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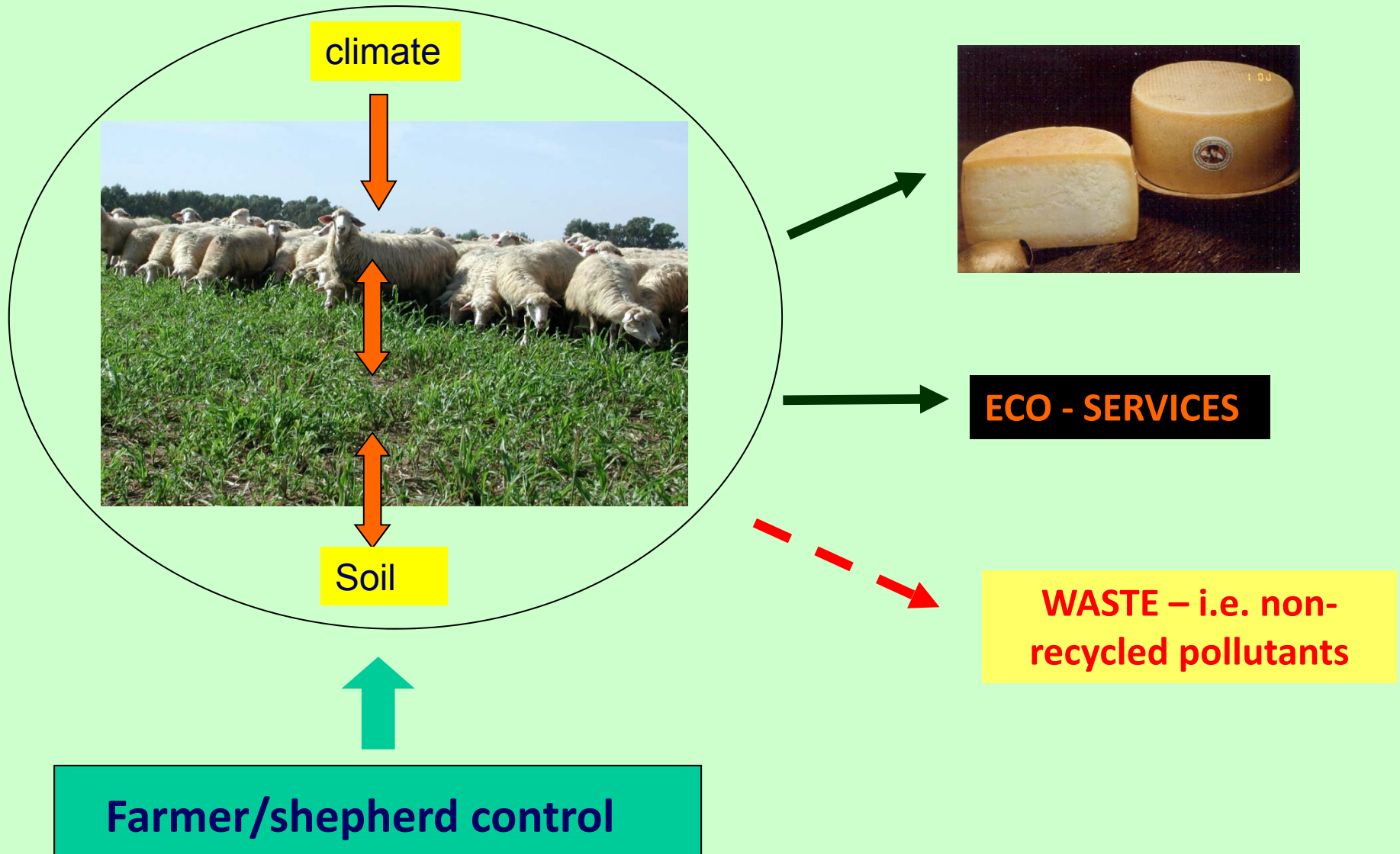


Grazing systems in Mediterranean Europe with focus on dairy sheep and goats: understanding and driving the forage-animal-livestock product continuum

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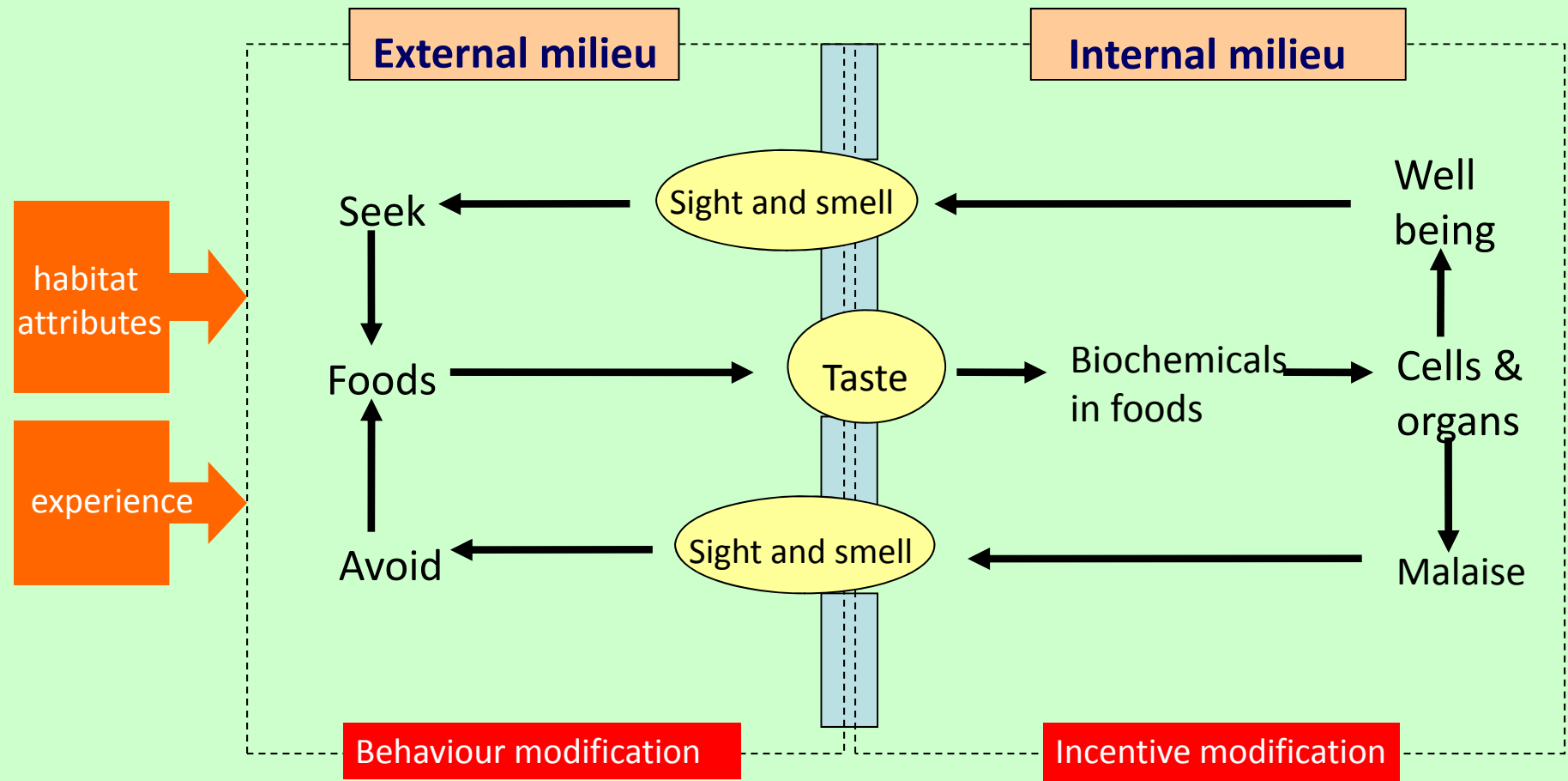
The continuum of Mediterranean grazing systems



Grazing systems' classification in South-EU (after Poux et al., 2009 – modified)

Farming type	Main grazer spp.	Main Product	Regions
Zero grazing or complementary grazing systems	Sheep and goats	Milk (mostly) and meat	e.g. Castile Leon in Spain Widespread in some Mediterranean islands
Sedentary – based on cultivated forages	Sheep and goats	Semi-intensive Milk (SG) (high value milk) and Meat (S)	Southern France, Sardinia on lowlands or arable plateau
Pastoral – cereal-sheep system	Sheep	Milk and meat	Rainfed lowlands and plateau (e.g. Castile La Mancha system)
Sedentary - based on semi-natural grassland, and open woodland	Sheep and sometimes goats and pigs	Meat and secondarily milk (e.g. Spanish merinos)	Steppes and dehesa silvo-pastoral system in Spain and montado in Portugal
Pastoral – based on rangeland, shrubland and forests	Goats and sheep (also cattle and pigs in some systems)	Meat and to a lesser extent milk	Usually mountain areas (LFA)

Foraging model (Provenza and Villalba, 2007, mod.)



Fundamental implications:

1. Herbivores' ability to self-adjust their diets – even to self-medicate
2. Need to offer animals diverse menus to let them express this ability
3. Need to favour animal experience of different foods and habitats

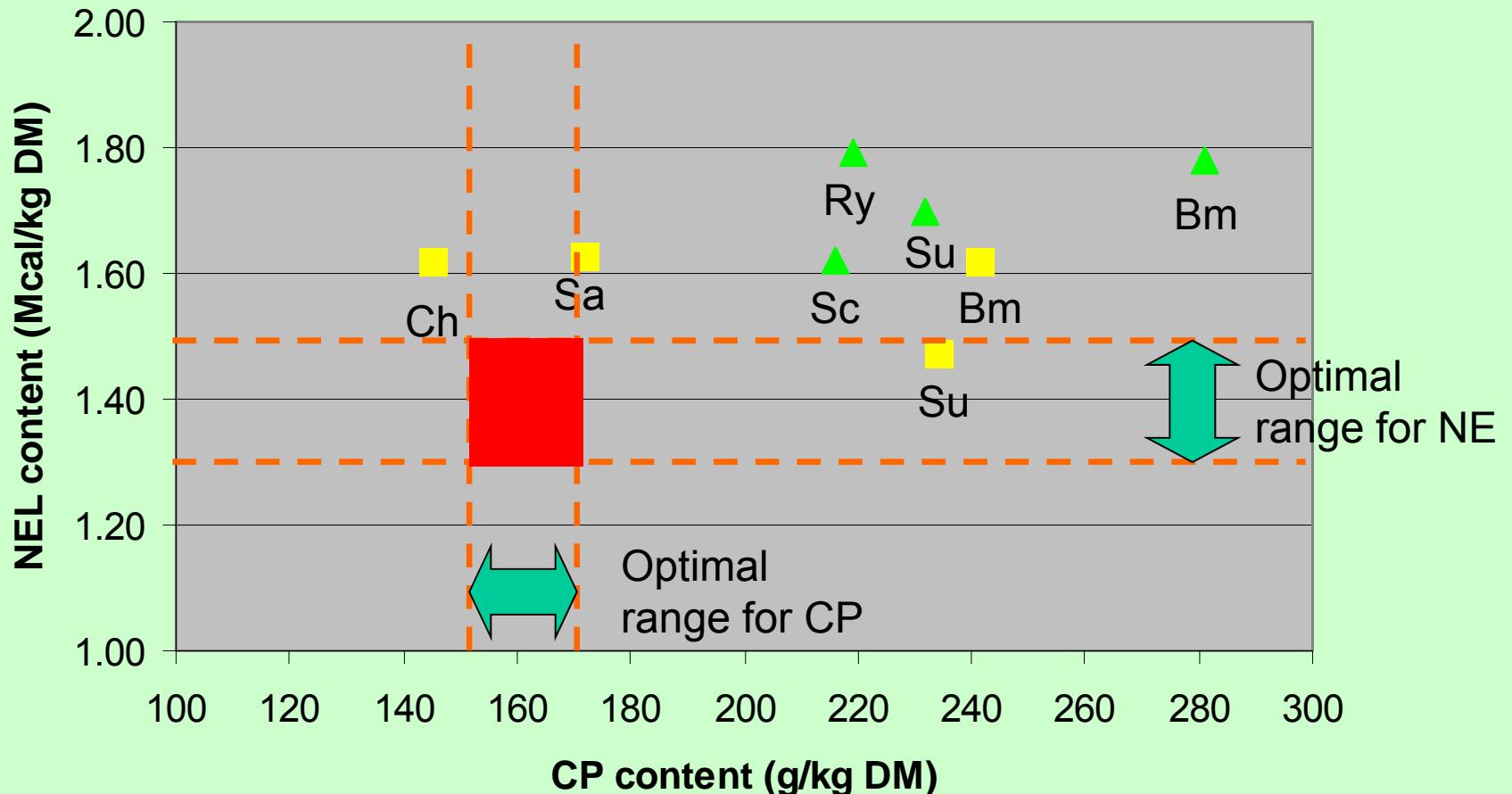
The case of dairy sheep grazing Mediterranean herbaceous pastures



Dairy sheep grazing systems are based on **annual grasses**, often established as **forage crops every autumn**.

To make these systems more sustainable, the **persistence of pastures** should be increased and the **grazing season expanded**. In the meantime nutritional unbalances should be addressed.....

....such as **the excess of CP in spring**, when herbage availability is not a problem



BM=burr medic, Ch=chicory, Ry=annual ryegrass, Sa=safflower, Sc=subclover, Su=sulla.
green symbols: vegetative stage; yellow symbols begin of reproduction stage.
Requirements for 50 kg LW sheep with 1 to 2 kg/d of FPCM (Cannas, 2002).

Solution: complementing grasses with perennial forage legumes containing moderate levels (2-5% DM) of condensed tannins (CT)

These forages can:

- ✓ modulate N degradation in the rumen and hence curb its waste, particularly as urine N;
- ✓ boost animals' appetite and intake;
- ✓ give performance responses (milk) higher than grass monocultures even in mixture (Berry and McNabb, 1999, Rochon et al., 2004)
- ✓ limit parasite burden effect (resistance-resilience);
- ✓ Complement other forages containing different PSMs, counterbalancing their putative toxic effects (self-medication)



Examples of complementary PSMs

PSM1	PSM2	Source
Tannins	Terpenes	Villalba et al., 2004
Tannins	Oxalates	Villalba et al., 2004
Terpenes	Oxalates	Villalba et al., 2004
Tannins	Saponins	Rogosic et al., 2007

Moderately tannic forage legumes

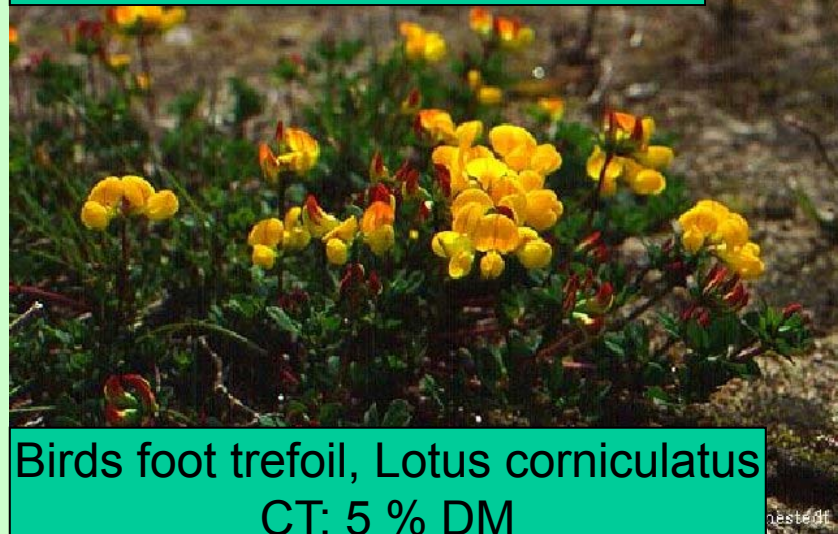


Sainfoin, *Onobrychis viciifolia*
CT: 3 % DM

Leggraze project: Sölter et al., 2006;
Molle et al., 2008; Sulas et al., submitted



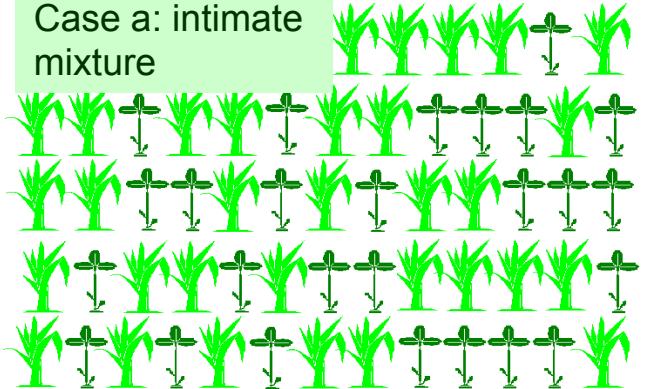
Sulla, *Hedysarum coronarium*
CT: 2-6 % DM



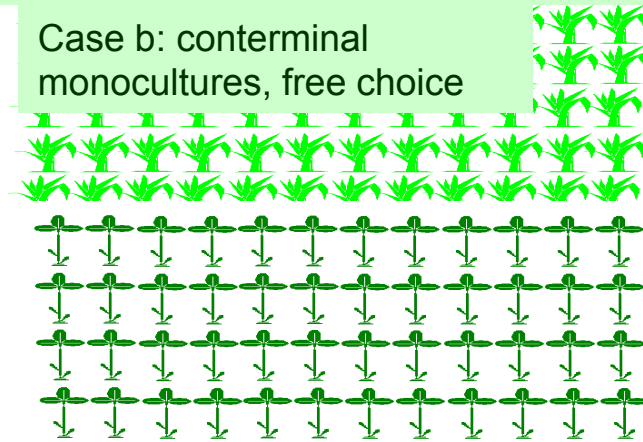
Birds foot trefoil, *Lotus corniculatus*
CT: 5 % DM

Establishing and grazing grass and legume forages: 4 main scenarios

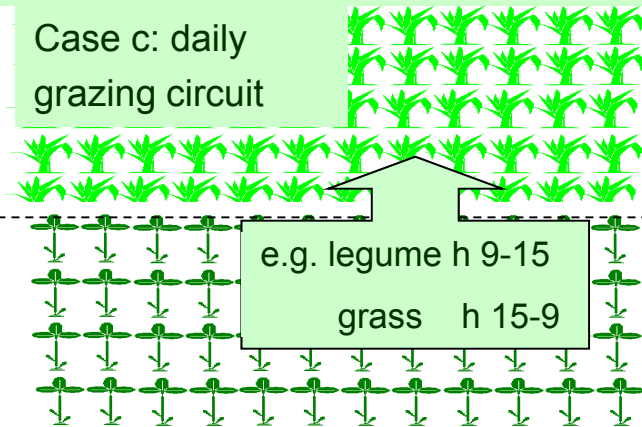
Case a: intimate mixture



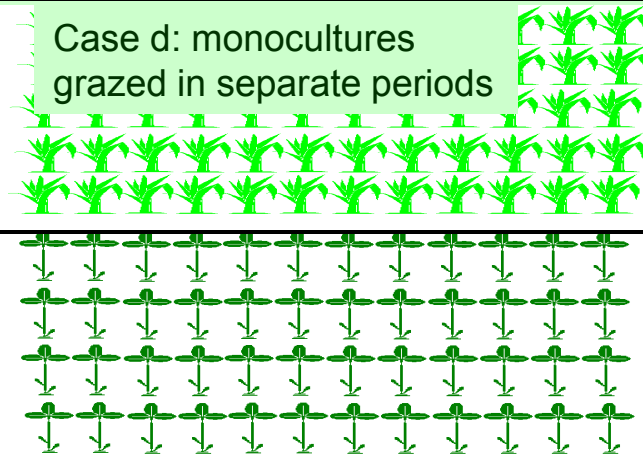
Case b: conterminal monocultures, free choice



Case c: daily grazing circuit

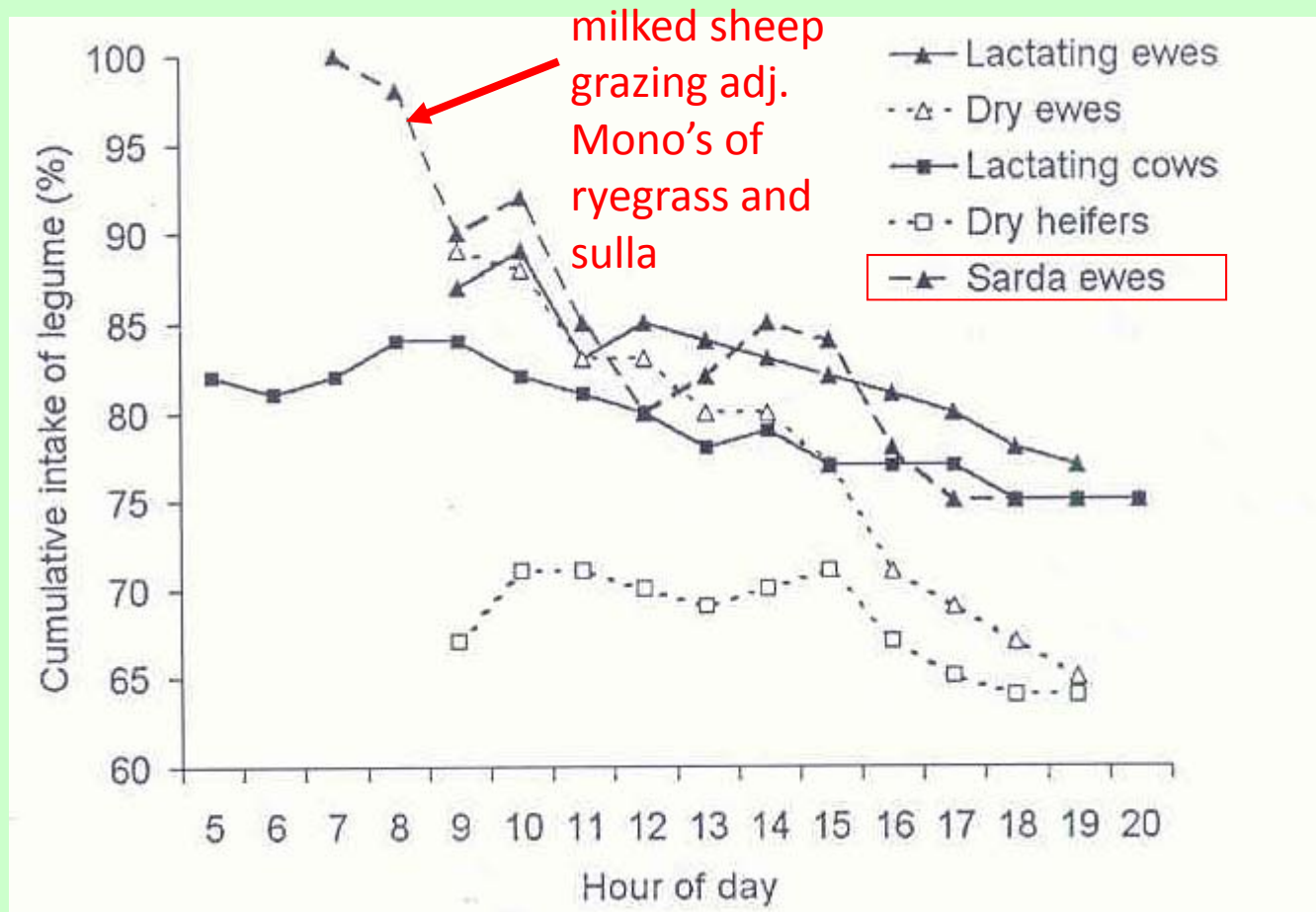


Case d: monocultures grazed in separate periods



Results on sheep and cattle performance suggest better animal response from conterminal monocultures than intimate mixtures (Chapman et al., 2007).

Grazing circuits pre-requisite: evaluation of diurnal pattern of preference: the case of legumes (Rutter, 2006)



Implication: Sequences of eating are important:

1. legumes should be grazed in the morning before grasses (Rutter 2006)
2. forages containing PSMs before forages without PSMs (Papachristou et al., 2007)
3. tannic forages before terpene or alkaloid-rich forages (Moote et al, 2007, Lyman et al., 2008)

Other grass or- grass-legume complements: the chicory



Cichorium intybus L
(short-lived perennial)

- ❑ It is a short-lived daisy containing phenolic compounds (1-3% DM) and sesquiterpene lactones (anti-helmintics, Athanasiadou et al., 2009)
- ❑ It has tap roots which allows for a longer growing and grazing season (vs. annual grass) providing green forage up to late-spring (Landau et al., 2005)
- ❑ High agronomic performance and long-term milk response in dairy sheep as good as sulla monoculture (Sitzia et al., 2006)
- ❑ **Warning: if dominant dietary component flavour can negatively impact cheese sensorial properties (Sitzia et al., 2009)**

The case of goats browsing Mediterranean 'maquis'



Goats, thanks to their anatomic and physiological characteristics, fit better than sheep to grazing systems based on woody species (e.g. Papachristou, 1997)

Native breeds usually have higher intake of bushes than foreign breeds, depending on innate and acquired behaviour (e.g maternal effect on kids behaviour, Glasser et al., 2009)

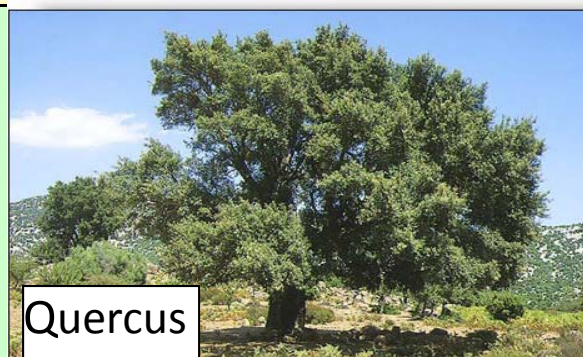
However, even in local breeds, **the foraging of goats** on Mediterranean bushland **is often constrained by the high level of CT in many bushes**, particularly in late-spring-early summer, when most goats are still milked

The effect of CT on the botanical composition of Sardinian goats'diets while browsing a lentisk-based bushland (Decandia et al., 2000)

Species	CSC %	Diet composition (%DM)	
		PEG50	C
Herbaceous species	27.87	34.0 a	47.8 b
<i>Pistacia lentiscus</i> L.	49.07	38.1 a	23.1 b
<i>Rhamnus alaternus</i> L.	<0.10	2.4	3.3
<i>Rubus ulmifolius</i> Schott.	0.27	3.8	2.8
<i>Smilax aspera</i> L.	0.70	4.9	4.1
<i>Quercus</i> spp..	4.13	4.5	4.6
Others species	11.56	12.3	14.3

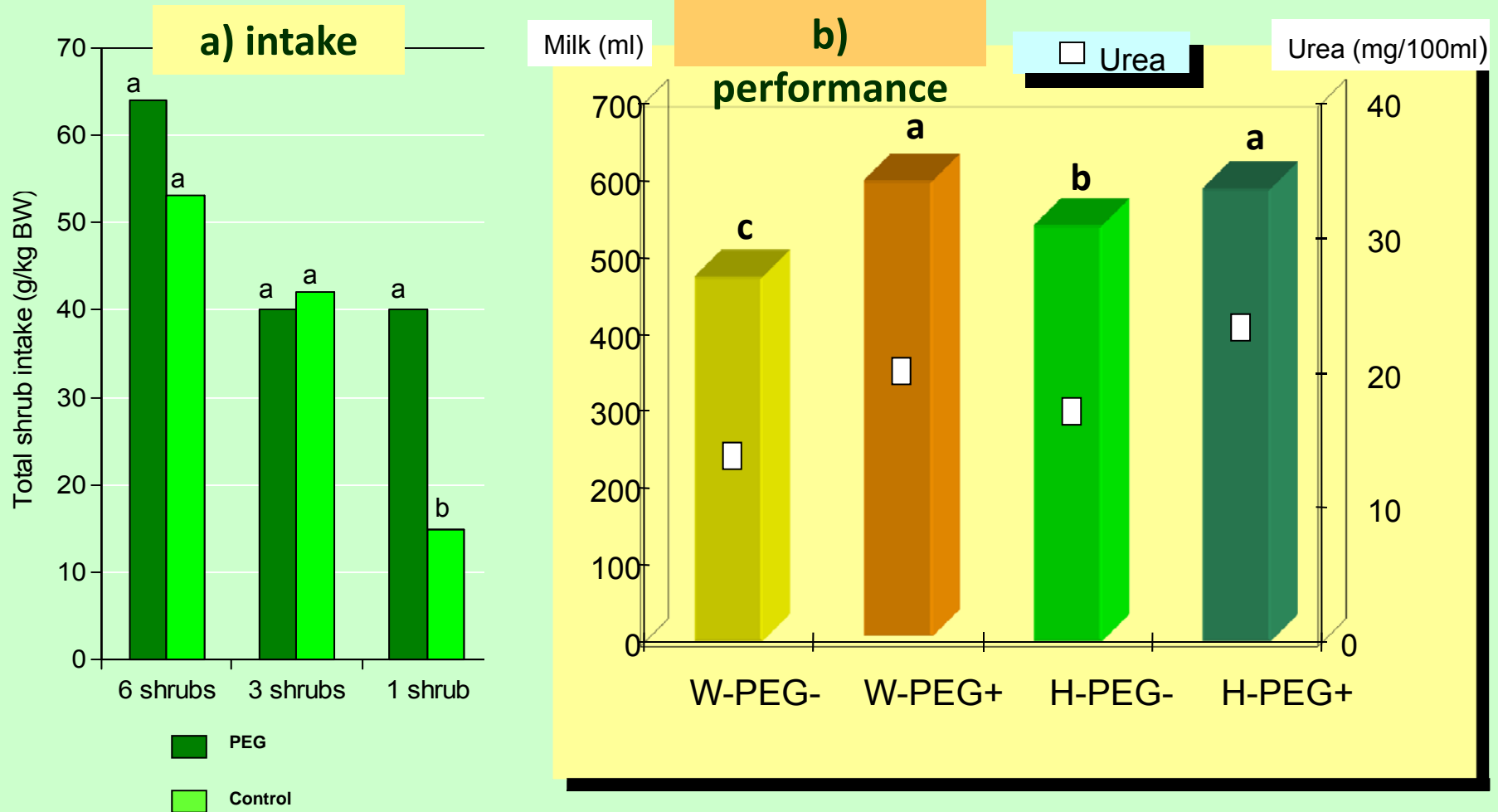


Pistacia
lentiscus



Quercus
ilex

The effects of CT at different levels of dietary diversity

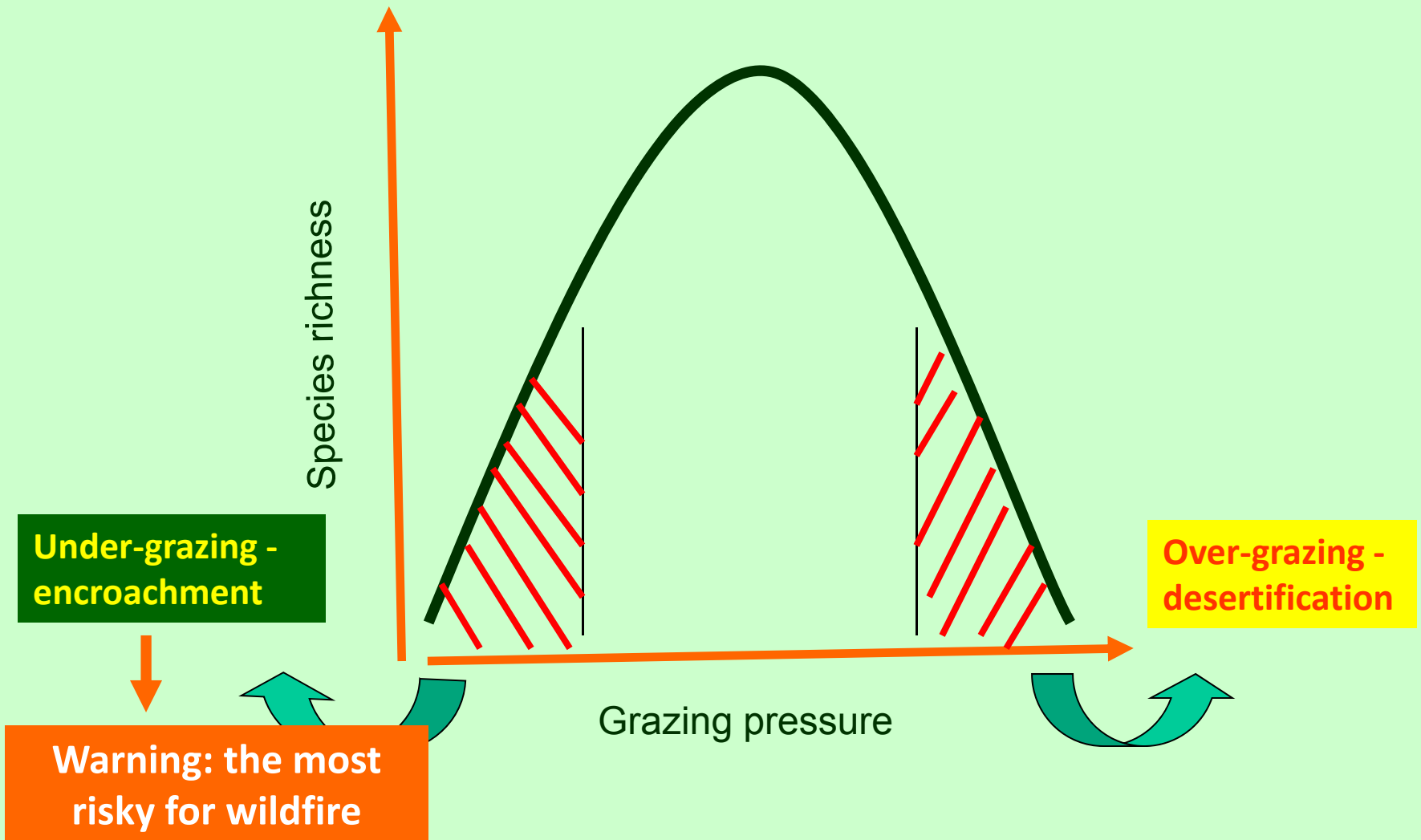


6 shrubs: *Quercus ilex*, *Erica multiflora*, *Arbutus unedo*, *Juniperus phoenicea*, *Viburnum tinus*, *Pistacia lentiscus*; 3: *Juniperus phoenicea*, *Helichrysum italicum*, *Juniperus oxycedrus*, and 1: *Juniperus phoenicea*. Adapted from Rogosic et al. (2008).

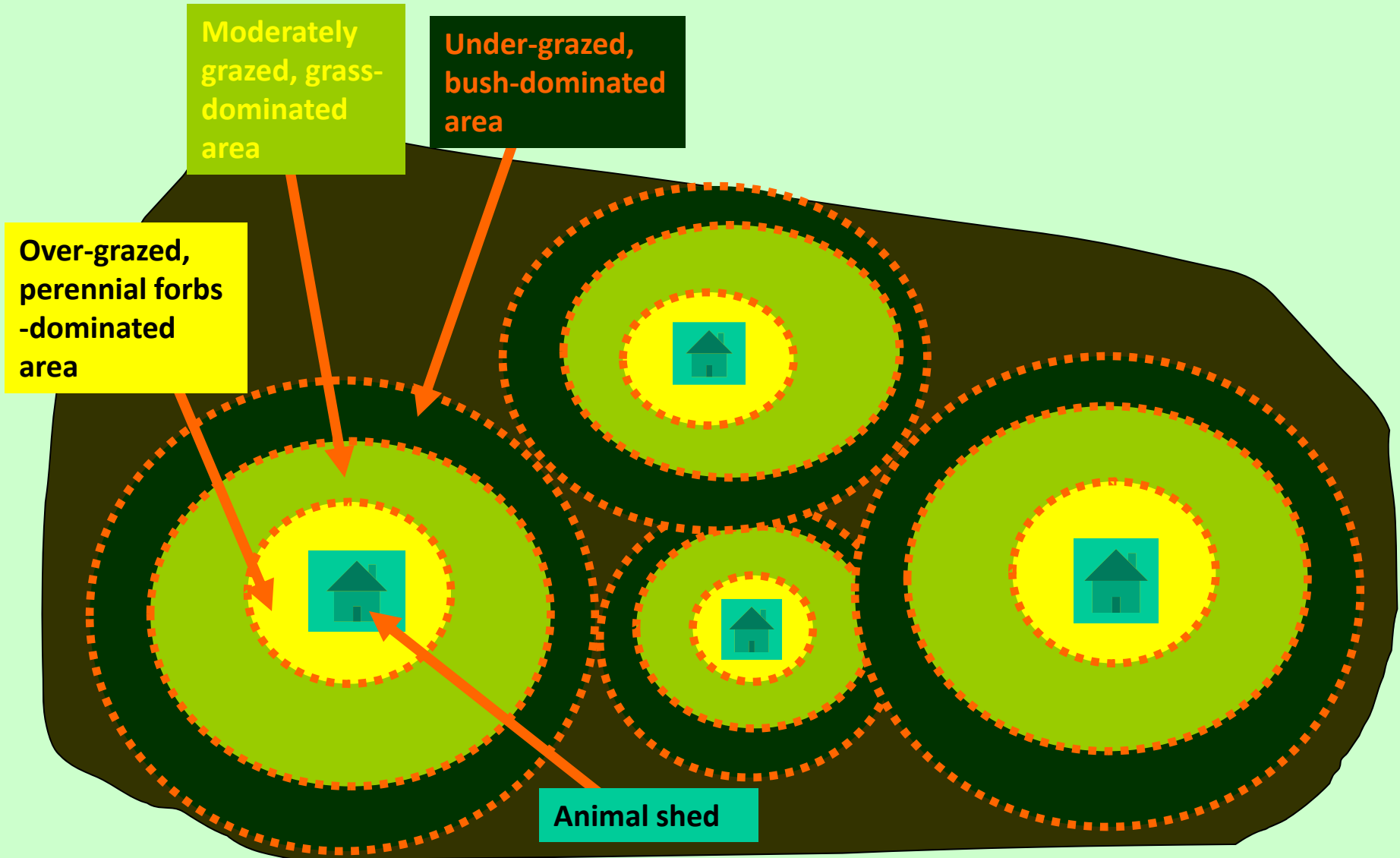
W, 10% herbaceous and 90% ligneous spp. cover; H, 30% herbaceous and 70 % ligneous spp. Cover
PEG +, supplemented with 50 g/d of PEG 4000;
PEG -, no PEG supplementation, Decandia et al., 2008

Main implication: the lower is the diet diversity (1 bush, close maquis (W)) the more constraining are CT on intake and performance

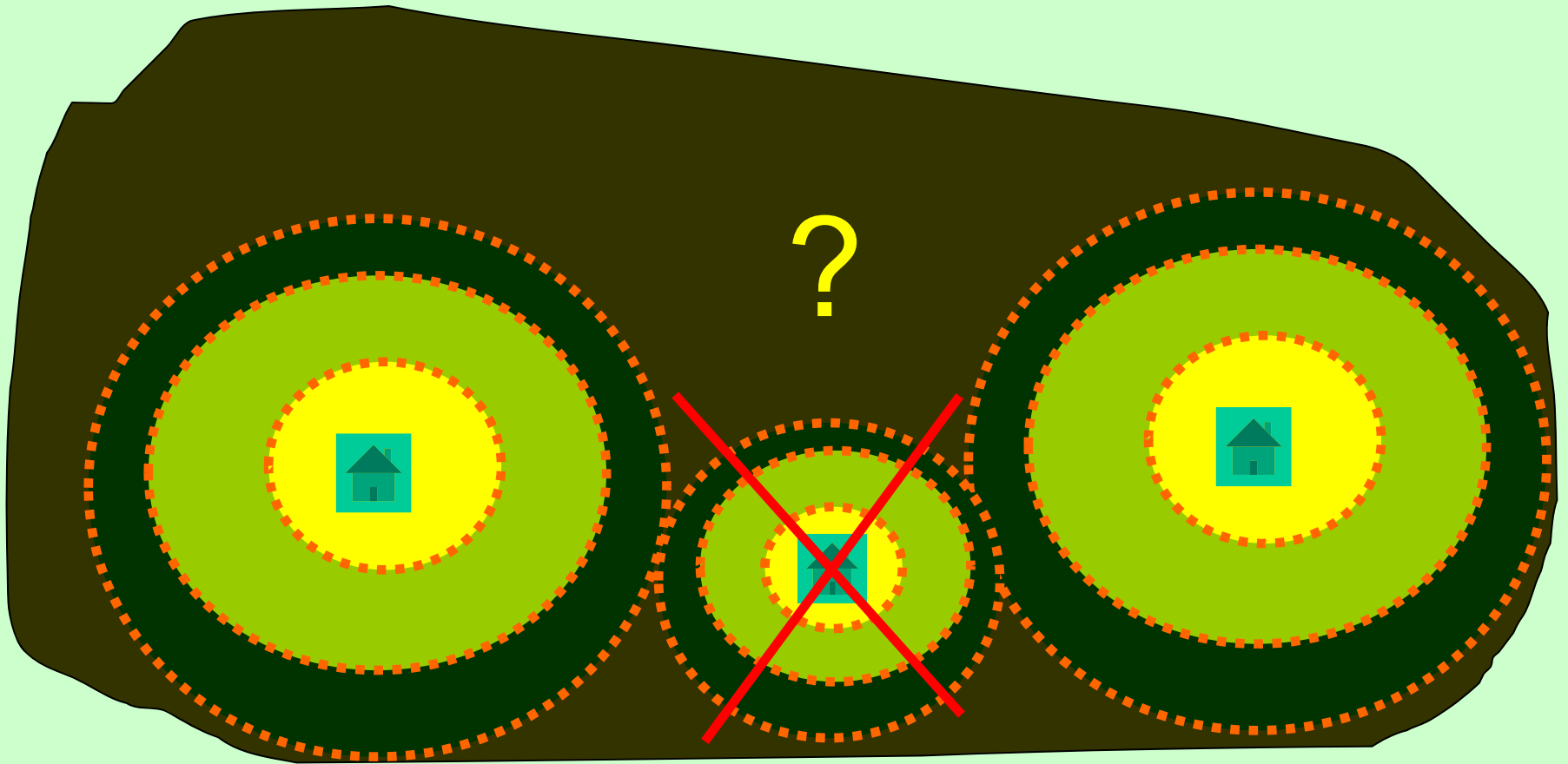
The role of grazing systems for eco-services purposes: grazing pressure – biodiversity interplay : a tentative generalization



The oikos-sphere effect of grazing/browsing heterogeneous Mediterranean pastures (Papanastasis et al., 2009)



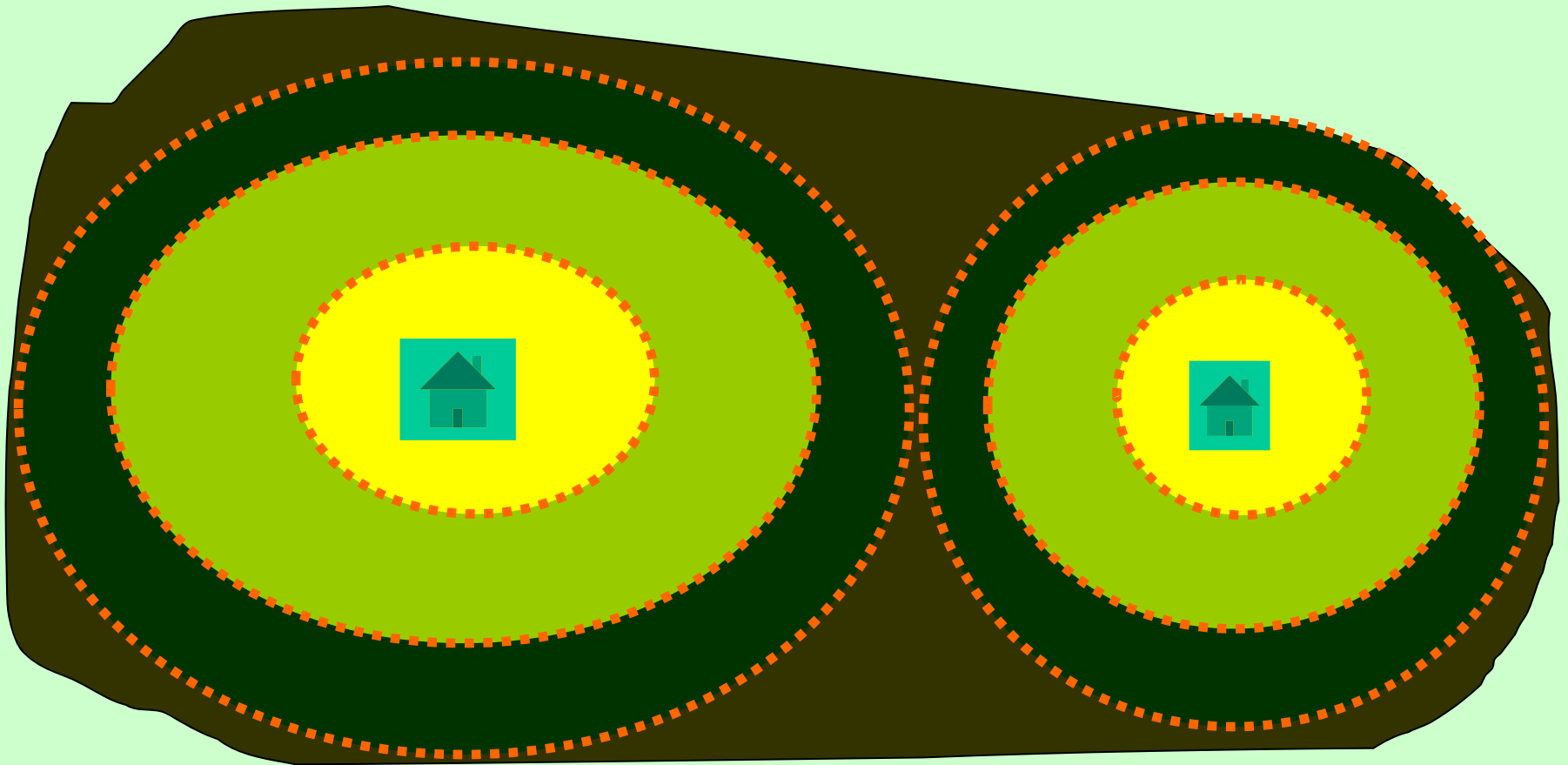
Small flocks/herds disappearance: where are we going to?



Probably to...**encroachment with increase of wildfires risks**

Possible solutions to encroachment problems:

Increasing the stock in the remaining flocks/herds: not applicable to many areas and probably effective only to a minor extent if not complemented by other management tools (strategies and tactics)



Strategies for a sustainable encroachment control

1.- A pre-requisite- Re-evaluating shepherds' role as:

- animals' primary teachers, they favour the 'learning by consequence' of flocks/herds
- fine-tuners of grazing pressure and, if *good shepherds*, promoters of long-term sustainability of the systems (Meuret, 2006, Rochon and Goby, 2009)

2. Co-grazing of goats with big herbivores (cattle, equids) of adapted breeds

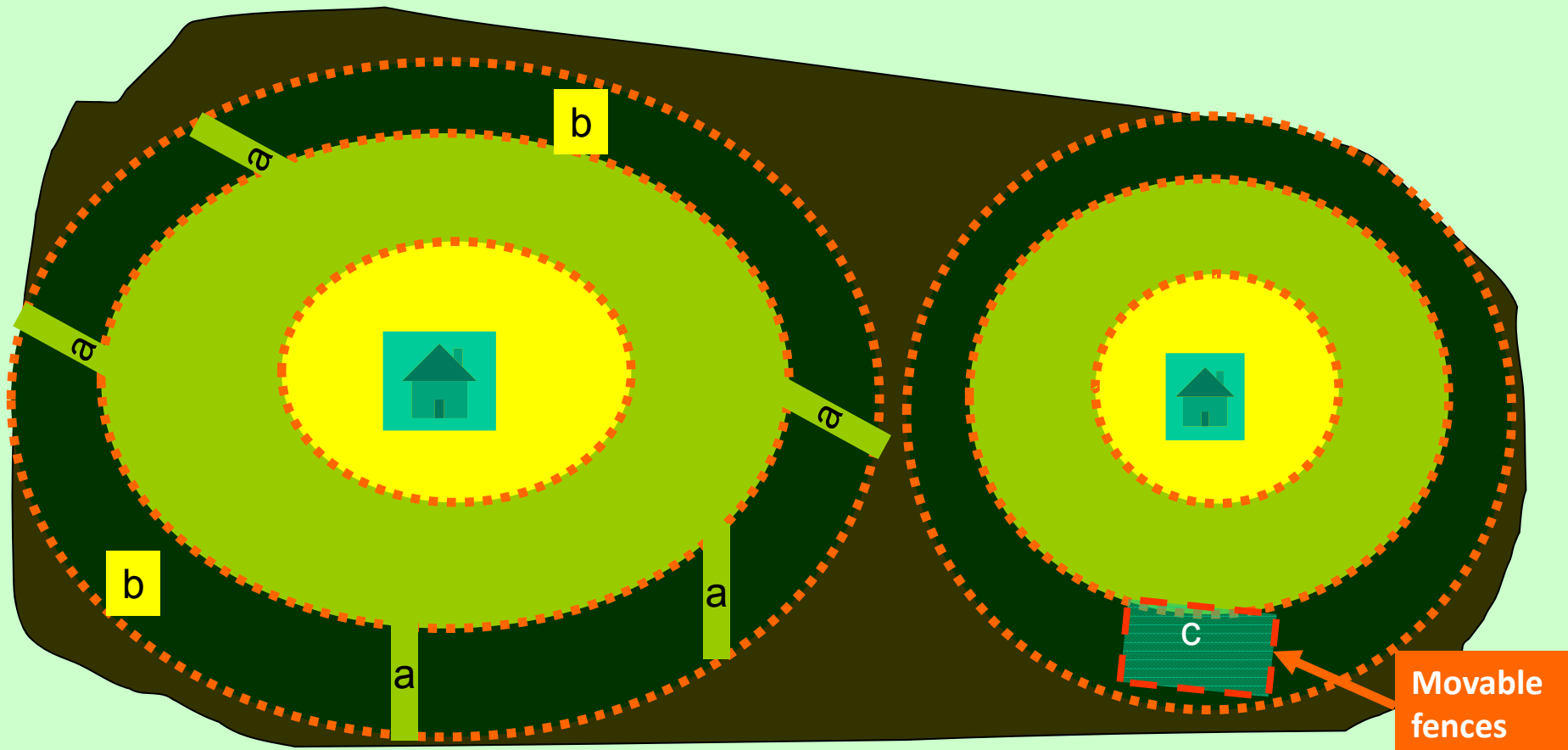
- effect of trampling and path opening by cattle in tall bushland (e.g. Mandaluniz et al., 2009)
- low dietary overlapping between goats and cattle (Nolan and Nastis, 1997)
- decrease of parasite burden in the small ruminant sp. (Hoste et al., 2003)
- added income, depending on breed, market conditions etc. (Nolan and Connolly, 1989)

3. Co-grazing or sequential grazing of goats with sheep (local or adapted breeds)

- useful with moderate to high bush cover 1-2 m tall (Animut and Goetsch, 2008)
- it could favour encroachment control at early successional stage after a fire or mechanical clearing (e.g. Papachristou, 1997, Jauregui et al., 2009)
- **warning: dietary overlapping.** But if it is lower than 50 % a sensible increase of stocking rate is possible (Animut and Goetsch, 2008).

Other strategies and tactics to mitigate encroachment:

- a. Mechanical clearings (+ seeding).** Opening the bushland is essential to increase the intake of bushes at the edges between grass and bush patches (e.g. Dumont et al., 2002)
- b. Point attractants** to be rotated in space and time (water points, salt, antitannic and nutrient blocks, (e.g. Ben Salem et al., 2006; Laca, 2009)
- c. Others.** E.g. rotational high-stocking short-duration method (need fences or strict shepherding). **Controlled burning, difficult and risky in common lands and small farms.**



Hints on the impact of Mediterranean grazing systems on the quality of sheep and goats dairy products

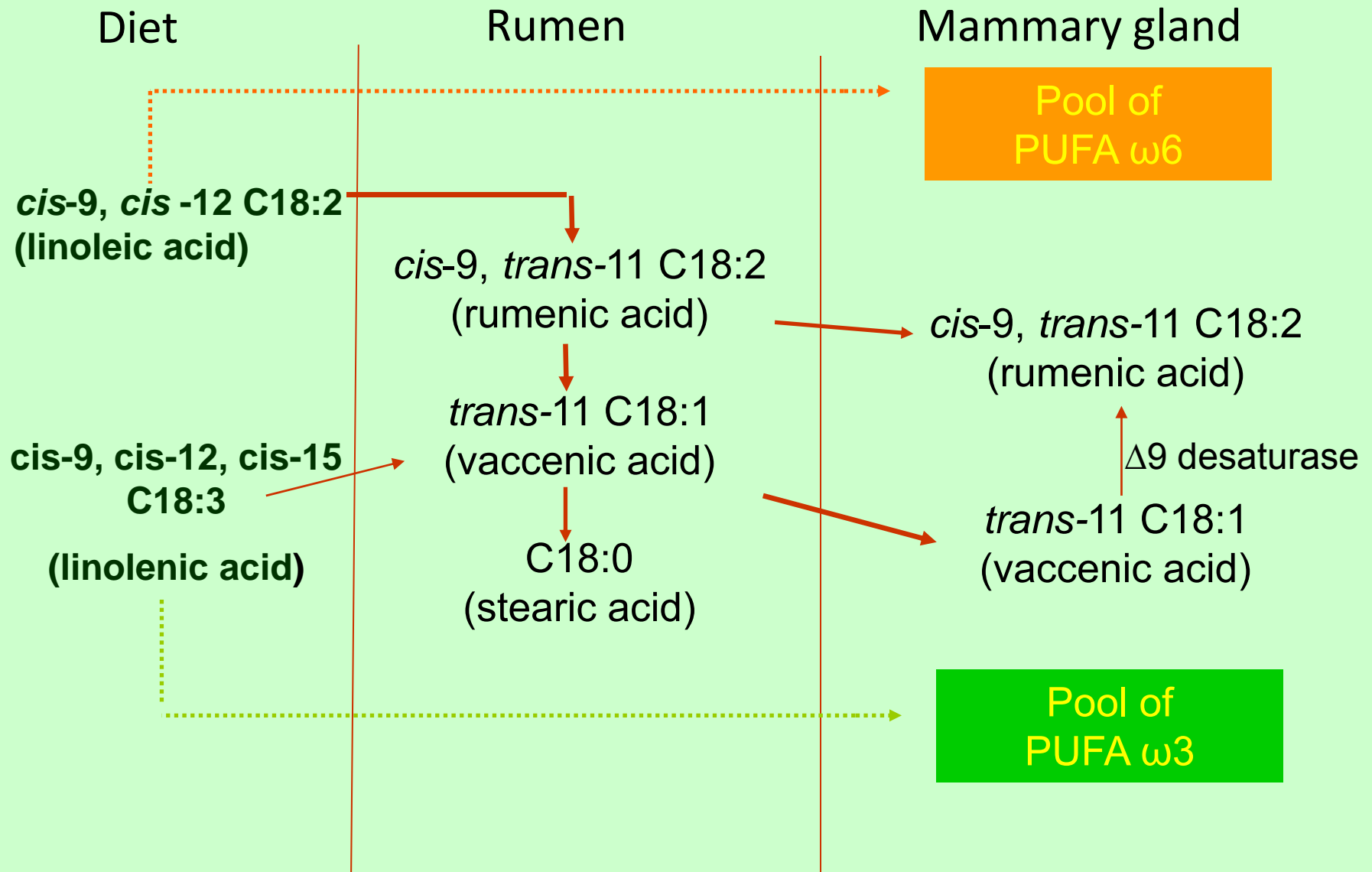
- Macro composition (DM, fat, protein, lactose, SCC (milk))
- N fractions
- Lipid fractions
- Vitamins
- Cheese yield at 24 h and recovery coefficients (only cheese)
- Microbial composition (hygienic quality)
- Sensorial analysis



Nutraceutical components

- CLA (rumenic acid);
- Omega 3 (n-3) PUFA:
Linolenic a.(C18:3);
Eicosapentaenoic a. (EPA, C20:5);
Docosohexaenoic a. (DHA, C22:6)

Pathways of CLA production in ruminants



Lolium rigidum
Gaudin, annual
ryegrass



Medicago
polimorpha,
burr medic



Hedysarum
coronarium, sulla

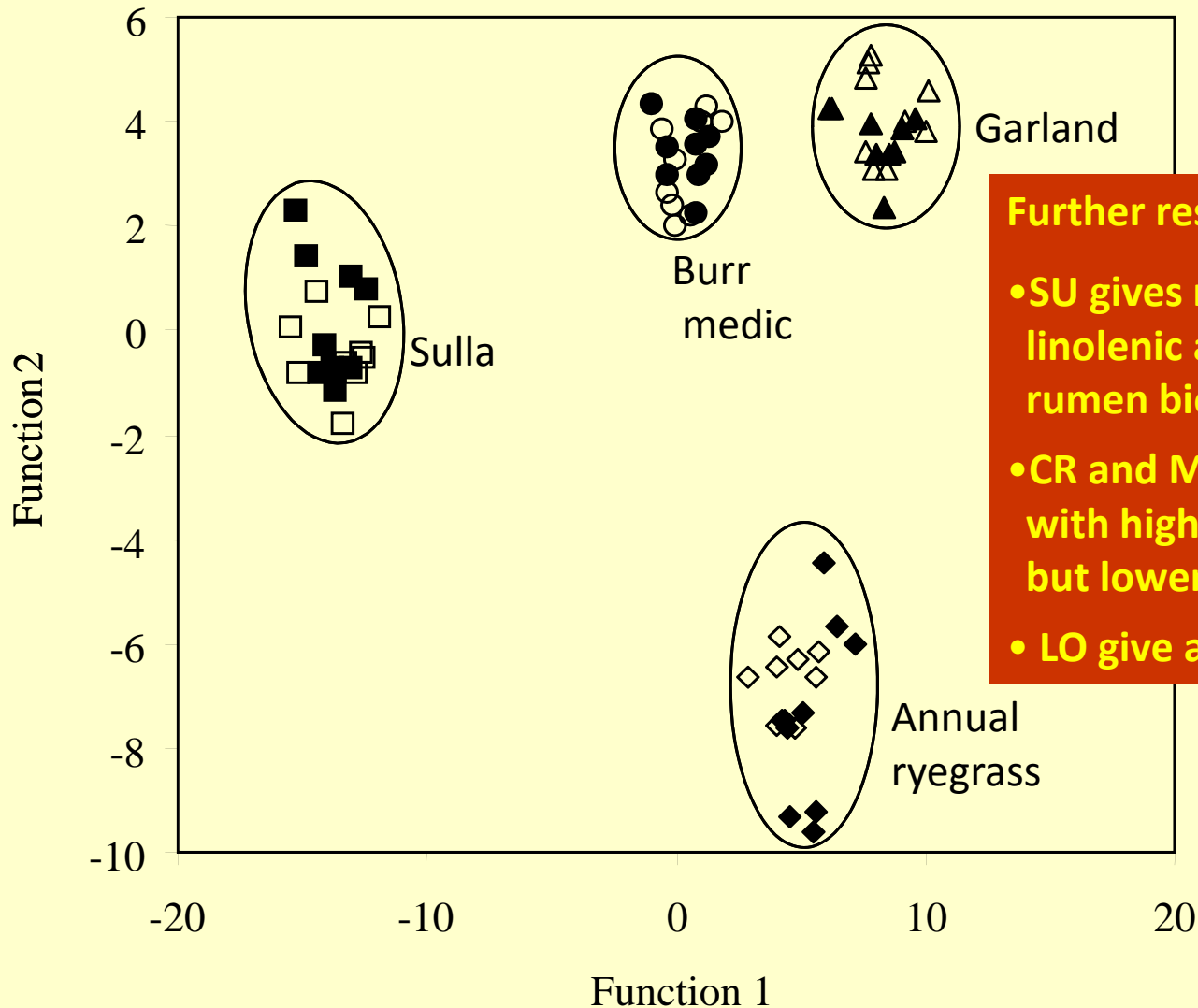


Chrysanthemum
coronarium,
garland



Effect of some Mediterranean forages on
dairy sheep products'quality

Discriminant canonical functions based on milk and cheese FA profiles in sheep fed different fresh forages at vegetative (filled symbols) or early reproductive (empty symbols) stages (Addis et al., 2005).

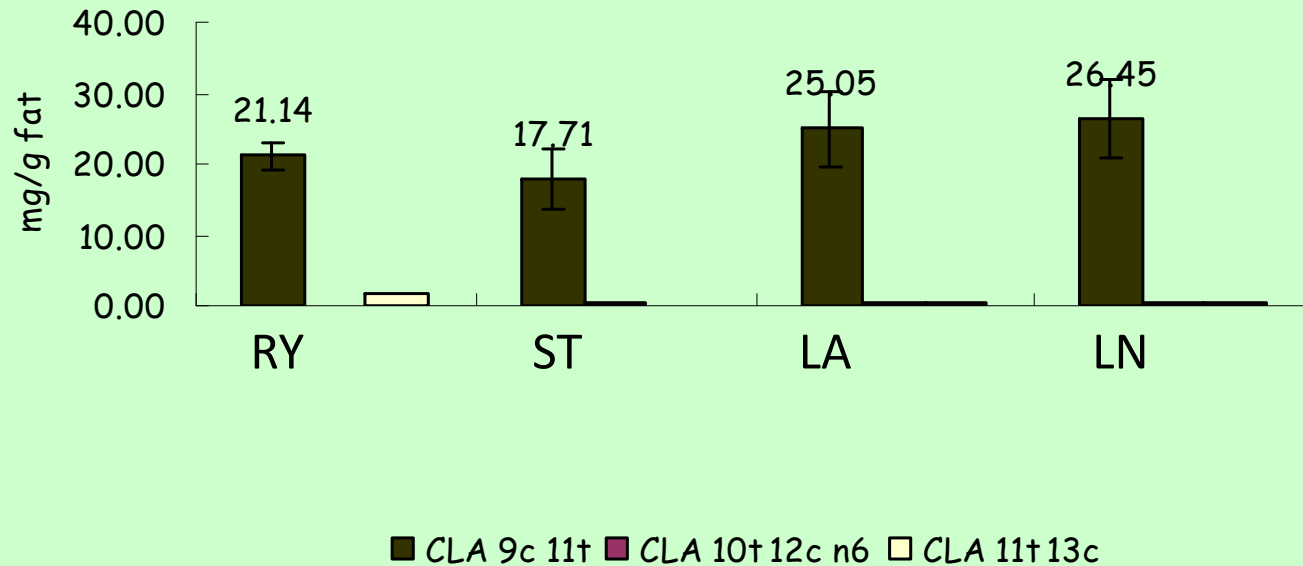


Further results:

- SU gives milk with high content in linolenic acid due to CT inhibition of rumen biohydrogenation;
- CR and ME source milk and cheese with high CLA and PUFA contents but lower in linolenic acid
- LO give an intermediate FA profile

Can fat-enriched supplements replace grazed herbage?

RY, 24 h/d pasture (Italian ryegrass), ST, 3 h/d pasture + 900 g/d standard concentrate; LA, 3h/d pasture + 900g/d linoleic-enriched concentrate; LN, 3h/d pasture + 900 g/d of linolenic-enriched concentrate



Warning: very high level of C 18:1 t 10 in LA milk: milk fat depression



Further warning: cost of feeding c.a. 60% higher in supplemented groups

Milk fat	%
RY	5.98
ST	5.47
LA	4.98
LN	5.46

Effect of diet on dairy products' quality in browsing goats

S stall fed hay of ryegrass and lucerne (1.2 kg/head/d) and concentrate (0.6 kg/head/d)

H 24 h per day on a open bushlands (70% “ligneous” and 30% herbaceous spp. + 0.3 kg/head/d of concentrate)

W 24 h per day on a close bushland (90% ligneous and 10% herbaceous spp. + 0.3 kg/head/d of concentrate)



Group S



Group H



Group W

Cheese FA composition at 60 days of ripening

FA (mg/g fat)	Treatments		
	S	H	W
Butiryc acid (C4)	23.9 b	27.7 a	27.2 a
Vaccenic acid (C18:1 11t)	7.9 b	12.9 a	14.5 a
Linoleic acid (C18:2 9c, 12c)	21.0 b	25.4 a	26.7 a
Linolenic acid (C18:3 9c, 12c, 15c)	5.4 b	12.3 a	12.1 a
CLA (C18:2 9c, 11t)	4.8 b	5.3 a	5.4 a
PUFA	40.0 b	54.6 a	55.4 a
n3	8.6 b	17.2 a	16.9 a
n6	23.8 b	28.4 a	29.7 a

Addis et al., 2008

Vitamin content in goat cheese at 60 d of ripening

mg/ 100 g fat	S	H	W
Vitamine A	0.66 c	0.86 b	1.01 a
Vitamine E	0.65 b	3.74 a	3.76 a
Colesterol	390 a	320 b	304 b

Cabiddu et al., 2007



Group S



Group H



Group W

HINTS on the environmental impact of Med grazing systems

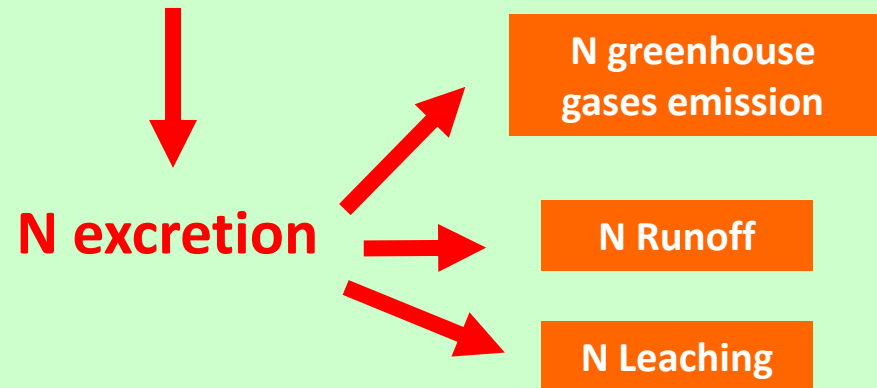


Classical plus

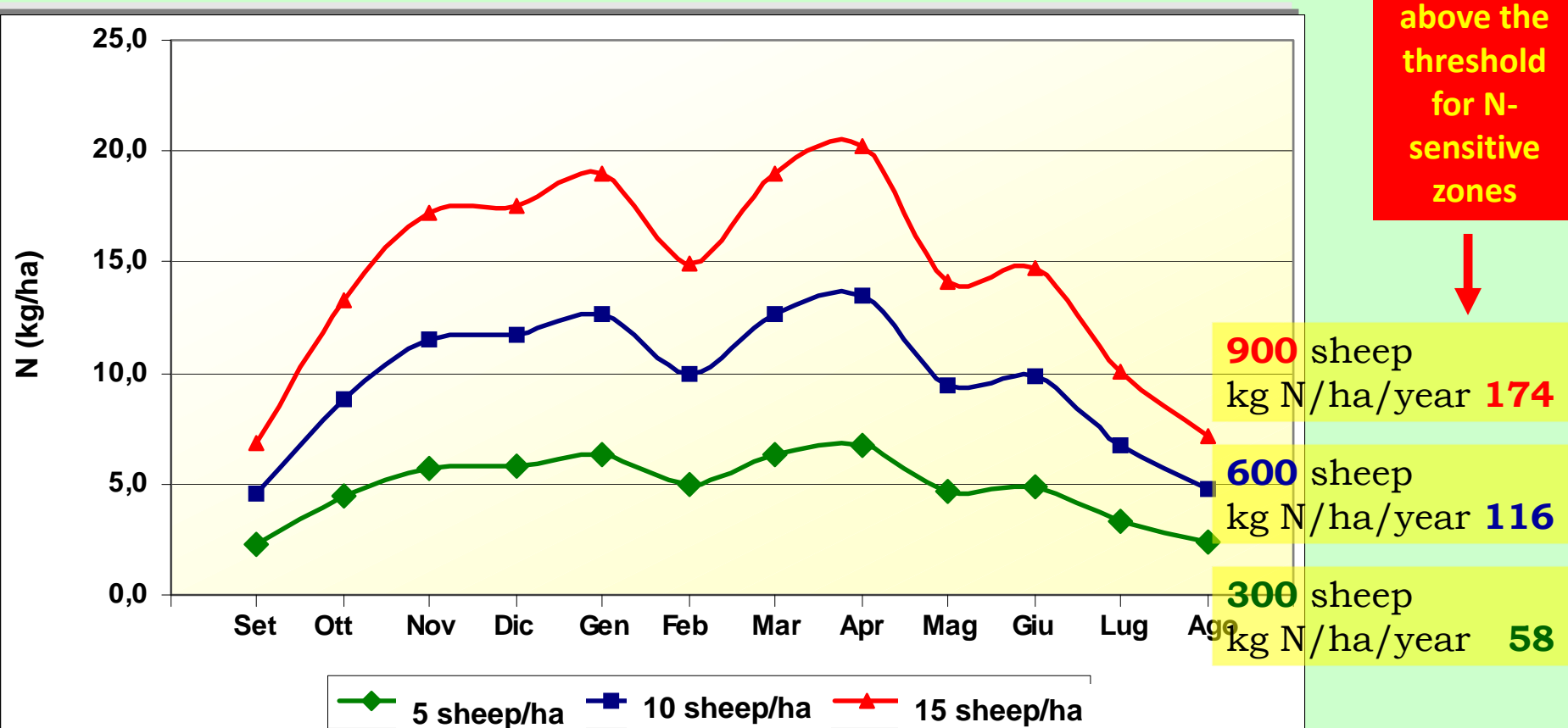
- Water resource saving
- Wildfire control
- Carbon sequestration (\pm)

Classical minus

- CH₄ production
- soil erosion (over-grazing)
- Nutrient excretion



'Ovisoft' model simulation of total N excretion in sheep flocks featured by different flock sizes and stocking rates (Rassu et al., 2009)



Review on farm-gate N balance (kg N/ha year) in different farm types in Italy (Porqueddu, 2008)

Input/Output	Dairy cows (Padana lowland) ¹ (n = 66)	Dairy cows (Tuscany) ² (n = 10)	Pastoral-cereal-sheep farms (n = 20) ³	Agro-pastoral sheep farms (n = 39) ⁴
Fertilizers	120	47	54	19
Off-farm hay + concentrates	303	31	11	15
N fixed	11	28	16	16
Total N Input	434	106	81	50
Total N Output	126	16	14	12
Surplus	308	90	68	38
Output/input (%)	29	15	17	24

¹ Grignani 1996, ² Argenti et al., 1996, ³ Caredda et al., 1997; Porqueddu et al., Leggraze survey, unpublished

Conclusions

- Grazing systems (GS) in Southern Europe can play **two important roles**: production of **food of distinctive quality** and **eco-services**.
 - To get these results, **farm management should be aimed at increasing forage self-sufficiency, pasture persistence and extended grazing season**.
 - **Feeding should be based on diverse diets, possibly offered as 'patches' of herbaceous forages/ligneous plants, complementary for nutrients and PSMs**.
 - Small ruminants fed living plant tissues rich in nutraceuticals invariably pass them or their metabolites to their products. **Dairy products in particular are top-ranking for FA composition and vitamins. Concentrates can replace grazed forages but have some counter-effects. Traceability of these GS is a must and urge research and technology development**.
 - **Grazing systems** featured by a high proportion of feed self-sufficiency are **environmental friendly** for many facets but this benefit should be adequately monitored and possibly valued.
 - **Further research is warranted to properly drive Med grazing systems with particular reference to specific eco-service targets**.

Many thanks for the kind attention with a ?

IS THERE A FUTURE FOR GRAZING SYSTEMS (AND US) WITHOUT SHEPHERDS ??

