Global Journal of Animal Science, Livestock Production and Animal Breeding

ISSN: 2408-5510 Vol. 3 (4), pp. 156-163, June, 2015.

http://www.globalscienceresearchjournals.org/

Full Length Research paper

Biomass production, nutrient quality, and in-vitro digestibility of herbaceous legume

***[1]Sophia Ratnawaty, [2]Hartutik and [3]Siti Chuzaemi**

[1]*Researchers of Assessment Institute of Agricultural Technology East Nusa Tenggara*
[2,3]Lecturer of Faculty of Animal Husbandry, University of Brawijaya, Malang

Accepted 25 May, 2015

Abstract

This study was held in order to investigate biomass production, nutrient quality, and *in-vitro* digestibility of legume in both 90 and 120 days after planting (DAP). The method used was experimental study using Completely Randomized Design (CRD) with 8 herbaceous legume as treatment and 4 replication of soil fertility or in another word 32 trials. At *in-vitro* investigation, method used was CRD with 8 herbaceous legume as treatment and 3 replication of rumen fluid. The results showed that herbaceous legume had very significant different (P<0.01) on Dry Matter (DM), Organic Matter (OM), and Crude Protein (CP) for both 90 and 120 DAP herbaceous legume. The highest production in 90 DAP was *CT cv. Milgarra* (4,577.6 kg DM/ha), while the lowest was *C. molle* (783 kg DM/ha). At 120 DAP, the highest production was *S. seabrana* (6,739.2 kg DM/ha), while the lowest was *LP cv. Highworth* (1,293.6 kg DM/ha). Further investigation reported that herbaceous legume had very significant effect on DM, OM, and CP digestibility for both 90 and 120 DAP. The highest average production of DM, OM, and CP for both 90 and 120 DAP were *CT Q5455* and *CT cv.Milgarra.* Different result was showed by *LP cv.Highworth* and *MB cv.Cadaarga* which declined at 120 DAP. Additionally, *CP cv.Bundey*, *MB cv.Juanita*, *C. molle,* and *S. seabrana* at 120 DAP which was consisten with the production of DM, OM, and CP. In conclusion, herbaceous legume *CT cv. Milgarra*, *CT Q5455* and *S. seabrana* had high productivity (the highest OM digestibility) at 90 and 120 DAP, while highest cumulative forage production were *CT cv. Milgarra, CT Q5455,* and *S. seabrana.*

Keywords: Biomass production, nutrient quality, *in-vitro* digestibility, herbaceous legume

INTRODUCTION

Forages used for cattle in Timor is commonly dominated with native grass which has low productivity. In order to improve forages productivity there are several herbaceous legumes such as *Clitoria ternatea Q5455*, *Clitoria ternatea cv.Milgarra, Centrosema pascuorum cv.Bundey, Centrosema molle* Mart. ex Benth*, Macroptilium bracteatum cv.Juanita, Macroptilium bracteatum cv.Cadarga, Lablab purpureus cv. Highworth*, and *Stylosanthes seabrana*. Those legumes are annual plant and also has the highest production in dry season.

Corresponding author. E-**mail**: sophiaratnawaty@yahoo.com

Thus, these can be used as protein resources in dry season and fertilize the land.

Bohlool *et al.*, (1992) stated that agricultural resources management, for long period of time, need good utilization and effective arrangement from internal resources itself. Economically and also ecologically, nitrogen-binding plant like herbaceous legume help us to improve internal resources for free and also indirectly reducing several cost production such as buying a fertilizer. Furthermore, herbaceous legume has 20-29% protein for ruminant feed and also provide sufficient nitrogen for corn to grow in the next season.

Seran (2008) report that planting corn in former herbaceous legume farm could produce corn seed almost

4.1 ton/hectare without any additional fertilizer. Based on this, herbaceous legume can support the next crop.

MATERIALS AND METHODS

Location

This was held in Experimental Farm of Agricultural Technology Institute East Nusa Tenggara. The land used was 2.2 hectare and had several characteristics as follows: (1) combination of inceptisol with vertisol; and (2) pH neutral or 6.9 to 7.0. Furthermore, based on land classification by Oldeman (1980), this land belong to D4 climate with 3 to 4 months wet season with low rainfall (<1000mm) and average temperature from 27 ^{o}C to 28 ^{o}C.

Sample Preparation

Herbaceous legume plants were harvested at 90 days old and 120 days old using three Pearson square for each experimental unit. Those plants were cut at 3 to 5 cm from surface. Total herbaceous legume plants harvested were 96 square unit. After harvested plants were weighted then sampled into different envelope for every square. Every sample was dried using oven with 60^{o} C temperature then grinded well (particle size 1mm) and saved into envelope until further analyzed.

Biomass Production Measurement

Fresh biomass production is determined by multiplying the average production of biomass each squared for each experimental unit. CP production is determined by multiplying C percentage with DM percentage in fresh biomass. CP production is determined by multiplying CP percentage with dry biomass production.

Chemical Analysis

Nutrient content and nutrient value from herbaceous legume analyzed were DM, OM, CP, Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), cellulose, hemi-cellulose, and lignin. There were also investigation in DM digestibility, OM digestibility, CP digestibility, and Total Digestible Nutrient (TDN). Determining DM, OM, and CP was based on AOAC (2011). More specifically, CP was determined using *Kjeldahl*, while ash was using combustion in the furnace at 550^{o}C. At the same time, DM had been determined using oven drying with 105ºC temperature for 24 hours. NDF and ADF were analyzed based on Goering and Van Soest (1970). DM and OM digestibility were determined using Tilley and Terry (1963) method with several modification by Van der Meer (1980).

Soil Analysis

Soil sampling was done twice, before planting and after herbaceous legume. The purpose of soil sampling was to know soil fertility if there were an introduction of herbaceous legume. Soil sample was collected on 5 spots with 150 cm depth using soil coring which consisted of 6 layer: (1) first layer 0 cm to 15 cm; (2) second layer 15 cm to 30 cm; (3) third layer 30 cm to 60 cm; (4) fourth layer 90 cm to 120 cm; and (5) fifth layer 120 cm to 150 cm. Based on this, there were 30 soil samples from 5 spots. Soil sample collected had been compiled based on layer then analyzed in order to know nitrate content.

Soil nitrate content was determined using RQEASY Nitrate. There were several procedures in order to measure soil nitrate. First, soft soil sample (0.1 mm) collected 10 grams into bottle then diluted with 50 ml water. Second, Soil solution had been shake using shaker with 25^{o} C degrees for 1 hour. Third, soil solution had been centrifuged 4000 rpm for 5 minutes. Fourth, soil solution was filtered using Whattman number 42 paper. Fifth, the clear filtered soil solution was measured using RQEASY Nitrate.

Tilley and Terry Procedure

On in-vitro experiment, the investigation was using Tilley and Terry method with several modification by Van Der Meer (1980). First, samples were incubated 96 hours then dipped into ice in order to stop rumen microbe's growth. Second, it centrifuged 15,000 rpm then filtered using Whatman paper number 41. Third, the residue sample dried using oven with 105^{o}C, while Organic Matter were analyzed after residue sample treated using furnace with 550^{o}C.

Rumen liquid was fast collected and filtered from cow with fistula using double layer muslin cloth then accommodated into the bottle. Those bottle then saved inside thermos with temperature 39^{o} C then distributed to laboratory. After had arrived in laboratory, rumen fluid were diluted into McDougall saliva with 1:4 ratio. The dilution itself was happen under CO_2 flow for one hour. Finally, the diluted rumen liquid was poured into *polypropylene* as much as 50 ml.

Statistical Analysis

This study used experimental method using Completely Randomized Design (CRD) using 8 treatment and 4 replication (8x4). Treatments used were 8 kinds of herbaceous legume, while replication were soil fertility. In total, there were 32 unit trial with each trial was 5x5 m^2.

in-vitro study was also using CRD. On this stage, the investigation was using 8 kinds of herbaceous legume as treatment and 3 sample of rumen fluid as replication (8x3).

Table 1 : Soil Characteristics on Study Location

Soil depth (cm)	pH H_2O	% C.org.	ppm P_2O_5	ml/100 g K	Nitrate/NO_3 before planting (mg/liter)	Nitrate/NO_3 after harvest (mg/liter)	Texture % Sand	% Dust	% Clay
0 – 15	6.9	0.10	43.10	0.42	1.50	5.97	6.57	54.77	38.66
15 – 30	7.2	0.10	24.10	0.30	3.39	4.07	14.21	53.33	32.46
30 – 60	7.5	0.07	32.80	0.36	3.95	4.51	3.31	53.44	43.26
60 – 90	7.5	0.07	6.90	0.36	Low	3.82	4.68	42.12	53.20
90 – 120	7.2	0.03	5.50	0.36	Low	3.51	17.55	29.60	52.85
120 - 150	7.3	0.03	17.20	0.42	Low	2.55	15.33	31.75	52.92

Source: BPTP East Nusa Tenggara Laboratory Analysis, 2011

Table 2: Herbaceous legume production at 90 and 120 DAP

Herbaceous legume	90 DAP kg DM/ha	kg OM/ha	kg CP/ha	120 DAP kg DM/ha	kg OM/ha	kg CP/ha
CT Q 5455	3783.7^{c}± 389.3	3296^{c}±352.9	723.6^{c}±73.4	5690.9^{d}± 294.0	4892.8^{bc}± 437.1	1028.9^{d}± 68.6
CP cv. Bundey	1074.4^{a}±563.4	996.4^{a}±518.4	198.4^{a}±103.6	3923.8^{bc}± 601.3	3689.5^{b}±732.8	712.6^{bc}± 141.0
LP cv. Highworth	3139.3^{bc}±396.4	2746.7^{bc}± 362.3	577.3^{bc}± 72.9	1293.6^{a}± 148,0	1156.9^{a}± 180.1	242.3^{a}± 35.8
MB cv. Juanita	1864^{ab}±343.5	1674.9^{ab}± 306.9	358.6^{ab}±66.1	2528^{ab}±286. 1	2276.8^{a}± 328.7	451.3^{ab}± 65.9
MB cv. Cadaarga	1901^{ab}±478.4	1698.3^{ab}±426. 5	359.2^{ab}±90.4	1476.9^{a}± 262.2	1343.3^{a}± 309.4	273.1^{a}± 62.6
CT cv. Milgarra	4577.6^{c}±1052.0	4124.8^{c}±939.6	847.7^{c}±194.8	5327.9^{cd}± 127.9	4879.7^{bc}± 167.3	971.8^{cd}± 30.1
C. molle	783^{a}±102.6	719^{a}± 89.1	151.1^{a}± 19.2	2272.8^{a}± 308.1	2116.3^{a}± 371.5	408.0^{a}± 71.4
S. seabrana	886.6^{a}±529.7	792.4^{a}± 473.7	156.6^{a}± 93.5	6739.2^{d}± 774.0	6120.1^{c}± 902.6	1224.5^{d}± 181.6

Description: $^{a-d}$ Different Superscript at the same column showed very significant different (P<0.01)

The equation model used in CRD was:

$$Y_{ij} = \mu + \alpha_i + \beta_j + \epsilon_{ij}$$

Description:

Y_{ij} = Result
μ = treatment mean
α_i = Effect of herbaceous legume treatment
ϵ_{ij} = random error treatment i group j

i = 1, 2, 3,4, 5
j = 1, 2, 3

Data was analyzed using analysis of variance with Genstat release 12.2 (2010). If there was significant different result, it will be analyzed using Duncan Test.

RESULTS

Soil Analysis

Soil in study places was neutral with pH 6.9 to 7.3. Additionally, there were several soil characteristics recognized: (1) high dust content; and (2) low organic content. Soil recognized had high dust content because it had 29.60% to 54.77% dust which was the highest then followed by clay (32.46% to 52.92%) then sand (3.31% to17.55%). Soil had low organic content because it had only 0.03% to 0.10%. As additional information, soil had several inorganic content: (1) P_2O_5 5.50 ppm to 43.10 ppm; (2) pottasium 0.30 to 0.42 ml/100 gram soil; and (3) Nitrate 1.50 mg/l to 3.95 mg/l. Nitrate content inside soil was higher after had been planted with herbaceous legume than before (2.55 to 5.97 mg/l vs 1.50mg/l to 3.95 mg/l respectively)

Based on soil characteristics, where study was held, had high dust content followed with sand and clay. The high content of dust described that there was high distribution of soft particle by surface flow. Soil texture was very important because it determined plant growth, such as: (1) cation distribution; (2) soil water flow characteristic; (3) various physical process inside soil; and (4) various chemical process inside soil. The higher sand content inside the soil would result in higher water loss inside it because soil become rougher. In additional, the capability of ion circulation become less at the same situation. Therefore, softer soil needed because of its high capability in both water bend and ion circulation.

Table 3: Proximate analysis of herbaceous legume at 90 and 120 DAP

Herbaceous legume	Dry Matter (%)	Nutrient Content (% DM)				
		Organic Matter	Ash	Crude Protein	Crude Fiber	Crude Fat
90 DAP						
CT Q 5455	26.5	92.44	7.56	18.38	32.99	1.75
CP cv.Bundey	27.5	90.14	9.86	18.52	35.23	1.67
LP cv.Highworth	31.2	87.36	12.64	18.39	27.65	1.94
MB cv.Juanita	31.5	89.88	10.12	19.24	38.32	1.35
MB cv.Cadaarga	28.3	89.51	10.49	18.89	35.82	2.08
CT cv.Millgarra	29.6	92.05	7.95	19.29	32.43	1.69
C. molle	34.2	87.00	13.00	18.86	28.76	1.75
S. seabrana	34.9	89.43	10.57	17.65	30.20	1.72
SEM	**1.08**	**0.68**	**0.68**	**0.19**	**1.30**	**0.08**
120 DAP						
CT Q 5455	22.3	93.84	6.16	18.16	38.03	2.43
CP cv. Bundey	29.2	90.80	9.20	18.24	38.34	2.02
LP cv.Highworth	13.8	92.16	7.84	18.73	32.49	2.66
MB cv.Juanita	20.3	90.62	9.38	18.49	41.27	2.83
MB cv.Cadarga	21.0	89.60	10.40	17.85	41.06	2.62
CT cv.Millgarra	21.3	93.13	6.87	17.95	37.24	2.77
C. molle	27.2	85.26	14.74	18.08	34.51	2.05
S. seabrana	25.1	90.93	9.07	18.17	38.23	2.36
SEM	**1.68**	**0.93**	**0.93**	**0.10**	**1.06**	**1.11**
T test						
90 vs 120	**SN**	**tn**	**tn**	**tn**	**SN**	**SN**

Description: SN : very significant tn: not significant
SN P<0.01 tn P>0.05 SEM = *Standard Error of Mean*
Source: Animal Feed Nutrition and Laboratory Analysis Result, Faculty of Animal Husbandry, Brawijaya, 2011

Production Performance of Herbaceous Legume

Analysis of covariance result showed that kind of herbaceous legume showed highly significant different (P<0.01) on DMr, OM, and CP production in both of 90 and 120 DAP. At 90 DAP, the highest DM production was *CT cv. Milgarra* (4,577.6 kg/hectare), while the lowest was *C. molle* (783 kg/hectare). Meanwhile at 120 DAP, the highest DM production was *S. seabrana* (6,739.2 kg/hectare) and the lowest was *LP cv. Highworth* (1,293.6 kg/hectare).

There was a consistent increase in most of herbaceous legume investigated from 90 to 120 DAP, such as *CT Q5455, CT cv. Milgarra*, *CP cv. Bundey*, *MB cv. Juanita, C. molle*, and *S. seabrana*. Contrary, there were only two kinds of herbaceous legume which decreased from 90 to 120 DAP, *LP cv. Highworth* and *MB cv. Cadaarga.*

Nutrient Content

Based on the content of DM, Crude Fiber (CF), and Crude Fat for different herbaceous legume showed highly significant different (P<0.001) at 90 and 120 DAP, but showed no significant different (P>0.05) on OM, Ash, and CP. Specifically, there was similar content CP on all of herbaceous legume (17.65% to 19.29%). As the additional information, the highest protein content *CT cv. Milgarra* while the lowest was *S seabrana* at 90 DAP. There was the decrease of CP content from 90 to 120 DAP for all herbaceous legume except *S. seabrana* which increase 18.17%. The increase protein content of *S. seabrana* from 90 to 120 DAP because it had higher leaf composition than stalk.

Based on the content of DM, CF, and Crude Fat in herbaceous legume was highly significant different (P<0.01) in 90 with 120 DAP. Contrary, the content of OM, ash, and CP was no significant different (P>0.05) in 90 with 120 DAP. Based on nutrient content, CP was relatively similar (17.65% to 19.29%) for overall herbaceous legume investigated. As the additional information, the lowest crude protein content was in *S seabrana*, while the highest was *CT cv. Milgarra* at 90 DAP. There was the decrease of crude protein content in herbaceous legume at 120 DAP except *S. seabrana* which increased 18.17% because leaf composition on *S. seabrana* was higher than stalk.

Based on the content of NDF, ADF, cellulose, and lignin from eight types of herbaceous legume at 120 days old was significantly different (P <0.01) at 90 DAP. This condition was due on relatively high fiber fraction and also protein content at 120 DAP. NDF content was the highest CF. Component from plant cell wall. CF

Table 4: Herbaceous legume fiber analysis result

Herbaceous legume	NDF (%)	ADF (%)	Hemi cellulose (%)	Cellulose (%)	Silica (%)	Lignin (%)
90 DAP						
CT Q 5455	51.42	37.33	14.09	25.03	0.56	11.74
CP cv.Bundey	56.36	36.45	19.91	24.83	0.48	11.14
LP cv.Highworth	47.65	31.23	16.42	20.09	0.67	10.47
MB cv. Juanita	52.27	35.49	16.78	23.69	0.60	11.21
MB cv. Cadarga	53.84	38.31	15.53	25.85	0.69	11.78
CT cv.Millgarra	51.53	35.96	15.58	23.84	0.72	11.40
C. molle	53.98	31.44	22.54	20.52	0.71	10.20
S. seabrana	47.49	34.10	13.38	21.99	0.61	11.50
SEM	1.09	0.92	1.08	0.76	0.03	0.20
120 DAP						
CT Q 5455	59.22	42.63	16.59	31.17	0.09	11.37
CP cv.Bundey	61.23	41.22	20.10	26.94	0.92	13.36
LP cv.Highworth	61.88	42.08	19.80	30.53	1.10	10.46
MB cv.Juanita	61.86	44.67	17.20	30.55	0.91	13.21
MB cv.Cadarga	60.29	45.50	14.79	29.97	1.30	14.23
CT cv.Millgarra	55.96	39.87	16.09	28.19	0.38	11.30
C. molle	56.68	40.04	16.64	23.73	4.35	11.95
S. seabrana	58.56	43.80	14.76	31.97	0.52	11.32
SEM	0.80	0.73	0.71	0.96	0.47	0.46
T test						
90 vs 120	**SN**	**SN**	**tn**	**SN**	**tn**	**SN**

Description: SN P<0.01 tn P>0.05 SEM = *Standard Error of Mean*
Source: Animal Feed Nutrition and Laboratory Analysis Result, Faculty of Animal Husbandry, Brawijaya, 2011

Table 5: Average *in-vitro* digestibility of herbaceous legume at 90 and 120 DAP

Herbaceous Legume	***In vitro*** **Digestibility (%) 90 DAP**				***In vitro*** **Digestibility (%) 120 DAP**			
	DM	**OM**	**CP**	**TDN**	**DM**	**OM**	**CP**	**TDN**
CT Q 5455	65.92^{a}	66.35^{ab}	59.77^{a}	70.07^{ab}	61.05^{a}	63.28^{c}	60.53^{a}	66.44^{ab}
CP cv. Bundey	68.67^{ab}	66.47^{ab}	56.72^{a}	69.02^{ab}	64.25^{a}	60.60^{bc}	70.62^{a}	63.63^{ab}
LP cvHighworth	74.85^{c}	74.37^{c}	56.72^{a}	78.09^{b}	74.17^{b}	74.65^{d}	57.74^{a}	78.37^{c}
MB cv.Juanita	67.85^{a}	64.80^{ab}	61.28^{a}	66.28^{a}	64.60^{a}	62.98^{c}	62.79^{a}	68.04^{b}
MB cvCadaarga	66.05^{a}	63.10^{a}	61.92^{a}	68.02^{a}	67.10^{a}	64.78^{c}	62.93^{a}	66.13^{ab}
CT cv.Milgarra	67.42^{a}	65.72^{ab}	66.53^{a}	69.37^{ab}	59.90^{a}	55.80^{ab}	67.52^{a}	65.05^{ab}
C. molle	67.67^{a}	66.02^{ab}	61.15^{a}	69.59^{ab}	64.70^{a}	61.92^{bc}	62.16^{a}	66.43^{ab}
S seabrana	73.85^{bc}	70.45^{bc}	58.95^{a}	73.99^{ab}	60.98^{a}	53.73^{a}	59.96^{a}	57.08^{a}

Description: $^{a-c}$:Different Superscript at the same column showed very significant different (P<0.01)
Source: Animal Feed Nutrition and Laboratory Analysis Result, Faculty of Animal Husbandry, Brawijaya, 2011
TDN: OM digestibility *in vitro* x 1.05 (Ibrahim, 1988)

Component was consist of: (1) cellulose; (2) hemicellulose; (3) lignin; (4) silica; and (5) several fibrous protein (Van Soest, 1982), so those nutrients were utilized by rumen microbes for their life.

In-vitro Digestibility

Analysis of variance result showed that 90 DAP herbaceous legumes had significant effect (P<0.05) on

Table 6. Digestible Nutrient Production of Herbaceous legume at 90 and 120 DAP

Herbaceous legume	90 DAP (kg/ha)			120 DAP (kg/ha)		
	DM	OM	CP	DM	OM	CP
CT Q 5455	2511,4[c]	2178,8[b]	418,3[cd]	3456,1[cd]	3066,5[bc]	612,8[bc]
CP cv. Bundey	741,9[a]	664,0[a]	143,3[ab]	2533,2[bc]	2259,1[b]	495,7[b]
LP cvHighworth	2351,8[bc]	2044,9[b]	318,3[bc]	955,8[a]	862,2[a]	143,7[a]
MB cv.Juanita	1263,4[ab]	1084,1[a]	219,6[abc]	1595,0[ab]	1410,0[a]	280,7[a]
MB cv.Cadarga	1301,4[ab]	1113,4[a]	223,2[abc]	1005,5[a]	885,7[a]	169,0[a]
CT cv.Milgarra	3080,8[c]	2702,2[b]	581,7[d]	3182,7[cd]	2732,1[bc]	656,2[bc]
C. molle	535,3[a]	479,0[a]	92,8[a]	1451,2[ab]	1299,4[a]	256,4[a]
S. seabrana	649,8[a]	550,4[a]	90,3[a]	4115,7[d]	3317,6[c]	731,2[c]

Description: [a-d]: Different Superscript at the same column showed very significant different (P<0.01)

DM and OM digestibility, but no significant different (P>0.05) on CP digestibility. At 120 DAP, herbaceous legume had very significant effect (P<0.01) on DM and OM digestibility, but still no significant different (P>0.05) on CP digestibility.

The average of DM and OM digestibility in *LP cv. Highworth* were the highest in both 90 and 120 DAP, while *S seabrana* decreased at 120 DAP. The lowest DM and OM digestibility were *CT Q5455* and *CT cv.Milgarra.* Meanwhile, the highest CP digestibility was on *CP cv.Bundey* then followed by *CT Q5455* and *CT cv.Milgarra*.

Analysis of variance result showed that the type herbaceous legume provided very significant different (P<0.01) on DM, OM, CP digestibility in both 90 and 120 DAP. The highest Average production of DM, OM, CP digestibility were *CT Q5455* and *CT cv.Milgarra* in both 90 and 120 DAP. Average production of DM, OM, CP digestibility of *LP cv.Highworth* and *MB cv.Cadaarga* declined at 120 DAP, while *CP cv.Bundey*, *MB cv.Juanita*, *C. molle* and *S. seabrana* which was consistent with the production of DM, OM, and CP in eight kind of herbaceous legume investigated.

DISCUSSION

Biomass Production

Different morphology makes different production capability among herbaceous legumes. Different morphology are located in the following sections: (1) total remaining buds after cutting; (2) plant height; (3) root size, and (4) regrown bud size. Those condition makes biomass production of *CT Q5455, CT cv. Milgarra* and *S. seabrana* higher at 120 than 90 DAP. These results are different with Ayiyi *et al.,* (2004) that *Lablab purpureus* had 1,000 kg/ha to 5,000 kg/ha at 87 DAP in Limpopo-South Africa. It is also different Clem and Cook (2004) who measured several herbaceous legumes for three years that *Lablab purpureus* 3,863 kg/ha had declined into 59 kg/ha except *Stylosanthes scabra* which had increased from 2,045kg/ha.

There were various herbaceous legume productions reported by several study (Gonzalez-Andres dan Ortiz, 1996[b]; Karachi *et al.,* 1997; and Larbi *et al.*, 2000). Those conditions was caused by different physiology such as leaf area index, leaf water relations, reserve carbohydrates in plants, and water use efficiency (Stur *et al.*, 1994). Furthermore, productions were also affected by total remaining buds after cutting; plant height; root size, and regrown bud size (Gonzalez-Andres dan Ortiz, 1996[a]; Oppong *et al.,* 2002). Lefi *et al*., (2005) reported that there were different production caused by aging in *M. Areborea* and *M. Citrina.* Pang *et al*., (2010) reported that there were different phosphorus utilization capability, root surface area, and root length among different perennial herbaceous legumes including *B. Bituminosa.*

Cox *et al.,* (2003) reported that the production of *Lablab*, *MB Juanita, MB Cadaarga,* and *CT Milgarra* decreased from 2.1; 2.0; and 1.0 t/hectare in first year to 0.2; 1.1 and 0.7 t/ha at second year. Different result was reported by Whitbread *et al.,* (2005) that biomass production of *CT milgarra* increased from 1,277 kg DM/ha in first year to 4,047 kg DM/ha in third year, while *MB Juanita* relatively constant 3,382 kg DM/ha in first year to 4940 3,382 kg DM/ha in third year.

Nutrient Quality

Based on nutrient content, CP of *CT Q5455, CT cv. Milgarra,* and *S. seabrana* were almost equal (17.65% to19.29%). Equal CP indicate that those legume provide same nutrient for rumen microbes to grow especially in their protein synthesis. If rumen microbes grows effectively, they can digest more organic matter and crude fiber. Those facts support feed protein content positively related with DM and OM consumption (Ketelaars dan Tolkamp, 1992; Paterson *et al*., 1994). Contrary there was negative correlation between feed protein content with NDF content through filling effect (Reid *et al*., 1988; Jung dan Allen, 1995).

Ginting and Tarigan (2005) reported that *Centrocema pubescens* showed netter CP, NDF, and ADF than *Arachis pintoi*. These result also showed the same result even those two herbaceous legume were planted in different condition (Khamseekhiew *et al*., 2001, Nasrullah *et al*., 2002; and Evitayani *et al*., 2004)

The highest NDF of herbaceous legume was *CP cv.Bundey* (90 DAP) indicated that it had the highest digestible matter (cell content) when compared with *CT Q5455, CT cv.Milgarra, CP cv. Bundey, C. molle, LP cv. Highworth*, *MB cv. Juanita, MB cv. Cadaarga* and *S. seabrana.* At 120 DAP, there were an equal increase of lignin content and NDF in all of eight kind herbaceous legumes. It was also reported that ADF in 120 DAP was higher than 90 DAP because older plant age will result in higher lignin content, silica content, and also lignocellulose bond which was hard to digest by ruminant microbes. Van Soest (1982) stated that hemi-cellulolytic bacteria cannot degrade cellulose, while cellulolytic bacteria can degrade hemicellulose. As additional information, Sayuti (1989) hemicellulose and cellulose are two main carbohydrate compounds found in forage and very important for ruminants as a source of energy. The factors affected cellulose itself were rumen microbes content, lignin percentage, silica percentage, and digestion time by rumen microbes.

In-vitro Digestibility

The average of DM and OM digestibility of *LP cv.Highworth* both in 90 and 120 DAP were the highest among eight kind of herbaceous legume. These were because *LP cv. Highworth* had relatively balanced branch-leaf ratio. It was reported also had the widest and the thickest leaf that affect those situation. Consistently, *LP cv.Highworth* had low crude fiber and ash. On the other hand, *LP cv.Highworth* had low CP digestibility both in 90 and 120 DAP because of the high tannin content (16.48%) which second highest after *S. seabrana* (21.10%).

OM digestibility *LP cv.Highworth* was high because of low ADF content. It was reported that ADF had higher correlation with feed digestibility than NDF (Van Soest, 1994; Jung, and Allen, 1995).

DM, OM, and CP on this study were lower than Ginting *et al.* (2005) which reported that DM, OM, and CP of were 73.3; 74.2 dan 89.9% respectively. Even though, DM and OM digestibility from this study were still higher than Rubianty *et al.*, (2009) which stated that DM digestibility (50.15% vs 53.52%) and OM digestibility (53.47% vs 55.67%) from *Clitoria ternatea* dan *Centrosema pascuorum* cv. Cavalcade in hay form. Further, Zhou *et al.*, (2011) reported that DM digestibility *Flemingia macrophylla* and *Casia bicapsularis* were 58.18% – 71.81%, while OM digestibility were 40.70%-72.70%. Mlay *et al.,* (2006) said that OM digestibility of *Macroptilium atropurpureun* cv Siratro was 65.8%. OM digestibility of *Macroptilium atropurpureun* was close with Mlay *et al.,* (2006).

McDonald *et al*., (1995) stated that both forage and concentrate were consist of DM fraction and OM. OM itself was composed from main nutrient which was essential for cattle life and growth. The increase of organic matter in *CP cv. Bundey*, *MB cv.Juanita*, *C. molle* and *S. seabrana* is expected because it contain more protein and carbohydrate which is easily digest and needed by cattle.

Campbell *et al.*, (2003) said that there were several factor affecting ration digestibility: (1) physical form of constituent material; (2) ration composition; (3) feed flow rate through the digestive tract; and (4) comparison of nutrients inside ration. On *CP cv. Bundey*, *MB cv.Juanita*, *C. molle* and *S. seabrana* inside rumen mucus would accelerate feed flow inside digestive tract which affect feed digestibility and help rumen microbes to become more active in digesting forage.

CONCLUSION

Herbaceous legume *CT cv. Milgarra*, *CT Q5455* and *S. seabrana* had high productivity (the highest digestible OM) at 90 and 120 DAP. Highest cumulative forage productions were *CT cv. Milgarra, CT Q5455,* and *S. seabrana.*

ACKNOWLEDGEMENT

The study was conducted in cooperation with Institute for Agricultural Technology of East Nusa Tenggara for PhD scholarship and foundation via Agricultural Research Partnership Cooperation Program with Institute for Research and Community Services, University of Brawijaya. Therefore, on this occasion we would like to thank Institute for Agricultural Technology of East Nusa Tenggara and Brawijaya University.

REFERENCES

Anonymous (2010). A Guide to Anova and Design in GenStat: GenStat Release 12 Reference Manual Supplement. VSN International, 5 The Waterhouse, Waterhouse Street, Hemel Hempstead, Hertfordshire HP1 1ES, United Kingdom.

AOAC (2011). Official Method of Analysis. 13th Ed. Association of Official Analytical of Chemists. Washington, D.C.

Ayiyi KK, MP Bopape, BC Pangelly (2004). Assessment of the Variation in Growth and Yield of Diverse Lablab (Lablab purpureus) Germplasm in Limpopo Province, South Africa .Tropical legumes for sustainable farming systems in southern Africa and Australia, edited by A.M. Whitbread and B.C. Pengelly, ACIAR Proceedings No. 115, Printed version published in 2004,pp44-50.

Bohlool BB, JK Ladha, DP Garrity and T George (1992). Biological Nitrogen Fixation for Sustainable Agriculture : A Perspective. In Ladha J.K., T. George, B.B. Bohlool. Biological Nitrogen Fixation for Sustainable Agriculture. Kluwer Academic Publishers. London.

Campbell JR, Kenealy MD, Karen L, Champbell (2003). Animal Sciences 4th Edition. McGraw-Hill, New York. USA.

Clem RL and Cook BG (2004). Identification and Development of Forage Species for Long-Term Pasture Leys for the Southern Speargrass Region of Queensland. Tropical legumes for sustainable farming systems in southern Africa and Australia, edited by A.M.

Whitbread and B.C. Pengelly. ACIAR Proceedings No. 115. Printed version published in 2004.pp64-79.

Cox Ch, A Whitbread and B Pengelly (2003). Establishing Grass-Legume Pastures on Rundown Cropping Soils of the Western Downs in Southern Queensland."Solutions for a Better Environment". Edited by Murray Uncovich and Garry O'leary. Proceedings of the 11th Australian Agronomy Conference, 2-6 Feb.2003, Geelong, Victoria.

Evitayani L, Warly A, Fariani T, I chinohe and T Fujihara (2004). Study on Nutritive Value of Tropical Forages in North Sumatra, Indonesia. Asian-Aust. J.Anim. Sci. 11: 1518-1523.

Ginting SP, dan A Tarigan (2005). Kualitas Nutrisi Beberapa Legum Herba Pada Kambing: Konsumsi, Kecernaan dan Neraca N. JITV 10 (4) : 268 – 273.

Goering HK and PJ Van Soest (1970). Forage Fiber Analysis (Apparatus, Reagent, Procedure, and Some Application). Agriculture Handbook. No.379 ARC. USDA. Washington DC.

Gonzalez-Andres F, Ortiz JM (1996[a]). Potential of Cytisus and Allied Genera (Genisteae: Fabaceae) as Forage Shrubs. 1. Seed Germination and Agronomy. New Zeland. J. Agric. Res. 39, 195–204.

Gonzalez-Andres F, Ortiz JM (1996[b]). Potential of Cytisus and Allied Genera (Genisteae: Fabaceae) as Forage Shrubs. 1. Seed germination and agronomy.New Zeland.J Agric. Res. 39, 205–213.

Ibrahim MNM (1988). Feeding Tables For Ruminants in Srilanka. First Edition. Kandy Offset Printers. Kandy.

Jung HG and MS Allen (1995). Characteristics of Plant Cell Walls Affecting Intake and Digestibility of Forages by Ruminants. J. Anim. Sci. 73:2774-2790.

Ketelaars JJMH and BJ Tolkamp (1992). Toward a New Theory of Feed Intake Regulation in Ruminants 1. Causes of Differences in Voluntary Feed Intake: Critique of Current Views. Lives. Prod. Sci. 30: 269-296.

Karachi M, Shirima D and N Lema (1997). Evaluation of 15 Leguminous Trees and Shrubs for Forage and Wood production in Tanzania. Agrofor. Syst. 37, 253–263.

Larbi AA, A Awojide IO, Adekunle, DO Ladipo and JA Akinlade (2000). Fodder Production Responses to Pruning Height and Fodder Quality of Some Trees. J.C., Alvarez-Fuentesa, G., Meddez-Villazana, J.C., 2007. Chemical and digestibility characteristics of some woody species browsed by goats in Central Mexico. J. Appl. Anim. Res. 32, 149–153.

Lefi E, J Gulias, J Cifre and MB Yaines (2005). Drought Effects on the Dynamics of Leaf Production and Senescence in Field Grown Medicago arborea and Medicago citrina. Ann. Appl. Biol. 144, 169–176.

Mlay PS, A Pareka E, C Phiri, S Balthazary, J Igusti, T Huelplund, MR Weisbjerg, J Madsen (2006). Feed value of selected tropical grasses, legumes and concentrates. Vet.Archiv 76: 53-63.

Nasrullah, M Niimi, R Akhasi and O Kawamura (2002). Nutritive Evaluation of Forage Plants Grown in South Sulawesi, Indonesia. Asian-Aust. J. Anim. Sci. 16: 693-701.

Oppong SK, Kemp PD, Douglas GB, Foote AG (2002). Effect of Season and Frequency of Harvest on Browse Yield and Root Carbohydrate Reserves of Willows (Salix spp.) in New Zealand. J. Agric. Res. 45, 87–95.

Pang J, MH Rayn, M Tibbett, GR Cawthray, KHM Siddique, MDA Bolland, MD Denton and H Lambers (2010). Variations in Morphological and Physiological Parameters in Herbaceous Perennial Legumes in Response to Phosphorus Applied. Plant & Soil 331: 241–255.

Paterson JA, RL Belyea, JP Bowman, MS Kerley and JE Wiliams (1994). The Impact of Forage Quality and Upplementation Regimen on Ruminant Animal Intake and Performance. In: Forage Quality, Evaluation, and Utilization. G.C. Fahey (Ed.). American Society of Agronomy, Crop Science Society of America and Soil Science Society of America. pp. 59-114.

Reid R, GA Jung and WV Thayne (1988). Relationships Between Nutritive Quality and Fiber Components of Cool Season and Warm Season Forages: A Retrospective Study. J. Anim. Sci. 66: 1275–1291.

Rubianti A, P Th Fernandez, HH Marawali and E Budisantoso (2009). Dry Matter and Organic Matter Digestibility of Hay Clitoria ternatea and Centrosema pascuorum cv Cavalcade on Bali Cattle post weaning. Proceeding of Livestock and Veterinary Nasional Technology Seminar, Bogor 3-4 August 2010. pp.177-181.

Sayuti N (1989). Ruminant Basic. Faculty of Animal Husbandry. Andalas University. Padang.

Seran YL (2008). Utilization of herbaceous legumes as a source of soil fertility and Forage in Supporting Sustainable Agricultural Systems. Thesis. Master Degree University of Nusa Cendana, Natural Resources and Environmental Management Study Program, Kupang.

Stur WW, Shelton M, Gutteridge RC (1994). Defoliation Management of Forage Tree Legumes. In: Gutteridge, R.C., Shelton, H.M. (Eds.), Forage Tree Legumes in Tropical Agriculture. CAB International, Wallingford, UK, pp. 158–167.

Tilley JMA and RA Terry (1963). A Two Stages Tecnique for The In vitro Digestion of Forage Crops. J. Brit.Grassland. Soc. 18:104-111.

Van der Meer, JM (1980). Determination of the In vitro Organic Matter Digestibility Coefficient of Feeds for Ruminant. Document Report no.67. IVVO. Lelystad.

Van Soest (1982). Nutrition Ecology of the Ruminant. Comstock Publishing House PVT,LTD. New Delhi.

Whitbread.A.M, B.C. Pengelly and B.R. Smith (2005). An Evaluation of Three Tropical Ley Legumes for Use in Mixed Farming Systems on Clay Soils in Southern Inland Queensland, Australia. Tropical Grasslands (2005) Volume 39, 9–21 9. CSIRO Sustainable Ecosystems APSRU,Brisbane. Australia.

Zhou H, M Li, Xuejuan Zi, T Xu and G Hou (2011). Nutritive Value of Several Legume Shrubs in Hainan Province of China. J.Anim.Vet.Adv., 10(13): 1640-1648