

# NITROGEN COMPARTIMENTALIZATION IN A SILVOPASTORAL SYSTEM

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## 1 INTRODUCTION

In a forest ecosystem, the amount of nutrients is determined by the content of these in the different parts of the trees (leaves, branches, bark, wood and roots), vegetation, soil and animals. Each component shows different concentrations of chemical elements in its tissues. Generally, the nutrients follow this sequence: leaves > bark > branches > wood (Schumacher, 1992).

The nutrients in the above ground biomass varies from element to element, and the concentration can be different due to the disponibility of these nutrients, from the different sites and different age of the stand (Caldeira, 1998).

For N and Mg, Silva (1996) observed a decrease in the amount of these elements along the stem, as way as the tree grows, indicting a possible migration of these nutrients to newer tissues.

The integration of animals to agricultural crops is not a new activity. What is new, is the fact that this integration will help to improve the productivity in the area. In a world where the population grows fast, especially in less developed countries, the increase in productivity is very important, because in a near future, the agricultural areas will be limited (Garcia, 1997).

The *Acacia mearnsii* De Wild. is a forest specie that was introduced in Brazil, in the state of Rio Grande do Sul, in the 30s. Nowadays, with a planted area of about 100.000 hectares, involves about 10 small rural producers, and it has a social hole (Embrapa, 2000).

The *Panicum maximum* Jacq. is a specie originated from Africa. It is very used in tropical and subtropical areas worldwide, because of its qualities as forage.

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## **2. MATERIAL AND METHODS**

### **2.1 Site characteristics**

#### **2.1.1 Location**

This study was conducted in a six years old *Acacia mearnsii* stand, located in an experimental area from FEPAGRO, in the county of Tupanciretã.

The stand is located between the geographic coordinates 29° 03' 10" of south latitude and 53° 50' 44" of west longitude, and an altitude of 431 m. The sampling was conducted in area 8 that has an area of 2.884 m<sup>2</sup>, where the trees are planted due to a 2 m x 3 m spacing, consorciated with *Panicum maximum*.

#### **2.1.2. Weather**

The weather is classificated as Cfa due to Köppen classification, the average of maximum temperatures are about 23,4°C and the average of the minimum temperatures are about 12,0°C. The yearly average temperature is 17,1°C, with an average of rainfall about 1.767 mm (Moreno, 1961).

#### **2.1.3. Soil**

The soil, due to Streck *et al.* (1999) is ARGISOIL YELLOW-REDDISH Dystrophical Typical.

### **2.2 Soil Sampling**

To the chemical characterization, four trenches were opened until the depth of 60 cm, where were collected 6 samples in the depths of: 0-10, 10-20, 20-30, 30-40, 40-50, 50-60 cm.

### **2.3 Forest Inventory**

The forest inventory was carried out in an area of 2.884 m<sup>2</sup> in January, 2002. All the diameters at breast height (DBH) and the total heights (h) of about 40% of the trees were measured. The DBHs were measured with a diametric tape and the height with the Vertex.

The heights of the non-measured trees were obtained by a model:  $d^2/\sqrt{(h-1,3)}=b_0*d+b_2*d^2$ , where  $d$  is the DBH,  $b_0$  and  $b_2$  are the coefficients of the model and  $h$  is the total height.

## **2.4 Biomass sampling**

### **2.4.1 *Acacia mearnsii* biomass**

Based on the forest inventory data, a distribution in seven diametric classes was done, with three centimeters of interval in each class (3,5 – 6,5 cm, 6,6 – 9,6 cm, 9,7 – 12,7 cm, 12,8 – 15,8 cm, 15,9 – 18,9 cm, 19,0 – 22,0 cm e > 22,0 cm) .

The number of the diametric classes were obtained by this equation:  $K = 1 + 3,3 * \log n$  ; where:  $n$ = number of the elements of the sample and of the interval :  $h= H/K$  owhere  $H$ = total spaciosnes  $DBH_{Max} - DBH_{min}$ .

In each class, 21 trees were cut, totalizing 21 trees.

After the cut, they were submitted to a cubing, due to the Smalian method, described by Finger (1992).

After, the stem was seccionated in trunks with 1m, until the point where the diameter was 7 centimeters (commercial diameter). After this point, until 3 centimeters, was considered as tree top, and from 3 cm to the top was considered as branches.

To dry weight determination of wood and bark, two samples along the stem were collected: one in the half of the distance from the tree basis to the point where the diameter was 7 cm; and the second, between the last point and the top of the tree.

After the seccioning, the trunks were weighed with and without bark.

The crown was divided in three compartments: leaves, branches and live and dead branches. All the components were weighed and sampled.

The last compartment to be weighed was the root. The rooty system of the 21 trees were totally extracted, washed and sampled representatively.

### **2.4.2 *Panicum maximum* Jacq. biomass**

In the line and between the planting lines of black wattle trees, five 3 m x 2 m plots were marked out. Inside this area, with hand tools, the soil was removed with handy tools and the plants were totally extracted. After, the separation was done (with scissors), in

below and above ground biomass. After the sampling of 127, 67 g of above ground biomass and 126, 60 g of below ground biomass of the *Panicum maximum* plants, they were stored in paper bags, identified and put on stove (75°C during 72 hours).

#### **2.4.3 Litter sampling**

Forty samples were randomized collected. For this collection, an iron frame (25 cm x 25 cm) was used. Each one of this samples was weighed and stored in paper bags, after they were conducted to the Forest Ecology Lab, at UFSM.

#### **2.4.4 Nutrients quantification**

All the samples collected to dry weight determination were weighed with a digital balance (0,1 g). These samples were identified, stored and conducted to the Forest Ecology Laboratory, UFSM.

At the laboratory, all the samples were put in a stove (75°C), until get a constant weight. To the dry weight biomass determination, a digital balance (0,1 g) was used.

After the determination of biomass dry weight, for each component and for each diametric class of the black wattle trees, the values were extrapolated by hectare, based on the number of trees per hectare obtained in the forest inventory.

### **3. RESULTS AND DISCUSSION**

#### **3.1 Biomass production**

##### **3.1.1 *Acacia mearnsii* De Wild. Biomass**

In Table 1, it is possible to see the coefficients of the equation, for the different components of the black wattle trees.

TABLE 1 – Coefficients of the adjusted equation for each component of the black wattle trees and its respective adjusted coefficients of the determination.

Component	$b_0$	$b_1$	$R^2$ aj.
Leaves	-2,187791	2,461315	0,927
Dead branches	-2,176574	2,475102	0,819
Live branches	-1,403205	2,275725	0,964
Bark	-1,518185	2,105691	0,960
Wood	-1,224742	2,588624	0,989
Roots	-1,715968	2,467488	0,969
Total	-0,774956	2,433163	0,995

In Table 2, it is possible to verify the average biomass in each component of the trees, in a 6 years old *Acacia mearnsii* stand.

The sequency found is wood > live branches > root > bark > dead branch > leaves. This data show the same tendency is showed by Barichello (2003) in a 8 years old *Acacia mearnsii* stand.

TABLE 2 – Average and percentage biomass of each studied component.

Component	Biomass (Mg ha <sup>-1</sup> )	%
Leaves	5,95	4,33
Dead branches	6,35	4,51
Live branches	21,19	15,07
Bark	9,96	7,08
Wood	79,14	56,30
Roots	17,96	12,71
Total	140,73	100

The biomass above ground represents 87,90% from the total biomass, being the stem (wood + bark) and the crown (leaves, dead branches and live branches) represents 63,38 and 23, 91% respectively.

Barichello (2003), studying 8 years old *Acacia mearnsii* trees, found 62,34% for wood, 12,45% for the roots, 9,37% for the live branches, 8,28% for the bark, 4,59% for the dead branches and 2,97% for the leaves.

### 3.1.2 *Panicum maximum* Jacq. biomass

The *Panicum maximum* was analyzed in its above and below ground biomass. The Table 3 shows the average and percentage biomass of the forage.

TABLE 3 – Average and percentage biomass of *Panicum maximum*

	%	Biomass
Above ground biomass	73,68	1.633,24
Below ground biomass	26,32	583,42
<b>TOTAL</b>	<b>100</b>	<b>2.216,66</b>

Melo *et al.* (2001) in a study of *Panicum maximum* costumes growth, obtained a total biomass production of dry mass of 23.714 kg ha<sup>-1</sup>yr<sup>-1</sup> in a pure planting of this specie.

### 3.1.3 Litter biomass

One of the main ways of nutrient returning is the litter.

In the place of this study, were found 9,1 Mg ha<sup>-1</sup> of dry biomass accumulated above the soil.

Hoppe (2003), studying 8 years old *Platanus X acerifolia*, found 12,8 Mg ha<sup>-1</sup>.

Barichelo (2003), in a work with 8 years old *Acacia mearnsii* accounted 25,73 Mg ha<sup>-1</sup>.

In Table 4 it is possible to see the average of litter biomass, variance coefficient and standard deviation.

TABLE 4 – Average, variance coefficient and standard deviation of litter biomass

<b>Biomass (kg ha<sup>-1</sup>)</b>	
Average*	9.085,33
$\sigma$	3970,58
CV (%)	43,70

\* Average of 40 samples.

### 3.2 Nitrogen cycling

The Figure 1 shows the Nitrogen compartmentalized in the silvopasture system totalizes 5.731,10 kg ha<sup>-1</sup>. From this total 9,96% corresponds to the black wattle, and it is distributed this way: 33,20% in the leaves; 26,42% in the branches, 17,90% in the bark; 16,67% in the wood and 5,81% in the roots.

The forage corresponds to 0,72 % from the total amount of Nitrogen, 75,72% in above ground biomass and 24,28% in below ground biomass.

The litter contains 2,48% from the total Nitrogen; the fertilizers contributed with 2,88% and the other 83,96% refers to the soil.

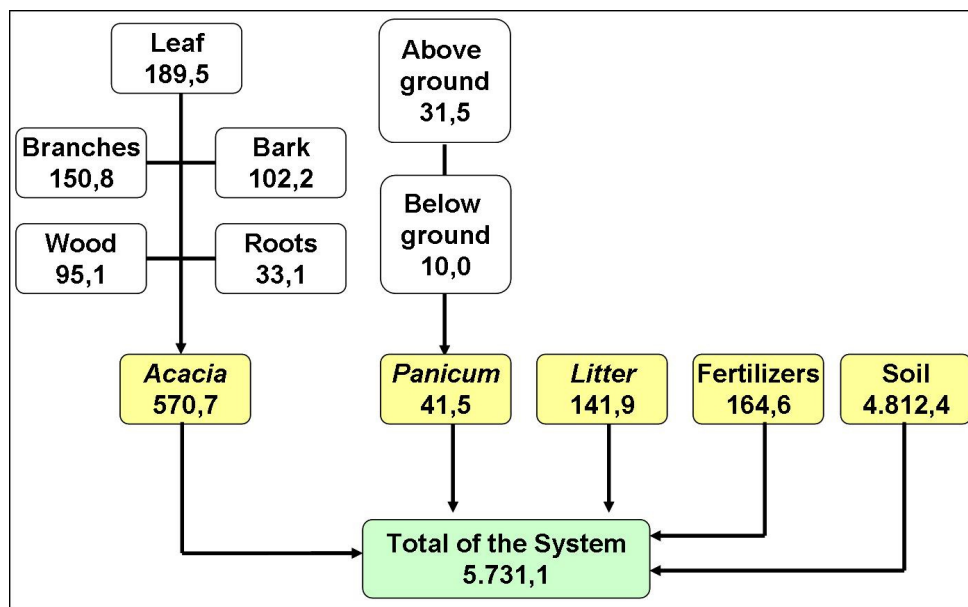


Figure 1 – Nitrogen cycling in a silvopasture system

### 4. CONCLUSIONS

- The estimated biomass from *Acacia mearnsii* was of 140,73 Mg ha<sup>-1</sup>, being 4,3 % in the leaves, 4,5 % in the dead branches, 15,7 % in the live branches, 7,1 % in the bark, 56,3 % in the wood and 12,7 % in the roots;
- The biomass found in the Panicum maximum was of 2.232,4 kg ha<sup>-1</sup> with 73,7 and 26,3% located in the above ground biomass and below ground biomass respectively;

- The Nitrogen compartmentalized in the silvopasture system totalizes 5.731,10 kg ha<sup>-1</sup>. From this total 9, 96% corresponds to the black wattle, and it is distributed this way: 33, 20% in the leaves; 26, 42% in the branches, 17, 90% in the bark; 16, 67% in the wood and 5, 81% in the roots.

- The forage corresponds to 0, 72 % from the total amount of Nitrogen, 75, 72% in above ground biomass and 24, 28% in below ground biomass.

- The litter contains 2,48% from the total Nitrogen; the fertilizers contributed with 2, 88% and the other 83, 96% refers to the soil.

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