Legume-cropping and research strategies in Brazil

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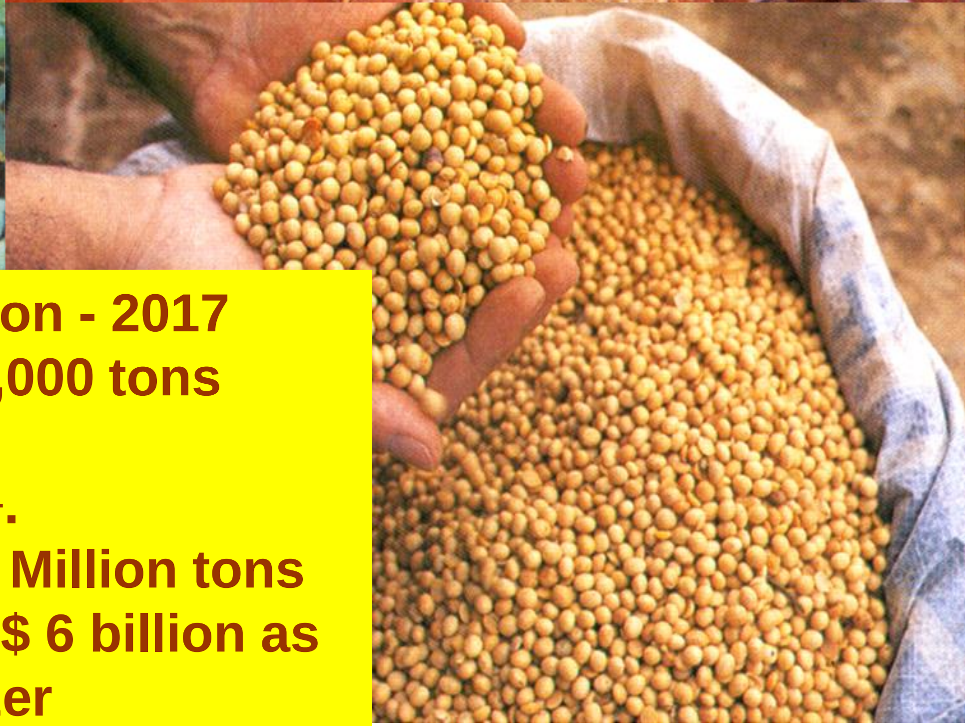
Grain legumes have a great importance in Brazilian agriculture

- The staple diet of most of the population contains rice and beans – either common bean (*Phaseolus vulgaris*) or cowpea (*Vigna unguiculata*).
- Brazil´s largest export crop is soybeans, 67 Mt exported in 2016 out of 114 Mt produced
- Recently, large scale farmers have become interested in growing cowpea or mung bean (*Vigna radiata*) as a short season crop after soybean.
- However, most common bean and cowpea are produced by family farmers.

A importance of BNF in soybean



Soybean Production - 2017
Harvest = 115,000,000 tons
Area = 34 Mha
Yield 3,300 kg ha^{-1}.
Total N fixed = 7.3 Million tons
Equivalent to US$ 6 billion as fertilizer

- The highly efficient N_2-fixing system that has been developed with soybean is largely due to the strategy of plant breeding with no application of N fertilizer and always with the best available inoculants.
- Varieties have now been developed suited to Brazilian conditions and all latitudes in the country.
- The rhizobium (*Bradyrhizobium* spp.) strains recommended for soybean were all isolated from Brazilian soils and are thought to be derivatives of imported strains used earlier in inoculants.
- Selection and testing of new strains goes on continuously

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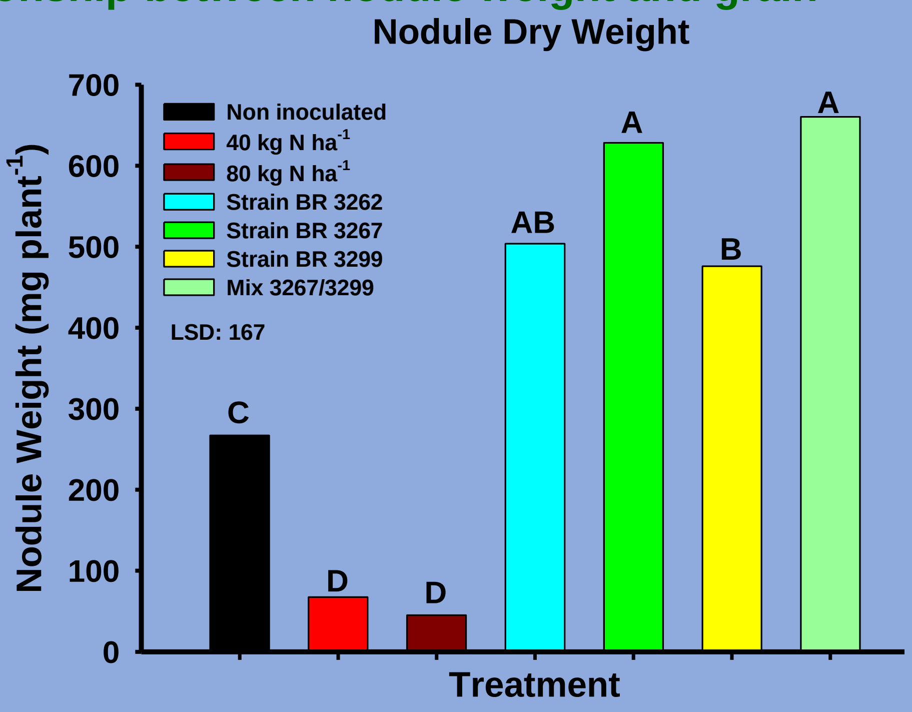
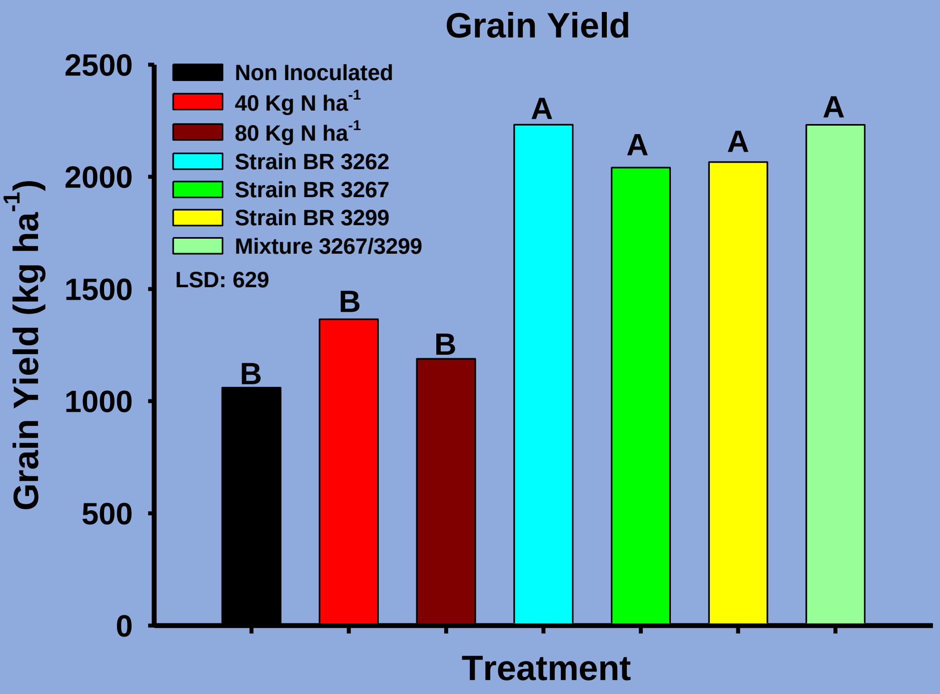
As it is usually found that crops such as cowpea, mung bean or groundnut are well nodulated with native soil rhizobium, inoculation would not result in yield increases.

However, research conducted in Ghana showed that often considerable yield increases could be obtained with good quality inoculants.

SARI Field station experiment Tamale (2012)

- In this trial P fertilizer (60 kg P_2O_5 ha^{-1}) was added. Even without inoculants grain yield was almost 1000 kg ha^{-1}
- As is often observed, there was a close relationship between nodule weight and grain yield





Rhizobium strain selection is still of great importance

In Mato Grosso cowpea is being planted after soybean in the short season before the end of the rains

The soil is very high in soybean rhizobia and these strains usually nodulate cowpea, but sometimes very ineffectively.

Recent work has shown that selected cowpea inoculants can increase grain yields and N_2 fixation even in these conditions

Strain BR 3262 raised yields of cowpea from 860 to 1430 kg ha^{-1} at one site (Sinop) and from 1215 to 1500 kg ha^{-1} at another (Primavera do Leste) and increased BNF inputs from between 48 and 77 %, while nodule weight was not significantly increased.*

*** Source: Silva Júnior et al. 2018. Agronomy Journal 110, 722–727.**

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Brazil has over 90 million ha of planted pastures, principally species of *Brachiaria*, used for beef cattle.

Most pastures receive very little fertilizer and no N fertilizer and in consequence are of low productivity or degraded.

As the cattle spend a long time to fatten, methane emissions per kg product (carcass or meat) are high.

Fertilization of pastures and improved animal management will increase the rate of weight gain but also increase enteric methane emissions per animal or per ha.

As BNF by legumes requires no fossil fuel inputs, this form of N amendment may be attractive to lower GHG emissions

We conducted a life-cycle study based on available Brazilian data to examine different scenarios for beef cattle production in the Cerrado region.

Analyses of GHG emissions in five different scenarios of beef cattle production

1. Degraded pasture (*Brachiaria* sp.)

2. Low input pasture (*Brachiaria*) system without N fertilizer, but reformed every 10 years

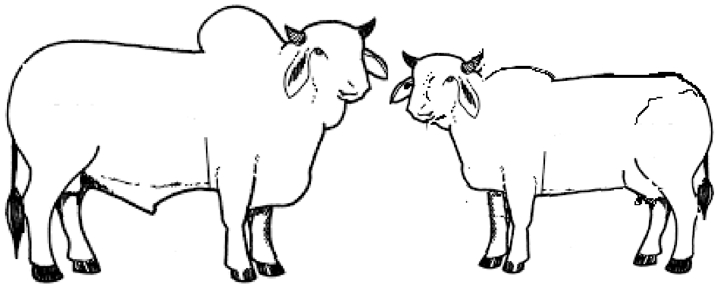
3. Mixed grass/legume pasture (no N fertilizer) and reformed every 5 years

4 and 5: Pastures of guinea grass (*Panicum maximum*) with 150 kg N/ha fertilizer per year reformed every 5 years. In scenario 05 the termination phase was with 75 days in feedlot and fed on total mixed ration (grains).

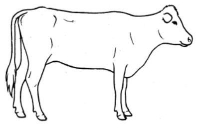
Source: Cardoso et al. (2016, Agricultural Systems 143: 86–96)

Herd evolution

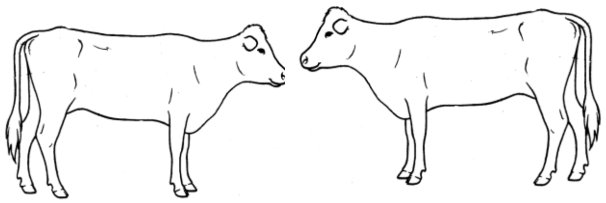
16 Bulls with 400 cows – ratio 1 a 25



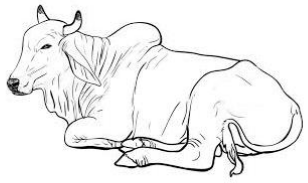
Calves - zero to 1 yr



Steers/heifers– 1 to 2 anos



Adults for fattening>2 years



1. Degraded pasture
Slaughter at 460 kg
Stocking rate 0.5 AU* ha^{-1}

2. Low input
Slaughter at 470 kg
Stocking rate 1.0 AU* ha^{-1}

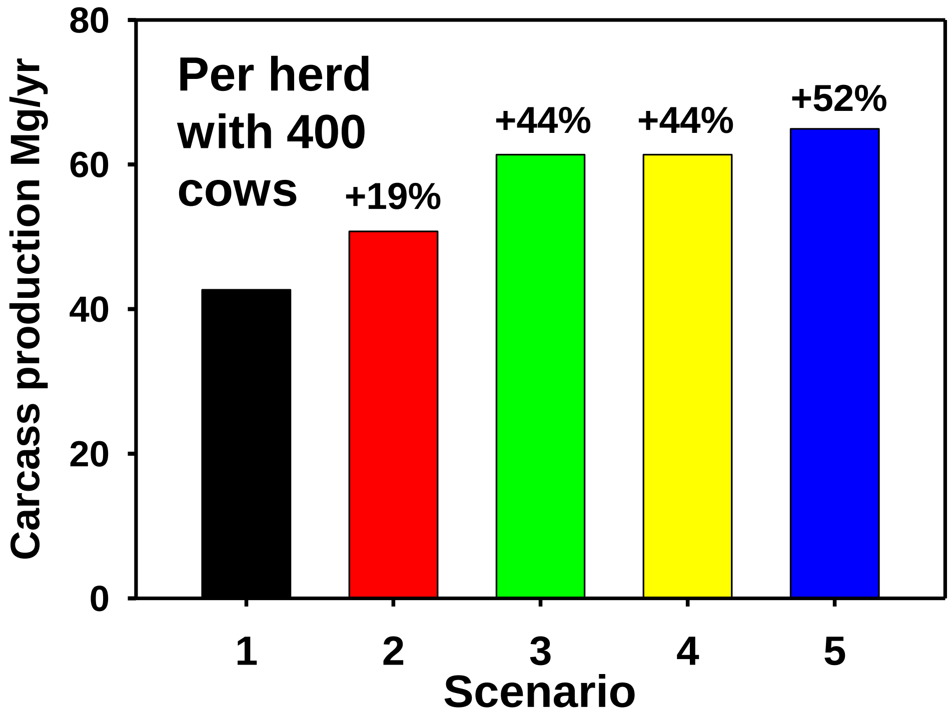
3. Mixed G/L pasture
Slaughter at 470 kg
Stocking rate 1.7 AU* ha^{-1}

4. Panicum + 150 kg N/ha
Slaughter at 470 kg
Stocking rate 2.5 AU* ha^{-1}

5. Panicum + 150 kg N/ha
Slaughter at 470 kg
Stocking rate 2.75 AU* ha^{-1}

*01 Animal unit (AU) = 450 kg live weight

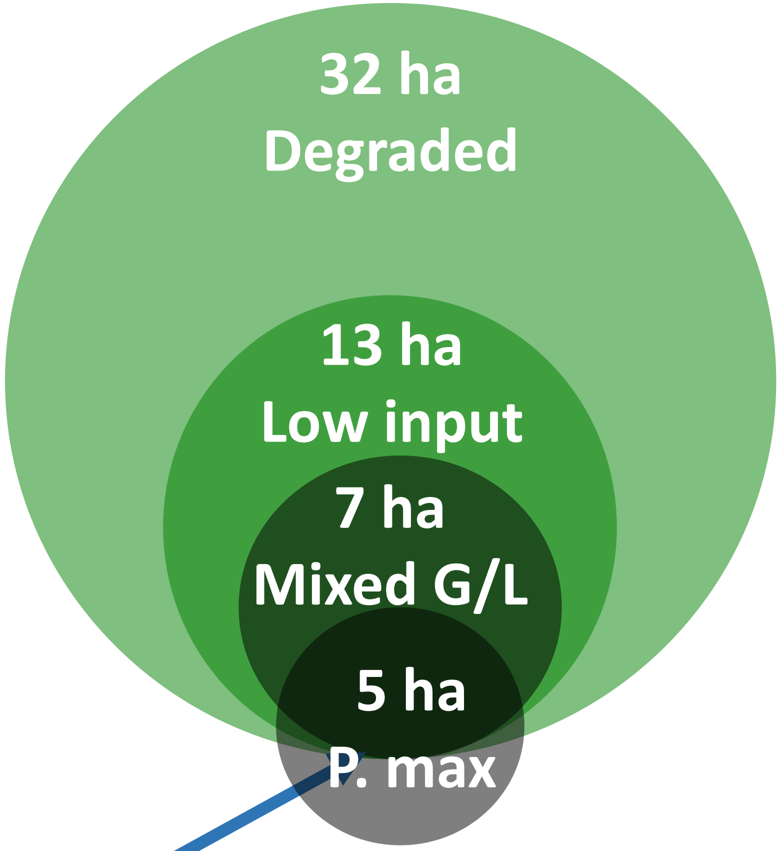
Animal carcass production in the five scenarios



Stocking rate
AU ha^{-1} (PV)

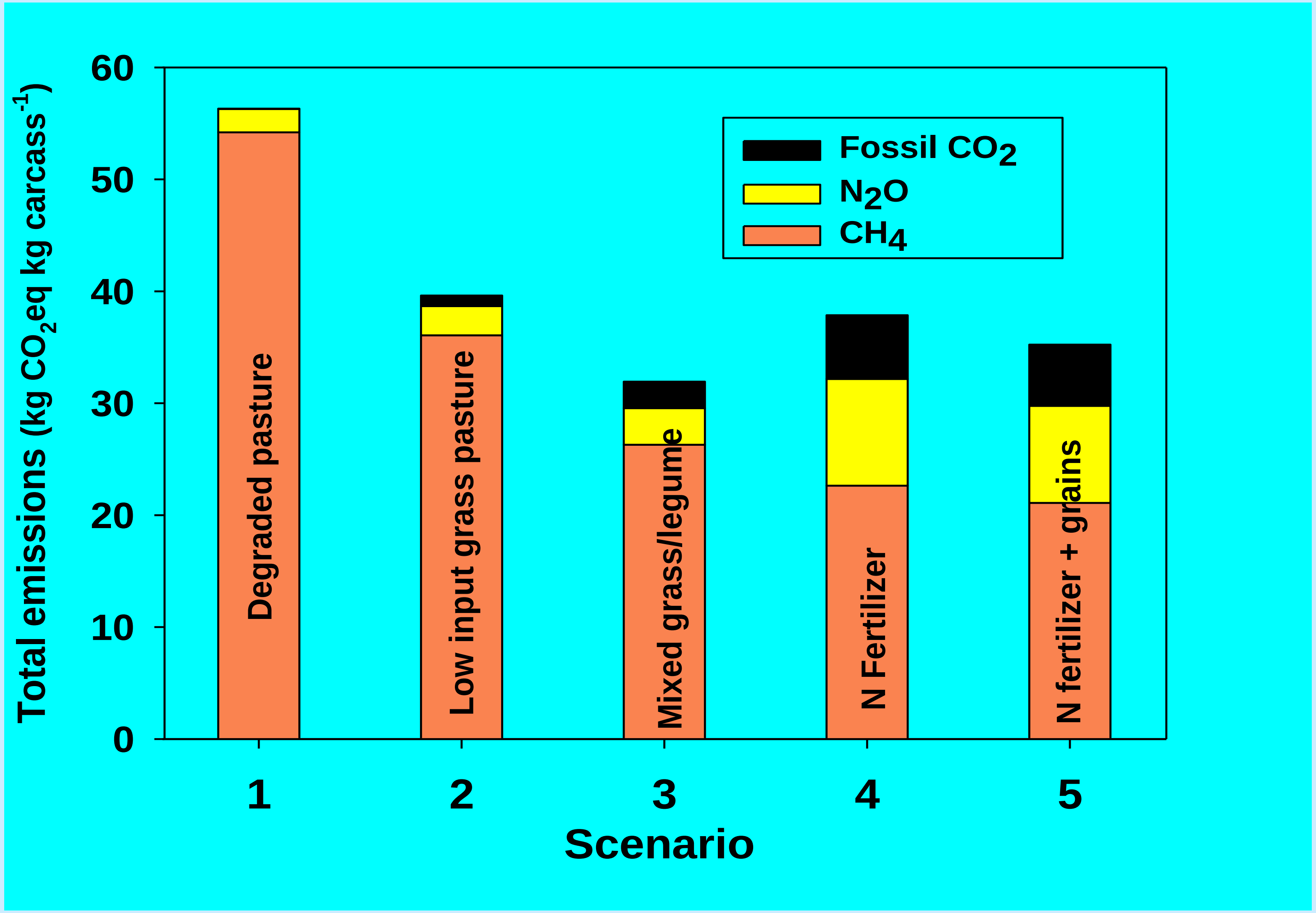
While the cattle fatten much more quickly in the more intensive systems, they only constitute a small proportion of the herd

Area necessary to produce 1,000 kg Carcass



Includes area to produce grain for the final fattening stage.

Total GHG emissions from five scenarios of beef production in Brazil
(Emissions per kg of carcass)



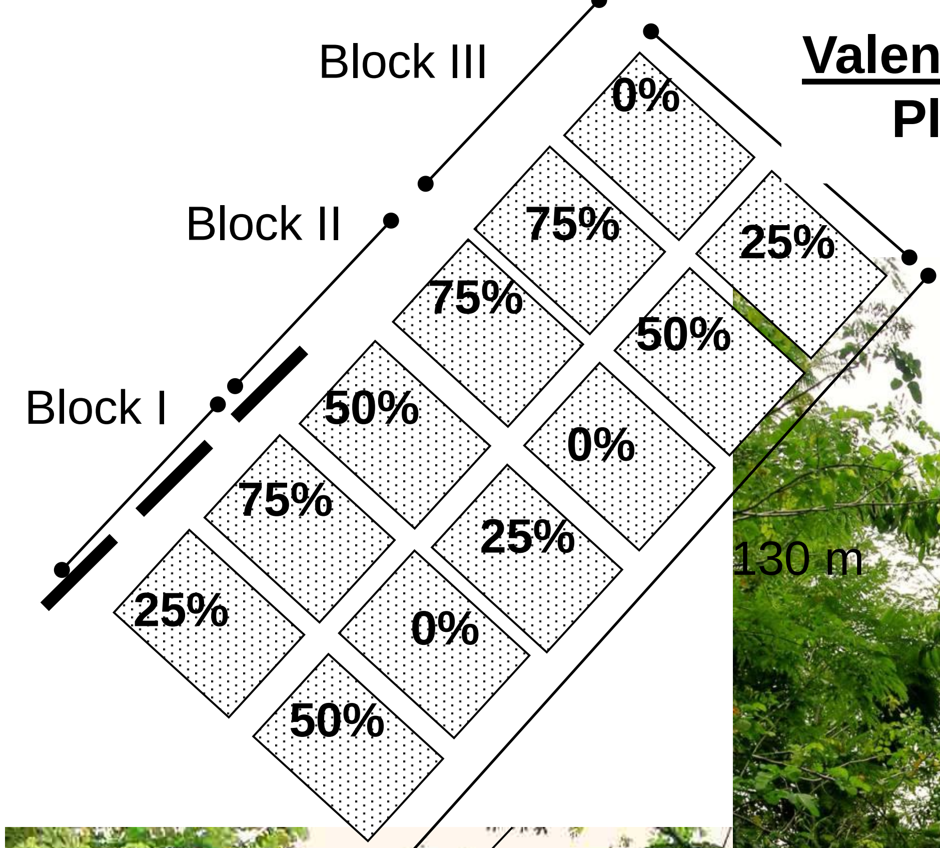
Cardoso et al. (2016, Agricultural Systems 143: 86–96)

- **Both *Arachis pintoi* and *Desmodium ovalifolium* have been shown to promote significant increases in live weight gain of beef cattle and have been shown to persist in the sward even under quite simple management strategies.**
- **Not only do they provide an N input with zero fossil fuel cost but preliminary results suggest that N_2O emissions (from dung, urine and plant litter) may be no higher than in N fertilized pastures.**
- **The major impediment to the adoption of mixed grass legume swards may be legume seed availability.**

So what can we do with tree legumes?

Eroded hillside Angra dos Reis,Rio de Janeiro

Valença, Rio State
Planted 2001



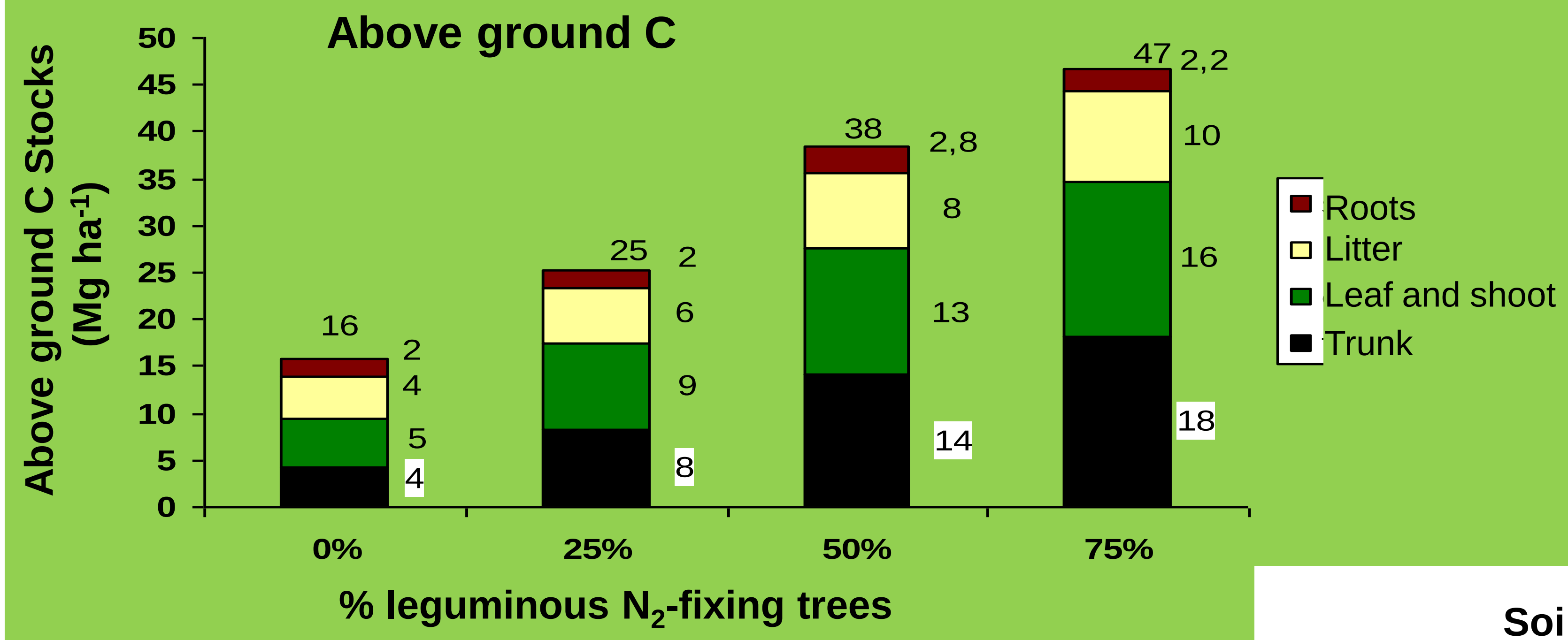
2002

2005

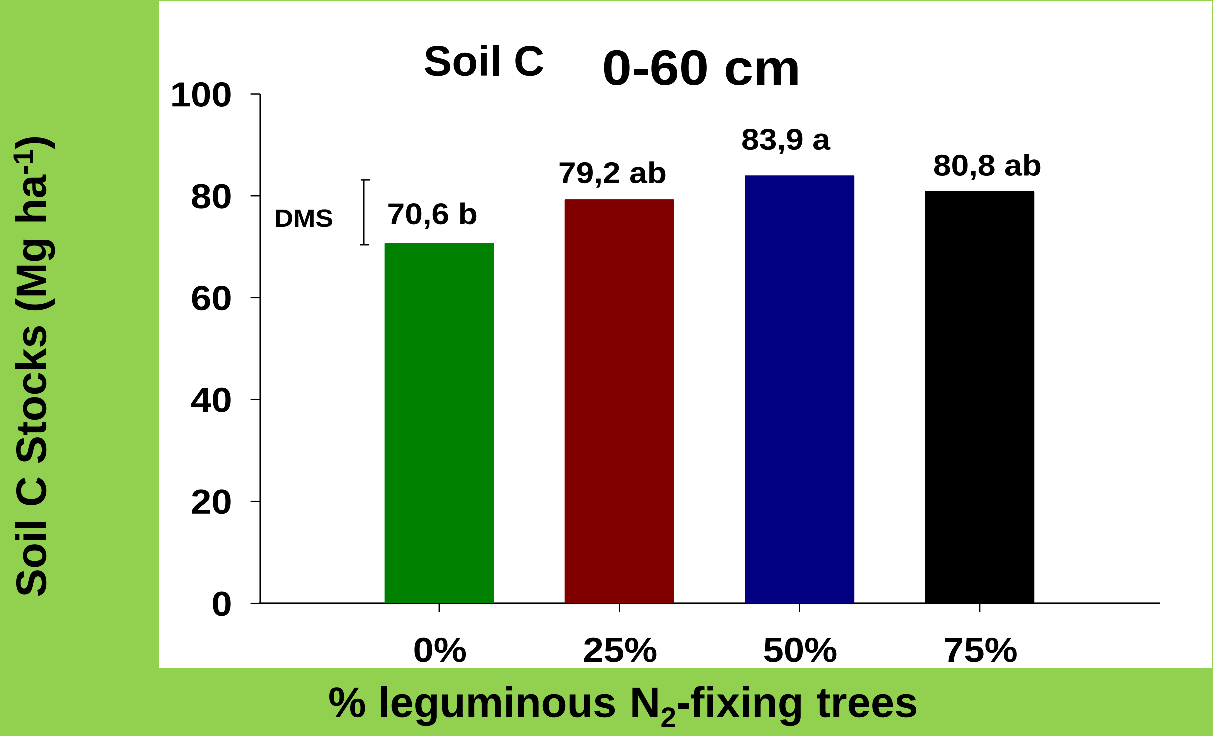
2007

Proportion of legume trees planted with non N_2-fixing trees ranged from 0 to 75 %.

From Anatoly Torres et al. 2007, Embrapa Agrobiologia



The mean increment in soil C was 10 Mg ha^{-1}, for the areas with legume trees
IN JUST 6 YEARS.



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Thank you for your attention

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