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Influence of organic fertilizer in the production and economic efficiency of *Brachiaria Humidicola*

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Abstract: Hairless grass (Brachiaria humidicola) grown in Thua Thien Hue initially showed that it can adapt to the weather and climate conditions in Thua Thien Hue. The study aimed to evaluate this grass species' growth capacity, production capacity, and economic efficiency when using different levels of organic fertilization. The experiment was conducted on four fertilization regimes of 10, 20, 30, and 50 tons of organic fertilizer per hectare in a 1-year cycle; for each hectare, we chose 5 points for data collection and analysis of nutritional values and measurement of productivity. The results showed that increasing the amount of fertilizer enhanced the green growth capacity, the yield of each hectare, and the economic efficiency of Brachiaria humidicola ($P < 0.05$). Increasing the amount of organic fertilizer to 50 tons per hectare did not differ from 30 tons per hectare. A fertilization regime of 30 tons per hectare for grass has brought high economic efficiency in livestock farming of goats and cattle. Additionally, green matter, dry matter, and protein yield were above 12.89, 3.62, and 0.98 tons per hectare per time harvested. Furthermore, this result also showed that dry matter (%), crude protein, total minerals, and insoluble fiber in the neutral detergent of B. humidicola were 25.36, 7.92, 70.87, and 8.73% dry matter, respectively. Our research results could provide more useful information about the newly introduced grass of B. humidicola planted in rice croplands. This might benefit local farmers in converting cultivated crops from growing rice to grasses for cattle. Our data will provide scientific data and experimental facilities for planting new species for climate change adaptation in Thua Thien Hue province areas.
Keywords: *Economics, Fertilization regime, Growth performance, Local grass species, Nutritional values, Productivity.*

1. Introduction

The ruminant livestock industry is increasingly important in agricultural production because of its advantages in using fibre feedstuffs in agri-systems and its contribution to sustainable development. In recent times, the industry has undergone remarkable changes. Livestock productivity has been increasingly improved, and many high-yield livestock breeds with good product quality have been born to meet people's needs. However, one of the biggest obstacles of the ruminant livestock industry is the lack of proactive green feed sources to meet livestock needs. To solve this problem, many localities have recently introduced experimental planting of some grasses as livestock feed. Therefore, the productivity and nutritional quality so are low, the planting area is still fragmented, mainly taking advantage of infertile, poor-nutrient land, and the quality of feed is not guaranteed for livestock farming.

Hairless grass (*Brachiaria humidicola*) was brought from the local Phu Yen province to Thua Thien Hue (now Hue City) for trial planting. Initially, it showed good adaptability and could be widely grown as feed for ruminants. However, appropriate fertilization regimes are necessary to improve the growth and productivity of Hairless grass. For the above reasons, we conducted a study on the topic "Effect of

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fertilization regime on the production capacity and economic efficiency of Hairless grass (*Brachiaria humidicola*)."

2. Materials and Methods

2.1. Research materials

Hairless grass was brought from Phu Yen province to be planted and propagated in Thua Thien Hue province (HUE). Organic fertilizer is composted cow manure purchased from cattle-raising households in this area. Nutritional composition of cow manure: organic matter (79.67%), Nitrogen (1.77%), phosphoric acid (1.54%), potassium acid (1.02%).

2.2. Time and Research Site

Four trials were carried out, each with a hectare of grass planting. All trials were set up from January 2021 to December 2022, and the research location was an experimental planting of *Brachiaria humidicola* in Huong Tho commune, Hue City, Thua Thien Hue province, Vietnam (now HUE, Vietnam).

2.3. Variables and Methods

2.3.1. Experimental Setting-Up, Planting and Care Techniques for Hairless Grass

The experiment of planting hairless grass was randomly arranged with four treatments corresponding to four different fertilizer regimes of 10, 20, 30, and 50 tons/ha. Each fertilizer regime was planted on four fields, with an area of 1 ha (250 m2/plot, 10x25 m). Then, the grass was planted on the fertilizer regimes, and the time, harvesting, care, and fertilization regimes in the fields were the same.

Techniques for planting and caring for Hairless grass and preparing the soil before planting. The soil was cleared of weeds and ploughed thoroughly to a depth of about 20 - 30 cm from the ground, ensuring it was loose, and manure was applied according to the fertilizer regimes mentioned above. When the soil was prepared, the grass was planted.

Select grass varieties: Choose large, healthy grass plants with green leaves, even eyes, no pests, and no wilting. Planting: grass is planted with cuttings, planted in rows, three cuttings placed together, about 7-10 cm deep in the soil in each row, about 30 cm from the base. After 15-20 days of planting, monitor and replant dead bushes to ensure uniformity of the grass field.

Weed care and cleaning: Make a fence with bamboo or wood to protect and prevent cattle from eating grass. Monitor and clean weeds 2-3 times a week before the grass covers the ground.

Evaluation of growth characteristics of Hairless grass

Five random points on the two diagonals of the plot were selected to evaluate the growth indicators of hairless grass and productivity for each sample plot.

Tallest plant height: each plot measured the height of the tallest plant selected at the monitoring time. The leaf-swiping method measured the distance from the ground to the highest point.

Grass height: This is measured at the time of harvest. A straight ruler is used to measure perpendicular to the ground, and the height measured from the ground to the flat point where about 70% of the leaves are achieved is the grass height.

Number of branches/bush: is the number of branches counted in a growth stage over the initial number of branches before planting (or compared to the number of branches/bush of the previous cutting). The number of branches includes the number of new branches growing from the base and the branches that continue to grow.

Bush circumference: Measure each bush during grass harvest, determined by a tape measure.

Leaf/green matter ratio: the grass leaves are separated from the stem to determine the time of grass harvest.

2.4. Evaluation of the Production Capacity of Hairless Grass

Hairless grass is planted 40 days after cutting the first crop and every 40 days after the next crop to evaluate the grass yield.

Green matter yield: Cut the entire amount of grass planted, including dry branches and leaves, and remove weeds. Cut when it is not raining, and the dew has dried. Cut about 5-10cm from the ground. After cutting, weigh immediately in the field to determine the green matter mass and calculate the yield.

Dry matter yield: productivity dry matter = green matter × % dry matter (DM). The DM ratio is determined by drying a sample at 105^0C until constant weight to determine the dry matter ratio.

Protein yield: productivity protein = dry matter × % Protein in DM.

Figure 1.
Grass on drying by sunshine on field.

Figure 2.
Growing grass in a month.

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Figure 3.
Pence and grass growing.

Figure 4.
Harvesting grass on the field.

Figure 5.
Grass with flat leaves, lanceolate leaf blades, bright green.

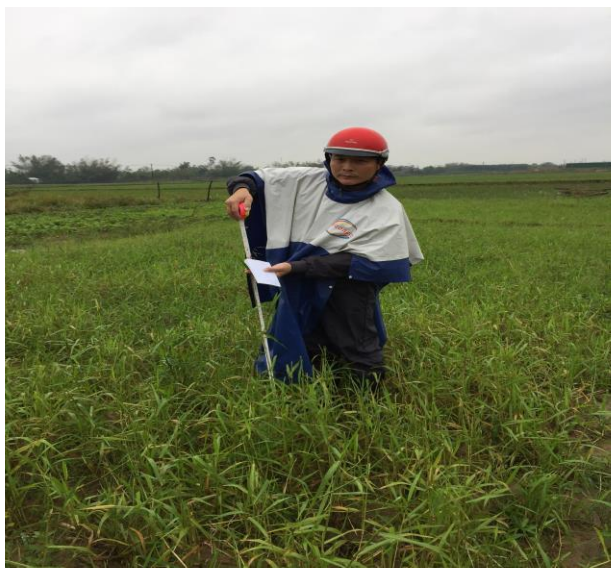

Figure 6.
The grass field is being tended by the researcher.

2.5. Evaluation of the Nutritional value of Hairless Grass

Samples of hairless grass were collected at each harvest time. The samples were brought to the laboratory and dried at 60. They were then ground to a fine size of 1 mm and analyzed for chemical composition, including DM (dry matter), OM (organic matter), CP (crude protein), and NDF (Neutral Detergent Fiber). Chemical composition was analyzed according to the method of AOAC [1] and Vietnamese standards [2].

2.6. Evaluation of economic efficiency

Evaluate the production cost of 1 kg of green fodder by calculating the costs of grass production and the grass yield harvested per hectare/year.

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2.7. Data Management and Processing

The collected data were managed using Microsoft Excel (2010) and processed using Minitab version 16.0 software, which used ANOVA analysis.

3. Results and Discussion

3.1. Effect of fertilization regime on the Morphological characteristics and Growth of Hairless grass

The experiment was conducted to monitor and evaluate the growth capacity and study the effects of different fertilization regimes on the growth of hairless grass, as presented in Table 1 below.

Table 1.
Effect of organic fertilization regime on Morphological characteristics and Growth of Hairless grass.

Variables/fertilizer regimes	10 tons	20 tons	30 tons	50 tons	P
Hairless grass is a leafy, procumbent, creeping perennial grass and forms dense sods. The culms remain prostrate and can form roots from the lower nodes. The leaves ar0e flat, lanceolate blades, bright green, 4-20 cm long x 3-10 mm wide. The inflorescences bear 2 to 4 racemes with hairy, bright green, 3-4 mm long spikelets, as shown in Figures 1, 2, 3, 4, 5, 6.					
Green matter (%), M ± s.e.	37.24^{a} ±1.22	46.85^{b} ±1.23	56.84^{c} ±1.38	50.66^{b}±1.22	0.000
Highest grass tree (cm), M ± s.e.	73.07^{a} ±1.34	78.06^{b} ±1.35	81.67^{bc} ±1.51	83.62^{c}±1.34	0.000
Lawn height (cm), M ± s.e.	57.27^{a} ±1.45	61.00^{bc} ±1.46	61.77^{bc} ±1.64	64.55^{c}±1.45	0.006
Number of branches, M ± s.e.	46.54^{a} ±2.47	52.37^{a} ±2.50	72.85^{b} ±2.80	67.85^{b}±2.48	0.000
Dust perimeter (cm), M ± s.e.	62.47^{a} ±1.841	73.52^{b} ±1.86	73.68^{b} ±2.08	74.21^{b}±1.84	0.000

Note: M (mean) and s.e. (standard error); a, b, c, ab, ac: numbers with different superscript letters in the same row are statistically different (P < 0.05).

Table 1 shows that the ratio of leaves/green matter, the highest plant height, the grass height, the number of branches/bush and the circumference of the bush differed between different organic fertilization regimes (P<0.05). When the amount of organic fertilizer increased, the growth indicators of hairless grass increased the most at the fertilization regime of 50 tons/1ha. However, the organic fertilizer regimes of 30 tons/1ha and 50 tons/1ha were similar [3] and there was no statistically significant difference, except for the ratio of leaves/green matter (P>0.05). This research result is consistent with Le, et al. [4] the author recommended that increasing the organic fertilizer regime to 10, 20 and 30 tons/1 has increased the ratio of leaves/green matter, increasing the height and uniformity of the grass carpet. The leaf/stem ratio is an essential indicator for evaluating the quality of green fodder for ruminants. The leaf/stem ratio is proportional to the quality of the feed; a high ratio indicates high-quality feed (edible part) and high feed intake of livestock. West grass's leaf/stem ratio fluctuates from 37.24 - 56.86%, changing according to the organic fertilizer regime, the highest at 30 tons/1ha (P<0.05). According to Le, et al. [4] grass's leaf/green matter ratio fluctuates significantly according to different fertilizer regimes of 10, 20 and 30 tons/ha. It is highest at the fertilizer regime of 30 tons/1ha, Specifically, the leaf/green matter ratio of *B. ruziziensis* grass (61.1 - 63.5%), B. Decumbens grass (62.2 - 64.4%) and B. Brizantha grass (56.8 - 57.4%). According to Hue [5] the leaf ratio of Guinea grass is 85.23% at 45 days old. According to Nguyen, et al. [6] the leaf/whole plant ratio of Ruzi grass, *Paspalum atratum*, and Setaria grass is 72.5, 82.6, and 60.0%, respectively. The highest plant height of Hairless West grass increases gradually according to fertilizer regimes, from 73.07 cm at the fertilizer level of 10 tons/1ha to 81.62 cm at the fertilizer level of 30 tons/1ha (P<0.05) and increases the most at the fertilizer level of 50 tons/1ha at 83.62 cm. However, the highest plant height at the fertilizer levels of 30 tons/ha and 50 tons/ha was not statistically different (P>0.05), Table 1. According to Nhung, et al. [7] the highest plant height of guinea grass was 80.9 - 11.3cm, and that of ruzi grass was 90.2cm. According to the research results of Van Trong, et al. [8] the highest plant height of guinea grass was 82.61cm, and that of Mulato II grass was 90.87cm. The carpet height of *Brachiaria humidicola* ranged from 57 - 65cm according to different fertilizer regimes, the highest at the fertilizer regime of 50 tons/ha, and there was no difference compared to the fertilizer regime of 30 tons/ha (Table 1); higher than other varieties such as *B. Ruziziensis* (50 – 56

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cm), *B. decumbens* (45 – 46 cm) and equivalent to *B. Brizantha* (57 – 65 cm) [4]. The height of the Guinea grass carpet is 48.55 – 88.33 cm (Pham The Hue 2017). The number of branches/bush of hairless West grass increased gradually in different fertilizer regimes; the 10 ton/ha fertilizer regime was 46.54 branches/bush, and the highest was in the 30 ton/ha fertilizer regime, 72.85 branches/bush ($P<0.05$), Table 1. However, there was no difference in the 50 ton/ha regime (67.85 branches/bush) ($P>0.05$) Table 1. According to Nguyen and Dao [9] the number of branches of Panicum maximum TD58 was 13.4 branches/bush, Mulato II was 27.3 branches/bush, and *B. Brizantha* was 20.2 branches/bush. The bush circumference of hairless grass increased gradually with fertilizer regimes. The 10 tons/ha regime was 62.47cm, increased to 73.68 cm in the 30 tons/ha regime, and reached its highest in the 50 tons/ha regime, 74.21cm. However, there was no difference in the 30 and 50 tons/ha regimes ($P>0.05$) Table 1. This shows that the fertilizer regime for hairless grass should be increased to improve the plant's growth capacity to 30 tons/ha, as referred by FAO [10].

3.2. Effect of Fertilization Regime on Yield of Hairless Grass

The green matter yield, dry matter yield and protein yield of hairless grass obtained with different fertilization regimes are presented in the following Table 2 shows that green matter yield, dry matter yield and protein yield of hairless grass differ between different organic fertilization regimes ($P<0.05$). When the amount of organic fertilizer is increased, the yield indicators of hairless grass increase, increasing the highest at the fertilization regime of 50 tons/1ha. However, the organic fertilizer regimes of 30 tons/1ha and 50 tons/1ha are equivalent, and there is no statistically significant difference ($P>0.05$). Le, et al. [4] recommended that green matter yield, dry matter yield and protein yield have many fluctuations depending on the fertilization regime of 10, 20 and 30 tons/1ha of *B. ruziziensis*, *B. decumbens*, *B. brizantha* and Mulato grass varieties, the highest at the fertilization regime of 30 tons/1ha. The green matter yield of *Paspalum atratum* under organic fertilizer regimes of 10, 20 and 30 tons/ha was 115.5, 156.9 and 185.8 tons/ha/year [11]. Under organic fertilizer regime of 40 tons/ha, lemongrass (Mombasa, Hamil and K280) had a green matter yield of 136.08 - 168.66 tons/ha/year, dry matter yield of 27.22 - 36.92 tons/ha/year and protein yield of 2.99 - 4.56 tons/ha/year [12]. Research results of Nghi, et al. [13] also gave similar results. The author recommended that when increasing the amount of organic fertilizer, grass varieties' green matter yield increased the most at the fertilizer level of 30 tons/ha, Table 2. Green matter yield, dry matter yield and protein yield varied depending on grass varieties and planting distance [14, 15]. Green matter yield, dry matter yield and protein yield of Brachiaria Mulato II grass were 271.7; 58.4 and 6.6 tons/ha, respectively [14]. According to Hue [5] green matter yield, dry matter yield and protein yield of guinea grass were 360, 73.94, and 8.74 tons/ha/year, respectively. The yield of *S. guianensis* CIAT 184 grass, green matter is 74.5 tons/ha, and protein is 1.85 tons/ha [16]. According to Nguyen, et al. [6] the green matter yield of Panicum maximum TD58 grass is 64.3 tons/ha/year, Mulato II grass is 56.3 tons/ha/year, and *B. brizantha* is 51.2 tons/ha/year. According to Nguyen , et al. [12] the green matter yield, dry matter yield and protein yield of *Panicum maximum* TD58 grass are 196.2, 37.94, 2.76 tons/ha/year, respectively; Paspalum grass is 181.4, 31.54; 2.55 tons/ha/year, respectively; Ruzi grass is 166.7; 31.72; 2.49 tons/ha/year, respectively and Mulato II grass is 161.5; 31.24; 2.98 tons/ha/year, respectively. The above analysis results show that increasing the fertilizer regime for hairless grass is necessary to increase the plant's productivity to 30 tons/1ha and ensure fertilizer savings.

Table 2.
Effect of Organic Fertilization Regime on Yield and Nutritional values of Hairless grass

Variables/fertiliser regimes	10 tons	20 tons	30 tons	50 tons	P
Green productivity (ton/ha/year) M ± s.e.	123.60^{ab}±3.72	115.39^{b} ±3.79	137.07^{ac}±3.79	138.42^{c}±3.79	0.000
Dry matter productivity (ton/ha/year) M ± s.e.	29.88^{ab} ±0.91	28.50^{b} ±0.93	35.64^{c} ±0.93	32.47^{ca} ±0.93	0.000
Protein productivity (ton/ha/year), M ± s.e.	8.92^{a} ±0.27	8.86^{a} ±0.28	10.21^{b} ±0.28	10.37^{b} ±0.28	0.000

Note: M (mean) and SE (standard error); a, b, c, ab, ac: numbers with different superscript letters in the same row are statistically different ($P < 0.05$).
The effect of fertilizer regime on the nutritional value of hairless grass

The nutritional value of hairless grass was analyzed under different organic fertilizer regimes, averaged, and shown in Table 3. Table 3 shows that the nutritional value of the grass fluctuates through different organic fertilization regimes. DM, NDF, and Ash decrease when the fertiliser content per hectare is increased, while CP and EE increase according to the fertilizer regime. The DM, CP, NDF, and Ash content of Ruzi grass is 21.6; 10.8; 75.5; 10.2%, respectively; *Paspalum atratum* grass is 15.9; 11.6; 69.4; 10.5%, respectively, and Setaria grass is 17.2; 11.5; 72.0; 12.0%, respectively, by Nguyen, et al. [6]. According to Nguyen and Dao [9] DM, CP, NDF, and Ash of Panicum maximum TD58 grass are 23.70; 7.28; 61.40; 8.48%, respectively; Paspalum grass is 20.63; 8.10; 56.57; 8.99%, respectively; Ruzi grass is 23.20; 7.86; 56.60; 7.40%, respectively; and Mulato II grass is 22.33; 9.54; 56.26; 8.01%, respectively, Table 3. Thus, increasing the amount of fertilizer has increased the yield and improved the nutritional composition of hairless West grass.

Table 3.
The Effect of Fertilizer Regime on the Nutritional Value of Hairless Grass (%).

Variables/fertiliser regimes	10 tons	20 tons	30 tons	50 tons	Average
DM	26.23	28.27	25.38	25.23	26.28
CP	7.53	7.73	7.92	8.54	7.93
EE	1.13	1.20	1.24	1.26	1.21
NDF	72.53	70.97	70.87	70.44	71.20
Ash	9.52	9.14	8.73	8.66	9.01

3.3. Evaluation of the economic efficiency of hairless West grass

The cost of grass production is calculated based on the input investment, the cost of planting, caring for and harvesting grass, and the cost of harvesting grass to calculate the economic efficiency of grass growing at the time of the study. Growing hairless grass as feed for cows in households makes it possible to estimate the economic efficiency of hairless grass with an organic fertilizer regime of 30 tons/1ha, with the amount of grass planted 1ha in a 1-year cycle shown in Table 4.

Table 4.
Economic efficiency of Hairless grass (1ha/year).

Variables	Numbers	Price and costs	Amount of income
Total costs			68,300,000 VND
Land rent	1,000 m^2	2,000 VND/m^2/month	20,000,000 VND
Seed	1,000 kg	10,000 VND/kg	10,000,000 VND
Organic fertilizer	30 tons	300,000 VND/ton	9,000,000 VND
Labours	20 days	300,000 VND/day	6,000,000 VND
Pences	6 days	300,000 VND/day	1,800,000 VND
Care and planting, seeding and intercropping	50 0days	300,000 VND/day	15,000,000 VND
Water spraying			3,000,000 VND
Materials and harvesting	03 units	500,000 VND	1,500,000 VND
Other costs		`	2,000,000 VND
Total income			137,000,000 VND
Grass income	137 tons/batch	1,000 VND/kg	137,000,000 VND
Total cost per kg of grass			498.5 VND
Benefits		VND	68,700,000 VND

Table 4 shows that the cost to produce 1 kg of hairless grass is 498.5 VND, which is suitable for the current livestock situation; if calculating the profit cost for 1 hectare of grass, it is 68,700,000 VND. Of these, labour 0costs are the highest, accounting for 37.79% of production costs. Our research is also consistent with the studies of other recommendations.

4. Conclusion

Hairless grass was grown in Thua Thien Hue with different organic fertilizer regimes of 10, 20, 30 and 40 tons of organic fertilizer/1ha in a 1-year cycle. The research results showed that increasing the amount of fertilizer increased the growth capacity, nutritional quality, yield and economic efficiency of hairless grass ($P<0.05$). Increasing the amount of organic fertilizer to 50 tons/ha is no different from 30 tons/ha. The fertilization regime of 30 tons/ha of hairless grass has brought high economic efficiency in livestock farming.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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