
Balas
Teruskan

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

Author(s) name:

MUHAKKA[1,2,♥], RUJITO AGUS SUWIGNYO[3], DEDIK BUDIANTA[4] AND YAKUP[3]

Address

(Fill in your institution's name and address, your personal cellular phone and email)

[1]Graduate School, Sriwijaya University, Jl. Padang Selasa 524 Palembang 30139, South Sumatera, Indonesia, Tel/Fax. +62813-67755499. ♥email: muhakka@fp.unsri.ac.id

[2]Department of Animal Husbandry, Faculty of Agriculture, Sriwijaya University, Jl. Palembang-Prabumulih Km. 32 Inderalaya 30662, South Sumatera, Indonesia, Tel/Fax. +62813-67755499. ♥email: muhakka@fp.unsri.ac.id

[3]Department of Agronomy, Faculty of Agriculture, Sriwijaya University, Inderalaya 30662, South Sumatera, Indonesia, Tel/Fax. +62812-90179286. email: rujito@unsri.ac.id

Tel/Fax. +62812-71742756. email: yakup.parto@yahoo.com

[4]Department of Soil Science, Faculty of Agriculture, Sriwijaya University, Inderalaya 30662, South Sumatera, Indonesia, Tel/Fax. +62812-7859781. email: dedik_budianto@yahoo.com

For possibility publication on the journal:

(fill in *Biodiversitas* or *Nusantara Bioscience* or *mention the others*)

Biodiversitas

Novelty:

(state your claimed novelty of the findings versus current knowledge)

Statements:

This manuscript has not been published and is not under consideration for publication to any other journal or any other type of publication (including web hosting) either by me or any of my co-authors.

Author(s) has been read and agree to the Ethical Guidelines.

List of five potential reviewers

(Fill in names of five potential reviewers **that agree to review your manuscpt** and their **email** addresses. He/she should have Scopus ID and come from different institution with the authors; and from at least three different countries)

Place and date:

Palembang, January 5th, 2019

Sincerely yours,

(fill in your name, no need scanned autograph)

MUHAKKA

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

MUHAKKA[1,2,♥], RUJITO AGUSSUWIGNYO[3], DEDIK BUDIANTA[4], YAKUP[3]

[1]Graduate School, Sriwijaya University, Jl. Padang Selasa 524 Palembang 30139, South Sumatera, Indonesia, Tel/Fax. +62-711-581106.
♥email: muhakka@fp.unsri.ac.id

[2]Department of Animal Husbandry, Faculty of Agriculture, Sriwijaya University, Jl. Palembang-Prabumulih Km, 32 Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia, Tel/Fax. +62-711-581106. ♥email: muhakka@fp.unsri.ac.id

[3]Department of Agronomy, Faculty of Agriculture, Sriwijaya University, Jl. Palembang-Prabumulih Km, 32 Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia

[4]Department of Soil Science, Faculty of Agriculture, Sriwijaya University, Jl. Palembang-Prabumulih Km, 32 Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia

Manuscript received: DD MM 2018 (Date of abstract/manuscript submission). Revision accepted: .... 2018.

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 under the auspices of preproduction of rubber plants is 0.14 AU. $ha^{-1}.year^{-1}$, while rubber production plants can only accommodate 0.06 AU. $ha^{-1}.year^{-1}$ (Pramana et al., 2015).

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

MATERIALS AND METHODS

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

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

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

Vegetation Analysis

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

a. Density

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

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

b. Relative Density

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

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

c. Frequency

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

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

d. Relative Frequency

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

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

Forage Production

The measurement of forage production adopted the *Halls* method (in Kleden et al., 2015) which used a 1m x 1m quadratic frame by sampling construction (Sutaryo, 2009). A total of 50 observation points were conducted in a grazing area on swamp lowland often used by farmers/ranchers. 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 forage biomass production
$\sum xi$ = The amount of forage biomass production at each observation
n = The amount of observation

Pasture Carrying Capacity

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 (2006).

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

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

Remarks:
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 $AU^{-1}day^{-1}$

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 the number of livestock available to find out the ratio of the two illustrating the number of buffaloes that could be developed in the study area using the following formulations: (a). AUp/AUt < 1 : if the number of livestock being grazed in swamp lowlands is greater than the amount of feed available, (b). AUp/AUt = 1 : If there is a balance between the amount of forage available and the number of livestock being grazed. (c). AUp/AUt > 1 : If the number of livestock being grazed is less than the amount of food available in the pasture. Remarks: AUp and AUt are animal units for feed and animal unit for livestock successively (Kleden *et al*., 2015).

RESULTS AND DISCUSSION

Results

Species of Forage Vegetation

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

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	*Eleocharis dulcis*	+	+	DP
2	Kumpai padi	*Oryza rupifogon*	+	+	DP
3	Kumpai tembaga	*Hymenachne acutigluma*	+	+	DP
4	Bento rayap	*Leersia hexandra*	+	+	DP
5	Kumpai minyak	*Hymenachne amplexicaulis*	+	+	DP
6	Pasiran / Kerak maling	*Digitaria fuscescens*	+	+	DP
7	Are bolong	*Polygonum barbatum L)*	+	-	DNP
8	Kumpai merah	*Hymenachne sp.*	+	-	NDP
9	Kasuran	*Cyperus digitatus*	-	+	NDP
10	Apit-apit	*Cyperus chephalotes* Vahl	+	-	NDP
11	Telepuk Gajah	*Nymphaea lotus*	+	-	NDP
12	Telepuk Padi	*Nymphaea adorata* Aiton	+	-	NDP
13	Kangkung merah	*Ipomoea aquatica* Forsk.	+	-	NDP
14	Tapak dara	*Catharanthus roseus* (L.) Don	+	-	NDP
15	Eceng gondok	*Eichhornia crassipes*	+	-	NDP
16	Kemon air	*Neptunia olerancia*	+	-	NDP
17	Mutiara	*Sesbania exasperata*	-	+	NDP
18	Cecengkehan	*Ludwigia hyssopifolia*	+	-	ND
19	Berondong	*Rhynchospora corymbosa. L*	-	+	ND

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

Analysis of Forage Vegetation

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).

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**

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

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 D	Wet Season RD (%)	Wet Season F	Wet Season RF (%)	Wet Season IVI (%)	Dry Season D	Dry Season RD (%)	Dry Season F	Dry Season RF (%)	Dry Season 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**

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).

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 FWP (kg)	Wet Season DMP (kg)	Wet Season CC (AU.ha^{-1}.year^{-1})	Dry Season FWP (kg)	Dry Season DMP (kg)	Dry Season 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**

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**

Discussion

Species of Forage Vegetation

There are dominant and palatable species of swamp lowland forage vegetation having potential as buffalo feed, namely Kumpai padi grass (*O. rupifogon*), Kumpai tembaga *(H. acutigluma)*, and Kumpai minyak *(H. amplexicaulis)*, not dominant and palatable such as Kumpai merah *(Hymenachne sp*) and Kemon air *(N. olerancia)*; 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 species to be eaten (Table 1).

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

Analysis of Forage Vegetation

The analysis results of the vegetation of Pulau Layang Village during the wet season having the highest relative density, relative frequency, and Important Value Index (IVI) were Kemon air (*N. olerancia*) having 0.56 density, 17.5% relative density, 0.32 frequency, 19.512% relative frequency, and 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. adorata* Aiton) and Telepuk gajah (*N. lotus*) which was 1.84% each. The highest relative density, relative frequency and importance value index in the dry season were Kemon air (*N. olerancia*) which was 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. rupifogon)* which was 13.71% (Table 2). Those results also showed that in Pulau Layang Village there was a difference in the amount of vegetation between the wet and dry seasons. In the wet season there were 14 forage vegetation species and in the dry season there were only 10 forage vegetation species. Meanwhile, Apit-apit *(C. chephalotes* Vahl*)* and Kerak maling *(D. fuscescens)* were not found in the wet season. Likewise, in the dry season, Purun tikus (*E. dulcis*), Kumpai padi (*O. rupifogon*), Tapak darah (*C. roseus* L. Don*)*, Kangkung merah (*I. aquatica* Forsk*)*, and Telepuk padi (*N. adorata* Aiton) were not found. The results show that there were some vegetation species tolerant of water and some others were not. In other words, those tolerant of water would survive and those which were not would die.

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

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. rupifogon)* 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. rupifogon)* 54.08%, and Kerak maling *(D. fuscescens)* 17.71%. The lowest value was Kumpai tembaga *(H. acutigluma)* 2.33% (Table 3). The highest density of swamp forage vegetation 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 plant vegetation had the highest density because this vegetation matched the environment to grow and reproduce under the conditions of land whose soil and water contained low pH. As for the plants having the lowest density, it might have been due to the unsuitable environmental and 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., 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 Production

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 (Bray 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 bioslury 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 Ilir was 6.90 tons ha^{-1}.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 Wulanggitang Subdistrict, East Flores District was 7.664 tons.ha^{-1}.year^{-1} and 6.98 tons.ha^{-1}.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.ha^{-1}.year^{-1}.

The production of fresh forage swamp lowland pastures of 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 fresh production 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 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 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 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} in the wet season and 5,422.9 kg.ha^{-1}. year^{-1} in the dry season. The pasture forage production of Sabana Timur 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 season in October and the highest in April (Manu, 2013; Damry, 2009). The forage production of *Pennisetum purpuphoides* was 70.4 ton.ha^{-1}, *Setaria sphasielata* 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} (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 used with certain animal feed plant species. Therefore, it is very important to find out the use and limited techniques of measuring forage production (Edvan et al., 2016; Badgery et al., 2017).

There were 5 swamp lowland forage species having high fresh production in the wet season in Pulau Layang Village, namely Kumpai padi (*O. rupifogon*) 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. adorata* Aiton), and the lowest one was Kemon air (*N. olerancia*) 1,910 kg.ha^{-1}.year^{-1}. In the dry season the highest fresh production was Kumpai tembaga (*H. acutigluma*) as many as 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. olerancia*) of only 2.870 kg.ha^{-1}.year^{-1}. 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 by Kumpai padi *(O. rupifogon*), Telepuk 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 7.480 kg.ha^{-1}.year^{-1}, followed by Bento rayap *(L. hexandra),* Are bolong *(P. barbatum* L*),* Apit-apit (*C. chephalotes* Vahl*)* and Kumpai merah *(Hymenachne sp.)*, and the lowest one was Kerak maling (*D. fuscescens*) as many as 2,420 kg.ha^{-1}.year^{-1} (Table 4).

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 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 those of the study conducted by (Purwantari et al. 2015; Praptiwi et al., 2017) reporting that the average availability of the 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 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:

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

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 wass 0.96 and 1.12 AU.ha^{-1}.year^{-1} (Karti et al., 2015). The pasture performance of the *Brachuaria 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 supported by the government and private companiesa 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 weight depicts the accumulation of organic compounds that are successfully synthesized by the plants from inorganic compounds, especially water and CO_2 (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).

When the pasture condition had one species of swamp forage, the highest carrying capacity in the wet season 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}, 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 *(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}. During the dry season the highest carrying capacity was Kumpai tembaga *(H. acutigluma)* as much as 6.29 AU.ha^{-1}.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 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}. 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 carrying capacity is very influential with the type of feed plan. In addition the most important thing is also cattle grazing system. Livestock grazing must be regulated to avoid over-grazing. 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 the forage availability was still sufficient to meet feed requirements for Pampangan buffaloes. The population of Pampangan buffaloes of Pulau Layang Village was 487 buffaloes with a grazing area of 500 ha with an 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 an average carrying capacity of 2.45 AU.ha^{-1}.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 Village and 0.59 AU.ha^{-1}.year^{-1} in Rambutan Village.

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

1. There were 19 species of swamp lowland forage vegetation found to have the potential to feed the Pampangan buffaloes in South Sumatra.
2. Important Value Index (IVI) is strongly influenced by grazing locations and seasons. The high IVI were Kemon air *(N. olerancia)* and Are bolong *(P. barbatum* L*)* in Pulau Layang Village. In Rambutan Village, the high IVI were Purun tikus *(E. dulcis),* Kerak maling *(D. fuscescens),* and Kumpai padi *(O. rupifogon).*
3. In Pulau Layang Village, the fresh forage and dry matter production of forage vegetation swamp lowland 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} and 0.91 ton.ha^{-1}.year^{-1} dry consecutively. 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 they were 2.52 tons.ha^{-1}.year^{-1} and 0.71 tons.ha^{-1}.year^{-1} consecutively.
4. The carrying capacity of swamp lowland pasture in the wet season in Pulau Layang Village was 3.66 AU.ha^{-1}.year^{-1} 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 dry season it was 2.04 AU.ha^{-1}.year^{-1}. Therefore, on the average the carrying capacity of the swamp lowland pasture in South Sumatra was 2.79 AU.ha^{-1}.year^{-1}.
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 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.
6. The highest forage production in the wet season in Pulau Layang Village was Purun tikus, followed by, Kumpai padi, Telepuk 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.

ACKNOWLEDGEMENTS

The author expresses his deepest gratitude to the Rector of Sriwijaya University through the Chair of the Institute for Research and Community Services funding this research in accordance with the Competitive Leading Research Contract of Sriwijaya University Number: 988 / UN9.3.1 / PP / 2017, dated 21 July 2017.

REFERENCES

Abdullah, M., Rafay, M., Sial, N., F. Rasheed, F., Nawaz M.F., Nouman, W., Ahmad, I.,Ruby, T and Khalil, S. 2017. Determination of forage productivity, carrying capasity and palatability of browse vegetation in arid rangelands of Cholistan Desert (Pakistan). Applied Ecology and Environmental Research. 15 (4): 623-637. http://dx.doi.org/10.15666/aeer/1504_623637.

Ali AIM, Sandi S., Muhakka dan Riswandi. 2012. *The quality of forage feed of the swampy lowland of pampangan buffalo pasture*. Prosiding InSINAS 2012. 307-312.

BPS (Central Statistics Agency). 2010. Directorate General of Food. Swamp lowland Area of Indonesia. Agriculture Department. Jakarta.

BPS (Central Statistics Agency). South Sumatra Province. 2014. South Sumatra in Value Provinsi Sumatera Selatan. 2014.

Badgery WB, Millar GD, Broadfoot K, Michalk DL, Cranney P, Mitchell D, Van de Ven R. 2017. Increased production and cover in a variable native paAUure following intensive grazing management. Animal Production Science. (57): 1812–1823.

Center for Agricultural Technology Assessment in South Sumatra. 2011. Pampangan buffalo as South Sumatra's Nutfah plasm. bptp-sumsel@litbang.deptan.go.id.

Camarao AP, Rodrigues Filho JA. 2001. Botanical composition of the available forage and the diet of water buffalo grazing native pastures of the medium Amazon region, Brazil. Buffalo Journal. 3: 307–316.

Cheng D, Peili S, Xianzhou Z, Ning Z, Xi C, Shoubao G, Wanrui Z. 2017. The Rangeland livestock carrying capacity and Stocking rate in the Kailash Sacred Landscape in China. Journal of Resources and Ecology. 8 (6): 551-558.

Damry. 2009. Production and content of forage nutrition of natural pasture of North Lore Subdistrict of Poso District. Jurnal Agroland. 16 (4): 296-300.

Daru TP, Suhardi, Yusuf R., Wibowo A, Pujowati P. 2012. Carrying capacity of feed forage on the ruminants development in West Kutai District. Jurnal Teknologi Pertanian 8(1): 30-36.

Daru TP, Yulianti A, Widodo E. 2014. Forage potential of palmoil plantation as beef cattle feed in Kutai Kartanegara District. Media Sains. 7: 79-86.

Delima M, Karim A, Yunus M. 2015. Study of feed forage production potency on existing areas potential to increase ruminant livestock population in Aceh Besar District. Jurnal Agripet : 15 (1): 33-40.

Dwyanto K, Handiwirawan E. 2006. Stratey of buffalo cattle development: network and distribution aspects. Pros. National Workshop of Buffalo Cattle Business to Support the Beef Adequacy Program. Sumbawa, 4-5 August 2006. Center for Animal Husbandry Research and Development in cooperation with the Directorate of Nursery, Director General of Animal Husbandry of West Nusa Tenggara Province, and Sumbawa Province. pp. 3-12

Edvan RL, Bezerra LR, Marques CAT, Carneiro MSS, Oliveira RL, Ferreira RR. 2016. Methods for estimating forage mass in pastures in a tropical climate. Revista de Ciências Agrárias. 39(1): 36-45.

Eoh M. 2014. Carrying capacity and composition of feed substance of buffalo pasture of Pulau Moa. Agrinimal. 4 (2): 77-82.

Hashemi N. 2017. Recognizing the potential of sustainable use of pasture resources in South Khorasan Province with approch of carrying capacity. Environment and Ecosystem Science (EES). 1 (2): 9-12.

Jarmani SN, Haryanto B. 2015. Improving productivity of animal feed forage to support buffalo pasture capacity of Kampar District of Riau (A suggestion of thought). Jurnal PaAUura. 4 (2): 95-99.

Jefferya RP, Simpsona RJ, Lambersc H, Orcharda S, Kidda DR, Halingb RE, Ryana MH. 2018. Contrasting communities of arbuscule-forming root symbionts change external critical phosphorus requirements of some annual pasture legumes. Applied Soil Ecology. xxx (xxx): 9-10.(https://doi.org/10.1016/j.apsoil.).

Jung-Feng S, Guo MX, Lian, JR, Xiaobin P, Guo WY, Ping CX. 2010. Gene expression profile of respon to water stress at the jointing stage in wheat. Agricultural Science in China. 9 (3): 323-330.

Karti PDMH, Abdullah L, Prihantoro I. 2015. Exploration and productivity of pastures of East Pamona Subdistrict of Poso District of Mid Sulawesi. Jurnal Pastura. 4 (2): 91-94.

Kleden MM., Ratu MRD, Randu MDS. 2015. Feed forage carrying capacity in coffee plantation areas and natural pasture of East Flores District of East Nusa Tenggara. Jurnal Zootek35 (2): 340-350.

Kumalasari NR, Sunardi. 2015. Variety of feed forage potential vegetation in rice field areas of different height conditions. Jurnal Pastura. 4 (2): 59-61.

Lakitan B. 1995. *Plant physiology and plant development*. Raja Grafindo Persada. Jakarta.

Manu AE. 2013. Productivity of sabana pasture of West Timor. Jurnal Pastura. 3 (1): 25-29.

Muhajirin, Despal, Khalil. 2017. Pemenuhan kebutuhan nutrien sapi potong bibit yang digembalakan Fulfilling the nutrient needs of grazed nursery beef cattle of Padang Mengatas. Buletin Makanan Ternak.104(1): 9-20.

Muhakka, Riswandi, Ali AIM. 2013. Morphological and Reproductive Characteristics of Pampangan Buffaloes of South Sumatra Province. Jurnal Sain Peternakan Indonesia. 8(8): 89-106.

Mulyani A, Sarwani M. 2013. Characteristics and potential of sub-optimal land for agricultural development. Jurnal Sumberdaya Lahan. 7 (1): 47-55.

Oktaviani SI, Santri DJ, Dayat E. 2015. Diversity of swamp vegetation of Tanjung Lago Subdistrict. Jurnal Lahan Suboptimal 4 (2) :133-148.

Omokanye A, Yoder C, Sreekumar L, Vihvelin L, Benoit M. 2018. Forage production and Economic performance of pasture rejuvenation methods in Northern Alberta, Canada. SuAUainable Agriculture Research. 7 (2): 94-110.

Parmadi JC EH, Dewiyanti I, Karina S. 2016. Important value index of mangrove vegetation in Kuala Idi area, East Aceh District. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah.1 (1): 82-95.

Praptiwi II, Susanti DS, Damayanti AT, Mangera Y. 2017. The potential of various vegetation species as animal feed forage in the pasture of Sota Village of Merauke District. Agricola. 7 (1): 15-24.

Purnomo J. 2006. Animal Feed Forage in Indonesia. Jakarta. Agricultural Research and Development Agency of the Ministry of Agriculture

Purwantari ND, Tiesnamurti B, Adinata Y. 2015. Availability of forage sources in palmoil plantations for cattle grazing. Watazoa. 25 (1): 47-54.

Rinduwati., Hasan S, Syamsu JA, Useng D. 2016. Carrying capacity and botanical diversity of paAUoral range in Gowa Regency.International Journal of Sciences: Basic and Applied Research (IJSBAR). 29 (3) : 105 - 111.

Rohaeni ES, Darmawan A, Qomariah R, Hamdan A, Subhan A. 2005. Inventory and Characterization of Swamp Buffaloes as Germplasm. Report of Study Result. Balai Pengkajian Teknologi Pertanian (BPTP) Kalimantan Selatan. Banjarbaru.

Rostini T, Abdullah L, Wiryawan KG, Karti PDMH. 2014. Production and nutrition potency of swamp local forage in South Kalimantan as ruminant feed. Glob. J. Anim. Sci. Livestock Prod. Anim. Breed.2 (2):107-113.

Salendu AHS, Elly FH. 2014. Potensi pengembangan hijauan pakan ternak sapi di bawah pohon kelapa Potential development of forage for cattle under the coconut trees in Lolayan Subdistrict of Bolaang Mongondow District. Jurnal Pastura. 4 (1): 7-10.

Samin AN, Chairul, Mukhtar E. 2016. Analysis of coastal vegetation in tourist area of Pasir Jambak, Kota Padang. Jurnal Biocelebes 10 (2): 32-42.

Se'u VE, Kartib PDMH, Abdullah L. 2015. Botanical composition, grass production, and carrying capacity of pasture in Timor Tengah Selatan District. Journal Media Peternakan 38(3):176-182.

South Sumatra Animal Husbandry Statistics. 2014. South Sumatra Province Animal Husbandry Office 2015 Budget Year: 14.

Suarna IW, Budiasa IKM. 2016. Effect of organic fertilizers on the production and quality of mixed pasture on the dry land of Sebudi Karangase Village. Majalah Ilmiah Peternakan. 19 (3): 125-128.

Sutaryo D. 2009. Calculation of Biomass. An Introduction to the Study of Carbon and Carbon Trading. Wetlands International Indonesia Programme.

Suveltri B, Syam Z, Solfiyeni. 2014. Analysis of weed vegetation in plantations of maize (Zea mays L) on maximum tillage in District of Lima Puluh Kota. Jurnal Biologi Universitas Andalas (J. Bio. UA.) 3(2): 103-108.

Syarifuddin H. 2011. Composition and Structure of animal feed forage under the trees of palmoil plantation. Agrinak. 1 (1): 25-30.

Taiz L, Zeiger E. 2002. *Plant Physiology*. 3 rd ED. Sinauer Association, Inc.

Thalib C, Herawati T, Hastono. 2014. Strategy of increasing buffalo productivity through the improvement of feed and genetics. Wartazoa. 24 (2): 83-96.

Yoku O, Supriyantono A, Widayati T, Sumpe I. 2014. Production of natural pasture and potency of Balinese cow development in supporting the meat adequacy program in West Papua. Jurnal Pastura 3 (2): 102 – 105.

Yoku O, Supriyantono A, Widayati T, Sumpe I. 2015. Composition of botany and distribution of local forage species of natural pasture in West Papua. Jurnal Pastura 4 (2): 62– 65.

Yasin S. 2013. Eating behavior of ruminants as phenology bioindicators and dynamics of pasture. Jurnal Pastura 3 (1) : 1–4.

SUBMISSION CHECKLIST

Ensure that the following items are present:

The first corresponding author must be accompanied with contact details: **Give mark (X)**

• E-mail address	x
• Full postal address (incl street name and number (location), city, postal code, state/province, country)	x
• Phone and facsimile numbers (incl country phone code)	x

All necessary files have been uploaded, and contain:

• Keywords	x
• Running titles	x
• All figure captions	
• All tables (incl title and note/description)	x

Further considerations

• Manuscript has been "spell & grammar-checked" Better, if it is revised by a professional science editor or a native English speaker	x
• References are in the correct format for this journal	x
• All references mentioned in the Reference list are cited in the text, and vice versa	x
• Colored figures are only used if the information in the text may be losing without those images	
• Charts (graphs and diagrams) are drawn in black and white images; use shading to differentiate	

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

https://smujo.id/biodiv/authorDashboard/submission/3348# 67%

Notifications

[biodiv] Editor Decision

2019-01-27 09:12 AM

Muhakka Muhakka Muhakka, Rujito Agus Suwignyo, Dedik Budianta Budianta, Yakup Yakup Yakup:

We have reached a decision regarding your submission to Biodiversitas Journal of Biological Diversity, "Analysis of Vegetation and Carrying Capacity of Pampangan Buffaloes in the Nontidal Swampland Pasture of South Sumatra Indonesia".

Our decision is: Revisions Required

Smujo Editors
editors@smujo.id

Reviewer A:

https://smujo.id/biodiv/authorDashboard/submission/3348# 67%

Reviewer A:

1. Title. I think it will be better to modify the title this way: *Analysis of the vegetation structure and carrying capacity of Nontidal Swampland Pasture to Pampangan Buffalo in South Sumatra, Indonesia*

2. In the abstract (Lines 19 and 21), you have the word, "successively" which I think should be "respectively"?

3. In the Materials and Methods, I suggest to present a map of the Study Area. It will enhance the imagination of readers not familiar to the place. In Line 122, 166, and 177 instead of Remarks, I suggest you use Legend or you may simply say :

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)

and so forth and so on...

4. In Tables 1-5, I suggest that the left most column should be the scientific names arranged alphabetically, because as an international journal, readers of Biodiversitas are from diverse countries. While nothing wrong with the local names at the leftmost especially in local journals, but international readers are not familiar with the local names, it will be best to have the scientific name as the point of reference at the international level, hence my strong suggestion for consideration.

5. The paper is good and the discussions are alright, though could be enhanced by some sort of editing by a language expert. I hope to see the paper revised and published soonest.

Recommendation: Revisions Required

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

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

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

MATERIALS AND METHODS

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

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

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

Vegetation Analysis

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

a. Density

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

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

b. Relative Density

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

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

c. Frequency

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

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

d. Relative Frequency

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

IVI = Relative Density + Relative Frequency

Forage Production

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

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

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

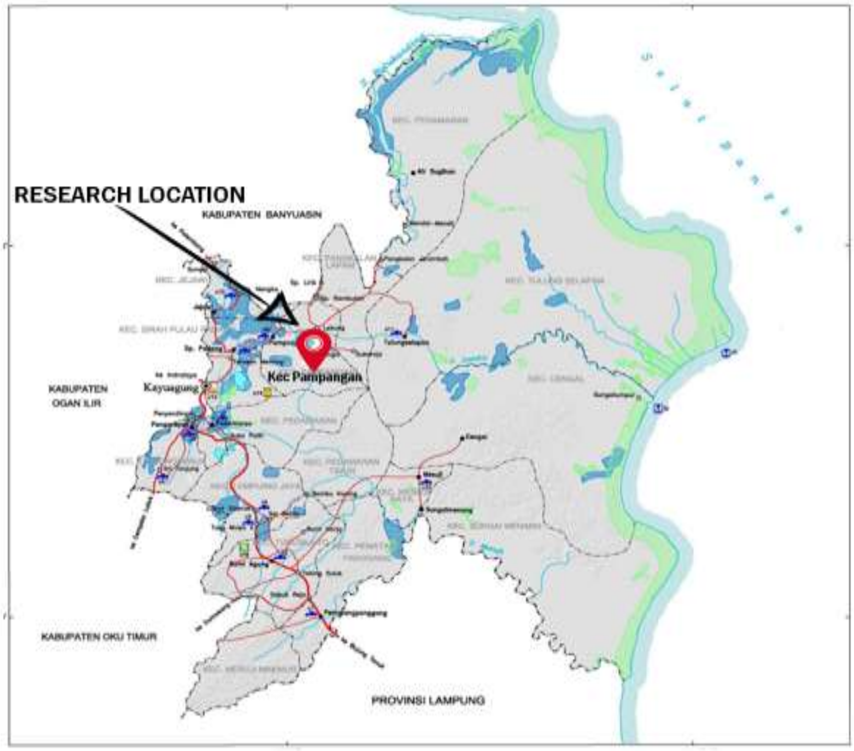


Figure 1. Research location : Pulau Layang Village, Pampangan sub-district, Ogan Komering Ilir District

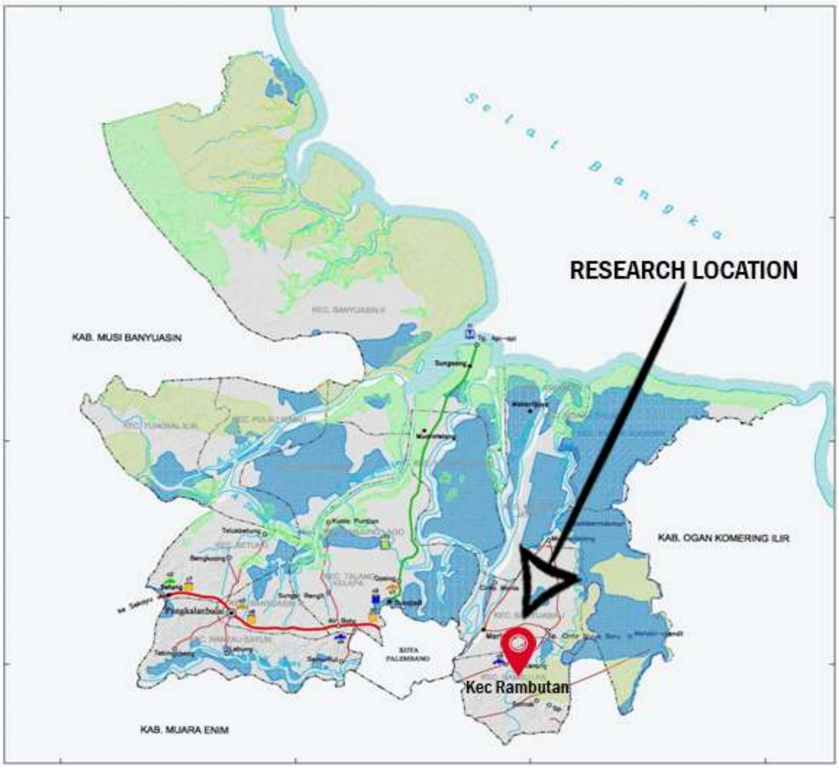


Figure 2. Research location : Rambutan Village, Rambutan sub-district , Banyuasin District

Pasture Carrying Capacity

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 (2006).

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

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

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 $AU^{-1}day^{-1}$

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 the number of livestock available to find out the ratio of the two illustrating the number of buffaloes that could be developed in the study area using the following formulations: (a). $AUp/AUt < 1$: if the number of livestock being grazed in swamp lowlands is greater than the amount of feed available, (b). $AUp/AUt = 1$: If there is a balance between the amount of forage available and the number of livestock being grazed. (c). $AUp/AUt > 1$: If the number of livestock being grazed is less than the amount of food available in the pasture. Remarks: AUp and AUt are animal units for feed and animal unit for livestock successively (Kleden *et al*., 2015).

RESULTS AND DISCUSSION

Results

Species of Forage Vegetation

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

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

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

Where: P : Pulau Layang Village; NDP : Not Dominant Palatabel
R : Rambutan Village; ND : Not Dominant
DP : Dominant, Palatabel; + : Available
DNP : Dominant Not Palatabel; - : Unavailable

Analysis of Forage Vegetation

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).

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.

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

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

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.

Latin Name	Wet Season					Dry Season				
	D	RD (%)	F	RF (%)	IVI (%)	D	RD (%)	F	RF (%)	IVI (%)
Cyperus digitatus	0,88	18,033	0,30	14,851	32.884	0,12	5,310	0,06	4,348	9,658^{4}
Eleocharis dulcis	1,68	34,426	0,74	36,634	71,060	1,00	44,248	0,62	44,928	89,176^{1}
Digitaria fuscescens	1,10	22,541	0,40	19,802	42,343	0,40	1,770	0,22	15,942	17,712^{3}
Hymenachne acutigluma	0,04	0,820	0,02	0,990	1,810	0,02	0,885	0,02	1,449	2,334^{8}
Hymenachne amplexicaulis	0,04	0,820	0,02	0,990	1,810	0,04	1,770	0,02	1,449	3,219^{7}
Leersia hexandra	0,06	1,230	0,04	1,980	3,210	0,04	1,770	0,04	2,899	4,659^{5}
Oryza rupifogon	0,80	16,393	0,40	19,802	36,195	0,60	26,549	0,38	27,536	54,085^{2}
Rhynchospora corymbosa. L	0,08	1,639	0,04	1,980	3,619	0,04	1,770	0,02	1,449	3,219^{6}
Sesbania exasperata	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**

Where: 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).

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.

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})
Catharanthus roseus (L.) Don	7.530	977,4	2,82	-	-	-
Cyperus chephalotes Vahl	-	-	-	4.580	1.145,00^{4}	3,30
Digitaria fuscescens	-	-	-	2.420	537,97^{10}	1,55
Eichhornia crassipes	5.940	1.097,7	3,17	4.700	830,49^{6}	2,40
Eleocharis dulcis	12.640	2.664,5	7,69	-	-	-
Hymenachne acutigluma	6.700	1.352,7	3,90	7.480	1.632,54^{1}	4,71
Hymenachne amplexicaulis	6.650	790,0	2,28	5.990	729,58^{8}	2,11
Hymenachne sp.	7.040	1.151,7	3,32	5.720	975,83^{5}	2,82
Ipomoea aquatica Forsk.	4.020	604,6	1,75	-	-	-
Leersia hexandra	4.740	1.232,4	3,56	5.290	1.385,45^{2}	4,00
Ludwigia hyssopifolia	1.980	346,9	1,00	4.290	777,35^{7}	2,24
Neptunia olerancia	1.910	394,8	1,14	2.870	607,01^{9}	1,75
Nymphaea adorata Aiton	7.500	1.286,3	3,71	-	-	-
Nymphaea lotus	9.800	1.983,5	5,72	-	-	-
Oryza rupifogon	12.960	2.225,2	6,42	-	-	-
Polygonum barbatum 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**

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.

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

Discussion

Species of Forage Vegetation

There are dominant and palatable species of swamp lowland forage vegetation having potential as buffalo feed, namely Kumpai padi grass (*O. rupifogon),* Kumpai tembaga *(H. acutigluma),* and Kumpai minyak *(H. amplexicaulis)*, not dominant and palatable such as Kumpai merah *(Hymenachne sp*) and Kemon air *(N. olerancia)*; 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 species to be eaten (Table 1).

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

Analysis of Forage Vegetation

The analysis results of the vegetation of Pulau Layang Village during the wet season having the highest relative density, relative frequency, and Important Value Index (IVI) were Kemon air (*N. olerancia*) having 0.56 density, 17.5% relative density, 0.32 frequency, 19.512% relative frequency, and 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. adorata* Aiton) and Telepuk gajah (*N. lotus*) which was 1.84% each. The highest relative density, relative frequency and importance value index in the dry season were Kemon air (*N. olerancia*) which was 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. rupifogon)* which was 13.71% (Table 2). Those results also showed that in Pulau Layang Village there was a difference in the amount of vegetation between the wet and dry seasons. In the wet season there were 14 forage vegetation species and in the dry season there were only 10 forage vegetation species. Meanwhile, Apit-apit *(C. chephalotes* Vahl*)* and Kerak maling *(D. fuscescens)* were not found in the wet season. Likewise, in the dry season, Purun tikus (*E. dulcis*), Kumpai padi (*O. rupifogon*), Tapak darah (*C. roseus* L. Don*)*, Kangkung merah (*I. aquatica* Forsk*)*, and Telepuk padi (*N. adorata* Aiton) were not found. The results show that there were some vegetation species tolerant of water and some others were not. In other words, those tolerant of water would survive and those which were not would die.

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

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. rupifogon)* 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. rupifogon)* 54.08%, and Kerak maling *(D. fuscescens)* 17.71%. The lowest value was Kumpai tembaga *(H. acutigluma)* 2.33% (Table 3). The highest density of swamp forage vegetation 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 plant vegetation had the highest density because this vegetation matched the environment to grow and reproduce under the conditions of land whose soil and water contained low pH. As for the plants having the lowest density, it might have been due to the unsuitable environmental and 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., 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 Production

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 (Bray 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 bioslury 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 Ilir was 6.90 tons ha^{-1}.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 Wulanggitang Subdistrict, East Flores District was 7.664 tons.ha^{-1}.year^{-1} and 6.98 tons.ha^{-1}.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.ha^{-1}.year^{-1}.

The production of fresh forage swamp lowland pastures of 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 fresh production 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 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 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 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} in the wet season and 5,422.9 kg.ha^{-1}. year^{-1} in the dry season. The pasture forage production of Sabana Timur 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 season in October and the highest in April (Manu, 2013; Damry, 2009). The forage production of *Pennisetum purpuphoides* was 70.4 ton.ha^{-1}, *Setaria sphasielata* 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} (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 used with certain animal feed plant species. Therefore, it is very important to find out the use and limited techniques of measuring forage production (Edvan et al., 2016; Badgery et al., 2017).

There were 5 swamp lowland forage species having high fresh production in the wet season in Pulau Layang Village, namely Kumpai padi (*O. rupifogon*) 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. adorata* Aiton), and the lowest one was Kemon air (*N. olerancia*) 1,910 kg.ha^{-1}.year^{-1}. In the dry season the highest fresh production was Kumpai tembaga (*H. acutigluma*) as many as 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. olerancia*) of only 2.870 kg.ha^{-1}.year^{-1}. 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 by Kumpai padi *(O. rupifogon*), Telepuk 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 7.480 kg.ha^{-1}.year^{-1}, followed by Bento rayap *(L. hexandra),* Are bolong *(P. barbatum* L*)*, Apit-apit (*C. chephalotes* Vahl*)* and Kumpai merah *(Hymenachne sp.)*, and the lowest one was Kerak maling (*D. fuscescens*) as many as 2,420 kg.ha^{-1}.year^{-1} (Table 4).

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 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 those of the study conducted by (Purwantari et al. 2015; Praptiwi et al., 2017) reporting that the average availability of the 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 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:

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

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 wass 0.96 and 1.12 AU.ha^{-1}.year^{-1} (Karti et al., 2015). The pasture performance of the *Brachuaria 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 supported by the government and private companiesa 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 weight depicts the accumulation of organic compounds that are successfully synthesized by the plants from inorganic compounds, especially water and CO_2 (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).

When the pasture condition had one species of swamp forage, the highest carrying capacity in the wet season 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}, 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 *(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}. During the dry season the highest carrying capacity was Kumpai tembaga *(H. acutigluma)* as much as 6.29 AU.ha^{-1}.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 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}. 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 carrying capacity is very influential with the type of feed plan. In addition the most important thing is also cattle grazing system. Livestock grazing must be regulated to avoid over-grazing. 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 the forage availability was still sufficient to meet feed requirements for Pampangan buffaloes. The population of Pampangan buffaloes of Pulau Layang Village was 487 buffaloes with a grazing area of 500 ha with an 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 an average carrying capacity of 2.45 AU.ha^{-1}.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 Village and 0.59 AU.ha^{-1}.year^{-1} in Rambutan Village.

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

1. There were 19 species of swamp lowland forage vegetation found to have the potential to feed the Pampangan buffaloes in South Sumatra.
2. Important Value Index (IVI) is strongly influenced by grazing locations and seasons. The high IVI were Kemon air *(N. olerancia)* and Are bolong *(P. barbatum* L*)* in Pulau Layang Village. In Rambutan Village, the high IVI were Purun tikus *(E. dulcis)*, Kerak maling *(D. fuscescens),* and Kumpai padi *(O. rupifogon).*
3. In Pulau Layang Village, the fresh forage and dry matter production of forage vegetation swamp lowland 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} and 0.91 ton.ha^{-1}.year^{-1} dry consecutively. 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 they were 2.52 tons.ha^{-1}.year^{-1} and 0.71 tons.ha^{-1}.year^{-1} consecutively.
4. The carrying capacity of swamp lowland pasture in the wet season in Pulau Layang Village was 3.66 AU.ha^{-1}.year^{-1} 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 dry season it was 2.04 AU.ha^{-1}.year^{-1}. Therefore, on the average the carrying capacity of the swamp lowland pasture in South Sumatra was 2.79 AU.ha^{-1}.year^{-1}.
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 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.
6. The highest forage production in the wet season in Pulau Layang Village was Purun tikus, followed by, Kumpai padi, Telepuk 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.

ACKNOWLEDGEMENTS

The author expresses his deepest gratitude to the Rector of Sriwijaya University through the Chair of the Institute for Research and Community Services funding this research in accordance with the Competitive Leading Research Contract of Sriwijaya University Number: 988 / UN9.3.1 / PP / 2017, dated 21 July 2017.

REFERENCES

Abdullah, M., Rafay, M., Sial, N., F. Rasheed, F., Nawaz M.F., Nouman, W., Ahmad, I.,Ruby, T and Khalil, S. 2017. Determination of forage productivity, carrying capasity and palatability of browse vegetation in arid rangelands of Cholistan Desert (Pakistan). Applied Ecology and Environmental Research. 15 (4): 623-637. http://dx.doi.org/10.15666/aeer/1504_623637.

Ali AIM, Sandi S., Muhakka dan Riswandi. 2012. *The quality of forage feed of the swampy lowland of pampangan buffalo pasture*. Prosiding InSINAS 2012. 307-312.

BPS (Central Statistics Agency). 2010. Directorate General of Food. Swamp lowland Area of Indonesia. Agriculture Department. Jakarta.

BPS (Central Statistics Agency). South Sumatra Province. 2014. South Sumatra in Value Provinsi Sumatera Selatan. 2014.

Badgery WB, Millar GD, Broadfoot K, Michalk DL, Cranney P, Mitchell D, Van de Ven R. 2017. Increased production and cover in a variable native paAUure following intensive grazing management. Animal Production Science. (57): 1812–1823.

Center for Agricultural Technology Assessment in South Sumatra. 2011. Pampangan buffalo as South Sumatra's Nutfah plasm. bptp-sumsel@litbang.deptan.go.id.

Camarao AP, Rodrigues Filho JA. 2001. Botanical composition of the available forage and the diet of water buffalo grazing native pastures of the medium Amazon region, Brazil. Buffalo Journal. 3: 307–316.

Cheng D, Peili S, Xianzhou Z, Ning Z, Xi C, Shoubao G, Wanrui Z. 2017. The Rangeland livestock carrying capacity and Stocking rate in the Kailash Sacred Landscape in China. Journal of Resources and Ecology. 8 (6): 551-558.

Damry. 2009. Production and content of forage nutrition of natural pasture of North Lore Subdistrict of Poso District. Jurnal Agroland. 16 (4): 296-300.

Daru TP, Suhardi, Yusuf R., Wibowo A, Pujowati P. 2012. Carrying capacity of feed forage on the ruminants development in West Kutai District. Jurnal Teknologi Pertanian 8(1): 30-36.

Daru TP, Yulianti A, Widodo E. 2014. Forage potential of palmoil plantation as beef cattle feed in Kutai Kartanegara District. Media Sains. 7: 79-86.

Delima M, Karim A, Yunus M. 2015. Study of feed forage production potency on existing areas potential to increase ruminant livestock population in Aceh Besar District. Jurnal Agripet : 15 (1): 33-40.

Dwyanto K, Handiwirawan E. 2006. Stratey of buffalo cattle development: network and distribution aspects. Pros. National Workshop of Buffalo Cattle Business to Support the Beef Adequacy Program. Sumbawa, 4-5 August 2006. Center for Animal Husbandry Research and Development in cooperation with the Directorate of Nursery, Director General of Animal Husbandry of West Nusa Tenggara Province, and Sumbawa Province. pp. 3-12

Edvan RL, Bezerra LR, Marques CAT, Carneiro MSS, Oliveira RL, Ferreira RR. 2016. Methods for estimating forage mass in pastures in a tropical climate. Revista de Ciências Agrárias. 39(1): 36-45.

Eoh M. 2014. Carrying capacity and composition of feed substance of buffalo pasture of Pulau Moa. Agrinimal. 4 (2): 77-82.

Hashemi N. 2017. Recognizing the potential of sustainable use of pasture resources in South Khorasan Province with approch of carrying capacity. Environment and Ecosystem Science (EES). 1 (2): 9-12.

Jarmani SN, Haryanto B. 2015. Improving productivity of animal feed forage to support buffalo pasture capacity of Kampar District of Riau (A suggestion of thought). Jurnal PaAUura. 4 (2): 95-99.

Jefferya RP, Simpsona RJ, Lambersc H, Orcharda S, Kidda DR, Halingb RE, Ryana MH. 2018. Contrasting communities of arbuscule-forming root symbionts change external critical phosphorus requirements of some annual pasture legumes. Applied Soil Ecology. xxx (xxx): 9-10.(https://doi.org/10.1016/j.apsoil.).

Jung-Feng S, Guo MX, Lian, JR, Xiaobin P, Guo WY, Ping CX. 2010. Gene expression profile of respon to water stress at the jointing stage in wheat. Agricultural Science in China. 9 (3): 323-330.

Karti PDMH, Abdullah L, Prihantoro I. 2015. Exploration and productivity of pastures of East Pamona Subdistrict of Poso District of Mid Sulawesi. Jurnal Pastura. 4 (2): 91-94.

Kleden MM., Ratu MRD, Randu MDS. 2015. Feed forage carrying capacity in coffee plantation areas and natural pasture of East Flores District of East Nusa Tenggara. Jurnal Zootek35 (2): 340-350.

Kumalasari NR, Sunardi. 2015. Variety of feed forage potential vegetation in rice field areas of different height conditions. Jurnal Pastura. 4 (2): 59-61.

Lakitan B. 1995. *Plant physiology and plant development*. Raja Grafindo Persada. Jakarta.

Manu AE. 2013. Productivity of sabana pasture of West Timor. Jurnal Pastura. 3 (1): 25-29.

Muhajirin, Despal, Khalil. 2017. Pemenuhan kebutuhan nutrien sapi potong bibit yang digembalakan Fulfilling the nutrient needs of grazed nursery beef cattle of Padang Mengatas. Buletin Makanan Ternak.104(1): 9-20.

Muhakka, Riswandi, Ali AIM. 2013. Morphological and Reproductive Characteristics of Pampangan Buffaloes of South Sumatra Province. Jurnal Sain Peternakan Indonesia. 8(8): 89-106.

Mulyani A, Sarwani M. 2013. Characteristics and potential of sub-optimal land for agricultural development. Jurnal Sumberdaya Lahan. 7 (1): 47-55.

Oktaviani SI, Santri DJ, Dayat E. 2015. Diversity of swamp vegetation of Tanjung Lago Subdistrict. Jurnal Lahan Suboptimal 4 (2) :133-148.

Omokanye A, Yoder C, Sreekumar L, Vihvelin L, Benoit M. 2018. Forage production and Economic performance of pasture rejuvenation methods in Northern Alberta, Canada. SuAUainable Agriculture Research. 7 (2): 94-110.

Parmadi JC EH, Dewiyanti I, Karina S. 2016. Important value index of mangrove vegetation in Kuala Idi area, East Aceh District. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah.1 (1): 82-95.

Praptiwi II, Susanti DS, Damayanti AT, Mangera Y. 2017. The potential of various vegetation species as animal feed forage in the pasture of Sota Village of Merauke District. Agricola. 7 (1): 15-24.

Purnomo J. 2006. Animal Feed Forage in Indonesia. Jakarta. Agricultural Research and Development Agency of the Ministry of Agriculture

Purwantari ND, Tiesnamurti B, Adinata Y. 2015. Availability of forage sources in palmoil plantations for cattle grazing. Watazoa. 25 (1): 47-54.

Rinduwati., Hasan S, Syamsu JA, Useng D. 2016. Carrying capacity and botanical diversity of paAUoral range in Gowa Regency.International Journal of Sciences: Basic and Applied Research (IJSBAR). 29 (3) : 105 - 111.

Rohaeni ES, Darmawan A, Qomariah R, Hamdan A, Subhan A. 2005. Inventory and Characterization of Swamp Buffaloes as Germplasm. Report of Study Result. Balai Pengkajian Teknologi Pertanian (BPTP) Kalimantan Selatan. Banjarbaru.

Rostini T, Abdullah L, Wiryawan KG, Karti PDMH. 2014. Production and nutrition potency of swamp local forage in South Kalimantan as ruminant feed. Glob. J. Anim. Sci. Livestock Prod. Anim. Breed.2 (2):107-113.

Salendu AHS, Elly FH. 2014. Potensi pengembangan hijauan pakan ternak sapi di bawah pohon kelapa Potential development of forage for cattle under the coconut trees in Lolayan Subdistrict of Bolaang Mongondow District. Jurnal Pastura. 4 (1): 7-10.

Samin AN, Chairul, Mukhtar E. 2016. Analysis of coastal vegetation in tourist area of Pasir Jambak, Kota Padang. Jurnal Biocelebes 10 (2): 32-42.

Se'u VE, Kartib PDMH, Abdullah L. 2015. Botanical composition, grass production, and carrying capacity of pasture in Timor Tengah Selatan District. Journal Media Peternakan 38(3):176-182.

South Sumatra Animal Husbandry Statistics. 2014. South Sumatra Province Animal Husbandry Office 2015 Budget Year: 14.

Suarna IW, Budiasa IKM. 2016. Effect of organic fertilizers on the production and quality of mixed pasture on the dry land of Sebudi Karangase Village. Majalah Ilmiah Peternakan. 19 (3): 125-128.

Sutaryo D. 2009. Calculation of Biomass. An Introduction to the Study of Carbon and Carbon Trading. Wetlands International Indonesia Programme.

Suveltri B, Syam Z, Solfiyeni. 2014. Analysis of weed vegetation in plantations of maize (Zea mays L) on maximum tillage in District of Lima Puluh Kota. Jurnal Biologi Universitas Andalas (J. Bio. UA.) 3(2): 103-108.

Syarifuddin H. 2011. Composition and Structure of animal feed forage under the trees of palmoil plantation. Agrinak. 1 (1): 25-30.

Taiz L, Zeiger E. 2002. *Plant Physiology*. 3 rd ED. Sinauer Association, Inc.

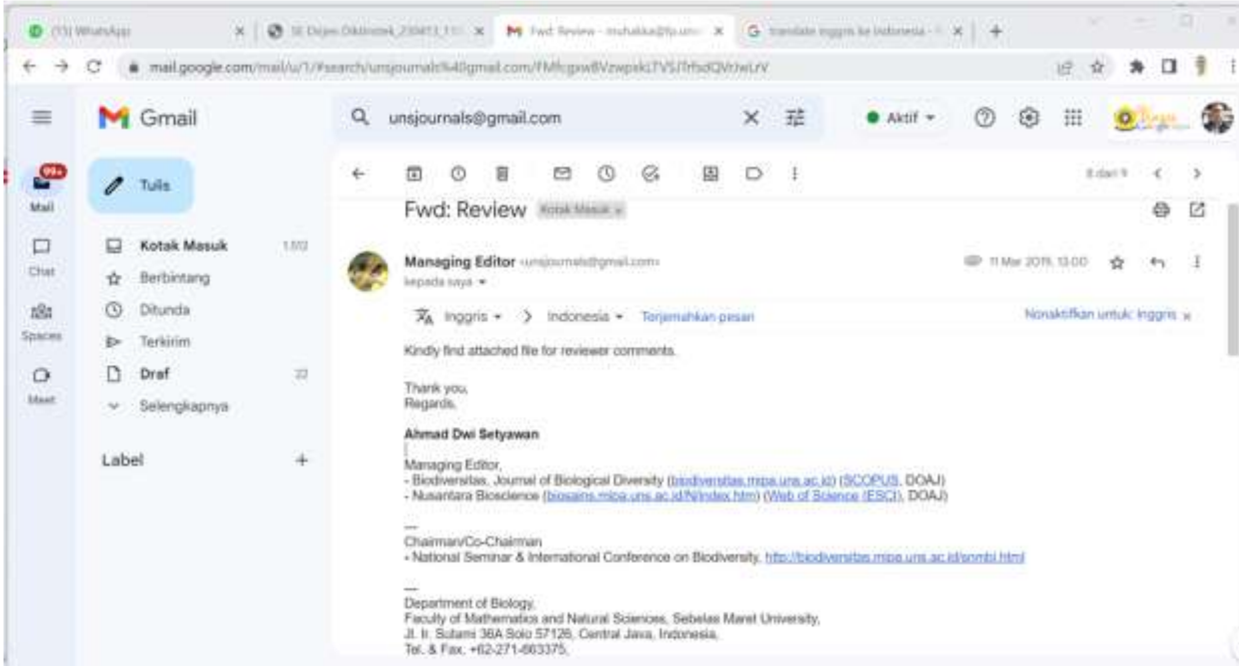
Thalib C, Herawati T, Hastono. 2014. Strategy of increasing buffalo productivity through the improvement of feed and genetics. Wartazoa. 24 (2): 83-96.

Yoku O, Supriyantono A, Widayati T, Sumpe I. 2014. Production of natural pasture and potency of Balinese cow development in supporting the meat adequacy program in West Papua. Jurnal Pastura 3 (2): 102 – 105.

Yoku O, Supriyantono A, Widayati T, Sumpe I. 2015. Composition of botany and distribution of local forage species of natural pasture in West Papua. Jurnal Pastura 4 (2): 62– 65.

Yasin S. 2013. Eating behavior of ruminants as phenology bioindicators and dynamics of pasture. Jurnal Pastura 3 (1) : 1–4.

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



Fwd: Review

Managing Editor <unsjournals@gmail.com>
kepada saya

11 Mar 2019, 13.00

Kindly find attached file for reviewer comments.

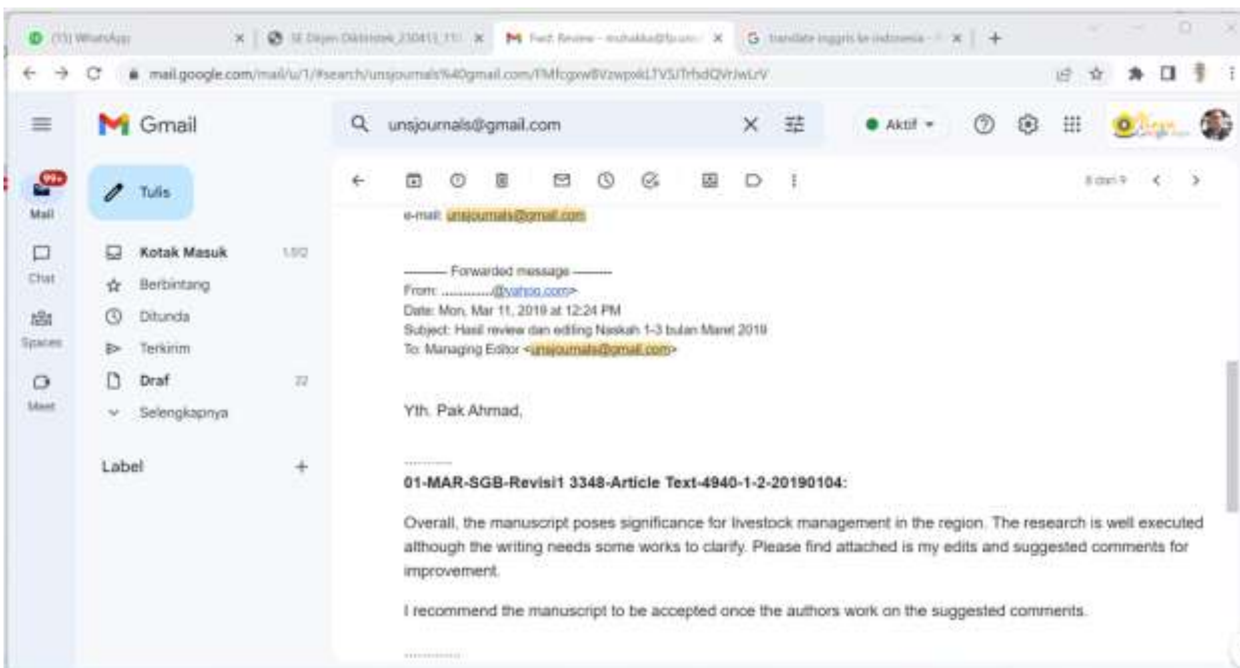
Thank you,
Regards,

Ahmad Dwi Setyawan

Managing Editor,
- Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id) (SCOPUS, DOAJ)
- Nusantara Bioscience (biosains.mipa.uns.ac.id/N/index.htm) (Web of Science (ESCI), DOAJ)

Chairman/Co-Chairman
- National Seminar & International Conference on Biodiversity, http://biodiversitas.mipa.uns.ac.id/snmbi.html

---
Department of Biology,
Faculty of Mathematics and Natural Sciences, Sebelas Maret University,
Jl. Ir. Sutami 36A Solo 57126, Central Java, Indonesia,
Tel. & Fax. +62-271-663375,



e-mail: unsjournals@gmail.com

---------- Forwarded message ---------
From: ....@yahoo.com>
Date: Mon, Mar 11, 2019 at 12:24 PM
Subject: Hasil review dan editing Naskah 1-3 bulan Maret 2019
To: Managing Editor <unsjournals@gmail.com>

Yth. Pak Ahmad,

....

01-MAR-SGB-Revisi1 3348-Article Text-4940-1-2-20190104:

Overall, the manuscript poses significance for livestock management in the region. The research is well executed although the writing needs some works to clarify. Please find attached is my edits and suggested comments for improvement.

I recommend the manuscript to be accepted once the authors work on the suggested comments.

....

V~~Analysis of the V~~egetation analysis ~~Structure~~ of non-tidal swampland in South Sumatra, Indonesia and its c~~C~~arrying c~~C~~apacity ~~of Nontidal Swampland~~for Pampangan buffalo p~~P~~asture ~~to Pampangan Buffalo in South Sumatra, Indonesia~~

Abstract. This study aim~~sed~~ to analyze ~~the~~ vegetation structure of non-tidal swampland in Pulau Layang village, Ogan Komering Ilir District and Rambutan village, Banyuasin Distruct, South Sumatera and to examine its carrying capacity ~~of~~ for Pampangan buffalo ~~in the swampland~~ pasture. ~~The m~~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 method~~s 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 ~~T~~the highest I~~i~~mportant V~~v~~alue I~~i~~ndex ~~of~~ were Purun tikus (*E.dulcis*) ~~was~~ with 89.71% and Kumpai padi (*O. ruf~~p~~ip~~f~~ogon*) with~~as~~ 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, c~~C~~arrying capacity, p~~P~~asture, n~~N~~on-tidal s~~S~~wampland~~land~~

INTRODUCTION

Non-tidal ~~S~~swampland~~land~~ is often considered as~~a~~ suboptimal land despite its ~~and the~~ availability is very extensive in Indonesia. The total extent~~The area~~ of non-tidal swampland~~land~~ is about 13.27 million h~~H~~a, 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 ~~was~~ have been developed with~~. The p~~ public and ~~the p~~private sectors manage~~d~~ 2.6 million ha ~~and~~ while 1.3 million h~~H~~a 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. N~~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 buffalo~~es~~ is ~~are the ones of the~~ potential germplasm of South Sumatra Province which is widely found and extensively farmed in Pulau Layang ~~V~~village, ~~of~~ Ogan Komering Ilir District and Rambutan v~~V~~illage, ~~of~~ Banyuasin District ~~which are generally extensively maintained~~ (Muhakka et al., 2013). In addition to being ~~taken~~ farmed for their meat, the buffalo~~hey~~ also produce milk to be processed into traditional food ~~(~~named *Gulo Puan*~~)~~. ~~The b~~Buffalo population in South Sumatra in 2014 was 33,369 buffaloes, ~~and the number~~ decreasing 4.29% than~~ed compared to~~ that in 2012 ~~to be~~with 34,866 buffaloes ~~(4.29%)~~ (Statistics of South Sumatra Animal Husbandry, 2014). There are three factors causing the~~a~~ decline in the ~~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

Commented [A1]: Please add one or two sentences to start the Abstract describing the background of study. Could extract from the Introduction.

Commented [A2]: Please mention the complete Latin name.

Formatted: Font: Italic

Formatted: Font: Italic

Commented [A3]: Throughout the manuscript, please be consistent in using thousands or decimal, either point or comma.

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.

land ~~decreased~~ (BPTP South Sumatra, 2011). The low productivity of the buffaloes~~es~~ in term of ~~(~~growth and milk production is) ~~resulted from~~caused by the consumed rations ~~which~~ could not meet the needs for ~~of~~ food substances which ~~; this was~~ characterized by low protein content, ~~and~~ high crude fiber, and low digestibility. However, the buffaloes have several advantages and their ~~roles~~ productivity can be enhanced especially through food and genetic improvement (Talib et al., 2014). The buffaloes have ~~their own~~ advantages compared to cows in which~~. T~~ they can survive particularly ~~if~~ when ~~the existing~~ available 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 ~~p~~Pampangan buffalo~~es~~ is by ~~conducting a~~ studying their~~y of~~ forag~~ee vegetation~~ in lowland swamp by analyzing the ~~lowland, through analysis of~~ vegetation and carrying capacity of pasture. ~~The s~~Stud~~iesy~~ o~~nf~~ vegetation analysis and pasture carrying capacity ~~at the present time~~up to date are~~is~~ only limited to ~~the~~ dry land areas, such as in Wulan Gitrang Sub-district, East Flores which 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~~ (Kleden et al., 2015). Another study investigating ~~The~~ carrying capacity of livestock ~~storage~~ forage ~~under~~during ~~the auspices of p~~reproduction of rubber ~~plants~~ (juvenile plants) is 0.14 AU. ha^{-1}.year^{-1}, while during rubber production (mature plants) ~~plants~~ can only accommodate 0.06 AU. ha^{-1}.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~~This study aimed to analyze swamp forage vegetation and the carrying capacity of Pampangan buffalo pasture in the swampland of South Sumatra~~.

MATERIALS AND METHODS

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

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

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

Vegetation Analysis

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

a. Density

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

Density = ~~The species n~~Number of individual of a species / ~~The t~~Total ~~area~~ extent of ~~the~~ sample plots

b. Relative Density

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

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

c. Frequency

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

Frequency = ~~The n~~Number of plots having a species / ~~The n~~Number of all observed plots

Formatted: Font: 10 pt, Not Bold

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.

Formatted: English (United States)

d. Relative Frequency

Relative Frequency is ~~a~~ the frequency of a species as a percent~~age 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:

IVI = Relative Density + Relative Frequency

Forage Production

~~The m~~Measurement o~~n~~f forage production adopted the *Halls* method (~~in~~ Kleden et al., 2015) ~~which~~ us~~inged~~ a 1m x 1m quadratic frame ~~by sampling construction~~ (Sutaryo, 2009). A total of 50 observation points were ~~conducted~~ done in ~~a~~ grazing area of~~on~~ 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 Komering Ilir District

Commented [A10]: Please be consistent. Do you refer the same thing with non-tidal as you mentioned in previous parts including in the Title?

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

Commented [A12]: 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.

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).

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

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

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 $AU^{-1}day^{-1}$

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.~~ C~~The c~~arrying capacity ~~data were~~was analyzed by comparing forage production ~~with~~ to the number of livestock available which result in~~to 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)~~.~~ AUp/AUt < 1~~-~~ means~~:~~ ~~if~~ the number of livestock ~~being~~ grazinged in swamp lowlands is greater than the amount of feed available;~~,~~ ~~(~~b). AUp/AUt = ~~1~~ 1 means~~: If~~ there is a balance between the amount of forage available and the number of livestock ~~being grazed~~;~~.~~ ~~(~~ c)~~)~~. AUp/AUt > 1 means~~: If~~ the number of livestock ~~being grazed~~ is less than the amount of food available in the pasture. AU is animal unit equivalents with ~~Remarks:~~ AUp and AUt are animal units for feed and animal unit for livestock, ~~successively~~ respectively (Kleden *et al*., 2015).

RESULTS AND DISCUSSION

Results

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

Table 1. ~~Species of f~~Forage species in the studied areas of Pampangan buffalo pasture in non-tidal ~~vegetation of~~ swamp~~y lowland~~land ~~of Pampangan buffalo pasture~~

Latin Name	Local Name	Village P	Village R	Remarks
Catharanthus roseus (L.) Don	Tapak dara	+	-	NDP
Cyperus c~~h~~ephalotes Vahl	Apit-apit	+	-	NDP
Cyperus digitatus	Kasuran	-	+	NDP
Digitaria fuscescens	Pasiran / Kerak maling	+	+	DP
Eichhornia crassipes	Eceng gondok	+	-	NDP
Eleocharis dulcis	Purun tikus	+	+	DP
Hymenachne acutigluma	Kumpai tembaga	+	+	DP
Hymenachne amplexicaulis	Kumpai minyak	+	+	DP
Hymenachne sp.	Kumpai merah	+	-	NDP
Ipomoea aquatica Forsk.	Kangkung merah	+	-	NDP
Leersia hexandra	Bento rayap	+	+	DP
Ludwigia hyssopifolia	Cecengkehan	+	-	ND
Neptunia olera~~n~~c~~i~~ea	Kemon air	+	-	NDP
Nymphaea ~~o~~a~~d~~orata Aiton	Telepuk Padi	+	-	NDP
Nymphaea lotus	Telepuk Gajah	+	-	NDP
Oryza ru~~f~~p~~i~~ifp~~o~~gon	Kumpai padi	+	+	DP
Polygonum barbatum L~~.)~~	Are bolong	+	-	DNP
Rhynchospora corymbosa~~.~~ L	Berondong	-	+	ND

Commented [A13]: Please be consistent

Formatted: English (United States)

Formatted: Font: Not Italic

Formatted: Font: Not Italic

Sesbania exasperata	Mutiara	-	+	NDP

Where: P : Pulau Layang ~~V~~village NDP : Not Dominant, Palatabele
R : Rambutan ~~V~~village ND : Not Dominant, Not Palatable?
DP : Dominant, Palatabele + : ~~Available~~Present
DNP : Dominant, Not Palatabele - : ~~Unavailable~~Absent

Analysis of Forage Vegetation

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

Table 2. Density ~~Value~~, Relative Density, Frequency, Relative Frequency, and Important Value Index of ~~Important Value of Swamp Lowland F~~forage species ~~Vegetation of~~ at Pampangan ~~B~~buffalo ~~P~~pasture during ~~the W~~wet and ~~D~~dry ~~S~~seasons in Pulau Layang ~~V~~village.

Latin Name	Wet Season D	Wet Season RD (%)	Wet Season F	Wet Season RF (%)	Wet Season IVI (%)	Dry Season D	Dry Season RD (%)	Dry Season F	Dry Season RF (%)	Dry Season IVI (%)
Catharanthus roseus (L.) Don	0,08	2,500	0,06	3,659	6,159	-	-	-	-	-
Cyperus c~~h~~ephalotes Vahl	-	-	-	-	-	0,16	8,421	0,12	9,524	17,945
Digitaria fuscescens	-	-	-	-	-	0,16	8,421	0,12	9,524	17,945
Eichhornia crassipes	0,48	15,000	0,20	12,195	27,195	0,18	9,474	0,08	6,349	15,823
Eleocharis dulcis	0,16	5,000	0,14	8,537	13,537	-	-	-	-	-
Hymenachne acutigluma	0,22	6,875	0,12	7,317	14,192	0,12	6,316	0,12	9,524	15,840
Hymenachne amplexicaulis	0,20	6,250	0,10	6,098	12,348	0,14	7,368	0,08	6,349	13,717
Hymenachne sp.	0,46	14,375	0,18	10,976	25,351	0,20	10,526	0,12	9,524	20,050
Ipomoea aquatica Forsk.	0,04	1,250	0,04	2,439	3,689	-	-	-	-	-
Leersia hexandra	0,06	1,875	0,04	2,439	4,314	0,12	6,316	0,10	7,936	14,252
Ludwigia hyssopifolia	0,18	5,625	0,06	3,659	9,284	0,16	8,421	0,08	6,349	14,770
Neptunia oleran~~c~~ic~~e~~a	0,56	17,500	0,32	19,512	37,012	0,38	20,000	0,24	19,048	39,048
Nymphaea ~~o~~adorata Aiton	0,02	0,625	0,02	1,220	1,845	-	-	-	-	-
Nymphaea lotus	0,02	0,625	0,02	1,220	1,845	-	-	-	-	-
Oryza ruf~~p~~ip~~f~~ogon	0,18	5,625	0,08	4,878	10,503	-	-	-	-	-
Polygonum barbatum 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**

Where: 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~~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 ~~V~~village.

Latin Name	Wet Season D	Wet Season RD (%)	Wet Season F	Wet Season RF (%)	Wet Season IVI (%)	Dry Season D	Dry Season RD (%)	Dry Season F	Dry Season RF (%)	Dry Season IVI (%)
Cyperus digitatus	0,88	18,033	0,30	14,851	32.884	0,12	5,310	0,06	4,348	9,658[4]
Eleocharis dulcis	1,68	34,426	0,74	36,634	71,060	1,00	44,248	0,62	44,928	89,176[1]
Digitaria fuscescens	1,10	22,541	0,40	19,802	42,343	0,40	1,770	0,22	15,942	17,712[3]
Hymenachne acutigluma	0,04	0,820	0,02	0,990	1,810	0,02	0,885	0,02	1,449	2,334[8]
Hymenachne amplexicaulis	0,04	0,820	0,02	0,990	1,810	0,04	1,770	0,02	1,449	3,219[7]
Leersia hexandra	0,06	1,230	0,04	1,980	3,210	0,04	1,770	0,04	2,899	4,659[5]
Oryza ru~~p~~fi~~p~~fogon	0,80	16,393	0,40	19,802	36,195	0,60	26,549	0,38	27,536	54,085[2]
Rhynchospora corymbosa~~.~~ L	0,08	1,639	0,04	1,980	3,619	0,04	1,770	0,02	1,449	3,219[6]
Sesbania exasperata	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**

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

Forage Production

The average ~~P~~production of fresh forage vegetation ~~fresh forage~~ of swamp lowland ~~in~~ at~~the~~ two study locations ~~on the average~~ w~~a~~as 6.90 tons.ha^{-1}.year^{-1} in ~~the pasture area of~~ Pulau Layang ~~V~~village, ~~of~~ Pampangan Sub-district, ~~of~~ Ogan Komering Ilir District (Table 4) and 3.68 tons.ha^{-1}.year^{-1} in ~~the pasture area of~~ Rambutan ~~V~~village, ~~of~~ Rambutan Sub-district, ~~of~~ Banyuasin District (Table 5).

Formatted: English (United States)

Formatted: English (United States)

Commented [A14]: Please clarify what do you means with dominant?

Formatted: English (United States)

Formatted: English (United States)

Formatted: Font: Not Italic

Commented [A15]: Please be consistent in using thousands or decimal, either point or comma.

Formatted: Font: Not Italic

Table 4. Fresh w~~W~~eight p~~P~~roduction, d~~D~~ry m~~M~~atter p~~P~~roduction, and f~~F~~orage c~~C~~arrying c~~C~~apacity of s~~S~~wamp l~~L~~owland in ~~the W~~w~~e~~t and d~~D~~ry s~~S~~easons in Pulau Layang ~~V~~village~~, of~~ Ogan Komering Ilir.

Latin Name	Wet Season FWP (kg)	Wet Season DMP (kg)	Wet Season CC (AU.ha^{-1}.year^{-1})	Dry Season FWP (kg)	Dry Season DMP (kg)	Dry Season CC (AU.ha^{-1}.year^{-1})
Catharanthus roseus (L.) Don	7.530	977,4	2,82	-	-	-
Cyperus c~~h~~ephalotes Vahl	-	-	-	4.580	1.145,00[4]	3,30
Digitaria fuscescens	-	-	-	2.420	537,97[10]	1,55
Eichhornia crassipes	5.940	1.097,7	3,17	4.700	830,49[6]	2,40
Eleocharis dulcis	12.640	2.664,5	7,69	-	-	-
Hymenachne acutigluma	6.700	1.352,7	3,90	7.480	1.632,54[1]	4,71
Hymenachne amplexicaulis	6.650	790,0	2,28	5.990	729,58[8]	2,11
Hymenachne sp.	7.040	1.151,7	3,32	5.720	975,83[5]	2,82
Ipomoea aquatica Forsk.	4.020	604,6	1,75	-	-	-
Leersia hexandra	4.740	1.232,4	3,56	5.290	1.385,45[2]	4,00
Ludwigia hyssopifolia	1.980	346,9	1,00	4.290	777,35[7]	2,24
*Neptunia olera~~n~~c~~i~~e**a*	1.910	394,8	1,14	2.870	607,01[9]	1,75
Nymphaea o~~a~~dorata Aiton	7.500	1.286,3	3,71	-	-	-
Nymphaea lotus	9.800	1.983,5	5,72	-	-	-
*Oryza ru~~f~~p~~i~~i**p**f~~o~~gon*	12.960	2.225,2	6,42	-	-	-
Polygonum barbatum 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**

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 buffalo~~es in the swamp lowland~~ pasture in~~of~~ Rambutan v~~V~~illage 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).

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 v~~V~~illage~~, of~~ Banyuasin.

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

Discussion

Diversity of forage ~~S~~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~~f**i**f~~p~~ogon*), 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~~c~~e~~i**a***);

Commented [A16]: Please provide remarks for the abbreviation as you did in the previous tables

Formatted: Font: Not Italic

Commented [A17]: Please be consistent in using thousands or decimal, either point or comma.

Commented [A18]: Please provide remarks for the abbreviation as you did in the previous tables

Formatted: Font: Not Italic

Formatted: Font: Not Italic

dominant and non palatable grass species (buffalo doesn't like it) namely Are bolong (*P.* b~~B~~*arbatum*~~.~~ L). Yet, this grass species would be eaten by the buffaloes if there were no other forage species to be eaten (Table 1).

Ali et al. (2012) conducted~~ing~~ a study on swamp land vegetation and found 25 species, while Rohaeni et al. (2005) found 24 species in South Kalimantan, and Camarao and Rodrigues Filho (2001) only found 7 species. In Gowa District, there were 15 ~~vegetation~~ species ~~on~~ found on~~the~~ natural grasslands consisting of 12 ~~vegetation~~ species classified as palatable forage (7 grasses and 5 legumes) and 3 non palatable species, all of them are native species (Rinduwati et al., 2016)~~. All of these vegetation species are of natural grass fields with local species.~~ Based on the number of species encountered (15 species), it can be said that the natural pasture in~~of~~ Gowa District is quite good ~~(Rinduwati et al., 2016)~~. Other studies show high diversity of forage species: ~~In Sota Village pasture there found~~ 33 ~~vegetation~~ species in Sota village, consisting of 61% grass, 3% legume and other plants 36% ~~,~~ (Praptiwi et al., 2017); 22 forage species (Abdullah et al., 2017), 40 forage species consisting of 82 – 87% forage grass, 1% legume and forage consumable by livestock, and 12 - 17% those ~~in~~not edible by livestock (Yoku et al., 2015). In Tobelo Sub-district, ~~The composition of feed~~ forage ~~in Tobelo Subdistrict~~ pasture ~~is~~ consisted of 58.33% grass, 25% legume, and 16.67% other forage (Matulessy and Kastanja, 2013; Eoh, 2014). ~~The s~~Species diversity ~~at different heights~~ is influenced by ~~the~~ season in which ~~where~~ 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 f~~F~~orage v~~V~~egetation

In Pulau Layang village, ~~The analysis results of the vegetation of Pulau Layang Village~~ during the wet season, species with ~~having~~ the highest ~~relative density, relative frequency, and~~ Important Value Index (IVI) were Kemon air (*N. olera~~n~~c~~i~~ea*) having ~~0.56 density, 17.5% relative density, 0.32 frequency, 19.512% relative frequency, and~~ 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. o~~a~~dorata* Aiton) and Telepuk gajah (*N. lotus*) which was 1.84% each. During the dry season, ~~T~~the highest ~~relative density, relative frequency and~~ IVI ~~importance value index in the dry season~~ were Kemon air (*N. olera~~n~~c~~i~~ea*) ~~which was~~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*) ~~which was~~with 13.71% (Table 2). ~~Those results also showed that in Pulau Layang Village there was a difference in the amount of vegetation between the wet and dry seasons. In the wet season there were 14 forage vegetation species and in the dry season there were only 10 forage vegetation species. Meanwhile, Apit-apit (*C. chephalotes* Vahl) and Kerak maling (*D. fuscescens*) were not found in the wet season. Likewise, in the dry season, Purun tikus (*E. dulcis*), Kumpai padi (*O. rupifogon*), Tapak darah (*C. roseus* L. Don), Kangkung merah (*I. aquatica* Forsk), and Telepuk padi (*N. adorata* Aiton) were not found. The results show that there were some vegetation species tolerant of water and some others were not.~~

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 value 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.

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

The Important Value Index (IVI) differences ~~of the swamp lowland forage vegetation~~among species might ~~have~~ be ~~resulted from~~caused by the competition of each species ~~of vegetation to~~ in obtain~~ing~~ soil nutrients ~~in the soil~~ and sunlight, as well as ~~the influencing~~ climatic factors of the wet and dry seasons ~~. This is in accordance with the results of~~ as also stated by Parmadi ~~JC~~ et al. (2016) ~~reporting that the IVI differences of each vegetation species were due to the their competition to obtain nutrients and sunlight~~. In addition ~~to nutrients and sun~~, there are other influencing factors ~~of~~ namely vegetation density and tides. The ~~V~~variation~~s~~ ~~of the~~in species diversity and composition ~~and amount of vegetation~~ indicate~~s~~ that even though ~~a~~one research location has the same age, yet the environmental conditions could result in different vegetation (Syarifuddin, 2011). In Pulau Layang village, ~~The vegetation s~~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~~. This shows that the vegetation species of Kemon air and Are bolong~~ they are the most dominant ~~ones~~ species among other ~~vegetation species~~. A ~~vegetation~~ species is ~~said~~ considered to be dominant in an area if it has ~~a percentage~~ IVI of more than 20% of ~~the total individuals~~all species and co-dominant if the percentage ranges from 10% to 20% (Suveltri et al., 2014).

Commented [A19]: You mention several studies related to forage species diversity. Please discuss the result of your study compared to those other studies.

Commented [A20]: Where?

Commented [A21]: Where

Commented [A22]: Where is it?

Commented [A23]: Where is it?

Commented [A24]: Where?

Commented [A25]: Where?

Commented [A26]: Please be consistent in using thousands or decimal, either point or comma

Formatted: Font: Not Italic

Commented [A27]: What do you mean?

~~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. rupifogon)* 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. rupifogon)* 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~~ strengthen 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 ~~matched~~ 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 p~~P~~roduction

~~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 (Bray 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 bioslury 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 Ilir was 6.90 tons ha^{-1}.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 Wulanggitang Subdistrict, East Flores District was 7.664 tons.ha^{-1}.year^{-1} and 6.98 tons.ha^{-1}.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.ha^{-1}.year^{-1}.~~

The production of fresh forage ~~swamp lowland~~ at pastures in ~~of~~ Pulau Layang v~~V~~illage 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 ~~fresh~~ 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~~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 ha^{-1} year^{-1} and in the dry season was 1,390 kg ha^{-1} 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 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 production~~ in~~of~~ Sabana Timur Barat on the average ranged from 0.61 to 4.33 tons ha^{-1} year^{-1}.

The lowest production usually occurs~~red~~ at the peak of ~~the~~ 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}, *Setaria sphasielata* 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} (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 ~~used with~~ applied to certain animal feed plant species. Therefore, it is very important ~~to find out the use and~~ understand the limitations of ~~ted~~ techniques used ~~of~~ to measure~~ing~~ forage production (Edvan et al., 2016; Badgery et al., 2017).

In Pulau Layang village, t~~T~~here 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 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*) ~~as many as~~ 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*) ~~of~~ with only 2.870 kg ha^{-1} year^{-1}. The highest dry matter production in the wet season was Purun tikus (*E. dulcis*) ~~as many as~~ 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 ~~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 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*) ~~as many as~~ with 2,420 kg ha^{-1} 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 ha^{-1} year^{-1} and the dry matter production was 905.52 kg ha^{-1} year^{-1}, whereas in the dry season

Commented [A28]: Please be consistent in using thousands or decimal, either point or comma. It is really confusing.

Commented [A29]: This paragraph is repetitive with the following one, suggest to remove.

Commented [A30]: Are these studies in Gowa District?

Commented [A31]: Where is this study?

Commented [A32]: This study by who?

Commented [A33]: Production per year?

Formatted: Font: Not Italic

Formatted: Font: Not Italic

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). Theseis results were higher than those of the study conducted by (Purwantari et al. (2015); and Praptiwi et al., (2017) who reporteding 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 the 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 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 Tthere were 5 forage 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} eachrespectively, followed by Kumpai padi (*O. rufpipfogon*), Bento rayap *(L. hexandra)*, Purun tikus (*E. dulcis*), and Kumpai minyak (*H. amplexicaulis*), and the lowest one was Kerak maling (*D. fuscescens*) of 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. rufpipfogon)*, Bento rayap *(L. hexandra)*, Kumpai minyak *(H. amplexicaulis)*, and Purun tikus *(E. dulcis)*, and the lowest 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 this study were still higher than those conducted by Rostini et al. (2014) stating that the highest grassfresh 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 bioslury 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 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:

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

Tthe carrying capacity for Pampangan buffaloes pasture 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). 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 corresponded to those of the study conducted by Rostini et al. (2014) which found 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 wass 0.96 and 1.12 AU.ha^{-1}.year^{-1} (Karti et al., 2015). The pasture performance of the *Brachuaria 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}.

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 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), and the pasture of *Brachuaria humidicola* (Rendle) with 2.31 AU ha^{-1} year^{-1} (Anis et al., 2014). 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.

Commented [A34]: This has been mentioned previously, suggest to remove it to be not repetitive.

Commented [A35]: This is already stated in the Methods. Suggest to remove it.

Commented [A36]: Where is the study?

Commented [A37]: Where is the study?

There is a decrease in the dry material production 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 affect 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 CO_2 (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 ~~of forage development~~ and selection of good species. ~~The m~~Management and strategy ~~carried out~~ to increase forage production require innovative facilitation and training to stockbreeders and -farmers ~~innovative training facilitated to have~~to increase their knowledge. These efforts ~~of breeding and it s~~should be supported by ~~the~~ government and private companies~~a~~ develop ~~to make a~~ programs regarding ~~about~~ the importance of forage ~~to~~ in increas~~ing~~e ruminant livestock production (Nigus, 2017~~.~~; Omokanye et al., 2018).

In Pulau Layang village, ~~I~~in a ~~the~~ pasture condition assumed to hav~~eing~~ one forage species ~~of swamp forage~~, the highest 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 Kumpai padi *(O. ru~~p~~fi~~p~~fogon)* 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~~consecutively~~, and the lowest ~~one~~ 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)* ~~as much as~~with 4.71 AU ~~.~~ha^{-1} ~~.~~year^{-1}, ~~and then 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 AU ~~.~~ha^{-1} ~~.~~year^{-1}, Apit-apit *(C. c~~h~~ephalotes* 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 ~~one~~ was Kerak maling *(D. fuscescens)* ~~as much as~~with 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 weight depicts the accumulation of organic compounds that are successfully synthesized by the plants from inorganic compounds, especially water and CO_2 (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).~~

~~When the pasture~~In Rambutan village, assuming that the pasture ~~condition had~~ had one forage species ~~of swamp forage~~, the highest carrying capacity in the wet season ~~consecutively included~~ was Kumpai tembaga *(H. acutigluma)* with ~~of~~ 9.06 AU~~.~~ ha^{-1} ~~.~~year^{-1}, followed by ~~-~~Kumpai padi *(O. ru~~p~~fi~~p~~fogon)* 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},~~.~~ ~~W~~while the lowest ~~one~~ was Kerak maling *(D. fuscescens)* ~~as much as~~with 0.31 AU ~~.~~ha^{-1} ~~.~~year^{-1}. During the dry season the highest carrying capacity was Kumpai tembaga *(H. acutigluma)* ~~as much as~~with 6.29 AU ~~.~~ha^{-1} ~~.~~year^{-1}, ~~and then~~ followed by Kumpai padi *(O. ru~~p~~fi~~p~~fogon)* ~~as much as~~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}, ~~. W~~while the lowest ~~one~~ was Kasuran *(C. digitatus)* ~~as much as~~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, ~~the most~~other important thing is ~~also~~ cattle grazing system in which ~~. L~~livestock grazing must be regulated to avoid over-grazing as ~~. T~~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 ~~the~~ forage availability ~~was~~ is still sufficient to meet feed requirements for Pampangan buffaloes. The population of Pampangan buffaloes ~~of~~ in Pulau Layang v~~V~~illage was 487 buffaloes with a grazing 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 Rambutan v~~V~~illage 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}. It is ~~projected~~ estimated that there ~~is~~ still ~~a need for~~can be add~~editional~~ buffalo cattle as much as 0.31 AU ~~.~~ha^{-1} ~~.~~year^{-1} in Pulau Layang v~~V~~illage and 0.59 AU ~~.~~ha^{-1} ~~.~~year^{-1} in Rambutan v~~V~~illage.

~~Based on the results of the study, the following is the~~ In conclusion, ~~:~~

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

~~2. Important Value Index (~~IVI~~)~~ is strongly influenced by grazing locations and seasons. The most important species ~~The high IVI~~ were Kemon air *(N. olera~~n~~ci~~e~~a)* and Are bolong *(P. barbatum* L*)* in Pulau Layang ~~V~~village and~~.~~ Purun tikus *(E. dulcis)*, Kerak maling *(D. fuscescens)*, and Kumpai padi *(O. rufipogon)* i~~I~~n Rambutan Village. ~~, the high IVI were Purun tikus (E. dulcis), Kerak maling (D. fuscescens), and Kumpai padi (O. rupifogon).~~

~~3. In~~ In Pulau Layang v~~V~~illage, the fresh forage and dry matter production ~~of forage vegetation swamp lowland pasture~~ in the wet season were 6.90 and 1.27 tons ~~.~~ha^{-1} ~~.~~year^{-1}, while in Rambutan v~~V~~illage they were 3.68 tons ~~.~~ha^{-1} ~~.~~year^{-1} and 0.91 ton ~~.~~ha^{-1} ~~.~~year^{-1} ~~dry consecutively~~, respectively. The fresh forage production and dry matter production in the dry

Commented [A38]: How many buffaloes if these number equivalent across grazing areas?

Formatted: Indent: Left: 0 cm, First line: 0.5 cm 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} .year^{-1} and 0.71 tons .ha^{-1} .year^{-1}, respectively consecutively.

4. The carrying capacity of swamp lowland pasture in the wet season in Pulau Layang Village was 3.66 AU.ha^{-1}.year^{-1} 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 dry season it was 2.04 AU.ha^{-1}.year^{-1}. Therefore, oOn the average the carrying capacity of the swamp lowland pasture in South Sumatra was 2.79 AU.ha^{-1}.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 additionaladded buffalo cattle for of 0.31 AU. ha^{-1} .year^{-1} in Pulau Layang vVillage and 0.59 AU .ha^{-1} .year^{-1} in Rambutan vVillage.

6. The highest forage production in the wet season in Pulau Layang Village was Purun tikus, followed by, Kumpai padi, Telepuk 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.

Formatted: Indent: Left: 0 cm, First line: 0.5 cm, Tab stops: Not at 1.25 cm

ACKNOWLEDGEMENTS

The authors expresses theirhis deepest gratitude to the Rector of Sriwijaya University through the Chair of the Institute for Research and Community Services by funding this research in accordance with the Competitive Leading Research Contract of Sriwijaya University Number: 988 / UN9.3.1 / PP / 2017, dated 21 July 2017.

REFERENCES

Abdullah, M., Rafay, M., Sial, N., F. Rasheed, F., Nawaz M.F., Nouman, W., Ahmad, I.,Ruby, T and Khalil, S. 2017. Determination of forage productivity, carrying capasity and palatability of browse vegetation in arid rangelands of Cholistan Desert (Pakistan). Applied Ecology and Environmental Research. 15 (4): 623-637. http://dx.doi.org/10.15666/aeer/1504_623637.

Ali AIM, Sandi S., Muhakka dan Riswandi. 2012. *The quality of forage feed of the swampy lowland of pampangan buffalo pasture*. Prosiding InSINAS 2012. 307-312.

BPS (Central Statistics Agency). 2010. Directorate General of Food. Swamp lowland Area of Indonesia. Agriculture Department. Jakarta.

BPS (Central Statistics Agency). South Sumatra Province. 2014. South Sumatra in Value Provinsi Sumatera Selatan. 2014.

Badgery WB, Millar GD, Broadfoot K, Michalk DL, Cranney P, Mitchell D, Van de Ven R. 2017. Increased production and cover in a variable native paAUure following intensive grazing management. Animal Production Science. (57): 1812–1823.

Center for Agricultural Technology Assessment in South Sumatra. 2011. Pampangan buffalo as South Sumatra's Nutfah plasm. bptp-sumsel@litbang.deptan.go.id.

Camarao AP, Rodrigues Filho JA. 2001. Botanical composition of the available forage and the diet of water buffalo grazing native pastures of the medium Amazon region, Brazil. Buffalo Journal. 3: 307–316.

Cheng D, Peili S, Xianzhou Z, Ning Z, Xi C, Shoubao G, Wanrui Z. 2017. The Rangeland livestock carrying capacity and Stocking rate in the Kailash Sacred Landscape in China. Journal of Resources and Ecology. 8 (6): 551-558.

Damry. 2009. Production and content of forage nutrition of natural pasture of North Lore Subdistrict of Poso District. Jurnal Agroland. 16 (4): 296-300.

Daru TP, Suhardi, Yusuf R., Wibowo A, Pujowati P. 2012. Carrying capacity of feed forage on the ruminants development in West Kutai District. Jurnal Teknologi Pertanian 8(1): 30-36.

Daru TP, Yulianti A, Widodo E. 2014. Forage potential of palmoil plantation as beef cattle feed in Kutai Kartanegara District. Media Sains. 7: 79-86.

Delima M, Karim A, Yunus M. 2015. Study of feed forage production potency on existing areas potential to increase ruminant livestock population in Aceh Besar District. Jurnal Agripet : 15 (1): 33-40.

Dwyanto K, Handiwirawan E. 2006. Stratey of buffalo cattle development: network and distribution aspects. Pros. National Workshop of Buffalo Cattle Business to Support the Beef Adequacy Program. Sumbawa, 4-5 August 2006. Center for Animal Husbandry Research and Development in cooperation with the Directorate of Nursery, Director General of Animal Husbandry of West Nusa Tenggara Province, and Sumbawa Province. pp. 3-12

Edvan RL, Bezerra LR, Marques CAT, Carneiro MSS, Oliveira RL, Ferreira RR. 2016. Methods for estimating forage mass in pastures in a tropical climate. Revista de Ciências Agrárias. 39(1): 36-45.

Eoh M. 2014. Carrying capacity and composition of feed substance of buffalo pasture of Pulau Moa. Agrinimal. 4 (2): 77-82.

Hashemi N. 2017. Recognizing the potential of sustainable use of pasture resources in South Khorasan Province with approch of carrying capacity. Environment and Ecosystem Science (EES). 1 (2): 9-12.

Jarmani SN, Haryanto B. 2015. Improving productivity of animal feed forage to support buffalo pasture capacity of Kampar District of Riau (A suggestion of thought). Jurnal PaAUura. 4 (2): 95-99.

Jefferya RP, Simpsona RJ, Lambersc H, Orcharda S, Kidda DR, Halingb RE, Ryana MH. 2018. Contrasting communities of arbuscule-forming root symbionts change external critical phosphorus requirements of some annual pasture legumes. Applied Soil Ecology. xxx (xxx): 9-10.(https://doi.org/10.1016/j.apsoil.).

Jung-Feng S, Guo MX, Lian, JR, Xiaobin P, Guo WY, Ping CX. 2010. Gene expression profile of respon to water stress at the jointing stage in wheat. Agricultural Science in China. 9 (3): 323-330.

Karti PDMH, Abdullah L, Prihantoro I. 2015. Exploration and productivity of pastures of East Pamona Subdistrict of Poso District of Mid Sulawesi. Jurnal Pastura. 4 (2): 91-94.

Kleden MM., Ratu MRD, Randu MDS. 2015. Feed forage carrying capacity in coffee plantation areas and natural pasture of East Flores District of East Nusa Tenggara. Jurnal Zootek35 (2): 340-350.

Kumalasari NR, Sunardi. 2015. Variety of feed forage potential vegetation in rice field areas of different height conditions. Jurnal Pastura. 4 (2): 59-61.

Lakitan B. 1995. *Plant physiology and plant development*. Raja Grafindo Persada. Jakarta.

Manu AE. 2013. Productivity of sabana pasture of West Timor. Jurnal Pastura. 3 (1): 25-29.

Muhajirin, Despal, Khalil. 2017. Pemenuhan kebutuhan nutrien sapi potong bibit yang digembalakan Fulfilling the nutrient needs of grazed nursery beef cattle of Padang Mengatas. Buletin Makanan Ternak.104(1): 9-20.

Muhakka, Riswandi, Ali AIM. 2013. Morphological and Reproductive Characteristics of Pampangan Buffaloes of South Sumatra Province. Jurnal Sain Peternakan Indonesia. 8(8): 89-106.

Mulyani A, Sarwani M. 2013. Characteristics and potential of sub-optimal land for agricultural development. Jurnal Sumberdaya Lahan. 7 (1): 47-55.

Oktaviani SI, Santri DJ, Dayat E. 2015. Diversity of swamp vegetation of Tanjung Lago Subdistrict. Jurnal Lahan Suboptimal 4 (2) :133-148.

Omokanye A, Yoder C, Sreekumar L, Vihvelin L, Benoit M. 2018. Forage production and Economic performance of pasture rejuvenation methods in Northern Alberta, Canada. SuAUainable Agriculture Research. 7 (2): 94-110.

Parmadi JC EH, Dewiyanti I, Karina S. 2016. Important value index of mangrove vegetation in Kuala Idi area, East Aceh District. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah.1 (1): 82-95.

Praptiwi II, Susanti DS, Damayanti AT, Mangera Y. 2017. The potential of various vegetation species as animal feed forage in the pasture of Sota Village of Merauke District. Agricola. 7 (1): 15-24.

Purnomo J. 2006. Animal Feed Forage in Indonesia. Jakarta. Agricultural Research and Development Agency of the Ministry of Agriculture

Purwantari ND, Tiesnamurti B, Adinata Y. 2015. Availability of forage sources in palmoil plantations for cattle grazing. Watazoa. 25 (1): 47-54.

Rinduwati., Hasan S, Syamsu JA, Useng D. 2016. Carrying capacity and botanical diversity of paAUoral range in Gowa Regency.International Journal of Sciences: Basic and Applied Research (IJSBAR). 29 (3) : 105 - 111.

Rohaeni ES, Darmawan A, Qomariah R, Hamdan A, Subhan A. 2005. Inventory and Characterization of Swamp Buffaloes as Germplasm. Report of Study Result. Balai Pengkajian Teknologi Pertanian (BPTP) Kalimantan Selatan. Banjarbaru.

Rostini T, Abdullah L, Wiryawan KG, Karti PDMH. 2014. Production and nutrition potency of swamp local forage in South Kalimantan as ruminant feed. Glob. J. Anim. Sci. Livestock Prod. Anim. Breed.2 (2):107-113.

Salendu AHS, Elly FH. 2014. Potensi pengembangan hijauan pakan ternak sapi di bawah pohon kelapa Potential development of forage for cattle under the coconut trees in Lolayan Subdistrict of Bolaang Mongondow District. Jurnal Pastura. 4 (1): 7-10.

Samin AN, Chairul, Mukhtar E. 2016. Analysis of coastal vegetation in tourist area of Pasir Jambak, Kota Padang. Jurnal Biocelebes 10 (2): 32-42.

Se'u VE, Kartib PDMH, Abdullah L. 2015. Botanical composition, grass production, and carrying capacity of pasture in Timor Tengah Selatan District. Journal Media Peternakan 38(3):176-182.

South Sumatra Animal Husbandry Statistics. 2014. South Sumatra Province Animal Husbandry Office 2015 Budget Year: 14.

Suarna IW, Budiasa IKM. 2016. Effect of organic fertilizers on the production and quality of mixed pasture on the dry land of Sebudi Karangase Village. Majalah Ilmiah Peternakan. 19 (3): 125-128.

Sutaryo D. 2009. Calculation of Biomass. An Introduction to the Study of Carbon and Carbon Trading. Wetlands International Indonesia Programme.

Suveltri B, Syam Z, Solfiyeni. 2014. Analysis of weed vegetation in plantations of maize (Zea mays L) on maximum tillage in District of Lima Puluh Kota. Jurnal Biologi Universitas Andalas (J. Bio. UA.) 3(2): 103-108.

Syarifuddin H. 2011. Composition and Structure of animal feed forage under the trees of palmoil plantation. Agrinak. 1 (1): 25-30.

Taiz L, Zeiger E. 2002. *Plant Physiology*. 3 rd ED. Sinauer Association, Inc.

Thalib C, Herawati T, Hastono. 2014. Strategy of increasing buffalo productivity through the improvement of feed and genetics. Wartazoa. 24 (2): 83-96.

Yoku O, Supriyantono A, Widayati T, Sumpe I. 2014. Production of natural pasture and potency of Balinese cow development in supporting the meat adequacy program in West Papua. Jurnal Pastura 3 (2): 102 – 105.

Yoku O, Supriyantono A, Widayati T, Sumpe I. 2015. Composition of botany and distribution of local forage species of natural pasture in West Papua. Jurnal Pastura 4 (2): 62– 65.

Yasin S. 2013. Eating behavior of ruminants as phenology bioindicators and dynamics of pasture. Jurnal Pastura 3 (1) : 1–4.

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

V~~Analysis of the V~~egetation analysis ~~Structure~~ of non-tidal swampland in South Sumatra, Indonesia and its c~~C~~arrying c~~C~~apacity ~~of Nontidal Swampland~~for Pampangan buffalo p~~P~~asture ~~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 assistanceThis study aims~~ed~~ to analyze ~~the~~ vegetation structure of non-tidal swampland in Pulau Layang village, Ogan Komering Ilir District and Rambutan village, Banyuasin Distruct, South Sumatera and to examine its carrying capacity ~~of~~ for Pampangan buffalo ~~in the swampland~~ pasture. ~~The m~~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 method~~s 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 ~~T~~the highest I~~i~~mportant V~~v~~alue I~~i~~ndex ~~of~~ were Purun tikus (***Eleocharis*** ~~*E*~~***.dulcis***) ~~was~~ with 89.71% and Kumpai padi (***Oryza*** ~~*O*~~***. ruf~~p~~ip~~f~~ogon***) w~~ith~~has 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 ***(Hymenachne acutigluma)***~~,~~ Kumpai padi ***(Oryza rupifogon)***, 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, c~~C~~arrying capacity, p~~P~~asture, n~~N~~on-tidal s~~S~~wampland~~land~~

INTRODUCTION

Non-tidal ~~S~~swampland~~land~~ is often considered as~~a~~ suboptimal land despite its ~~and the~~ availability is very extensive in Indonesia. The total extent~~The area~~ of non-tidal swampland~~land~~ is about 13.27 million h~~H~~a, 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 ~~was~~ have been developed with~~. The p~~ public and ~~the pp~~private sectors manage~~d~~ 2.60 million ha ~~and~~ while 1.3 million h~~H~~a 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. N~~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 buffalo~~es~~ is ~~are the ones of~~ ~~the~~ potential germplasm of South Sumatra Province which is widely found and extensively farmed in Pulau Layang ~~V~~village, ~~of~~ Ogan Komering Ilir District and Rambutan v~~V~~illage, ~~of~~ Banyuasin District

Commented [A1]: Please add one or two sentences to start the Abstract describing the background of study. Could extract from the Introduction.

Commented [A2]: Latine name has been added

Formatted: Font: English (United States)

Formatted: Font: 10 pt

Commented [A3]: Please mention the complete Latin name.

Formatted: Font: 9 pt, English (United States)

Formatted: Font: Italic, English (United States)

Formatted: Font: Italic

Formatted: Font: Italic, English (United States)

Formatted: Font: Italic, English (United States)

Commented [A4]: Throughout the manuscript, please be consistent in using thousands or decimal, either point or comma.

Commented [A5]: Has been consistent

Formatted: Font: 9 pt, English (United States)

Formatted: Font: 9 pt

Formatted: Font: English (United States)

Formatted: Font: English (United States)

Formatted: Font: English (United States)

Commented [A6]: Please mention the Latin names instead of local name as local name might be different across place.

Formatted: Font: English (United States)

Formatted: Font: English (United States)

Formatted: Font:

Formatted: Font: English (United States)

Commented [A7]: Please add one or two sentences as concluding remarks stating the implication of the results of this study on livestock management in the region.

Formatted: Font: English (United States)

Formatted: Font: Not Bold

which are generally extensively maintained (Muhakka et al., 2013). In addition to being taken farmed for their meat, tthe buffalohey also produce milk to be processed into traditional food (named *Gulo Puan*). The bBuffalo population in South Sumatra in 2014 was 33,369 buffaloes, and the number decreasing 4.29% thaned compared to that in 2012 to bewith 34,866 buffaloes (4.29%) (Statistics of South Sumatra Animal Husbandry, 2014). There are three factors causing thea decline in the 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 lowswamp, and (3) decreasing extent of the grazing pasture land decreased (BPTP South Sumatra, 2011). The low productivity of the buffaloeses in term of (growth and milk production is) resulted fromcaused by the consumed rations which could not meet the needs for of food substances which ; this was characterized by low protein content, and high crude fiber, and low digestibility. However, the buffaloes have several advantages and their roles productivity can be enhanced especially through food and genetic improvement (Talib et al., 2014). The buffaloes have their own advantages compared to cows in which. T they can survive particularly if when the existing available 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 pPampangan buffaloes is by conducting a studying theiry of foragee vegetation in lowland swamp by analyzing the lowland, through analysis of vegetation and carrying capacity of pasture. The sStudiesy onf vegetation analysis and pasture carrying capacity at the present timeup to date areis only limited to the dry land areas, such as in Wulan Gitrang Sub-district, East Flores which 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 (Kleden et al., 2015). Another study investigating The carrying capacity of livestock storage forage underduring the auspices of preproduction of rubber plants (juvenile plants) is 0.14 AU. ha^{-1}.year^{-1}, while during rubber production (mature plants) plants can only accommodate 0.06 AU. ha^{-1}.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 pastureThis study aimed to analyze swamp forage vegetation and the carrying capacity of Pampangan buffalo pasture in the swampland of South Sumatra.

MATERIALS AND METHODS

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

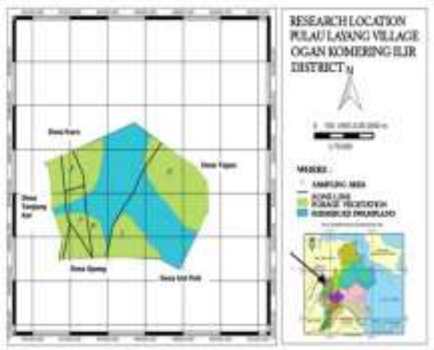


Figure 1. Sampling Area in Pulau Layang Village

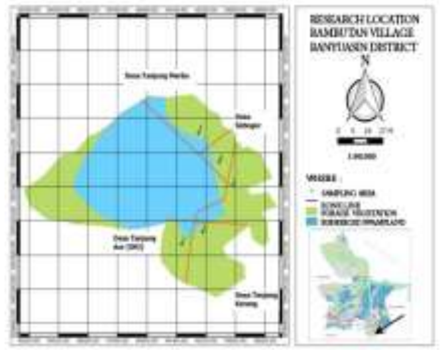


Figure 2. Sampling Area in Rambutan Village

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

Formatted: Font: 10 pt, Not Bold

Commented [A8]: 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 [A9]: Please be consistent in using terminology if you refer to the same thing.

Formatted: Strikethrough

Formatted: Strikethrough

Formatted: Strikethrough

Formatted: Indonesian

Commented [A10]: Please clarify what do you means with dominant value?

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

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

Vegetation Analysis

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

a. Density

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

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

b. Relative Density

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

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

c. Frequency

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

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

d. Relative Frequency

Relative Frequency is ~~a~~ the frequency of a species as a percent~~age 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:

IVI = Relative Density + Relative Frequency

Forage Production

~~The m~~Measurement o~~n~~f forage production adopted the *Halls* method (~~in~~ Kleden et al., 2015) ~~which~~ us~~inged~~ a 1m x 1m quadratic frame ~~by sampling construction~~ (Sutaryo, 2009). A total of 50 observation points were ~~conducted~~ done in ~~a~~ grazing area of~~on~~ swampland ~~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

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.

Formatted: English (United States)

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

Formatted: Strikethrough

Formatted: Strikethrough

Formatted: Strikethrough

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

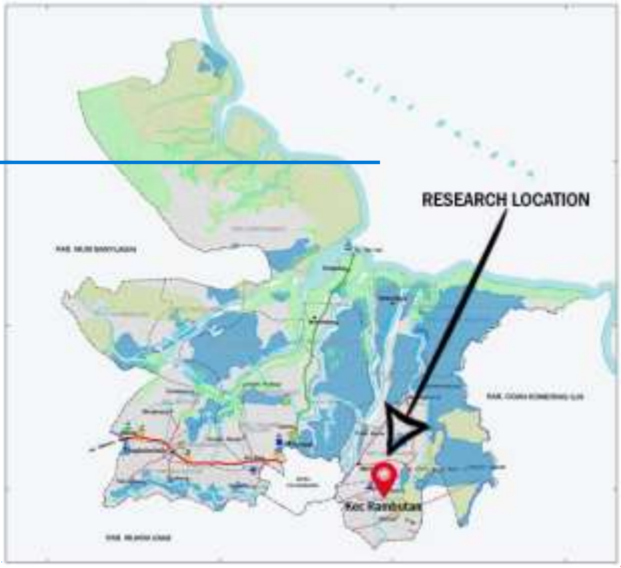
Figure 3. Research location in South Sumatera, Indonesia.

Commented [A13]: 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.

Formatted: Indent: First line: 0.5 cm

Formatted: Left

Formatted: Font: Bold



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

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).

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

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

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 $AU^{-1}day^{-1}$

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.~~ C~~The c~~arrying capacity ~~data were~~was analyzed by comparing forage production ~~with~~ to the number of livestock available which result in~~to 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)~~.~~ AUp/AUt < 1~~-~~ means~~:~~ ~~if~~ the

Commented [A14]: 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.

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

Commented [A15]: Please be consistent

Formatted: Strikethrough

Formatted: Strikethrough

Formatted: Strikethrough

RESULTS AND DISCUSSION

Results

~~Species of Forage Vegetation~~Forage species

Formatted: English (United States)

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

Table 1. ~~Species of f~~Forage species in the studied areas of Pampangan buffalo pasture in non-tidal ~~vegetation of~~ swamp~~y lowland~~land ~~of Pampangan buffalo pasture~~

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

Formatted: Font: 9 pt, Not Italic

Formatted: Font: 9 pt, Not Italic

Sesbania exasperata	Mutiara	-	+	NDP

Where: P : Pulau Layang vVillage NDP : Not Dominant, Palatabele
R : Rambutan vVillage ND : Not Dominant, Not Palatable?
DP : Dominant, Palatabele + : AvailablePresent
DNP : Dominant, Not Palatabele - : UnavailableAbsent

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

Analysis of Forage Vegetation

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

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

Latin Name	Wet Season D	Wet Season RD (%)	Wet Season F	Wet Season RF (%)	Wet Season IVI (%)	Dry Season D	Dry Season RD (%)	Dry Season F	Dry Season RF (%)	Dry Season IVI (%)
Catharanthus roseus (L.) Don	0,08	2,5000	0,06	3,659	6,159	-	-	-	-	-
Cyperus chephalotes Vahl	-	-	-	-	-	0,16	8,421	0,12	9,524	17,945
Digitaria fuscescens	-	-	-	-	-	0,16	8,421	0,12	9,524	17,945
Eichhornia crassipes	0,48	15,000	0,20	12,195	27,195	0,18	9,474	0,08	6,349	15,823
Eleocharis dulcis	0,16	5,000	0,14	8,537	13,537	-	-	-	-	-
Hymenachne acutigluma	0,22	6,875	0,12	7,317	14,192	0,12	6,316	0,12	9,524	15,840
Hymenachne amplexicaulis	0,20	6,250	0,10	6,098	12,348	0,14	7,368	0,08	6,349	13,717
Hymenachne sp.	0,46	14,375	0,18	10,976	25,351	0,20	10,526	0,12	9,524	20,050
Ipomoea aquatica Forsk.	0,04	1,250	0,04	2,439	3,689	-	-	-	-	-
Leersia hexandra	0,06	1,875	0,04	2,439	4,314	0,12	6,316	0,10	7,936	14,252
Ludwigia hyssopifolia	0,18	5,625	0,06	3,659	9,284	0,16	8,421	0,08	6,349	14,770
Neptunia oleranciea	0,56	17,500	0,32	19,512	37,012	0,38	20,000	0,24	19,048	39,048
Nymphaea oadorata Aiton	0,02	0,625	0,02	1,220	1,845	-	-	-	-	-
Nymphaea lotus	0,02	0,625	0,02	1,220	1,845	-	-	-	-	-
Oryza rufpipfogon	0,18	5,625	0,08	4,878	10,503	-	-	-	-	-
Polygonum barbatum 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**

Where: 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 inDensity 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 Vvillage.

Latin Name	Wet Season D	Wet Season RD (%)	Wet Season F	Wet Season RF (%)	Wet Season IVI (%)	Dry Season D	Dry Season RD (%)	Dry Season F	Dry Season RF (%)	Dry Season IVI (%)
Cyperus digitatus	0,88	18,033	0,30	14,851	32.884	0,12	5,310	0,06	4,348	9,6584
Eleocharis dulcis	1,68	34,426	0,74	36,634	71,060	1,00	44,248	0,62	44,928	89,1761
Digitaria fuscescens	1,10	22,541	0,40	19,802	42,343	0,40	1,770	0,22	15,942	17,7123
Hymenachne acutigluma	0,04	0,820	0,02	0,990	1,810	0,02	0,885	0,02	1,449	2,3348
Hymenachne amplexicaulis	0,04	0,820	0,02	0,990	1,810	0,04	1,770	0,02	1,449	3,2197
Leersia hexandra	0,06	1,230	0,04	1,980	3,210	0,04	1,770	0,04	2,899	4,6595
Oryza rupfipfogon	0,80	16,393	0,40	19,802	36,195	0,60	26,549	0,38	27,536	54,0852
Rhynchospora corymbosa. L	0,08	1,639	0,04	1,980	3,619	0,04	1,770	0,02	1,449	3,2196
Sesbania exasperata	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**

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

Forage Production

The average Pproduction of fresh forage vegetation fresh forage of swamp lowland in atthe two study locations on the average wasas 6.90 tons.ha^{-1}.year^{-1} in the pasture area of Pulau Layang Vvillage, of Pampangan Sub-district, of Ogan

Formatted: English (United States)
Formatted: English (United States)
Commented [A16]: Please clarify what do you means with dominant?
Formatted: English (United States)
Formatted: English (United States)
Formatted: Font: Not Bold
Formatted: Font: Not Bold
Formatted: Font: Not Bold
Formatted: Font: Not Bold
Formatted: Font: 9 pt, Not Italic
Commented [A17]: be consistent in using.
Formatted: Font: 9 pt, Not Italic
Formatted: Right

Komering 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 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})**
Catharanthus roseus (L.) Don	7.530	977,40	2,82	-	-	-
Cyperus cephalotes Vahl	-	-	-	4.580	1.145,00[4]	3,30
Digitaria fuscescens	-	-	-	2.420	537,97[10]	1,55
Eichhornia crassipes	5.940	1.097,70	3,17	4.700	830,49[6]	2,40
Eleocharis dulcis	12.640	2.664,50	7,69	-	-	-
Hymenachne acutigluma	6.700	1.352,70	3,90	7.480	1.632,54[1]	4,71
Hymenachne amplexicaulis	6.650	790,00	2,28	5.990	729,58[8]	2,11
Hymenachne sp.	7.040	1.151,70	3,32	5.720	975,83[5]	2,82
Ipomoea aquatica Forsk.	4.020	604,60	1,75	-	-	-
Leersia hexandra	4.740	1.232,40	3,56	5.290	1.385,45[2]	4,00
Ludwigia hyssopifolia	1.980	346,90	1,00	4.290	777,35[7]	2,24
Neptunia oleracea	1.910	394,80	1,14	2.870	607,01[9]	1,75
Nymphaea odorata Aiton	7.500	1.286,30	3,71	-	-	-
Nymphaea lotus	9.800	1.983,50	5,72	-	-	-
Oryza rufipogon	12.960	2.225,20	6,42	-	-	-
Polygonum barbatum 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**

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 buffalo~~es 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).

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

Discussion

Diversity of forage species ~~of Forage Vegetation~~

Commented [A18]: thousands or decimal, either point or comma Please provide remarks for the abbreviation as you did in the previous tables

Formatted: Font: 9 pt, Not Italic

Commented [A19]: Please be consistent in using thousands or decimal, either point or comma.

Commented [A20]: Please provide remarks for the abbreviation as you did in the previous tables

Formatted: Font: 9 pt, Not Italic

There are dominant and palatable forage vegetation species of in swamp lowland forage vegetation having potential as buffalo feed, namely Kumpai padi grass (*O. rupfifpogon)*, Kumpai tembaga *(H. acutigluma)*, and Kumpai minyak *(H. amplexicaulis)*, not dominant and palatable such as Kumpai merah *(Hymenachne* sp) and Kemon air *(N. oleranceia)*; dominant and non palatable grass species (buffalo doesn't like it) namely Are bolong (*P. bBarbatum*. 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 about 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) conductedding a study on swamp land 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 vegetation species on found onthe natural grasslands consisting of 12 vegetation species classified as palatable forage (7 grasses and 5 legumes) and 3 non palatable species, all of them are native species (Rinduwati et al., 2016). All of these vegetation species are of natural grass fields with local species. Based on the number of species encountered (15 species), it can be said that the natural pasture inof Gowa District is quite good (Rinduwati et al., 2016). Other studies show high diversity of forage species: In Sota Village pasture there found 33 vegetation species in Sota village in Marauke, 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 innot edible by livestock in West Papua (Yoku et al., 2015). In Tobelo Sub-district, The composition of feed forage in Tobelo Subdistrict pasture is consisted of 58.33% grass, 25% legume, and 16.67% other forage (Matulessy and Kastanja, 2013; Eoh, 2014). The sSpecies diversity at different heights is influenced by the season in which where 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 fForage vVegetation

In Pulau Layang village, The analysis results of the vegetation of Pulau Layang Village during the wet season, species with having the highest relative density, relative frequency, and Important Value Index (IVI) were Kemon air (*N. oleranciea*) having 0.56 density, 17.5% relative density, 0.32 frequency, 19.512% relative frequency, and 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. oadorata* Aiton) and Telepuk gajah (*N. lotus*) which was 1.84% each. During the dry season, Tthe highest relative density, relative frequency and IVI importance value index in the dry season were Kemon air (*N. oleranciea*) which waswith 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. rufpipfogon)* which waswith 13.71% (Table 2). Those results also showed that in Pulau Layang Village there was a difference in the amount of vegetation between the wet and dry seasons. In the wet season there were 14 forage vegetation species and in the dry season there were only 10 forage vegetation species. Meanwhile, Apit-apit *(C. chephalotes* Vahl*)* and Kerak maling *(D. fuscescens)* were not found in the wet season. Likewise, in the dry season, Purun tikus (*E. dulcis*), Kumpai padi (*O. rupifogon*), Tapak darah (*C. roseus* L. Don*)*, Kangkung merah *(I. aquatica* Forsk*)*, and Telepuk padi (*N. adorata* Aiton) were not found. The results show that there were some vegetation species tolerant of water and some others were not.

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 value 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.

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

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

Formatted: Font: 10 pt, Not Italic

Commented [A21]: You mention several studies related to forage species diversity. Please discuss the result of your study compared to those other studies.

Formatted: Font: 10 pt

Commented [A22]: Where?

Commented [A23]: Where

Commented [A24]: Where is it?

Commented [A25]: Where is it?

Commented [A26]: Where?

Commented [A27]: Where?

Commented [A28]: Please be consistent in using thousands or decimal, either point or comma

Formatted: Font: 10 pt, Not Italic

by Parmadi JC et al. (2016) reporting that the IVI differences of each vegetation species were due to the their competition to obtain nutrients and sunlight. In addition to nutrients and sun, there are other influencing factors of namely vegetation density and tides. The Vvariations of thein species diversity and composition and amount of vegetation indicates that even though aone research location has the same age, yet the environmental conditions could result in different vegetation (Syarifuddin, 2011). In Pulau Layang village, The vegetation sspecies 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. This shows that the vegetation species of Kemon air and Are bolong they are the most dominant ones species among other vegetation species. A vegetation species is said considered to be dominant in an area if it has a percentage IVI of more than 20% of the total individualsall species and co-dominant if the percentage ranges from 10% to 20% (Suveltri et al., 2014).

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. rupifogon)* 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. rupifogon)* 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 withstrengthen the study result conducted by Oktaviani et al. (2015) that the plants vegetation had thewith the highest density because canthis vegetation adapt tomatched 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 tobe 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 pProduction

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 (Bray 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 bioslury 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 Ilir was 6.90 tons ha^{-1}.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 Wulanggitang Subdistrict, East Flores District was 7.664 tons.ha^{-1}.year^{-1} and 6.98 tons.ha^{-1}.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.ha^{-1}.year^{-1}.

The production of fresh forage swamp lowlandat pastures in of Pulau Layang vVillage 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 fresh 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 iswas higher than those conducted by in Canada (Rinduwati et al., 2016; (Omokanye et al., 2018) and ;in Timor Tengah Selatan District (Se'u et al., 2015) stating that the average fresh production of pasture inof 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 those the results of this study were lower than the study of 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 forage production inof Sabana Timur Barat on the average ranged from 0.61 to 4.33 tons .ha^{-1} .year^{-1} (Manu, 2013).

The lowest production usually occursred at the peak of the 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 used withapplied to certain animal feed plant species. Therefore, it is very important to find out the use andunderstand the limitations of ted techniqueees used of to measureing forage production (Edvan et al., 2016; Badgery et al., 2017).

In Pulau Layang village, tThere were 5 forage species swamp lowland forage species having high fresh production in the wet season in Pulau Layang Village, namely Kumpai padi (*O. rufpifpogon*) with 12,960 kg .ha^{-1} .year^{-1}, followed by Purun

Commented [A29]: What do you mean?

Commented [A30]: Please be consistent in using thousands or decimal, either point or comma. It is really confusing.

Commented [A31]: This paragraph is repetitive with the following one, suggest to remove.

Commented [A32]: Are these studies in Gowa District?

Commented [A33]: Are these studies in Gowa District?

Commented [A34]: Where is this study?

Commented [A35]: This study by who?

Commented [A36]: Production per year?

tikus (*E. dulcis*), Telepuk gajah (*N. lotus*), Are bolong *(P. barbatum* L*)* and Telepuk padi (*N. oadorata* 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*) as many aswith 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. oleranciea)* of with only 2.870 kg .ha^{-1} .year^{-1}. The highest dry matter production in the wet season was Purun tikus (*E. dulcis*) as many aswith 2,664.5 kg .ha^{-1} .year^{-1}, followed by Kumpai padi *(O. rupfifpogon*), Telepuk 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 aswith 7.480 kg .ha^{-1} .year^{-1}, followed by Bento rayap *(L. hexandra),* Are bolong *(P. barbatum* L*)*, Apit-apit (*C. chephalotes* Vahl*)* and Kumpai merah *(Hymenachne* sp.*)*, and the lowest one was Kerak maling (*D. fuscescens*) as many aswith 2,420 kg .ha^{-1} .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. 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 2,523.75 kg .ha^{-1}.year^{-1} and the dry matter production was 705.66 kg .ha^{-1} .year^{-1} (Table 5). Theseis results were higher than those of the study conducted by (Purwantari et al. (2015); and Praptiwi et al., (2017) who reporteding 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 the 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 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 Tthere were 5 forage 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} eachrespectively, followed by Kumpai padi (*O. rufpipfogon*), Bento rayap (*L. hexandra*), Purun tikus (*E. dulcis*), and Kumpai minyak (*H. amplexicaulis*), and the lowest one was Kerak maling (*D. fuscescens*) of 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. rufpipfogon)*, Bento rayap *(L. hexandra),* Kumpai minyak *(H. amplexicaulis),* and Purun tikus *(E. dulcis)*, and the lowest 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 this study were still higher than those conducted by Rostini et al. (2014) stating that the highest grassfresh 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 bioslury 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 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:

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

Tthe carrying capacity for Pampangan buffaloes pasture 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). 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 corresponded to those of the study conducted by Rostini et al. (2014) which found 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

Formatted: Font: 10 pt, Not Italic

Formatted: Font: 10 pt, Not Italic

Commented [A37]: This has been mentioned previously, suggest to remove it to be not repetitive.

Formatted: Font: 10 pt

Commented [A38]: This is already stated in the Methods. Suggest to remove it.

~~still relatively small (Praptiwi et al., 2017). The carrying capacity of pasture in Kelei and Didiri Villages of Poso Districts wass 0.96 and 1.12 AU.ha^{-1}.year^{-1} (Karti et al., 2015). The pasture performance of the *Brachuaria 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}.~~

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 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), ~~and the pasture of *Brachuaria humidicola* (Rendle) with 2.31 AU ha^{-1} year^{-1} (Anis et al., 2014).~~ 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.

Commented [A39]: Where is the study?

Commented [A40]: Where is the study?

There is a decrease in the dry material production 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 affect 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 CO_2 (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 ~~of forage development~~ and selection of good species. ~~The m~~Management and strategy ~~carried out~~ to increase forage production require innovative facilitation and training to stockbreeders and farmers ~~innovative training facilitated to have~~ to increase their knowledge. These efforts ~~of breeding and it s~~should be supported by ~~the~~ government and private companies~~a~~ develop ~~to make a~~ programs regarding ~~about~~ the importance of forage ~~to~~ in increasing~~e~~ ruminant livestock production (Nigus, 2017; Omokanye et al., 2018).

In Pulau Layang village, ~~I~~in a ~~the~~ pasture condition assumed to hav~~eing~~e one forage species ~~of swamp forage~~, the highest 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 Kumpai padi *(O. ru~~p~~fi~~p~~fogon)* 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~~consecutively~~, and the lowest ~~one~~ 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)* ~~as much as~~with 4.71 AU ha^{-1} year^{-1}, ~~and then 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 AU ha^{-1} year^{-1}, Apit-apit (*C. c~~h~~ephalotes* 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 ~~one~~ was Kerak maling *(D. fuscescens)* ~~as much as~~with 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 weight depicts the accumulation of organic compounds that are successfully synthesized by the plants from inorganic compounds, especially water and CO_2 (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).~~

~~When the pasture~~In Rambutan village, assuming that the pasture ~~condition had~~ had one forage species ~~of swamp forage~~, the highest carrying capacity in the wet season ~~consecutively included~~ was Kumpai tembaga *(H. acutigluma)* with ~~of~~ 9.06 AU ha^{-1} year^{-1}, followed by Kumpai padi (*O. ru~~p~~fi~~p~~fogon*) 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}, ~~W~~while the lowest ~~one~~ was Kerak maling *(D. fuscescens)* ~~as much as~~with 0.31 AU ha^{-1} year^{-1}. During the dry season the highest carrying capacity was Kumpai tembaga *(H. acutigluma)* ~~as much as~~with 6.29 AU ha^{-1} year^{-1}, ~~and then~~ followed by Kumpai padi *(O. ru~~p~~fi~~p~~fogon)* ~~as much as~~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}, ~~W~~while the lowest ~~one~~ was Kasuran *(C. digitatus)* ~~as much as~~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, ~~the most~~other important thing is ~~also~~ cattle grazing system in which ~~. L~~livestock grazing must be regulated to avoid over-grazing as ~~. T~~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 ~~the~~ forage availability ~~was~~ is still sufficient to meet feed requirements for Pampangan buffaloes. The population of Pampangan buffaloes ~~of~~ in Pulau Layang v~~V~~illage was 487 buffaloes with a grazing 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 Rambutan v~~V~~illage 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}. It is ~~projected~~ estimated that there ~~is~~ still ~~a need for~~can be added~~itional~~ buffalo cattle as much as 0.31 AU ~~.~~ha^{-1} ~~.~~year^{-1} in Pulau Layang v~~V~~illage so 155 buffaloes and 0.59 AU ~~.~~ha^{-1} ~~.~~year^{-1} in Rambutan v~~V~~illage ~~.~~709 buffaloes

~~Based on the results of the study, the following is the~~ In conclusion, ~~:~~

~~1. T~~there were 19 forage species ~~of swamp lowland forage vegetation found~~ to have the potential ~~to~~ as feeding source ~~of the~~ Pampangan buffaloes in South Sumatra. The importance of species indicated by ~~2. Important Value Index (~~IVI~~)~~ is strongly influenced by grazing locations and seasons. The most important species ~~The high IVI~~ were Kemon air *(N. olera~~n~~ci~~e~~a)* and Are bolong *(P. barbatum* L*)* in Pulau Layang ~~V~~village and~~.~~ Purun tikus *(E. dulcis)*, Kerak maling *(D. fuscescens)*, and Kumpai padi *(O. rufipogon)* i~~I~~n Rambutan Village. ~~, the high IVI were Purun tikus (E. dulcis), Kerak maling (D. fuscescens), and Kumpai padi (O. rupifogon).~~

~~3. In~~ In Pulau Layang v~~V~~illage, the fresh forage and dry matter production ~~of forage vegetation swamp lowland pasture~~ in the wet season were 6.90 and 1.27 tons ~~.~~ha^{-1} ~~.~~year^{-1}, while in Rambutan v~~V~~illage they were 3.68 tons ~~.~~ha^{-1} ~~.~~year^{-1} and 0.91 ton ~~.~~ha^{-1} ~~.~~year^{-1} ~~dry consecutively~~, respectively. The fresh forage production and dry matter production in the dry season in Pulau Layang v~~V~~illage were 4.86 and 0.99 tons ~~.~~ha^{-1} ~~.~~year^{-1}, while in Rambutan v~~V~~illage ~~they~~ were 2.52 tons ~~.~~ha^{-1} ~~.~~year^{-1} and 0.71 tons ~~.~~ha^{-1} ~~.~~year^{-1}, respectively ~~consecutively~~.

~~4. The carrying capacity of swamp lowland pasture in the wet season in Pulau Layang Village was 3.66 AU.ha^{-1}.year^{-1} 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 dry season it was 2.04 AU.ha^{-1}.year^{-1}. Therefore, o~~On the average the carrying capacity of the swamp lowland pasture in South Sumatra was 2.79 AU.ha^{-1}.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~~.~~ ha^{-1} ~~.~~year^{-1} in Pulau Layang v~~V~~illage and 0.59 AU ~~.~~ha^{-1} ~~.~~year^{-1} in Rambutan v~~V~~illage.

~~6. The highest forage production in the wet season in Pulau Layang Village was Purun tikus, followed by, Kumpai padi, Telepuk 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.~~

ACKNOWLEDGEMENTS

The authors expresses~~es~~ their~~his~~ deepest gratitude to the Rector of Sriwijaya University through the Chair of the Institute for Research and Community Services by funding this research ~~in accordance~~ with the Competitive Leading Research Contract of Sriwijaya University Number: 988 / UN9.3.1 / PP / 2017, dated 21 July 2017.

REFERENCES

Abdullah, M., Rafay, M., Sial, N., F. Rasheed, F., Nawaz M.F., Nouman, W., Ahmad, I.,Ruby, T and Khalil, S. 2017. Determination of forage productivity, carrying capasity and palatability of browse vegetation in arid rangelands of Cholistan Desert (Pakistan). Applied Ecology and Environmental Research. 15 (4): 623-637. http://dx.doi.org/10.15666/aeer/1504_623637.

Ali AIM, Sandi S., Muhakka dan Riswandi. 2012. *The quality of forage feed of the swampy lowland of pampangan buffalo pasture*. Prosiding InSINAS 2012. 307-312.

BPS (Central Statistics Agency). 2010. Directorate General of Food. Swamp lowland Area of Indonesia. Agriculture Department. Jakarta.

BPS (Central Statistics Agency). South Sumatra Province. 2014. South Sumatra in Value Provinsi Sumatera Selatan. 2014.

Badgery WB, Millar GD, Broadfoot K, Michalk DL, Cranney P, Mitchell D, Van de Ven R. 2017. Increased production and cover in a variable native paAUure following intensive grazing management. Animal Production Science. (57): 1812–1823.

Center for Agricultural Technology Assessment in South Sumatra. 2011. Pampangan buffalo as South Sumatra's Nutfah plasm. bptp-sumsel@litbang.deptan.go.id.

Camarao AP, Rodrigues Filho JA. 2001. Botanical composition of the available forage and the diet of water buffalo grazing native pastures of the medium Amazon region, Brazil. Buffalo Journal. 3: 307–316.

Cheng D, Peili S, Xianzhou Z, Ning Z, Xi C, Shoubao G, Wanrui Z. 2017. The Rangeland livestock carrying capacity and Stocking rate in the Kailash Sacred Landscape in China. Journal of Resources and Ecology. 8 (6): 551-558.

Damry. 2009. Production and content of forage nutrition of natural pasture of North Lore Subdistrict of Poso District. Jurnal Agroland. 16 (4): 296-300.

Daru TP, Suhardi, Yusuf R., Wibowo A, Pujowati P. 2012. Carrying capacity of feed forage on the ruminants development in West Kutai District. Jurnal Teknologi Pertanian 8(1): 30-36.

Daru TP, Yulianti A, Widodo E. 2014. Forage potential of palmoil plantation as beef cattle feed in Kutai Kartanegara District. Media Sains. 7: 79-86.

Delima M, Karim A, Yunus M. 2015. Study of feed forage production potency on existing areas potential to increase ruminant livestock population in Aceh Besar District. Jurnal Agripet : 15 (1): 33-40.

Dwyanto K, Handiwirawan E. 2006. Stratey of buffalo cattle development: network and distribution aspects. Pros. National Workshop of Buffalo Cattle Business to Support the Beef Adequacy Program. Sumbawa, 4-5 August 2006. Center for Animal Husbandry Research and Development in cooperation with the Directorate of Nursery, Director General of Animal Husbandry of West Nusa Tenggara Province, and Sumbawa Province. pp. 3-12

Edvan RL, Bezerra LR, Marques CAT, Carneiro MSS, Oliveira RL, Ferreira RR. 2016. Methods for estimating forage mass in pastures in a tropical climate. Revista de Ciências Agrárias. 39(1): 36-45.

Eoh M. 2014. Carrying capacity and composition of feed substance of buffalo pasture of Pulau Moa. Agrinimal. 4 (2): 77-82.

Hashemi N. 2017. Recognizing the potential of sustainable use of pasture resources in South Khorasan Province with approch of carrying capacity. Environment and Ecosystem Science (EES). 1 (2): 9-12.

Commented [A41]: How many buffaloes if these number equivalent across grazing areas?

Formatted: Indent: Left: 0 cm, First line: 0.5 cm

Formatted: Indent: Left: 0 cm, First line: 0.5 cm, Tab stops: Not at 1.25 cm

Jarmani SN, Haryanto B. 2015. Improving productivity of animal feed forage to support buffalo pasture capacity of Kampar District of Riau (A suggestion of thought). Jurnal PaAUura. 4 (2): 95-99.
Jefferya RP, Simpsona RJ, Lambersc H, Orcharda S, Kidda DR, Halingb RE, Ryana MH. 2018. Contrasting communities of arbuscule-forming root symbionts change external critical phosphorus requirements of some annual pasture legumes. Applied Soil Ecology. xxx (xxx): 9-10.(https://doi.org/10.1016/j.apsoil.).
Jung-Feng S, Guo MX, Lian, JR, Xiaobin P, Guo WY, Ping CX. 2010. Gene expression profile of respon to water stress at the jointing stage in wheat. Agricultural Science in China. 9 (3): 323-330.
Karti PDMH, Abdullah L, Prihantoro I. 2015. Exploration and productivity of pastures of East Pamona Subdistrict of Poso District of Mid Sulawesi. Jurnal Pastura. 4 (2): 91-94.
Kleden MM., Ratu MRD, Randu MDS. 2015. Feed forage carrying capacity in coffee plantation areas and natural pasture of East Flores District of East Nusa Tenggara. Jurnal Zootek35 (2): 340-350.
Kumalasari NR, Sunardi. 2015. Variety of feed forage potential vegetation in rice field areas of different height conditions. Jurnal Pastura. 4 (2): 59-61.
Lakitan B. 1995. *Plant physiology and plant development*. Raja Grafindo Persada. Jakarta.
Manu AE. 2013. Productivity of sabana pasture of West Timor. Jurnal Pastura. 3 (1): 25-29.
Muhajirin, Despal, Khalil. 2017. Pemenuhan kebutuhan nutrien sapi potong bibit yang digembalakan Fulfilling the nutrient needs of grazed nursery beef cattle of Padang Mengatas. Buletin Makanan Ternak.104(1): 9-20.
Muhakka, Riswandi, Ali AIM. 2013. Morphological and Reproductive Characteristics of Pampangan Buffaloes of South Sumatra Province. Jurnal Sain Peternakan Indonesia. 8(8): 89-106.
Mulyani A, Sarwani M. 2013. Characteristics and potential of sub-optimal land for agricultural development. Jurnal Sumberdaya Lahan. 7 (1): 47-55.
Oktaviani SI, Santri DJ, Dayat E. 2015. Diversity of swamp vegetation of Tanjung Lago Subdistrict. Jurnal Lahan Suboptimal 4 (2) :133-148.
Omokanye A, Yoder C, Sreekumar L, Vihvelin L, Benoit M. 2018. Forage production and Economic performance of pasture rejuvenation methods in Northern Alberta, Canada. SuAUainable Agriculture Research. 7 (2): 94-110.
Parmadi JC EH, Dewiyanti I, Karina S. 2016. Important value index of mangrove vegetation in Kuala Idi area, East Aceh District. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah.1 (1): 82-95.
Praptiwi II, Susanti DS, Damayanti AT, Mangera Y. 2017. The potential of various vegetation species as animal feed forage in the pasture of Sota Village of Merauke District. Agricola. 7 (1): 15-24.
Purnomo J. 2006. Animal Feed Forage in Indonesia. Jakarta. Agricultural Research and Development Agency of the Ministry of Agriculture
Purwantari ND, Tiesnamurti B, Adinata Y. 2015. Availability of forage sources in palmoil plantations for cattle grazing. Watazoa. 25 (1): 47-54.
Rinduwati., Hasan S, Syamsu JA, Useng D. 2016. Carrying capacity and botanical diversity of paAUoral range in Gowa Regency.International Journal of Sciences: Basic and Applied Research (IJSBAR). 29 (3) : 105 - 111.
Rohaeni ES, Darmawan A, Qomariah R, Hamdan A, Subhan A. 2005. Inventory and Characterization of Swamp Buffaloes as Germplasm. Report of Study Result. Balai Pengkajian Teknologi Pertanian (BPTP) Kalimantan Selatan. Banjarbaru.
Rostini T, Abdullah L, Wiryawan KG, Karti PDMH. 2014. Production and nutrition potency of swamp local forage in South Kalimantan as ruminant feed. Glob. J. Anim. Sci. Livestock Prod. Anim. Breed.2 (2):107-113.
Salendu AHS, Elly FH. 2014. Potensi pengembangan hijauan pakan ternak sapi di bawah pohon kelapa Potential development of forage for cattle under the coconut trees in Lolayan Subdistrict of Bolaang Mongondow District. Jurnal Pastura. 4 (1): 7-10.
Samin AN, Chairul, Mukhtar E. 2016. Analysis of coastal vegetation in tourist area of Pasir Jambak, Kota Padang. Jurnal Biocelebes 10 (2): 32-42.
Se'u VE, Kartib PDMH, Abdullah L. 2015. Botanical composition, grass production, and carrying capacity of pasture in Timor Tengah Selatan District. Journal Media Peternakan 38(3):176-182.
South Sumatra Animal Husbandry Statistics. 2014. South Sumatra Province Animal Husbandry Office 2015 Budget Year: 14.
Suarna IW, Budiasa IKM. 2016. Effect of organic fertilizers on the production and quality of mixed pasture on the dry land of Sebudi Karangase Village. Majalah Ilmiah Peternakan. 19 (3): 125-128.
Sutaryo D. 2009. Calculation of Biomass. An Introduction to the Study of Carbon and Carbon Trading. Wetlands International Indonesia Programme.
Suveltri B, Syam Z, Solfiyeni. 2014. Analysis of weed vegetation in plantations of maize (Zea mays L) on maximum tillage in District of Lima Puluh Kota. Jurnal Biologi Universitas Andalas (J. Bio. UA.) 3(2): 103-108.
Syarifuddin H. 2011. Composition and Structure of animal feed forage under the trees of palmoil plantation. Agrinak. 1 (1): 25-30.
Taiz L, Zeiger E. 2002. *Plant Physiology*. 3 rd ED. Sinauer Association, Inc.
Thalib C, Herawati T, Hastono. 2014. Strategy of increasing buffalo productivity through the improvement of feed and genetics. Wartazoa. 24 (2): 83-96.
Yoku O, Supriyantono A, Widayati T, Sumpe I. 2014. Production of natural pasture and potency of Balinese cow development in supporting the meat adequacy program in West Papua. Jurnal Pastura 3 (2): 102 – 105.
Yoku O, Supriyantono A, Widayati T, Sumpe I. 2015. Composition of botany and distribution of local forage species of natural pasture in West Papua. Jurnal Pastura 4 (2): 62– 65.
Yasin S. 2013. Eating behavior of ruminants as phenology bioindicators and dynamics of pasture. Jurnal Pastura 3 (1) : 1–4.

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

BIODIVERSITAS
Volume 20, Number 4, April 2019
Pages: xxxx

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d2004xx

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

MUHAKKA[1,2,♥], RUJITO AGUSSUWIGNYO[3], DEDIK BUDIANTA[4], YAKUP[3]
[1]Graduate School, Universitas Sriwijaya. Jl. Padang Selasa No. 524, Palembang 30139, South Sumatera, Indonesia. Tel./fax.: +62-711-581106.
♥email: muhakka@fp.unsri.ac.id
[2]Department of Animal Husbandry, Faculty of Agriculture, Universitas Sriwijaya. Jl. Palembang-Prabumulih Km. 32, Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia
[3]Department of Agronomy, Faculty of Agriculture, Universitas Sriwijaya. Jl. Palembang-Prabumulih Km. 32 Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia
[4]Department of Soil Science, Faculty of Agriculture, Universitas Sriwijaya. Jl. Palembang-Prabumulih Km. 32 Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia

Manuscript received: 4 January 2018. Revision accepted: xxx March 2019.

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 assistanceThis study aims to analyze vegetation structure of non-tidal swampland in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin Distruct, 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 rupifogon)*, 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).

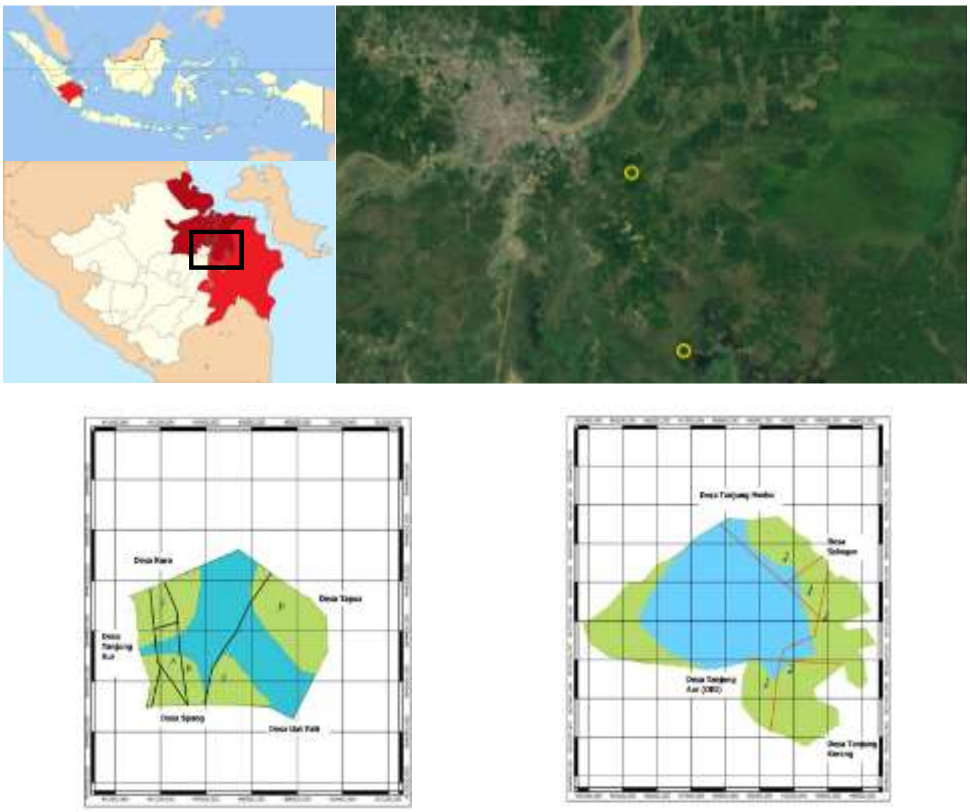
Pampangan buffalo is potential germplasm of South Sumatra Province which is widely found and extensively farmed in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin District (Muhakka et al. 2013). In addition to being farmed for their meat, the buffalo also produce milk 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 $AU.ha^{-1}.year^{-1}$ on coffee plantation and 0.38 $AU.ha^{-1}.year^{-1}$ on grassland (Kleden et al. 2015). Another study investigating carrying capacity of livestock forage during preproduction of rubber (juvenile plants) is 0.14 $AU. ha^{-1}.year^{-1}$, while during rubber production (mature plants) can only accommodate 0.06 $AU. ha^{-1}.year^{-1}$ (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.



A

B

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:

IVI = Relative Density + 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).

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

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

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 $AU^{-1}day^{-1}$

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	
Catharanthus roseus (L.) Don	Tapak dara	+	-	NDP
Cyperus cephalotes Vahl	Apit-apit	+	-	NDP
Cyperus digitatus	Kasuran	-	+	NDP
Digitaria fuscescens	Pasiran / Kerak maling	+	+	DP
Eichhornia crassipes	Eceng gondok	+	-	NDP
Eleocharis dulcis	Purun tikus	+	+	DP
Hymenachne acutigluma	Kumpai tembaga	+	+	DP
Hymenachne amplexicaulis	Kumpai minyak	+	+	DP
Hymenachne sp.	Kumpai merah	+	-	NDP
Ipomoea aquatica Forsk.	Kangkung merah	+	-	NDP
Leersia hexandra	Bento rayap	+	+	DP
Ludwigia hyssopifolia	Cecengkehan	+	-	ND
Neptunia oleracea	Kemon air	+	-	NDP
Nymphaea odorata Aiton	Telepuk Padi	+	-	NDP
Nymphaea lotus	Telepuk Gajah	+	-	NDP
Oryza rufipogon	Kumpai padi	+	+	DP
Polygonum barbatum L	Are bolong	+	-	DNP
Rhynchospora corymbosa L	Berondong	-	+	ND
Sesbania exasperata	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. Dominand means a type of forages that always appears in sampling and have high production.

Commented [a1]: Whay is it?

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 (%)
Catharanthus roseus (L.) Don	0,08	2,50	0,06	3,65	6,15	-	-	-	-	-
Cyperus cephalotes Vahl	-	-	-	-	-	0,16	8,42	0,12	9,52	17,94
Digitaria fuscescens	-	-	-	-	-	0,16	8,42	0,12	9,52	17,94
Eichhornia crassipes	0,48	15,00	0,20	12,19	27,19	0,18	9,47	0,08	6,34	15,82
Eleocharis dulcis	0,16	5,00	0,14	8,53	13,53	-	-	-	-	-
Hymenachne acutigluma	0,22	6,87	0,12	7,31	14,19	0,12	6,31	0,12	9,52	15,84
Hymenachne amplexicaulis	0,20	6,25	0,10	6,09	12,34	0,14	7,36	0,08	6,34	13,71
Hymenachne sp.	0,46	14,37	0,18	10,97	25,35	0,20	10,52	0,12	9,52	20,05
Ipomoea aquatica Forsk.	0,04	1,25	0,04	2,43	3,68	-	-	-	-	-
Leersia hexandra	0,06	1,87	0,04	2,43	4,31	0,12	6,31	0,10	7,93	14,25
Ludwigia hyssopifolia	0,18	5,62	0,06	3,65	9,28	0,16	8,42	0,08	6,34	14,77
Neptunia oleracea	0,56	17,50	0,32	19,51	37,01	0,38	20,00	0,24	19,04	39,04
Nymphaea odorata Aiton	0,02	0,62	0,02	1,22	1,84	-	-	-	-	-
Nymphaea lotus	0,02	0,62	0,02	1,22	1,84	-	-	-	-	-
Oryza rufipogon	0,18	5,62	0,08	4,87	10,50	-	-	-	-	-
Polygonum barbatum 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 (%)**
Cyperus digitatus	0,88	18,03	0,30	14,85	32.88	0,12	5,31	0,06	4,34	9,65[4]
Eleocharis dulcis	1,68	34,42	0,74	36,63	71,06	1,00	44,24	0,62	44,92	89,17[1]
Digitaria fuscescens	1,10	22,54	0,40	19,80	42,34	0,40	1,77	0,22	15,94	17,71[3]
Hymenachne acutigluma	0,04	0,82	0,02	0,99	1,81	0,02	0,88	0,02	1,44	2,33[8]
Hymenachne amplexicaulis	0,04	0,82	0,02	0,99	1,81	0,04	1,77	0,02	1,44	3,21[7]
Leersia hexandra	0,06	1,23	0,04	1,98	3,21	0,04	1,77	0,04	2,89	4,65[5]
Oryza rufipogon	0,80	16,39	0,40	19,80	36,19	0,60	26,54	0,38	27,53	54,08[2]
Rhynchospora corymbosa L	0,08	1,63	0,04	1,98	3,61	0,04	1,77	0,02	1,44	3,21[6]
Sesbania exasperata	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 ($AU.ha^{-1}.year^{-1}$)**
Catharanthus roseus (L.) Don	7.530	977,40	2,82	-	-	-
Cyperus cephalotes Vahl	-	-	-	4.580	1.145,00[4]	3,30
Digitaria fuscescens	-	-	-	2.420	537,97[10]	1,55
Eichhornia crassipes	5.940	1.097,70	3,17	4.700	830,49[6]	2,40
Eleocharis dulcis	12.640	2.664,50	7,69	-	-	-
Hymenachne acutigluma	6.700	1.352,70	3,90	7.480	1.632,54[1]	4,71
Hymenachne amplexicaulis	6.650	790,00	2,28	5.990	729,58[8]	2,11
Hymenachne sp.	7.040	1.151,70	3,32	5.720	975,83[5]	2,82
Ipomoea aquatica Forsk.	4.020	604,60	1,75	-	-	-
Leersia hexandra	4.740	1.232,40	3,56	5.290	1.385,45[2]	4,00
Ludwigia hyssopifolia	1.980	346,90	1,00	4.290	777,35[7]	2,24
Neptunia oleracea	1.910	394,80	1,14	2.870	607,01[9]	1,75
Nymphaea odorata Aiton	7.500	1.286,30	3,71	-	-	-
Nymphaea lotus	9.800	1.983,50	5,72	-	-	-
Oryza rufipogon	12.960	2.225,20	6,42	-	-	-
Polygonum barbatum 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 ($AU.ha^{-1}.year^{-1}$)**
Cyperus digitatus	2.590	248,90	0,72	240	28,61	0,08
Digitaria fuscescens	790	108,00	0,31	1.100	152,79	0,44
Eleocharis dulcis	4.370	921,20	2,66	1.700	376,21	1,09
Hymenachne acutigluma	8.540	3.139,30	9,06	5.900	2.181,82	6,29
Hymenachne amplexicaulis	4.860	577,40	1,67	3.200	489,28	1,41
Oryza rufipogon	4.690	1.462,80	4,22	4.420	1.421,03	4,10
Rhynchospora corymbosa L	1.510	441,80	1,28	250	77,88	0,22
Sesbania exasperata	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 (Matulessy 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} $year^{-1}$ $harvest^{-1}$ 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 bioslury 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 CO_2 (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.

ACKNOWLEDGEMENTS

The authors express their deepest gratitude to the Rector of Sriwijaya University, Palembang, Indonesia through the Chair of the Institute for Research and Community Services by funding this research with the Competitive Leading Research Contract of Sriwijaya University No. 988 / UN9.3.1 / PP / 2017, dated 21 July 2017.

REFERENCES

Abdullah, M., Rafay, M., Sial, N., F. Rasheed, F., Nawaz M.F., Nouman, W., Ahmad, I., Ruby, T and Khalil, S. 2017. Determination of forage productivity, carrying capacity and palatability of browse vegetation in arid rangelands of Cholistan Desert (Pakistan). Applied Ecology and Environmental Research. 15 (4): 623-637. http://dx.doi.org/10.15666/aeer/1504_623637.

Ali AIM, Sandi S., Muhakka dan Riswandi. 2012. *The quality of forage feed of the swampy lowland of Pampangan buffalo pasture*. Prosiding InSINAS 2012. 307-312.

BPS (Central Statistics Agency). 2010. Directorate General of Food. Swamp lowland Area of Indonesia. Agriculture Department. Jakarta.

BPS (Central Statistics Agency). South Sumatra Province. 2014. South Sumatra in Value Provinsi Sumatera Selatan. 2014.

Badgery WB, Millar GD, Broadfoot K, Michalk DL, Cranney P, Mitchell D, Van de Ven R. 2017. Increased production and cover in a variable native pasture following intensive grazing management. Animal Production Science. (57): 1812–1823.

Center for Agricultural Technology Assessment in South Sumatra. 2011. Pampangan buffalo as South Sumatra's Nutfah plasm. bptp-sumsel@litbang.deptan.go.id.

Camarao AP, Rodrigues Filho JA. 2001. Botanical composition of the available forage and the diet of water buffalo grazing native pastures of the medium Amazon region, Brazil. Buffalo Journal. 3: 307–316.

Cheng D, Peili S, Xianzhou Z, Ning Z, Xi C, Shoubao G, Wanrui Z. 2017. The Rangeland livestock carrying capacity and Stocking rate in the Kailash Sacred Landscape in China. Journal of Resources and Ecology. 8 (6): 551-558.

Damry. 2009. Production and content of forage nutrition of natural pasture of North Lore Subdistrict of Poso District. Jurnal Agroland. 16 (4): 296-300. [Indonesian]

Daru TP, Suhardi, Yusuf R., Wibowo A, Pujowati P. 2012. Carrying capacity of feed forage on the ruminants development in West Kutai District. Jurnal Teknologi Pertanian 8(1): 30-36. [Indonesian]

Daru TP, Yulianti A, Widodo E. 2014. Forage potential of palmoil plantation as beef cattle feed in Kutai Kartanegara District. Media Sains. 7: 79-86. [Indonesian]

Delima M, Karim A, Yunus M. 2015. Study of feed forage production potency on existing areas potential to increase ruminant livestock population in Aceh Besar District. Jurnal Agripet 15 (1): 33-40. [Indonesian]

Dwyanto K, Handiwirawan E. 2006. Strategy of buffalo cattle development: network and distribution aspects. Pros. National Workshop of Buffalo Cattle Business to Support the Beef Adequacy Program. Sumbawa, 4-5 August 2006. Center for Animal Husbandry Research and Development in cooperation with the Directorate of Nursery, Director General of Animal Husbandry of West Nusa Tenggara Province, Mataram. [Indonesian]

Edvan RL, Bezerra LR, Marques CAT, Carneiro MSS, Oliveira RL, Ferreira RR. 2016. Methods for estimating forage mass in pastures in a tropical climate. Revista de Ciências Agrárias 39(1): 36-45.

Eoh M. 2014. Carrying capacity and composition of feed substance of buffalo pasture of Pulau Moa. Agrinimal 4 (2): 77-82.

Hashemi N. 2017. Recognizing the potential of sustainable use of pasture resources in South Khorasan Province with approach of carrying capacity. Environ Ecosyst Sci 1 (2): 9-12.

Jarmani SN, Haryanto B. 2015. Improving productivity of animal feed forage to support buffalo pasture capacity of Kampar District of Riau (A suggestion of thought). Jurnal Pastura 4 (2): 95-99. [Indonesian]

Jefferya RP, Simpsona RJ, Lambersc H, Orcharda S, Kidda DR, Halingb RE, Ryana MH. 2018. Contrasting communities of arbuscular-forming root symbionts change external critical phosphorus requirements of some annual pasture legumes. Applied Soil Ecology. xxx (xxx): 9-10.(https://doi.org/10.1016/j.apsoil.).

Jung-Feng S, Guo MX, Lian, JR, Xiaobin P, Guo WY, Ping CX. 2010. Gene expression profile of response to water stress at the jointing stage in wheat. Agricultural Science in China. 9 (3): 323-330.

Karti PDMH, Abdullah L, Prihantoro I. 2015. Exploration and productivity of pastures of East Pamona Subdistrict of Poso District of Mid Sulawesi. Jurnal Pastura 4 (2): 91-94. [Indonesian]

Kleden MM., Ratu MRD, Randu MDS. 2015. Feed forage carrying capacity in coffee plantation areas and natural pasture of East Flores District of East Nusa Tenggara. Jurnal Zootek35 (2): 340-350. [Indonesian]

Kumalasari NR, Sunardi. 2015. Variety of feed forage potential vegetation in rice field areas of different height conditions. Jurnal Pastura 4 (2): 59-61. [Indonesian]

Lakitan B. 1995. *Plant physiology and plant development*. Raja Grafindo Persada. Jakarta. [Indonesian]

Manu AE. 2013. Productivity of sabana pasture of West Timor. Jurnal Pastura. 3 (1): 25-29.

Muhajirin, Despal, Khalil. 2017. Pemenuhan kebutuhan nutrien sapi potong bibit yang digembalakan Fulfilling the nutrient needs of grazed nursery beef cattle of Padang Mengatas. Buletin Makanan Ternak.104(1): 9-20. [Indonesian]

Muhakka, Riswandi, Ali AIM. 2013. Morphological and Reproductive Characteristics of Pampangan Buffaloes of South Sumatra Province. Jurnal Sain Peternakan Indonesia 8 (8): 89-106. [Indonesian]

Mulyani A, Sarwani M. 2013. Characteristics and potential of sub-optimal land for agricultural development. Jurnal Sumberdaya Lahan. 7 (1): 47-55. [Indonesian]

Oktaviani SI, Santri DJ, Dayat E. 2015. Diversity of swamp vegetation of Tanjung Lago Subdistrict. Jurnal Lahan Suboptimal 4 (2) :133-148. [Indonesian]

Omokanye A, Yoder C, Sreekumar L, Vihvelin L, Benoit M. 2018. Forage production and Economic performance of pasture rejuvenation methods in Northern Alberta, Canada. Suit Agric Res . 7 (2): 94-110.

Parmadi JC EH, Dewiyanti I, Karina S. 2016. Important value index of mangrove vegetation in Kuala Idi area, East Aceh District. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah.1 (1): 82-95.

Praptiwi II, Susanti DS, Damayanti AT, Mangera Y. 2017. The potential of various vegetation species as animal feed forage in the pasture of Sota Village of Merauke District. Agricola. 7 (1): 15-24. [Indonesian]

Purnomo J. 2006. Animal Feed Forage in Indonesia. Jakarta. [Indonesian]Agricultural Research and Development Agency of the Ministry of Agriculture

Purwantari ND, Tiesnamurti B, Adinata Y. 2015. Availability of forage sources in palm oil plantations for cattle grazing. Watazoa. 25 (1): 47-54.

Rinduwati., Hasan S, Syamsu JA, Useng D. 2016. Carrying capacity and botanical diversity of pastoral range in Gowa Regency. Intl J Sci: Basic Appl Res 29 (3) : 105 - 111.

Rohaeni ES, Darmawan A, Qomariah R, Hamdan A, Subhan A. 2005. Inventory and Characterization of Swamp Buffaloes as Germplasm. Report of Study Result. Balai Pengkajian Teknologi Pertanian (BPTP) Kalimantan Selatan. Banjarbaru. [Indonesian]

Rostini T, Abdullah L, Wiryawan KG, Karti PDMH. 2014. Production and nutrition potency of swamp local forage in South Kalimantan as ruminant feed. Glob J Anim Sci Livestock Prod Anim Breed 2 (2):107-113.

Salendu AHS, Elly FH. 2014. Potential development of forage for cattle under the coconut trees in Lolayan Subdistrict of Bolaang Mongondow District. Jurnal Pastura 4 (1): 7-10. [Indonesian]

Samin AN, Chairul, Mukhtar E. 2016. Analysis of coastal vegetation in tourist area of Pasir Jambak, Kota Padang. Jurnal Biocelebes 10 (2): 32-42. [Indonesian]

Se'u VE, Kartib PDMH, Abdullah L. 2015. Botanical composition, grass production, and carrying capacity of pasture in Timor Tengah Selatan District. Media Peternakan 38 (3):176-182. [Indonesian]

South Sumatra Animal Husbandry Statistics. 2014. South Sumatra Province Animal Husbandry Office 2015 Budget Year: 14.

Suarna IW, Budiasa IKM. 2016. Effect of organic fertilizers on the production and quality of mixed pasture on the dry land of Sebudi Karangase Village. Majalah Ilmiah Peternakan. 19 (3): 125-128.
Sutaryo D. 2009. Calculation of Biomass. An Introduction to the Study of Carbon and Carbon Trading. Wetlands International Indonesia Programme, Bogor.
Suveltri B, Syam Z, Solfiyeni. 2014. Analysis of weed vegetation in plantations of maize (Zea mays L) on maximum tillage in District of Lima Puluh Kota. Jurnal Biologi Universitas Andalas (J. Bio. UA.) 3(2): 103-108. [Indonesian]
Syarifuddin H. 2011. Composition and Structure of animal feed forage under the trees of palm oil plantation. Agrinak. 1 (1): 25-30.
Taiz L, Zeiger E. 2002. *Plant Physiology*. 3 rd ed. Sinauer Association, Inc., New York.
Thalib C, Herawati T, Hastono. 2014. Strategy of increasing buffalo productivity through the improvement of feed and genetics. Wartazoa 24 (2): 83-96.
Yoku O, Supriyantono A, Widayati T, Sumpe I. 2014. Production of natural pasture and potency of Balinese cow development in supporting the meat adequacy program in West Papua. Jurnal Pastura 3 (2): 102 – 105. [Indonesian]
Yoku O, Supriyantono A, Widayati T, Sumpe I. 2015. Composition of botany and distribution of local forage species of natural pasture in West Papua. Jurnal Pastura 4 (2): 62– 65. [Indonesian]
Yasin S. 2013. Eating behavior of ruminants as phenology bioindicators and dynamics of pasture. Jurnal Pastura 3 (1) : 1–4. [Indonesian]

BIODIVERSITAS
Volume 20, Number 4, April 2019
Pages: xxxx

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d2004xx

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

MUHAKKA[1,2,♥], RUJITO AGUSSUWIGNYO[3], DEDIK BUDIANTA[4], YAKUP[3]
[1]Graduate School, Universitas Sriwijaya. Jl. Padang Selasa No. 524, Palembang 30139, South Sumatera, Indonesia. Tel./fax.: +62-711-581106. [♥]email: muhakka@fp.unsri.ac.id
[2]Department of Animal Husbandry, Faculty of Agriculture, Universitas Sriwijaya. Jl. Palembang-Prabumulih Km. 32, Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia
[3]Department of Agronomy, Faculty of Agriculture, Universitas Sriwijaya. Jl. Palembang-Prabumulih Km. 32 Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia
[4]Department of Soil Science, Faculty of Agriculture, Universitas Sriwijaya. Jl. Palembang-Prabumulih Km. 32 Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia

Manuscript received: 4 January 2018. Revision accepted: xxx March 2019.

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 assistanceThis study aims to analyze vegetation structure of non-tidal swampland in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin Distruct, 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 rupifogon)*, 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 $AU.ha^{-1}.year^{-1}$ on coffee plantation and 0.38 $AU.ha^{-1}.year^{-1}$ on grassland (Kleden et al. 2015). Another study investigating carrying capacity of livestock forage during preproduction of rubber (juvenile plants) is 0.14 AU. $ha^{-1}.year^{-1}$, while during rubber production (mature plants) can only accommodate 0.06 AU. $ha^{-1}.year^{-1}$ (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.

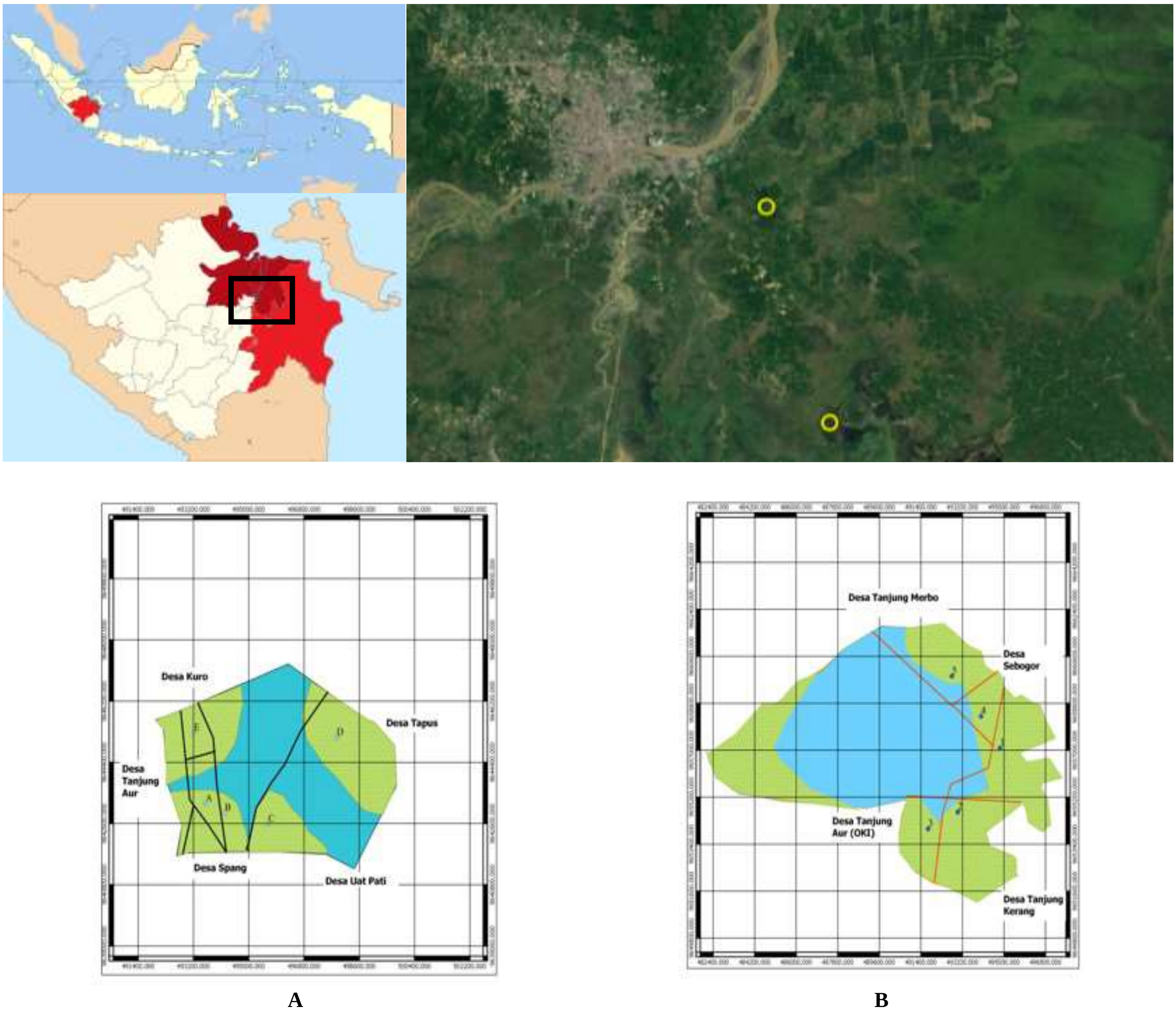


Figure 1. Research location in South Sumatera, Indonesia. A. Pulau Layang Village, Pampangan Sub-district, Ogan Komering Ilir District, South Sumatra, B. Rambutan Village, Rambutan Sub-district, Banyuasin District, South Sumatra

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:

IVI = Relative Density + 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
∑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).

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

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

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 $AU^{-1}day^{-1}$

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	
Catharanthus roseus	Tapak dara	+	-	NDP
Cyperus cephalotes	Apit-apit	+	-	NDP
Cyperus digitatus	Kasuran	-	+	NDP
Digitaria fuscescens	Pasiran / Kerak maling	+	+	DP
Eichhornia crassipes	Eceng gondok	+	-	NDP
Eleocharis dulcis	Purun tikus	+	+	DP
Hymenachne acutigluma	Kumpai tembaga	+	+	DP
Hymenachne amplexicaulis	Kumpai minyak	+	+	DP
Hymenachne sp.	Kumpai merah	+	-	NDP
Ipomoea aquatica	Kangkung merah	+	-	NDP
Leersia hexandra	Bento rayap	+	+	DP
Ludwigia hyssopifolia	Cecengkehan	+	-	ND
Neptunia oleracea	Kemon air	+	-	NDP
Nymphaea odorata Aiton	Telepuk Padi	+	-	NDP
Nymphaea lotus	Telepuk Gajah	+	-	NDP
Oryza rufipogon	Kumpai padi	+	+	DP
Polygonum barbatum	Are bolong	+	-	DNP
Rhynchospora corymbosa	Berondong	-	+	ND
Sesbania exasperata	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 (%)
Catharanthus roseus	0,08	2,50	0,06	3,65	6,15	-	-	-	-	-
Cyperus cephalotes	-	-	-	-	-	0,16	8,42	0,12	9,52	17,94
Digitaria fuscescens	-	-	-	-	-	0,16	8,42	0,12	9,52	17,94
Eichhornia crassipes	0,48	15,00	0,20	12,19	27,19	0,18	9,47	0,08	6,34	15,82
Eleocharis dulcis	0,16	5,00	0,14	8,53	13,53	-	-	-	-	-
Hymenachne acutigluma	0,22	6,87	0,12	7,31	14,19	0,12	6,31	0,12	9,52	15,84
Hymenachne amplexicaulis	0,20	6,25	0,10	6,09	12,34	0,14	7,36	0,08	6,34	13,71
Hymenachne sp.	0,46	14,37	0,18	10,97	25,35	0,20	10,52	0,12	9,52	20,05
Ipomoea aquatica	0,04	1,25	0,04	2,43	3,68	-	-	-	-	-
Leersia hexandra	0,06	1,87	0,04	2,43	4,31	0,12	6,31	0,10	7,93	14,25
Ludwigia hyssopifolia	0,18	5,62	0,06	3,65	9,28	0,16	8,42	0,08	6,34	14,77
Neptunia oleracea	0,56	17,50	0,32	19,51	37,01	0,38	20,00	0,24	19,04	39,04
Nymphaea odorata	0,02	0,62	0,02	1,22	1,84	-	-	-	-	-
Nymphaea lotus	0,02	0,62	0,02	1,22	1,84	-	-	-	-	-
Oryza rufipogon	0,18	5,62	0,08	4,87	10,50	-	-	-	-	-
Polygonum barbatum	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 (%)
Cyperus digitatus	0,88	18,03	0,30	14,85	32.88	0,12	5,31	0,06	4,34	9,65[4]
Eleocharis dulcis	1,68	34,42	0,74	36,63	71,06	1,00	44,24	0,62	44,92	89,17[1]
Digitaria fuscescens	1,10	22,54	0,40	19,80	42,34	0,40	1,77	0,22	15,94	17,71[3]
Hymenachne acutigluma	0,04	0,82	0,02	0,99	1,81	0,02	0,88	0,02	1,44	2,33[8]
Hymenachne amplexicaulis	0,04	0,82	0,02	0,99	1,81	0,04	1,77	0,02	1,44	3,21[7]
Leersia hexandra	0,06	1,23	0,04	1,98	3,21	0,04	1,77	0,04	2,89	4,65[5]
Oryza rufipogon	0,80	16,39	0,40	19,80	36,19	0,60	26,54	0,38	27,53	54,08[2]
Rhynchospora corymbosa	0,08	1,63	0,04	1,98	3,61	0,04	1,77	0,02	1,44	3,21[6]
Sesbania exasperata	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 ($AU.ha^{-1}.year^{-1}$)
Catharanthus roseus	7.530	977,40	2,82	-	-	-
Cyperus cephalotes	-	-	-	4.580	1.145,00[4]	3,30
Digitaria fuscescens	-	-	-	2.420	537,97[10]	1,55
Eichhornia crassipes	5.940	1.097,70	3,17	4.700	830,49[6]	2,40
Eleocharis dulcis	12.640	2.664,50	7,69	-	-	-
Hymenachne acutigluma	6.700	1.352,70	3,90	7.480	1.632,54[1]	4,71
Hymenachne amplexicaulis	6.650	790,00	2,28	5.990	729,58[8]	2,11
Hymenachne sp.	7.040	1.151,70	3,32	5.720	975,83[5]	2,82
Ipomoea aquatica	4.020	604,60	1,75	-	-	-
Leersia hexandra	4.740	1.232,40	3,56	5.290	1.385,45[2]	4,00
Ludwigia hyssopifolia	1.980	346,90	1,00	4.290	777,35[7]	2,24
Neptunia oleracea	1.910	394,80	1,14	2.870	607,01[9]	1,75
Nymphaea odorata	7.500	1.286,30	3,71	-	-	-
Nymphaea lotus	9.800	1.983,50	5,72	-	-	-
Oryza rufipogon	12.960	2.225,20	6,42	-	-	-
Polygonum barbatum	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 ($AU.ha^{-1}.year^{-1}$)
Cyperus digitatus	2.590	248,90	0,72	240	28,61	0,08
Digitaria fuscescens	790	108,00	0,31	1.100	152,79	0,44
Eleocharis dulcis	4.370	921,20	2,66	1.700	376,21	1,09
Hymenachne acutigluma	8.540	3.139,30	9,06	5.900	2.181,82	6,29
Hymenachne amplexicaulis	4.860	577,40	1,67	3.200	489,28	1,41
Oryza rufipogon	4.690	1.462,80	4,22	4.420	1.421,03	4,10
Rhynchospora corymbosa	1.510	441,80	1,28	250	77,88	0,22
Sesbania exasperata	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 (Matulessy 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} $year^{-1}$ $harvest^{-1}$ 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 bioslury 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 CO_2 (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.

ACKNOWLEDGEMENTS

The authors express their deepest gratitude to the Rector of Sriwijaya University, Palembang, Indonesia through the Chair of the Institute for Research and Community Services by funding this research with the Competitive Leading Research Contract of Sriwijaya University No. 988 / UN9.3.1 / PP / 2017, dated 21 July 2017.

REFERENCES

Abdullah, M., Rafay, M., Sial, N., F. Rasheed, F., Nawaz M.F., Nouman, W., Ahmad, I., Ruby, T and Khalil, S. 2017. Determination of forage productivity, carrying capacity and palatability of browse vegetation in arid rangelands of Cholistan Desert (Pakistan). Applied Ecology and Environmental Research. 15 (4): 623-637. http://dx.doi.org/10.15666/aeer/1504_623637.

Ali AIM, Sandi S., Muhakka dan Riswandi. 2012. *The quality of forage feed of the swampy lowland of Pampangan buffalo pasture*. Prosiding InSINAS 2012. 307-312.

BPS (Central Statistics Agency). 2010. Directorate General of Food. Swamp lowland Area of Indonesia. Agriculture Department. Jakarta.

BPS (Central Statistics Agency). South Sumatra Province. 2014. South Sumatra in Value Provinsi Sumatera Selatan. 2014.

Badgery WB, Millar GD, Broadfoot K, Michalk DL, Cranney P, Mitchell D, Van de Ven R. 2017. Increased production and cover in a variable native pasture following intensive grazing management. Animal Production Science. (57): 1812–1823.

Center for Agricultural Technology Assessment in South Sumatra. 2011. Pampangan buffalo as South Sumatra's Nutfah plasm. bptp-sumsel@litbang.deptan.go.id.

Camarao AP, Rodrigues Filho JA. 2001. Botanical composition of the available forage and the diet of water buffalo grazing native pastures of the medium Amazon region, Brazil. Buffalo Journal. 3: 307–316.

Cheng D, Peili S, Xianzhou Z, Ning Z, Xi C, Shoubao G, Wanrui Z. 2017. The Rangeland livestock carrying capacity and Stocking rate in the Kailash Sacred Landscape in China. Journal of Resources and Ecology. 8 (6): 551-558.

Damry. 2009. Production and content of forage nutrition of natural pasture of North Lore Subdistrict of Poso District. Jurnal Agroland. 16 (4): 296-300. [Indonesian]

Daru TP, Suhardi, Yusuf R., Wibowo A, Pujowati P. 2012. Carrying capacity of feed forage on the ruminants development in West Kutai District. Jurnal Teknologi Pertanian 8(1): 30-36. [Indonesian]

Daru TP, Yulianti A, Widodo E. 2014. Forage potential of palmoil plantation as beef cattle feed in Kutai Kartanegara District. Media Sains. 7: 79-86. [Indonesian]

Delima M, Karim A, Yunus M. 2015. Study of feed forage production potency on existing areas potential to increase ruminant livestock population in Aceh Besar District. Jurnal Agripet 15 (1): 33-40. [Indonesian]

Dwyanto K, Handiwirawan E. 2006. Strategy of buffalo cattle development: network and distribution aspects. Pros. National Workshop of Buffalo Cattle Business to Support the Beef Adequacy Program. Sumbawa, 4-5 August 2006. Center for Animal Husbandry Research and Development in cooperation with the Directorate of Nursery, Director General of Animal Husbandry of West Nusa Tenggara Province, Mataram. [Indonesian]

Edvan RL, Bezerra LR, Marques CAT, Carneiro MSS, Oliveira RL, Ferreira RR. 2016. Methods for estimating forage mass in pastures in a tropical climate. Revista de Ciências Agrárias 39(1): 36-45.

Eoh M. 2014. Carrying capacity and composition of feed substance of buffalo pasture of Pulau Moa. Agrinimal 4 (2): 77-82.

Hashemi N. 2017. Recognizing the potential of sustainable use of pasture resources in South Khorasan Province with approach of carrying capacity. Environ Ecosyst Sci 1 (2): 9-12.

Jarmani SN, Haryanto B. 2015. Improving productivity of animal feed forage to support buffalo pasture capacity of Kampar District of Riau (A suggestion of thought). Jurnal Pastura 4 (2): 95-99. [Indonesian]

Jefferya RP, Simpsona RJ, Lambersc H, Orcharda S, Kidda DR, Halingb RE, Ryana MH. 2018. Contrasting communities of arbuscular-forming root symbionts change external critical phosphorus requirements of some annual pasture legumes. Applied Soil Ecology. xxx (xxx): 9-10.(https://doi.org/10.1016/j.apsoil.).

Jung-Feng S, Guo MX, Lian, JR, Xiaobin P, Guo WY, Ping CX. 2010. Gene expression profile of response to water stress at the jointing stage in wheat. Agricultural Science in China. 9 (3): 323-330.

Karti PDMH, Abdullah L, Prihantoro I. 2015. Exploration and productivity of pastures of East Pamona Subdistrict of Poso District of Mid Sulawesi. Jurnal Pastura 4 (2): 91-94. [Indonesian]

Kleden MM., Ratu MRD, Randu MDS. 2015. Feed forage carrying capacity in coffee plantation areas and natural pasture of East Flores District of East Nusa Tenggara. Jurnal Zootek35 (2): 340-350. [Indonesian]

Kumalasari NR, Sunardi. 2015. Variety of feed forage potential vegetation in rice field areas of different height conditions. Jurnal Pastura 4 (2): 59-61. [Indonesian]

Lakitan B. 1995. *Plant physiology and plant development*. Raja Grafindo Persada. Jakarta. [Indonesian]

Manu AE. 2013. Productivity of sabana pasture of West Timor. Jurnal Pastura. 3 (1): 25-29.

Muhajirin, Despal, Khalil. 2017. Pemenuhan kebutuhan nutrien sapi potong bibit yang digembalakan Fulfilling the nutrient needs of grazed nursery beef cattle of Padang Mengatas. Buletin Makanan Ternak.104(1): 9-20. [Indonesian]

Muhakka, Riswandi, Ali AIM. 2013. Morphological and Reproductive Characteristics of Pampangan Buffaloes of South Sumatra Province. Jurnal Sain Peternakan Indonesia 8 (8): 89-106. [Indonesian]

Mulyani A, Sarwani M. 2013. Characteristics and potential of sub-optimal land for agricultural development. Jurnal Sumberdaya Lahan. 7 (1): 47-55. [Indonesian]

Oktaviani SI, Santri DJ, Dayat E. 2015. Diversity of swamp vegetation of Tanjung Lago Subdistrict. Jurnal Lahan Suboptimal 4 (2) :133-148. [Indonesian]

Omokanye A, Yoder C, Sreekumar L, Vihvelin L, Benoit M. 2018. Forage production and Economic performance of pasture rejuvenation methods in Northern Alberta, Canada. Suit Agric Res . 7 (2): 94-110.

Parmadi JC EH, Dewiyanti I, Karina S. 2016. Important value index of mangrove vegetation in Kuala Idi area, East Aceh District. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah.1 (1): 82-95.

Praptiwi II, Susanti DS, Damayanti AT, Mangera Y. 2017. The potential of various vegetation species as animal feed forage in the pasture of Sota Village of Merauke District. Agricola. 7 (1): 15-24. [Indonesian]

Purnomo J. 2006. Animal Feed Forage in Indonesia. Jakarta. [Indonesian]Agricultural Research and Development Agency of the Ministry of Agriculture

Purwantari ND, Tiesnamurti B, Adinata Y. 2015. Availability of forage sources in palm oil plantations for cattle grazing. Watazoa. 25 (1): 47-54.

Rinduwati., Hasan S, Syamsu JA, Useng D. 2016. Carrying capacity and botanical diversity of pastoral range in Gowa Regency. Intl J Sci: Basic Appl Res 29 (3) : 105 - 111.

Rohaeni ES, Darmawan A, Qomariah R, Hamdan A, Subhan A. 2005. Inventory and Characterization of Swamp Buffaloes as Germplasm. Report of Study Result. Balai Pengkajian Teknologi Pertanian (BPTP) Kalimantan Selatan. Banjarbaru. [Indonesian]

Rostini T, Abdullah L, Wiryawan KG, Karti PDMH. 2014. Production and nutrition potency of swamp local forage in South Kalimantan as ruminant feed. Glob J Anim Sci Livestock Prod Anim Breed 2 (2):107-113.

Salendu AHS, Elly FH. 2014. Potential development of forage for cattle under the coconut trees in Lolayan Subdistrict of Bolaang Mongondow District. Jurnal Pastura 4 (1): 7-10. [Indonesian]

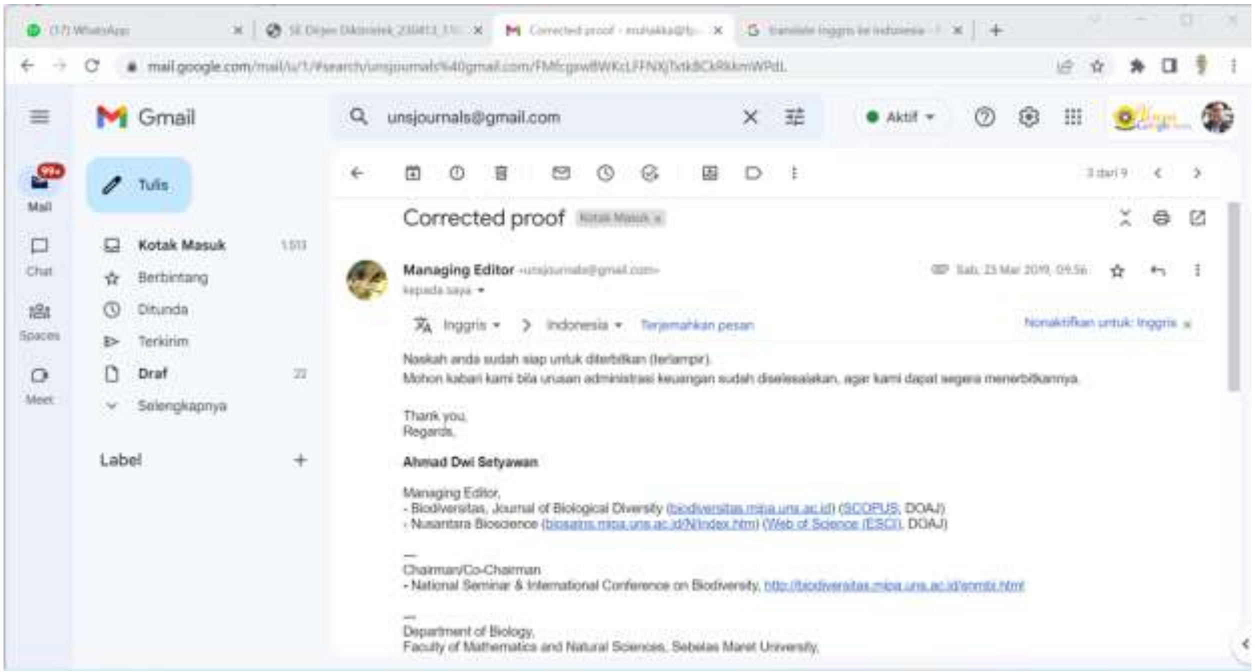
Samin AN, Chairul, Mukhtar E. 2016. Analysis of coastal vegetation in tourist area of Pasir Jambak, Kota Padang. Jurnal Biocelebes 10 (2): 32-42. [Indonesian]

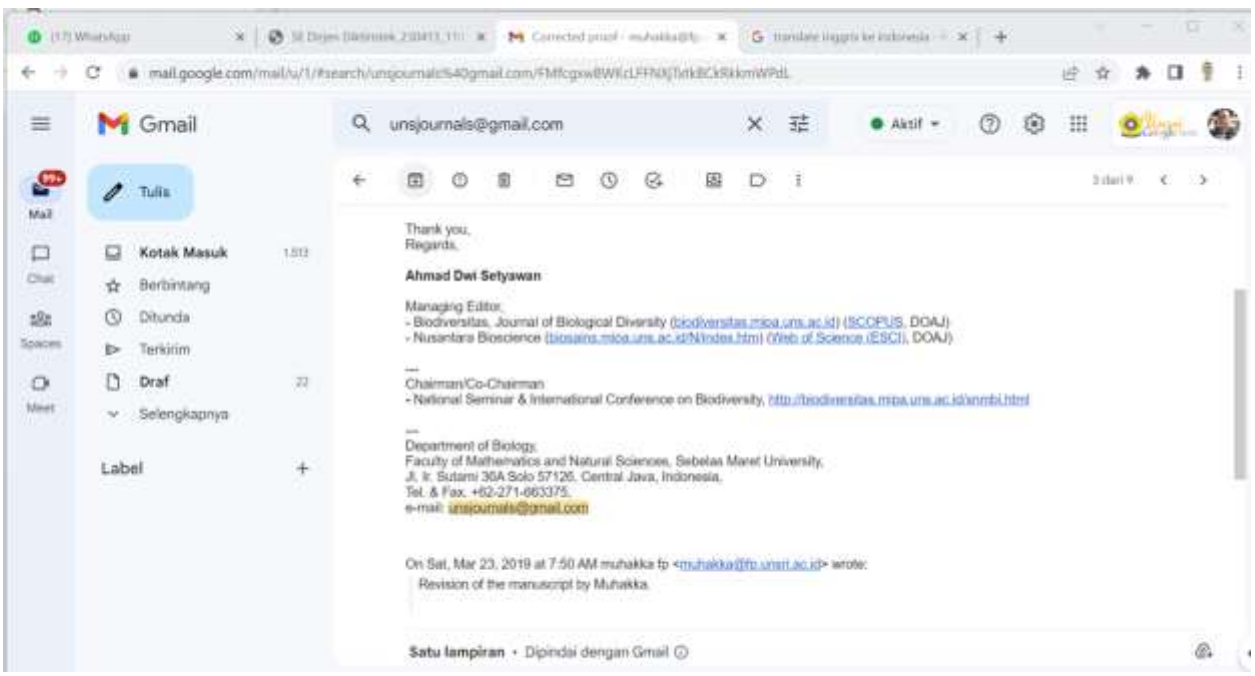
Se'u VE, Kartib PDMH, Abdullah L. 2015. Botanical composition, grass production, and carrying capacity of pasture in Timor Tengah Selatan District. Media Peternakan 38 (3):176-182. [Indonesian]

South Sumatra Animal Husbandry Statistics. 2014. South Sumatra Province Animal Husbandry Office 2015 Budget Year: 14.

Suarna IW, Budiasa IKM. 2016. Effect of organic fertilizers on the production and quality of mixed pasture on the dry land of Sebudi Karangase Village. Majalah Ilmiah Peternakan. 19 (3): 125-128.
Sutaryo D. 2009. Calculation of Biomass. An Introduction to the Study of Carbon and Carbon Trading. Wetlands International Indonesia Programme, Bogor.
Suveltri B, Syam Z, Solfiyeni. 2014. Analysis of weed vegetation in plantations of maize (Zea mays L) on maximum tillage in District of Lima Puluh Kota. Jurnal Biologi Universitas Andalas (J. Bio. UA.) 3(2): 103-108. [Indonesian]
Syarifuddin H. 2011. Composition and Structure of animal feed forage under the trees of palm oil plantation. Agrinak. 1 (1): 25-30.
Taiz L, Zeiger E. 2002. *Plant Physiology*. 3 rd ed. Sinauer Association, Inc., New York.
Thalib C, Herawati T, Hastono. 2014. Strategy of increasing buffalo productivity through the improvement of feed and genetics. Wartazoa 24 (2): 83-96.
Yoku O, Supriyantono A, Widayati T, Sumpe I. 2014. Production of natural pasture and potency of Balinese cow development in supporting the meat adequacy program in West Papua. Jurnal Pastura 3 (2): 102 – 105. [Indonesian]
Yoku O, Supriyantono A, Widayati T, Sumpe I. 2015. Composition of botany and distribution of local forage species of natural pasture in West Papua. Jurnal Pastura 4 (2): 62– 65. [Indonesian]
Yasin S. 2013. Eating behavior of ruminants as phenology bioindicators and dynamics of pasture. Jurnal Pastura 3 (1) : 1–4. [Indonesian]

6. Bukti konfirmasi artikel accepted (23 Maret 2019)


Gmail
unsjournals@gmail.com
Aktif
Tulis
Mail
Chat
Spaces
Meet
Kotak Masuk
Berbintang
Ditunda
Terkirim
Draf
Selengkapnya
Label
Corrected proof
Managing Editor
kepada saya
Inggris
Indonesia
Terjemahkan pesan
Naskah anda sudah siap untuk diterbitkan (terlampir).
Mohon kabari kami bila urusan administrasi keuangan sudah diselesaikan, agar kami dapat segera menerbitkannya.
Thank you,
Regards,
Ahmad Dwi Setyawan
Managing Editor,
- Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id) (SCOPUS, DOAJ)
- Nusantara Bioscience (biosains.mipa.uns.ac.id/N/index.htm) (Web of Science (ESCI), DOAJ)
Chairman/Co-Chairman
- National Seminar & International Conference on Biodiversity, http://biodiversitas.mipa.uns.ac.id/snmbi.html
Department of Biology,
Faculty of Mathematics and Natural Sciences, Sebelas Maret University,


Gmail
unsjournals@gmail.com
Aktif
Tulis
Mail
Chat
Spaces
Meet
Kotak Masuk
Berbintang
Ditunda
Terkirim
Draf
Selengkapnya
Label
Thank you,
Regards,
Ahmad Dwi Setyawan
Managing Editor,
- Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id) (SCOPUS, DOAJ)
- Nusantara Bioscience (biosains.mipa.uns.ac.id/N/index.htm) (Web of Science (ESCI), DOAJ)
Chairman/Co-Chairman
- National Seminar & International Conference on Biodiversity, http://biodiversitas.mipa.uns.ac.id/snmbi.html
Department of Biology,
Faculty of Mathematics and Natural Sciences, Sebelas Maret University,
Jl. Ir. Sutami 36A Solo 57126, Central Java, Indonesia,
Tel. & Fax. +62-271-663375,
e-mail: unsjournals@gmail.com
On Sat, Mar 23, 2019 at 7:50 AM muhakka fp <muhakka@fp.unsri.ac.id> wrote:
Revision of the manuscript by Muhakka.
Satu lampiran · Dipindai dengan Gmail

BIODIVERSITAS
Volume 20, Number 4, April 2019
Pages: 1069-1078

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d200419

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

MUHAKKA[1,2,♥], RUJITO AGUSSUWIGNYO[3], DEDIK BUDIANTA[4], YAKUP[3]
[1]Graduate School, Universitas Sriwijaya. Jl. Padang Selasa No. 524, Palembang 30139, South Sumatera, Indonesia. Tel./fax.: +62-711-581106.
♥email: muhakka@fp.unsri.ac.id
[2]Department of Animal Husbandry, Faculty of Agriculture, Universitas Sriwijaya. Jl. Palembang-Prabumulih Km. 32, Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia
[3]Department of Agronomy, Faculty of Agriculture, Universitas Sriwijaya. Jl. Palembang-Prabumulih Km. 32 Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia
[4]Department of Soil Science, Faculty of Agriculture, Universitas Sriwijaya. Jl. Palembang-Prabumulih Km. 32 Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia

Manuscript received: 4 January 2018. Revision accepted: 23 March 2019.

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 assistanceThis study aims to analyze vegetation structure of non-tidal swampland in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin Distruct, 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 rupifogon)*, 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).

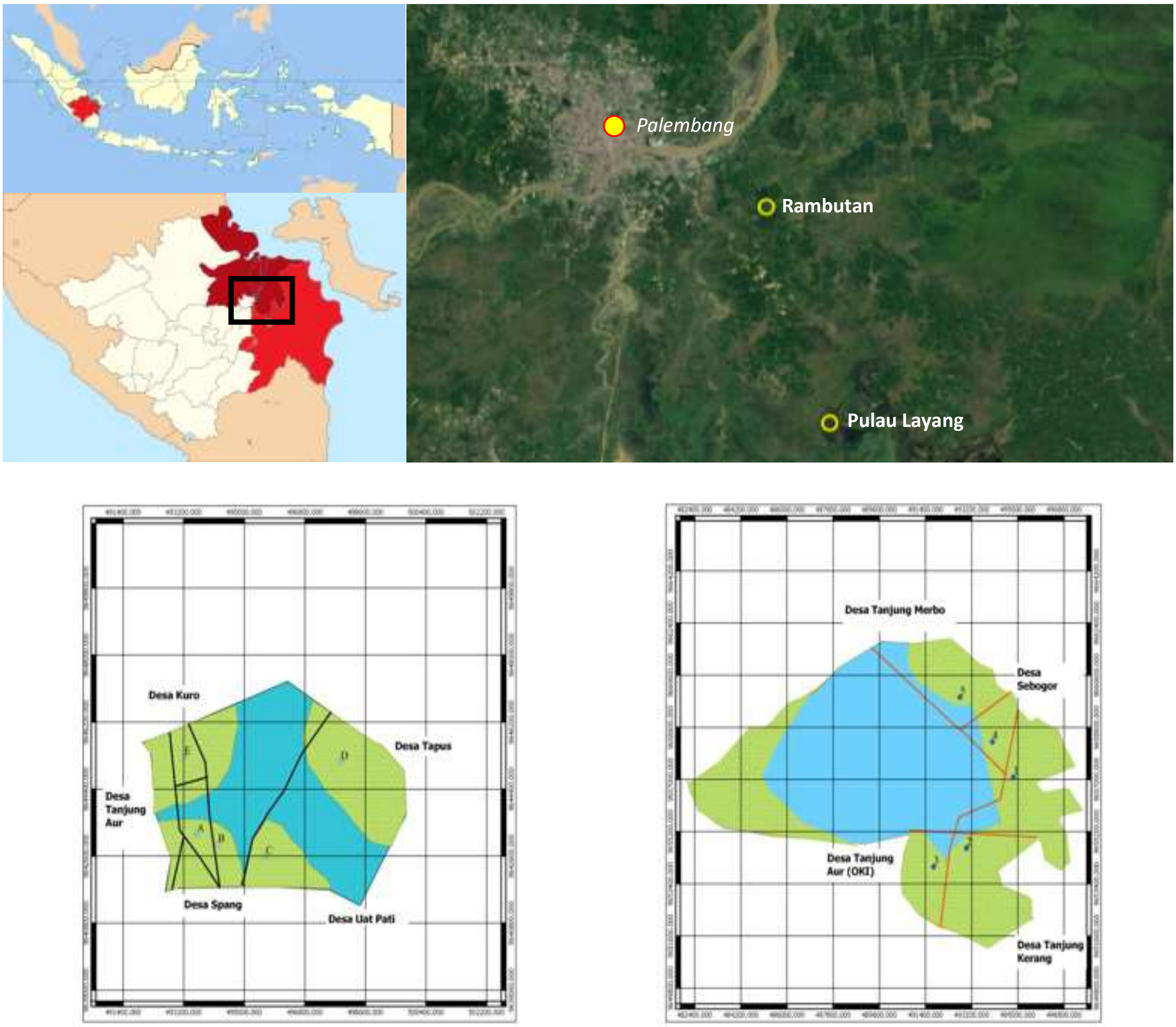
Pampangan buffalo is potential germplasm of South Sumatra Province which is widely found and extensively farmed in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin District (Muhakka et al. 2013). In addition to being farmed for their meat, the buffalo also produce milk 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 AU.ha^{-1}.year^{-1} on coffee plantation and 0.38 AU.ha^{-1}.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 AU. ha^{-1}.year^{-1}, while during rubber production (mature plants) can only accommodate 0.06 AU. ha^{-1}.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.



A **B**

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:

IVI = Relative Density + 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
∑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).

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

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

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 $AU^{-1}day^{-1}$

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	
Catharanthus roseus	Tapak dara	+	-	NDP
Cyperus cephalotes	Apit-apit	+	-	NDP
Cyperus digitatus	Kasuran	-	+	NDP
Digitaria fuscescens	Pasiran/Kerak maling	+	+	DP
Eichhornia crassipes	Eceng gondok	+	-	NDP
Eleocharis dulcis	Purun tikus	+	+	DP
Hymenachne acutigluma	Kumpai tembaga	+	+	DP
Hymenachne amplexicaulis	Kumpai minyak	+	+	DP
Hymenachne sp.	Kumpai merah	+	-	NDP
Ipomoea aquatica	Kangkung merah	+	-	NDP
Leersia hexandra	Bento rayap	+	+	DP
Ludwigia hyssopifolia	Cecengkehan	+	-	ND
Neptunia oleracea	Kemon air	+	-	NDP
Nymphaea lotus	Telepuk Gajah	+	-	NDP
Nymphaea odorata	Telepuk Padi	+	-	NDP
Oryza rufipogon	Kumpai padi	+	+	DP
Polygonum barbatum	Are bolong	+	-	DNP
Rhynchospora corymbosa	Berondong	-	+	ND
Sesbania exasperata	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 (%)
Catharanthus roseus	0.08	2.50	0.06	3.65	6.15	-	-	-	-	-
Cyperus cephalotes	-	-	-	-	-	0.16	8.42	0.12	9.52	17.94
Digitaria fuscescens	-	-	-	-	-	0.16	8.42	0.12	9.52	17.94
Eichhornia crassipes	0.48	15.00	0.20	12.19	27.19	0.18	9.47	0.08	6.34	15.82
Eleocharis dulcis	0.16	5.00	0.14	8.53	13.53	-	-	-	-	-
Hymenachne acutigluma	0.22	6.87	0.12	7.31	14.19	0.12	6.31	0.12	9.52	15.84
Hymenachne amplexicaulis	0.20	6.25	0.10	6.09	12.34	0.14	7.36	0.08	6.34	13.71
Hymenachne sp.	0.46	14.37	0.18	10.97	25.35	0.20	10.52	0.12	9.52	20.05
Ipomoea aquatica	0.04	1.25	0.04	2.43	3.68	-	-	-	-	-
Leersia hexandra	0.06	1.87	0.04	2.43	4.31	0.12	6.31	0.10	7.93	14.25
Ludwigia hyssopifolia	0.18	5.62	0.06	3.65	9.28	0.16	8.42	0.08	6.34	14.77
Neptunia oleracea	0.56	17.50	0.32	19.51	37.01	0.38	20.00	0.24	19.04	39.04
Nymphaea lotus	0.02	0.62	0.02	1.22	1.84	-	-	-	-	-
Nymphaea odorata	0.02	0.62	0.02	1.22	1.84	-	-	-	-	-
Oryza rufipogon	0.18	5.62	0.08	4.87	10.50	-	-	-	-	-
Polygonum barbatum	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 (%)
Cyperus digitatus	0.88	18.03	0.30	14.85	32.88	0.12	5.31	0.06	4.34	9.65[4]
Digitaria fuscescens	1.10	22.54	0.40	19.80	42.34	0.40	1.77	0.22	15.94	17.71[3]
Eleocharis dulcis	1.68	34.42	0.74	36.63	71.06	1.00	44.24	0.62	44.92	89.17[1]
Hymenachne acutigluma	0.04	0.82	0.02	0.99	1.81	0.02	0.88	0.02	1.44	2.33[8]
Hymenachne amplexicaulis	0.04	0.82	0.02	0.99	1.81	0.04	1.77	0.02	1.44	3.21[7]
Leersia hexandra	0.06	1.23	0.04	1.98	3.21	0.04	1.77	0.04	2.89	4.65[5]
Oryza rufipogon	0.80	16.39	0.40	19.80	36.19	0.60	26.54	0.38	27.53	54.08[2]
Rhynchospora corymbosa	0.08	1.63	0.04	1.98	3.61	0.04	1.77	0.02	1.44	3.21[6]
Sesbania exasperata	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 ($AU.ha^{-1}.year^{-1}$)
Catharanthus roseus	7,530	977.40	2.82	-	-	-
Cyperus cephalotes	-	-	-	4,580	1,145.00[4]	3.30
Digitaria fuscescens	-	-	-	2,420	537.97[10]	1.55
Eichhornia crassipes	5,940	1,097.70	3.17	4,700	830.49[6]	2.40
Eleocharis dulcis	12,640	2,664.50	7.69	-	-	-
Hymenachne acutigluma	6,700	1,352.70	3.90	7,480	1,632.54[1]	4.71
Hymenachne amplexicaulis	6,650	790.00	2.28	5,990	729.58[8]	2.11
Hymenachne sp.	7,040	1,151.70	3.32	5,720	975.83[5]	2.82
Ipomoea aquatica	4,020	604.60	1.75	-	-	-
Leersia hexandra	4,740	1,232.40	3.56	5,290	1,385.45[2]	4.00
Ludwigia hyssopifolia	1,980	346.90	1.00	4,290	777.35[7]	2.24
Neptunia oleracea	1,910	394.80	1.14	2,870	607.01[9]	1.75
Nymphaea lotus	9,800	1,983.50	5.72	-	-	-
Nymphaea odorata	7,500	1,286.30	3.71	-	-	-
Oryza rufipogon	12,960	2,225.20	6.42	-	-	-
Polygonum barbatum	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 ($AU.ha^{-1}.year^{-1}$)
Cyperus digitatus	2,590	248.90	0.72	240	28.61	0.08
Digitaria fuscescens	790	108.00	0.31	1,100	152.79	0.44
Eleocharis dulcis	4,370	921.20	2.66	1,700	376.21	1.09
Hymenachne acutigluma	8,540	3,139.30	9.06	5,900	2,181.82	6.29
Hymenachne amplexicaulis	4,860	577.40	1.67	3,200	489.28	1.41
Oryza rufipogon	4,690	1,462.80	4.22	4,420	1,421.03	4.10
Rhynchospora corymbosa	1,510	441.80	1.28	250	77.88	0.22
Sesbania exasperata	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).* 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 (Matulessy 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} 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 bioslury 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 CO_2 (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.

ACKNOWLEDGEMENTS

The authors express their deepest gratitude to the Rector of Sriwijaya University, Palembang, Indonesia through the Chair of the Institute for Research and Community Services by funding this research with the Competitive Leading Research Contract of Sriwijaya University No. 988/UN9.3.1/PP/2017, dated 21 July 2017.

REFERENCES

Abdullah, M., Rafay, M., Sial, N., F. Rasheed, F., Nawaz M.F., Nouman, W., Ahmad, I., Ruby, T and Khalil, S. 2017. Determination of forage productivity, carrying capacity and palatability of browse vegetation in arid rangelands of Cholistan Desert (Pakistan). Appl Ecol Environ Res 15 (4): 623-637.

Ali AIM, Sandi S, Muhakka, Riswandi. 2012. The quality of forage feed of the swampy lowland of Pampangan buffalo pasture. Prosiding InSINAS 2012. 307-312.

Badgery WB, Millar GD, Broadfoot K, Michalk DL, Cranney P, Mitchell D, Van de Ven R. 2017. Increased production and cover in a variable native pasture following intensive grazing management. Anim Prod Sci 57: 1812-1823.

BPS [Central Statistics Agency]. 2010. Swamp lowland Area of Indonesia. Directorate General of Food, Ministry of Agriculture and Central Statistics Agency Jakarta.

BPS [Central Statistics Agency]. 2014. South Sumatra in Figure 2015. Central Statistics Agency of South Sumatra Province, Palembang.

Camarao AP, Rodrigues Filho JA. 2001. Botanical composition of the available forage and the diet of water buffalo grazing native pastures of the medium Amazon region, Brazil. Buffalo J 3: 307-316.

Center for Agricultural Technology Assessment in South Sumatra. 2011. Pampangan buffalo as South Sumatra's Nutfah plasm. Center for Agricultural Technology Assessment in South Sumatra, Palembang.

Cheng D, Peili S, Xianzhou Z, Ning Z, Xi C, Shoubao G, Wanrui Z. 2017. The rangeland livestock carrying capacity and stocking rate in the Kailash Sacred Landscape in China. J Resour Ecol 8 (6): 551-558.

Damry. 2009. Production and content of forage nutrition of natural pasture of North Lore Subdistrict of Poso District. Jurnal Agroland 16 (4): 296-300. [Indonesian]

Daru TP, Suhardi, Yusuf R., Wibowo A, Pujowati P. 2012. Carrying capacity of feed forage on the ruminants development in West Kutai District. Jurnal Teknologi Pertanian 8 (1): 30-36. [Indonesian]

Daru TP, Yulianti A, Widodo E. 2014. Forage potential of palmoil plantation as beef cattle feed in Kutai Kartanegara District. Media Sains 7: 79-86. [Indonesian]

Delima M, Karim A, Yunus M. 2015. Study of feed forage production potency on existing areas potential to increase ruminant livestock population in Aceh Besar District. Jurnal Agripet 15 (1): 33-40. [Indonesian]

Dwyanto K, Handiwirawan E. 2006. Strategy of buffalo cattle development: network and distribution aspects. Pros. National Workshop of Buffalo Cattle Business to Support the Beef Adequacy Program. Sumbawa, 4-5 August 2006. Center for Animal Husbandry Research and Development in cooperation with the Directorate of Nursery, Director General of Animal Husbandry of West Nusa Tenggara Province, Mataram. [Indonesian]

Edvan RL, Bezerra LR, Marques CAT, Carneiro MSS, Oliveira RL, Ferreira RR. 2016. Methods for estimating forage mass in pastures in a tropical climate. Revista de Ciências Agrárias 39 (1): 36-45.

Eoh M. 2014. Carrying capacity and composition of feed substance of buffalo pasture of Pulau Moa. Agrinimal 4 (2): 77-82.

Hashemi N. 2017. Recognizing the potential of sustainable use of pasture resources in South Khorasan Province with approach of carrying capacity. Environ Ecosyst Sci 1 (2): 9-12.

Jarmani SN, Haryanto B. 2015. Improving productivity of animal feed forage to support buffalo pasture capacity of Kampar District of Riau (A suggestion of thought). Jurnal Pastura 4 (2): 95-99. [Indonesian]

Jefferya RP, Simpsona RJ, Lambersc H, Orcharda S, Kidda DR, Halingb RE, Ryana MH. 2018. Contrasting communities of arbuscular-forming root symbionts change external critical phosphorus requirements of some annual pasture legumes. Appl Soil Ecol. DOI: 10.1016/j.apsoil.

Jung-Feng S, Guo MX, Lian, JR, Xiaobin P, Guo WY, Ping CX. 2010. Gene expression profile of response to water stress at the jointing stage in wheat. Agric Sci China 9 (3): 323-330.

Karti PDMH, Abdullah L, Prihantoro I. 2015. Exploration and productivity of pastures of East Pamona Subdistrict of Poso District of Mid Sulawesi. Jurnal Pastura 4 (2): 91-94. [Indonesian]

Kleden MM., Ratu MRD, Randu MDS. 2015. Feed forage carrying capacity in coffee plantation areas and natural pasture of East Flores District of East Nusa Tenggara. Jurnal Zootek 35 (2): 340-350. [Indonesian]

Kumalasari NR, Sunardi. 2015. Variety of feed forage potential vegetation in rice field areas of different height conditions. Jurnal Pastura 4 (2): 59-61. [Indonesian]

Lakitan B. 1995. Plant Physiology and Plant Development. Raja Grafindo Persada, Jakarta. [Indonesian]

Manu AE. 2013. Productivity of sabana pasture of West Timor. Jurnal Pastura 3 (1): 25-29.

Muhajirin, Despal, Khalil. 2017. Pemenuhan kebutuhan nutrien sapi potong bibit yang digembalakan Fulfilling the nutrient needs of grazed nursery beef cattle of Padang Mengatas. Buletin Makanan Ternak 104 (1): 9-20. [Indonesian]

Muhakka, Riswandi, Ali AIM. 2013. Morphological and reproductive characteristics of Pampangan Buffaloes of South Sumatra Province. Jurnal Sain Peternakan Indonesia 8 (8): 89-106. [Indonesian]

Mulyani A, Sarwani M. 2013. Characteristics and potential of sub-optimal land for agricultural development. Jurnal Sumberdaya Lahan 7 (1): 47-55. [Indonesian]

Oktaviani SI, Santri DJ, Dayat E. 2015. Diversity of swamp vegetation of Tanjung Lago Subdistrict. Jurnal Lahan Suboptimal 4 (2): 133-148. [Indonesian]

Omokanye A, Yoder C, Sreekumar L, Vihvelin L, Benoit M. 2018. Forage production and Economic performance of pasture rejuvenation methods in Northern Alberta, Canada. Suit Agric Res 7 (2): 94-110.

Parmadi JC EH, Dewiyanti I, Karina S. 2016. Important value index of mangrove vegetation in Kuala Idi area, East Aceh District. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah 1 (1): 82-95.

Praptiwi II, Susanti DS, Damayanti AT, Mangera Y. 2017. The potential of various vegetation species as animal feed forage in the pasture of Sota Village of Merauke District. Agricola 7 (1): 15-24. [Indonesian]

Purnomo J. 2006. Animal Feed Forage in Indonesia. Jakarta. [Indonesian]Agricultural Research and Development Agency of the Ministry of Agriculture

Purwantari ND, Tiesnamurti B, Adinata Y. 2015. Availability of forage sources in palm oil plantations for cattle grazing. Watazoa 25 (1): 47-54.

Rinduwati., Hasan S, Syamsu JA, Useng D. 2016. Carrying capacity and botanical diversity of pastoral range in Gowa Regency. Intl J Sci: Basic Appl Res 29 (3) : 105-111.

Rohaeni ES, Darmawan A, Qomariah R, Hamdan A, Subhan A. 2005. Inventory and characterization of swamp buffaloes as germplasm. [Research Report]. Center for Agricultural Technology Assessment in South Kalimantan, Banjarbaru. [Indonesian]

Rostini T, Abdullah L, Wiryawan KG, Karti PDMH. 2014. Production and nutrition potency of swamp local forage in South Kalimantan as ruminant feed. Glob J Anim Sci Livestock Prod Anim Breed 2 (2): 107-113.

Salendu AHS, Elly FH. 2014. Potential development of forage for cattle under the coconut trees in Lolayan Subdistrict of Bolaang Mongondow District. Jurnal Pastura 4 (1): 7-10. [Indonesian]

Samin AN, Chairul, Mukhtar E. 2016. Analysis of coastal vegetation in tourist area of Pasir Jambak, Kota Padang. Jurnal Biocelebes 10 (2): 32-42. [Indonesian]

Se'u VE, Kartib PDMH, Abdullah L. 2015. Botanical composition, grass production, and carrying capacity of pasture in Timor Tengah Selatan District. Media Peternakan 38 (3):176-182. [Indonesian]

South Sumatra Province Animal Husbandry Office. 2014. South Sumatra Animal Husbandry Statistics in 2014. South Sumatra Province Animal Husbandry Office, Palembang.

Suarna IW, Budiasa IKM. 2016. Effect of organic fertilizers on the production and quality of mixed pasture on the dry land of Sebudi Karangase Village. Majalah Ilmiah Peternakan 19 (3): 125-128.

Sutaryo D. 2009. Calculation of Biomass. An Introduction to the Study of Carbon and Carbon Trading. Wetlands International Indonesia Programme, Bogor.

Suveltri B, Syam Z, Solfiyeni. 2014. Analysis of weed vegetation in plantations of maize (*Zea mays* L.) on maximum tillage in District of Lima Puluh Kota. Jurnal Biologi Universitas Andalas (J Bio UA) 3 (2): 103-108. [Indonesian]

Syarifuddin H. 2011. Composition and Structure of animal feed forage under the trees of palm oil plantation. Agrinak 1 (1): 25-30.

Taiz L, Zeiger E. 2002. Plant Physiology. 3 rd ed. Sinauer, New York.

Thalib C, Herawati T, Hastono. 2014. Strategy of increasing buffalo productivity through the improvement of feed and genetics. Wartazoa 24 (2): 83-96.

Yasin S. 2013. Eating behavior of ruminants as phenology bioindicators and dynamics of pasture. Jurnal Pastura 3 (1) : 1-4. [Indonesian]

Yoku O, Supriyantono A, Widayati T, Sumpe I. 2014. Production of natural pasture and potency of Balinese cow development in supporting the meat adequacy program in West Papua. Jurnal Pastura 3 (2): 102-105. [Indonesian]

Yoku O, Supriyantono A, Widayati T, Sumpe I. 2015. Composition of botany and distribution of local forage species of natural pasture in West Papua. Jurnal Pastura 4 (2): 62-65. [Indonesian]

7. Bukti konfirmasi artikel published online (1 April 2019)

BIODIVERSITAS
Volume 20, Number 4, April 2019
Pages: 1077-1086

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d200420

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

MUHAKKA[1,2,♥], RUJITO AGUS SUWIGNYO[3], DEDIK BUDIANTA[4], YAKUP[3]
[1]Graduate School, Universitas Sriwijaya. Jl. Padang Selasa No. 524, Palembang 30139, South Sumatra, Indonesia. Tel./fax.: +62-711-581106.
♥email: muhakka@fp.unsri.ac.id
[2]Department of Animal Husbandry, Faculty of Agriculture, Universitas Sriwijaya. Jl. Palembang-Prabumulih Km. 32, Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia
[3]Department of Agronomy, Faculty of Agriculture, Universitas Sriwijaya. Jl. Palembang-Prabumulih Km. 32 Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia
[4]Department of Soil Science, Faculty of Agriculture, Universitas Sriwijaya. Jl. Palembang-Prabumulih Km. 32 Inderalaya, Ogan Ilir 30662, South Sumatra, Indonesia

Manuscript received: 4 January 2018. Revision accepted: 23 March 2019.

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).

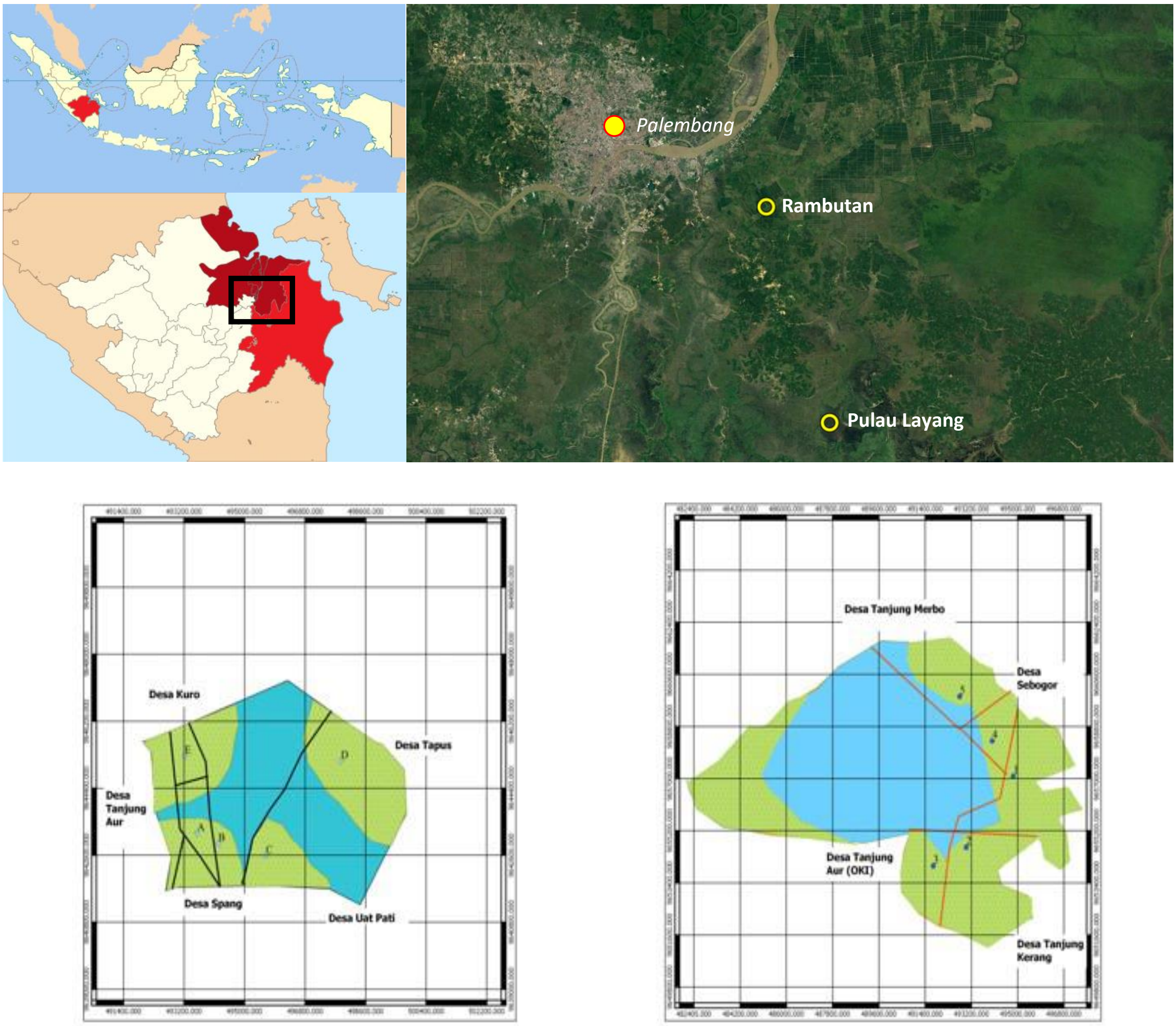
Pampangan buffalo is potential germplasm of South Sumatra Province which is widely found and extensively farmed in Pulau Layang Village, Ogan Komering Ilir District and Rambutan Village, Banyuasin District (Muhakka et al. 2013). In addition to being farmed for their meat, the buffalo also produce milk 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 $AU.ha^{-1}.year^{-1}$ on coffee plantation and 0.38 $AU.ha^{-1}.year^{-1}$ on grassland (Kleden et al. 2015). Another study investigating carrying capacity of livestock forage during preproduction of rubber (juvenile plants) is 0.14 $AU. ha^{-1}.year^{-1}$, while during rubber production (mature plants) can only accommodate 0.06 $AU. ha^{-1}.year^{-1}$ (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.



A B

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:

IVI = Relative Density + 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).

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

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

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 $AU^{-1}day^{-1}$

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	
Catharanthus roseus	Tapak dara	+	-	NDP
Cyperus cephalotes	Apit-apit	+	-	NDP
Cyperus digitatus	Kasuran	-	+	NDP
Digitaria fuscescens	Pasiran/Kerak maling	+	+	DP
Eichhornia crassipes	Eceng gondok	+	-	NDP
Eleocharis dulcis	Purun tikus	+	+	DP
Hymenachne acutigluma	Kumpai tembaga	+	+	DP
Hymenachne amplexicaulis	Kumpai minyak	+	+	DP
Hymenachne sp.	Kumpai merah	+	-	NDP
Ipomoea aquatica	Kangkung merah	+	-	NDP
Leersia hexandra	Bento rayap	+	+	DP
Ludwigia hyssopifolia	Cecengkehan	+	-	ND
Neptunia oleracea	Kemon air	+	-	NDP
Nymphaea lotus	Telepuk Gajah	+	-	NDP
Nymphaea odorata	Telepuk Padi	+	-	NDP
Oryza rufipogon	Kumpai padi	+	+	DP
Polygonum barbatum	Are bolong	+	-	DNP
Rhynchospora corymbosa	Berondong	-	+	ND
Sesbania exasperata	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 (%)
Catharanthus roseus	0.08	2.50	0.06	3.65	6.15	-	-	-	-	-
Cyperus cephalotes	-	-	-	-	-	0.16	8.42	0.12	9.52	17.94
Digitaria fuscescens	-	-	-	-	-	0.16	8.42	0.12	9.52	17.94
Eichhornia crassipes	0.48	15.00	0.20	12.19	27.19	0.18	9.47	0.08	6.34	15.82
Eleocharis dulcis	0.16	5.00	0.14	8.53	13.53	-	-	-	-	-
Hymenachne acutigluma	0.22	6.87	0.12	7.31	14.19	0.12	6.31	0.12	9.52	15.84
Hymenachne amplexicaulis	0.20	6.25	0.10	6.09	12.34	0.14	7.36	0.08	6.34	13.71
Hymenachne sp.	0.46	14.37	0.18	10.97	25.35	0.20	10.52	0.12	9.52	20.05
Ipomoea aquatica	0.04	1.25	0.04	2.43	3.68	-	-	-	-	-
Leersia hexandra	0.06	1.87	0.04	2.43	4.31	0.12	6.31	0.10	7.93	14.25
Ludwigia hyssopifolia	0.18	5.62	0.06	3.65	9.28	0.16	8.42	0.08	6.34	14.77
Neptunia oleracea	0.56	17.50	0.32	19.51	37.01	0.38	20.00	0.24	19.04	39.04
Nymphaea lotus	0.02	0.62	0.02	1.22	1.84	-	-	-	-	-
Nymphaea odorata	0.02	0.62	0.02	1.22	1.84	-	-	-	-	-
Oryza rufipogon	0.18	5.62	0.08	4.87	10.50	-	-	-	-	-
Polygonum barbatum	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 (%)
Cyperus digitatus	0.88	18.03	0.30	14.85	32.88	0.12	5.31	0.06	4.34	9.65[4]
Digitaria fuscescens	1.10	22.54	0.40	19.80	42.34	0.40	1.77	0.22	15.94	17.71[3]
Eleocharis dulcis	1.68	34.42	0.74	36.63	71.06	1.00	44.24	0.62	44.92	89.17[1]
Hymenachne acutigluma	0.04	0.82	0.02	0.99	1.81	0.02	0.88	0.02	1.44	2.33[8]
Hymenachne amplexicaulis	0.04	0.82	0.02	0.99	1.81	0.04	1.77	0.02	1.44	3.21[7]
Leersia hexandra	0.06	1.23	0.04	1.98	3.21	0.04	1.77	0.04	2.89	4.65[5]
Oryza rufipogon	0.80	16.39	0.40	19.80	36.19	0.60	26.54	0.38	27.53	54.08[2]
Rhynchospora corymbosa	0.08	1.63	0.04	1.98	3.61	0.04	1.77	0.02	1.44	3.21[6]
Sesbania exasperata	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 ($AU.ha^{-1}.year^{-1}$)
Catharanthus roseus	7,530	977.40	2.82	-	-	-
Cyperus cephalotes	-	-	-	4,580	1,145.00[4]	3.30
Digitaria fuscescens	-	-	-	2,420	537.97[10]	1.55
Eichhornia crassipes	5,940	1,097.70	3.17	4,700	830.49[6]	2.40
Eleocharis dulcis	12,640	2,664.50	7.69	-	-	-
Hymenachne acutigluma	6,700	1,352.70	3.90	7,480	1,632.54[1]	4.71
Hymenachne amplexicaulis	6,650	790.00	2.28	5,990	729.58[8]	2.11
Hymenachne sp.	7,040	1,151.70	3.32	5,720	975.83[5]	2.82
Ipomoea aquatica	4,020	604.60	1.75	-	-	-
Leersia hexandra	4,740	1,232.40	3.56	5,290	1,385.45[2]	4.00
Ludwigia hyssopifolia	1,980	346.90	1.00	4,290	777.35[7]	2.24
Neptunia oleracea	1,910	394.80	1.14	2,870	607.01[9]	1.75
Nymphaea lotus	9,800	1,983.50	5.72	-	-	-
Nymphaea odorata	7,500	1,286.30	3.71	-	-	-
Oryza rufipogon	12,960	2,225.20	6.42	-	-	-
Polygonum barbatum	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 ($AU.ha^{-1}.year^{-1}$)
Cyperus digitatus	2,590	248.90	0.72	240	28.61	0.08
Digitaria fuscescens	790	108.00	0.31	1,100	152.79	0.44
Eleocharis dulcis	4,370	921.20	2.66	1,700	376.21	1.09
Hymenachne acutigluma	8,540	3,139.30	9.06	5,900	2,181.82	6.29
Hymenachne amplexicaulis	4,860	577.40	1.67	3,200	489.28	1.41
Oryza rufipogon	4,690	1,462.80	4.22	4,420	1,421.03	4.10
Rhynchospora corymbosa	1,510	441.80	1.28	250	77.88	0.22
Sesbania exasperata	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).* 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 (Matulessy 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} $year^{-1}$ $harvest^{-1}$ 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 bioslury 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 CO_2 (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.

ACKNOWLEDGEMENTS

The authors express their deepest gratitude to the Rector of Sriwijaya University, Palembang, Indonesia through the Chair of the Institute for Research and Community Services by funding this research with the Competitive Leading Research Contract of Sriwijaya University No. 988/UN9.3.1/PP/2017, dated 21 July 2017.

REFERENCES

Abdullah, M., Rafay, M., Sial, N., F. Rasheed, F., Nawaz M.F., Nouman, W., Ahmad, I., Ruby, T and Khalil, S. 2017. Determination of forage productivity, carrying capacity and palatability of browse vegetation in arid rangelands of Cholistan Desert (Pakistan). Appl Ecol Environ Res 15 (4): 623-637.

Ali AIM, Sandi S, Muhakka, Riswandi. 2012. The quality of forage feed of the swampy lowland of Pampangan buffalo pasture. Prosiding InSINAS 2012. 307-312.

Badgery WB, Millar GD, Broadfoot K, Michalk DL, Cranney P, Mitchell D, Van de Ven R. 2017. Increased production and cover in a variable native pasture following intensive grazing management. Anim Prod Sci 57: 1812-1823.

BPS [Central Statistics Agency]. 2010. Swamp lowland Area of Indonesia. Directorate General of Food, Ministry of Agriculture and Central Statistics Agency Jakarta.

BPS [Central Statistics Agency]. 2014. South Sumatra in Figure 2015. Central Statistics Agency of South Sumatra Province, Palembang.

Camarao AP, Rodrigues Filho JA. 2001. Botanical composition of the available forage and the diet of water buffalo grazing native pastures of the medium Amazon region, Brazil. Buffalo J 3: 307-316.

Center for Agricultural Technology Assessment in South Sumatra. 2011. Pampangan buffalo as South Sumatra's Nutfah plasm. Center for Agricultural Technology Assessment in South Sumatra, Palembang.

Cheng D, Peili S, Xianzhou Z, Ning Z, Xi C, Shoubao G, Wanrui Z. 2017. The rangeland livestock carrying capacity and stocking rate in the Kailash Sacred Landscape in China. J Resour Ecol 8 (6): 551-558.

Damry. 2009. Production and content of forage nutrition of natural pasture of North Lore Subdistrict of Poso District. Jurnal Agroland 16 (4): 296-300. [Indonesian]

Daru TP, Suhardi, Yusuf R., Wibowo A, Pujowati P. 2012. Carrying capacity of feed forage on the ruminants development in West Kutai District. Jurnal Teknologi Pertanian 8 (1): 30-36. [Indonesian]

Daru TP, Yulianti A, Widodo E. 2014. Forage potential of palmoil plantation as beef cattle feed in Kutai Kartanegara District. Media Sains 7: 79-86. [Indonesian]

Delima M, Karim A, Yunus M. 2015. Study of feed forage production potency on existing areas potential to increase ruminant livestock population in Aceh Besar District. Jurnal Agripet 15 (1): 33-40. [Indonesian]

Dwyanto K, Handiwirawan E. 2006. Strategy of buffalo cattle development: network and distribution aspects. Pros. National Workshop of Buffalo Cattle Business to Support the Beef Adequacy Program. Sumbawa, 4-5 August 2006. Center for Animal Husbandry Research and Development in cooperation with the Directorate of Nursery, Director General of Animal Husbandry of West Nusa Tenggara Province, Mataram. [Indonesian]

Edvan RL, Bezerra LR, Marques CAT, Carneiro MSS, Oliveira RL, Ferreira RR. 2016. Methods for estimating forage mass in pastures in a tropical climate. Revista de Ciências Agrárias 39 (1): 36-45.

Eoh M. 2014. Carrying capacity and composition of feed substance of buffalo pasture of Pulau Moa. Agrinimal 4 (2): 77-82.

Hashemi N. 2017. Recognizing the potential of sustainable use of pasture resources in South Khorasan Province with approach of carrying capacity. Environ Ecosyst Sci 1 (2): 9-12.

Jarmani SN, Haryanto B. 2015. Improving productivity of animal feed forage to support buffalo pasture capacity of Kampar District of Riau (A suggestion of thought). Jurnal Pastura 4 (2): 95-99. [Indonesian]

Jefferya RP, Simpsona RJ, Lambersc H, Orcharda S, Kidda DR, Halingb RE, Ryana MH. 2018. Contrasting communities of arbuscular-forming root symbionts change external critical phosphorus requirements of some annual pasture legumes. Appl Soil Ecol. DOI: 10.1016/j.apsoil.

Jung-Feng S, Guo MX, Lian, JR, Xiaobin P, Guo WY, Ping CX. 2010. Gene expression profile of response to water stress at the jointing stage in wheat. Agric Sci China 9 (3): 323-330.

Karti PDMH, Abdullah L, Prihantoro I. 2015. Exploration and productivity of pastures of East Pamona Subdistrict of Poso District of Mid Sulawesi. Jurnal Pastura 4 (2): 91-94. [Indonesian]

Kleden MM., Ratu MRD, Randu MDS. 2015. Feed forage carrying capacity in coffee plantation areas and natural pasture of East Flores District of East Nusa Tenggara. Jurnal Zootek 35 (2): 340-350. [Indonesian]

Kumalasari NR, Sunardi. 2015. Variety of feed forage potential vegetation in rice field areas of different height conditions. Jurnal Pastura 4 (2): 59-61. [Indonesian]

Lakitan B. 1995. Plant Physiology and Plant Development. Raja Grafindo Persada, Jakarta. [Indonesian]

Manu AE. 2013. Productivity of sabana pasture of West Timor. Jurnal Pastura 3 (1): 25-29.

Muhajirin, Despal, Khalil. 2017. Pemenuhan kebutuhan nutrien sapi potong bibit yang digembalakan Fulfilling the nutrient needs of grazed nursery beef cattle of Padang Mengatas. Buletin Makanan Ternak 104 (1): 9-20. [Indonesian]

Muhakka, Riswandi, Ali AIM. 2013. Morphological and reproductive characteristics of Pampangan Buffaloes of South Sumatra Province. Jurnal Sain Peternakan Indonesia 8 (8): 89-106. [Indonesian]

Mulyani A, Sarwani M. 2013. Characteristics and potential of sub-optimal land for agricultural development. Jurnal Sumberdaya Lahan 7 (1): 47-55. [Indonesian]

Oktaviani SI, Santri DJ, Dayat E. 2015. Diversity of swamp vegetation of Tanjung Lago Subdistrict. Jurnal Lahan Suboptimal 4 (2): 133-148. [Indonesian]

Omokanye A, Yoder C, Sreekumar L, Vihvelin L, Benoit M. 2018. Forage production and Economic performance of pasture rejuvenation methods in Northern Alberta, Canada. Suit Agric Res 7 (2): 94-110.

Parmadi JC EH, Dewiyanti I, Karina S. 2016. Important value index of mangrove vegetation in Kuala Idi area, East Aceh District. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah 1 (1): 82-95.

Praptiwi II, Susanti DS, Damayanti AT, Mangera Y. 2017. The potential of various vegetation species as animal feed forage in the pasture of Sota Village of Merauke District. Agricola 7 (1): 15-24. [Indonesian]

Purnomo J. 2006. Animal Feed Forage in Indonesia. Jakarta. [Indonesian]Agricultural Research and Development Agency of the Ministry of Agriculture

Purwantari ND, Tiesnamurti B, Adinata Y. 2015. Availability of forage sources in palm oil plantations for cattle grazing. Watazoa 25 (1): 47-54.

Rinduwati., Hasan S, Syamsu JA, Useng D. 2016. Carrying capacity and botanical diversity of pastoral range in Gowa Regency. Intl J Sci: Basic Appl Res 29 (3) : 105-111.

Rohaeni ES, Darmawan A, Qomariah R, Hamdan A, Subhan A. 2005. Inventory and characterization of swamp buffaloes as germplasm. [Research Report]. Center for Agricultural Technology Assessment in South Kalimantan, Banjarbaru. [Indonesian]

Rostini T, Abdullah L, Wiryawan KG, Karti PDMH. 2014. Production and nutrition potency of swamp local forage in South Kalimantan as ruminant feed. Glob J Anim Sci Livestock Prod Anim Breed 2 (2): 107-113.

Salendu AHS, Elly FH. 2014. Potential development of forage for cattle under the coconut trees in Lolayan Subdistrict of Bolaang Mongondow District. Jurnal Pastura 4 (1): 7-10. [Indonesian]

Samin AN, Chairul, Mukhtar E. 2016. Analysis of coastal vegetation in tourist area of Pasir Jambak, Kota Padang. Jurnal Biocelebes 10 (2): 32-42. [Indonesian]

Se'u VE, Kartib PDMH, Abdullah L. 2015. Botanical composition, grass production, and carrying capacity of pasture in Timor Tengah Selatan District. Media Peternakan 38 (3):176-182. [Indonesian]

South Sumatra Province Animal Husbandry Office. 2014. South Sumatra Animal Husbandry Statistics in 2014. South Sumatra Province Animal Husbandry Office, Palembang.

Suarna IW, Budiasa IKM. 2016. Effect of organic fertilizers on the production and quality of mixed pasture on the dry land of Sebudi Karangase Village. Majalah Ilmiah Peternakan 19 (3): 125-128.

Sutaryo D. 2009. Calculation of Biomass. An Introduction to the Study of Carbon and Carbon Trading. Wetlands International Indonesia Programme, Bogor.

Suveltri B, Syam Z, Solfiyeni. 2014. Analysis of weed vegetation in plantations of maize (*Zea mays* L.) on maximum tillage in District of Lima Puluh Kota. Jurnal Biologi Universitas Andalas (J Bio UA) 3 (2): 103-108. [Indonesian]

Syarifuddin H. 2011. Composition and Structure of animal feed forage under the trees of palm oil plantation. Agrinak 1 (1): 25-30.

Taiz L, Zeiger E. 2002. Plant Physiology. 3 rd ed. Sinauer, New York.

Thalib C, Herawati T, Hastono. 2014. Strategy of increasing buffalo productivity through the improvement of feed and genetics. Wartazoa 24 (2): 83-96.

Yasin S. 2013. Eating behavior of ruminants as phenology bioindicators and dynamics of pasture. Jurnal Pastura 3 (1) : 1-4. [Indonesian]

Yoku O, Supriyantono A, Widayati T, Sumpe I. 2014. Production of natural pasture and potency of Balinese cow development in supporting the meat adequacy program in West Papua. Jurnal Pastura 3 (2): 102-105. [Indonesian]

Yoku O, Supriyantono A, Widayati T, Sumpe I. 2015. Composition of botany and distribution of local forage species of natural pasture in West Papua. Jurnal Pastura 4 (2): 62-65. [Indonesian]