The potential of the legume types in the quality and economic value of Nitrogen of *Setaria anceps* Stapf

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**Abstract.** The study aimed to identify the effect of legume types on the biomass, protein content, and economic value of nitrogen in *Setaria anceps* Stapf and legume intercropping. The research site was in Makassar. This study employed Completely Randomized Design consisting of 5 groups. The experimental land area of 408 m² (17 x 24m) was divided into 25 plots (each 3 x 4 m). The used forages in this study were *Setaria anceps* Stapf, *Centrosema pubescens*, *Clitoria ternatea* and *Dioclea quanensis*. The treatments in this study were L0: *Setaria anceps* Stapf; L1: *Setaria anceps* Stapf + *Centrosema pubescens*; L2: *Setaria anceps* Stapf + *Clitoria ternatea*; L3: *Setaria anceps* Stapf + *Dioclea quanensis*; L4: Urea fertilizer (20 kg N/ha). The study indicated the legume-grass intercropping in *Setaria anceps* Stapf may result in the increased protein content and forage biomass. *Clitoria ternatea* contributed higher economic value of nitrogen compared to *Centrosema pubescens* and *Dioclea quanensis*.

1. **Introduction**

The farming development could be substantially considered as biological industry managed by humans. Various elements play important roles that are intercorrelated in a system. The farming enterprise in Indonesia should be further developed to ensure the success of a farming enterprise. The needs of feed primarily forage, are one important factor in determining the success of a ruminant farming enterprise.

Despite the demand on forage quality and production improvement, there are some challenges may occur such as declining productivity of pasture and limited availability of pasture. The tropical pasture productivity and quality in Indonesia are very low because some portion of the land areas is characterized by dryland pasture. The availability of land resource including pasture tends to decline from 1 to 2% per year. The soil as the media for plant growth should be concerned to generate better quality and safe consumption of pasture. This is primarily for livestock productivity and quality improvement as well as the increase in livestock population [1,2].

One method in improving the production and quality of the grass is legume-grass intercropping. The grass may be grown separately. However, production and quality will be low. Grass-legume intercropping will contribute positively to the grass growth since legume can fixate atmospheric nitrogen. One important concern in the intercropping system to consider is the suitability of grass and legume species. Both grass and legumes are expected to not interfere with one another in the growth progress. The suitability of grass and legume species depends on the morphological characteristics of grass and legume themselves [2].

The combination of several types of legume and gramineae could be implemented. One of the applicable species is *Setaria anceps* stapf as highly palatable forage and dominantly cultivated in...
Indonesia. In addition to its adaptability in the tropical area, the annual production of this grass may achieve 31 tons/acre/year. This grass contains 9.5% crude protein, 31.7% crude fiber, 2.5% ether extract, 45.2% nitrogen-free extract, 11.1% ash, and 7% oxalic acid [3]. Setaria grass grows straight up reaching 2 m in height and forms large clumps. It is a grass type tolerant to drought and therefore, it may be utilized as forage supply during the dry season. Setaria anceps stapf as potential ruminants feeds contributes massively to the development of ruminant farming. Eroni and Aregheore [4] stated that dairy cows with the bodyweight of 430-447 kg are capable of consuming 10.5 kg dry matter in a day.

This research aims to identify the effect of intercropping between Setaria anceps stapf and some types of legumes to the protein content biomass and nitrogen economic value of Setaria anceps Stapf.

2. Research Methods
The experiment of this study was performed on soil texture containing 22% clay, 50% silt, and 28% sand categorized as loam. During the experiment, there was no pest or disease attack identified on Setaria anceps Stapf except weed that could be anticipated by weekly weeding.

Land clearing from weed and soil cultivation before planting was performed to prepare suitable growing media. After that, 25 plots (each 3 x 4 meters) were provided on the site.

This study employed Completely Randomized Design (CRD) consisting of 5 groups. The land area of 408 m$^2$ (17 x 24 m) was divided into 25 plots (each 3 x 4 meters) at a spacing of 1 meter for the group and a spacing of 0.5 meters for the treatments within the groups. The forages used in this study were Setaria anceps Stapf, Centrosema pubescens, Clitoria ternatea and Dioclea quanensis. The treatments consisted of L0: Setaria anceps Stapf; L1: Setaria anceps Stapf + Centrosema pubescens; L2: Setaria anceps Stapf + Clitoria ternatea; L3: Setaria anceps Stapf + Dioclea quanensis; L4: Urea fertilizer dose of 20 kg N.

The legume seedlings raised in the polybags were moved into the land site at a plant spacing of 50 x 50 cm. The cultivation of legume cultivation in the land site was performed 7 days before Setaria anceps stapf cultivation. The legumes were planted in a row spacing of Setaria anceps Stapf. The use of urea fertilizer at 20 kg N/ha dose was performed after 30 days Setaria anceps stapf cultivation by injecting the fertilizer around the grass. After 70 days of cultivation, the sample collection was performed randomly from each plot.

The measured parameters in this study were protein content and biomass through proximate analysis and economic value of nitrogen through legume combination in the intercropping system [5].

3. Results and Discussion
At the beginning, the effect of grass-legume intercropping on Setaria grass was not able to identify. The grass leaves turned yellow, withered, and dried. The leaves of Setaria ancep stapf began to grow equally after two weeks and the leaf color turned light green. This growth seemed to boost due to the use of pools as media, the environmental adaptability, and drought tolerance. According to Wiswasta [6], Setaria anceps Stapf grown in Indonesia is more preferable for the livestock. In addition, it is also highly productive and tolerant to drought.

The effect of grass-legume intercropping was able to be seen after one month of cultivation. The grass seemed to thrive especially the grass intercropped with Centrosema pubescens and Clitoria ternatea compared to other treatments.

3.1. The protein content of setaria anceps Stapf in different treatments
The protein content and biomass production in Setaria anceps Stapf intercropped with legume and added with higher N fertilizer than control group. It was later identified that the highest protein content was produced by Setaria anceps Stapf intercropped with Clitoria ternatea as presented in table 1.
Table 1. Protein content (%) and dry eeight (kg/ha) of *Setaria ancpes* Stapf in different treatments.

| Treatment       | Protein (%) | Dry Weight (kg/ha) |
|-----------------|-------------|--------------------|
| L0              | 7.47<sup>a</sup> | 1979.222<sup>a</sup> |
| L1              | 9.05<sup>ab</sup> | 3224.108<sup>cd</sup> |
| L2              | 9.87<sup>b</sup> | 3897.854<sup>ab</sup> |
| L3              | 8019<sup>a</sup> | 2340.188<sup>ab</sup> |
| L4              | 8.45<sup>ab</sup> | 2814.036<sup>bc</sup> |

Description: L0: *Setaria ancpes* Stapf; L1: *Setaria ancpes* Stapf + *Centrosema pubescens*; L2: *Setaria ancpes* Stapf + *Clitoria ternatea*; L3: *Setaria ancpes* Stapf + *Dioclea quanensis*; L4: Urea fertilizer dose of 20 kg N; The values with different superscript letters in a column are significantly different (p<0.05).

Based on the analysis of variance, it showed that the treatment significantly affected (P<0.05) the protein content of *Setaria ancpes* Stapf. The LSD (Least Significance Different) Test showed that protein content of *Setaria ancpes* Stapf in L2 was significantly higher (p<0.01) than L0, significantly higher (p<0.05) than L3 and not significantly different from L4 and L1. L1 significantly different (p<0.05) and higher than L0. There was no significant difference among L0, L3 and L4.

The high protein content in *Setaria ancpes* Stapf intercropped with legume was resulted by legume ability in fixating nitrogen and supplying it to the grass. This was indicated by the increase in grass protein content. Marliani [7] stated that nitrogen is very important for plant growth since it may increase protein content and dry matter per land unit.

Each legume intercropped with *Setaria ancpes* Stapf produced different protein content. This was due to the differences among the legume species in atmospheric nitrogen fixation abilities. As the consequence, the amount of nitrogen supplied to the grass would also be different. As can be seen from the data in table 1, the highest grass protein content was identified in the intercropping of *Clitoria ternatea*. This indicated that *Clitoria ternatea* contribute the highest amount of nitrogen to *Setaria ancpes* Stapf compared to the other two legumes.

This was also confirmed by the plant effective response to the research site environment where the soil provided both necessary nutrients for the plant’s growth and Rhizobium bacteria in legume. According to [8] the amount of N<sub>2</sub> fixation by the legumes varies depending on the cultivars, the species, bacteria, growth environment including pH and soil nitrogen. The environmental factor of soil such as Carbon-N ratio, high N content may be the obstacle for microbial activity in legume nodulation.

The soil nitrogen content in the research site was considered very low, the C-N ratio was very high and soil pH was neutral. Therefore, the soil characteristics would enable the nodule of legume roots, especially for *Clitoria ternatea*. This was also observable from the protein content in *Setaria ancpes* Stapf within the monocropping system (control) that indicated significant differences from the *Setaria ancpes* Stapf intercropped with various legume types. [9] in his study, concluded that the combination of legume and *Pennisetum purpureum* cv Mott. in the intercropping system could positively contribute to the *Pennisetum purpureum* cv Mott. protein content compared to monocropping system.

### 3.2. Biomass production in *Setaria ancpes* Stapf

The biomass of *Setaria ancpes* Stapf intercropped with legume and supplied with N fertilizer was higher compared to the control group. It was also revealed that the highest production in *Setaria ancpes* Stapf was observed in the intercropping with *Clitoria ternatea* (L2: 3897.854 kg/ha), followed by intercropping with *Centrosema pubescens* (L1: 3224.108 kg/ha), monocropping with urea fertilizer use (L4) (2814.036 kg/ha), intercropping with *Dioclea quanensis*

Analysis of variance showed that the treatments significantly affected (p<0.01) the biomass production of *Setaria ancpes* Stapf. Least Significant Different test showed that biomass production of...
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setaria ancpes Stapf in L2 was significantly higher (p<0.01) than L0, L3 and L4. However, L2 was not significantly higher (p<0.05) than L3.

Both the intercropping with various types of legumes and fertilizer use may improve Setaria ancpes Stapf biomass. The increase of biomass through intercropping system indicated that N fixation by legumes was able to be absorbed by Setaria ancpes Stapf. According to [10], legumes in the intercropping system supply nitrogen to improve the biomass production of pasture.

In addition to the nitrogen role in contributing to protein production, nitrogen also plays an important role in the plant's metabolism such as growth and cell division. Therefore, through the increase in nitrogen absorption, leaf, stem, and root formation during the vegetative phase will improve. The number of leaves will increase and the number of stems will grow taller. According do [11], the increase of nitrogen absorption in plants will significantly affect the enlargement of leaf area and subsequently, the increase in assimilation rate during the vegetative phase affects the maximum biomass production in plants.

3.3. The economic value of nitrogen in Setaria ancpes Stapf intercropped with varieties of legumes
Economic value of N in some legumes within the intercropping system was presented in table 2. Clitoria ternatea contributed to the highest economic value of Nitrogen (45.97 kg N/ha) followed by Centrosema pubescens (29.82 kg N/ha), and Dioclea quanensis (8.65 kg N/ha).

Table 2. The economic value of Nitrogen (kg N/ha) in various types of legumes.

| Treatment                                             | Ekonomic value of N (kg N/ha) |
|-------------------------------------------------------|------------------------------|
| L1 (grass+Centrosema pubescens)                      | 29.82                        |
| L2 (grass+Clitoria ternatea)                         | 45.97                        |
| L3 (grass+ Dioclea quanensis)                        | 8.65                         |

Description: L0: Setaria ancpes Stapf; L1: Setaria ancpes Stapf + Centrosema pubescens; L2: Setaria ancpes Stapf+Clitoria ternatea; L3: Setaria ancpes Stapf+Dioclea quanensis; L4: Urea fertilizer dose of 20 kg N

Table 2 showed that legume intercropping contributed N differently to setaria ancpes Stapf. Of all three types of the observed legume, Clitoria ternatea contributed the highest economic value of nitrogen. This indicated that Clitoria ternatea performed well in rejuvenating soil fertility and improving grass biomass. This was proved by the total production assessment of Setaria ancpes Stapf intercropped with Clitoria ternatea exceeding the biomass of grass biomass production in monocropping system.

This indicated that the component of legume also plays an important role in supplying N in the soil. Additionally, Clitoria ternatea as a legume also contains higher nutritional value compared to grass. This is correlated to a study performed by [11] that the biomass of grass intercropped with legume exceeds the biomass of grass in monocropping system. There is a strong correlation between the grass-legume intercropping and the economic value of nitrogen.

According to [12] the use of legume in pasture may be very advantageous in monocropping system since legume can supply N nutrient to grass for production improvement and fertilizer efficient use. [13] stated that N supply to the pasture will improve the production of dry matter and forage quality especially the protein content.

4. Conclusion
The intercropping of Setaria ancpes Stapf and types of legume could improve the protein content and forage biomass. Clitoria ternatea contributed the highest economic value of nitrogen compared to the other legume types such as Centrosema pubescens and Dioclea quanensis.

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