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Integrated Crop-Livestock-Forest System For Sheeps And Goats

Sistema Integração Lavoura-Pecuária-Floresta Para Ovinos E Caprinos

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conservação da água; conservação do solo; sustentabilidade.

Keywords:
water conservation; soil conservation; sustainability.

Abstract

The Crop-Livestock-Forest Integration (ILPF) is a soil management that, if conducted with the recommended technical and agronomic principles, allows the maximization of productivity leveraged by sustainability. The chemical, physical and biological attributes of the soil should be evaluated, based on soil and water management and conservation needs, as well as the requirements of the most demanding components of the ILPF. The objective of this work was to evaluate the resistance to soil penetration in a pasture area and another with a conventional system. For this, the PenetroLOG Falker model was used. The experiment was conducted in one of the pastures belonging to UniRV on goat grazing. In this area, degraded pasture systems were implemented with crop-livestock-forest integration (ILPF). The leucena was aligned with 3 meters between plants, 20 meters between rows. Leucaena (Leucaena leucocephala), a plant native to Central America, is a perennial, palatable legume with great utility in the feeding of pigs, cattle and goats, and resistance to drought. Soil compaction by trampling of goats in a grazing area with a conventional area in the ILPF showed levels of similar compaction, being detrimental to pasture and tree development.

Resumo

A Integração Lavoura-Pecuária-Floresta (ILPF) é um manejo do solo que, se realizado com os princípios técnicos e agronômicos recomendados, permite a maximização da produtividade alavancada pela sustentabilidade. Os atributos químicos, físicos e biológicos do solo devem ser avaliados, com base nas necessidades de manejo e conservação do solo e da água, bem como nas exigências dos componentes mais exigentes do ILPF. O objetivo deste trabalho foi avaliar a resistência à penetração e a infiltração de água no solo em área de pastagem e outro em sistema convencional. Para isso, foi utilizado o modelo PenetroLOG Falker. O experimento foi conduzido em uma das pastagens pertencentes à UniRV em pastejo de caprinos. Nesta área, foram implantados sistemas de pastagem degradada com integração lavoura-pecuária-floresta (ILPF). A leucena foi alinhada com 3 metros entre plantas, 20 metros entre fileiras. Leucaena (Leucaena leucocephala), uma planta nativa da América Central, é uma leguminosa perene, palatável, com grande utilidade na alimentação de suínos, bovinos e caprinos e resistência à seca. A compactação do solo por pisoteio de cabras em área de pastejo com área convencional no ILPF apresentou níveis de compactação semelhantes, prejudicando o desenvolvimento de pastagens e árvores.

INTRODUCTION

The Integrated Crop-Livestock-Forest integration (ILPF) is a production system that concentrates agricultural, livestock and forestry components in rotation, consortium or succession, in the same area. Thus, it is possible to have a production of grains, grass, wood, meat and milk simultaneously and / or successively; although the synergistic effects among the components of the agro ecosystem include environmental suitability, human valorization and economic viability (Balbino et al., 2011).

Aidar & Kluthcouski (2003) warn that the main problems of Brazilian livestock are the degradation of pastures and soils, inadequate animal management, low replenishment of nutrients in the soil, physical impediments of the soil, and low technological investments. Such restrictions have negative consequences for livestock sustainability, such as low grass supply, low zootechnical indexes and low meat and milk yield per hectare, as well as low economic returns and inefficiency of the system.

Castro et al. (2003) evaluated the productive performance of sheep fed with Tanzania grassland (*Panicum maximum*), under coconut palm (*Cocus nucifera*) with 2.5 years old, found na average daily gain of 27.6 (44 animals/ha) and 66.2 g/animal/day (11 animals/ha).

Improving soil chemical, physical and biological attributes, reducing pressures on native forests, increasing productivity with less necessity of new agricultural frontiers, and greater efficiency in the use of land and natural resources are also considered benefits of iLPF for the environment (BUNGENSTAB, 2012).

The data maps of spatial variability reveal that the analysis of a single point measurement must be done with caution, so that a sub or overestimated value is not reported as a representative condition of the phenomena under study, and in this sense, geostatistics allows the understanding of spatial phenomena within animal housing facilities showing the distributions of environmental variables (SILVA et al., 2013).

The knowledge of the Basic Infiltration Rate (TIB) of water in the soil is a way to assist in the management and conservation of the soil and allows greater control of erosive processes and consequently the silting of water resources, since soil degradation leads to the transport of nutrients and sediments to the springs, which according to Dalri et al. (2010) the knowledge of TIB and its relationship with soil properties is fundamental for the efficient management of soil and water.

In irrigated areas, the knowledge of TIB in the soil determines the duration of the spraying, in relation to the desired amount of water to avoid excesses, which provide waste of water and leaching of nutrients in the soil (BERNARDO et al.; 2009).

This work aims to evaluate the effect of the iLPF system implementation on the physical and water characteristics of goat grazing area.

MATERIAL AND METHODS

The experiment was conducted on goats and sheep sector at the University of Rio Verde (UniRV). The soil was classified as dystrophic red latosol, according to the Brazilian Soil Classification System (Embrapa, 2013) with presence of clay (%) 36, silt (%) 7 y sand 57.

In order to evaluate the influence of iLPF implementation system on the soil characteristics, the variables soil resistance and water infiltration rate in the soil were analyzed. For the resistance of the soil to penetration was used the penetrometer with electronic data record, PLG 1020 penetroLOG® (Falker Automação, Porto Alegre, RS)

Soil resistance was evaluated by spatial dependence using geostatistical techniques, according to Cambardella et al. (1994).

The results obtained in dm^{-1} impacts were converted to dynamic resistance using the equation 1 (Stolf, 1991):

$$RP = 5.6 + 6.89*N \qquad (1)$$

where RP is the resistance to penetration ($kgf.cm^{-2}$) and N is the number of impacts of the metallic weight.

The results were obtained in $kgf.cm^{-2}$ and then multiplied by the constant 0.0980665 for transformation in MPa (Beutler et al., 2001). After each penetration resistance (PR) measurement and at the same depths, deformed soil samples were collected for determination of gravimetric moisture (Ug), according to Embrapa (1997).

For the assembly of the experiment was used a randomized complete block design with subdivided plots and four replications. It were applied five treatments of soil preparation in the main plots, which were:

1. To evaluate soil resistance to penetration, the PenetroLOG®, Falker model, and gravimetric soil moisture method (EMBRAPA, 1997) were used, and in the layers of 0 to 30 cm, the maps were made every 10 cm;
2. In order to collect the spatial mode RP in the soil profile, it were used PenetroLOG® electronic Penetrometer PLG1020 model (Falker Automação, Porto Alegre, RS);
3. To place the sample, with or without deformed structure, in a numbered aluminum can of known weights, transfering to greenhouse at 105-110 °C, leaving in this condition for 24 hours and removing from the oven, put in desiccator, to cool and weigh.

4. In order to determine the water infiltration rate in the soil, in each soil management system, 3 samples were taken, before and after the iLPF installation. The ring infiltrator method was used, consisting of two concentric rings, with a diameter of 30 cm and 50 cm, and a height of 35 cm (both are fixed to the ground up to approximately 5 cm deep).

The reading interval was two minutes during two hours of evaluation.

5. The mathematical model of Kostiakov was used to represent the accumulated infiltration (Equation 2) and velocity of water infiltration in the soil (Equation 3).

$$I = k*T \quad (2)$$

where I is the Infiltration of soil water (mm), k and m are the coefficients that depend on the soil (0-1) and T is the accumulated infiltration time (minutes)

$$VI = m*k*T^{-1} \quad (3)$$

where VI is the instantaneous velocity of infiltration of soil water (mm), k and m are the coefficients that depend on the soil (0-1) and T is the accumulated infiltration time (minutes)

In order to analyze the basic infiltration velocity of the soil, it were used a classification table, which may vary in low to very high (Table 2).

Table 1. Classification of water infiltration velocity in soil (Bernardo et al., 2009).

Very high TIB	30 $mm*h^{-1}$
High TIB	15-30 $mm*h^{-1}$
Average TIB	5-15 $mm*h^{-1}$
Low TIB	< 5 $mm*h^{-1}$

RESULTS AND ISCUSSION

In the geostatistical analysis (Table 2), it is observed that the layers of pasture presented strong (0 to 10 and 10 to 20 cm) and moderate (20 to 30 cm) spatial dependence. The one without grass presented weak dependence in the layers of 0 to 20 cm and the model that presented better behavior was the gaussian for pasture and exponential for the layers of (0 to 20 cm) and nugget effect in the layers of 20 to 30 cm.

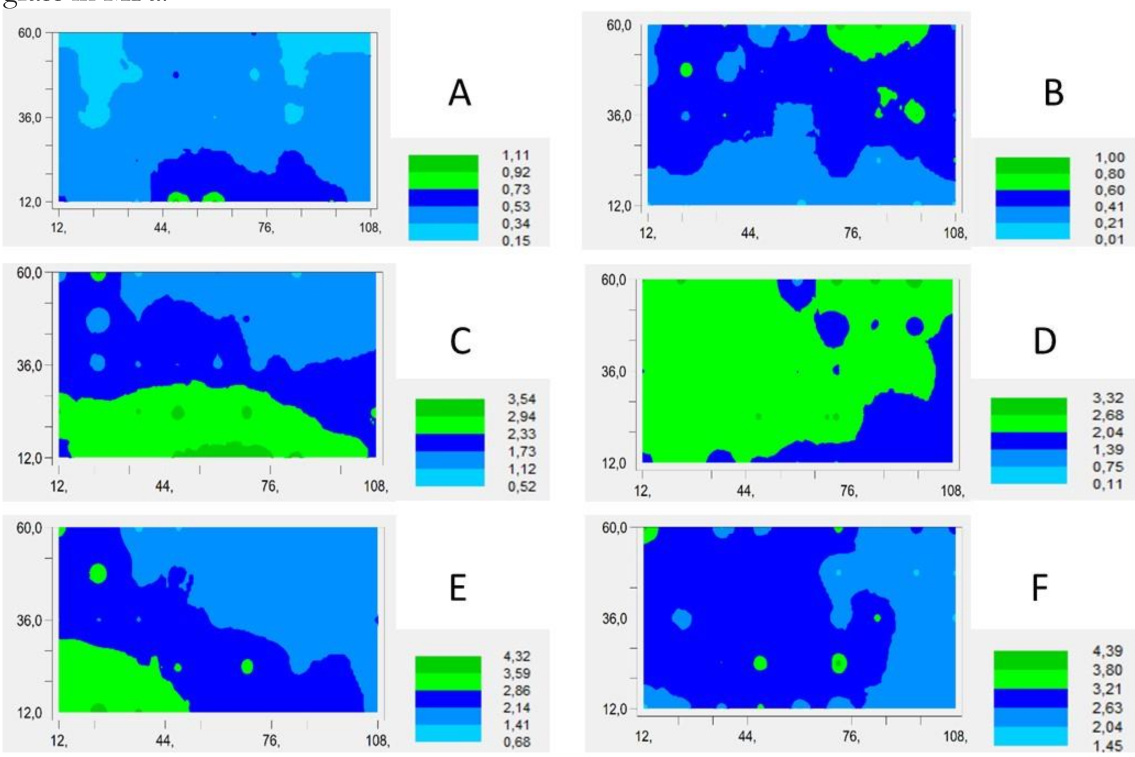
The degree of spatial dependence is a function of the nugget effect (C_0) and the level (C_0 + C), with the following relationships: variable with strong spatial dependence (C_0 / C_0 + C <25.0%); variable with moderate spatial dependence (25.0% <C_0 / C0 + C <75.0%); variable with low spatial dependence (75.0% <C0 / C0 + C <100.0%) (CAMBARDELLA, et. al., 1994).

Table 2. Modelos e parâmetros estimados aos semivariogramas experimentados.

Local	Layer	Model	C_0*	$C_0 + C$†	A_0‡	r^2(§)	IDP**
With grass	0-10	Gaussian	0,0236	0,1769	153,81	0,38	87
With grass	10-20	Gaussian	0,349	1,442	60,45	0,61	76
With grass	20-30	Gaussian	0,774	1,549	138,73	0,042	50
No grass	0-10	Exponential	0,025	0,105	108,9	0,38	76
No grass	10-20	Exponential	0,106	0,529	38,4	0,224	80
No grass	20-30	Nugget effect	-	-	-	-	-

After the evaluation of the parameters, the maps were made for the respective layers (figure 1).

Figure 1. Soil compaction maps by IDW being 0 to 10 cm (a) with pasture and (b) without pasture, 10 to 20 cm (c) with pasture and (d) without pasture, 20 to 30 cm (e) with pasture and (f) without grass in MPa.



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* C_0: nugget effect;
† C_0+C: baseline;
‡ A_0: extent of spatial dependence (m)
§ r^2: correlation coefficient;
** IDP: spatial dependence index.

In the comparison of the maps of the two analysis areas, the following variations were observed: the 20 to 30 cm layer with pasture had the highest compaction value of 3.59 MPa, which was similar to that without grass (3.21 MPa). Values caused by the trampling of the animals, independent of the presence or not of grass.

In intensive grazing systems, the probability of occurrence of trampling repeatedly at the same site increases, promoting increases in soil density values ranging from 7% to 18% (Azenegashe et al., 1997).

Sobrinho and Gastaldi (1996) observed the occurrence of a reduction in the degree of soil compaction in all treatments with 25, 40, 55 sheep/ha, being more accentuated in the soil layers and in the lower stocking.

Values of the mass, hull area and pressure of animals of the Pajeú Valley, in Pernambuco with caprine average hull area (m^2) of 0.0016, average weight (kg) of 35, pressure (KPa) of 107.2 and percentage (%) of 56 (SOUSA et al., 1998).

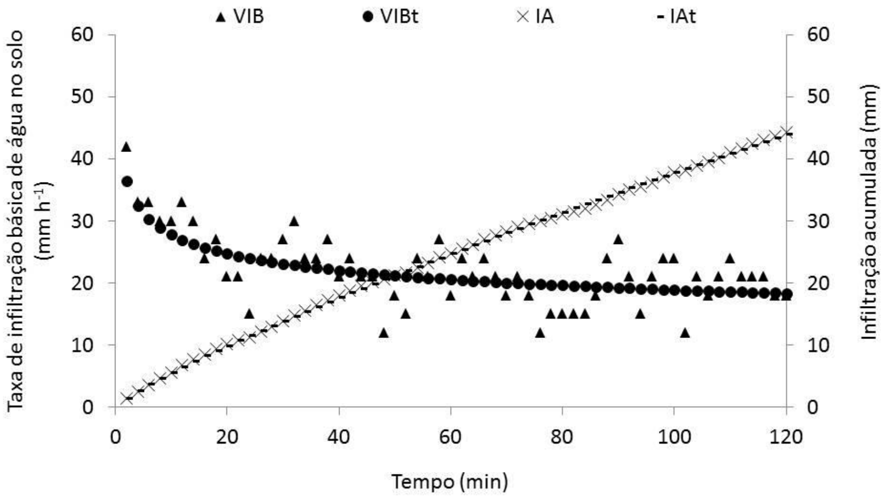
The water infiltration rate in the soil, after two hours of evaluation, was 23 $mm.h^{-1}$ and 20 $mm.h^{-1}$ and the accumulated infiltration was 58 mm and 44 mm for the pasture and conventional areas respectively (Figure 2).

For Sarmento et al. (2008), the effect of trampling animals on the soil increases when grazing is carried out on soils with high humidity and low vegetation cover, and this evidences the importance to control of the animal stocking rates for the amount of pasture produced and the vegetal cover, to mitigate the trampling effect on the physical quality of the soils.

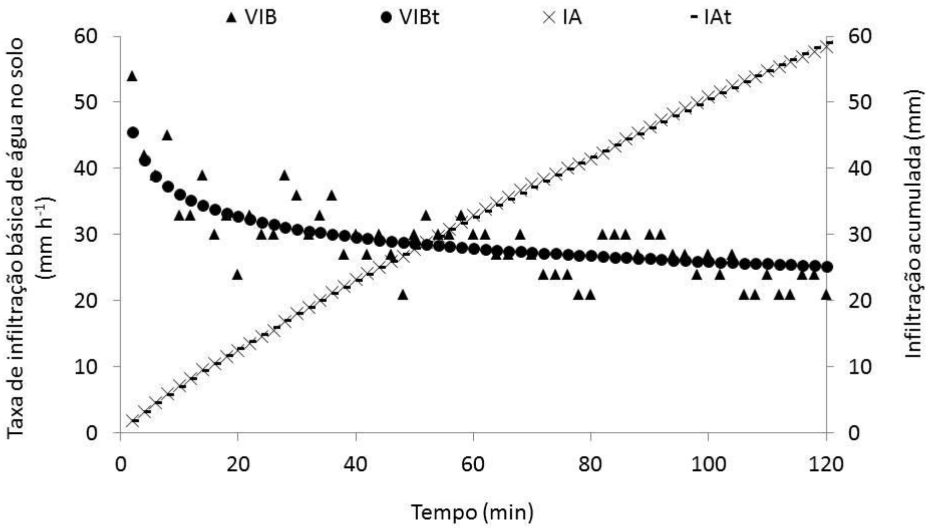
Evaluating grazing of goats and soil attributes, there was a reduction in the mean value of infiltration, a fact that may be associated to trampling and the reduction of the forage mass that was consumed by the animals, promoting a reduction in organic matter and exposing the soil to the greater performance of the luminosity (SILVA et al., 2012).

Both areas showed high TIB. However, there was higher TIB and consequently higher AI in the pasture areas compared to the conventional cultivation system. The pasture areas tend to present higher TIB in relation to the other areas due to the constant death and regrowth of the root system, favoring the increase of the continuous infiltration, favoring the creation of macro and micro pores to the soil. (Table 2).

Figure 2. Basic infiltration rate of soil water and soil water infiltration in conventional (a) and pasture (b) areas.



(a)



(b)

Table 3. Models of infiltration rate and accumulated infiltration of water in the soil at the experimental area.

Local	Modelo	TIB (mm/h)	IA (mm)
Pastagem	Modelo de Kostiakov	$0{,}8394 \cdot T^{-0{,}1441}$	$0{,}9808 \cdot T^{0{,}8559}$
	Valores de campo	23	58
	Valores teóricos	26	59
Convencional	Modelo de Kostiakov	$0{,}6822 \cdot T^{-0{,}1678}$	$0{,}8198 \cdot T^{0{,}8322}$
	Valores de campo	20	44
	Valores teóricos	19	44

Lanzanova et al. (2007), when working with different grazing systems integrated with agriculture in a Red Yellow Argisol, observed that the rate of infiltration of water in the soil was not altered after maize cultivation, due to the high contribution and maintenance of cultural residues on the soil surface.

CONCLUSION

The compaction of the soil by the trampling of goats in a grazing area with a conventional area in the ILPF showed similar compaction levels in this first analysis, being detrimental to pasture and tree development.

Both areas showed high TIB. However, there was higher TIB and consequently higher AI in the pasture areas compared to the conventional cultivation system.

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