Improving Beef Productivity via Soil Nutrient Management - A Challenge for Brazilian Livestock Production Systems

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Land use in Brazil

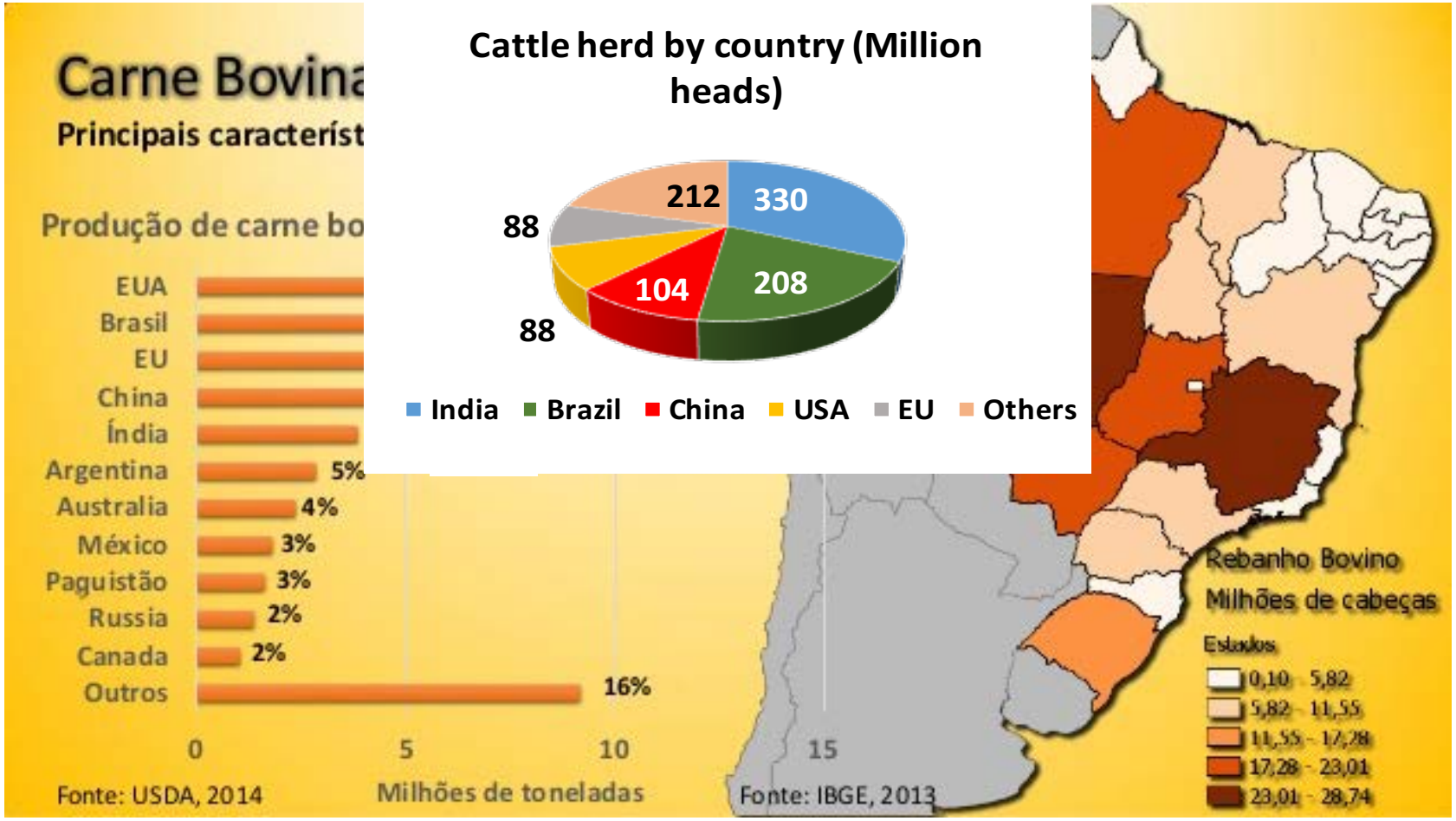
Land use	Area	
	Million ha	%
Total territory	851	100
Country land	153	18
Conservation units	128	15
Forest & natural vegetation	111	13
Indian reservations	111	13
Other purposes	127	15
Cities & infrastructure	1.7	0.2
Livestock & agriculture	213	25

Source: IBGE, IBAMA, INCRA, FUNAI, CNA (2012).

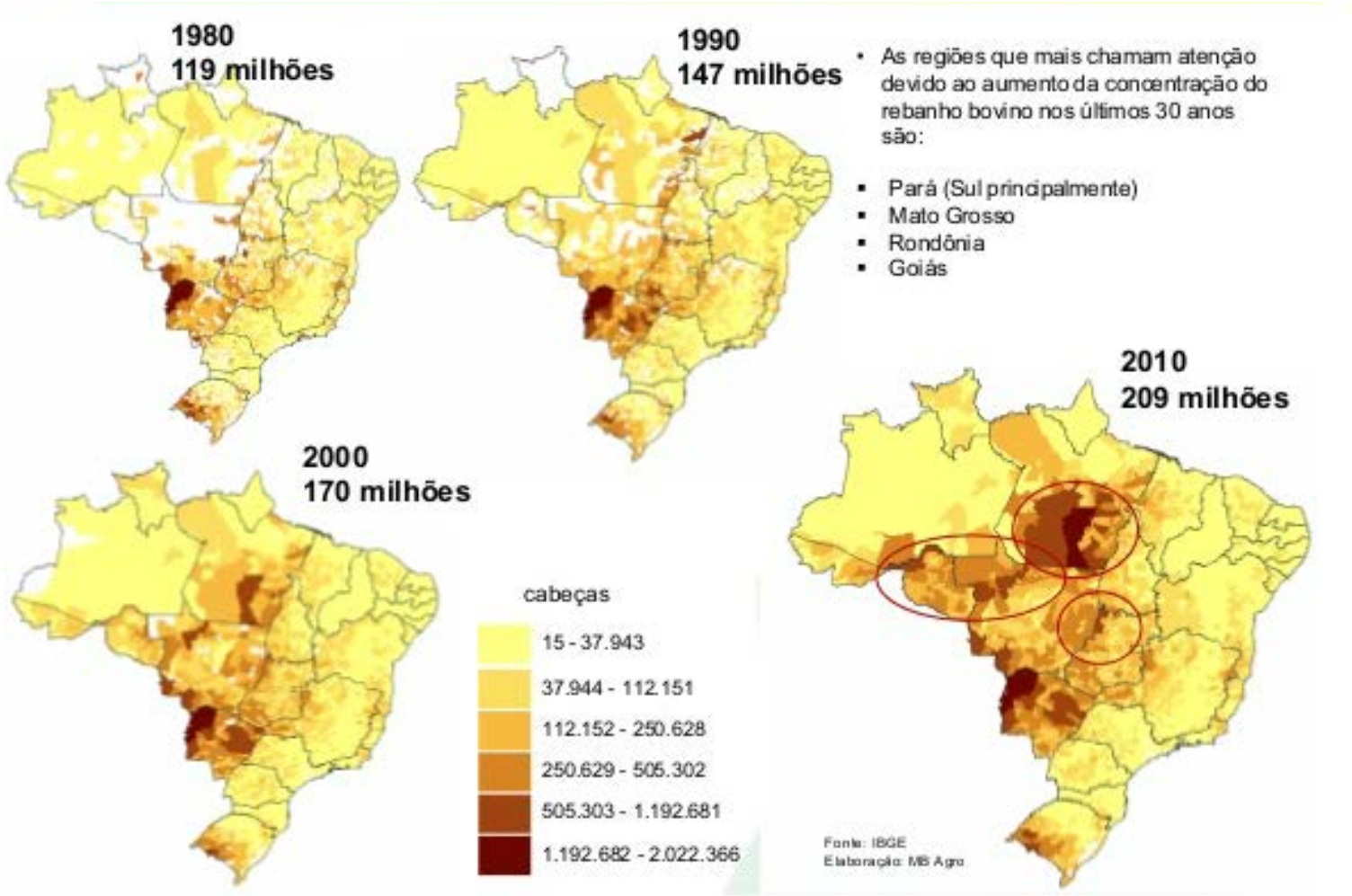
Land use for Livestock/Agriculture	Area	
	Million ha	%
Pasture	160	19
Soybeans	32	3.8
Maize	16	1.9
Sugarcane	9.0	1.0
Reforestation	5.7	0.7
Edible beans	3.1	0.4
Rice	2.3	0.3
Coffee	2.4	0.3
Wheat	2.5	0.3
Other	7.3	0.8

Source: Conab/IBGE (2015).

World cattle size and beef production



Evolution of Cattle herd in Brazil: *size and distribution*



Main source of feed for cattle in Brazil: *grass*

While 200 million heads are grassfed...

...5 million heads are in feedlots

85% of all cattle is Nelore (*Bos taurus*)

Brachiaria **sp. dominates the majority of all pastures**

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Pasture degradation: *low productivity*

Level 1: low (<20%)
Less vigor + uncovered soil

Level 2: moderate (21-50%)
Level 1 + weeds

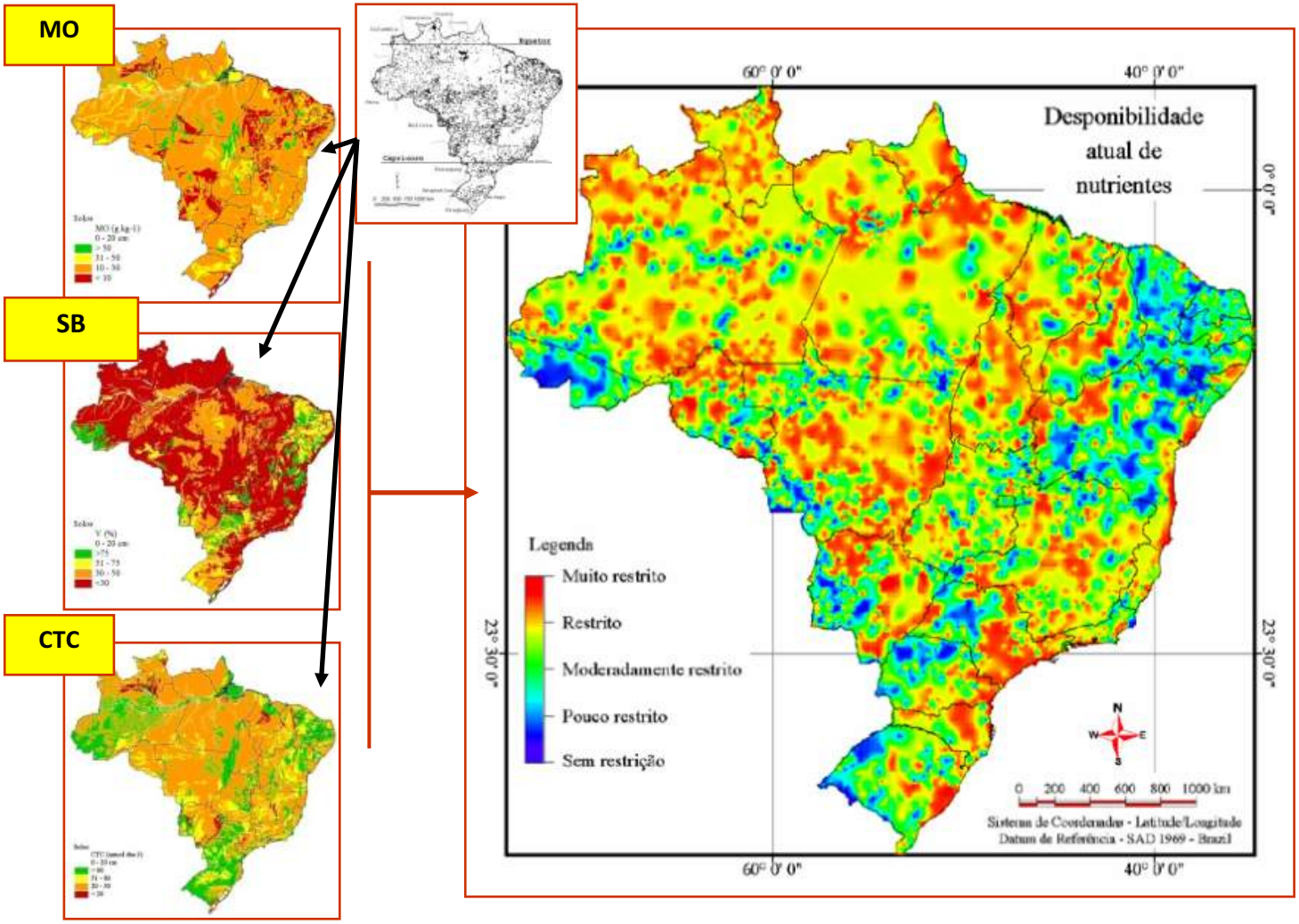
✓ About 50% present some level of degradation
✓ At least 10 million ha are severely degraded

Level 3: strong (51-80%)
Level 2+strong stand decline

Level 4: very strong (>80%)
Level 3 + soil erosion

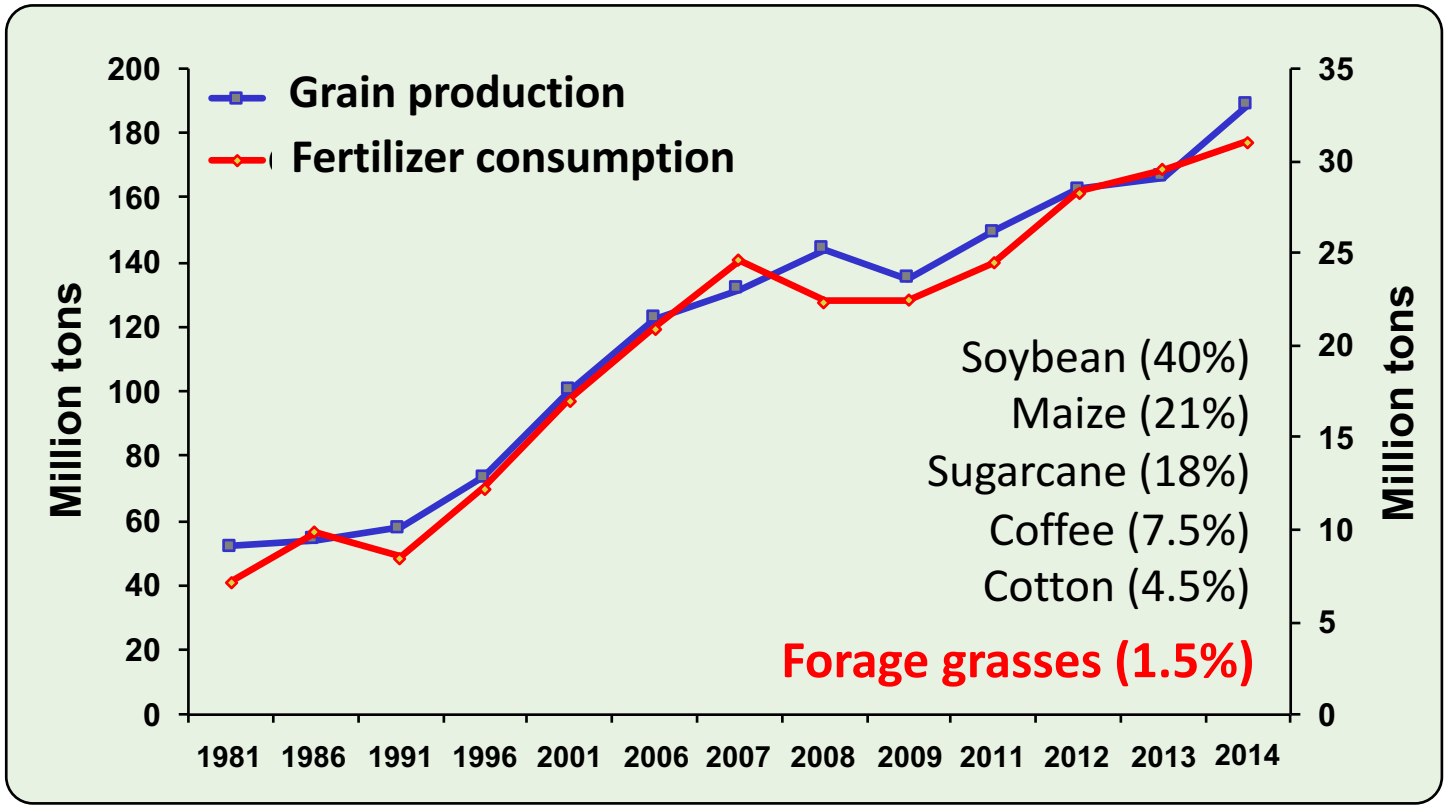
Source: Dias-Filho (2014).

Soil fertility restrictions in Brazilian soils



Fonte: Sparovek et al.

Total grain production and fertilizer consumption in Brazil



Source: ANDA e CONAB (2014),

Cotton seed, peanut, rice, barley, canola, rye, oak, beans, sunflower, castorbeans, maize, soybean, sorghum, and wheat.

Total grain production and fertilizer consumption in Brazil

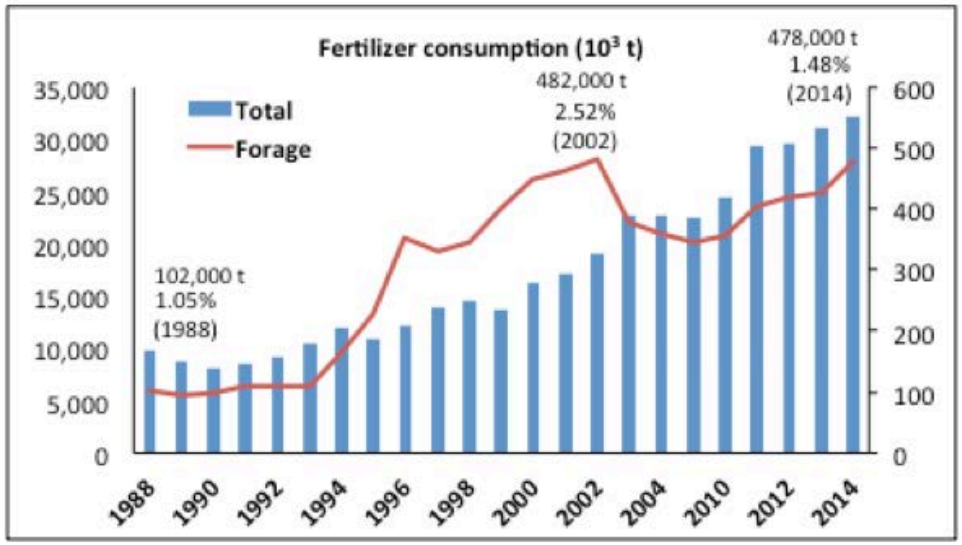


Figure 2. Fertilizer consumption for forage grasses and total in Brazil. (Source: ANDA)

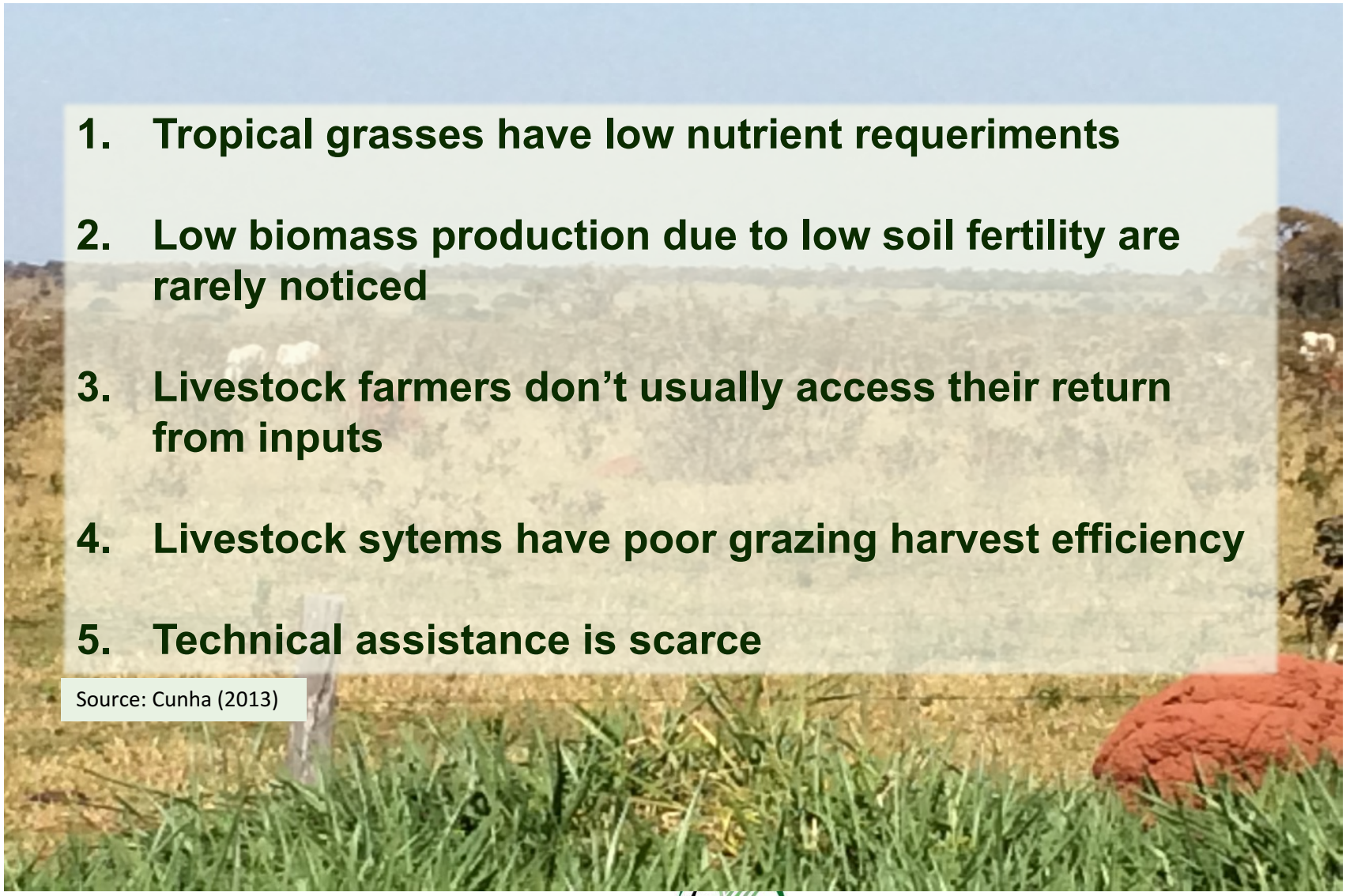
Table 1. Estimate of fertilized forage production systems in Brazil.

Estimate of fertilized forage land - Rally da safra 2014			
Declares application	**Land applied**	**Value used**	**Pondered**
14	<5	3	0.41
12	6 to 10	7.5	0.91
5	11 to 15	12.5	0.62
5	16 to 25	20	0.99
10	>25	30	2.97
Total % pondered			5.9
Forage total area considered			170,000,000
Fertilized area (total x total % pondered)			10,021,500
Consumption (kg/ha)			200
Total consumption			**2,004,300**

Source: Cunha (2014)

Average of 3 kg fertilizer product/ha **or**
1 kg of nutrients/ha

Reasons for low nutrient inputs in livestock systems in Brazil



1. Tropical grasses have low nutrient requeriments
2. Low biomass production due to low soil fertility are rarely noticed
3. Livestock farmers don't usually access their return from inputs
4. Livestock sytems have poor grazing harvest efficiency
5. Technical assistance is scarce

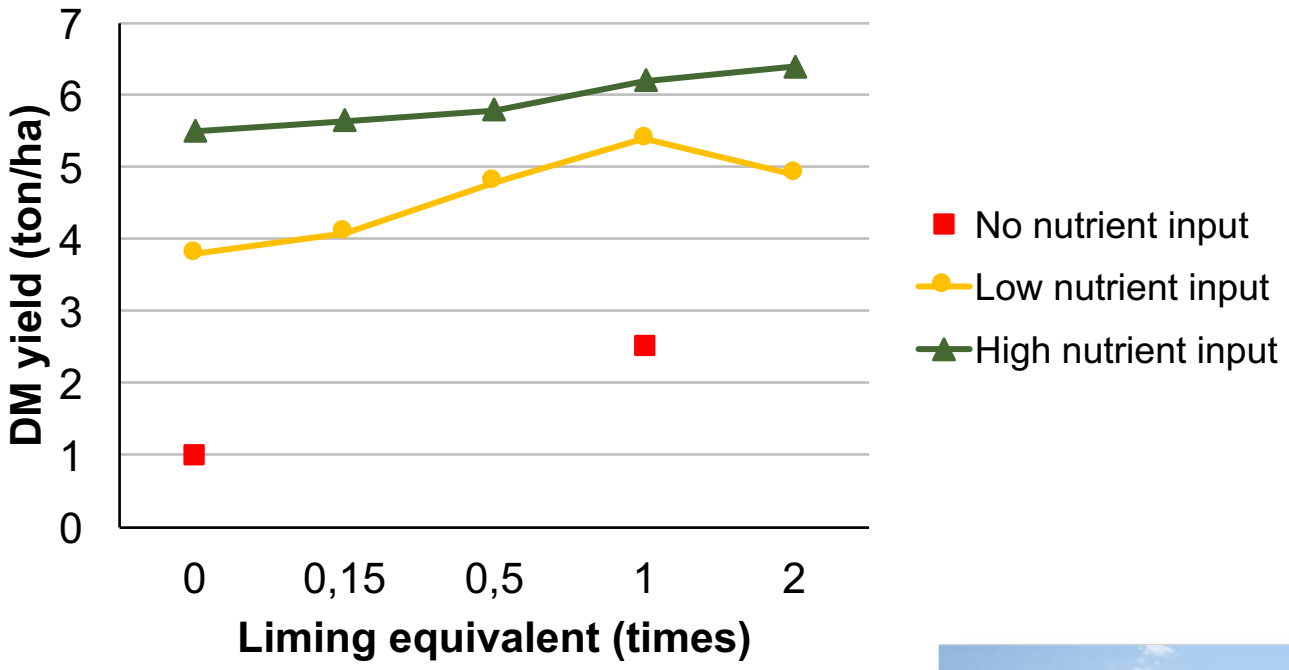
Source: Cunha (2013)

Nutrients demand and tolerances of *Brachiaria* grasses

Scientific and Common Name		Nutrients demand	Tolerance to			
			Drought	Freeze	Wet soil	Soil acidity
B. decumbens	Decumbens	Low	Medium	Low	Low	High
B. brizantha	Braquiarão	Medium	Medium	Low	Low	High
B. humidicola	Quicuio	Low	Low	Medium	High	Very High
B. ruziziensis	Ruziziensis	Medium	Low	Low	Low	Medium
B. dictyoneura	Dictioneura	Low	High	Low	Low	Very High
B. mutica	Angola	Medium	Low	Low	High	Medium
B. arrecta	Tanner grass	Medium	Medium	Medium	High	-

Source: Alvim et al. (2002)

Dry matter yield of *Brachiaria decumbes* in response to liming and nutrient application



Liming recommendation (BS):

- ✓ 30 to 35% for low demanding grasses
- ✓ 40 to 45% for medium demanding grasses
- ✓ 50 to 60% for high demanding grasses

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Table. Grouping of forage grasses regarding nutrient requirements and adaptation to the level of technology adoption in the farming system.

Nutrient requeriments[1]	Technology level[2]	Forage grass
Group I - High	High	*Panicum maximum*, *Pennisetum purpureum, Cynodon*, *Brachiaria* brizantha, Hyparrenia rufa
Group II – Medium	Medium	*P. maximum*, *B. brizantha*, B. decumbens, *Cynodon plectostachyus*, *Andropogon gayanus*, Hyparrenia rufa
Group III - Low	Low	*B. decumbens*, *B. Humidicola*, *B. dictioneura, Paspalum notatum*, Milinis minutiflora, *Andropogon gayanus*, Hyparrenia rufa

Adaptaded from: [1] Werner et al. (1996); 2 Cantarutti et al. (1999).

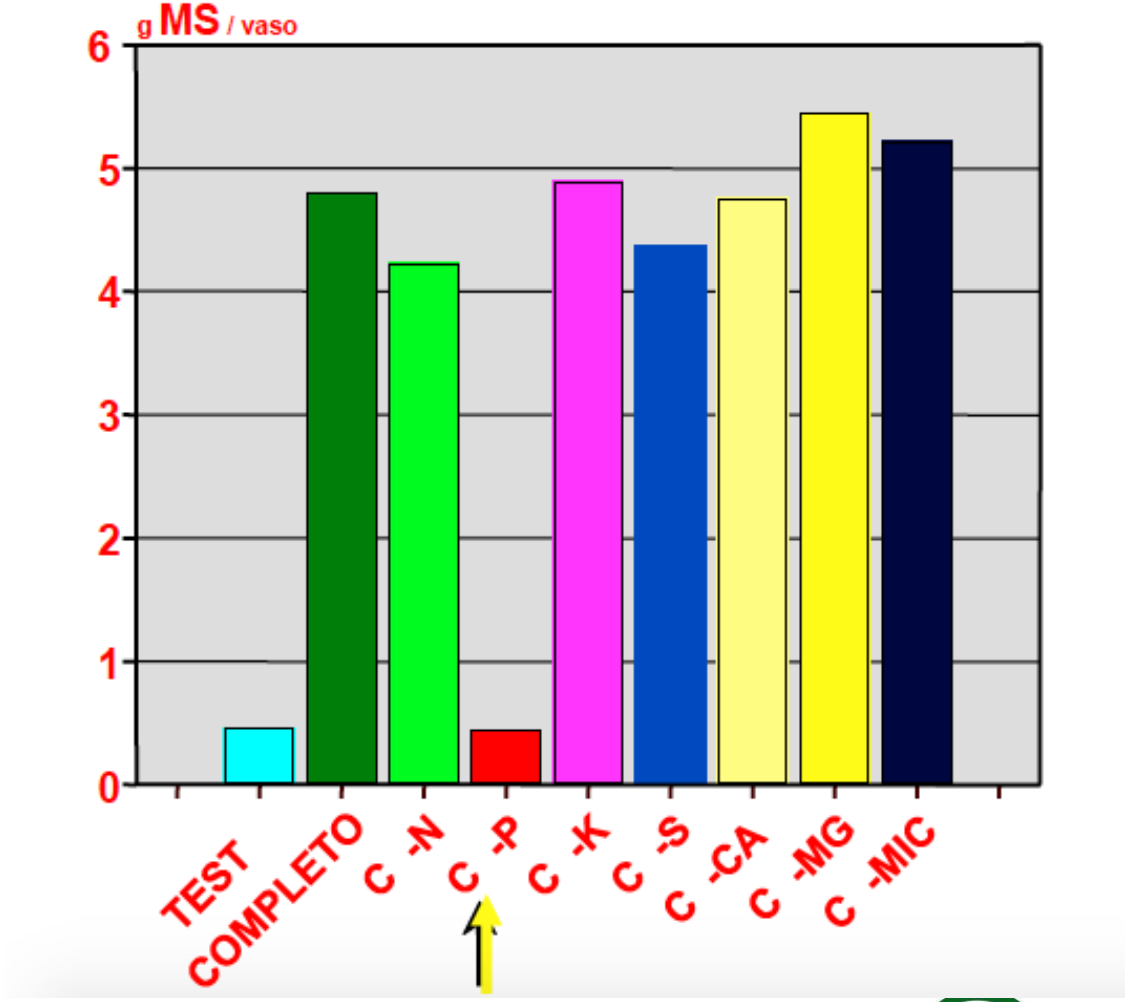
Level high: irrigated systems with high biomass yield, intensive grazing, and stock rates above 5 heads/ha/year.

Level medium: non-irrigated systems with medium biomass yield, less intensive grazing, and stock rates among 2 to 5 heads/ha/year.

Level low: non-irrigated systems with low biomass yield, non-intesive grazing, and stock rates bellow 2 heads/ha/ano.

Brachiaria grasses response to fertilization

Source: Macedo (2014)



Lopes & Fox (1977):

- 518 soil samples analyzed
- Available P: 0.1 to 16.5 ppm
- **92% of samples:** P < 2 ppm

Phosphorus recommendation

Tabela. Phosphorus recommendation for grasses in soils with P medium availability and cattle performance of 120 kg LW/head/year.

Level of plant requirements	Expectated Beef Yield (kg LW/ha)				
	200	350	500	650	800
	Kg P_2O_5/ha				
Low	12	20	30	40	50
Medium	14	25	35	47	58
High	17	30	40	55	67

Source: Cunha (2013). Average values of LW (200 to 450 kg) and ADG (100 to 700 g/head). Value for NDF of 55 to 60% and grazing efficiency of 50%.

P sources for grasses

Dry Matter Yield of a Brachiaria grass grown for 10 years and the Relative Agronomic Effectiveness of P sources applied (150 kg P/ha)

Sources of P	Biomass	RAE
	t/ha	%
Araxá, Brazil	48	61
Gafsa, Tunisia	64	93
North Carolina, EUA	61	89
Termophosphate, Brazil	65	97
Single Superphosphate	67	100

Source: Lobato et al. (1986).

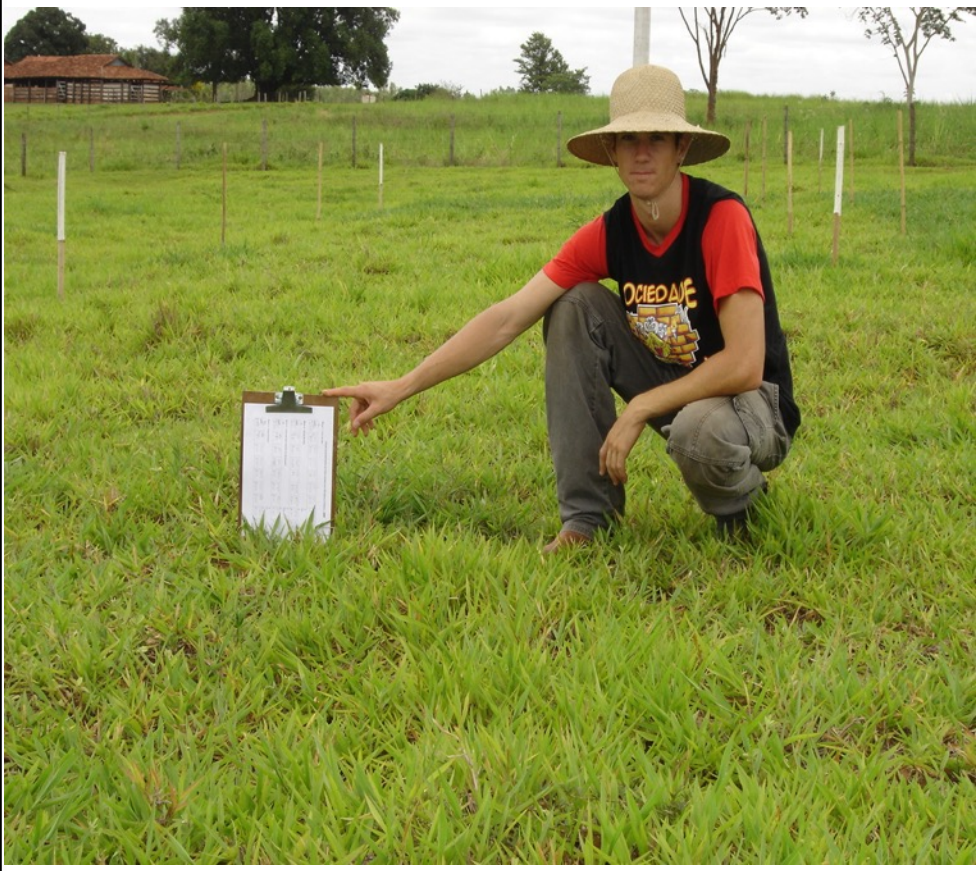
Relavite Agronomic Effectiveness of P sources for different grasses in the Cerrado region of Brazil

Fontes de P	RAE (%)		
	Year 1	Year 2	Year 3
Arad, Israel	69	102	101
North Carolina, EUA	86	116	128
Gafsa, Tunisia	103	100	88

Source: Bono e Macedo (1998) e Lobato et al. (1999).

Increasing dry matter yield via fertilization:

Sinergism between P and N



Increasing biomass through nutrient application:
Sinergism between P and N

Dry matter yield of *Brachiaria decumbens* in response to NP rates and nutrient use efficiency

Phosphorus rate (kg P_2O_5/ha)	Nitrogen rate (kg N/ha)			
	0	75	150	300
	Dry matter yield (ton/ha.ano)			
0	3.35	-	-	-
60	3.39	8.14	9.95	11.9
120	3.56	8.31	12.1	15.3
	Nutrient use efficiency (kg de MS/kg de N)			
60	-	57	39	23
120	-	61	51	32

Source: Lupatini et al. (2010).

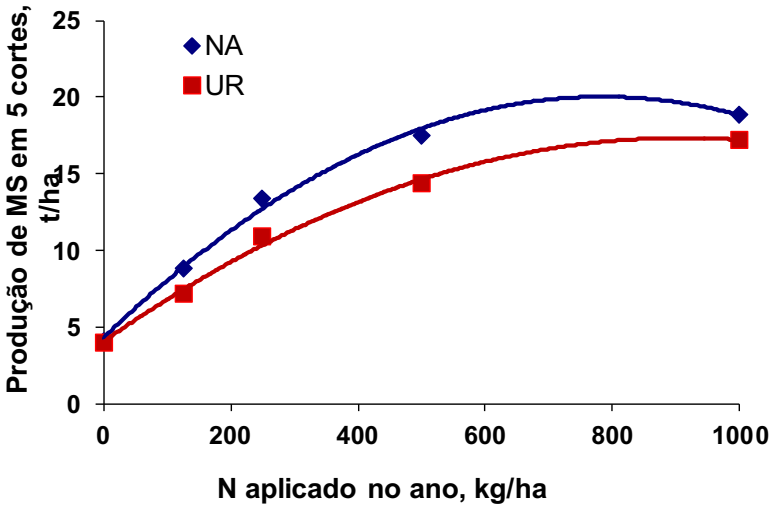
Nitrogen recommendation

Nitrogen requirements (kg N/UA) regarding the impact of the farming management on N use efficiency and grazing harvest efficiency

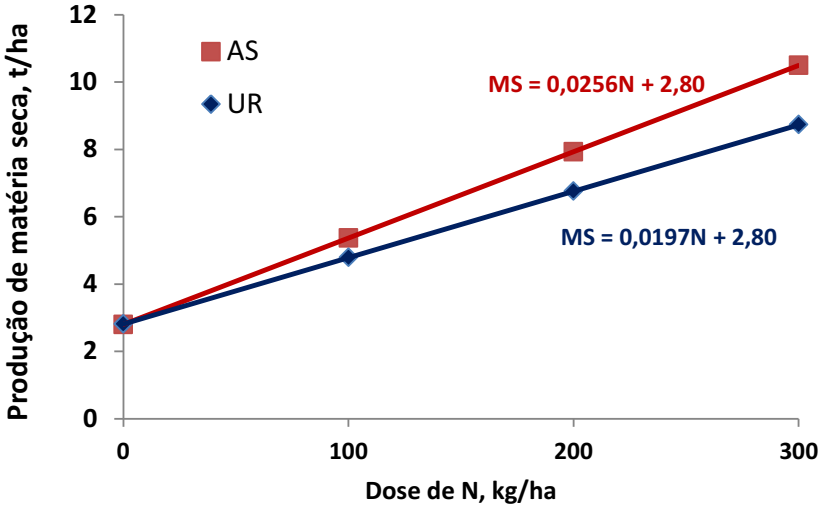
Farming management	Grazing management		Nitrogen need (kg N/UA)
	kg DM/kg N	Grazing harvest efficiency (%)	
Very bad	<30	<40	170
Bad	30-35	40-45	130
Medium	35-40	45-50	100
Good	40-45	50-55	85
Very good	45-50	55-60	70
Excelent	>50	>60	60

Source: Martha Júnior et al. (2004)

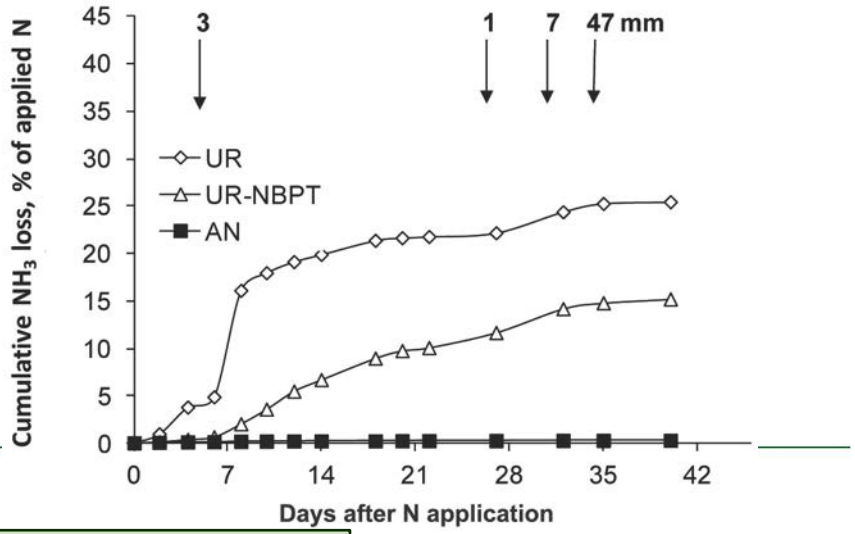
Right Source of Nitrogen



Cumulative DM yield in response to N rate and source (Source: Cantarella et al., 2002)



Cumulative DM yield in response to N rate and source (Source: Costa et al., 2010)



Fonte: Cantarella et al. (2008).

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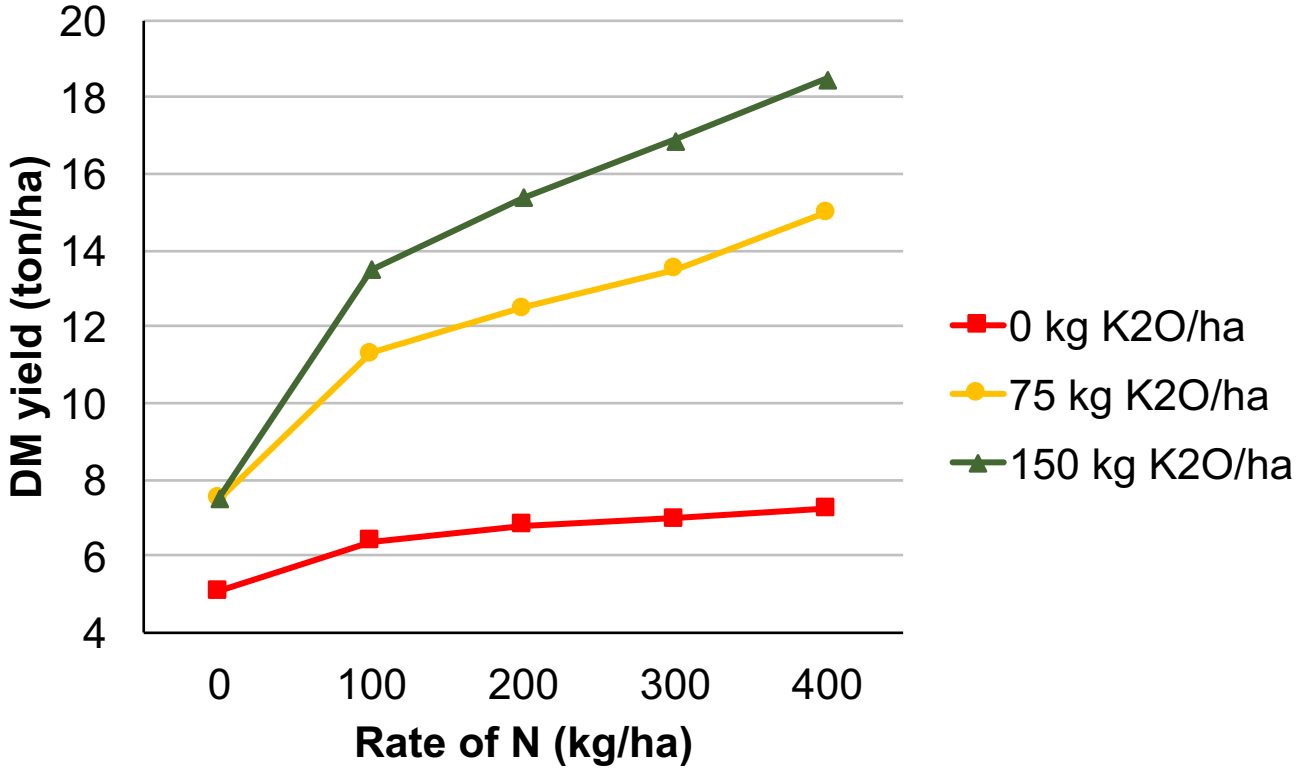
Tabela. Dry matter yield (ton/ha) of three different grasses in response to NP rates.

P application	*B. decumbens*	*B. decumbens*	*B. ruziziensis*
		Control (no N)	
Control (no P)	1.89	3.72	0.67
100 kg P_2O_5/ha	1.90	3.38	0.64
		100 kg N/ha)	
Control (no P)	2.86	5.43	1.44
100 kg P_2O_5/ha	5.14	6.63	2.10

Fonte: Oliveira et al. (2001).

Cumulative dry matter yield of a *Brachiaria* grass in response to NK application



Source: Carvalho et al. (1991).

Nutrient concentration (g/kg) in the shoots of a Brachiaria grass field in Cacoal-RO.

Source: Bergamin (2016)

N	P	K	Ca	Mg	S
24.7	1.0	14.8	3.3	2.9	1.0
16.8	1.1	2.6	3.6	5.9	1.0

Intensification of livestock systems via fertilization:
does it pay off?

Comparasion of livestock production systems in Mato Grosso do Sul state

System	DM yield	Stocking rate		ADG	Beef production	Cost	Operating Profit
	ton/ha/year	kg/ha	head/ha	kg/day	kg/ha/year	R$/kg	R$/ha/year
1	unknow	400	1.30	3.35	82.9	3.38	216
2	4,3	380	1.24	0.46	118.0	3.50	295
3	38,1	3,720	10.7	0.62	1,287	3.22	3,559

System 1: MS state average
System 2: low input cattle farm
System 3: high input cattle farm (liming, fertilization, and irrigation)

Source: Aguiar (2015).

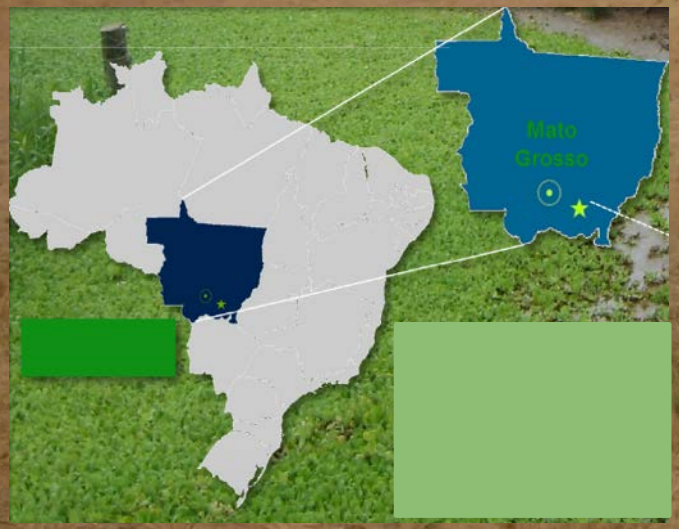
Intensification of livestock systems promotes land saving

Stocking rate	LW gain	Beef yield	Land saving
head/ha	kg/head	kg/head	ha saved/ ha recovered
0.4	100	40	-
0.7	120	84	1.1
1.1	135	149	2.7
1.4	160	224	4.6

Source: Martha Jr. (2013)

Increasing beef production via nutrient application:
practical example

2010



ANÁLISE DE SOLO													
AMOSTRA	PROF.	PH		P	K	CA + MG	CA	MG	AL	H	Mat. Org.	ARGILA	V%
		ÁGUA	$CaCl_2$	Mg/dm^3		$Cmol_c / dm^3$					G/dm^3	G/Kg	
MÓDULO 03	0-20	6,4	5,6	5,9	175,0	5,9	4,2	1,7	0,0	3,0	41,0	34,4	67,7
MÓDULO 03	20-40	6,3	5,5	3,6	109,0	4,5	3,0	1,5	0,0	3,0	29,5	36,0	61,2

- **Field 1** (SAFRA → 2011/2012)
  - ✓ 550 Kg/ha (04-20-10 +9%Ca, 5%S);
  - ✓ 120 Kg/ha Nitrato de Amônio (32-00-00+3,5%S).

Source: Max Padin (personal communication, 2016)

ANÁLISE DE SOLO													
AMOSTRA	PROF.	PH		P	K	CA + MG	CA	MG	AL	H	Mat. Org.	ARGILA	V%
		ÁGUA	$CaCl_2$	Mg/dm^3		$Cmol_c / dm^3$					G/dm^3	G/Kg	
MÓDULO 02	0-20	6,3	5,5	5,6	131,0	5,7	4,0	1,7	0,0	4,0	43,3	27,7	60,1

- **Field 2** (SAFRA → 2011/2012)
  - ✓ 550 Kg/ha (04-20-10 +9%Ca, 5%S);
  - ✓ 300 Kg/ha Nitrato de Amônio (32-00-00 + 3,5%S).

Source: Max Padin (personal communication, 2016)

Source: Max Padin (personal communication, 2016)

- **Field 2** → **SAFRA 2012/2013**
  - ✓ 500 Kg/ha (Gesso);
  - ✓ 450 Kg/ha (05-12-10 +9%Ca, 5%S);
  - ✓ 600 Kg/ha Nitrato de Amônio (32-00-00 + 3,5%S).

Source: Max Padin (personal communication, 2016)

Performance of the Farm in Numbers

Item	Field 1	Field 2	Farm
Total grazing area (ha)	88.4	85.3	1,720
Fertilized area (ha)	88.4	85.3	-
Occupation (# of heads)	500	750	3,250
Average stocking rate (head/ha)	5.7	8.8	1.9
Average daily gain (kg/head/day)	0.65	0.60	0.60
Occupation period (day)	211	211	211
Average total gain (kg/head)	137.1	126.6	126.6
Beef productivity (kg/ha)	388	555	120

Item	Field 1	Field 2	Farm
Oportunity cost (R$/ha/year)	340.10	340.10	340.10
Fertilization cost (R$/ha/year)	884.00	1,020.00	-
Total cost of the pasture (R$/ha/year)	1,224.00	1,360.00	340.10
Stocking rate	5.7	8.8	1.9
Suplementation cost (head/month)	5.00	5.00	5.00
Labor cost (head/month)	1.40	1.40	2.00
Production cost (R$/kg of beef)	3.83	3.17	3.64

Source: Max Padin (personal communication, 2016)

Performance of the Farm in Numbers

Year	Size of herd	Sent to slaughter house	Meat yield
	head	head	%
2011	2,406	1,555	54.5
2012	3,258	955	54.9
2013	4,019	1,978	54.8
2014	4,788	2,319	55.5
2015	4,864	2,482	55.5

Source: Max Padin (personal communication, 2016)

Intensifing livestock production via crop integration systems:
another possibility

Association of crops: Maize + Brachiaria grass

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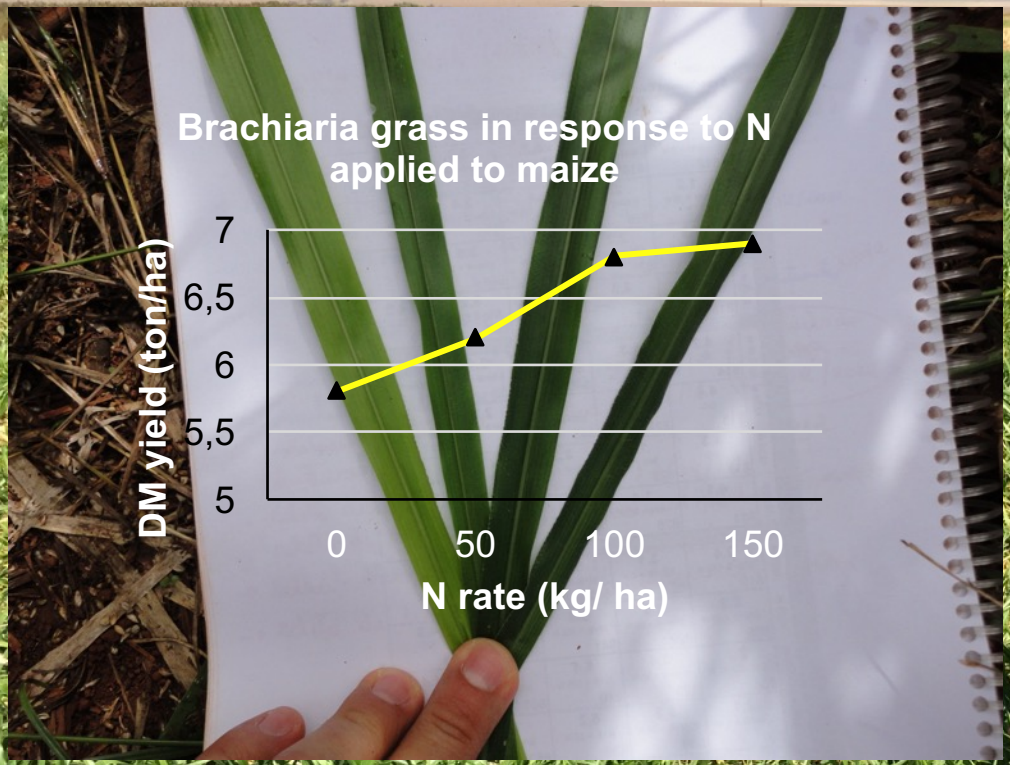

IPNI Global Maize Project
Itiquira-Mato Grosso
2015

Livestock-Agriculture Integration

Livestock-Agriculture Integration

- ✓ Growing soybeans for 2-3 years

Livestock-Agriculture Integration

Livestock-Agriculture-Forest Integration

Final Considerations

- ✓ Brazil = Largest beef exporter but system is inefficient. Half animal per hectare. 1 Kg nutrients per ha.
- ✓ ANDA = less than 2% of fertilizer for pasture lands.
- ✓ 160-180 million ha of pasture land in Brazil, partially under degradation.
- ✓ High increase in soybean area expansion, part coming from forage grasses.
- ✓ Beef production will have to increase efficiency with time, which should mean better pasture lands and most likely more fertilizer application.

Thanks for your attention!

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