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# Productivity and Structures of Marandu Grass Fertilized with Poultry Manure Both with and Without Soil Chiseling

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Additional information is available at the end of the chapter

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## Abstract

With annual increase in production poultry the use of manure can be for the fertilization of pastures. The objective of this study was to evaluate the production of Marandu grass fertilized with poultry manure applied to the soil with and without soil chiseling, between September 2012 and September 2013. The study design was a randomized block with four replications in a 5 × 2 factorial arrangement with five doses of manure (0, 1.073, 2.074, 4.148, 6.222 t ha<sup>-1</sup>) both with and without soil chiseling. The cuts were made with light interception of 95% of the canopy with a depth of residue of 0.15 m. With accumulated production during the period there was no interaction (Dose × Management, Cutting Number, Dry Mass (Total and Waste), Leaf Blade (Total and Waste) and Mass Dead of Waste). The application of poultry manure doses caused changes in the stem and the sheath (total and waste) and mass dead total as well as the production of dry mass, blade blade and stems and sheath. All set to the linear model, and the production of dry mass and blade blade 19.31 and 13.52 Mg ha<sup>-1</sup> at the highest dose of manure. Poultry manure can be an alternative fertilizer for productive of the leaf blade recovery of Marandu grass.

**Keywords:** fertilization, forage crops, management, forage mass, soil

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## 1. Introduction

Globalization has promoted the need for agricultural systems to become efficient and highly productive. Addressing the ratio of production to the environment and creating links between different supply chains, whilst maintaining their sustainability, is a challenge for any agro-industrial system model.

In the Brazilian agricultural production context, in 2012, highlighting poultry, there were 5.23 billion slaughtered animals and the production of eggs and number of hens was 499.85 million [9]. According to [11], broiler breeding produces on average four tonnes of bed per year per 1000 birds. It has been calculated that 1000 hens produce about 0.12 t day<sup>-1</sup> of manure [14]. Every year 42.85 million tonnes (t) of solid waste is generated in Brazil which could be used both in agriculture and in pastures.

There is a need to research development enabling the use of agricultural waste, so it becomes possible to improve the physical, chemical and biological aspects of tropical soils. Organic fertilizers can provide a greater contribution under these conditions when compared to mineral fertilizers [10]. The use of residue in agricultural soils is favored because of the low cost of manure from farms, with the buyer being responsible for low-density transport and huge volume.

The use of solid manure is a cost-saving alternative to fertilized pastures [2]; poultry manure has higher levels of organic matter, total nitrogen, total phosphorus and carbon than other types of manure [3]. According to the Ministry of Agriculture Livestock and Supply [6], it is permitted to use poultry manure on pastures and forages with a grace period of 40 days after application and incorporation.

The mechanical soil incorporation of poultry manure on recovering areas can be performed with the use of light tiling with a disc harrow or chisel plow. In this process the disc harrow causes greater movement of soil and forage, due to cutting by the action of the discs, while the chisel plow opens small grooves preserving forage crops on the soil surface.

The *Brachiaria brizantha* cv. Marandu, with 30 years of cultivation in Brazil, is the forage crop used most favorably by producers, who do not practice soil fertility control and proper pasture management. There are information gaps on the structural characteristics of the crop during regrowth under nitrogen and pasture management [1]. It is known that the maximum rates of dry matter forage accumulation are associated with light interception in 95% of incident radiation [19, 23].

Although there is a complex dynamic process between soil, plants, climate and animals it is also important to know the mechanical and fertilization alternatives for the recovery of the forage. As the dry matter production of Marandu grass fertilized with chicken manure and managed with, and without soil chiseling, in light interceptions of 95% at canopy height up to 0.15 m, total dry mass of the canopy at ground level and dry mass residue to height of 0.15 m, and their structures as Leaf Blade, Stem + Sheath and dead material. Assessing how the chicken manure applied on grass Marandu changes its production within this system.

## 2. Productivity and structures of Marandu grass

The experiment was conducted in an area of 0.16 hectares cultivated with Marandu grass which had experienced 10 years of grazing, had a slope of 5% in dystrophic Red Latosol with the presence, in the 0.0-0.2-m layer, of 87.25%, 1.00% and 11.75% sand, silt and clay, respectively.

Chemical analysis of soil collected at 0.0-0.2 m, showed average levels of pH (H<sub>2</sub>O) = 6.00; C = 8.23 g dm<sup>-3</sup>; P = 6.28 mg dm<sup>-3</sup>; H<sup>+</sup>+ Al<sup>3+</sup> = 2.54 cmol<sub>c</sub> dm<sup>-3</sup>; Ca<sup>+2</sup> = 0.87 cmol<sub>c</sub> dm<sup>-3</sup>; Mg<sup>+2</sup> = 0.57 cmol<sub>c</sub> dm<sup>-3</sup>; K<sup>+</sup> = 0.13 cmol<sub>c</sub> dm<sup>-3</sup> and Fe = 180.86 mg dm<sup>-3</sup>; Zn = 4.04 mg dm<sup>-3</sup>; Cu = 3.20 mg dm<sup>-3</sup>; Mn = 144.21 mg dm<sup>-3</sup>; S-SO<sub>4</sub><sup>2-</sup> = 3.25 mg dm<sup>-3</sup>.

The poultry manure Hy Line W36 lineage posture with cages, was stored in the shade for 45 days and covered with canvas. Chemical analysis of the manure was found to introduce the following: pH (H<sub>2</sub>O) = 6.98; organic material = 60%; N<sub>total</sub> = 6.64%, P<sub>2</sub>O<sub>5</sub> = 2.41%; K<sub>2</sub>O = 3.73%; CaO = 3.53%; MgO = 5.51%; C/N = 4.96:1; Cu = 220.10 mg kg<sup>-1</sup>; Mn = 1226.90 mg kg<sup>-1</sup> and Zn = 368.00 mg kg<sup>-1</sup>.

Toraise the saturation of soil bases by 50% manual application of 0.490 t ha<sup>-1</sup> of dolomitic lime (32% CaO and 15% MgO) was applied to the Marandu grass in August 2012. After 25 days a standardization cut was made using rotary mowers to 0.1 m above the ground.

The application of organic fertilizer rates should be determined based on the need for production and forage cutting in order to avoid the associated risks of soil and water contamination [8]. According to [5], the contamination problem is restricted to some micronutrients and especially to macronutrients such as nitrogen and phosphorus.

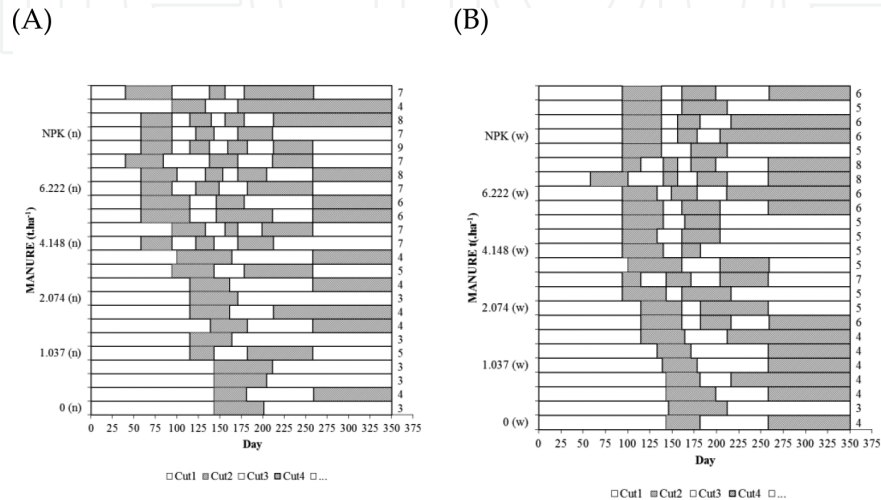
A dose of 50 kg ha<sup>-1</sup> of P<sub>2</sub>O<sub>5</sub> was based on maintaining species of Group III [13, 16] present in 2.074 t ha<sup>-1</sup> manure. The experimental design was a randomized block with four replications in a 5 x 2 factorial arrangement, comprising five doses of manure (0, 1.037, 2.074, 4.148, 6.222 t ha<sup>-1</sup>) and two management regimes with and without soil chiseling. A treatment was added of mineral fertilization of Nitrogen (N), phosphorus (P) and potassium (K) contained in 2.074 t ha<sup>-1</sup> of the poultry manure: 138 kg ha<sup>-1</sup> (N), 50 kg ha<sup>-1</sup> (P<sub>2</sub>O<sub>5</sub>), 77 kg ha<sup>-1</sup> (K<sub>2</sub>O).

At the end of September application was made of 0.270 t ha<sup>-1</sup> of gypsum and a unique manure dose, as well as a treatment with mineral fertilizer P<sub>2</sub>O<sub>5</sub> and 1/3 of the N and K<sub>2</sub>O, parceled every 60 days. Soil chiseling was then undertaken in the corresponding portion using a tractor to plow (Subsoiler Tandem IKEDA brand, DPT320M). This featured a cutting disc, positioned at each helical rod to cut and not accumulate spall the Marandu grass and inclined ferrule steel blades to 0.2 m depth.

A productive evaluation of Marandu grass was via alight interception (LI) of 95% by the canopy of Marandu grass [23]; measured using an AccuPAR model LP - 80 PAR/LAI Ceptometer with weekly evaluations being made via readings above the level canopy and below the soil surface in each plot. The residual height was 0.15 m [23] and was lowered [7] by the use of a mechanical trimmer followed by manual removal of all biomass.

Three to nine cuts (95% IL) were performed between the control combination (without manure) and chiseling with the largest poultry manure dose given without chiseling (**Figure 1**). There

was an increase in number of cuts (NC) with an increase in poultry manure doses and soil management with scarification over a uniform cutting period within treatments. With a dose of 6.222 t ha<sup>-1</sup> of poultry manure and mineral fertilizer (NPK), without scarifying, the first cut occurred at 40 days and without the use of manure the period was longer with 143 days after the application of manure with and without chiseling. Among the manure doses given accompanied by physical changes to the soil via chisel plowing there was a longer period for early cutting compared to that without physical soil management.



**Figure 1.** Section period of Marandu grass fertilized with poultry manure and soil management: A - without (n) and B - with soil chiseling (w).

With a dose of 6.222 t ha<sup>-1</sup> of poultry manure and mineral fertilizer (NPK) without scarifying the first cut occurred at 40 days and without the use of manure the period was longer with 143 days after the application of manure both with and without chiseling. Among the manure doses accompanied by physical changes of soil by chisel plowing the period was longer for early cutting compared to that without the physical soil management.

The highest average interval between cuts was 177 days for lower doses of manure and control. According to [19], under this situation the chance of the plant community in any way replacing the used reserves in the recovery of a new canopy are greater, creating changes to accumulation patterns. The lowest average interval between cuts was 44 days accompanied by the higher dose of manure and chemical fertilizers. According to [7], the greatest Marandu grass efficiency is achieved with more frequent cuts. The results confirm [23] dependence of Marandu grass on the natural soil fertility and higher nitrogen fertilization for new structures of the canopy divide the incorporation of nitrogen in organic compounds largely occur in young cells and the growth of roots.

The favorable weather conditions in this region also contributed to the frequency of cuts between 90 and 210 days mainly via high temperatures and rainfall. After this period of time, the frequency was compromised by low temperatures, around 20 °C, typical to this region, with prevailing climatic characteristics, C famesothermal humid subtropical (Köppen classifica-

tion). Regarding soil management with and without soil chiseling, the possibility of increased use of pasture was identified with treatments of 6.222 t ha<sup>-1</sup> poultry manure and mineral chemicals (NPK) - both with application on Marandu grass and without the mechanical handling of soil scarification.

With a dose of manure of 6.222 t ha<sup>-1</sup>, the results of number of cuts (NC) are similar to those found working with a cutting interval expressed in days, varying according to wet and dry seasons, totaling 6-7 cuts over a year evaluation [18, 22]. Despite the relevance of this work, the cuts made at IL 95% consider the physiological aspects of forage during the highest production levels with greater production of leaf.

The difference in management, and the increased availability of macronutrients and mineralized micronutrients, has contributed to the evolution of the leaf area index (LAI) and light interception (LI), provided by higher tillering due to larger spaces LI and structural restoration sward in less time by the appearance of younger leaves. In grass Marandu cuts to 0.15 m high [7] it was observed more stable populations of tillers, confirming [21], with lower grass level in maintained pastures, higher population density of small tillers the greater incidence of light within the sward.

According to [19] the role of the leaves in increasing the LAI is key, while high growth rates can be achieved in a LAI that causes almost total interception of the incident light. Thus, canopies where cutting or grazing occurs over shorter intervals, keeping an IL close to 95%, will be more efficient in assimilating carbon [20]. However, as the regrowth time is shorter the result is a lower average rate of forage accumulation.

According to [15], the recovery of the leaf area index (LAI), which can be defined as the land area occupied by leaves, with 95% IL, the removal of part of the biomass produced as a result of cutting or grazing, is variable due to environmental conditions - especially soil nitrogen availability.

In forage mass production, quadrats were used 0.25 m<sup>2</sup> (0.50x0.50 m), allowing a total of four samplings per plot, and two samples at ground level IL 95% and two 0.15 m. In each forage sample two aliquots were withdrawn, one for determining the dry mass at IL 95% for stem and sheath total (SST) and the residue of 0.15 m stem and sheath residue (SSR) and the other for separation of the morphological components of forage. A subsample of IL 95% and residue of 0.15 m was carried out via manual separation for structural characterization: green leaf blade (LB) fraction, green stem and sheath (SS) and dead (D) material. There were weighed and placed in a forced air circulation oven at 55 °C for 72 hours for subsequent weighing of the dry fractions. The dry mass amounts of forage and structural features were retained and converted to Mg ha<sup>-1</sup> to compare the results.

The poultry manure doses caused significant change to biomass accumulation IL 95% SST and dead material total (DT), the residue of 0.15 m for SSR and production of dry mass (DM), LB and SS. There was interaction with the mechanical handling in the number of cuts, total dry mass (DST), leaf blade total (LBT), dry mass residue (DMR), leaf blade residue (LBR) and dead material residue (DR). Dead material (D) was not significant, being assigned to the handling system with IL 95% and reinforcing the conclusions from [19] and [23].

	Mean squares			Re	CV (%)	Manure Dose (t ha <sup>-1</sup> )					NPK
	Dose (DO)	Management (M)	DOXM			0	1.037	2.074	4.148	6.222	
(n)	15,13	0,08	2,33	0,96	18,54	3,25 a	4,00 a	4,00 a	6,50 b	7,75 b	6,50 b
NC						3,75 a	4,50 a	5,50 ab	5,25 ab	6,75 b	5,75 ab
(w)											
(n)	814,07	23,26	120,04	42,61	16,37	23,86 a	30,08 a	32,62 a	49,97 b	56,62 b	50,30 b
DMT						27,21 a	33,74 ab	41,04 ab	40,99 ab	45,61 b	46,51 b
(w)											
(n)	209,86	0,12	26,92	8,74	20,33	6,60 a	9,50 a	9,97 a	17,86 b	22,82 b	20,17 b
LBT						8,21 a	11,95 ab	15,50 bc	15,76 bc	18,92 c	17,21 bc
(w)											
SST	96,61	7,08	8,55	4,32	19,07	6,24 a	7,94 ab	9,76 bc	12,59 cd	15,04 d	13,85 d
DT	21,22	6,40	14,44	7,76	19,31	11,88 a	13,23 a	14,33 a	16,07 a	15,20 a	15,85 a
(n)	331,02	41,51	75,42	22,993	20,27	14,16 a	17,07 a	18,56 a	31,38 b	37,15 b	29,15 b
DMR						16,42 a	19,75 ab	22,96 ab	23,76 ab	26,44 ab	26,98 b
(w)											
(n)	27,85	4,65	9,65	2,16	29,96	2,58 a	2,57 a	3,09 a	7,33 b	9,08 b	6,66 b
LBR						3,07 a	3,70 ab	4,68 ab	4,29 ab	5,62 ab	6,23 b
(w)											
SSR	52,83	5,50	4,96	3,00	27,87	3,14 a	4,10 a	4,85 ab	7,38 bc	9,70 c	8,13 c
(n)	35,44	3,80	13,43	5,51	18,76	8,32 a	10,16 ab	11,88 abc	15,73 cd	17,03 d	13,64 bcd
DR						10,31 a	11,66 a	12,67 a	13,02 a	12,43 a	13,31 a
(w)											
DM	116,05	2,62	8,60	9,31	18,81	10,24 a	13,50 ab	16,07 bc	17,90 bc	19,31 c	20,33c
LB	87,89	6,32	8,22	4,48	21,99	4,58 a	7,33 ab	9,11 bc	11,00 cd	13,52 d	12,24 cd
SS	8,01	0,10	0,82	1,58	26,91	3,10 a	3,84 ab	4,90 ab	5,20 b	5,33 b	5,71 b
D	4,75	0,33	2,71	3,76	101,46	-	-	-	-	-	-

Notes:

Re = residue; CV = coefficient of variation; NPK =mineral source;

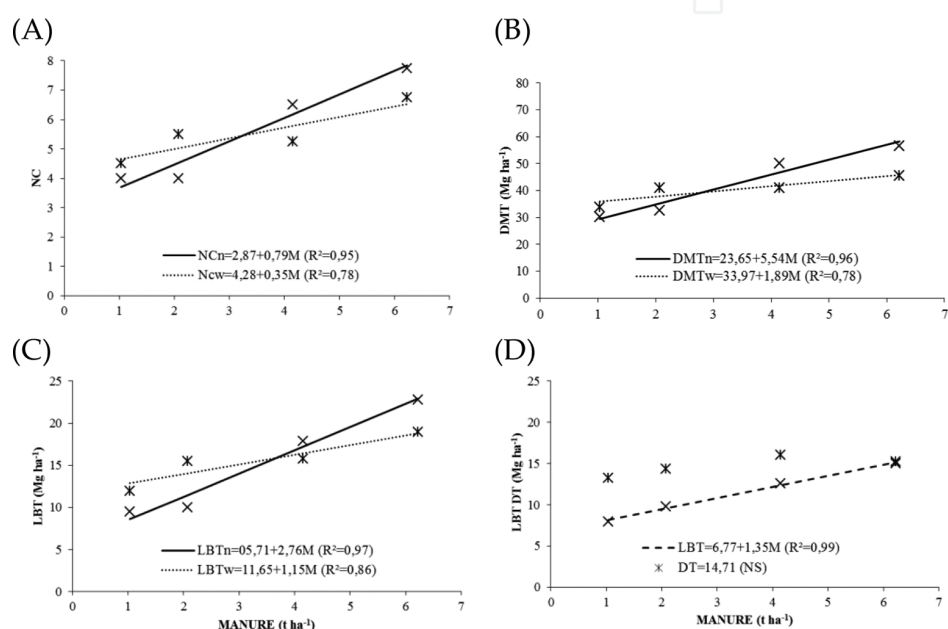
\* significant ( $p < 0.05$ ); means followed by the same letters in the row do not differ by Tukey test ( $p > 0.05$ ); n – management no soil chiseling; w – management with soil chiseling.

**Table 1.** Summary of the analysis of variance and test for number of cuts (NC), dry mass cumulative (DM), leaf blade (LB), stem and sheath (SS) and dead material (D) with IL95% (T), residue (R) between the two management systems for Marandu grass fertilized with poultry manure without dose (n) and soil chiseling (w).

With an equivalence of NPK minerals contained in a dose of 2.074 t ha<sup>-1</sup> of poultry manure, chemical treatment (NPK) was similar to the highest doses of manure to NC values, dry herbage mass and structural characteristics between the management systems, all except DR (Table 1). The 60-day periods of application at 1/3 dosage for N and K contributed to the

availability of these macronutrients for Marandu grass. The results were in accordance with those reported by [12] in which the chemical fertilizer, with a dose of 100 kg ha<sup>-1</sup> N, was higher than the corresponding dose of 5 t ha<sup>-1</sup> of poultry litter.

With IL 95%, increasing the application of poultry manure doses promoted an increase in the number of cutson no soil chiseling (NCn) and with soil chiseling (NCw) with adjustments to linear models (**Figure 2A**). Being assigned mineralization of increasing amounts of macronutrients and micronutrients supplied on the highest doses of manure to Marandu grass. According to [15], the recovery of blade area index is partly dependent on soil nitrogen availability evidenced by higher emission ranging from young leaves intercept light from the sun.



**Figure 2.** Assessment of Marandu grass fertilized with poultry manure with IL 95% for: A. number of sut (NC), B. dry mass total (DMT); C. leaf blade total (LBT) and D. stem and sheath total (SST) and dead material total (DT). Applied manure (M) and management with no soil chiseling (n) and with soil chiseling (w).

The most NCn in relation to the NCw between doses of 1.037 and 6.222 t ha<sup>-1</sup> is related to the physical changes caused by the plow chisel shank, which can be unbundled from the soy, next to the ground roots. This justifies the reduction in NC even with increasing doses of manure. With fertilization lower than 3.20 t ha<sup>-1</sup> NCw is greater than NCn, the increased macroporosity of 0.04 m m<sup>-3</sup> (layer 0.0-0.20m) provided by greater microorganism action in the decomposition of organic matter in this layer even with a low manure dose applied to the surface soil with grass Marandu. The occurrence of this new recycling of nutrients by physical alteration of the soil is because of the new interaction and development of decomposing microorganisms populations of organic matter in soil [4].

Regarding dry mass without soil chiseling (DMTn) and with soil chiseling (DMTw), linear models demonstrate that the increase of manure and soil management offered favorable production conditions (**Figure 2B**). Regarding the applied dose range of 1.037-6.222 t ha<sup>-1</sup> of poultry manure, there is an increase of 26.53 Mg ha<sup>-1</sup> DMTn and 11.86 Mg ha<sup>-1</sup> DMTw. Accord-



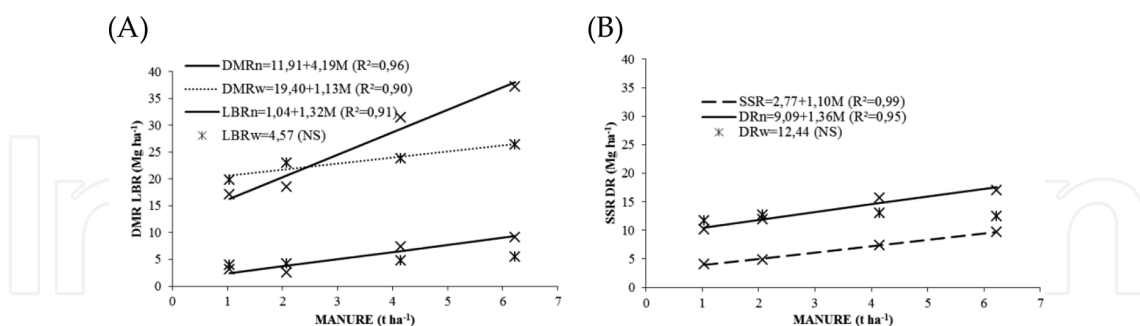
ing to [1], this increase is probably because of the increase in blade area and better relationship between carbon and nitrogen and new tillers and leaves, especially in higher doses.

The DMw exceeds DMTn when fertilization with manure is less than 2.82 t ha<sup>-1</sup>. Indeed the physical changes in the soil allow the mineralization of organic nutrients for microorganisms and higher conditions for absorption even at low doses of manure. With higher fertilization doses than 2.82 t ha<sup>-1</sup> DMTn was greater than ground DMTw.

There was an adjustment to linear models for blade production total accumulated without soil chiseling (LBTn) and with soil chiseling (LBTw). With poultry manure doses, there was production of 14.33 Mg ha<sup>-1</sup> for LBTn and 5.96 Mg ha<sup>-1</sup> for LBTw, which corresponded to an increase of 140.37% in the management without soil chiseling (**Figure 2C**). The LBTn and LBTw increased according to manure dose increase, with similar values managing with a dose of 3.68 t ha<sup>-1</sup>.

The increase in poultry manure doses promoted linear increase in the SST production of Marandu grass (**Figure 2D**). The increase of SST among the tested doses was 7.09 Mg ha<sup>-1</sup>, an increase of 89.24%, caused by higher timbering due to the greater availability of nutrients coming from manure and performed by NC. In the case of total cumulative dead material (DT), no adjustment to the two proposed designs with an average of 14.71 Mg ha<sup>-1</sup>.

For DMR, without soil chiseling (DMRn) and with soil chiseling (DMRw), linear models increased according to the increasing doses of poultry manure (**Figure 3A**). The DMRn and DMRw are similar for applications of 2.44 t ha<sup>-1</sup>, and in a dose of 6.222 Mg ha<sup>-1</sup> DMRn and DMRw is greater than 43.55%. The results differ from [17] who found no differences between the forms of application of urea (superficial and incorporated with cultivator) in Marandu grass to the mass of the accumulated residue on the soil surface.



**Figure 3.** Assessment of Marandu grass fertilized with poultry manure for: A. dry residue mass (DMR) and leaf blade residue (LBR), B. stem and sheath residue (SSR) and dead material residue (DR). Applied manure (M) and management with no soil chiseling (n) and with soil chiseling (w).

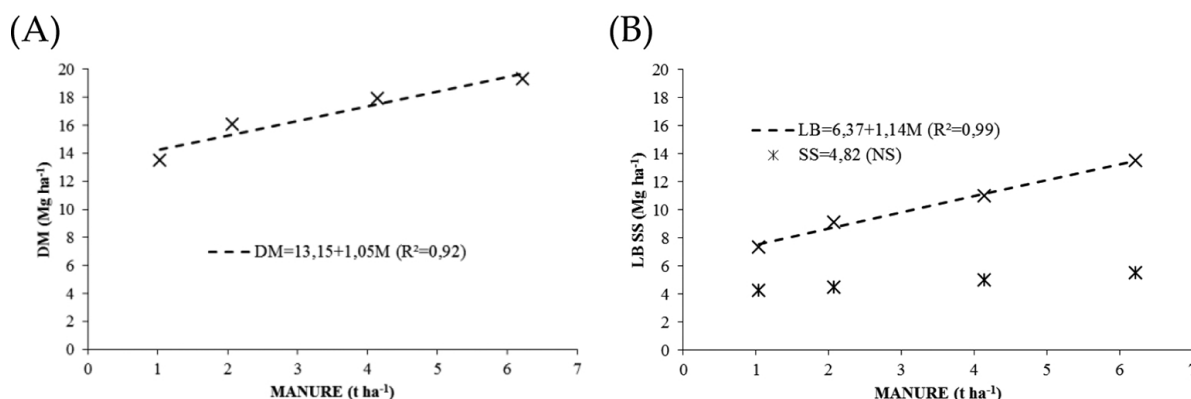
The foliar blade residue without soil chiseling (LBRn) was linear with the increase in poultry manure dose and soil chiseling (LBRw) no adjustment to the proposed models. The greatest production LBRn with was with 9.08 Mg ha<sup>-1</sup> poultry manure dose - showing an increase of 283.46% compared with the lowest dose. Regarding the dependence on the nutrients provided by the manure, the LBRn relates to the ability of an increased light interception and a photo-

synthetic assimilation of carbon buildup. With frequency and cut intensity, results confirm those of [23] in the management of Marandu grass with 0.15 m waste time, increasing the accumulation of waste sheets in extracts near the soil surface, with higher IL by the leaves left over.

The SSR matter fitted the linear model with a production of 3.92 and 9.67 mg ha<sup>-1</sup> at a dose of 1.037 and 6.222 t ha<sup>-1</sup> manure, respectively (**Figure 3B**). The favorable production conditions, with increased mineralization of chicken manure nutrients coupled and with appropriate management with residue tall (0.15 m) were stimulate the generation of new tiller's by increased lighting within the sward that will form new stems and sheath for issuing its leaves.

The mass of DR without soil chiseling (DRn) showed a linear increase with increase in fertilization with manure - an increase of 7.08 Mg ha<sup>-1</sup> for a dose of manure. The DR is important for reducing erosion, keeping moisture in the soil surface and favoring the action of microorganisms to synthesize various enzymes the breaking of the material for formation of new organic compounds with release of macro- and micronutrients for own grass Marandu [17].

In the production of dry mass (DM) between IL95% and waste 0.15 m showed a linear growth with an increase of poultry manure dose. A dose of 6.222 t ha<sup>-1</sup> led to the production of 19.69 Mg ha<sup>-1</sup> MS, or 38.22% greater than the dose of 1.074 t ha<sup>-1</sup> (**Figure 4A**). For [12], the dry matter yield of Marandu grass increased linearly with the increase of poultry litter doses, with a maximum dose of 20 t ha<sup>-1</sup> (80 kg P<sub>2</sub>O<sub>5</sub>) and production of 21.3 Mg ha<sup>-1</sup> DM, which was higher by 126% compared to the dose of 5 t ha<sup>-1</sup>. In extracted, the increased production of grass DM Marandu with application of chicken manure without interaction handling with or without chiseling the soil is very favorable because for the farmer would be a cost with the use of machines incorporating this soil residue.



**Figure 4.** Evaluation of Marandu grass production for: A. dry mass (DM), B. leaf blade (LB) and stemsheath (SS). Applied manure (M) and management with no soil chiseling (n) and with soil chiseling (w).

For leaf blade (LF) there was linear adjustment with an increase of 5.94 Mg ha<sup>-1</sup> on the applied manure doses (**Figure 4B**). The increase of 78.58% represents the increase of macronutrients and micronutrients in the soil by fertilization with poultry manure, mainly nitrogen mineralized by microorganisms in the forms of ammonium and nitrate. This encourages the increase of production and expansion of sheets in the Marandu grass. For SS there were no adjustments

to the proposed models as a result of the proposed management systems. Between IL 95% and waste 0.15m is the ideal extract where the Animas will feed with the cutting blade leaf younger and more massive, little stem and dead dead leaves of grass Marandu.

### 3. Conclusion

Poultry manure application management without soil chiseling, showed a higher cumulative production of total dry matter and residue of Marandu grass.

Matter yield and accumulated blades were higher with poultry manure application on grass Marandu.

### Author details

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