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ECONOMIC ANALYSIS OF FORAGE PRODUCTION CULTIVATED IN NUTRIENT SOLUTION BASED ON RUMINANT URINE

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ABSTRACT

The objective of this study was to conduct an economic analysis of forage production cultivated in a nutrient solution based on ruminant urine. The experimental treatments that served as a basis for costing consisted of different nutrient solutions (cow urine, sheep urine and commercial nutritional solution – CNS), to obtain the following variables: water quantity (m^3/ha^{-1}) and economic aspects of forage production in the hydroponic system based on ruminant urine. The partial budget analysis was used to evaluate the expected changes in costs and returns by introducing some changes in the production system. The treatments in which corn hydroponic forage was cultivated with nutrient solution from sheep and cow urine presented satisfactory economic results, because they presented better yields and lower costs compared to the commercial nutrient solution. These values make the use of ruminant urine economically viable, because it provides better benefit and economic the return, without compromising the production the hydroponic forage of maize.

Keywords: Agricultural residues, Cultivation without soil, Hydroponics, Sustainable systems

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1. INTRODUCTION

In Brazil, the main food of ruminants is usually forage plants, however this demand for production is linked to climatic conditions, mainly in regions with low rainfall index, as well as in northeastern region. Due to climatic conditions, there is unfeasibility in production of foods for animals, in view thereof, the hydroponic corn forage present itself not just the choice for herd fatting and of the few alternatives for herd survival of the little producers in drought seasons [1]. Being that the pastures dry in the drought periods and are with bigger fiber content and little nutrients content, reducing produce capacity of meat and milk.

In order to alleviate this problem, several alternatives have been pointed out and used to supply the food deficit in the herds and one of them is the production of hydroponic forage [2]. In that context, the production of hydroponic forage arises as an alternative for the increase of animal production. This hydroponic farming system has already spread throughout the world and is being adopted in Brazil as reduction rational technology for use of water, space, time, nutrients and manpower. Another important aspect to be taken into account is that the agricultural activity has demanded for external agricultural materials and natural resources that increase the cost of production, besides social demands that insist on the charge of produce in order not to exhaust the natural resources, but to enjoy with greater efficiency, adopting precise techniques and incentive to reuse products and by-products from livestock, agroindustry, fruits and vegetables to mitigate social, environmental and economic problems linked to the activity.

In this context, as already mentioned, the cultivation of hydroponic forage has been alternative food production for animal feed, because according [3], it's about a production technology that stand up for to present advantages, as: short cycle, continuous production out of time with lower meteorological adversities risk, applies in any season, adapts to various plant species, requires low water consumption, high productivity, exclusion of pesticide use and of investments in machinery for the execution of the conservation processes of forage or its storage. Based on the above, the objective was to carry out an economic analysis of forage production cultivated in nutrient solution based on ruminant urine.

2. MATERIAL AND METHODS

2.1 Location and duration

The experiment was carried out in greenhouse, in the Center of Agrarian and Environmental Sciences of the Federal University of Maranhão, during the period of August / September 2017.

2.2 Experimental design and treatments

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The experiment was arranged in a completely randomized design with 4 treatments and 8 replications. The experimental treatments consisted of different nutritive solutions, being:

T1 – Water

T2 - Commercial Nutrition Solution (CNS),

T3 – Urine of sheep (USH) and

T4 – Urine of cow (UCO).

2.3 Experimental system

Manual seeding was carried out at a density of 0.5 kg/m^2, in polypropylene trays with a total area of 0.12 m^2, with corn seeds, Agroceres AG1051, placed on a substrate layer 3 cm thick before and 2cm after sowing, with the highest possible uniformity, distributed according to the experimental treatments, being, the substrate was constituted of crushed grass. The seeds underwent a pre-germination process, to accelerate the germination, where they were in plastic bags and submerged in water for 24 hours, after water runoff and rest for another 24 hours and cultivation and harvesting were performed, according to the methodology recommended by [4].

The control treatment consisted only of water, sheep and cow urine were diluted 1% (one liter of urine in 100 liters of water) and the commercial nutrient solution, in the dosage of 1kg/1000 liters of water and prepared according to the manufacturer's recommendation, whose guarantee levels are described in table 1.

Irrigation in the first three days was done only with water and thereafter with nutrient solution, in the frequency of three daily irrigations, applied using a volume of 1.0 L/m^2 in each irrigation.

Table 1: Commercial nutrient solution guarantees levels

Nutrients	%
Total Nitrogen - N (water)	10
Phosphorus - P_2O_5 (water)	2
Potassium - K_2O (water)	30
Boron - B	0,03
Sulfur - S	3
Iron - Fe	0,2
Magnesium - Mg	1

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2.4 Measurements and data collection

On the 15th day after sowing, in the morning period, the harvest was performed without previous irrigation of the plants. During harvest, the production of natural matter/m^2 was determined by means of weighing on digital scale with capacity of 40 kg, all the forage produced in the experimental plot in order to quantify thegreen production of forage biomass (PFB).

The amount of water was calculated in m3, where the values of the tariffs were used taking into account the wholesale price to systems not operated by the Environmental Sanitation Company of Maranhão (CAEMA), published in the electronic page of the concessionaire and public service providers, as defined by Law 13673 of June 5, 2018 [5].

The evaluation of the economic viability of the use of nutrient solutions in the production of hydroponic fodder was the budget analysis. The partial budget analysis was used to evaluate the expected changes in costs and returns by introducing some changes in the production system [6]. Partial budget reports the marginal concept in which only the changes are evaluated, in this analysis, only changes in income and expenditures are included, not total values. The end result is an estimate of gain or loss in the benefit (profit) [7, 8].

The economic viability of the change is simply calculated with the total of the revenue minus the total costs. The only variations were the addition of CNS, in replacement of ruminant urine (sheep and cow) compared to exclusive use of water (control), in the forage biomass (PFB) production costs; the others were the same. The income was calculated by estimating the cost of PFB (US$/kg) compared to the cost of corn silage (US$/kg).

2.5 Statistical analysis

The data obtained for the production of forage biomass (PFB), were submitted to analysis of variance and the means were compared by the F test, using the statistical program SISVAR version 5.6 software [9].

3. RESULTS AND DISCUSSION

The medium yield of green forage, consumption and water costs, in function of nutritious solutions in production hydroponic forage, are presents in table 2.

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Table 2: Medium yield estimated green forage (PFB), consumption and economics water costs of hydroponic forage

Variables	Hydroponic Nutritious Solutions				Pr>F
	Water	CNS	USH	UCO	
PFB (ton/ha^{-1})	69.53^{a}	49.19^{b}	67.05^{a}	64.89^{a}	0.0000
Water Consumption (m³/Ton/PFB)	0.0503	0.0711	0.0522	0.0539	-
Water cost (US$/m^{3})	0.019	0.027	0.023	0.020	-

Water value US$ 0.39/m^{3} (tariff CAEMA). US Dollar Quotation – US$1.00 = R$ 3,78 in 11/16/2018.

A significant effect was observed for the yield of green forage, where the production of fertirrigated hydroponic forages with commercial nutrient solution presented lower productive performance, while the others (control and urine of sheep and cattle) did not differ statistically.

What likely justify these results is that the commercial nutrient solution is not specific to maize, but to horticulture. What likely justify these results is that the commercial nutrient solution is not specific to maize, but to horticulture. However, observed that the urines of sheep and cow, feed the nutritional necessities of hydroponic corn forage, without harm your performance, allowing an increase in production.

When evaluating the yield of maize grown in a hydroponic system, fertirrigated with increasing doses of human urine diluted in water [10], observed that concentration of 3% urine provided gain of green bulk in aerial part of the forage and the others caused loss bulk, in comparison with the witness, according to the authors, a probable explanation for the decrease in the yield of green bulk and dry of the aerial part of the forage, with the increase of the applied concentrations, are the high concentrations of chloride and sodium.

Table 3: Analysis of partial budget

Items	Hydroponic Nutritious Solutions			
	Water	CNS	USH	UCO
Partial Revenue	10,429.50	7,378.50	10,057.50	9,733.50
Partial Cost	142.35	188.04	155.22	196.58
Partial Profit	10,287.15	7,190.46	9,902.28	9,536.92
Benefit in relation the CNS	-	-	2,711.82	2,346.46

(Tonne price/hydroponic forage of US$ 27.78)

Partial revenue = yield of natural phytomass x price kg of the hydroponic forage

Partial cost = water Cost + cost of the nutrient solution (commercial and of the sheep and cow urine)

Partial profit = partial revenue – partial cost

The analysis of the partial budget was utilized, in this case, for being harnessed as economic evaluation of determined a change in the context studied, in the case addition nutritious solutions, in which same could modify the revenue and the cost in relation upon control treatment. According [6], the analysis of partial budget identify and qualify all the gains and costs resulting from the changes made, in this case, utilized the addition nutritious solutions commercial and natural - urines of sheep and cow, showing whether the changes made resulting in answer viable or not economically with your utilization. The main focus of this analysis was to show whether the CNS and the urine of ruminants used caused economic benefit or not.

The treatments in which the hydroponic corn forage was cultivated with nutrient solution from urine of sheep and cow, presented satisfactory economic results, because presented best yields and lower cost compared with commercial nutrient solution. These data make viable economically the utilization of ruminant urine, mainly of the sheeps for providing better benefit and return. Authors as [11], they evaluated the yield of hydroponic green forage of corn in cow residual water with different concentrations of nitrogen and concluded that these solution type can be utilized in replacement the standard nutrient solution, without the need for nitrogen enrichment. However, [12] observed that the increase in the concentration of serum of cow milk in replacement the nutrition solution in the cultivated of hydroponic corn forage, promoted reduction in the productivity of hydroponic forage.

Regarding water consumption, was observed that treatment with commercial nutrition solution, required a higher amount of water for to produce one tonne of green natural forage, and consequently a higher cost compared to the other treatments. In this context, lower water consumption for production hydroponic forage were obtained with nutrient solutions based on urine from sheep and cows, being recommended for regions with low water potential. These results are corroborated by [13], who recommend the cultivated of hydroponic forage for regions with low water availability due to their low consumption, 3-4 L/m^{-2}, very short period of time, and for regions very cold and with low fertility soils.

4. CONCLUSION

It is recommended to use ruminant urine as a nutrient solution in the production of corn hydroponic forage to increase yield and provide a better economic return when compared to commercial nutrient solution.

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