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Improvement of Native Pasture Productivity through Introduction of Various Types of Palatable Species on Dry Lands in Timor

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Abstract: This research was aimed to evaluate the productivity of native pasture in Timor Island by introducing various palatable species. The study was carried out on native pasture in Tuatuka, Timor Island for seven months. The study was performed by using randomized block design (RBD) with eight treatments (S_0: no introduction, S_1: *Cynodon dactilon*, S_2: *Dicanthium aristatum*, S_3: *C. plectotachyus*, S_4: *Brachiaria decumbens*, S_5: *Desmanthus virgatus*, S_6: *Macroptilium atropurpureum*, S_7: *Clitoria ternatea*) with four replications. Procedures on this study include trial plots preparation, tillers preparation for each species, introduction of species in trial plots, maintenance and observation of the productivity. Variables observed were forage production (fresh and dry matter (DM) in ton/ha), nutrient content (%) and stock capacity (animal unit (AU)/ha). Data were analyzed for variance based on RBD and followed by Duncan's test. Analysis of variance showed that introduction of species had a very significant effect ($p < 0.01$) on all observed variables. The introduction of *M. atropurpureum* produced the highest fresh forage (2.1 t/ha) and DM production (0.69 t/ha). *M. atropurpureum* also had the highest DM content (43.61%), nitrogen free extract (52.52%) and stock capacity (1.06 AU/ha). The highest crude protein and crude fiber content were found in *D. virgatus* (4.31% and 36.62%). The highest extract ether was observed in *D. aristatum* (1.48%). No introduction had the lowest productivity, but demonstrated the highest ash content. The introduction of palatable species increased the productivity of native pasture in Timor and *M. atropupureum* was the best introduced species.

Key words: Species introduction, legume, *Macroptilium atropurpureum*, native pasture in Timor, forage production, grass, dry land.

1. Introduction

Ruminant production sector in East Nusa Tenggara potentially could be a main income source—compared to other livestock. The Government of East Nusa Tenggara is currently focusing to boost its economy through husbandry sector. This sector is mostly occupied by small holder farm with extensive or semi-extensive rearing management—depending on the availability of the natural pasture land as feed source. Increasing number of livestock should be followed by improvement of pasture production. However, the availability of high-quality feed still remains as a serious constraint in dry season [1].

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Overgrazing can cause poor pasture productivity by reducing or even losing the palatable species, increasing the population and invasion of spiky weed, decreasing the stock capacity (0.63 animal unit (AU)/ha to 0.24 AU/ha) [2]. Species composition in a pasture influences the pasture's holding and caring capacity. A pasture with 90.4% grass, 4.3% legumes and 5.3% non-palatable plant has a holding capacity of 1.20 AU/ha. A pasture with 99% grass, 1% non-palatable plant without legumes has a holding capacity of 0.17 AU/ha causing deficiency of dry matter (DM) feed consumption as much as 1.54%-2.15% DM from the requirement 3% DM/day. This causes poor productivity and also mortality of livestock [3].

An improvement to increase the potency of natural

pasture in Timor needs to be done by introducing new grass and legume species that have high productivity and are adaptable to drought [4]. *Cynodon dactilon*, *Dicanthium aristatum*, *C. plectotachyus*, *Brachiaria decumbens*, *Desmanthus virgatus*, *Macroptilium atropurpureum* and *Clitoria ternatea* are local forages that have high palatability and remain alive until the end of dry season [5]. The natural pasture productivity is affected by species, the ability to associate with other plants, and the adaptability to environment. The productivity of feed plants introduced in a land is determined by the ability of the plants to adapt to the environment [6].

Information regarding natural pasture productivity as a source to provide high quality feed on dry land that has been improved by species introduction is required to determine the productivity and sustainability of the pasture on holding livestock. This research was aimed to evaluate the productivity of native pasture in Timor Island in the introduction of various local grasses and legume species.

2. Materials and Methods

2.1 Study Site Description

The study was carried out in Tuatuka region, Kupang Timur Sub-district, Kupang district, Timor Island in the province of Nusa Tenggara Timur, Indonesia. Based on soil analysis, the soil type in this study was vertisol containing 30% of clay, 6.7% of acidity level, 0.04% of nitrogen (N), 4.21% of phosphor (P) and 0.39% of potassium (K) (laboratory analysis by the Agricultural Technology Research Center of East Nusa Tenggara (BPTP NTT), 2017). Based on observation on location of study, it showed that the temperature was recorded 27.7 °C at 06:00, 38 °C at 12:00 and 27 °C at 18:00.

2.2 Materials

Instrument used in this study includes metric tape, plastic rope, 1 m × 1 m quadrant, agricultural tools, thermometer, scale, sample grinder and apparatus to evaluate nutrient content. Materials used in this study include 3,200 m^2 of natural pasture land, *C. dactilon*, *D. aristatum*, *C. plectotachyus*, *B. decumbens*, *D. virgatus*, *M. atropurpureum*, *C. ternatea*, envelope-shaped newspaper, plastic bag and water.

2.3 Methods

2.3.1 Procedure

The preparation procedure in this study includes land preparation, 10 m × 10 m plots preparation, 20 cultivation sports determination, 2 m × 2.5 m of planting space determination. The introduced forages are 21 d old forages (two on each polybag). The observation procedure includes grouping, plots randomization and planting. Native forages are kept on the land. Watering is equally performed to each plot. Harvesting is carried out at the Day 90 after the introduction (four samples for each plot determined by using quadrant). Forages are cut, weighed, dried, ground and subjected to chemical analysis to evaluate its nutrient content.

2.3.2 Statistic

This study was designed by using randomized block design (RBD) with eight treatments (S_0: no introduction as control, S_1: *C. dactilon*, S_2: *D. aristatum*, S_3: *C. plectotachyus*, S_4: *B. decumbens*, S_5: *D. virgatus*, S_6: *M. artropupureum*, S_7: *C. ternatea*) with four replications. Variables observed in this study include fresh forage production (t/ha), DM production (t/ha), nutrient content (% DM basis) [7], and stock capacity (AU/ha) that were calculated by Voisin's formula [2]. All data were statistically analyzed by using RBD based on its variances, followed by Duncan's test for differences among treatments [8].

3. Results and Discussion

3.1 Effects of Treatments on the Productivity of the Pasture

The effects of treatments on the productivity of natural pasture in Timor are shown in Table 1.

Variance analysis confirmed that treatments in this study had significant effects ($p < 0.01$) on the natural pasture productivity in Timor. Duncan's test showed that forages introduction to the pasture resulted in the highest production compared to control. The highest production was observed on pasture with *Clitoria*, *Macroptilium* legume and *Brachiaria* grass introduction. *Clitoria* and *Macroptilium* are vining legumes that are resistant to drought—producing high yield until the end of dry season. *Brachiaria* grass has bigger morphology compared to other grasses—one of vining grasses with stolon that reproduces itself easily when intact with soil [9].

The vegetative part of this grass will increase its forage production. Vining forages are able to retain soil humidity, improve nutrient decomposition and microbe activity that will help on the organic matter mineralization. Hence, the products can be utilized by the forage and other surrounding forages to produce high yield. Humidity affects the soil microbe activity that will provide nutrients for forages. These nutrients are convertible through photosynthesis process—producing energy that will be stored on the forages [10].

3.2 The Effects of Treatments on Nutrient Value of the Pasture

The effects of treatments on the nutrition content of native pasture in Timor are shown in Table 2. The highest nutrient contents are obtained on pasture with *Desmanthus* legume, *Clitoria* and *Macroptilium* introduction. Legume contains more nutrient than grass. The activity of rhizobium bacteria on legume's root helps with their nitrogen fixation to improve the nutrient content of the legume.

The falling leaves from the legume also provide the material that will undergo decomposition to produce more organic material, used to improve forage quality. Nitrogen content on the soil and fertilizer will affect plant protein [11], and 55%-60% of absorbed nitrogen

Table 1 Average of forage production and stock capacity animal of native pasture caused by treatments.

Treatments	Forage production (t/ha)		Stock capacity (animal unit (AU)/ha)
	Fresh weight	Dry matter (DM)	
S_0 (no introduction)	$0.77^{d} \pm 0.05$	$0.34^{b} \pm 0.04$	$0.37^{d} \pm 0.01$
S_1 (*Cynodon dactilon*)	$1.37^{bc} \pm 0.02$	$0.72^{a} \pm 0.05$	$0.69^{bc} \pm 0.26$
S_2 (*Dicanthium aristatum*)	$1.09^{d} \pm 0.02$	$0.72^{a} \pm 0.07$	$0.55^{cd} \pm 0.18$
S_3 (*C. plectotachyus*)	$1.32^{bc} \pm 0.05$	$0.84^{a} \pm 0.03$	$0.66^{bc} \pm 0.08$
S_4 (*Brachiaria decumbens*)	$1.78^{ab} \pm 0.05$	$0.77^{a} \pm 0.05$	$0.89^{ab} \pm 0.17$
S_5 (*Desmanthus virgatus*)	$1.47^{bc} \pm 0.03$	$0.78^{a} \pm 0.07$	$0.74^{bc} \pm 0.04$
S_6 (*Macroptilium atropupureum*)	$2.10^{a} \pm 0.11$	$0.96^{a} \pm 0.12$	$1.06^{a} \pm 0.06$
S_7 (*Clitoria ternatea*)	$1.79^{ab} \pm 0.03$	$0.81^{a} \pm 0.05$	$0.90^{ab} \pm 0.01$

$^{a, b, c, d}$ different superscripts in the same column indicate significant difference ($p < 0.05$).

Table 2 Average of the nutrient value of native pasture forages caused by treatments.

Treatments	Nutrient value (% DM basis)				
	DM	Crude protein	Extract ether	Crude fiber	Ash
S_0 (no introduction)	$43.15^{e} \pm 0.13$	$3.59^{cd} \pm 0.95$	$1.29^{c} \pm 0.14$	$34.26^{d} \pm 0.81$	$12.84^{a} \pm 0.01$
S_1 (*C. dactilon*)	$43.45^{bc} \pm 0.03$	$3.31^{e} \pm 0.02$	$1.35^{b} \pm 0.03$	$34.14^{d} \pm 0.03$	$11.99^{b} \pm 0.21$
S_2 (*D. aristatum*)	$43.42^{c} \pm 0.02$	$3.37^{e} \pm 0.02$	$1.48^{a} \pm 0.05$	$36.28^{b} \pm 0.03$	$9.90^{e} \pm 0.08$
S_3 (*C. plectotachyus*)	$43.31^{d} \pm 0.02$	$3.54^{d} \pm 0.03$	$1.14^{d} \pm 0.04$	$32.41^{e} \pm 0.03$	$11.18^{c} \pm 0.09$
S_4 (*B. decumbens*)	$43.41^{c} \pm 0.02$	$3.65^{c} \pm 0.02$	$1.33^{bc} \pm 0.02$	$32.45^{e} \pm 0.02$	$11.86^{b} \pm 0.08$
S_5 (*D. virgatus*)	$43.46^{bc} \pm 0.03$	$4.31^{a} \pm 0.44$	$1.09^{d} \pm 0.05$	$36.63^{a} \pm 0.01$	$9.28^{f} \pm 0.13$
S_6 (*M. atropupureum*)	$43.61^{a} \pm 0.02$	$4.01^{b} \pm 0.07$	$1.14^{d} \pm 0.02$	$32.60^{e} \pm 0.02$	$10.12^{e} \pm 0.03$
S_7 (*C. ternatea*)	$43.48^{b} \pm 0.02$	$4.26^{a} \pm 0.04$	$1.11^{d} \pm 0.02$	$35.77^{c} \pm 0.02$	$10.65^{d} \pm 0.01$

$^{a, b, c, d, e, f}$ different superscripts in the same column indicate significant difference ($p < 0.05$).

can be used for protein synthesis [12]. The highest carrying capacity was attained on pasture that had been introduced with *Clitoria*, *Macroptilium* and *Brachiaria*. It was a result from the high production and quality of the forages on those pasture lands.

4. Conclusions

According to this study, the introduction of palatable-drought resistant legumes and grasses to natural pastures can improve the productivity of the pasture in Timor. *Macroptilium* and *Clitoria* introduction produced the highest production.

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