

Forest Stand Formation

Prof. Titular Dr.nat.techn. Mauro V. Schumacher
E-mail: schumacher.professor@gmail.com

"ECOLOGICAL ASPECTS OF FORESTS AND PLANTATIONS"



What is forest?



Source: © Schumacher (2019)

Image of the Amazon Forest.



Biodiversity I



Source: © Schumacher (2008)

Biodiversity II



Source: © Schumacher (2008)

What is a plantation?

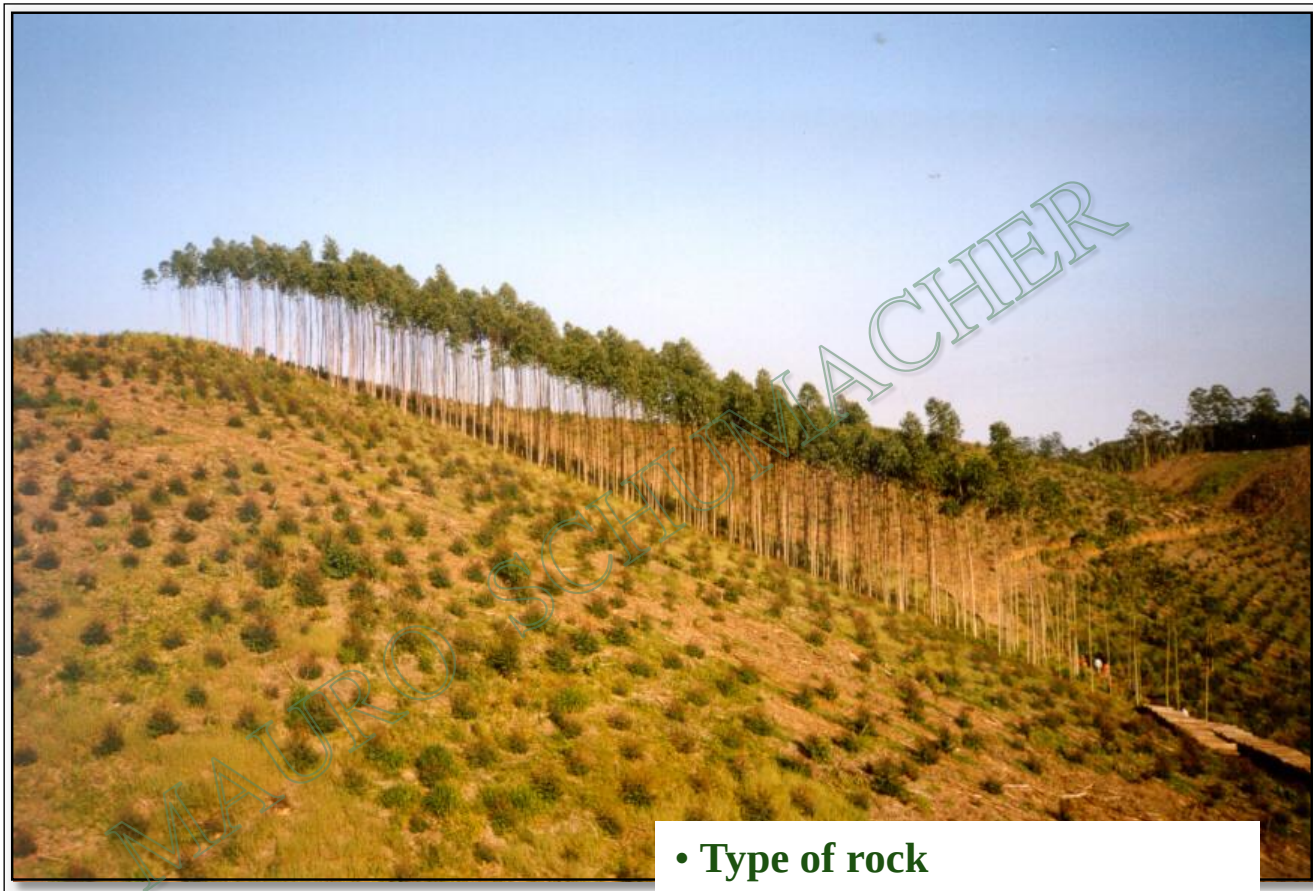


Source: © Schumacher (2007)

Biodiversity in Pinus plantation?



Source: © Schumacher (2009)

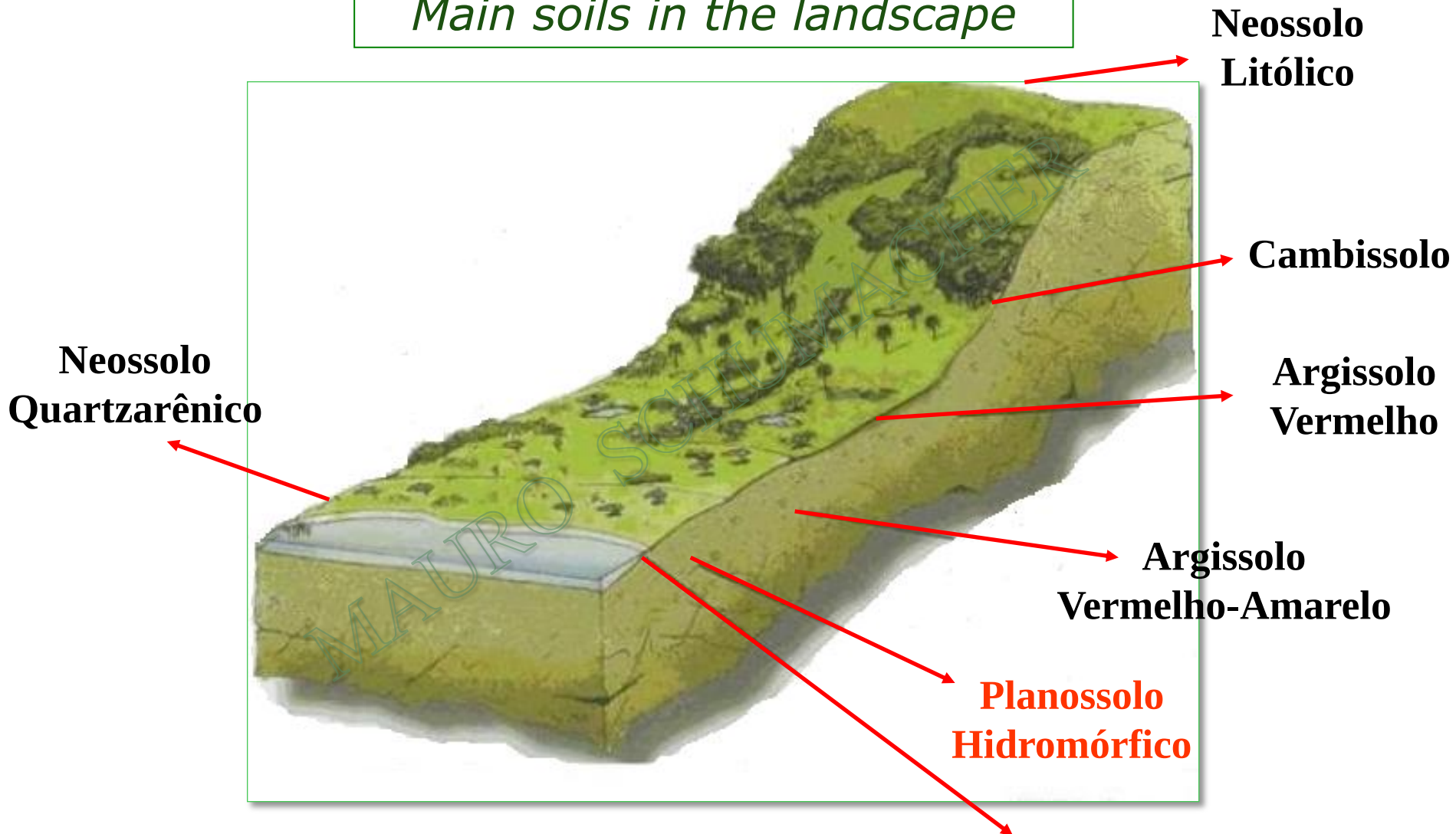


Growth/
Productivity

f }

- Type of rock
- Type of soil
- Depth of soil
- Physical characteristics
- Water available
- Total and available nutrients
- Organic matter / CEC
- Solar radiation

Main soils in the landscape



Source: Adaptado de CURI (2008)

Sistema radicular de Pinus taeda em solo raso.



Source: © Schumacher (2007)

Climate and slow growth



Source: © Schumacher (2007)

Degraded soils in RS



Source: © Schumacher (2007)

Soil loss in eucalyptus plantation



Source: © Schumacher (2008)

Soil loss in native forest

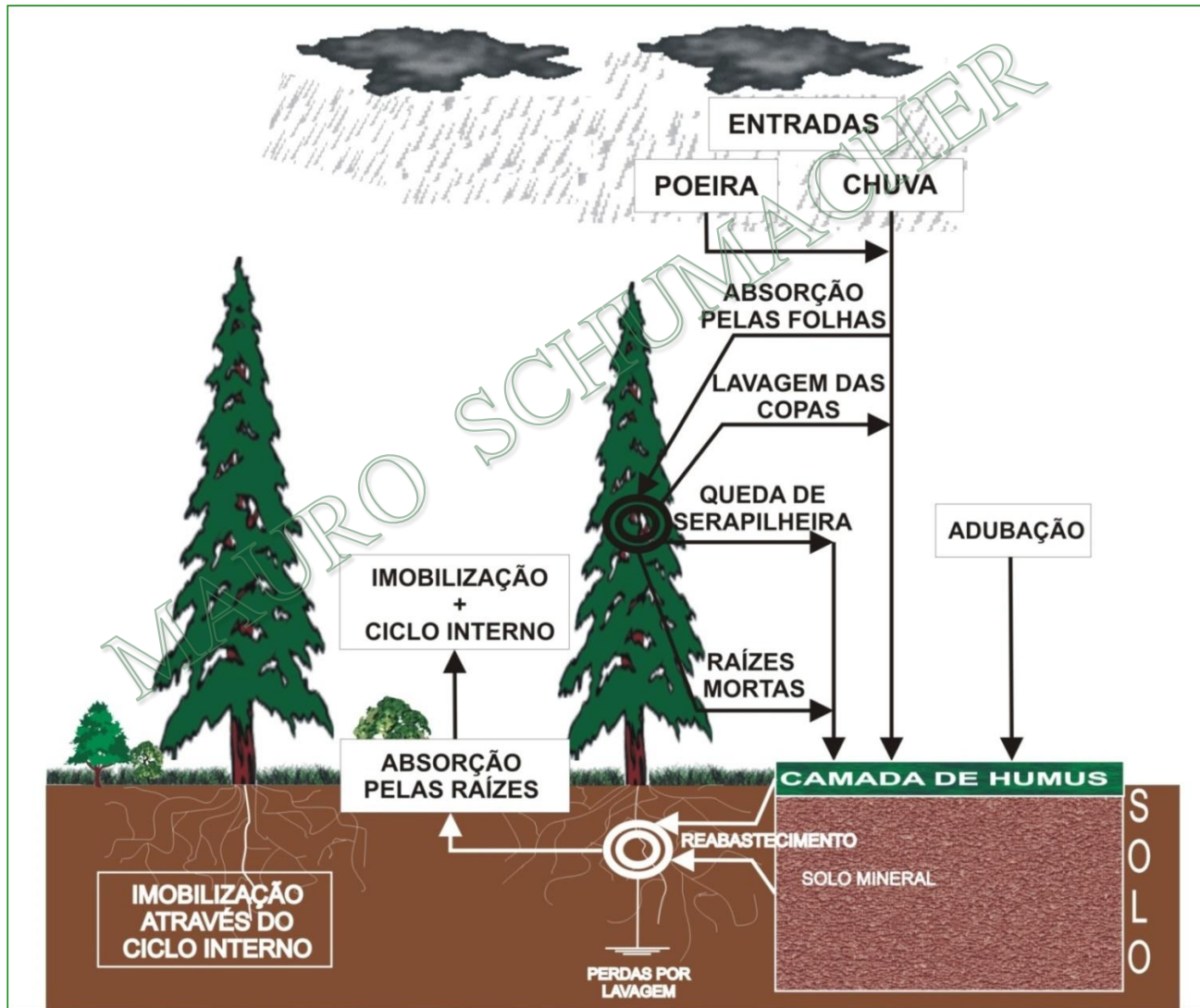


Source: © Schumacher (2008)

"Deserto" do São João – Alegrete-RS"



Nutrient cycling in forest ecosystems



*Nutrient inputs via
atmospheric deposition*

<i>Element (kg ha⁻¹ ano⁻¹)</i>					<i>Source</i>
K	Ca	Mg	Na	Cl	
9,4	7,8	1,1	6,8	-/-	1
17,1	23,3	2,9	15,8	23,3	2
1,9	4,1	0,7	3,9	7,7	3
11,0	5,7	1,7	33,3	40,3	4
3,6	9,3	1,5	4,8	14,0	5

1 = Castro (1980) região de Viçosa onde não existem indústrias;
 2 = SIF (1986) no Vale do Aço;
 3 = Armbruster et al. (1997) Alemanha;
 4 = Schumacher et al. (2009) Cambará do Sul /RS;
 5 = Laclau et al. (2010) Itatinga/SP.

Relationship between rainfall entry and biotic reservoir of mature rainforest (kg ha⁻¹)

Element	Reserv. biótico	Input via rainfall	Years to Input = Reservoir.
<i>P</i>	164	1	164
<i>K</i>	3103	9,5	327
<i>Ca</i>	4103	29	141
<i>Mg</i>	429	4,9	88

Source: GOLLEY et al. (1975)

*Transfer of nutrients from vegetation to soil in
tropical rainforest (kg ha⁻¹ year⁻¹)*

Componente	P	K	Ca	Mg
Folhas para serapilheira	8,6 (86,0)	129 (65,1)	240 (81,6)	22 (64,7)
Ramos caídos	0,8 (8,0)	19 (9,6)	17 (5,8)	2 (5,9)
Lavagem pela chuva	0,6 (6,0)	50 (25,3)	37 (12,6)	10 (29,4)
Total	10,0	198	294	34

Source: Golley et al. (1975)

*Biomass ($Mg\ ha^{-1}$) for *Eucalyptus saligna*
at different ages.*

Age	Leaf	Branch	Bark	Wood	Root	Total
2	6,6	5,0	3,1	19,4	21,4	55,5
3	5,6	7,0	6,8	57,9	28,9	106,2
4	5,7	10,8	10,2	111,6	40,4	178,7
5	5,0	7,8	10,9	137,1	43,1	203,9
6	4,2	7,0	15,2	155,4	32,5	214,3
7	5,0	9,7	18,4	221,1	45,7	299,9

Source: Londero (2011)

Intensity of biomass harvest and export of nutrients (kg ha^{-1}) in an 8-years-old eucalyptus plantation.

Component	Biomass (Mg ha^{-1})	N	P	K	Ca	Mg
W	173,20	228,6	15,5	91,8	107,4	20,8
	59,73	233,3	26,7	214,0	535,9	68,6
W + B	187,14	266,2	28,0	155,4	472,0	51,1
	45,79	121,3	8,1	81,6	53,6	20,4
W + B + C	200,98	297,2	31,2	187,1	531,8	64,3
	31,95	164,7	11,1	118,9	111,5	25,1
	232,93	461,9	42,3	306,0	643,3	89,4



Exportado



Permanece

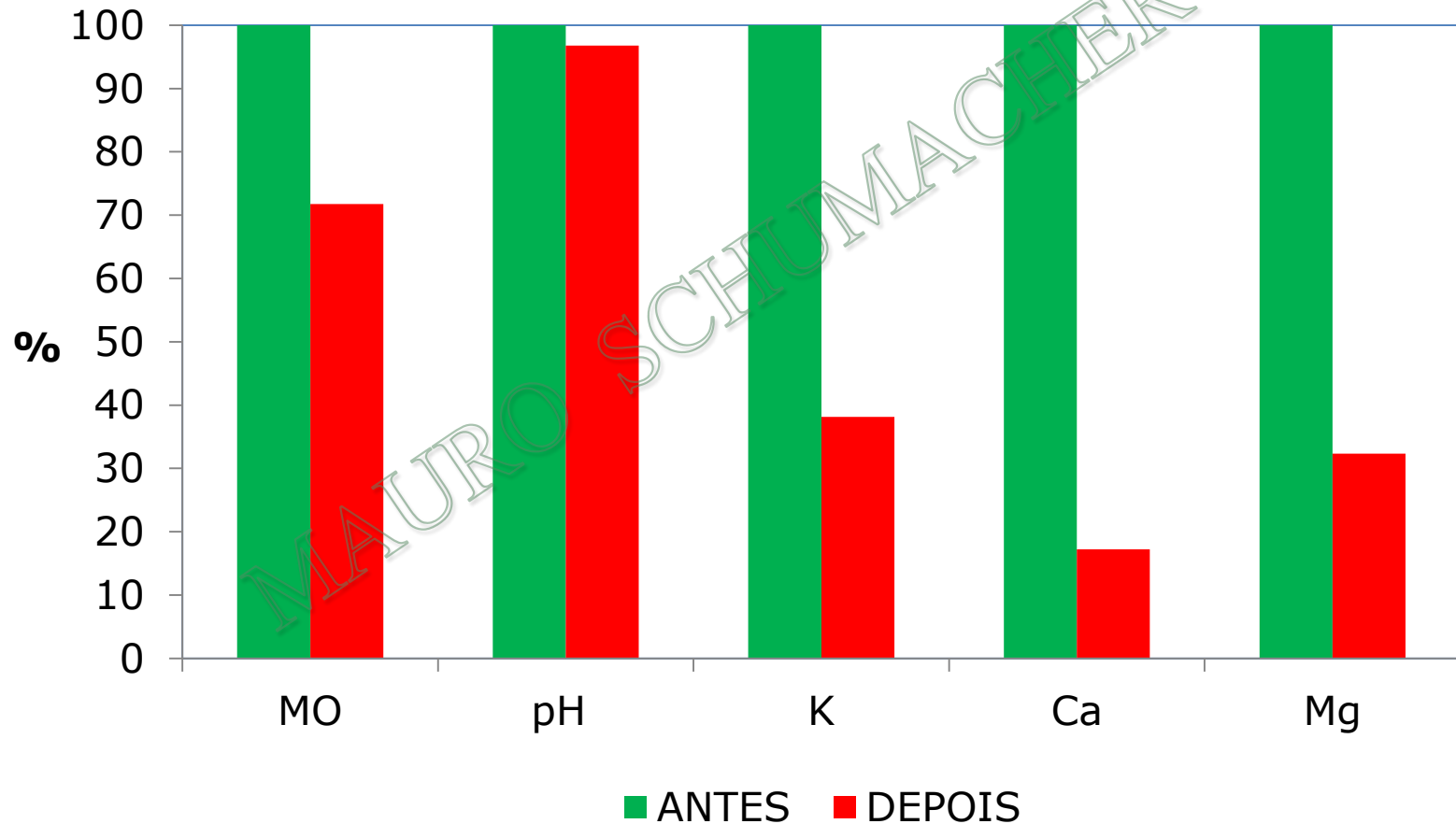
Source: Schumacher et al (2003)

Removal of nutrients from soil by forest species and agricultural crops

Espécie	Idade (anos)	Kg ha ⁻¹ ano ⁻¹				
		N	P	K	Ca	Mg
<i>Eucalyptus saligna</i>	10	21,9	5,8	19,1	95,4	8,1
<i>Eucalyptus grandis</i>	2,5	110,3	11,2	94,9	50,0	13,1
<i>Eucalyptus grandis</i>	10	42,0	1,6	15,6	76,7	5,1
Fumo virginia	*	78,5	13,5	90,00	61,5	24,7
Cenoura	*	267,0	42,0	835,0	199,0	32,0
Milho	*	127,0	26,0	37,5	1,0	11,0
Cana-de-açúcar	*	208,0	22,0	200,0	153,0	67,0
Trigo	*	80,0	8,0	12,0	1,0	4,0
Eucalipto	8	33,2	3,5	19,4	59,0	

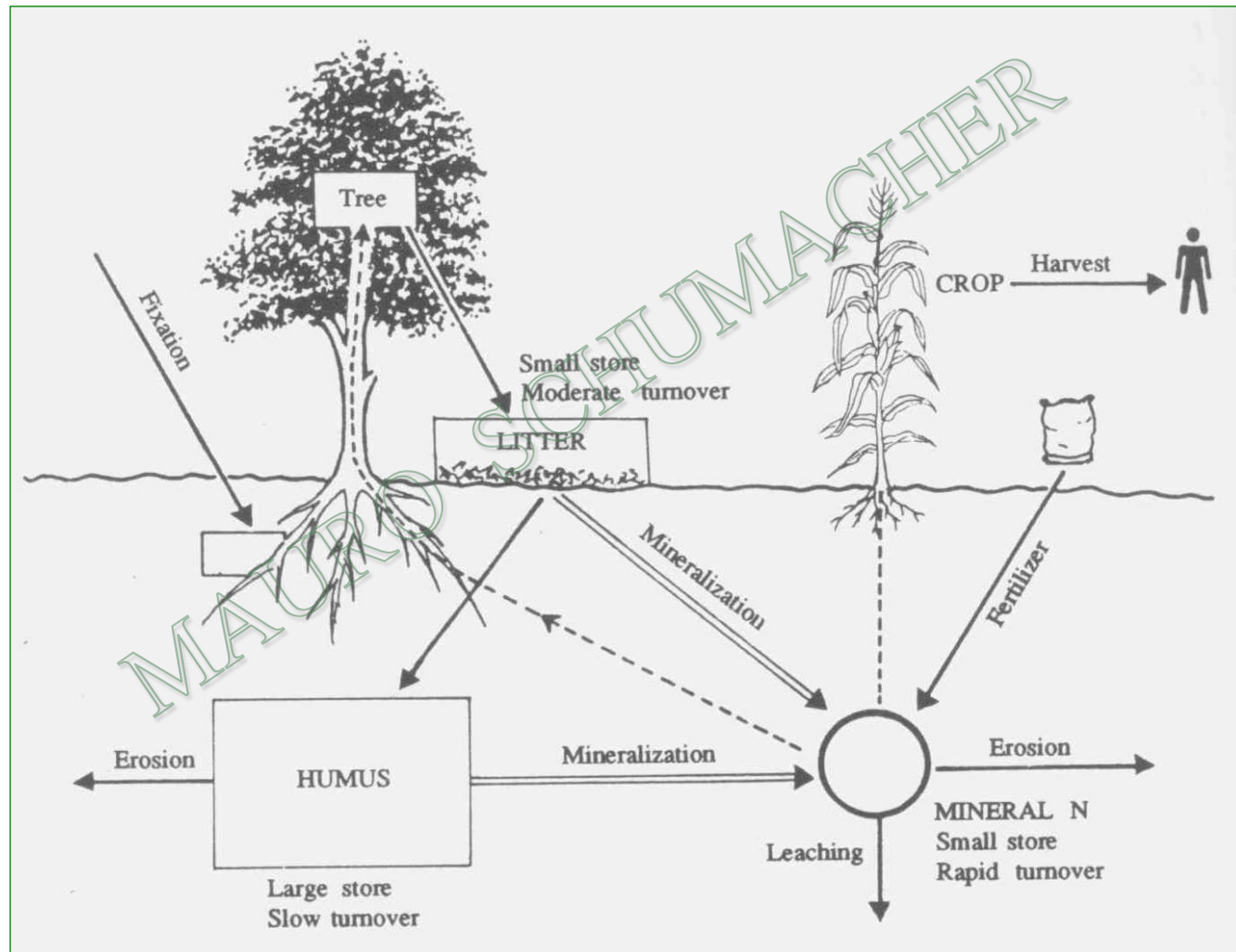
* Valores referentes a uma colheita

*Alteration of soil characteristics by
Pinus taeda after 15 years.*

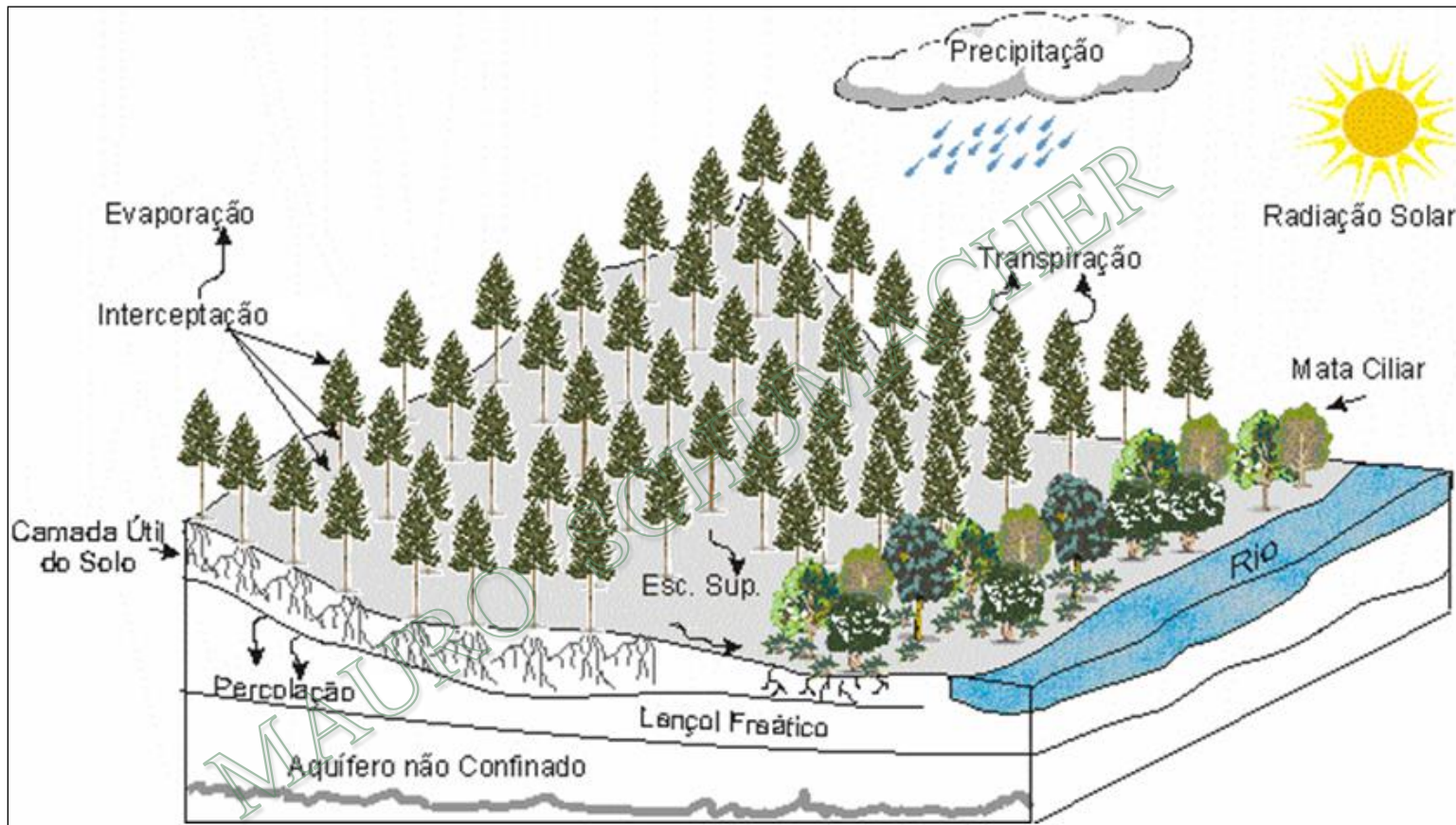


Source: Lopes (2009)

The N cycle in Agroforestry



Source: Young (1989).

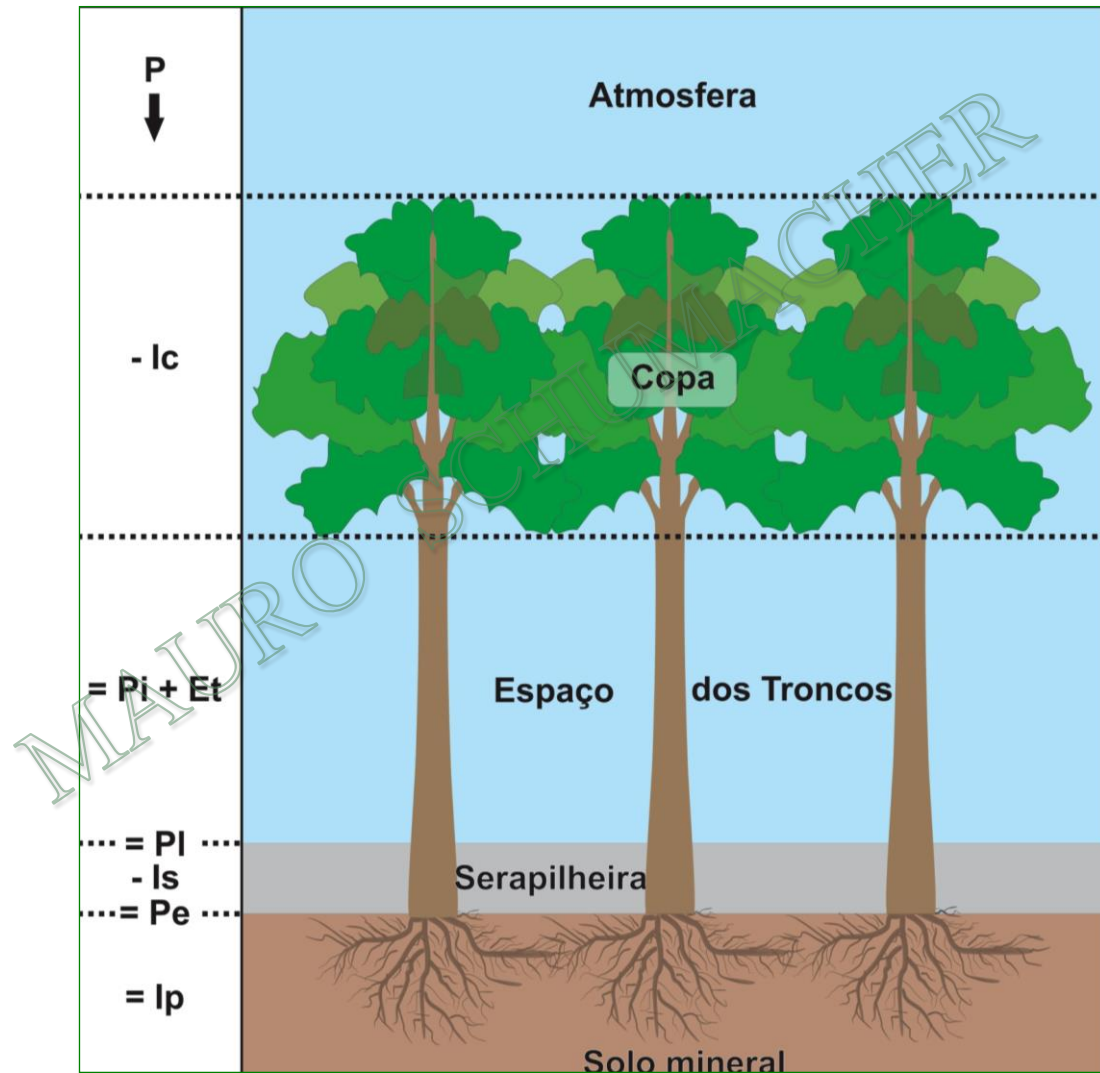


Water use

$f = \left\{ \begin{array}{l} \end{array} \right.$

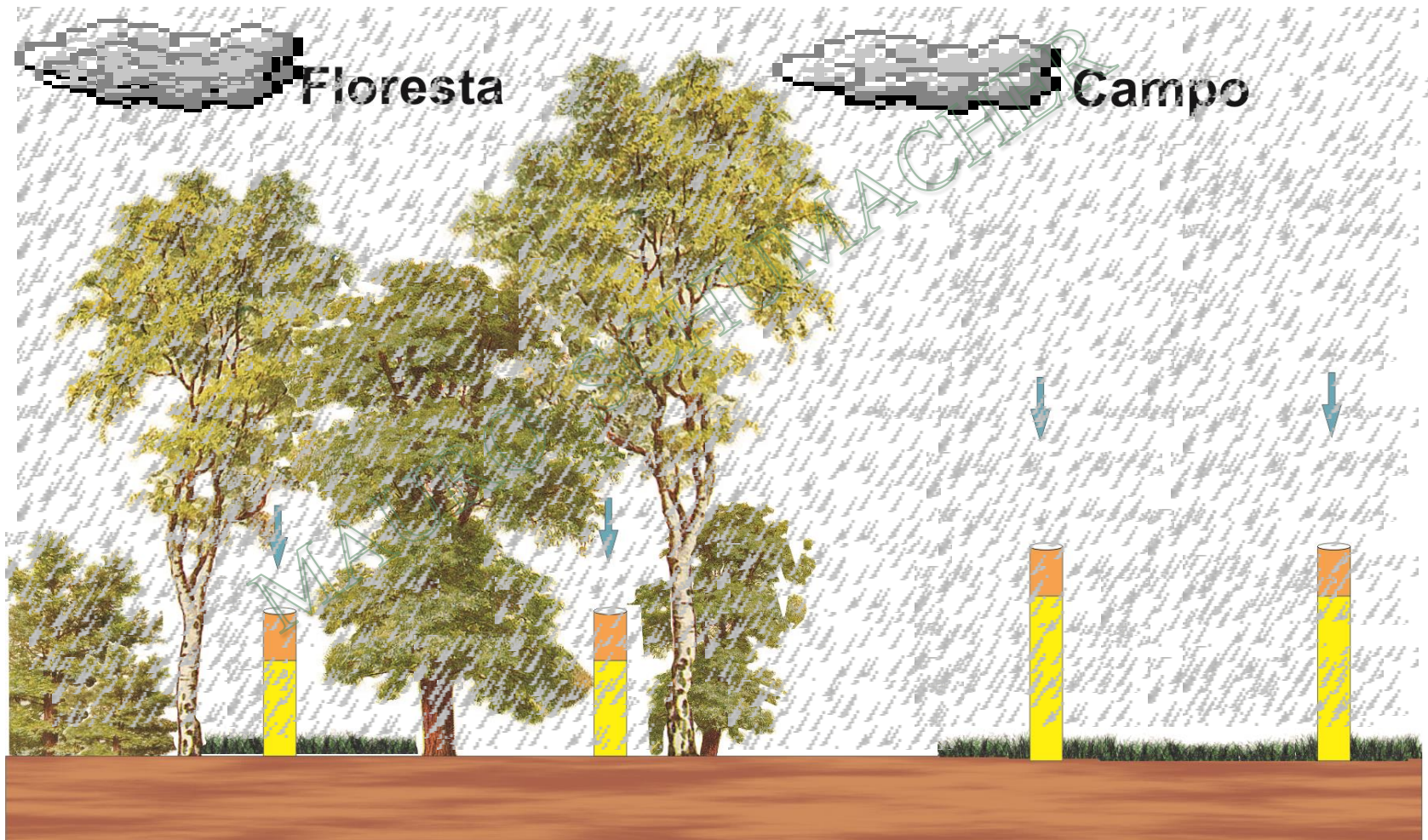
- Number of trees (LAI)
- Species: Genetic material
- Soil and climate characteristics
- Watershed occupation (%)
- Solar radiation

Distribution of rainfall

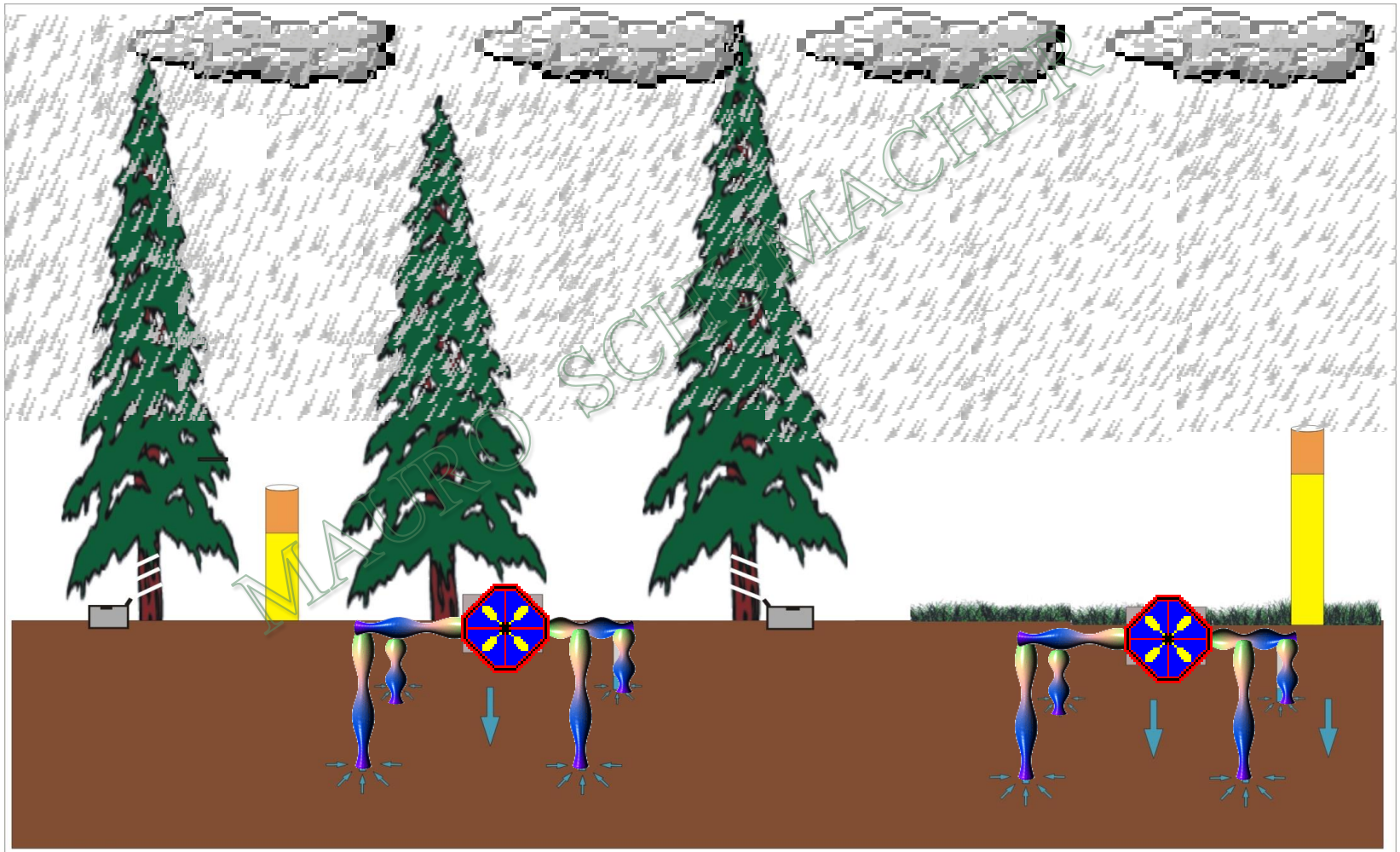


Source : Adapted from LEE (1980)

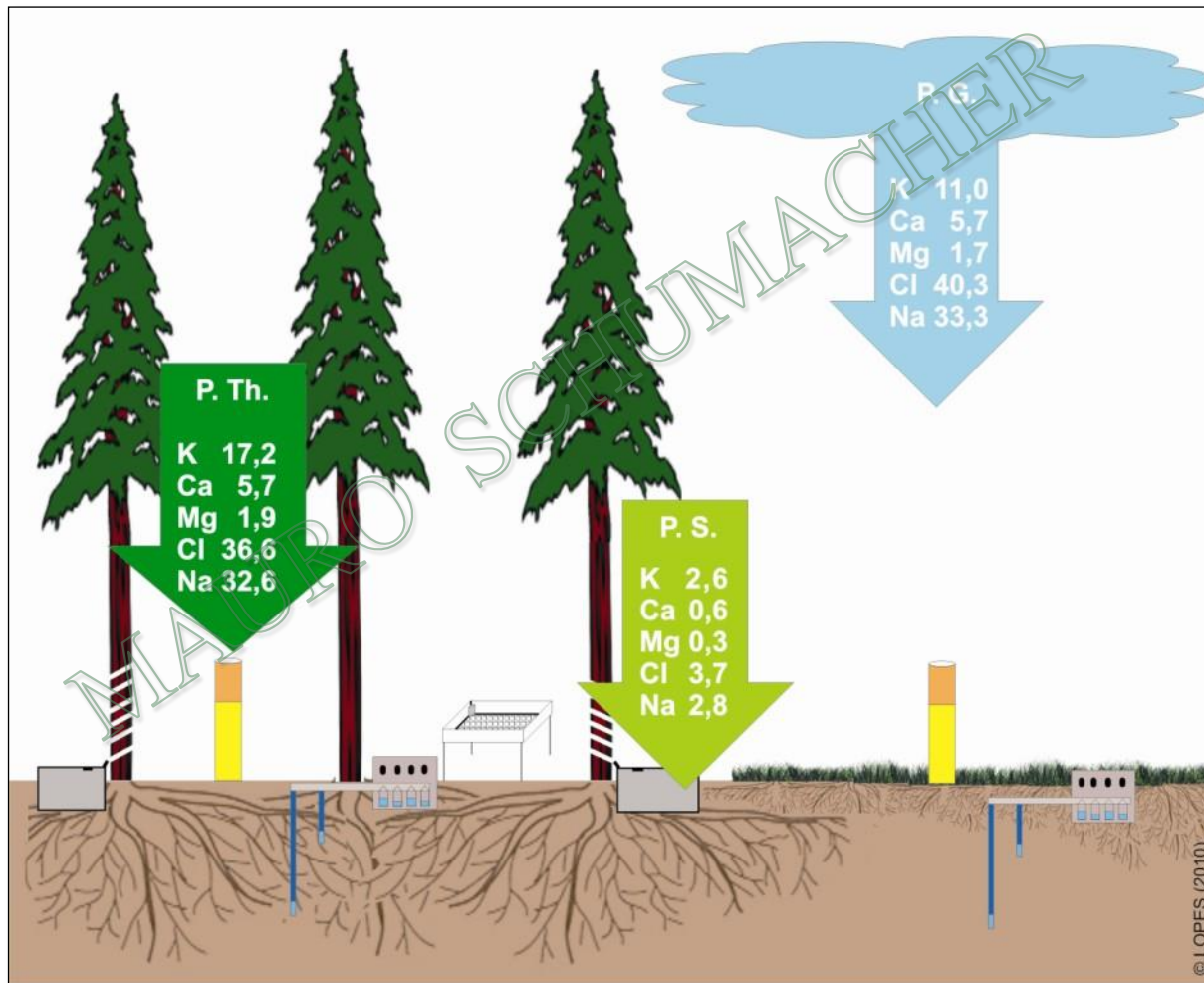
Nutrient Cycle in Native Forests



Nutrient Cycle in Plantations

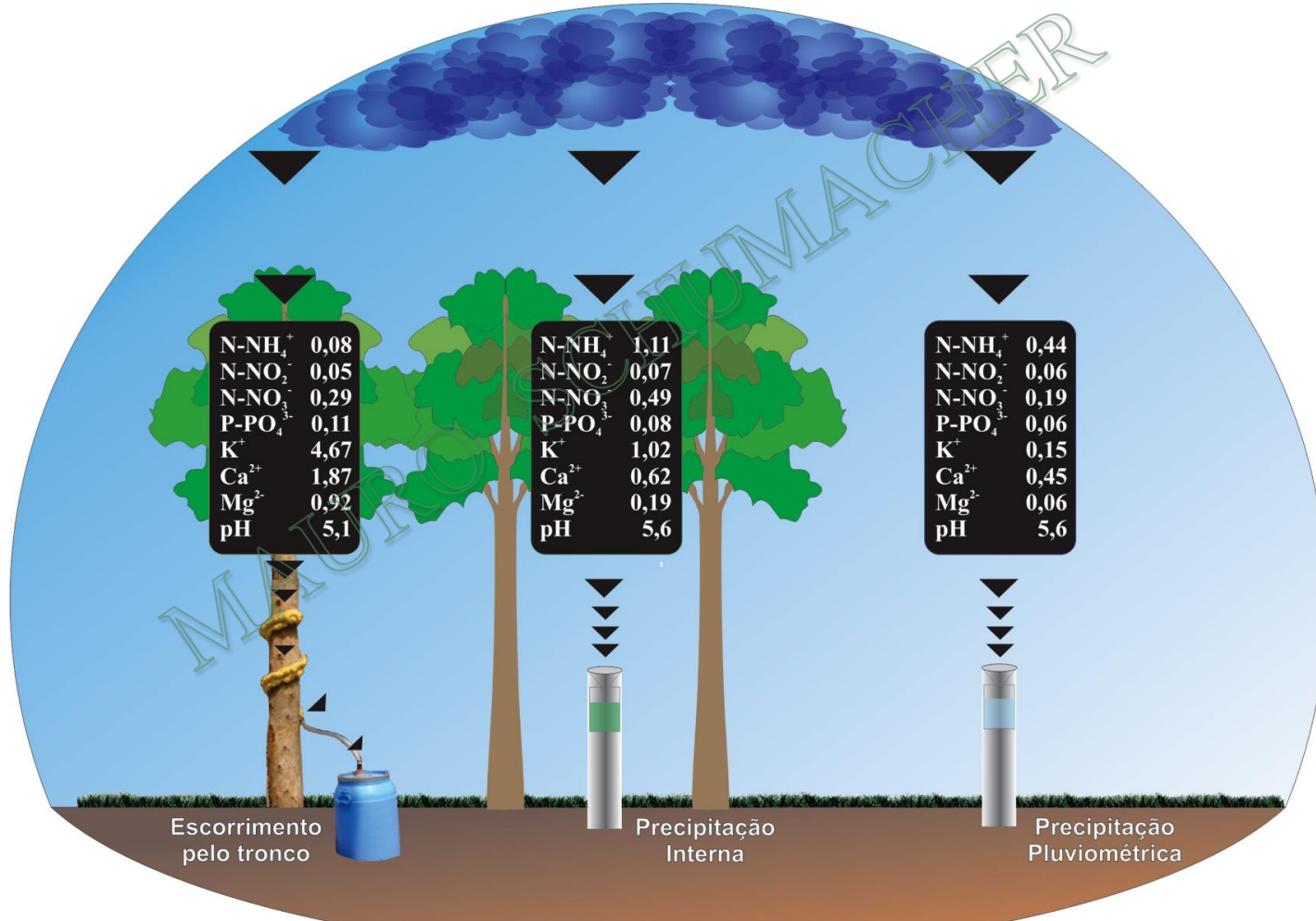


*Input of ions (kg ha⁻¹ year⁻¹)
by R, Th and Sf in Pinus taeda*



Source: Schumacher et al. (2009)

*Concentration (mg L^{-1}) of ions in
R, Th, and Sf in a 5-years-old *E. dunnii* stand.*

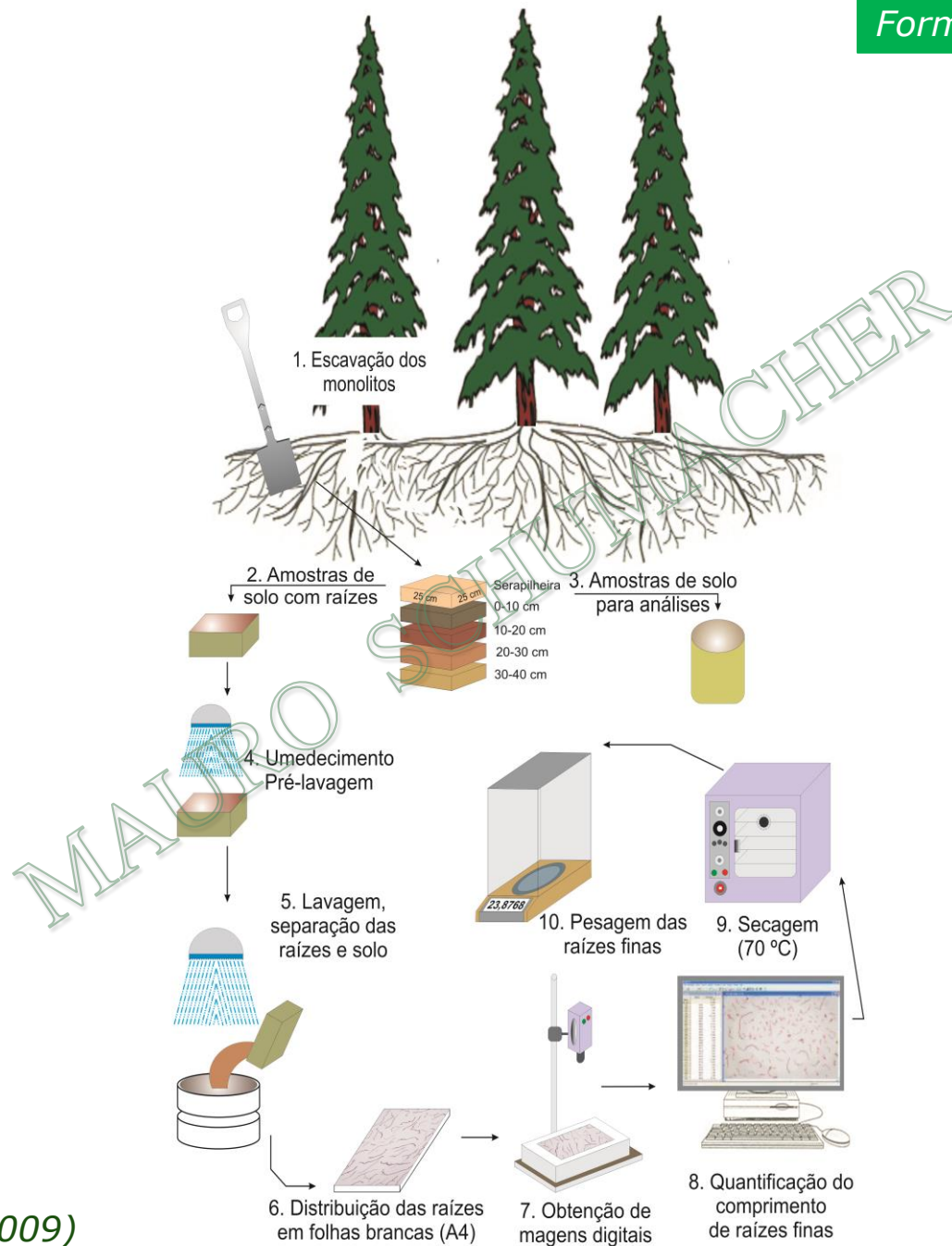


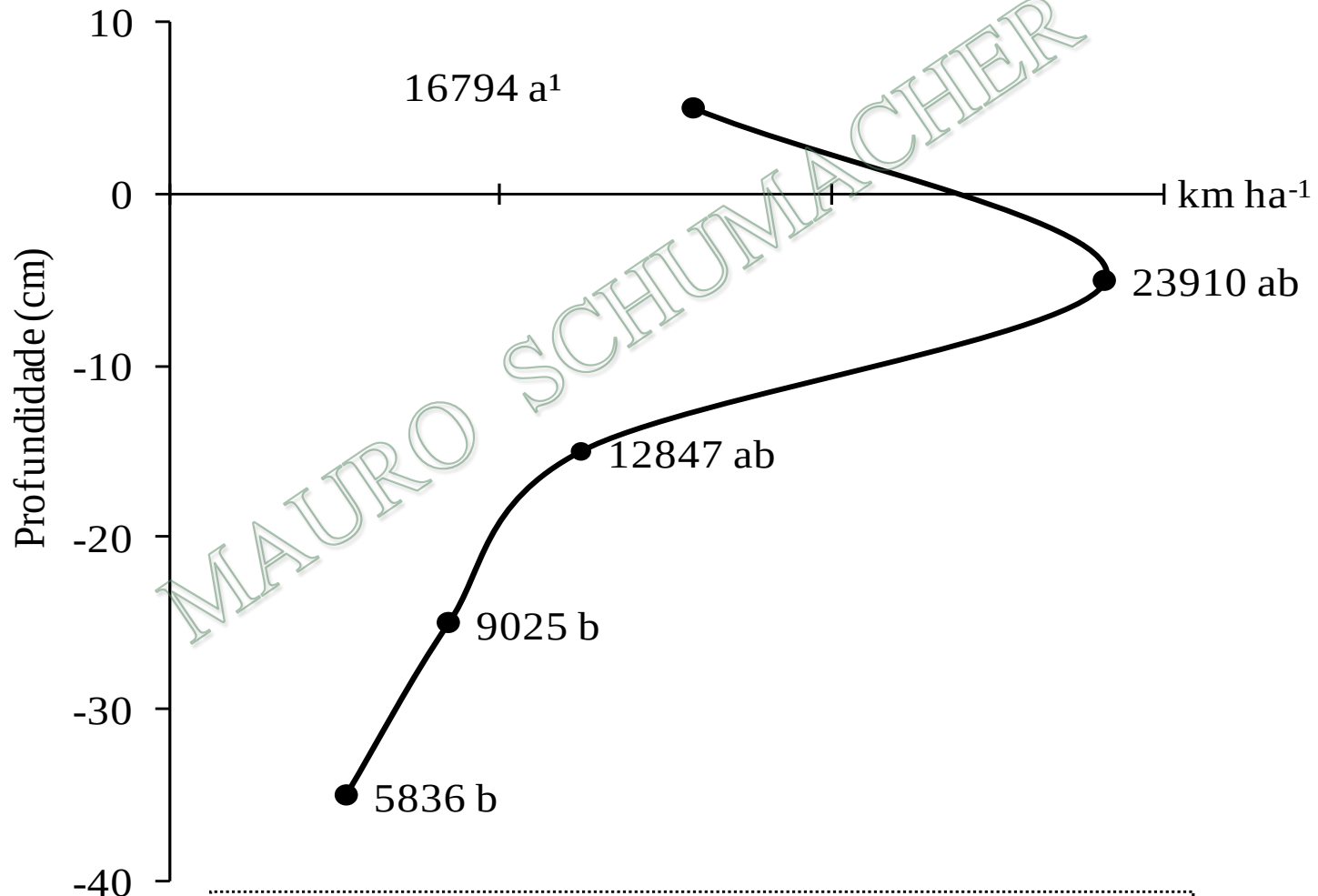
Source: Schumacher et al. (2012)

Dynamics of fine roots (< 2,0 mm)



Source: © Schumacher (2008)



Length of fine roots (km ha^{-1})

Source: Lopes (2009)

Fine root biomass (kg ha⁻¹)

Profundidade (cm)		Monolitos (kg ha ⁻¹)			Média	Desvio-padrão	CV (%)
		A	B	C			
Pinus	Serapilheira	505,74	763,97	1100,48	790,06 b ¹	298,23	37,75
	0 - 10	1518,80	1083,44	1634,46	1412,23 a	290,56	20,57
	10 - 20	809,52	532,13	524,11	621,92 b	162,52	26,13
	20 - 30	463,68	351,20	453,97	422,95 b	62,33	14,74
	30 - 40	150,82	282,46	372,98	268,75 b	111,71	41,57
	Total	3448,56	3013,20	4086,00	3515,92	539,56	15,35
Campo	0 - 10	2345,87	3369,73	3535,98	3083,86 a	644,50	20,90
	10 - 20	1490,24	1168,16	1401,25	1353,22 b	166,33	12,29
	20 - 30	689,23	980,26	536,29	735,26 b	225,53	30,67
	30 - 40	416,34	582,48	370,75	456,52 b	111,44	24,41
	Total	4941,68	6100,63	5844,27	5628,86	608,76	10,81

