Cactus holds promises as a tool to improve the productivity & sustainability of livestock-based production systems under the climate change context

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Not concerned with this talk

CONCERNED

Outline

- Livestock – Importance & Threats.
- Mutations of the production systems.
- Merits & better use of cactus.

- Conclusions & recommandations.

Livestock

- Key to security for many smallholder farmers.
- Indicator of wealth.
- Social, economical & environmental roles
- Better adaptation of sheep & goats to semiarid cond.

Sustainability ?

- Rangeland degradation
- Biofuel industry
- Global warming
- Prices of concentrate feeds

Consumers

- No antibiotics for animals
- No chemicals in feeds
- Dietetic meat & milk

Climate change is threatening the sustainability of livestock production systems

How Climate Change may affect livestock production systems?

Water	**Increassing water scarcity will affect feed availability and modify range use pattern** (Thornton & Herrero, 2008).
Feeds	**Increased prices, Changes in land use**
Biodiversity	**CC will accelerate the loss of genetic resources** (Ehrenfeld, 2005).
Rangeland	**Changes in primary productivity, Increase of rangeland area** **Change in botanical composition (legumes vs. grasses, browse vs. grassland, changes in quality plant material** (Thornton & Herrero, 2008).
Livestock	**Increase of diseases, heat stress, decrease of productivity**

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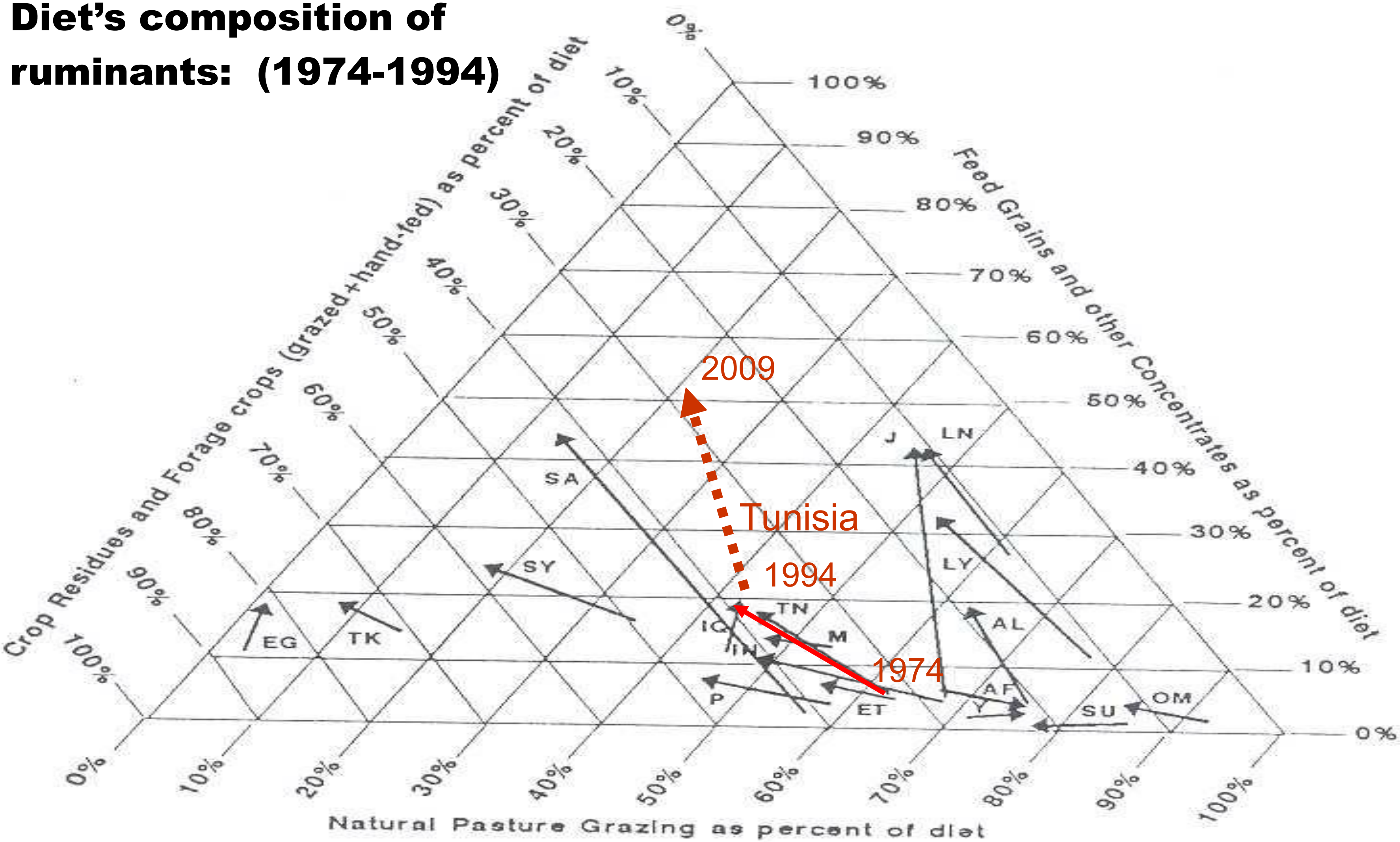
Diet's composition of ruminants: (1974-1994)



Nordblom et al. (1997)

Key:

AF=Afghanistan, AL=Algeria, EG=Egypt, ET=Ethiopia, IN=Iran, IQ=Iraq, J=Jordan, LN=Lebanon, LY=Libya, M=Morocco, OM=Oman P=Pakistan, SA=Saudi Arabia, SU=Sudan, SY=Syria, TN=Tunisia, TK=Turkey, Y=Yemen.

Rangelands: decreasing area and productivity: Causes of desertification …

Regions/ countries	Over-cropping	Over-grazing	Fuel-wood collection	Salinizati on	Urbanizat ion	Others
NENA Region	**50**	**26**	**21**	2	1	6
Sahel and East Africa	25	**60**	10	-	-	-
Central Asia	10	**62**	-	9	10	9
USA	22	**73**	-	5	-	-
Australia	20	**75**	-	2	1	-

Le Houérou (1996)

Values are expressed as % of the total "desertified" area in the corresponding region.

Deep changes in the pastoral & agropastoral systems

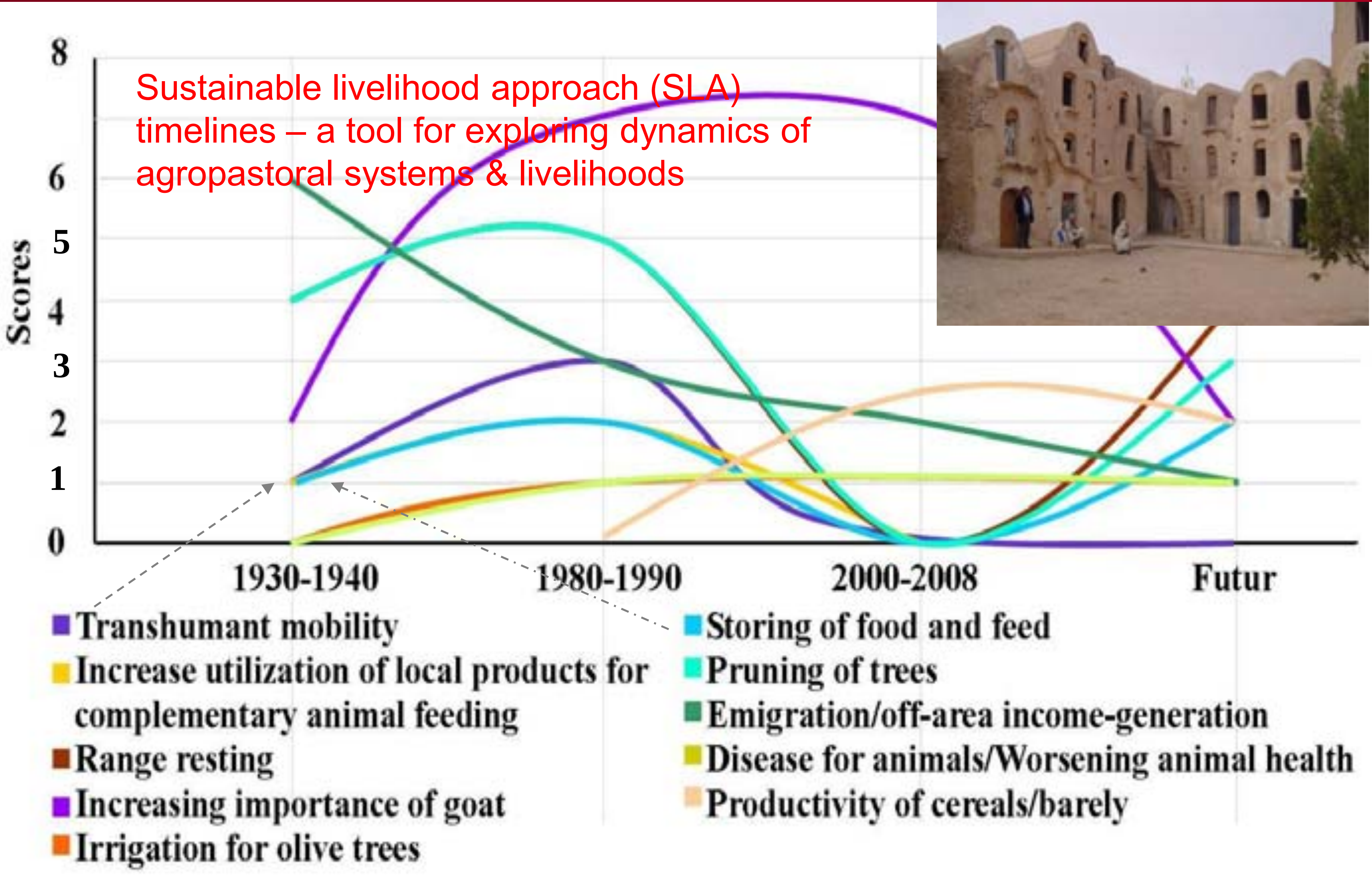
In some countries, drought is not an event, but the perception of drought changed
(Previous *vs* recent generations)

- Dismantlement of traditional organizations
- Privatization of communal rangelands
- Regression of animal mobility
- Reliance on supplemental feed
- Mechanization
- Inequity between poor and rich herders

Nefzaoui & Ben Salem (2009)
Tunisia

Tendencies of major drought strategies in Chénini agropastoral community, Southern Tunisia (M&M III/ Sghaier et al., 2008)

Sustainable livelihood approach (SLA) timelines – a tool for exploring dynamics of agropastoral systems & livelihoods



Feeding: major constraint for livestock production & sustainability

- Scarcity and fluctuant availability of feed resources
- Discordance between increasing flock sizes and nutrient requirements and feed availability
- Major part of livestock flocks is raised in low fodder potential areas

Promote and better use of local feed resoures

Manipulation of feed resources & animal

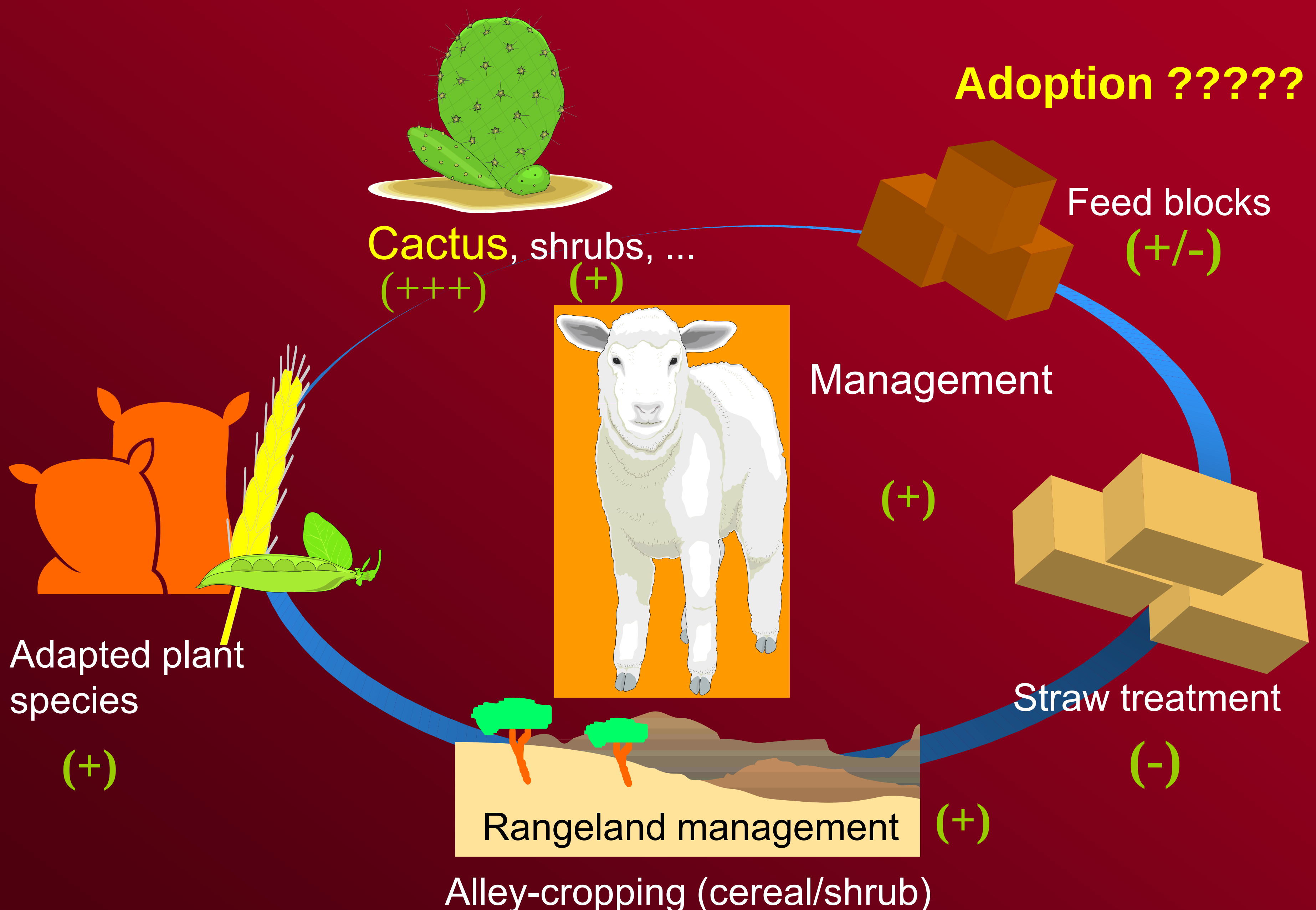
Feed resources

- Breeding programs (drought and/or salt-tolerant plant species)
- Increase forage production (fodder shrubs, cactus, etc.)
- Better use of local feed resources
  - Targeted supplementation
  - Alkali treatment of straws (urea, ash, etc.)
  - Ensiling AGIBPs
  - Feed blocks
  - AGIBPs-based pellets

Animal

- Breeding – adapted breeds
- Rumen manipulation (e.g. tannins, saponins)
- Rumen fluid transfer from adapted to non adapted animals
- Animal manipulation
  - Foetal programming
  - Behavior (Early experience)

Technologies transferred in WANA



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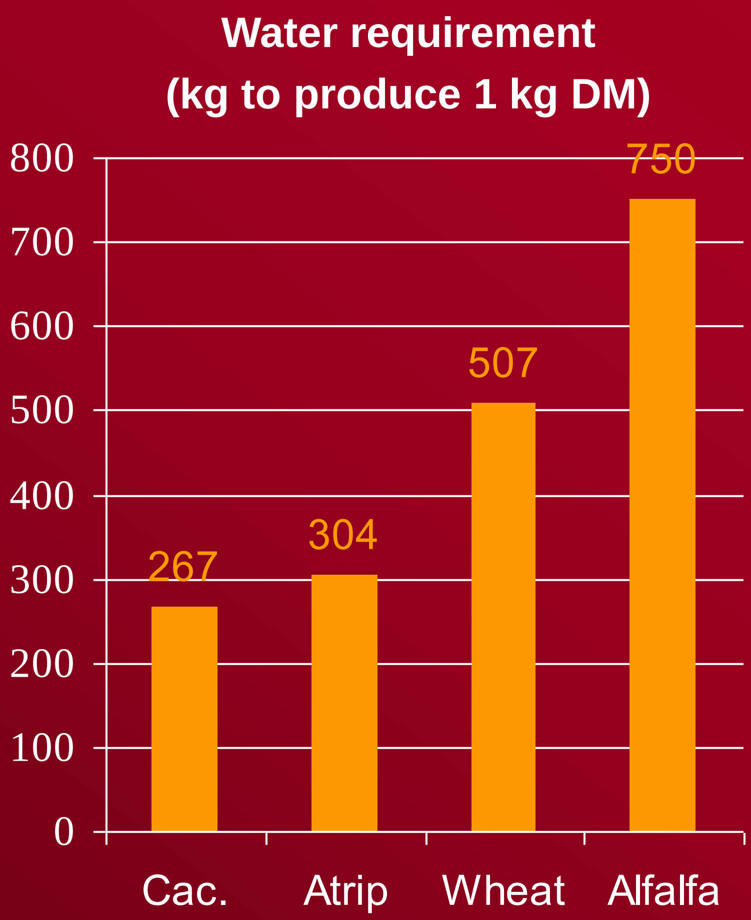
- „Camels of the plant world"
- „Nature fodder bank"
- „Living fodder banks"

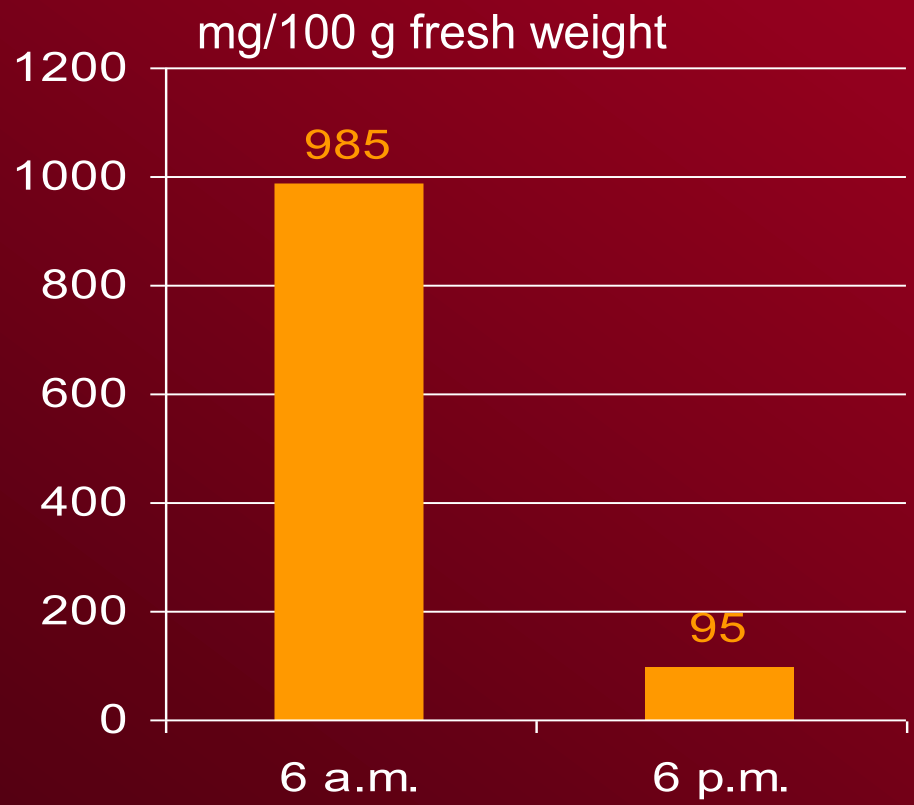


De Kock (1980) – South Africa

Multipurpose plant:
Forage –fruits – food industry
Pharmaceutical industry….

High in sugars – Vit. A
Mucilage - pectins

Cactus fixes CO_2 as malic acid and releases O_2 during the night to prevent water losses through transpiration.



Stintzing et al. (2005) - Germany

Malic acid is decarboxylated & the released CO_2 is converted into glucose via photosynthetic action during the day when stomata are closed.

Malic acid reduces methane production in the rumen

Could cactus contribute to reduce GHG emissions by livestock ????

Tunisia (30 – 100 Tons /ha)

Brazil (200 – 260 Tons /ha)

Breeding programs for disease control and to improve fodder potential of cactus by IPA – Arcoverde in Brazil (my visit July 2008)

Farmers in Arcoverde region (Brazil) are happy with the use of cactus cladodes in goat & dairy cattle feeding

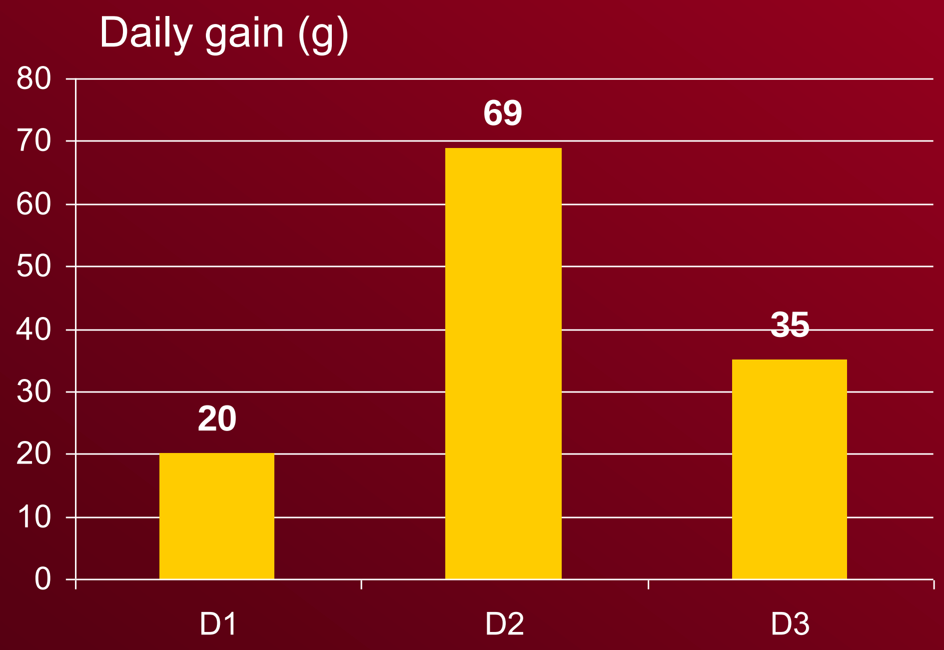
Complete Mixed Diet

- Cactus 60%
- Fibrous feed (hay) 20%
- Concentrate 20%

Milk production: 8 liters/goat/d
25 liters/cattle/d

Better use of cactus

Nitrogen supplementation of cactus-diets (sheep)



D1: Tef straw + 172 g cactus

D2: D1 + 145 g cotton seed cake

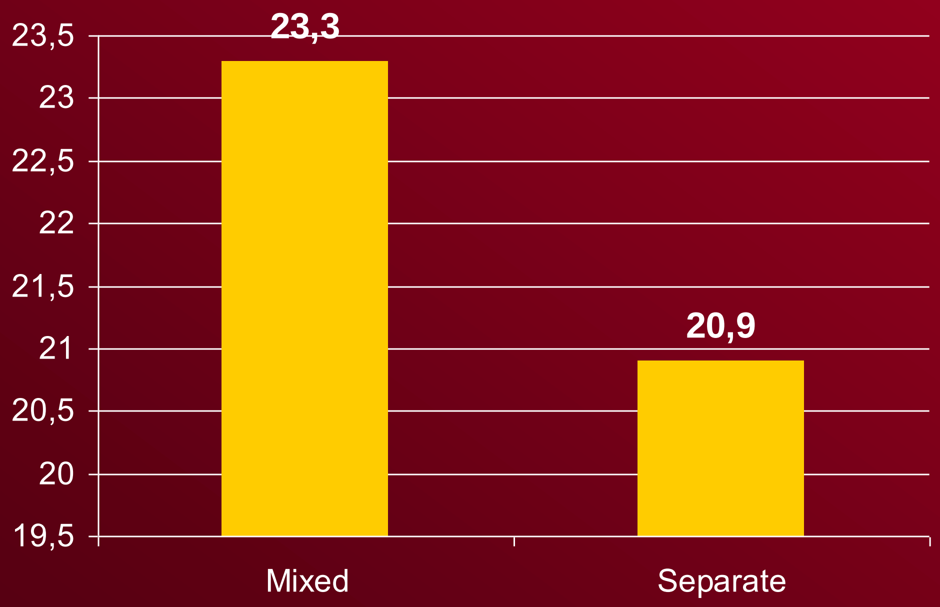
D3: D1 + 149 g peanut cake

Degu et al. (2009) - Ethiopia

Better use of cactus

Mixing ingredients vs. separate ingredients

Milk yield (kg/day) – Holstein cattle



Diet: Cactus (39%) + Sorghum silage (31%) + Concentrate (30%)

Pessoa et al. (2004) - Brazil

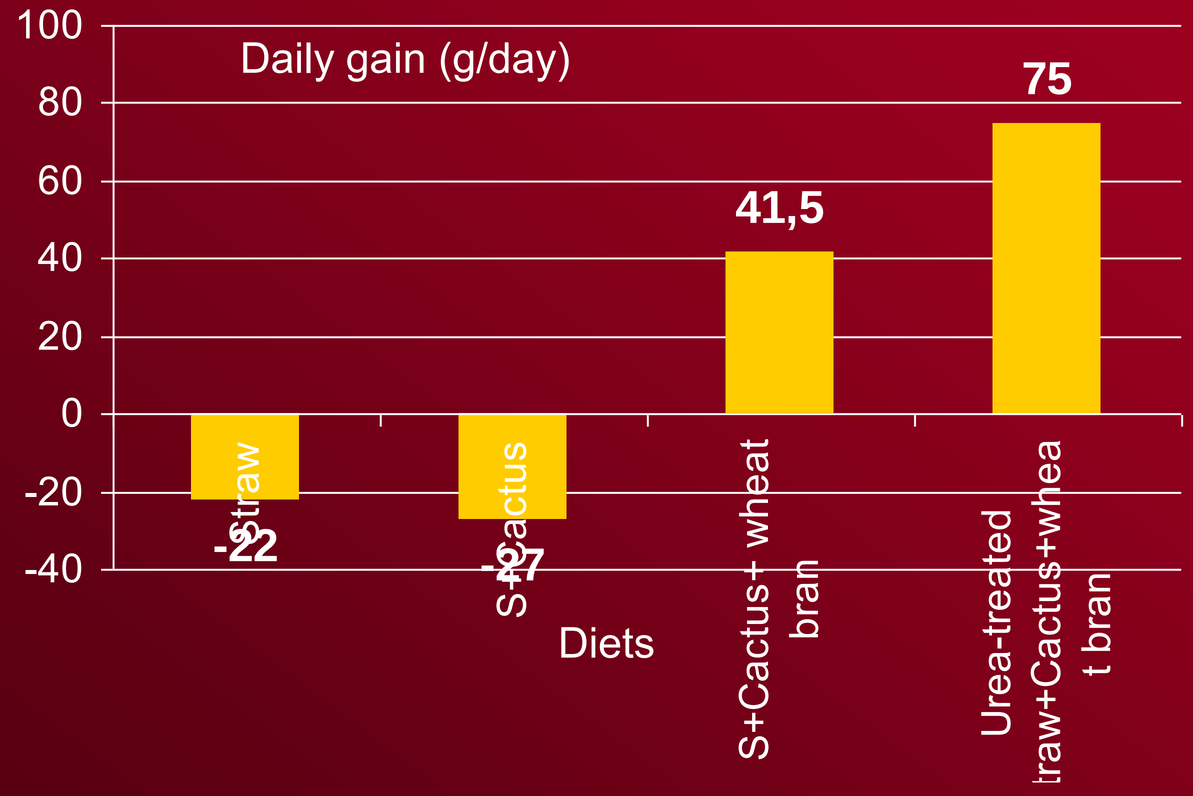
Cactus vs. Alfalfa hay in mixed diets for finishing lambs

Alfalfa hay	12.0	-
Cactus	-	20.0
Sorghum grain	43.2	42.2
Corn grain	22.0	19.6
Soybean meal	14.0	11.0
Mineral premix	8.8	7.2
Energy intake (Mcal/d)	5.38	4.42
N intake (g/d)	40.7	32.1
Daily gain (g)	370	270

Pinos-Rodriguez et al. (2007) - Mexico

Better use of cactus

Urea-treated straw in cactus diets for sheep



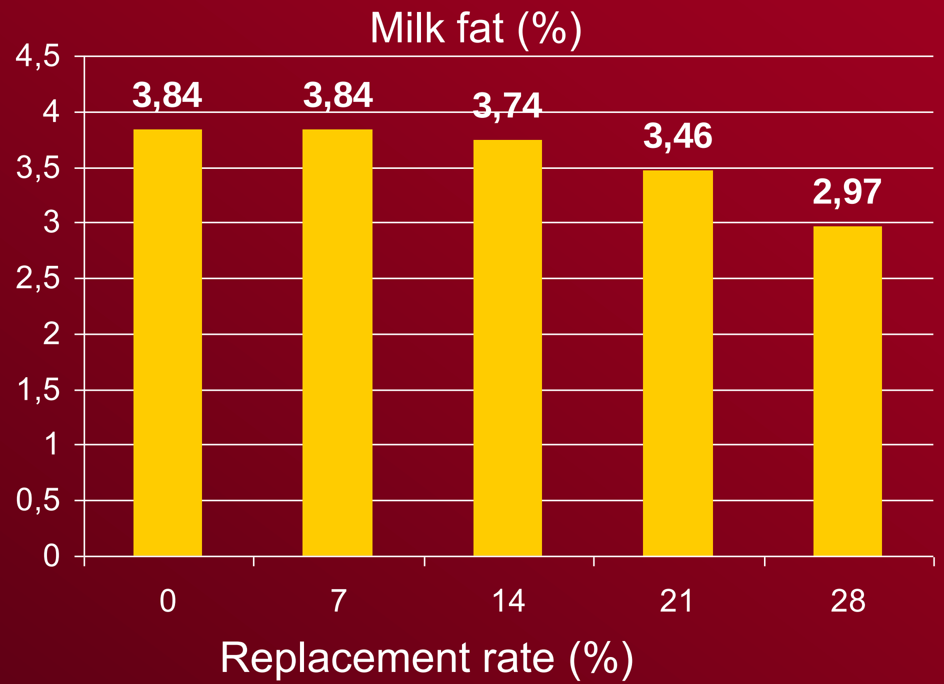
Tegegne et al. (2005) - Ethiopia

Cactus alleviates feeding cost

Replacing corn meal with cactus for dairy goats

(0, 7, 14, 21 and 28%)

- No effect on milk production (1.5 – 1.63 kg/day)
- Linear decrease of milk fat (%)



Roberto Germano Costa et al. (2009) - Brazil

- Target association of drought tolerant species

Weaned lambs fed on straw

Energy	Barley	Barley	Cactus	Cactus
Nitrogen	Soyabean	Atriplex	Soybean	Atriplex
Microbial N (g/kg DOMI)	3,5 b	3,2 b	8,3 a	11,4 a
Growth (g/d)	108 a	59 c	119 a	81 b

Ben Salem et al. (2004) - Tunisia

Impact of cactus on product quality

Meat quality of kids

Zouaghi et al. (2005) - Tunisia

Diet 1: Oat hay (600 g) + Soybean meal (200 g) + Cactus

Diet 2: Oat hay (600 g) + Concentrate (600 g)

- No effect on PUFA, MUFA & SFA
- CLA increased in the meat of cactus-kids

Meat quality of lambs

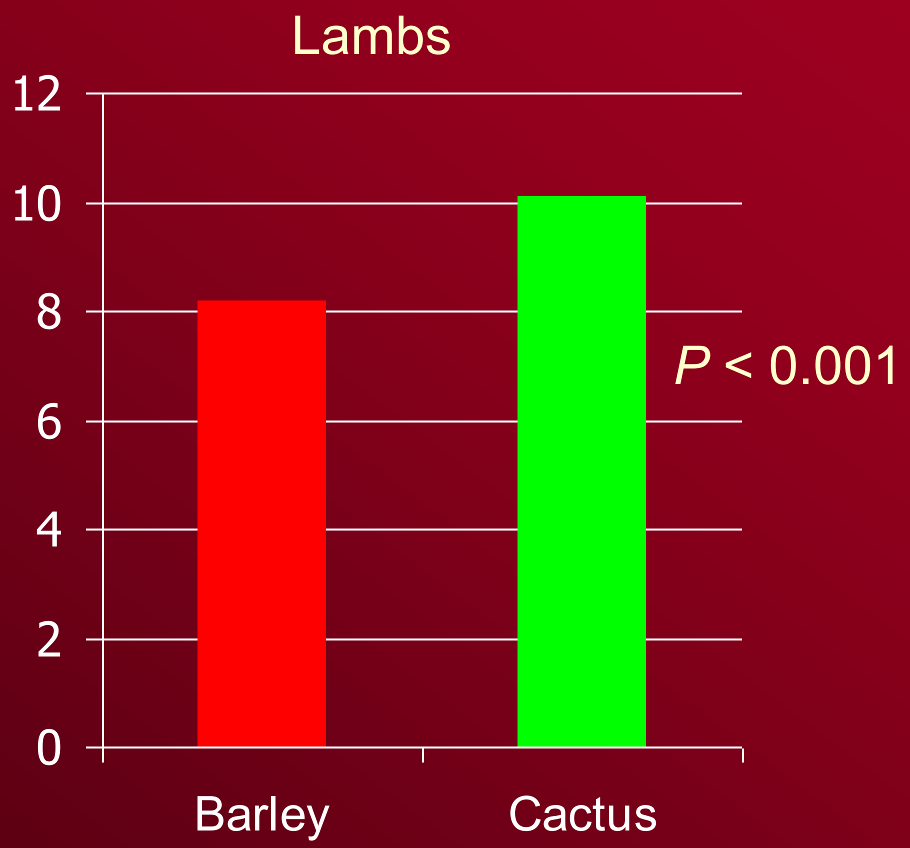
Vasta et al. (2006) - Tunisia

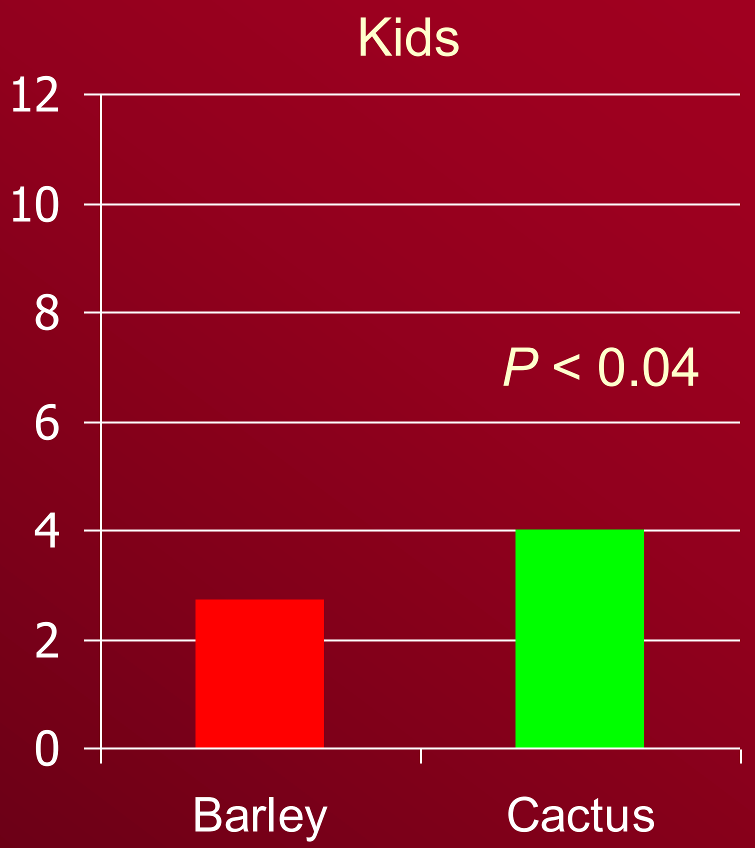
Diet 1: Silage (cactus-olive cake-wheat bran) + Soybean meal (200 g) + Cactus

Diet 2: Oat hay + Concentrate

- No effect on PUFA & MUFA
- Silage decreased SFA

C18:3 in meat





Abidi et al. (2010) - Tunisia

Cactus vs Barley on reproductive traits in ewes

Barbarine ewes: Late gestation-early suckling

Diet 1: Oat hay + barley + Soybean meal

Diet 2: Oat hay + cactus + Soybean meal

No effect on:

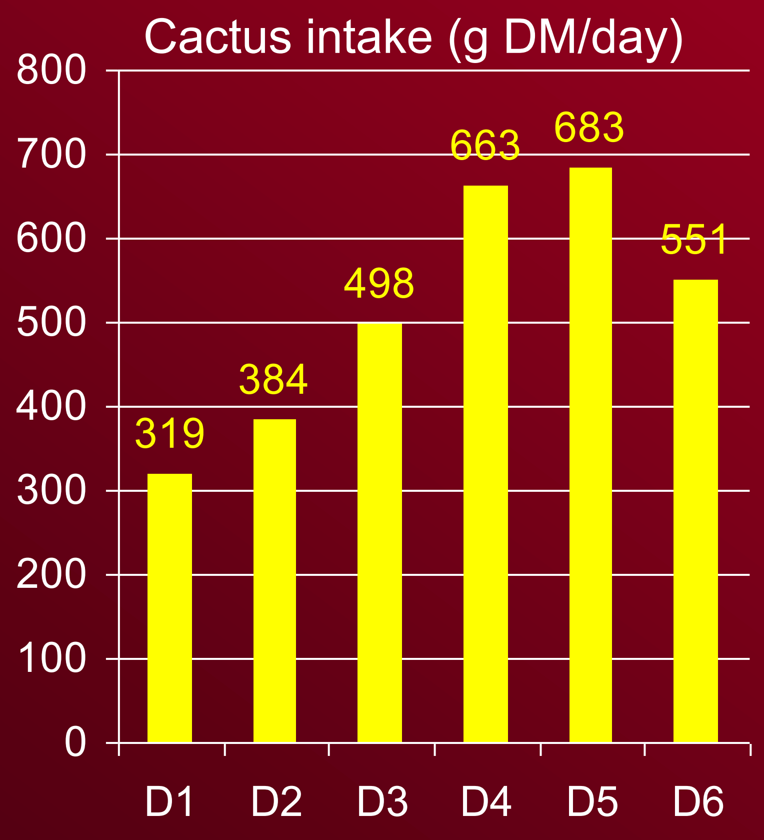
- Colostrum production
- Colostrum immunoglobulin G (160 vs 149 g/liter)
- Milk yiel at 30 days (1030 vs 1041 g/day)
- Live weight of lambs at 30 days of age
- Ovarian activity at 30 days from lambing

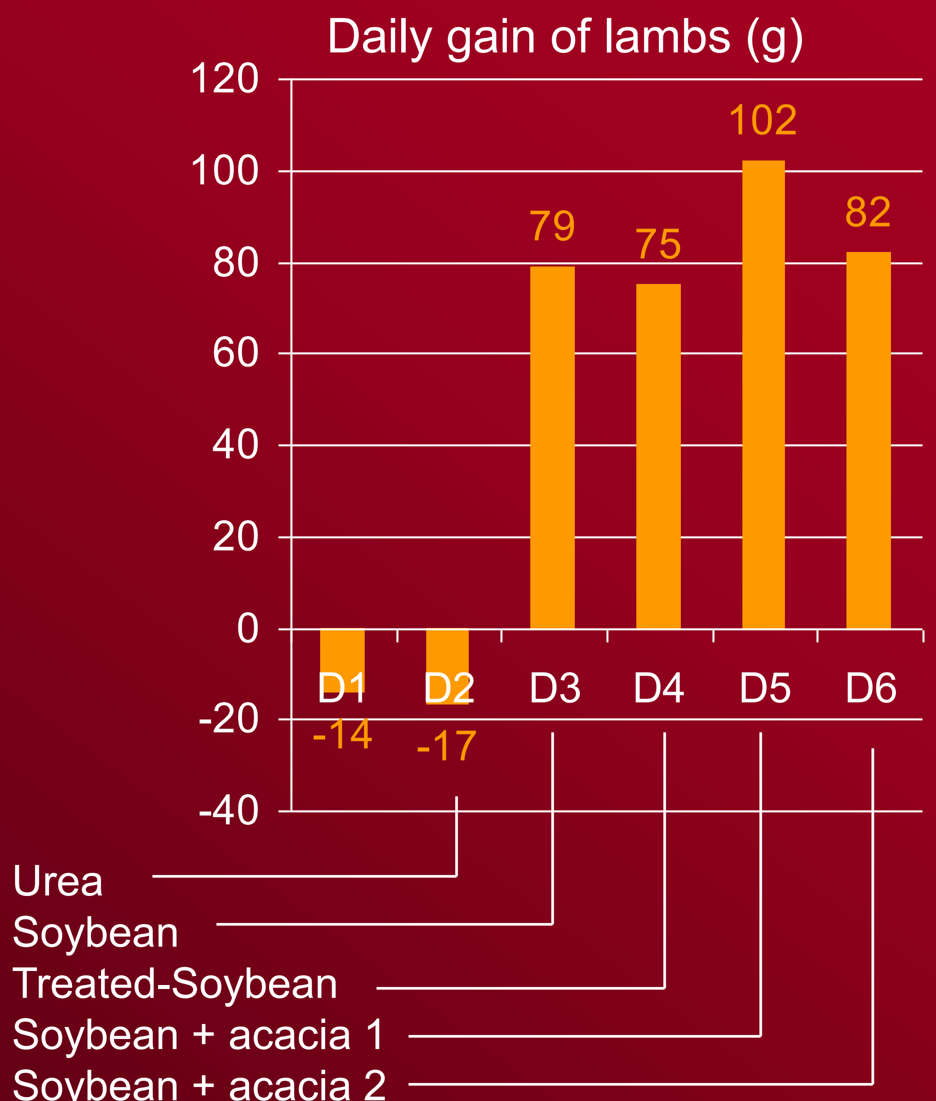
Rekik et al. (2010) - Tunisia

Rumen manipulation with plant secondary metabolites

- Condensed tannins
  - Present in herbaceous & woody species (Sulla, acacia,..)
  - Bind to proteins in the rumen
  - Reduce protein degradation
  - When proteins >> requirements (increased performance)
  - Detrimental effect when dietary protein low

Supplementing cactus with quality proteins





Ben Salem et al. (2002) - Tunisia

Rumen manipulation with saponins

- Glycosides of aglycone linked to sugar
- Detergent action kills rumen protozoa
  - Less ammonia in the rumen
  - Enhance the flow of microbial proteins from the rumen
  - Increase the efficiency of feed utilization

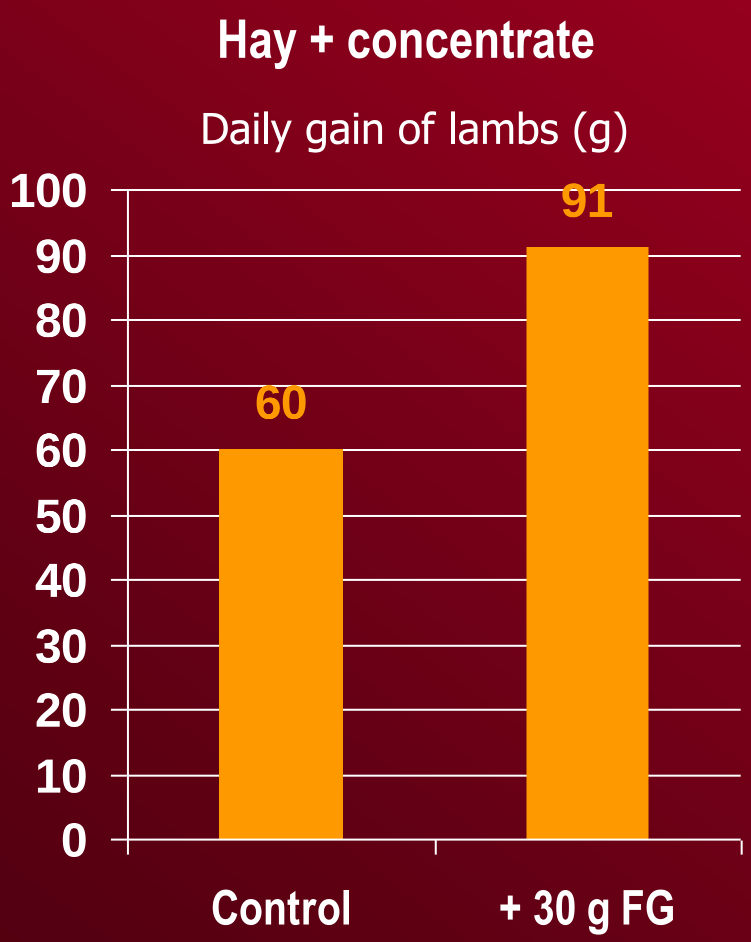
- Other effects
  - Increase permeability of the intestinal mucosal cells
  - Reduce methane production

Local sources of saponins

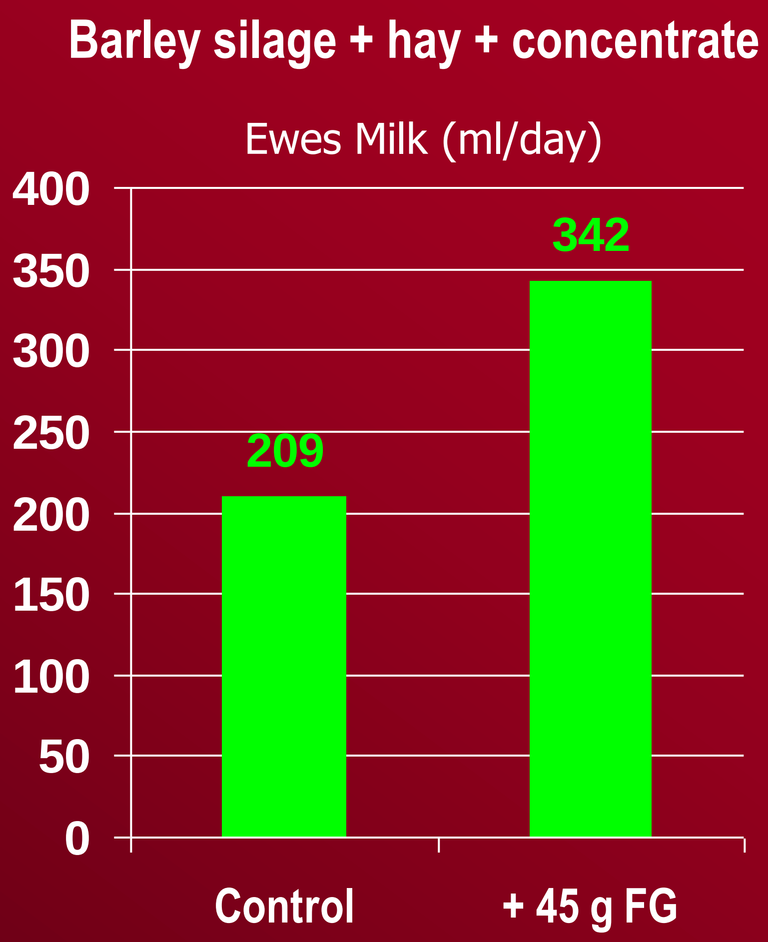
Trigonella foenum-graecum (4% sap.)

Agavae americana (8% sap.)

Positive effects of Fenugreek saponins



H. Ben Salem (unpublished)

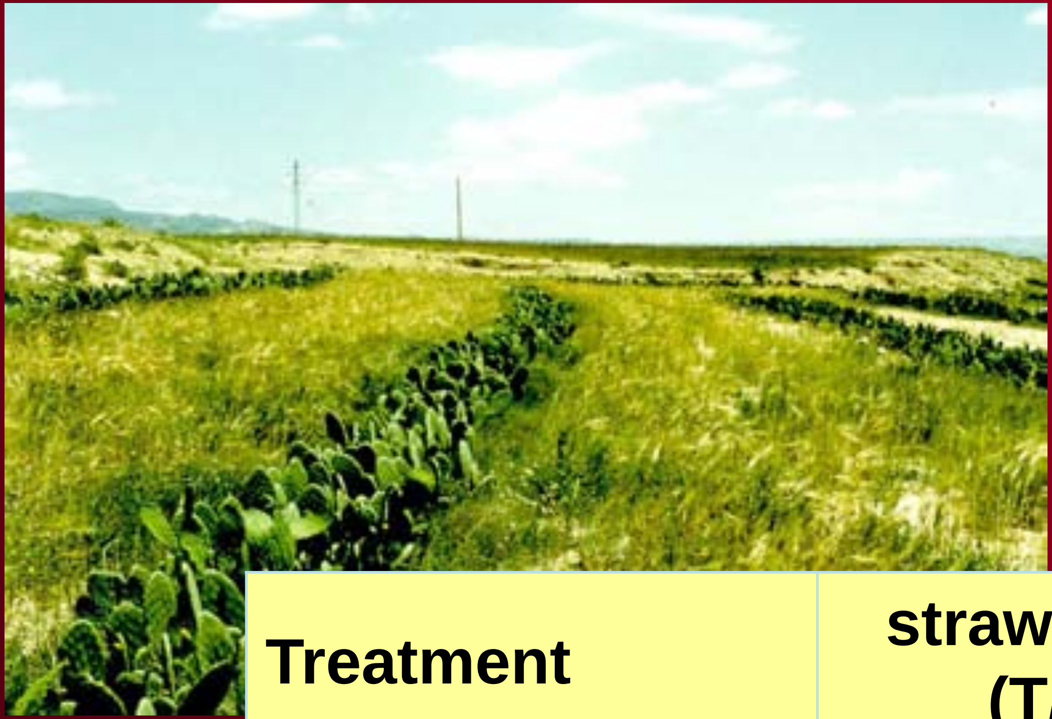


Ben Salem & Othmane (unpublished)

What about cactus-based diets?

- **Alley-cropping technology**

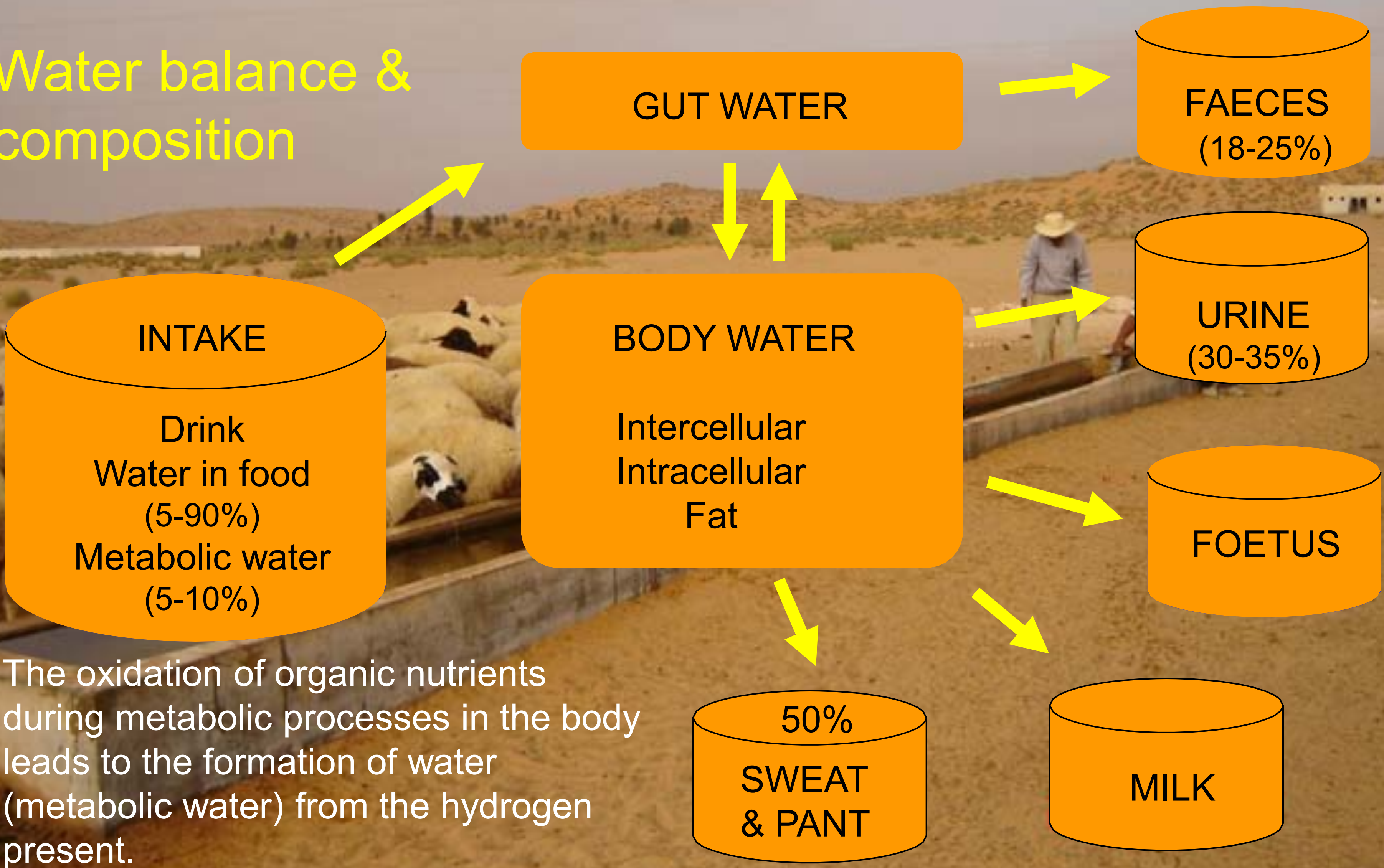
Alary & Nefzaoui (2006) - Tunisia



Treatment	straw+ grain (T/ha)	Grain (T/ha)
Cactus+ barley crop	6.65	2.23
Barley crop	4.24	0.82

Importance of water to livestock
What do we know?

Water balance & composition



The oxidation of organic nutrients during metabolic processes in the body leads to the formation of water (metabolic water) from the hydrogen present.

Importance of water to livestock

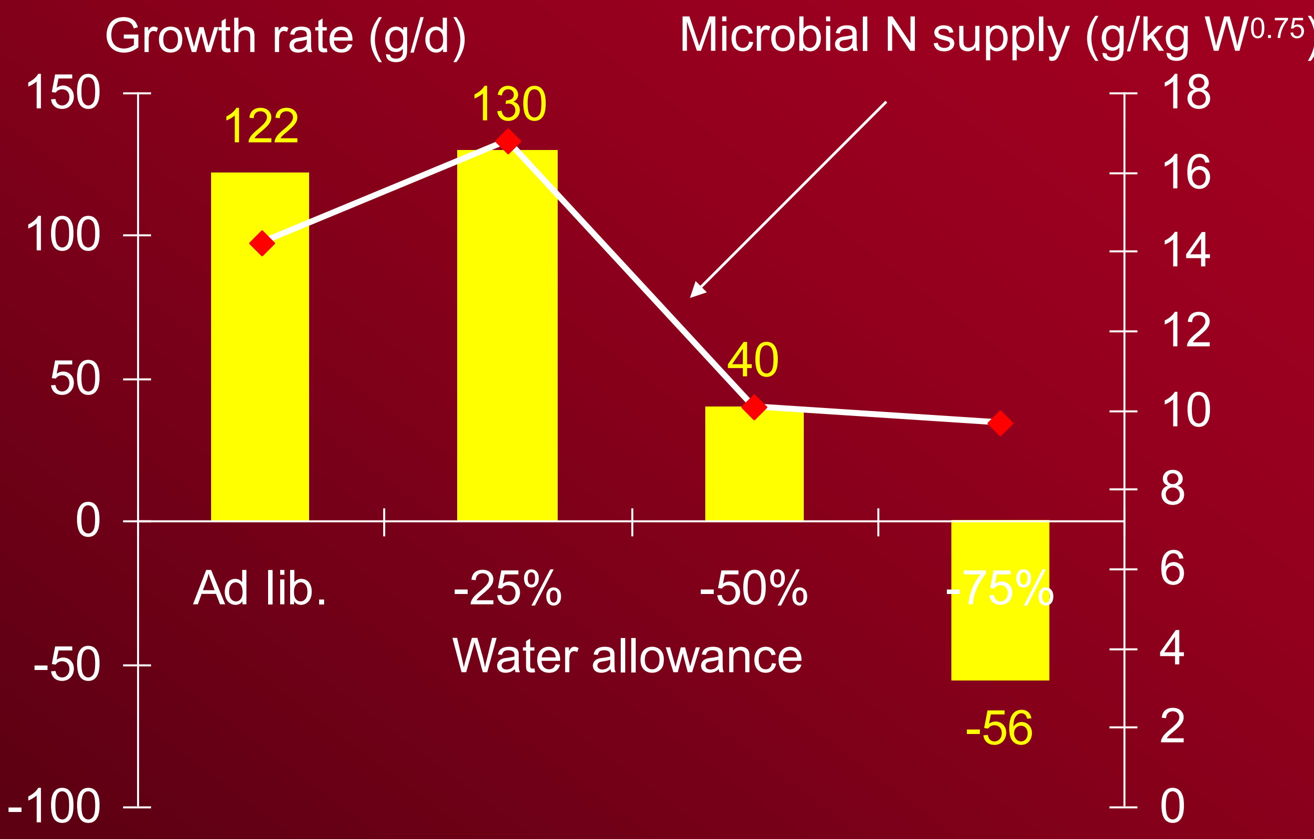
- Medium in which all chemical reactions in the body take place
- Acts as:
  - An ideal lubricant to transport feed
  - An aid in excretion
  - A regulator of body temperature
  - A buffering agent to regulate pH of body fluids

A loss of one-tenth of the water from the body means death
But, animals may lose nearly all the fat and about 50% of the protein of the body and survive

Water restriction

Water allow.	DMI (g/Kg $W^{0.75}$)	OM dig. (%)
Ad lib	89.2	73.4
- 25%	84.8	73.0
- 50%	71.6	75.4
-75%	59.5	78.0
Signif.	***	***
Contrast	L	L

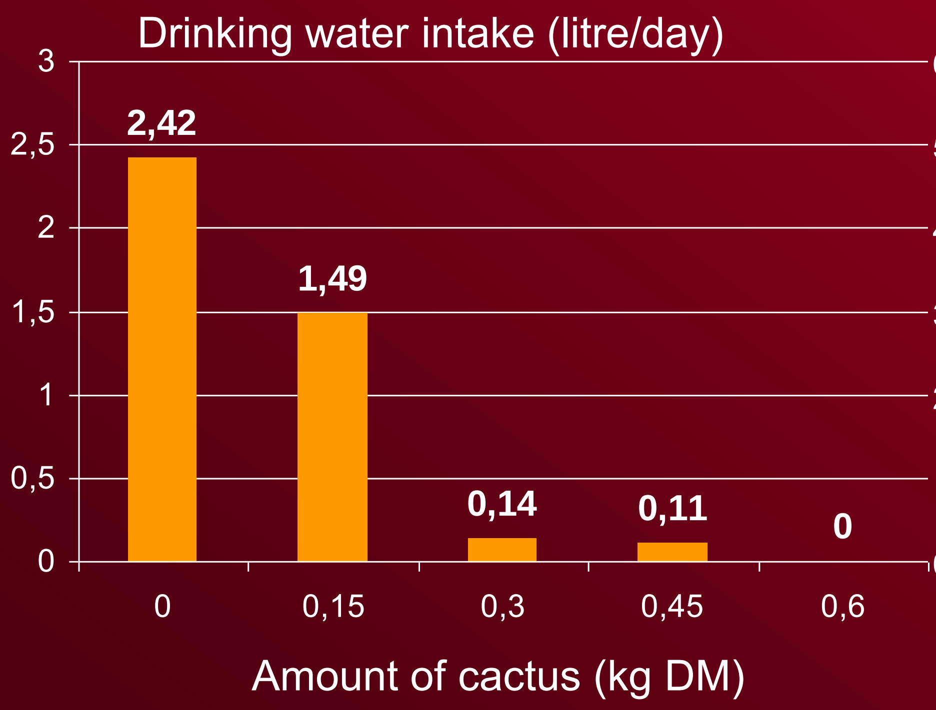
Barbarine lambs tolerate moderate water restriction



Ben Salem & Abidi (2009) - Tunisia

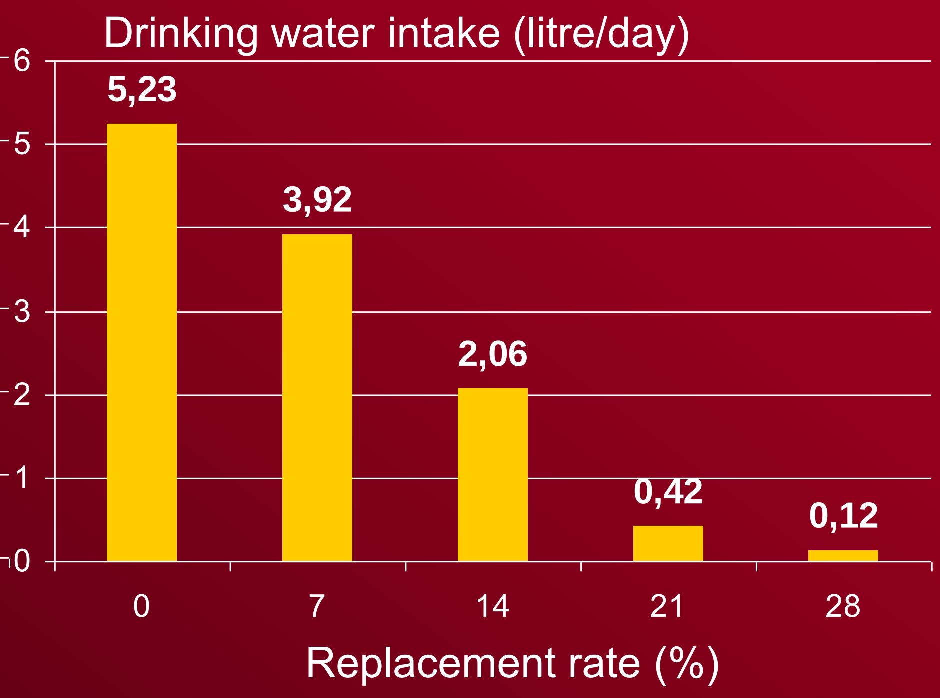
Cactus could resolve watering problem in arids areas

Increasing level of cactus in straw based-diets for sheep



Ben Salem et al. (1996) - Tunisia

Replacing corn meal with cactus for dairy goats



Roberto Germano Costa et al. (2009) - Brazil

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- Livestock agriculture is very sensitive to resource competition.
- Competition for water, land and feed will increase at the same time as demand is rising.
- This will increase the risk of insecurity of supply and possibly reduce food safety.

- Develop drought mitigation strategies (long term)
- Build up local fodder reserves “cost-effective and environmentally friendly tools”

- Cactus, a promising fodder plant
  - Source of energy.
  - Needs appropriate supplementation with protein sources
  - Reduces feeding cost.
  - Solution for livestock watering.
  - No detrimental effect on productive and reproductive performances.
  - No detrimental effects on product quality

- Further research on Cactus
  - Protein supply.
  - Tanins and saponins administration.
  - Impact on ruminal bacteria & protozoa.
  - Cactus in complete mixed diets.
  - Effect of malic acid in cactus on microflora and methanogenesis.
  - The fate of oxalates.
  - Effect on reproduction career of male and female ruminants.

- „Cactus - camel of the plant
- Physiological mechanisms to cope with harsh conditions