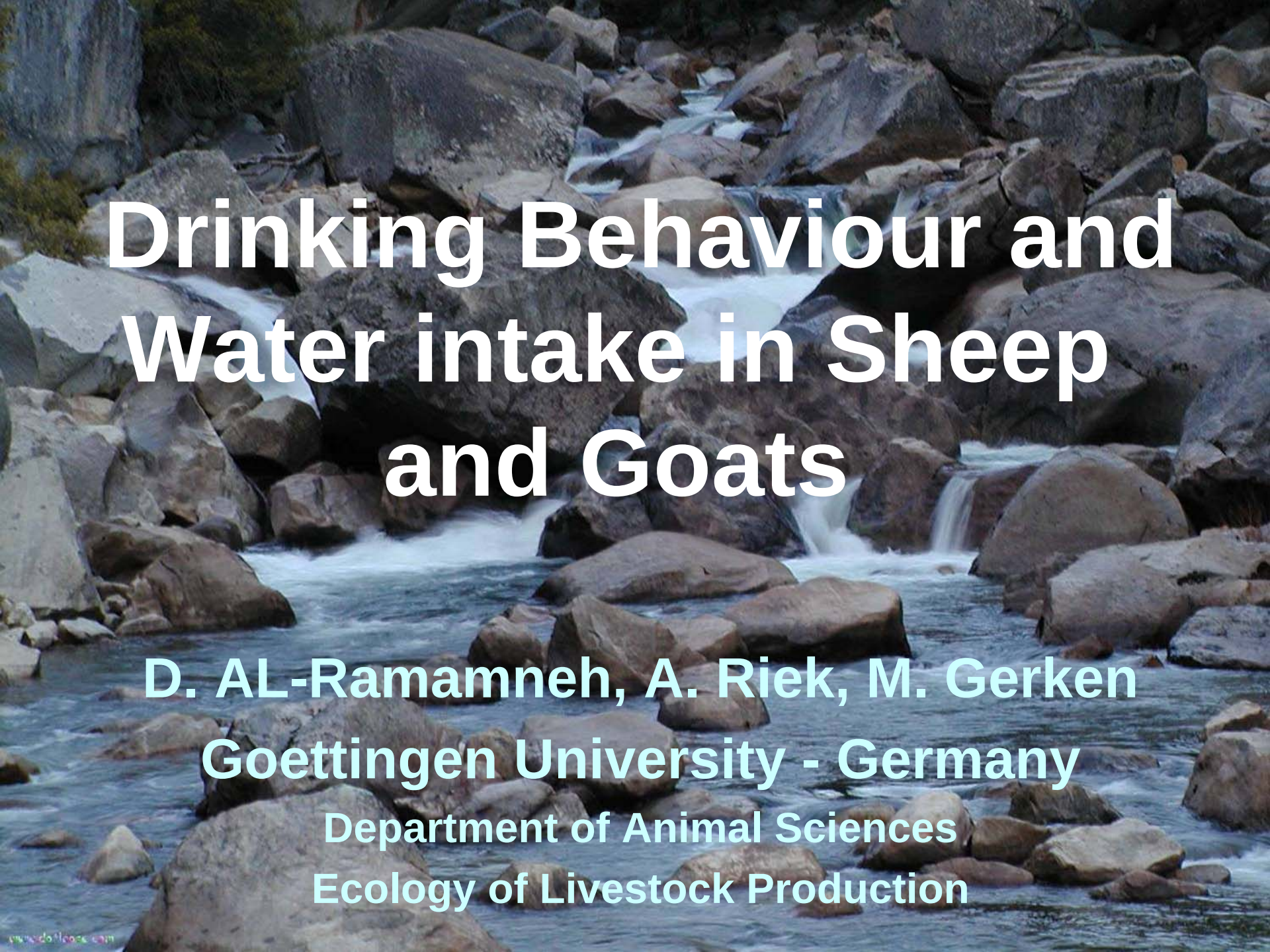

Drinking Behaviour and Water intake in Sheep and Goats

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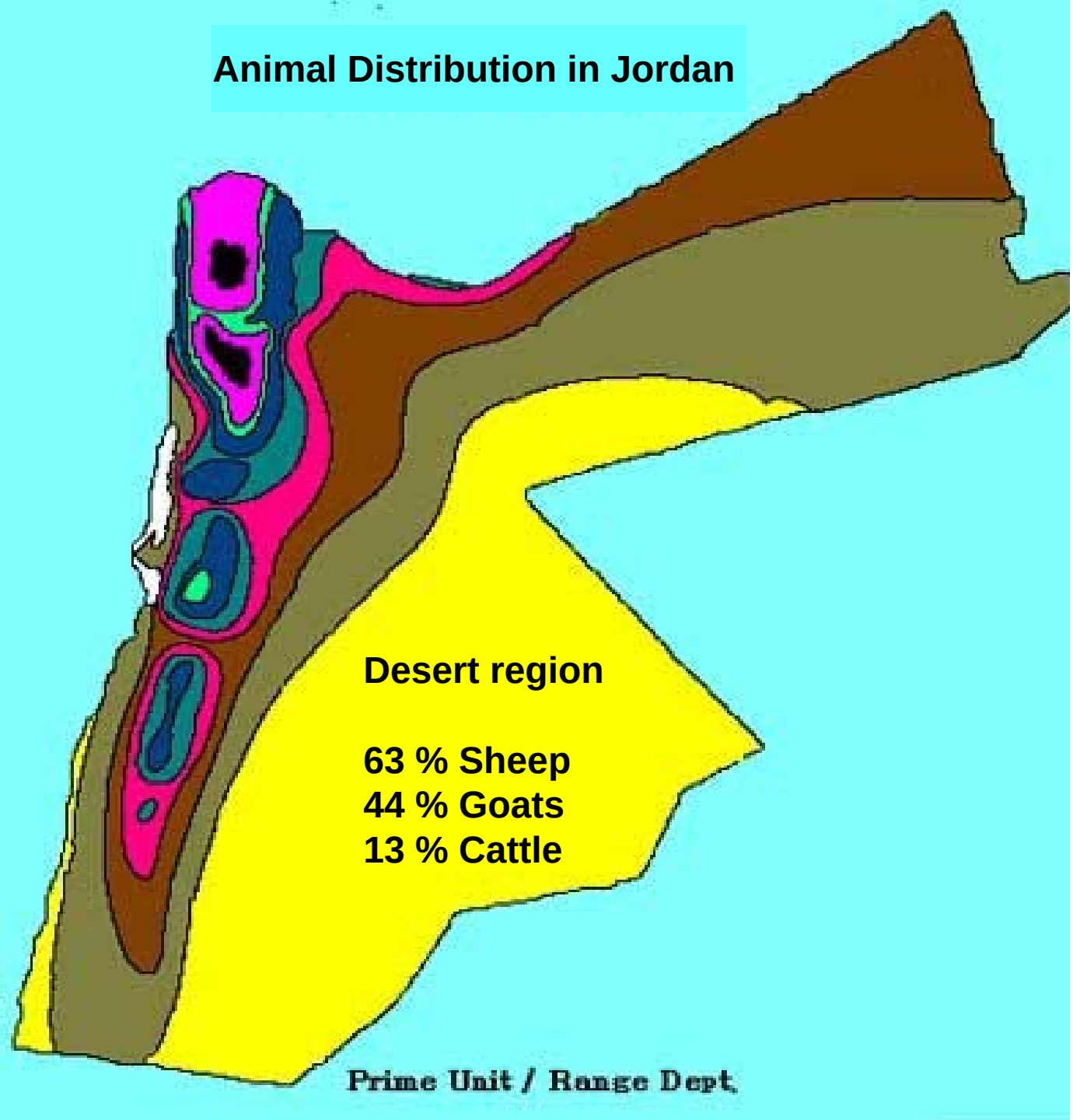
Ecology of Livestock Production

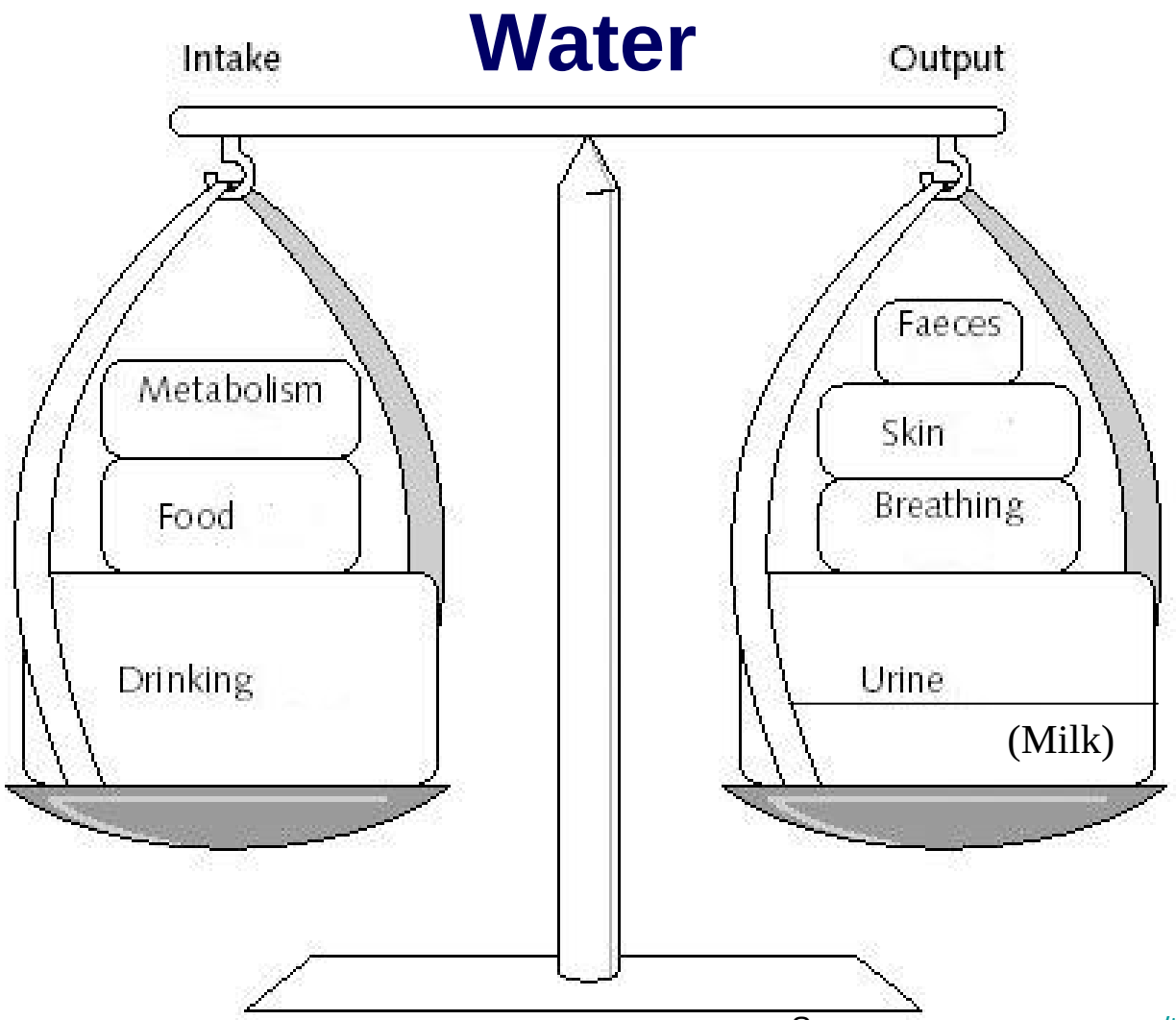


2007 Survey
Source: DOS, Jordan

Total Sheep (N)
2,251,440

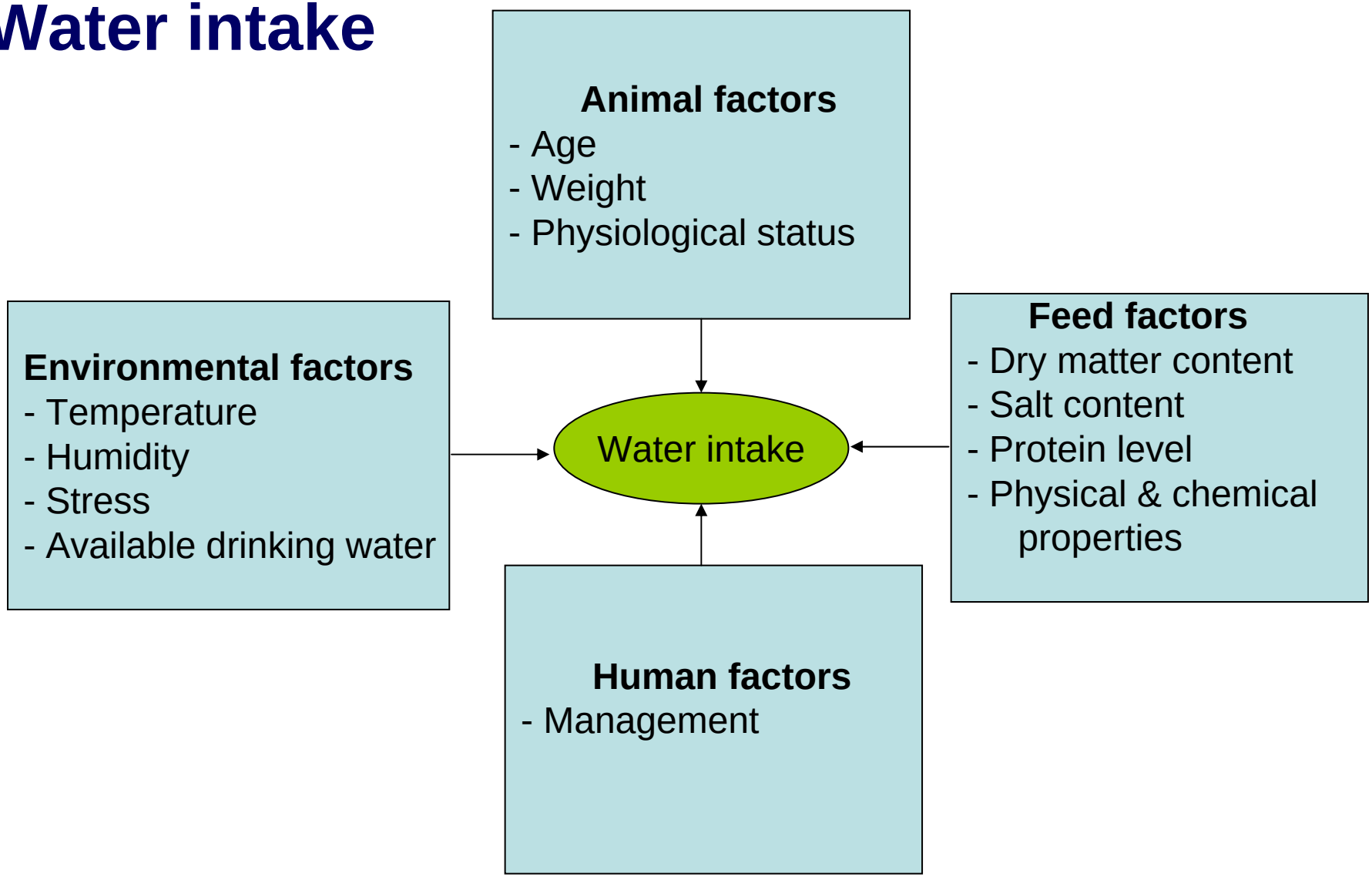
Total Goats (N)
569,380

Total Cattle (N)
80,990



Source: www.answers.com/topic/water-balance-1

Water intake



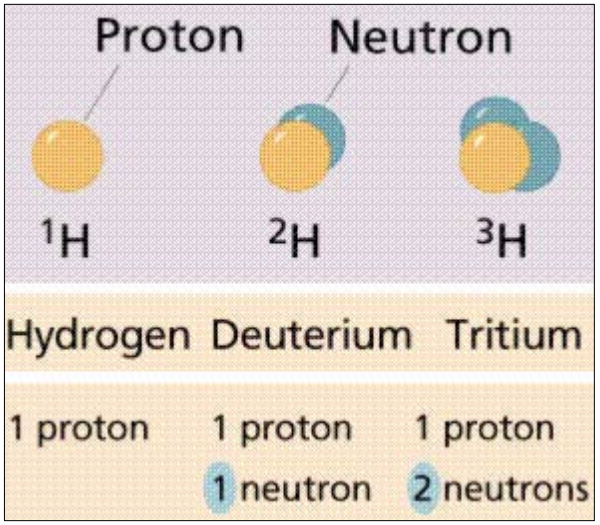
Daily water consumption

Type of livestock		Consumption per head per day (L)
Sheep	Lactating ewes	4-10
	Mature sheep on grassland	2-6
	Mature sheep on saltbush	4-12
	Sheep Weaners	2–4
Cattle	Lactating cows on grassland	40-100
	Lactating cows on saltbush	70-140
	Young stock	25-50
	Dry stock (400 kg)	35-80

Source:Markwick, 2007

D_2O technique for measurement of water intake in farm animals

- Heavy water **1 ml D_2O = 1.1067 g**
- Stable isotope
- Non toxic
- Uniformly dispersed in TBW
- Cross body barriers at the same rate as body water
- Easy measurement in any body fluid



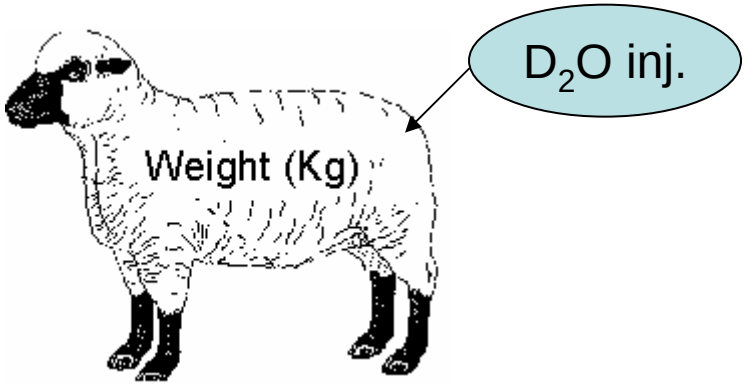
Source: Holleman et al., 1982

Deuterium Oxide D_2O

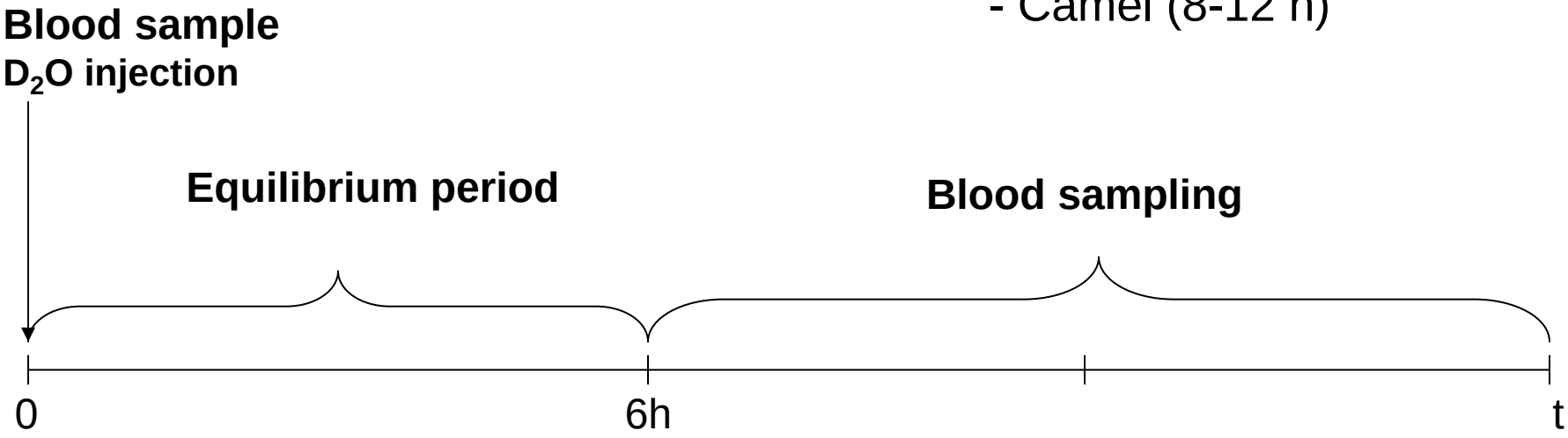
- Provides a convenient method for determining TBW and water intake
- Does not require killing of animals
- Allows animals to range freely within their normal habitat
- Understanding the reactions of animals to their environments under natural conditions

* Source: Makkar, 2008

D_2O as a marker



Equilibrium period*
- Small rodents (30 min)
- Birds (45 min)
- Dogs (1.5 h)
- Human (2 h)
- Sheep & goats (5-6 h)
- Cattle (7-8 h)
- Camel (8-12 h)



* Source: Degen et al. (1981); Holleman (1983); Attia et al.(2000)

Comparison between sheep and goats

Research Objective

- Compare the actual and estimated water intake by using D_2O dilution technique in two species (German Blackhead Mutton Sheep and Boer Goat) receiving water *ad libitum*

Comparison between sheep and goats

German Blackhead Mutton Sheep
N=8

Boer Goats
N=8

Experimental measurements

- Daily water intake
- Daily hay intake
- Animal weight

- Drinking behaviour (i.e. drinking frequency and duration) by using a time-lapse video recording system & video analysis interact® 8.0 system

Experimental conditions

Temperature	13.6 ± 0.4 ºC
Relative humidity	49.1 ± 9.7%
Light schedule	14 h light : 10 h dark

Results

Average water intake in sheep and goats / day (means ± SEM)

Species	Sheep N=8	Goats N=8	Sign.
Body weight (Kg)	69.0 ± 0.7	64.2 ± 0.3	***
Daily Water intake (g/kgBW$^{0.75}$)	195.5 ± 9.0	103.6 ± 9.0	***
Daily DMI (g/kgBW$^{0.75}$)	68.4 ±3.8	57.2 ± 3.8	**
WI / DMI	2.9 ± 0.1	1.9 ± 0.1	***

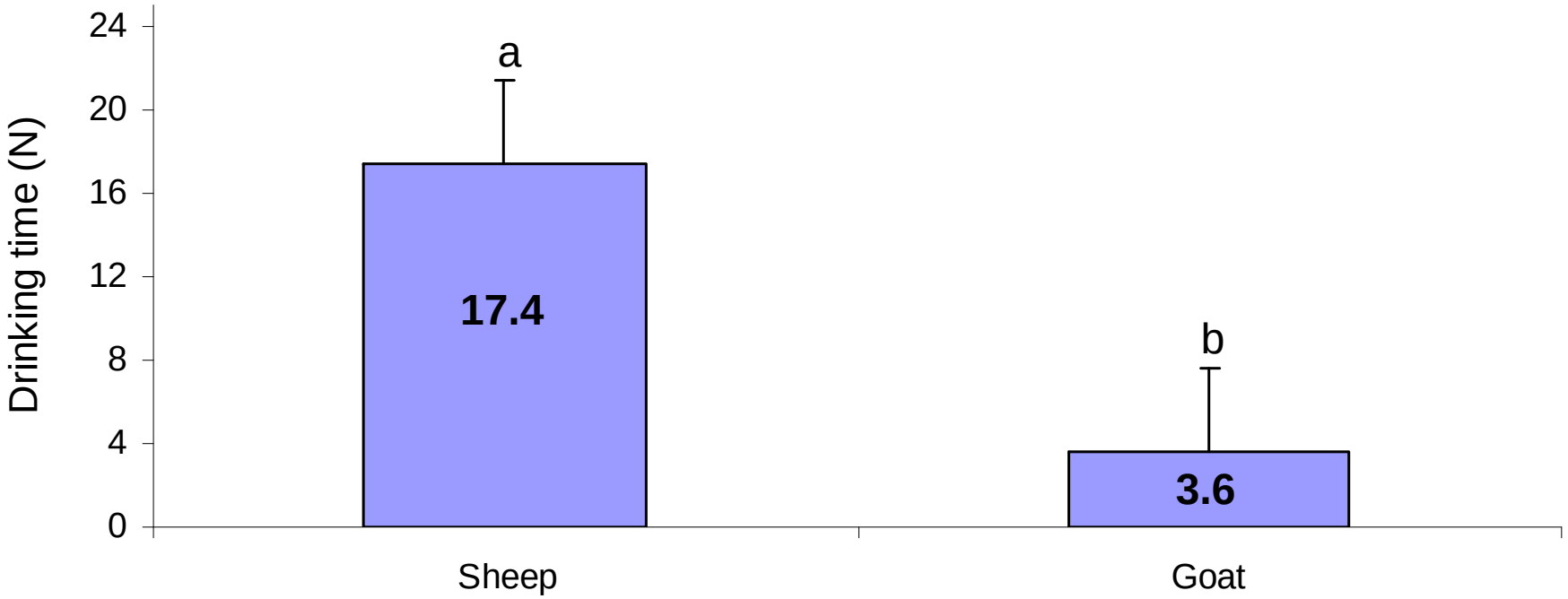
Average water intake in sheep and goats / day (means ± SEM)

Species	Sheep N=8	Goats N=8	Sign.
Daily Water intake (g/kgBW$^{0.75}$)	195.5 ± 9.0	103.6 ± 9.0	***
Measured TWI (g/kgBW$^{0.75}$)	230.5 ±10.7	132.9 ±10.7	***
Estimated TWI by D_2O (g/kgBW$^{0.75}$)	219.3 ± 7.6	143.1 ± 7.6	***
Estimated TWI / Measured TWI (%)	**95.8 ± 2.5**	**108.9 ± 2.5**	**

Measured TWI = Metabolic water +Preformed water + water drunk

Drinking behaviour

Average drinking frequency in sheep and goats / 24 h

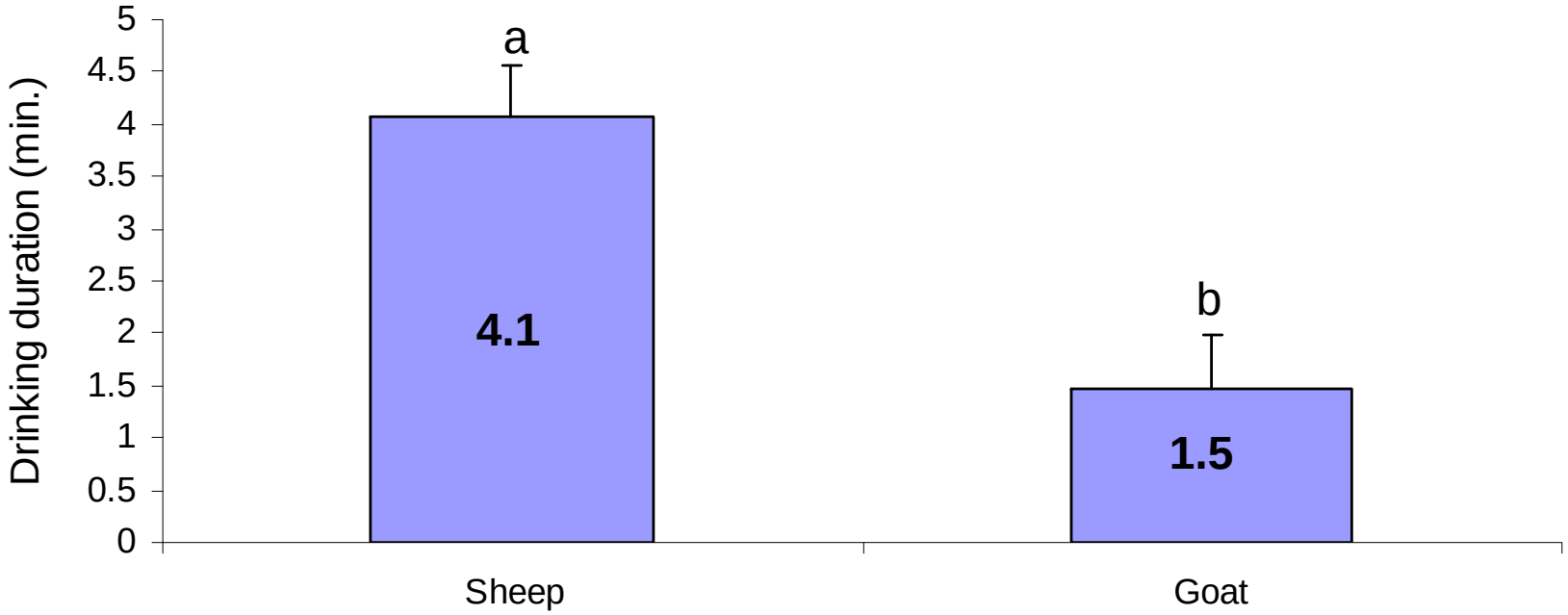


N = 8
(based on 64 video recordings)

N = 8
(based on 53 video recordings)

Drinking behaviour

Average drinking duration in sheep and goats / 24 h



N = 8
(based on 64 video recordings)

N = 8
(based on 53 video recordings)

Conclusions

- Significant species differences between sheep and goats in water intake and drinking behaviour
  → higher water and DM intakes in sheep

- The D_2O method gave very good estimates of actual water intake in sheep and goats

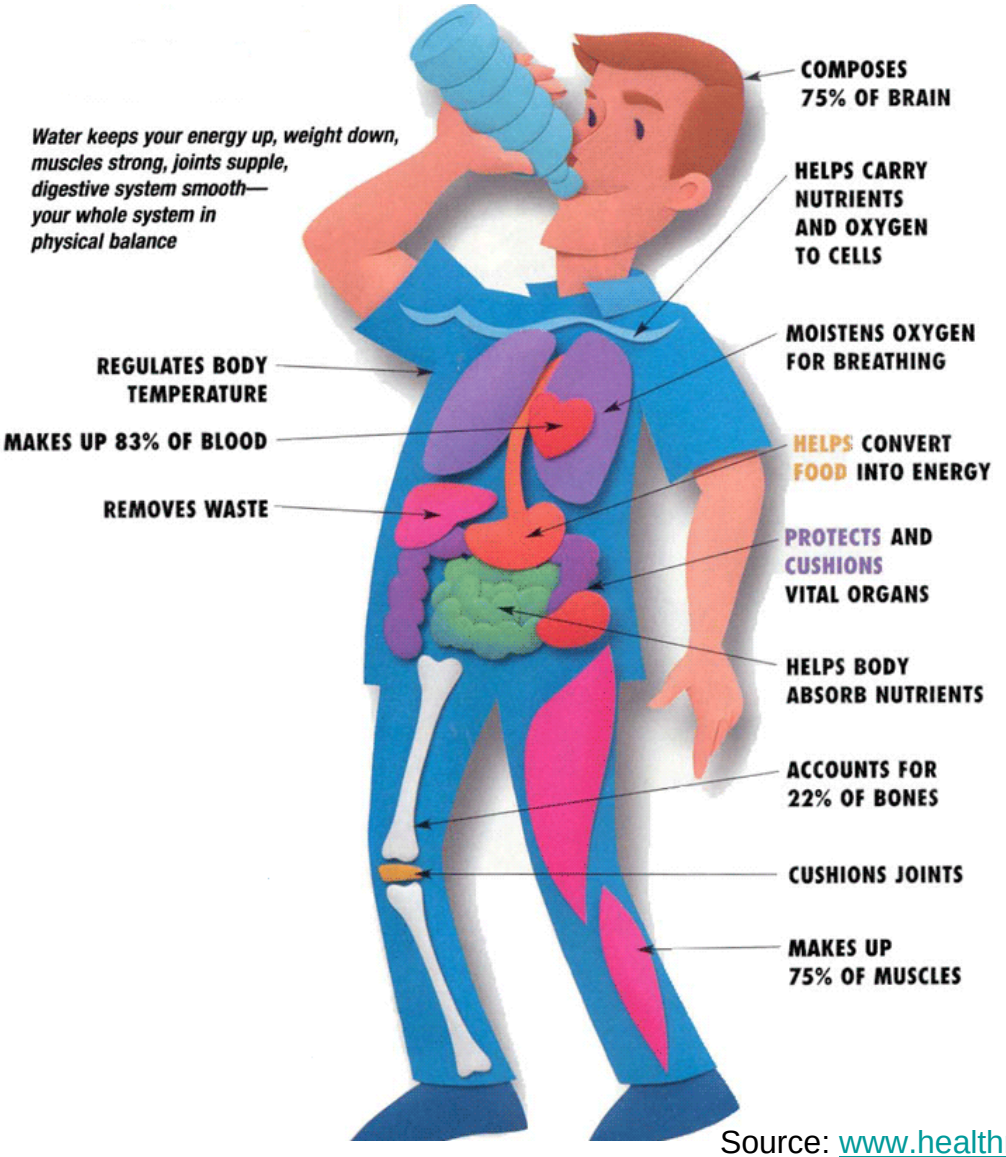
- Lower water intake in Boer goats seems to be an adaptive mechanism to arid climates

General conclusion

- Isotope dilution technique is a suitable method to estimate water consumption in free ranging ruminants, e.g. in Bedouin goats and Awassi sheep production systems, where water availability is a crucial factor influencing the productivity.

Thank you for your attention

Water



Source: www.healthnutrition4u.blogspot.com/

Isotope techniques in animal production

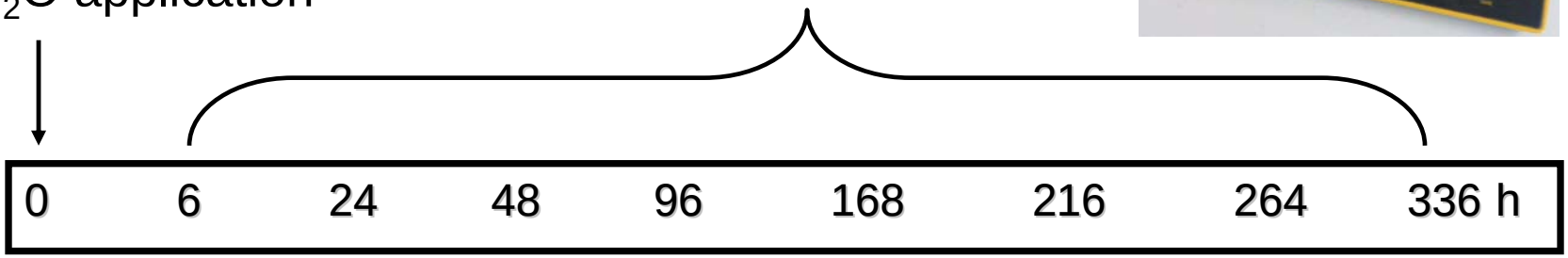
- Substance used to measure TBW, body water turnover, body composition, milk intake and feed intake:
  - sulphonamides
  - urea
  - T1824 (Evans Blue)
  - isotopic water (D_2O, T_2O, $H_2{}^{18}O$)

Source: Holleman et al., 1982

D_2O application

Baseline blood sample
D_2O application

Blood sampling (5 ml)

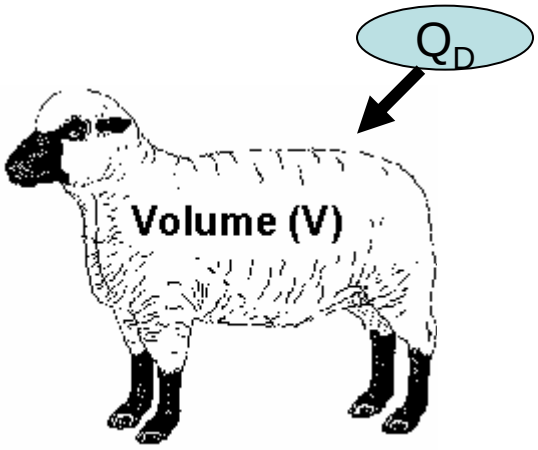


Centrifuged (3500 rpm for 10 min)
Frozen at -20 °C
KOSI- Goettingen*

* KOSI: Competence Center of Stable Isotope-Goettingen University

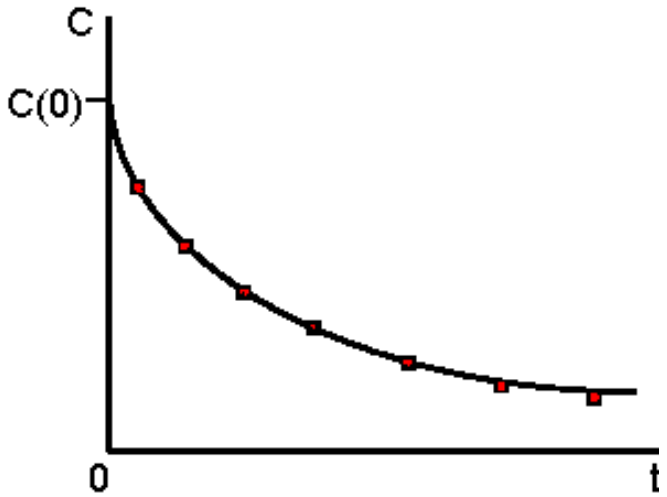
D_2O as a marker

$$C_t = C_0 . e^{-k.t}$$



$$V_{(i)} = \frac{Q_D}{C_{(0)}}$$

Least-squares regression



* C_0 : equilibrium concentration (intercept)
k : fractional water turnover (slope)
t : time elapsed since D_2O injection

* Source: Holleman, 1982

D_2O as a marker

$$TWI = L + G = TBW * k + G$$

Where:

TWI: Total water intake per day

L: Amount of daily water lost

G: Amount of daily water stored

TBW: Total body water pool size

k: Daily water turnover rate

* Source:Oftedal et al., 1983 & Schoeller et al., 1983