The importance of ecosystem function in the restoration of bush thickened savanna in southern Africa

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Bush thickening !

The problem

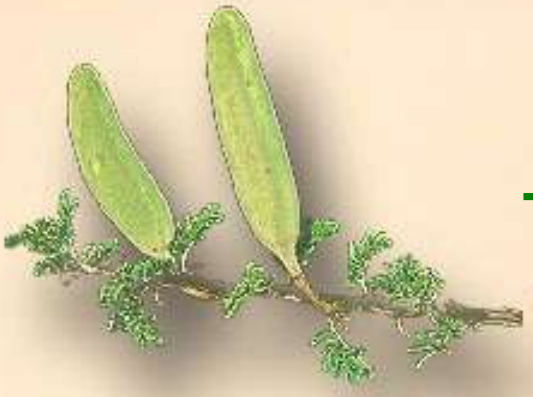
- **Negative grass-tree competition interactions for <u>available soil water</u> the most important**
- **Herbaceous layer (grasses) suppressed**

- **Dry matter production decline**
- **Grazing capacity decline**
- **Ground cover is reduced**
- **Increased rainwater runoff losses**
- **Reduced soil water (effective rainfall decreased)**
- **Soil erosion**

The solution !

Typical response of land owners

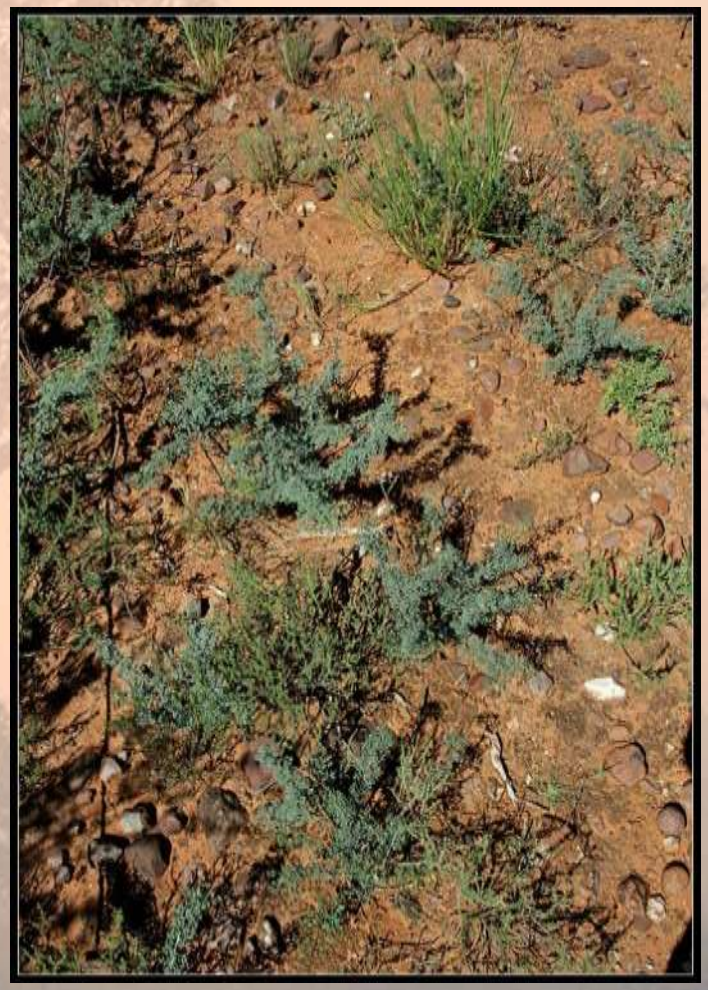
“What is the CHEAPEST, FASTEST and EASIEST method to get rid of the encroacher bush?”

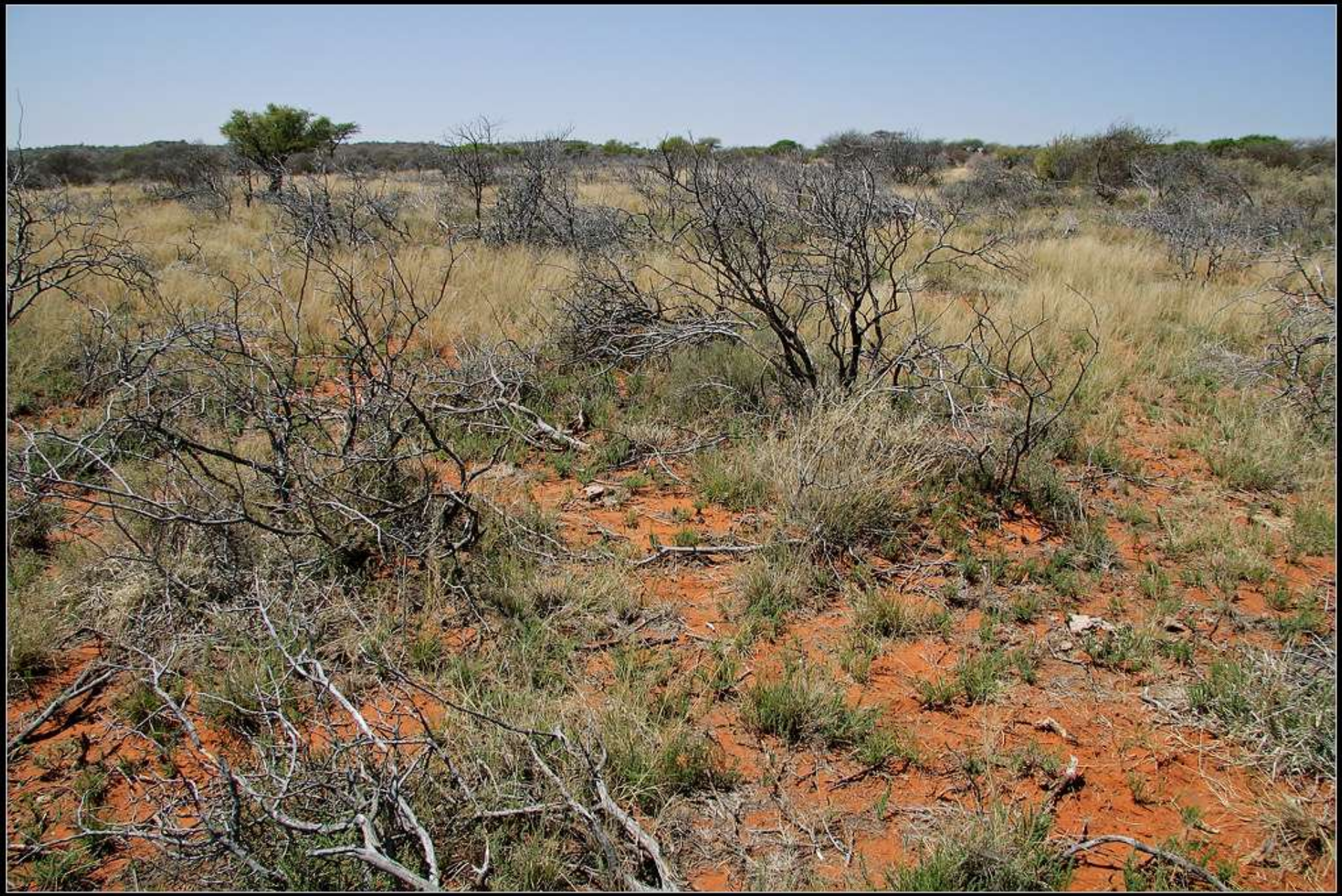


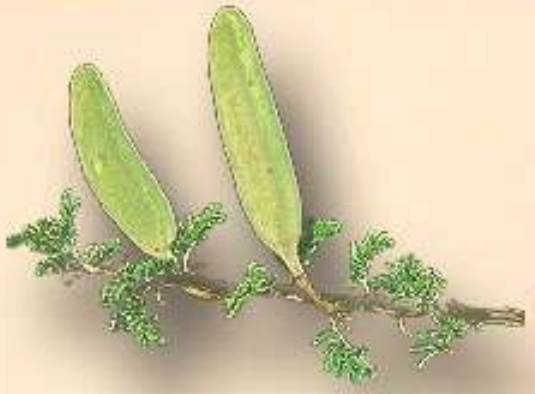
After tree thinning / clearing

The result is often not as expected or as desired

- Establishment of new seedlings
- Coppice of untreated plants
- Loss of species diversity and an increase in undesirable species







Important questions

Why does bush thickening happen?

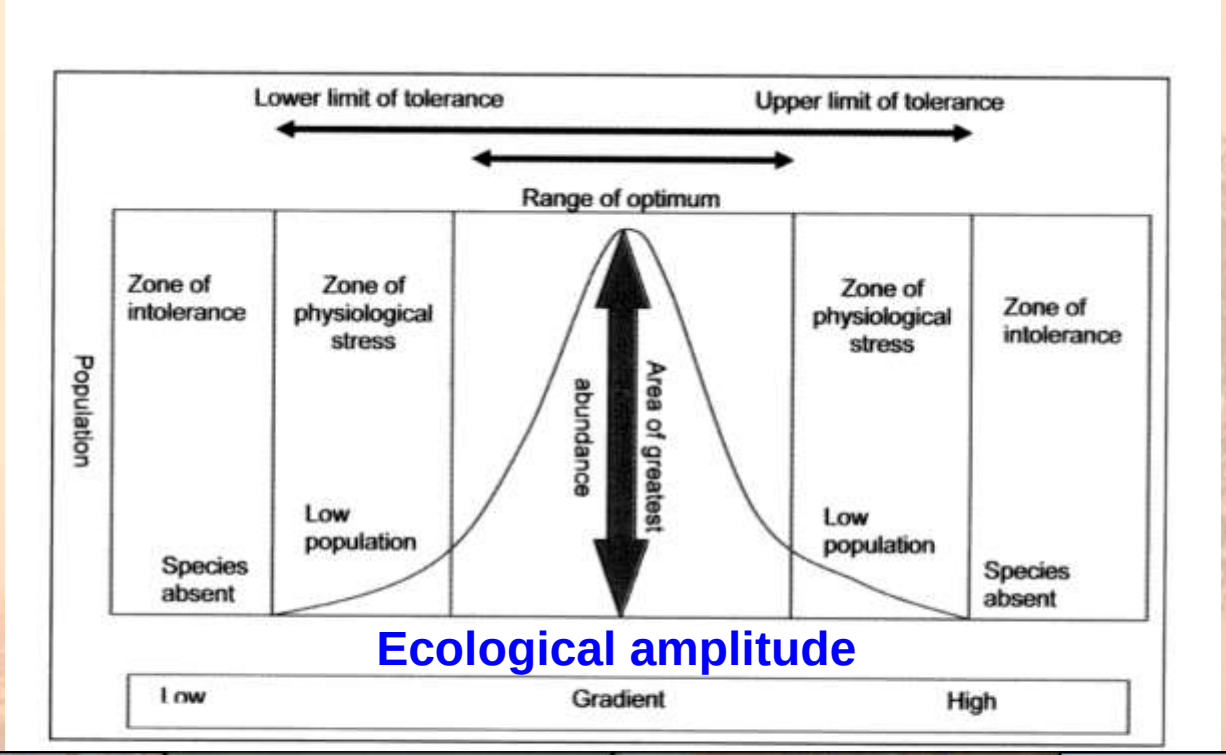
How do we get it back?

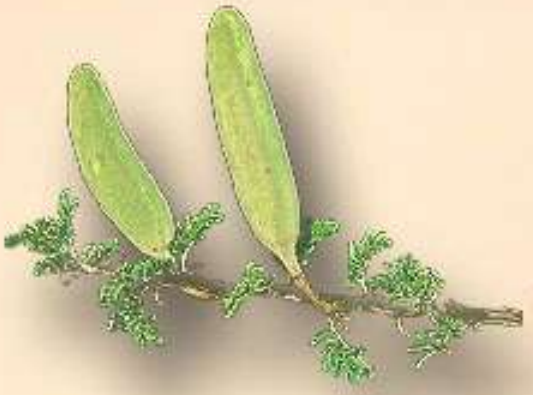
How do we prevent it?

WHY (Causes of bush thickening)

The vegetation of an area is a reflection of those species that is best adapted to the prevailing conditions that influence their:

(i) Establishment, (ii) Survival, and (iii) Reproduction

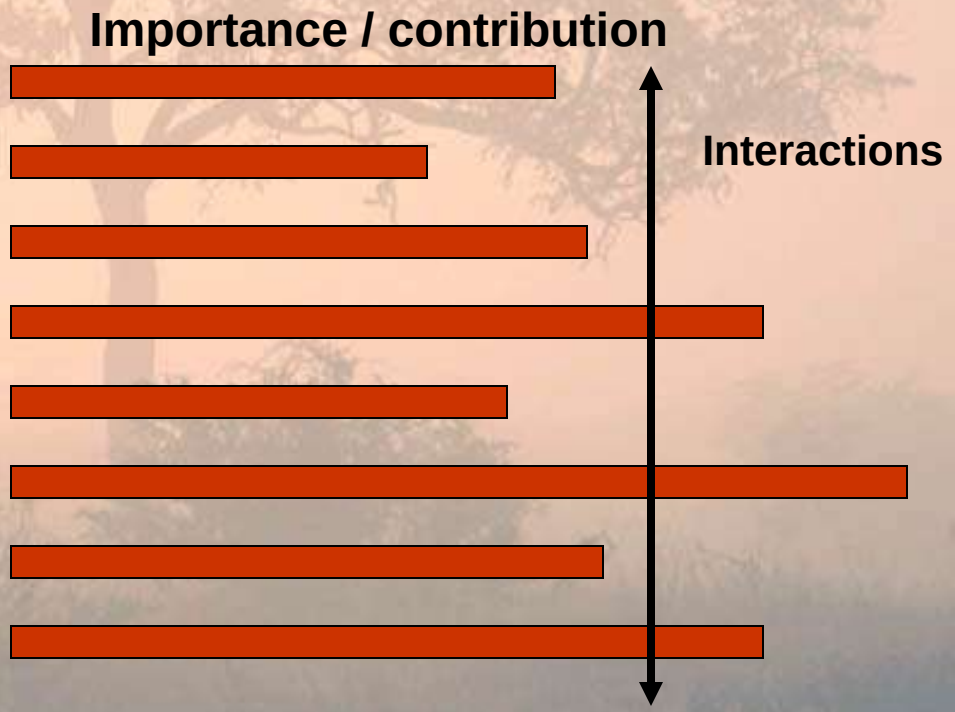




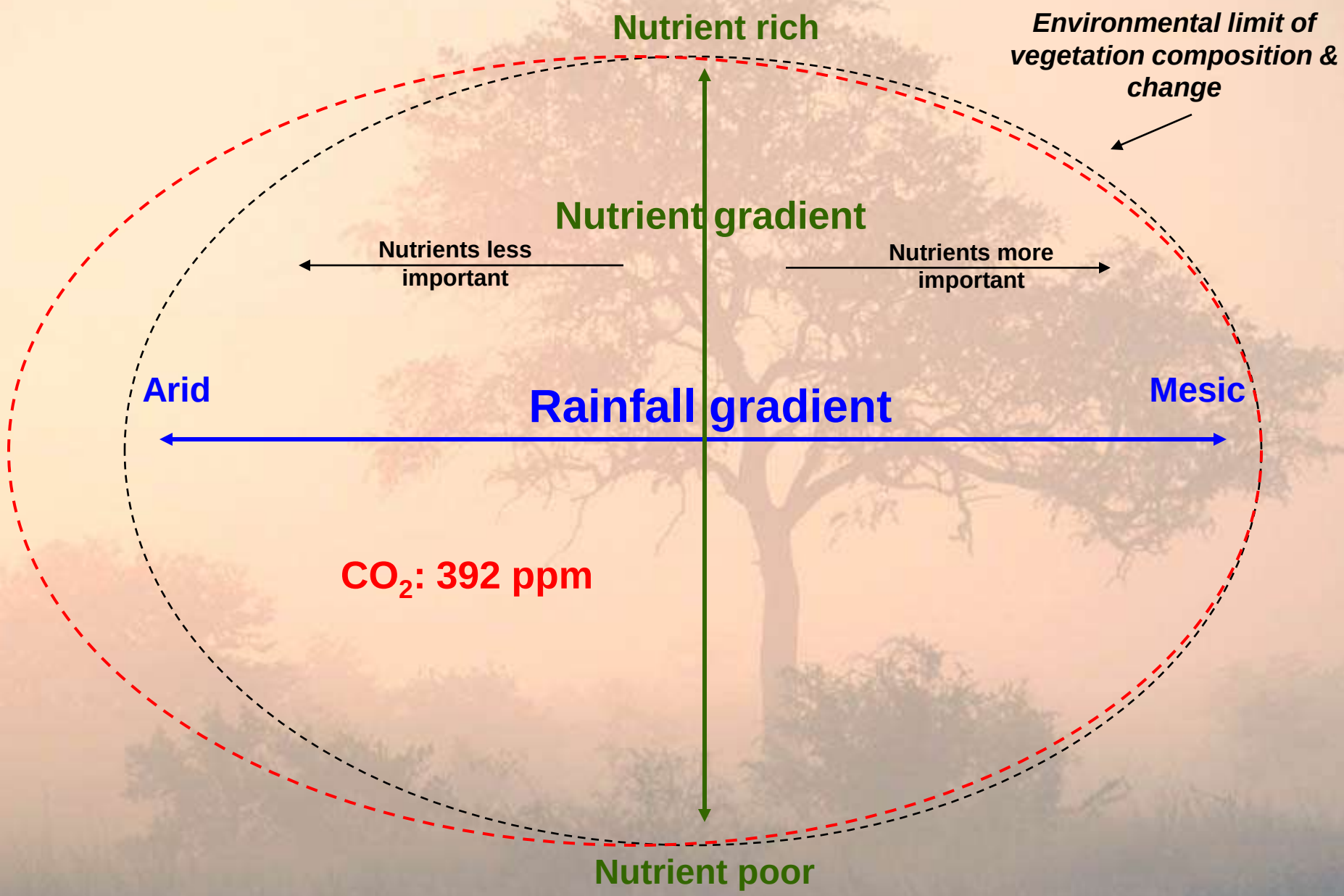
WHY (Causes of bush thickening)

Two processes: (i) an increase in the biomass of already established plants (vegetative growth), and (ii) an increase in tree density from the establishment of seedlings (reproduction)

- Over utilization of the grass layer
- Under utilization of the grass layer
- Removal of all browser herbivores
- Prevention of hot, brush killing fires
- Reduced soil fertility (N)
- Loss of savanna structure
- Changes in rainfall / temperature
- Increases in atmospheric CO_2



Primary determinants of savanna ecosystems: Water, Soil nutrients, CO_2



Relationship between Tree and Grass above-ground biomass

Open savanna: more grass, less woody plants

Accelerate it →

Natural mechanisms

← Slow it down

Closed savanna: more woody plants, less grass

Previous — Lower CO_2 levels

Trend towards a natural equilibrium

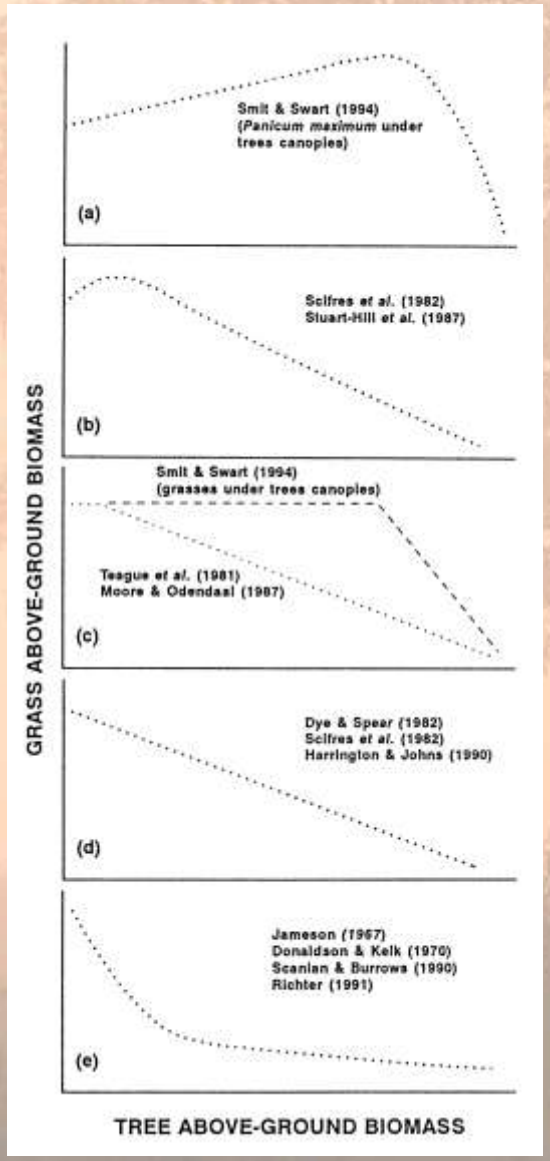
Accelerate it →

Management interventions

← Slow it down

Future — Higher CO_2 levels

Relationship between Tree and Grass above-ground biomass



← Higher rainfall

Soil nutrients more important

← Lower rainfall

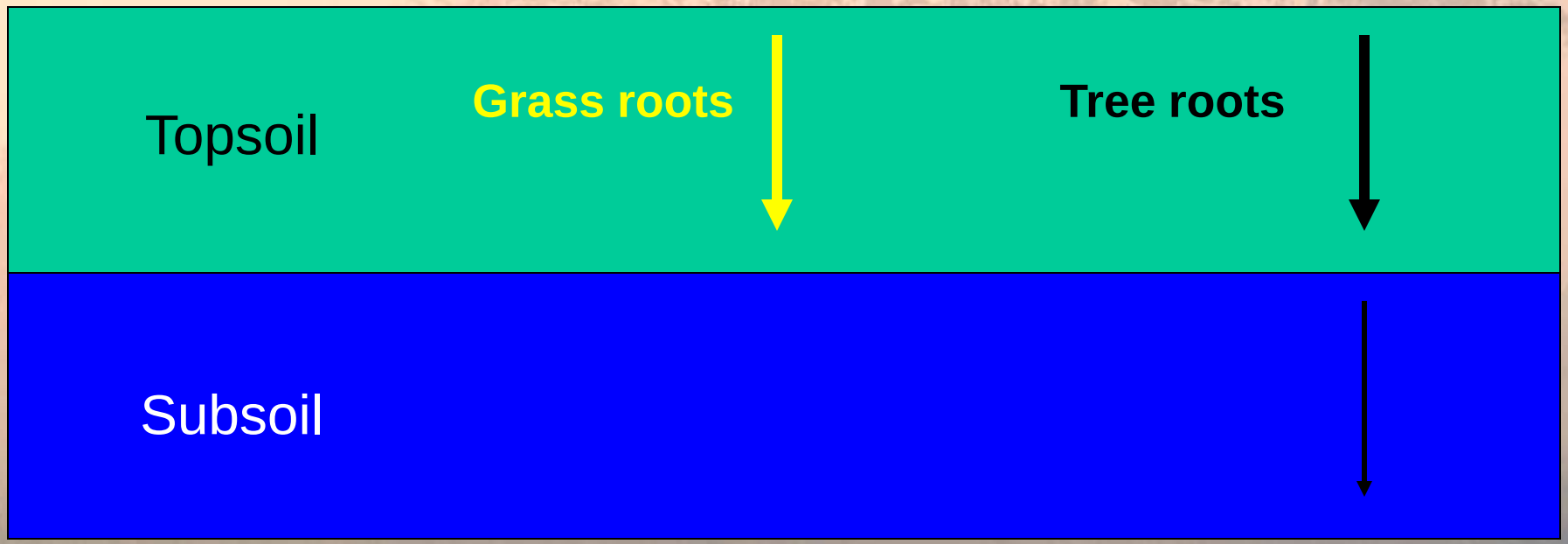
Soil nutrients less important

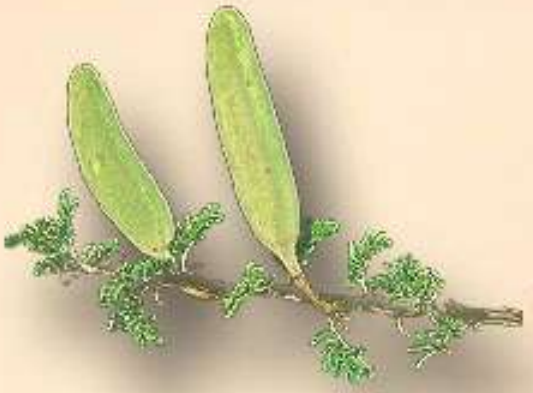
Relationship between Tree and Grass above-ground biomass

Open savanna: more grass, less woody plants

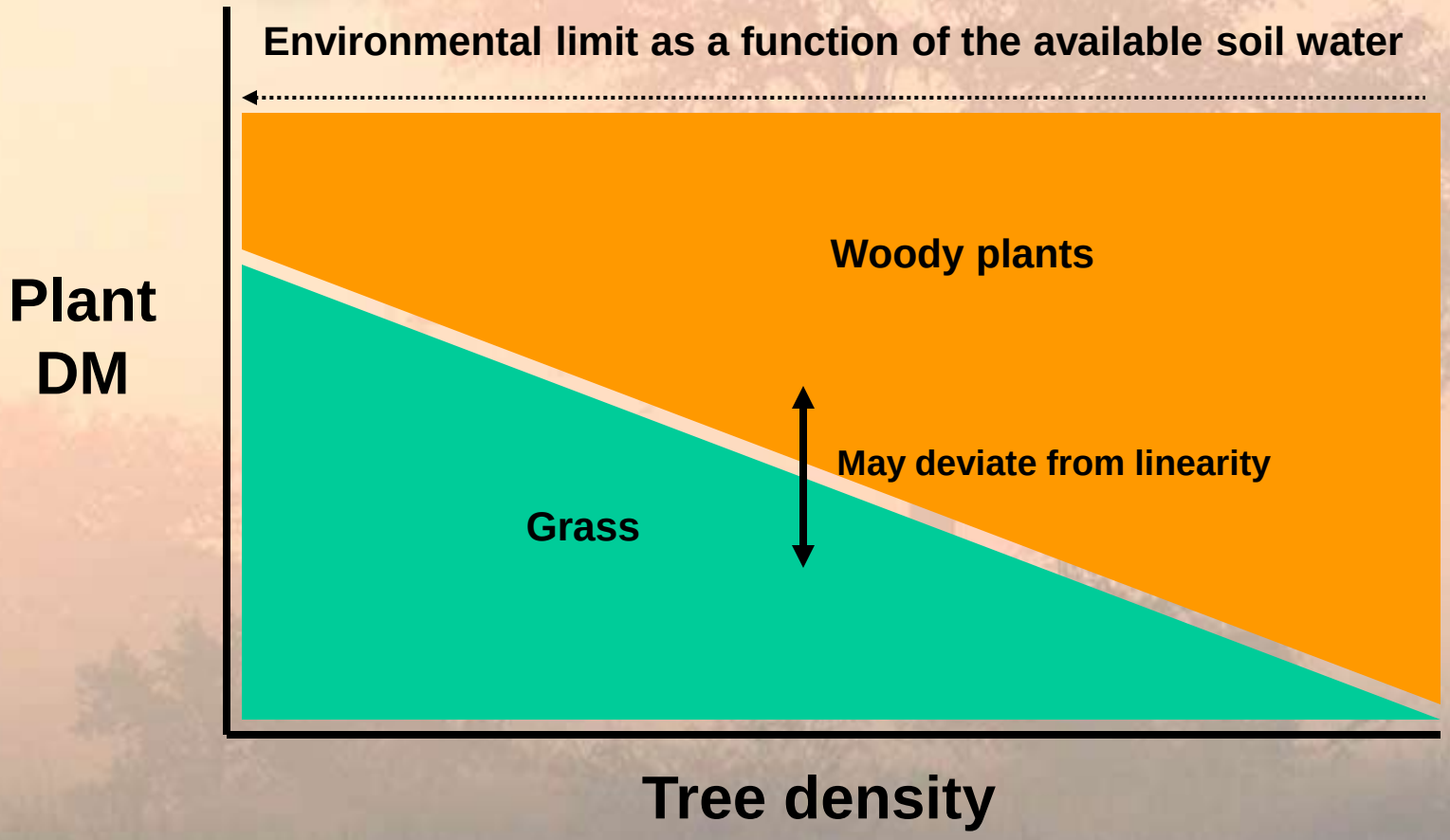
Understand the competition interaction

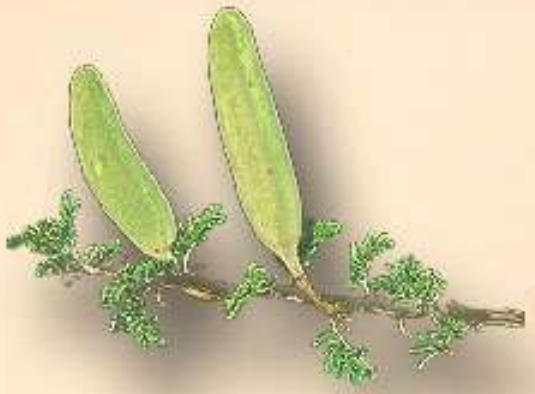
Closed savanna: more woody plants, less grass





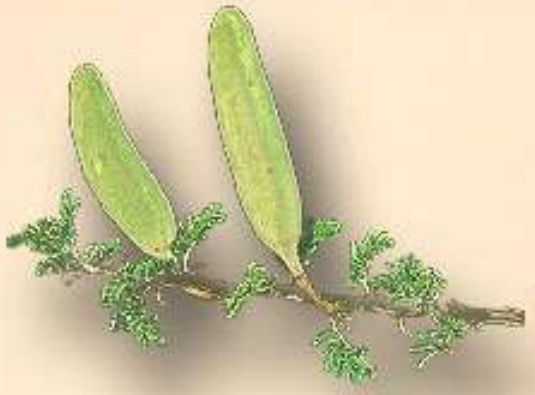
The savanna ecosystem can support a maximum plants leaf biomass under a specific rainfall regime





The savanna ecosystem can support a maximum plants leaf biomass under a specific rainfall regime

Season (rainfall)	Exp. plot	Dry mass production (kg ha^{-1})			WUE (kg ha^{-1} mm^{-1})		
		Leaves	Grass	Combined	Leaves	Grass	Combined
1990/91 (440 mm)	0 %	0	1 106	1 106	0	2.51	2.51
,,	10 %	209	842	1 051	0.48	1.91	2.39
,,	20 %	486	849	1 335	1.10	1.93	3.03
,,	35 %	551	442	993	1.25	1.00	2.26
,,	50 %	903	410	1 313	2.05	0.93	2.98
,,	75 %	972	176	1 148	2.21	0.40	2.61
,,	100 %	1 537	125	1 662	3.49	0.28	3.78
1991/92 (223 mm)	0 %	0	1 055	1 055	0	4.73	4.73
,,	10 %	257	459	716	1.15	2.06	3.21
,,	20 %	560	355	915	2.51	1.59	4.10
,,	35 %	655	230	885	2.94	1.03	3.97
,,	50 %	998	81	1 079	4.48	0.36	4.84
,,	75 %	1 082	38	1 120	4.85	0.17	5.02
,,	100 %	1 736	50	1 786	7.78	0.22	8.01



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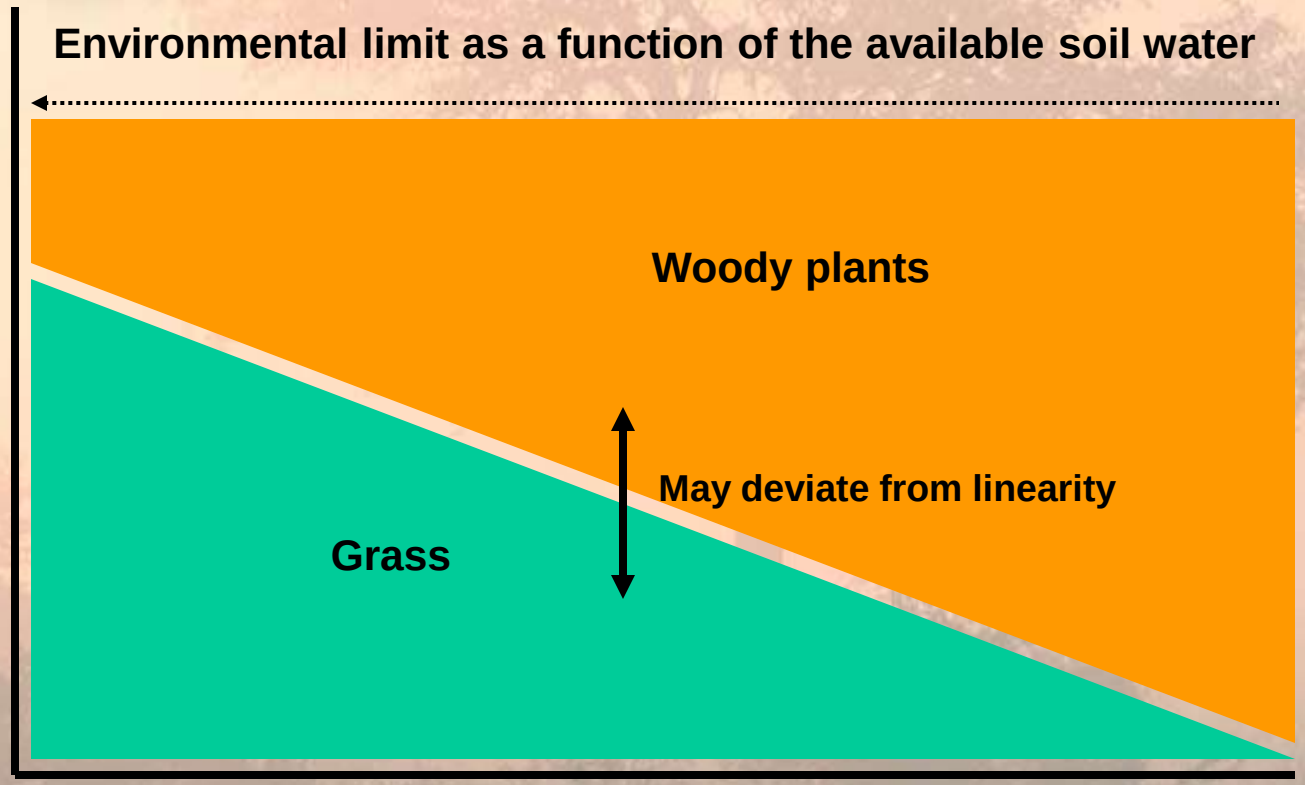

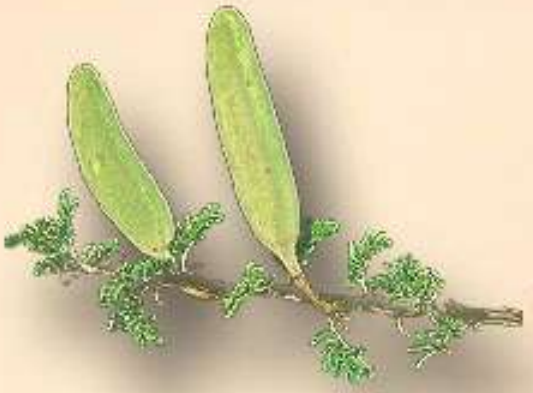

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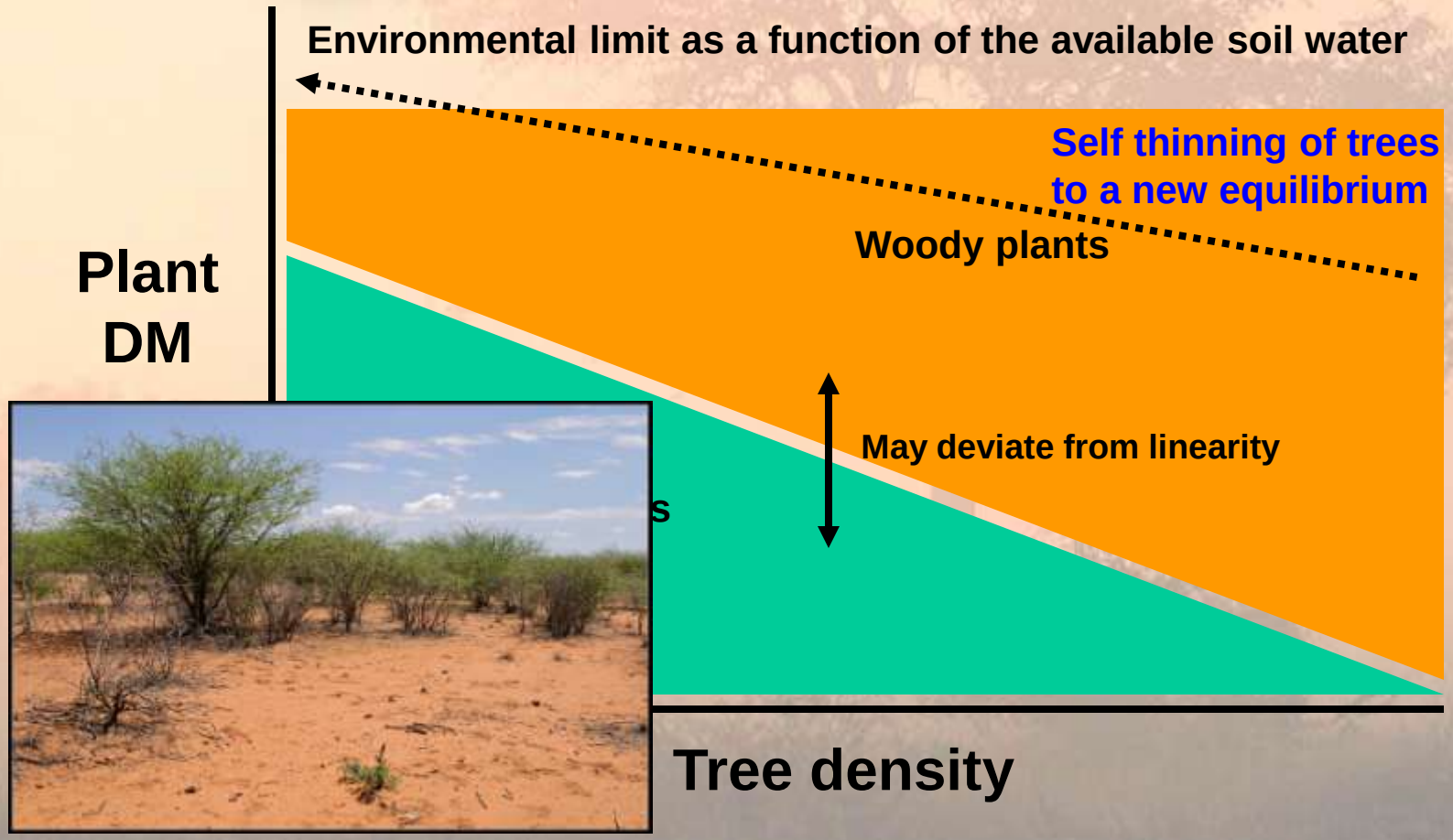
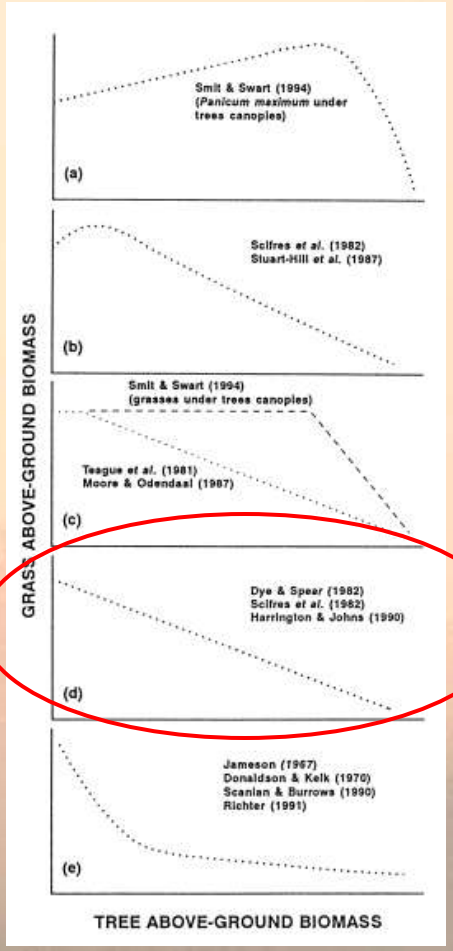


Fire

Fire



Grass DM required for a HOT fire:
2 000 - 4 000 kg DM ha^{-1}

- 2 000 kg DM ha^{-1}

Dry season

Wet season

Fire can be used

Fire can generally NOT be used

Critical tree density

Savanna structure

Tree-on-tree competition appears to be species specific

Positive correlation between the size of a tree and the distance to its nearest neighbour reported

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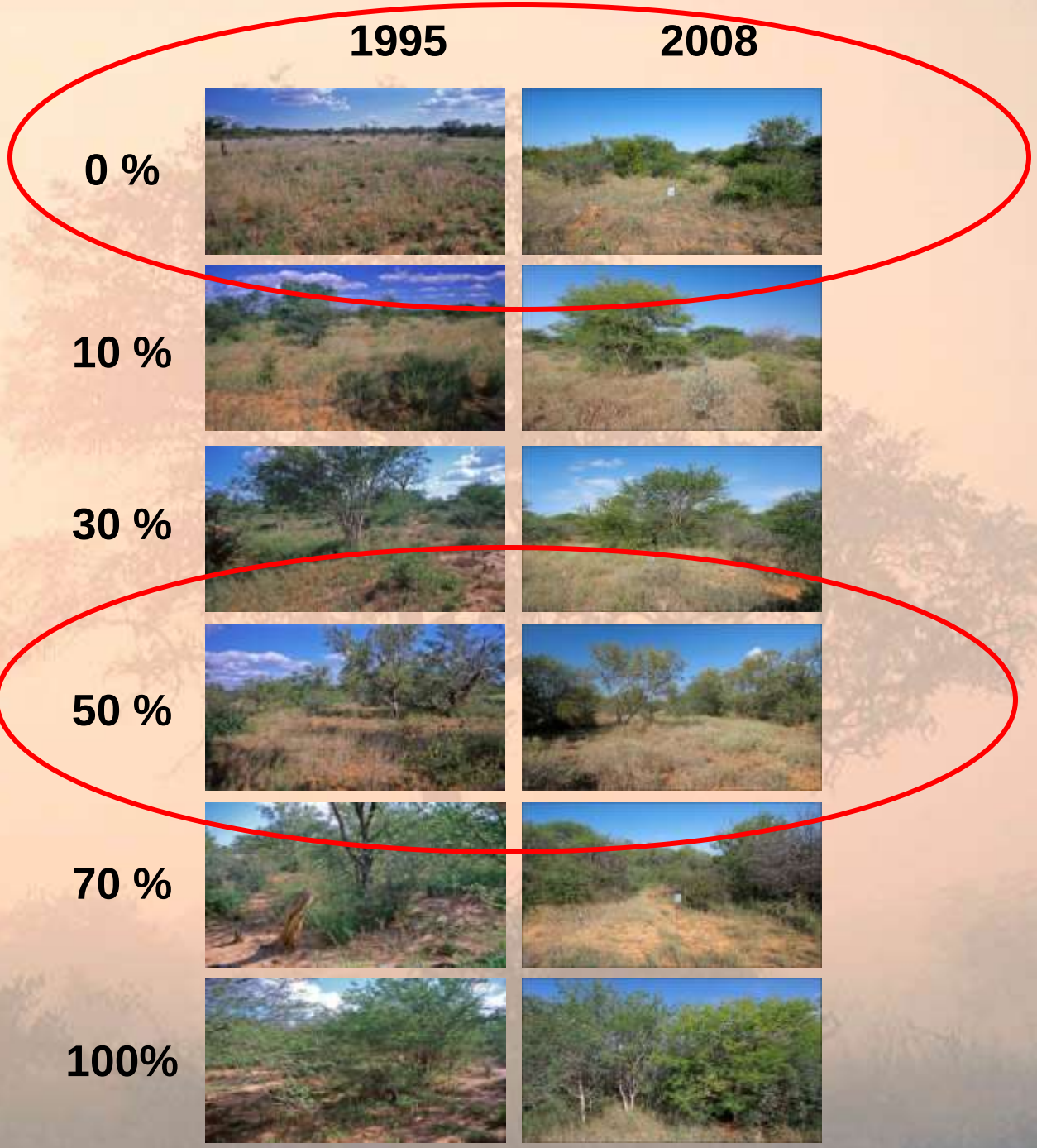
Ellisras

Acacia erubescens & Combretum apiculatum



Ellisras

Acacia erubescens & Combretum apiculatum

0% Plot (total clearing)

1995

2008

50% Plot

1995

Ellisras

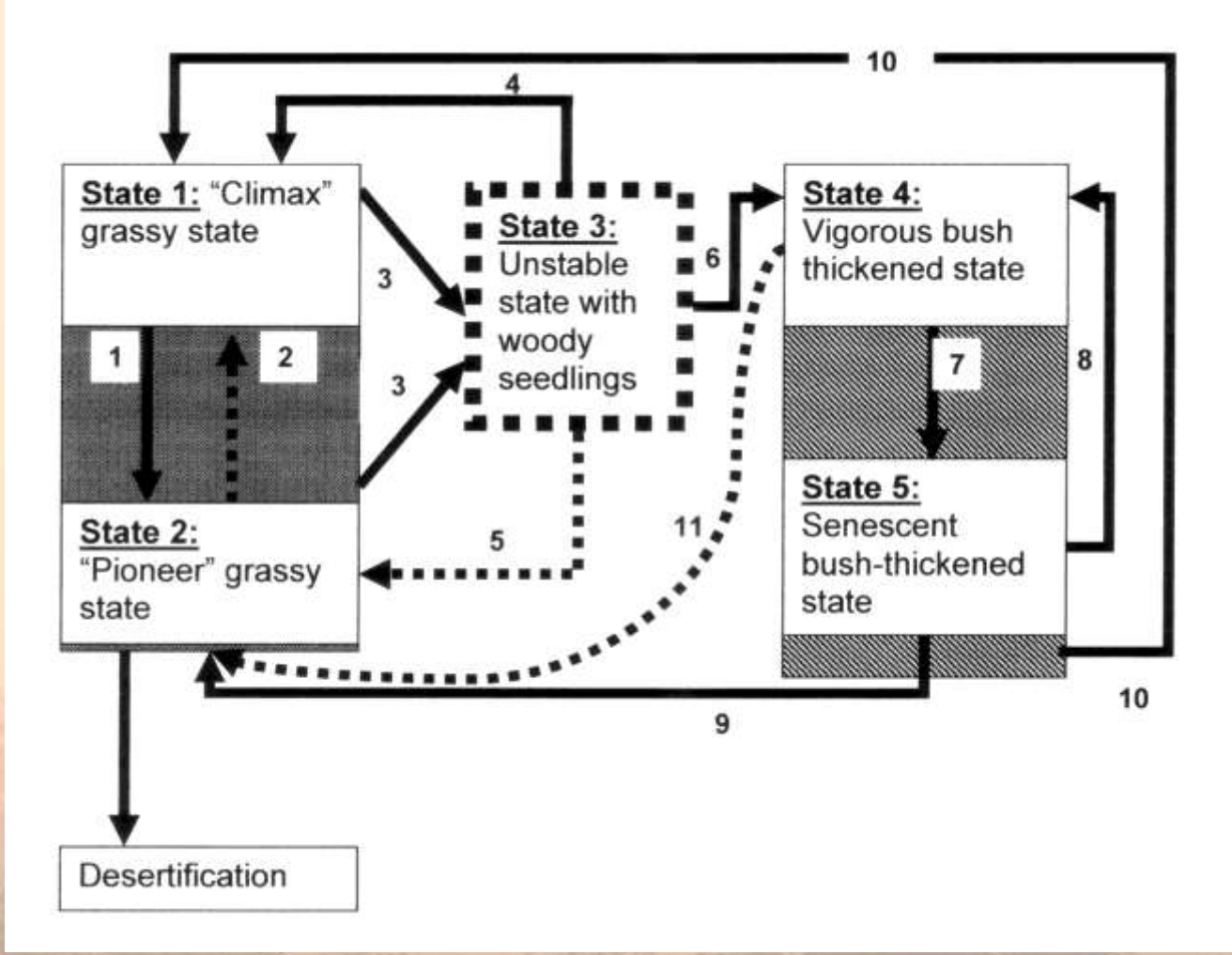
Acacia erubescens & Combretum apiculatum

2008


Key element !
Preserve or Restore
SAVANNA STRUCTURE

In Conclusion

State-and-transition models



Joubert D.F., Rothauge A. & Smit G.N. 2008. A conceptual model of vegetation dynamics in the semi-arid Highland savanna of Namibia, with particular reference to bush thickening by *Acacia mellifera*. *Journal of Arid Environments* 72(12): 2201-2210.


Thank you