Potential of Intensive Silvopastoral Systems in Colombia: Productive and environmental benefits

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Clima y Sector Agropecuario Colombiano
Adaptación para la Sostenibilidad Productiva

Silvopastoral Systems

Agroforestry arrangements that combine fodder plants, such as grasses and leguminous herbs, with shrubs and trees for animal nutrition and complementary uses.

Pezo & Ibrahim, 1998; Harvey 2004

Four silvopastoral systems

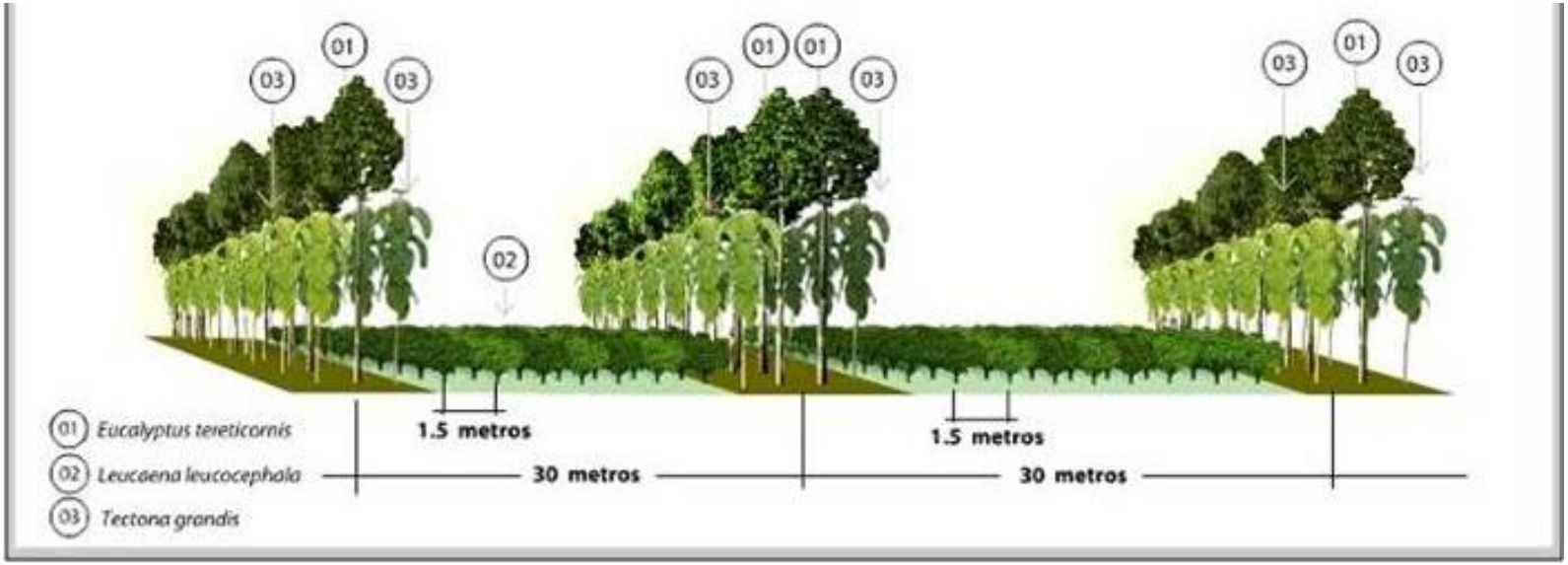
Live fences

Scattered trees in pastureland

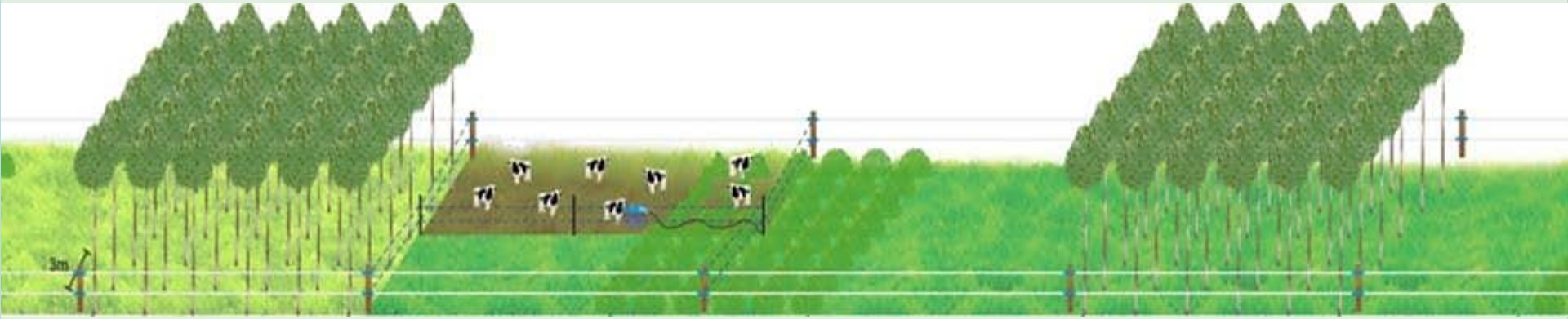
Mixed fodder bank (cut-and-carry system)

Intensive silvopastoral system ISS

- A system that can be directly grazed by livestock. It combines:
  - Fodder shrubs planted at high densities (>10,000 plants ha^{-1}), intercropped with
  - highly-productive pastures, and
  - 500 timber trees planted in east-west lines to minimize shading.



Intensive Silvopastoral System with Timber Trees



Intensive Silvopastoral Systems (iSPS)

1. iSPS with *L. leucocephala*, associated with *Cynodon plectostachyus and Megathyrsus maximus*. Montenegro, Quindío, Cerrito y Bugalagrande, Valle del Cauca.

2. iSPS with *T. diversifolia and* P*ennisetum clandestinum*. Rionegro, Antioquia.

3. iSPS with *T. diversifolia* and *Brachiaria*. Pailitas, Cesar.

iSPS Productivity

Productive parameters and stocking rate in different scenarios

	System			
	DP	IP	iSPS	iSPS + Timber
Plant productivity; t DM/ha/yr	7	19,2	28	28
Stocking rate AU/ha (1 AU=450 kg)	0,85	2,34	3	3
Yield; kg beef/ha/yr	77,6	341,6	711,8	711,8

Naranjo *et al.*, 2012

iSPS Productivity

Stocking rate and animal productivity				
Region	System	Stocking rate (an/ha)	ADG (g/an/d)	Yield Live weight (kg/ha/año)
Bajo Magdalena	Traditional	1,2	296,0	129,6
	Improved Pasture	3,6	453,8	596,2
Valle del Cesar	iSPS + mango	3,5	651,3	827,3
	iSPS + timber	4,7	790,2	1341,2

Naranjo *et al.*, 2012

Systems under study

Farm	Location	Coordenadas	Rainfall (mm/year)	Altitude (masl)	Zone
Cien años de Soledad	Rionegro, Antioquia	6° 8' 27.35" N - 75° 28' 5.45" O	2500	2350	bmh - MB
San Diego	Montenegro, Quindío	4° 30' 54.22" N - 75° 51' 0.81" O	1750	1230	bh - T
Sinaí	Pailitas, Cesar	8°57'14.20" N - 73°39'12.87" O	1100	76	bs - T
Lucerna	Bugalagrande, Valle	4º 13´ 07" N y 76º 09´03" O	1110	960	bs - T

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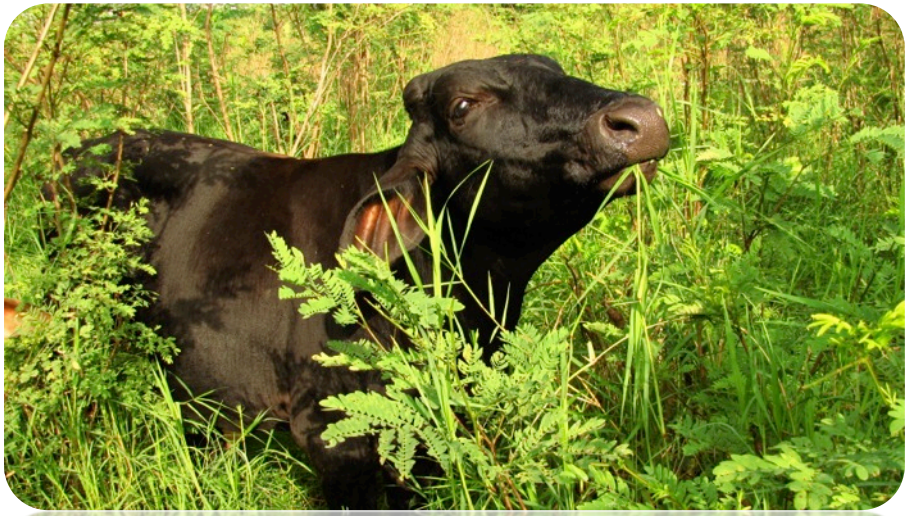
iSPS

iSPS Leucaena – Cynodon, Megathyrsus

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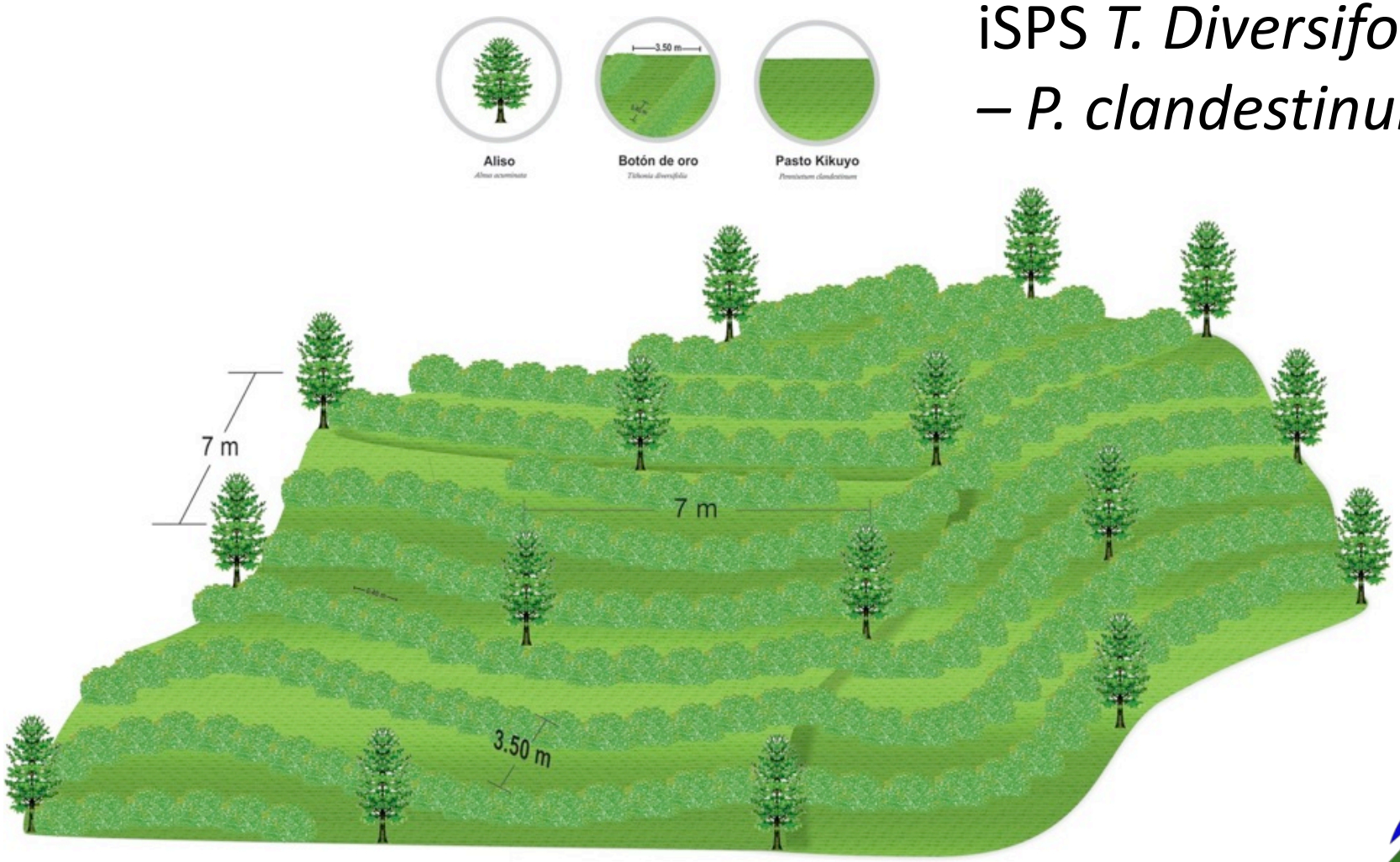
iSPS under study

iSPS *T. Diversifolia* – *P. clandestinum*



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iSPS

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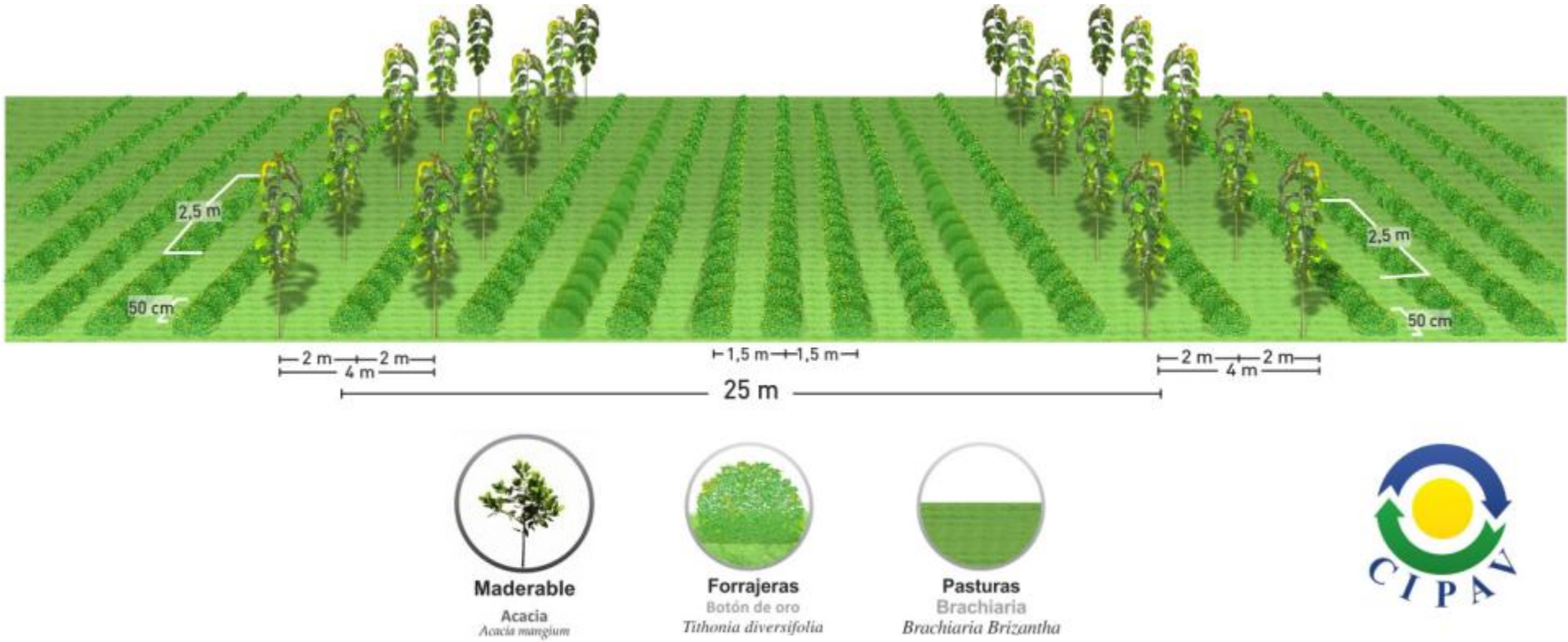
iSPS *T. diversifolia – Brachiaria + A. Mangium*



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Carbon Stock

Biomass of grass, shrubs and trees

Roots
Main and
secondary

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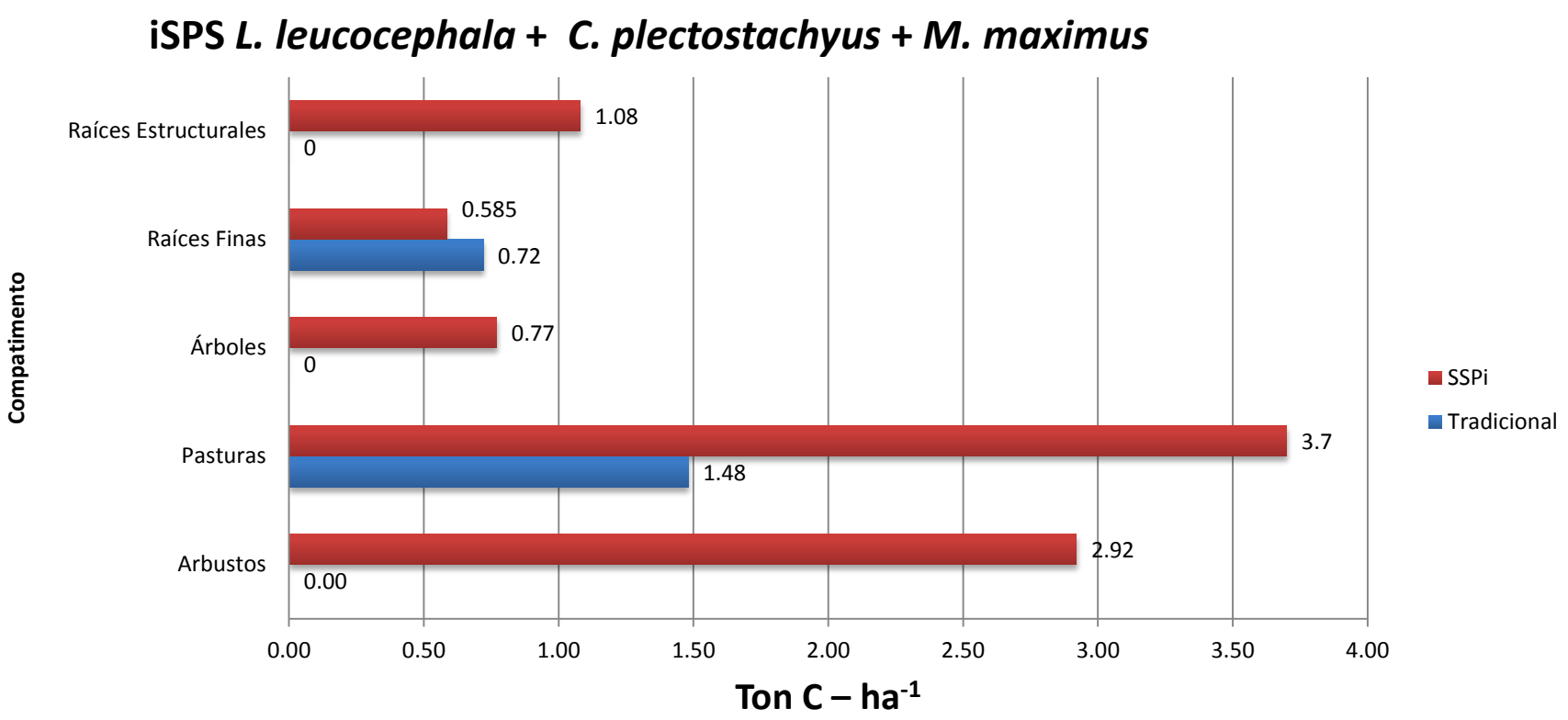
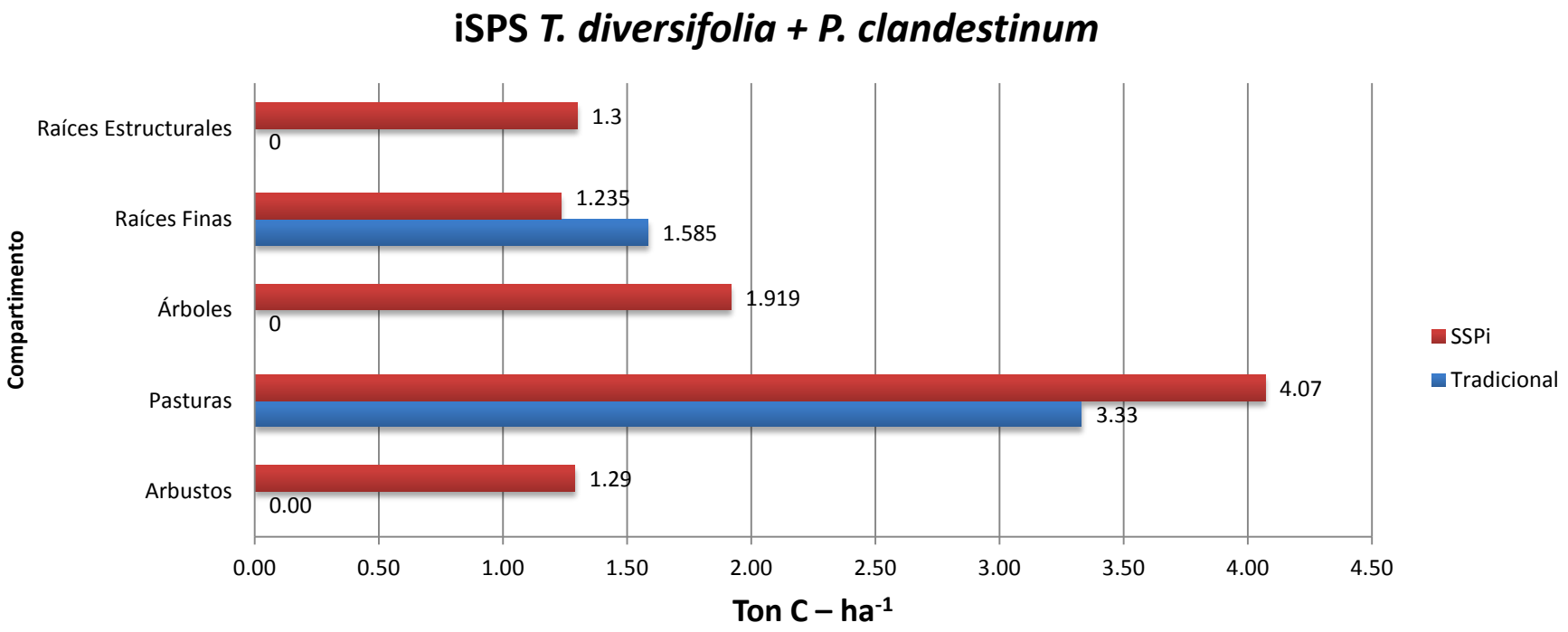
Carbon Stock

Plant Biomass



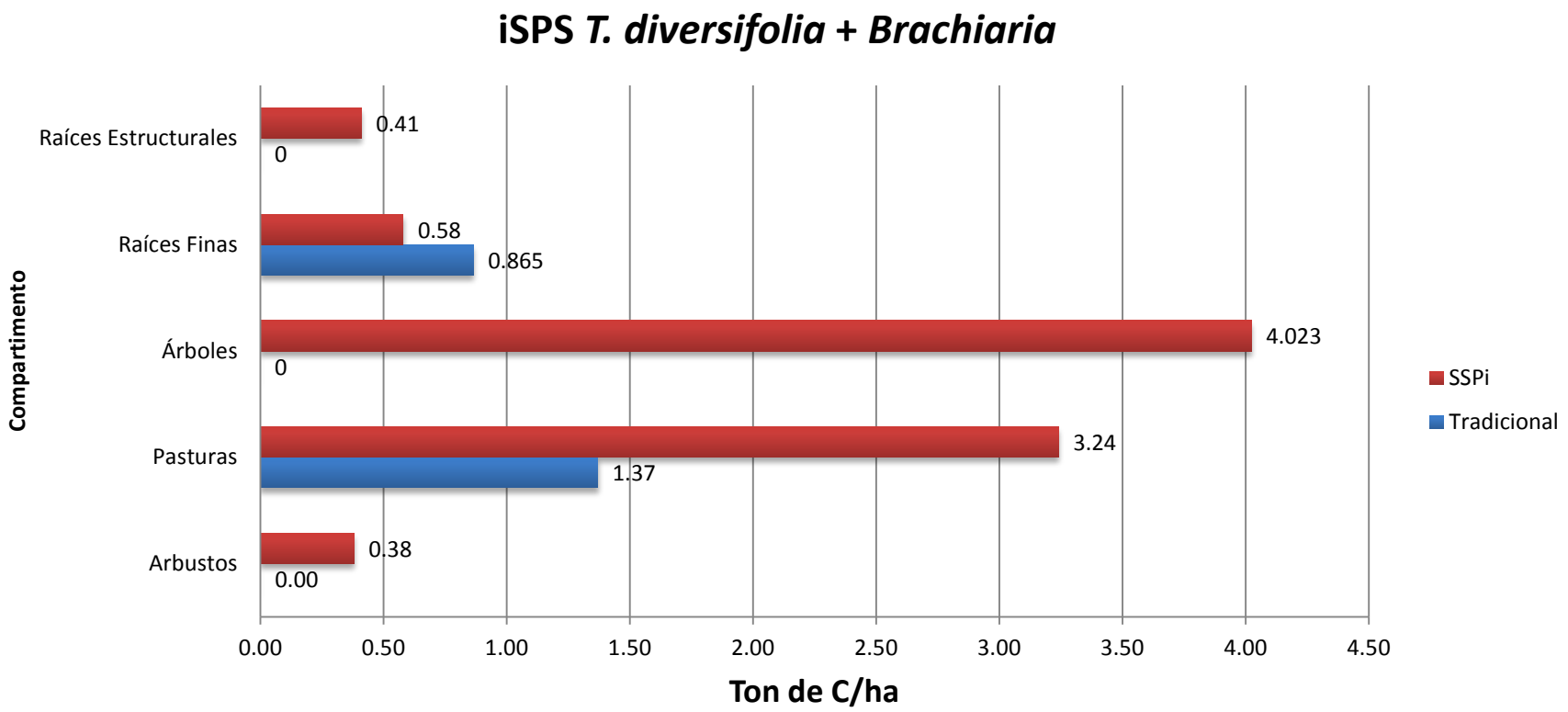
Carbon Stock

Plant Biomass



Carbon Stock

Plant Biomass



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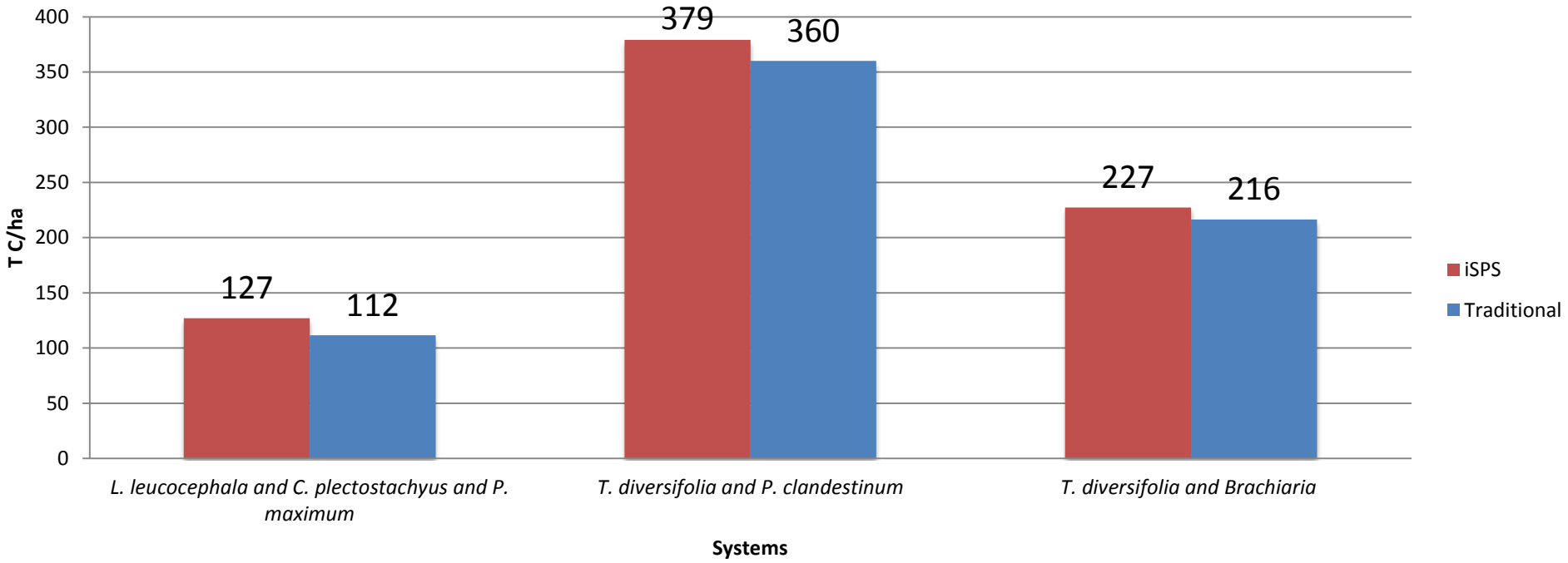
Carbon Stock

Soils Ton C ha^{-1}



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Enteric Emissions

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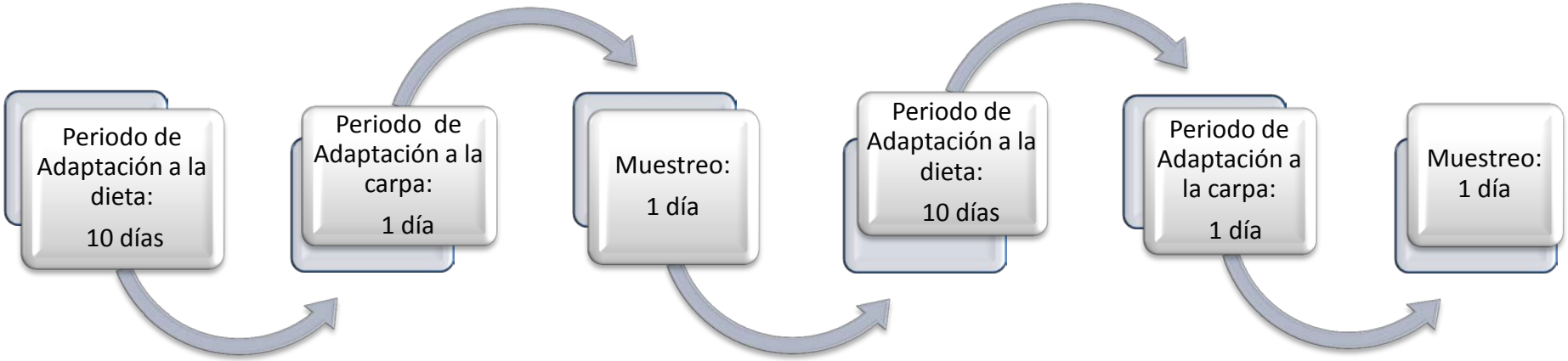
Poly-tunnel Technique



Adapted from Lockyer (1997) and Murray *et al.* (2002)

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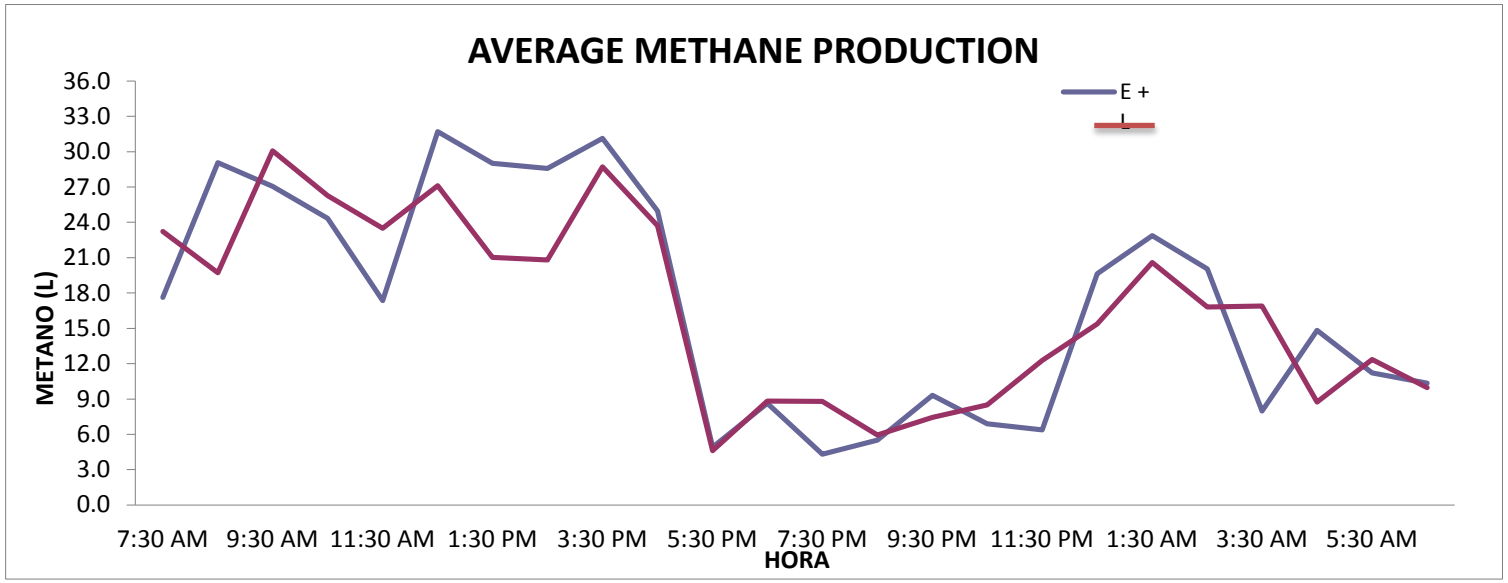
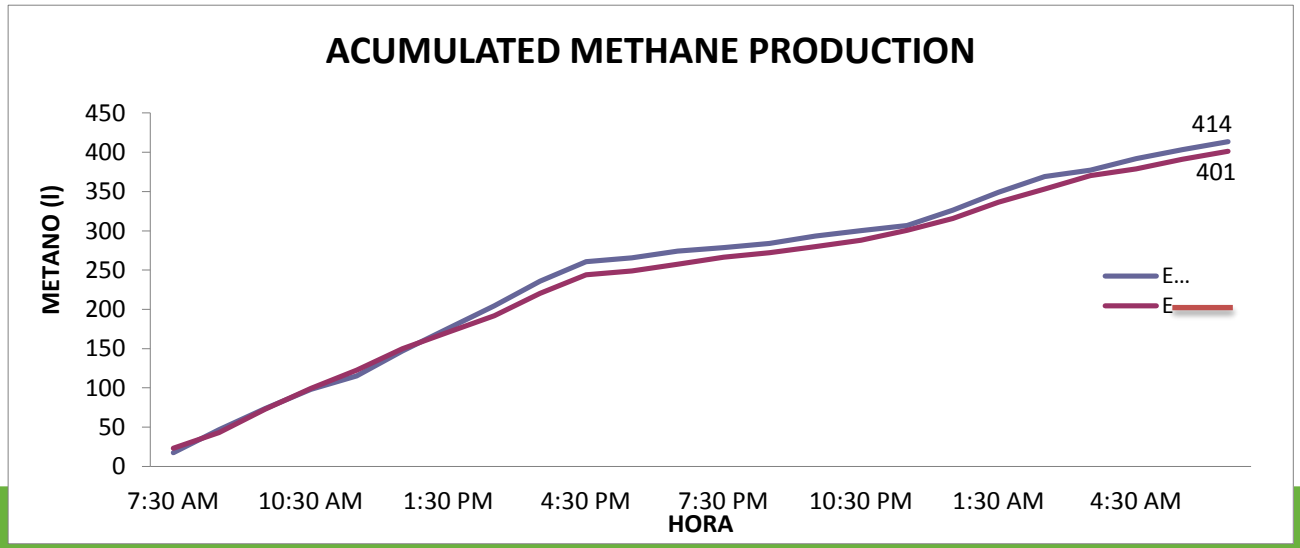
Forage Quality

Análisis	Cien Años de Soledad			Lucerna			Sinaí	
	Kikuyo	Botón de Oro	Concentrado	Estrella	Guinea	Leucaena	Braquiaria Decumbens	Botón de Oro
Humedad (%)	84,3	80,6	11,8	76,1	78,8	72,4	76,7	81,2
Proteína (%)	17,3	21,1	7,1	11,8	11,6	27,0	6,3	23,4
Fibra Detergente Acido (%)	31,3	45,9	3,5	40,6	41,1	30,9	42,1	37,1
Fibra Detergente Neutro (%)	59,5	47,7	8,7	71,3	68,6	34,0	69,1	35,7
Grasa Bruta (%)	1,92	1,19	18,59	1,26	1,63	1,82	1,56	3,68
Cenizas (%)	11,17	12,50	1,12	10,02	13,37	7,07	8,22	13,72
Calcio (%)	0,34	1,96	403	0,27	0,29	0,88	0,24	2,01
Fosforo (%)	0,29	0,31	0,20	0,30	0,26	0,24	0,14	0,43
Valor Calorífico (cal /g)			2630					

Methane emissions





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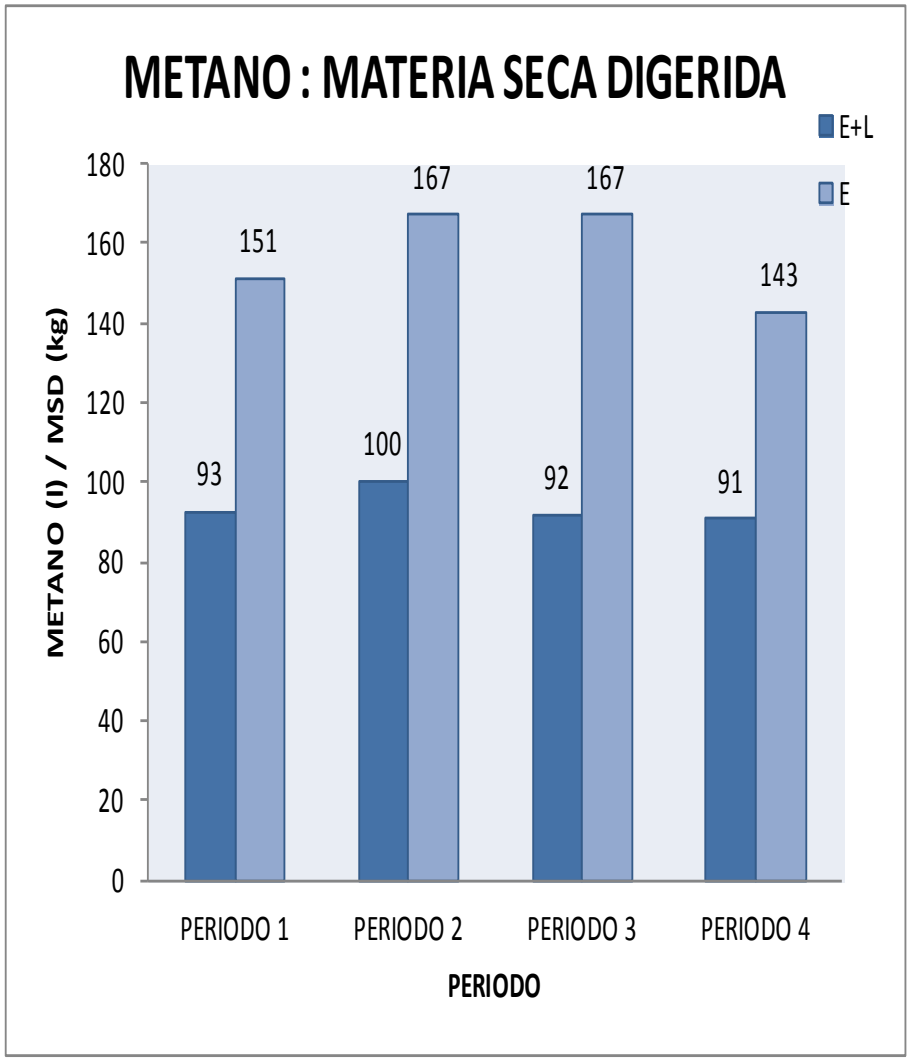
Methane emissions



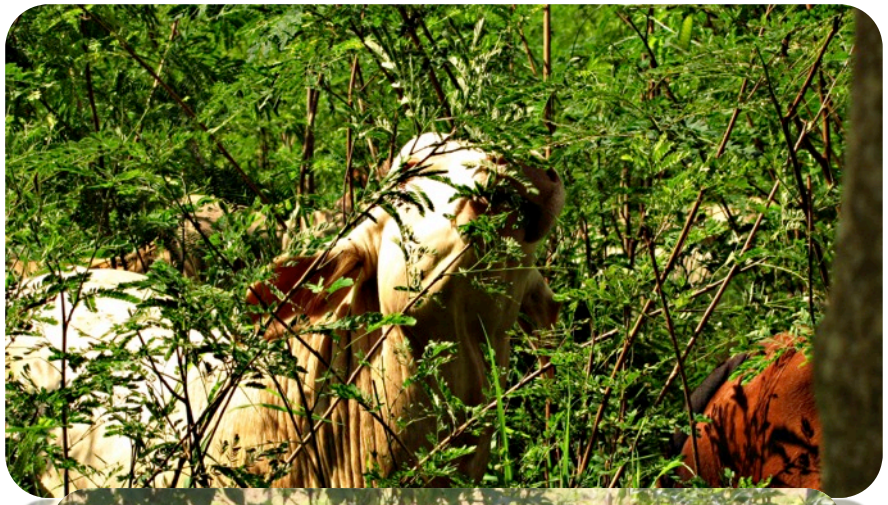
Carbon Footprint

In-farm

Sources
CH_4 - Enteric (kg/DMI)
CH_4 - Heces Líquidas (m3/día)
CH_4 - Heces Sólidas (m3/día)
CH_4 - Heces en Campo (m3/día)
CO_2 Por quema de Diesel (lt-Usado)
N_2O de Orina aplicado y depositado por animales (Kg N-Excretado)
N_2O de estiercol aplicado y depositado por animales (Kg N-Excretado)
N_2O de Fertilizante (1 % N del aplicado) kg

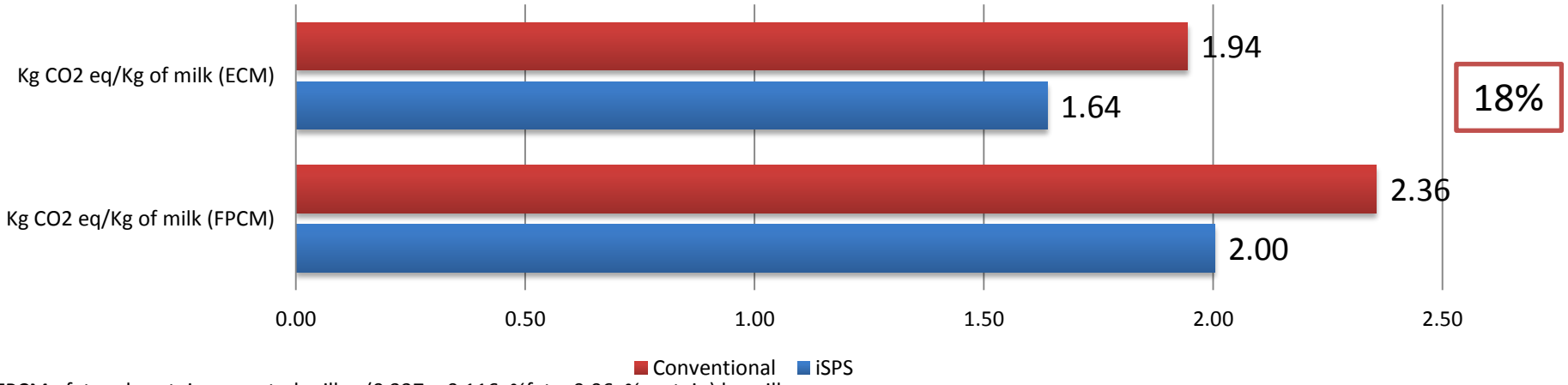
Outside

CH_4 - Diesel (kg) - Elaboración
CH_4 - Urea (KgN) - Elaboración
CH_4 - Concentrado (kg) - Elaboración
CH_4 - Cal (kg) - Elaboración
CO_2 - Electricidad (Kwh)
CO_2 - Diesel (kg) - Elaboración
CO_2 - Urea (KgN) - Elaboración
CO_2 - Cal (kg) - Elaboración
CO_2 - Concentrado (kg) - Elaboración
N_2O Urea - (KgN) - Elaboración
NO_2 Concentrado (kg) - Elaboración



Preliminary Results

Carbon footprint. Dairy System with *T. diversifolia (>2000m)*



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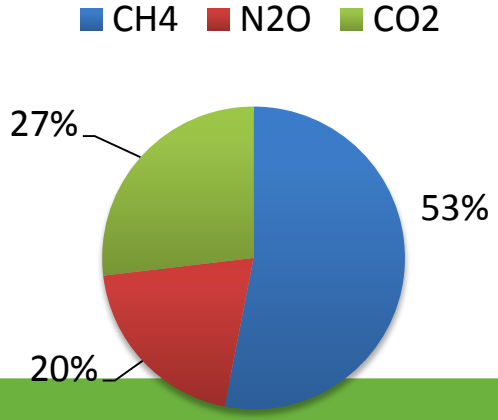
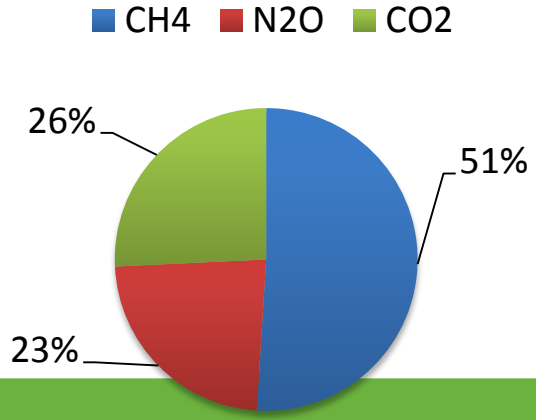
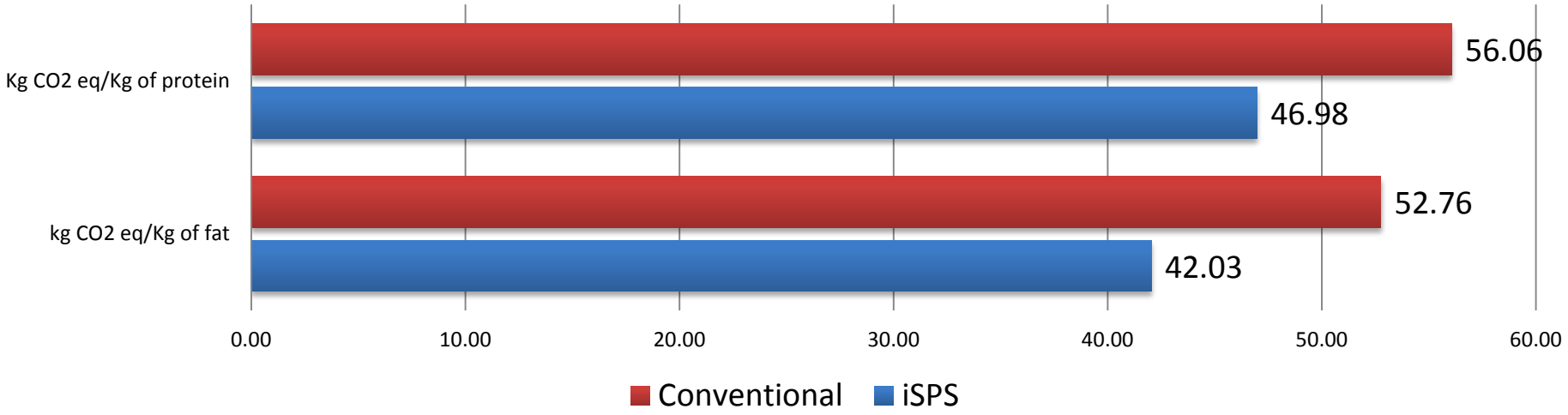
GHG distribution in ISPS



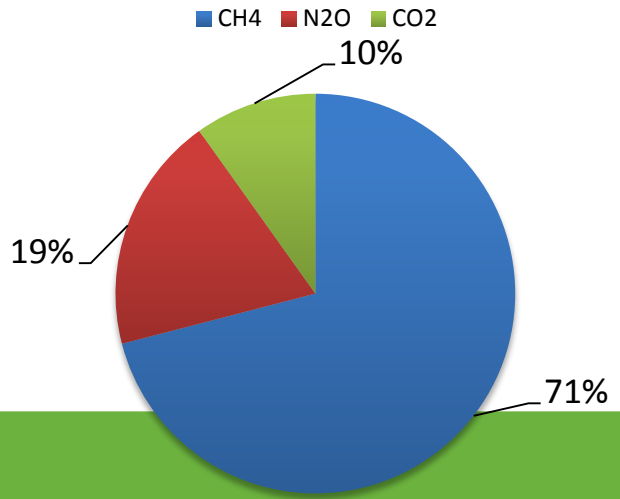
GHG distribution in conventional system



kg CO2 - eq/ kg of fat and protein



GHG Internal distribution in ISPS



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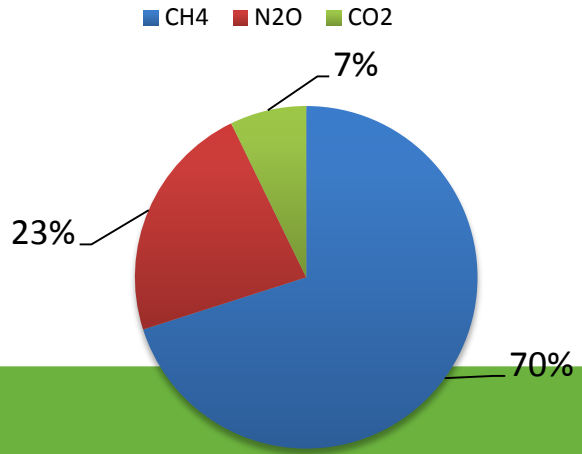

On - farm	iSPS t CO2 - eq	On - farm %	Conventional t CO2 - eq	On - farm %
CH4 emissions				
Enteric fermentation	167,71	68,16%	239,07	67,53%
Manure storage	5,54	2,25%	7,57	2,14%
Grasslands	1,35	0,55%	1,42	0,40%
	174,61		**248,07**	
N2O emissions				
Fertiliser application	21,98	8,93%	49,46	13,97%
Grazing excretion - Manure	12,43	5,05%	15,48	4,37%
Grazing excretion - Urine	10,81	4,39%	13,42	3,79%
Grasslands	1,95	0,79%	2,06	0,58%
	47,18		**80,41**	
CO2 emissions				
fuel combustion	18,99	7,72%	19,99	5,65%
Grasslands	5,30	2,15%	5,58	1,58%
	24,29		**25,57**	
Emissions/ha	12,95		17,70	
Total on farm emissions	**246,07**		**354,04**	
		Off - farm		
CH4 emissions				
Fuel (kg)	0,24	0,22%	0,25	0,14%
Urea (KgN)	0,03	0,03%	0,08	0,04%
Concentrate (kg)	2,54	2,35%	4,16	2,36%
Lime (kg)	0,07	0,07%	0,08	0,04%
	2,89		**4,56**	
N2O emissions				
N2O Urea - (KgN)	3,58	3,30%	8,05	4,56%
NO2 Concentrado (kg)	16,36	15,09%	26,76	15,17%
	19,93		**34,80**	
CO2 emissions				
Electricity (Kwh)	6,26	5,78%	7,20	4,09%
Diesel (kg)	2,31	2,13%	2,43	1,38%
Urea (KgN)	1,24	1,14%	2,79	1,58%
Lime (kg)	3,12	2,88%	3,44	1,95%
Concentrate (kg)	52,63	48,56%	86,10	48,83%
	65,56		**101,97**	
Transport	20	18,45%	35	19,85%
Total off farm emissions	**108,38**		**176,34**	
Total (t CO2 - eq)	**354,45**		**530,38**	

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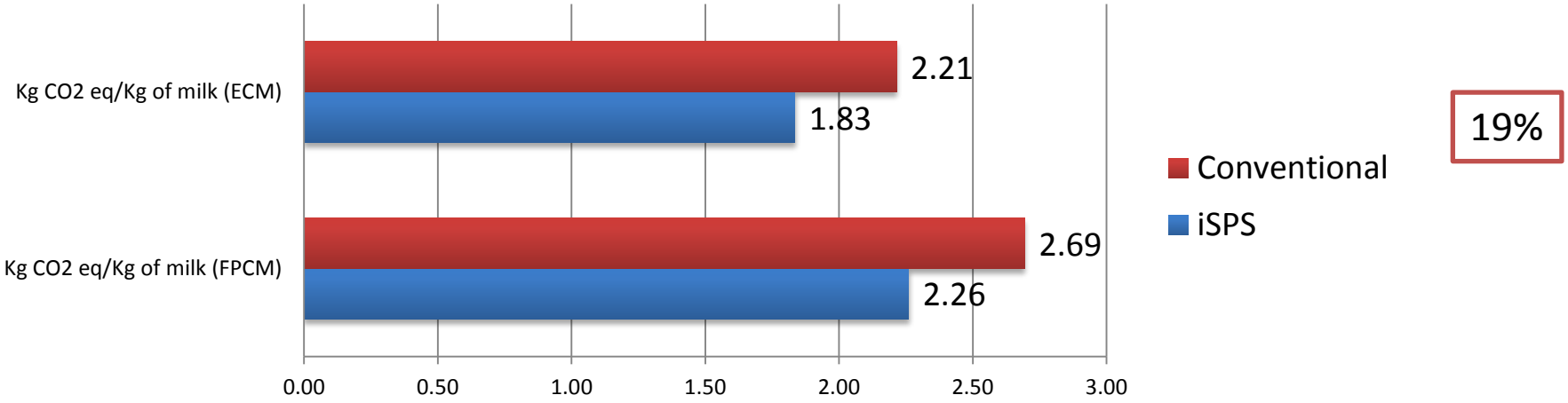
Carbon footprint. Dairy System with *L. leucocephala*



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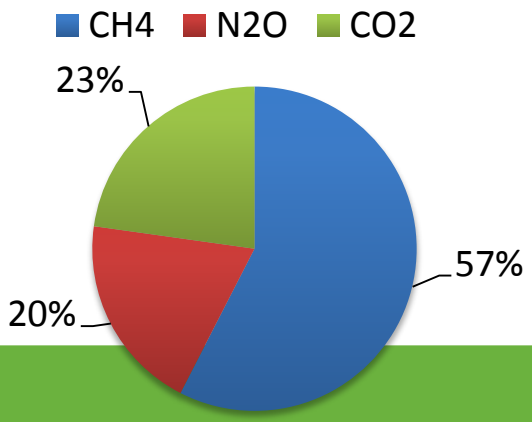

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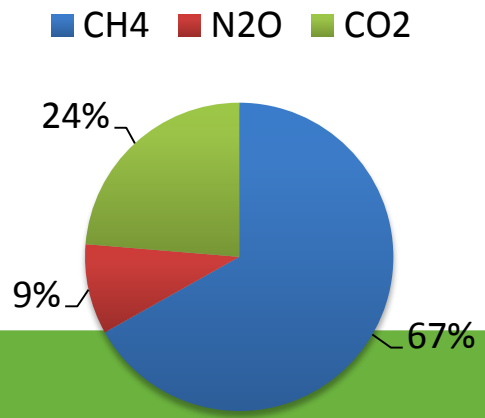
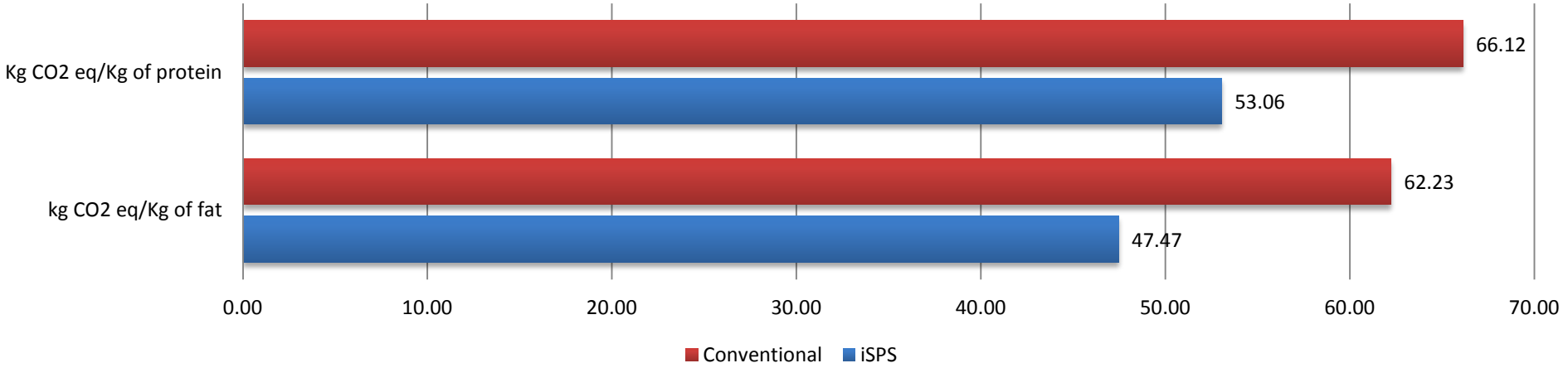
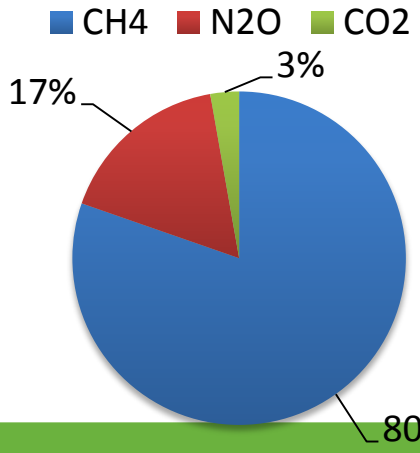


kg CO2 - eq/ kg of fat and protein



GHG internal distribution in conventional system



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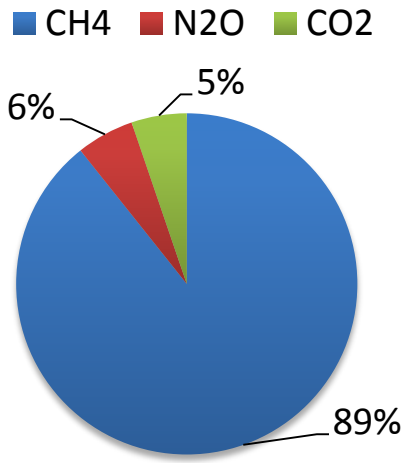
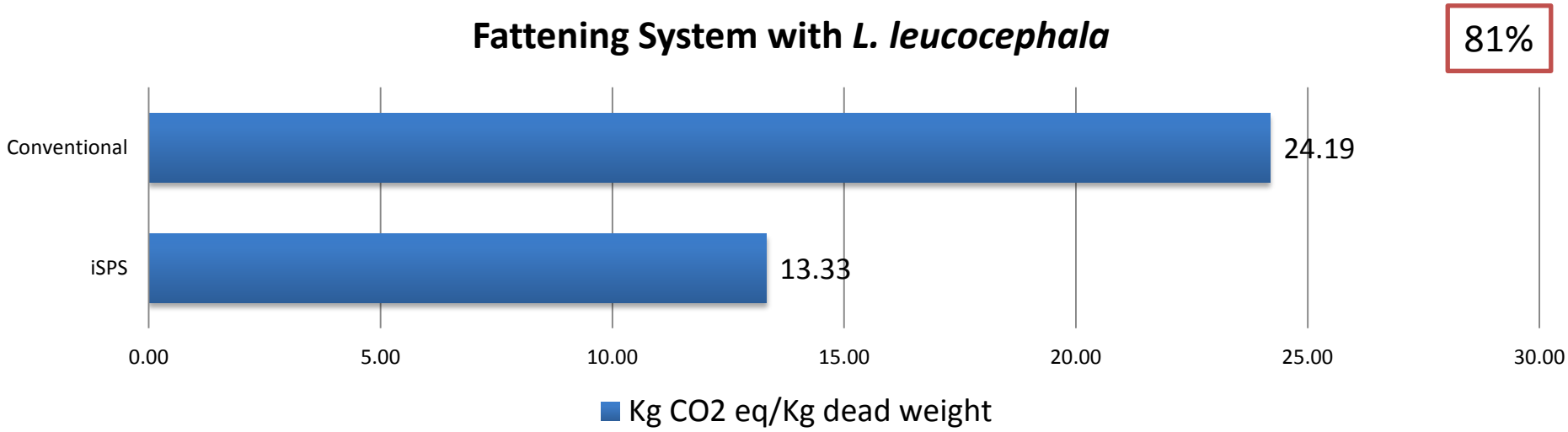


Fattening System with *L. leucocephala*



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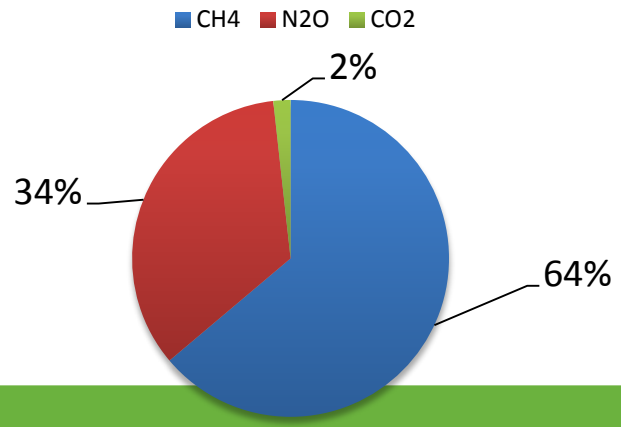

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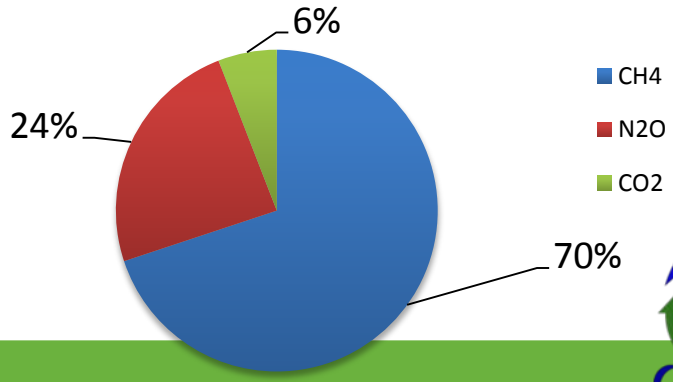
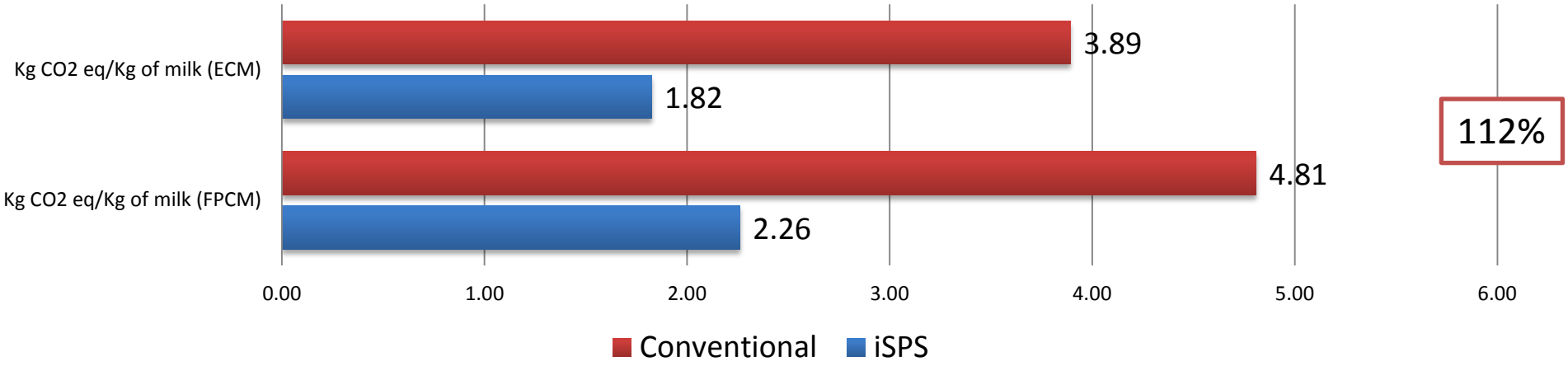


Carbon footprint. Dairy System with *T. diversifolia*



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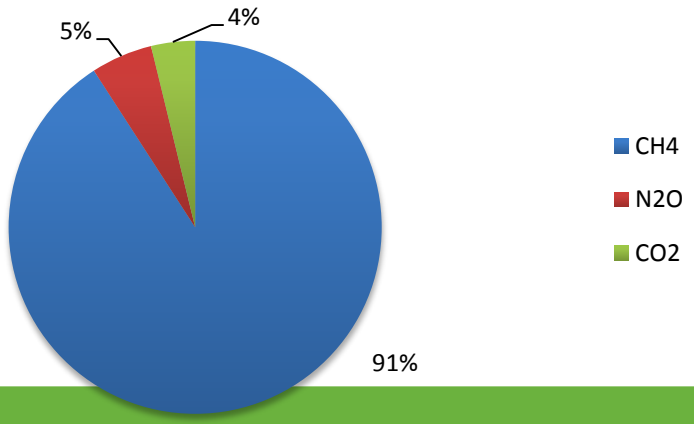

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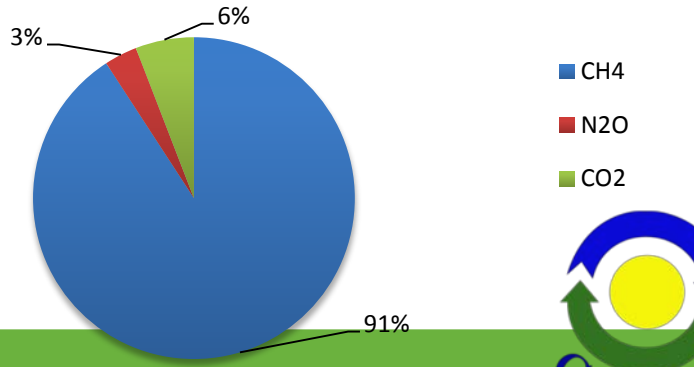

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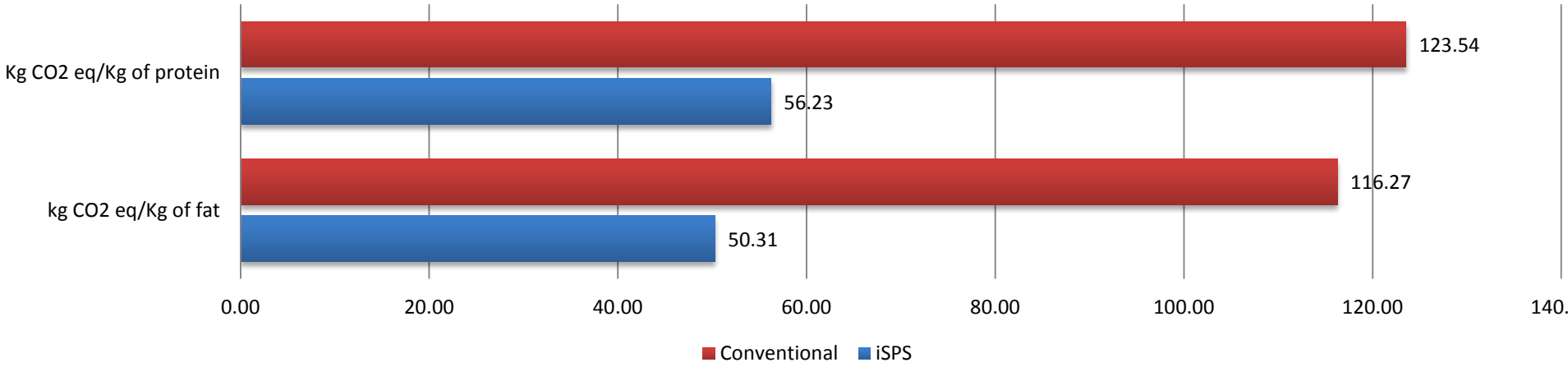

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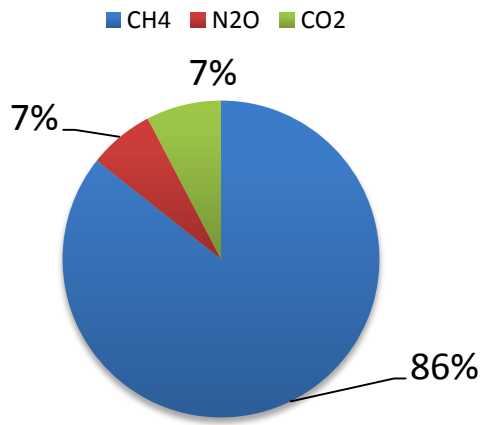

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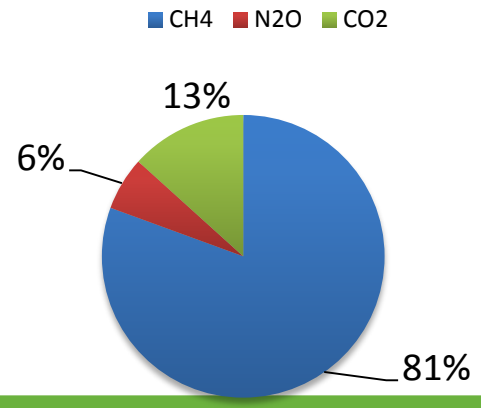

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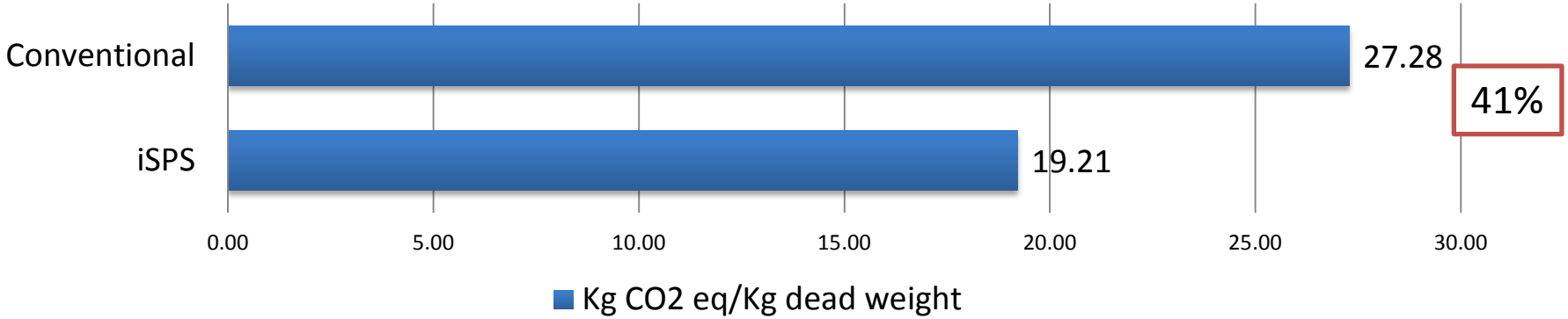

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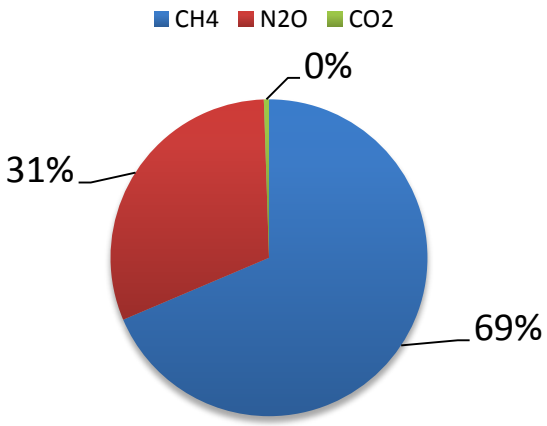
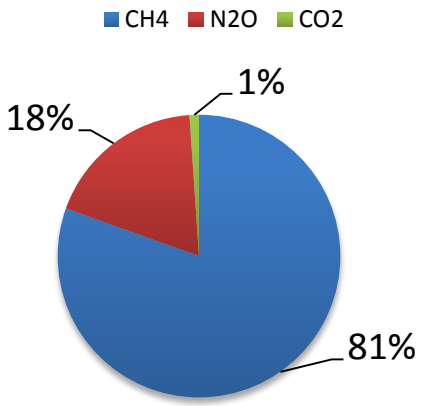
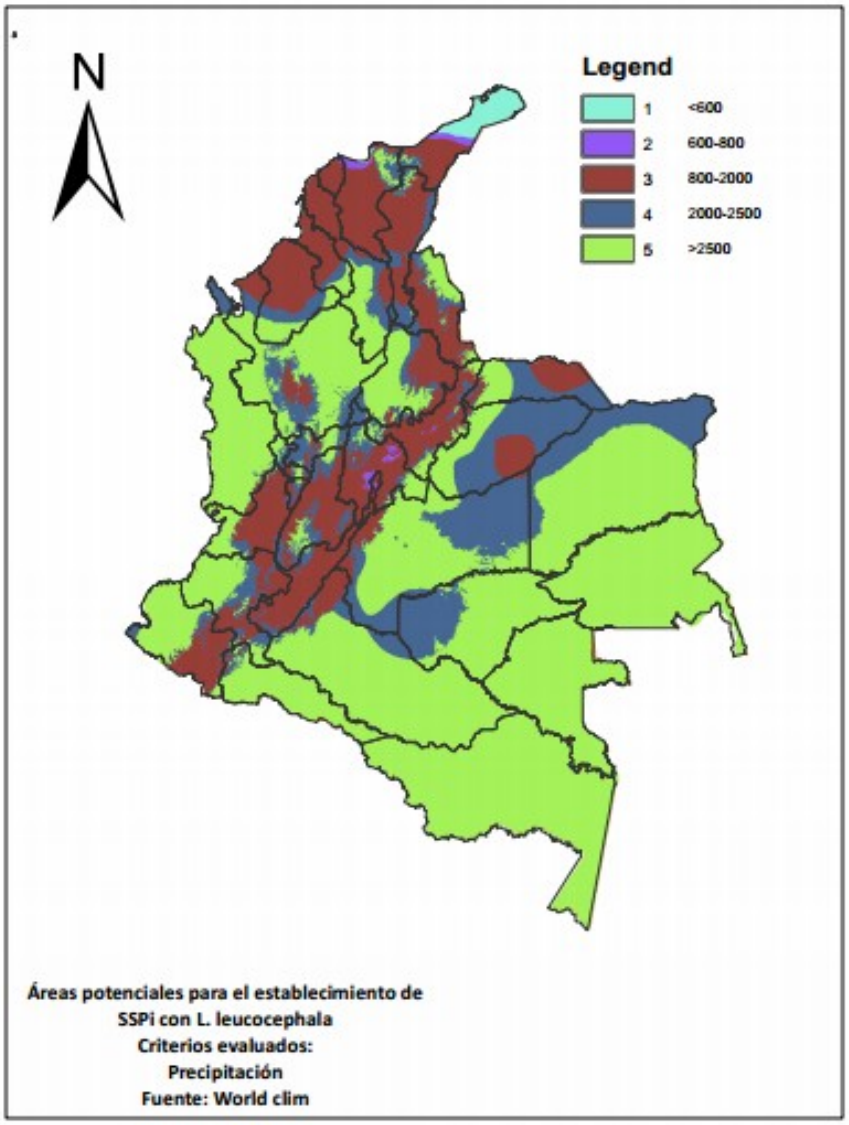


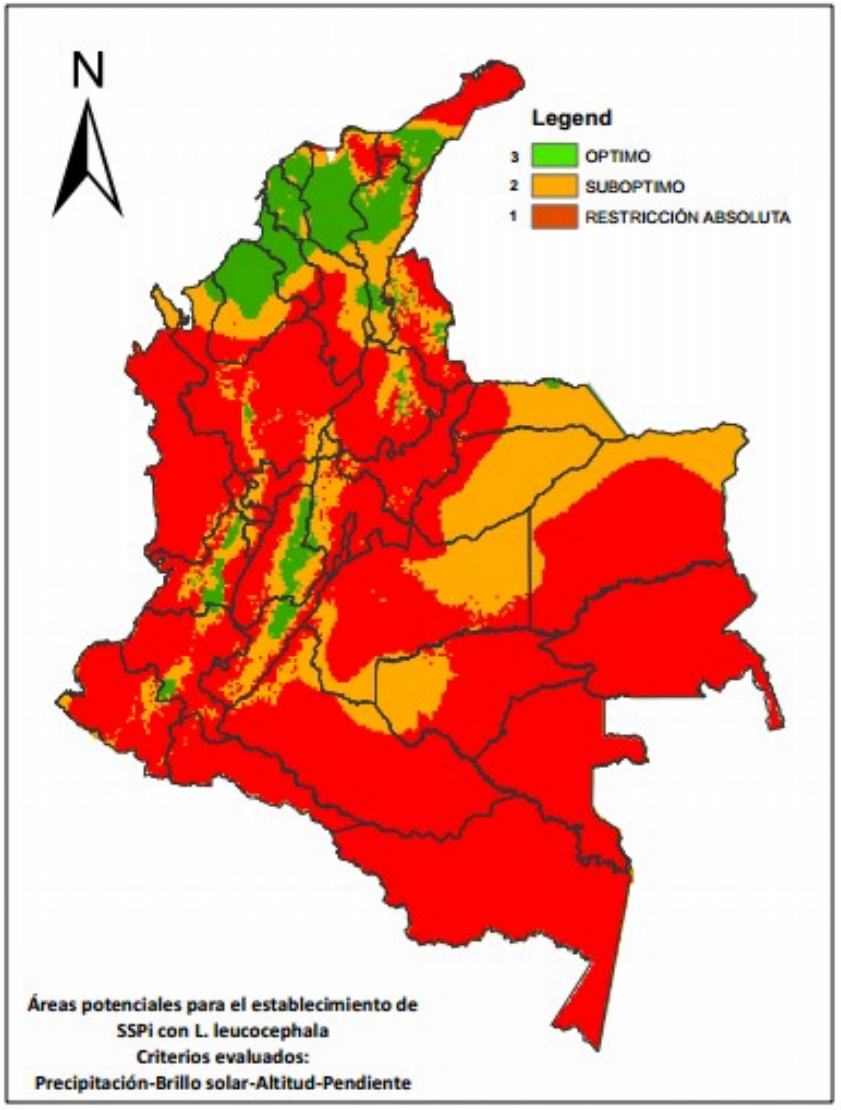
GHG distribution in conventional system



Potential Areas for iSPS with Leucaena

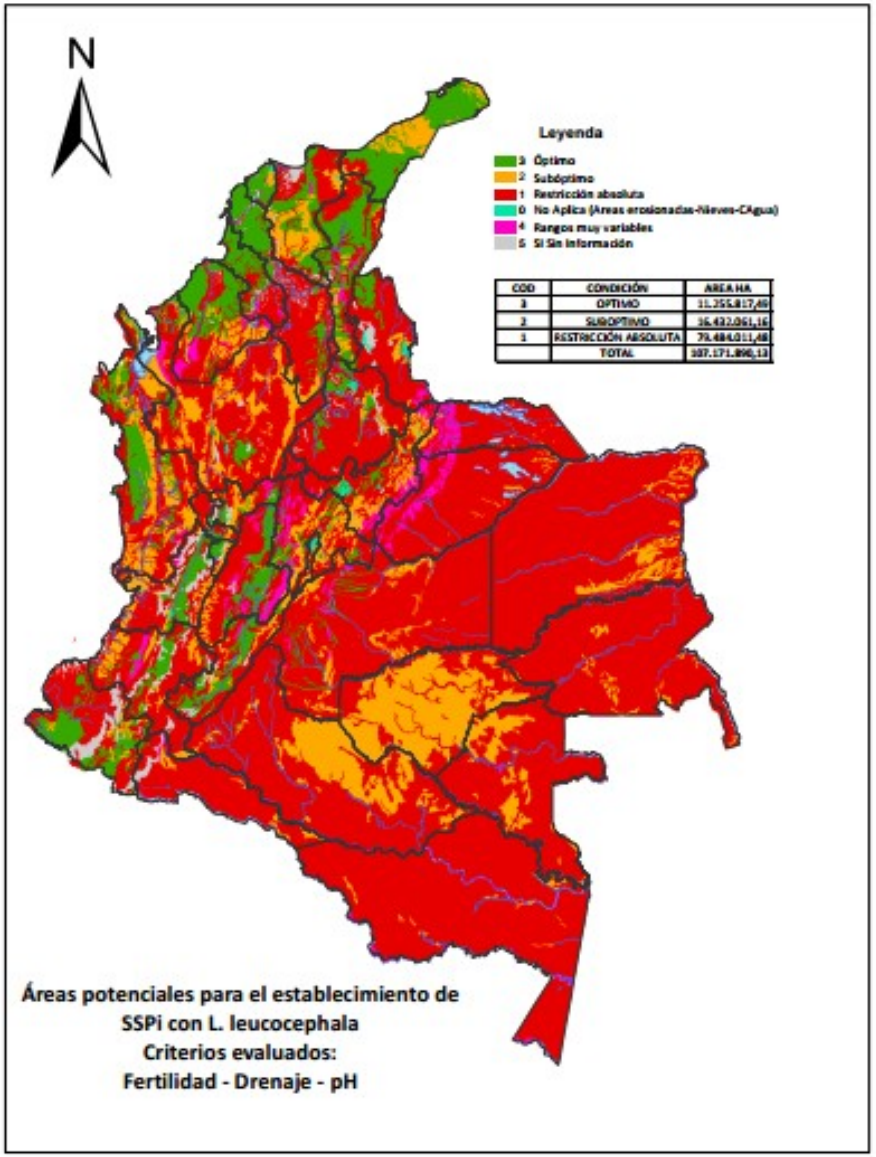


Rain fall

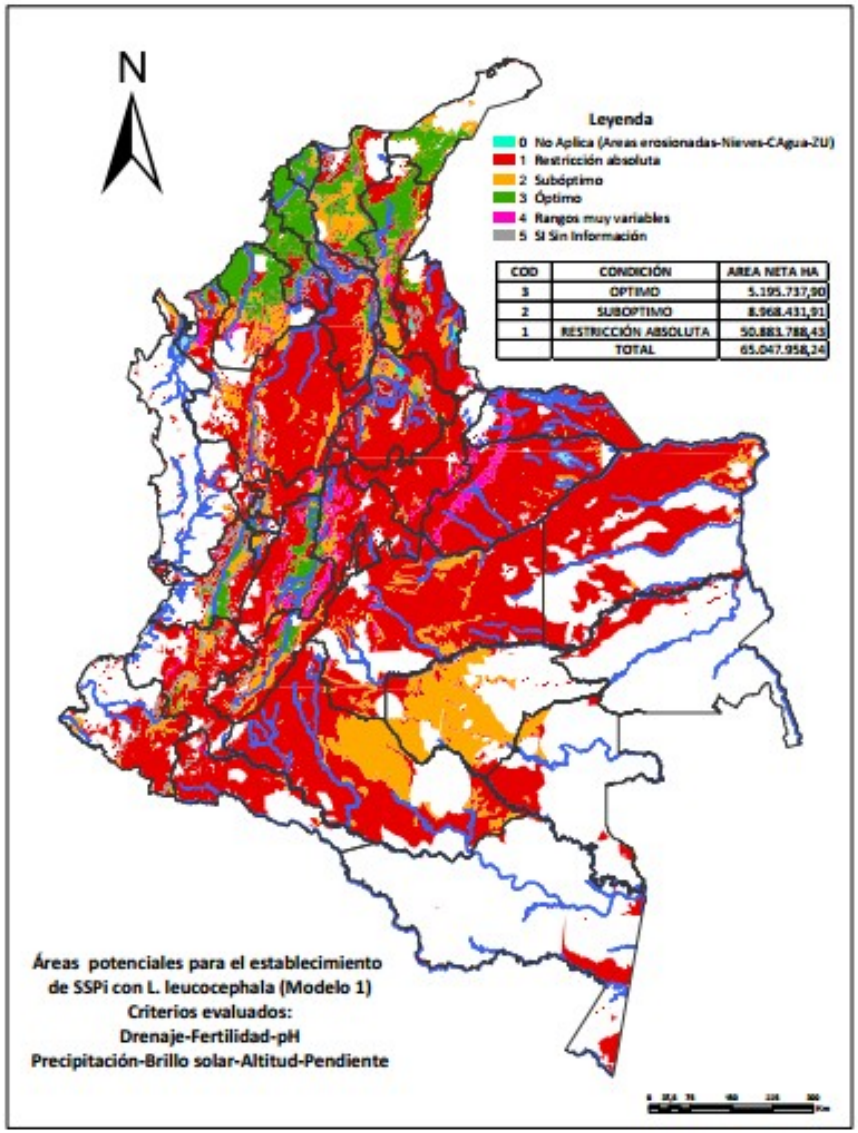


Rain fall + sunshine + Altitude

Potential Areas for iSPS with Leucaena



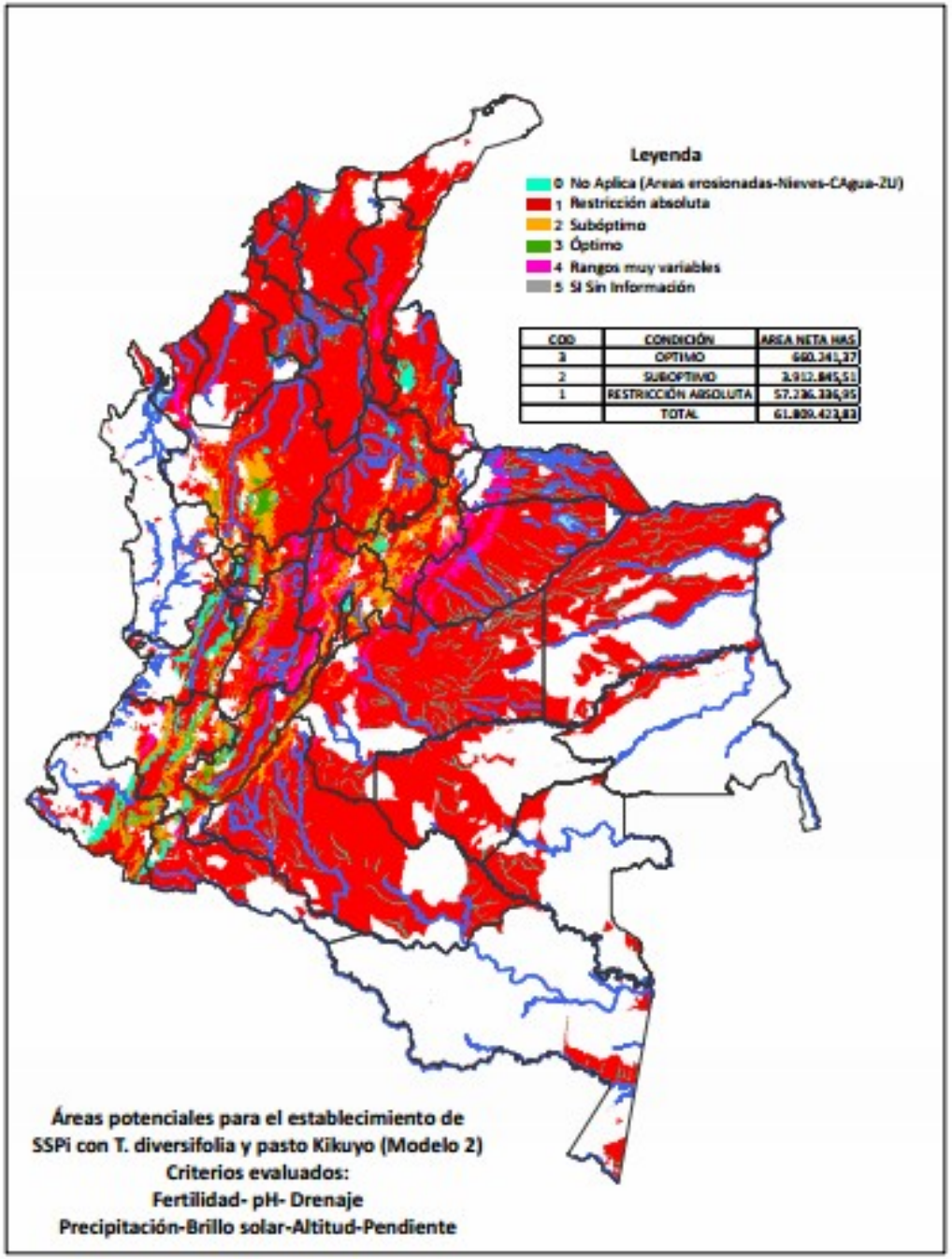
Soils (pH, Fertility, Drainage)



Potential Areas for Leucaena

Potential Areas for iSPS with Tithonia Diversifolia + Kikuyo

Optimo: 660mil Ha



Thanks!!!

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