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How mixing bioactive legumes with grass impacts animal productivity?

Vincent Niderkorn

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How mixing bioactive legumes with grass impacts animal productivity ?



INRA, UMR1213 Herbivores



V. NIDERKORN
(Thesis G. COPANI)



PITN-GA-2011-289377, 'LegumePlus' Project

NIAB event, 21 October 2015



Benefits of legumes

Agronomy

Fix atmospheric N



- High N content
- Sustainable protein source

Environment



Chemical fertilizers

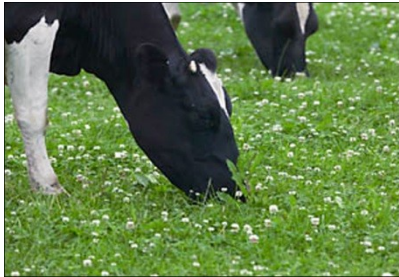
Farm

N self-sufficiency



Utilization of fodder legumes

Grazing



Conservation

Hay preparation



Leaves losses

Silage



Leaves losses

Animal nutrition

Unbalanced N & Energy

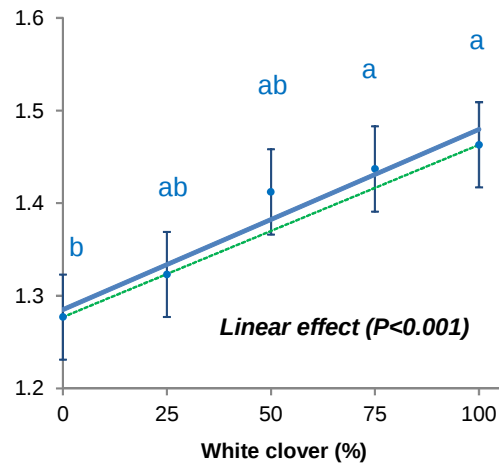


Grass – legume mixtures

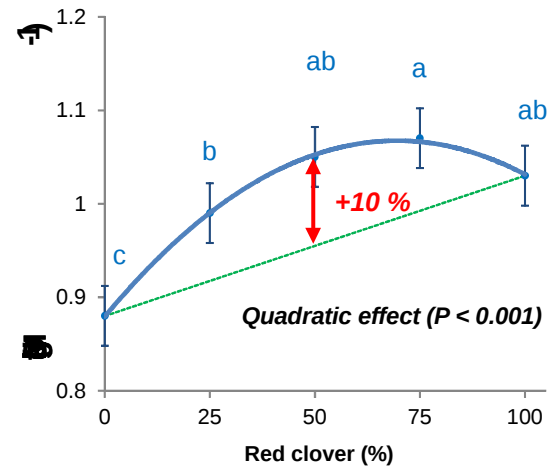
Benefits of grass-legume mixtures for animal

Daily intake of the digestible fraction (indicator of performances)

Ryegrass / white clover (fresh)

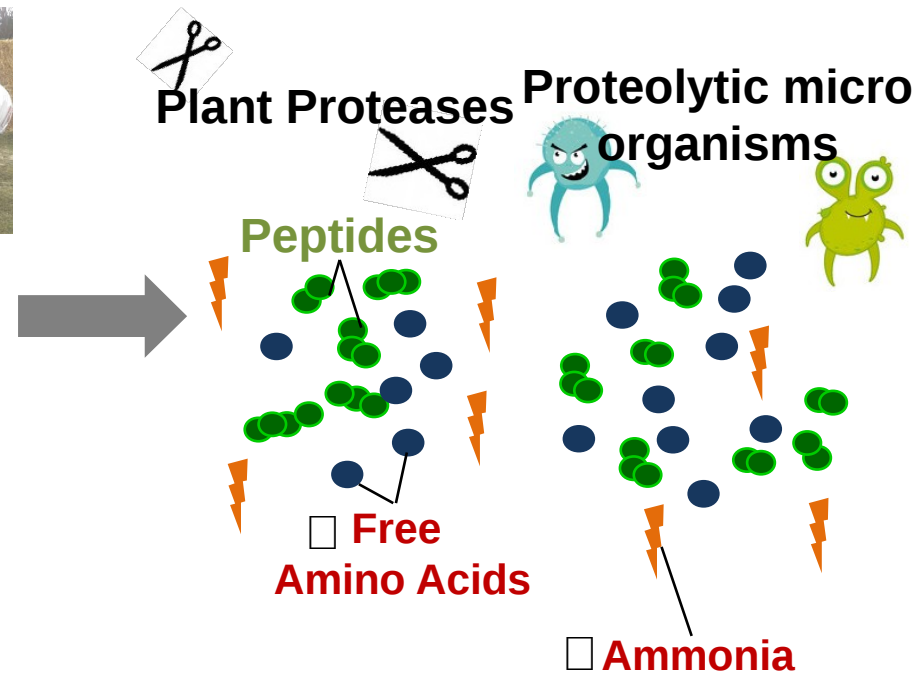
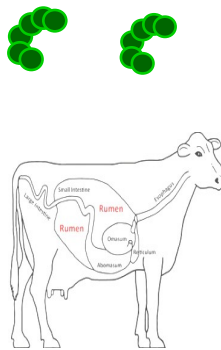
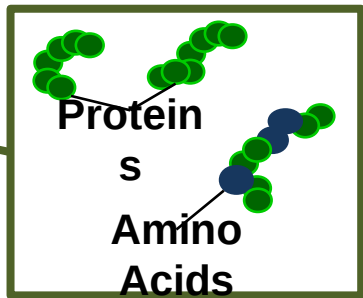
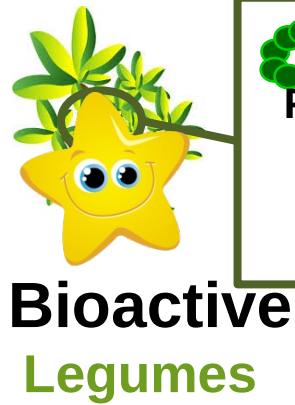


Cocksfoot / red clover (silage)



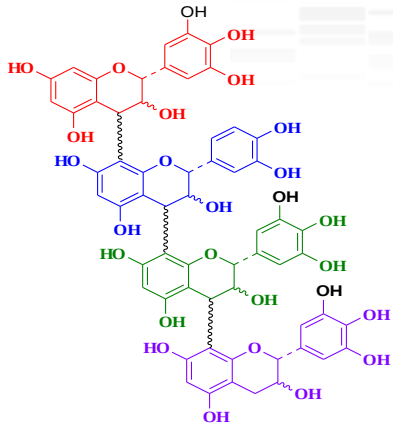
Niderkorn et al., 2014

Protein degradation during fermentation in silage and rumen



- Condensed tannins
- Polyphenol oxydase

Condensed tannins (CT)



CT-Protein complex



**Active in the silo
and the rumen**

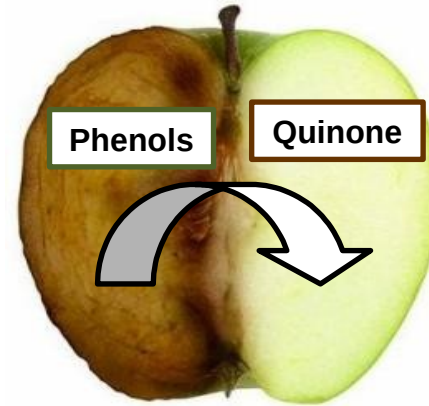
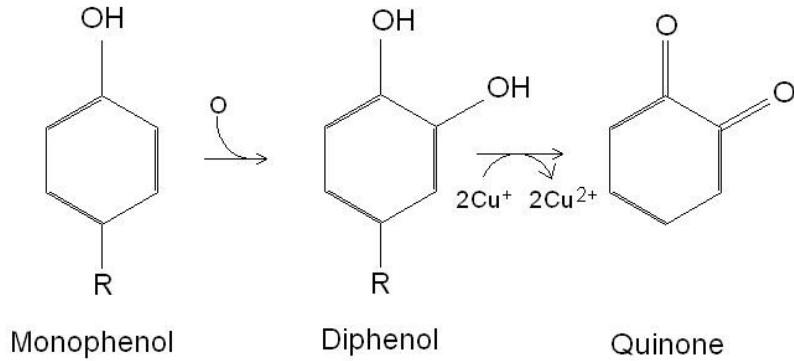
Urinary N

CH₄

+ Anthelmintic effect

Theodoridou et al. 2010, 2011, 2012; Hoste et al., 2012;
Min et al., 2003; Paolini et al., 2003

Polyphenol oxydase (PPO)



**Red
clover**

- Quinones are highly reactive to bind protein
- The enzyme works in presence of O₂
- Silage has the right requirements

Lee et al., 2009, 2012

Proteolysis

N use efficiency



Main results obtained in LegumePlus



Thesis objective

To evaluate and understand the benefits of **mixing** bioactive legumes with grass as **silages** for sheep nutrition and the environment

Silage fermentation

Protein degradation

N use efficiency

Animal performance

Pollutant emissions



Hypotheses

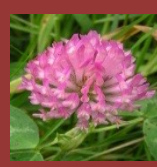
Plant material and treatments

SF – Sainfoin
Onobrychis viciifolia



Early flowering stage

RC – Red Clover
Trifolium pratense



Early flowering stage

T – Timothy
Phleum pratense



End of ear emergence

Ensiled at the same targeted DM ~ 30%

Treatments	T (%)	SF (%)	RC (%)
T	100		
SF		100	
RC			100
T-SF	50	50	
T-RC	50		50
T-SF-RC	50	25	25

In vitro
18 small scale silos

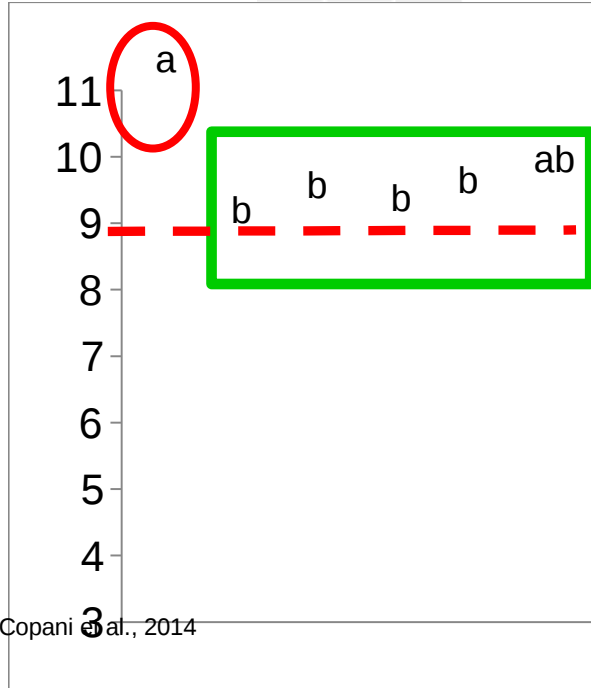


Silage quality

- ❖ Fermentation
- ❖ Protein degradation

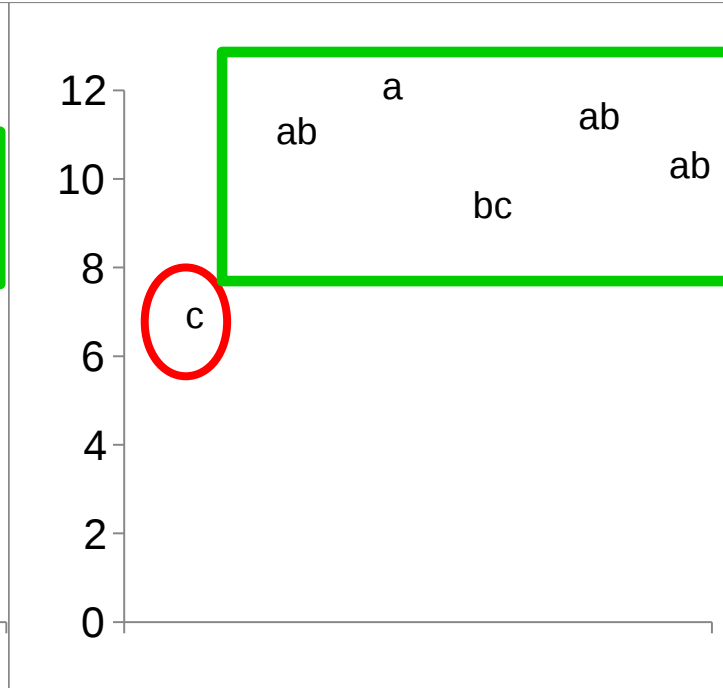
Silage quality - Acidification

pH values



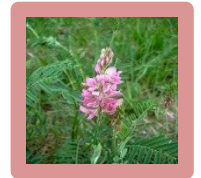
All silages including SF or RC: pH around 4.5 as requested for good silage quality

Lactic acid content (g/kg DM)



Better lactic fermentation when SF or RC in silage

Bioactive Legumes



Better acidification

□ pH

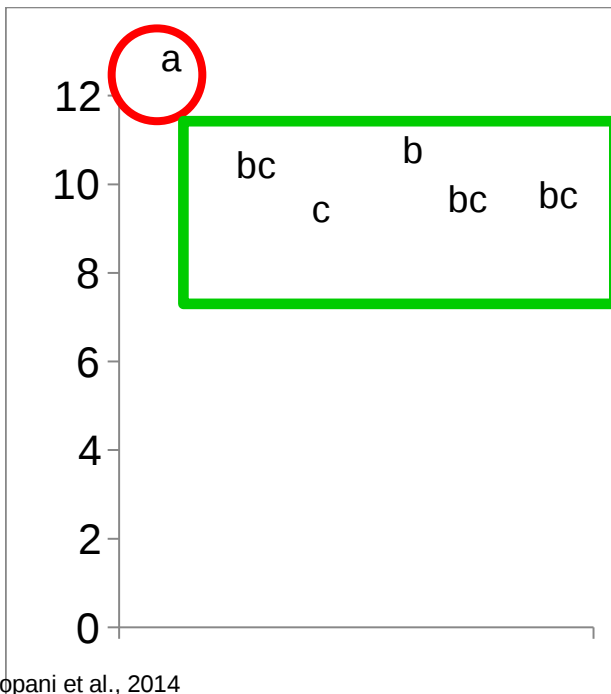
□ Lactic acid

T: Timothy; SF: Sainfoin; RC: Red clover

Silage quality - Protein degradation

Soluble N (% total N)

NH₃ (% total N)



Bioactive Legumes



RC: better protein protection

Copani et al., 2014

T: Timothy; SF: Sainfoin; RC: Red clover

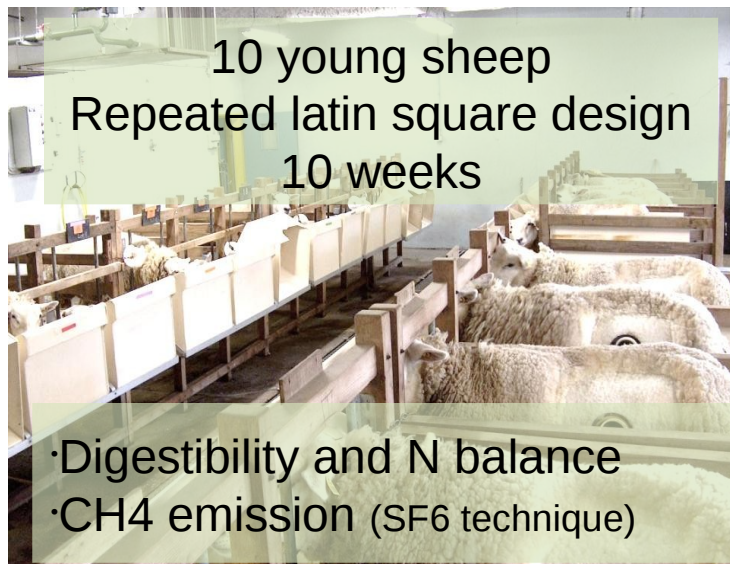
5 large scale silos

In vivo trials



Treatments	T (%)	SF (%)	RC (%)
T	100		
T-SF	50	50	
T-RC	50		50
T-SF-RC	50	25	25
SF-RC		50	50

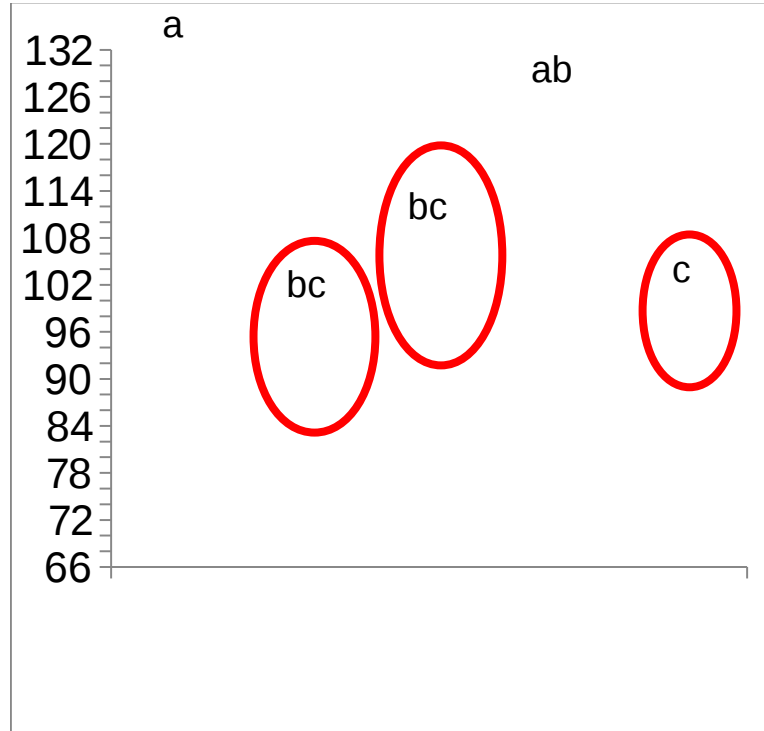
Digestion



Performances



Organic matter digestibility

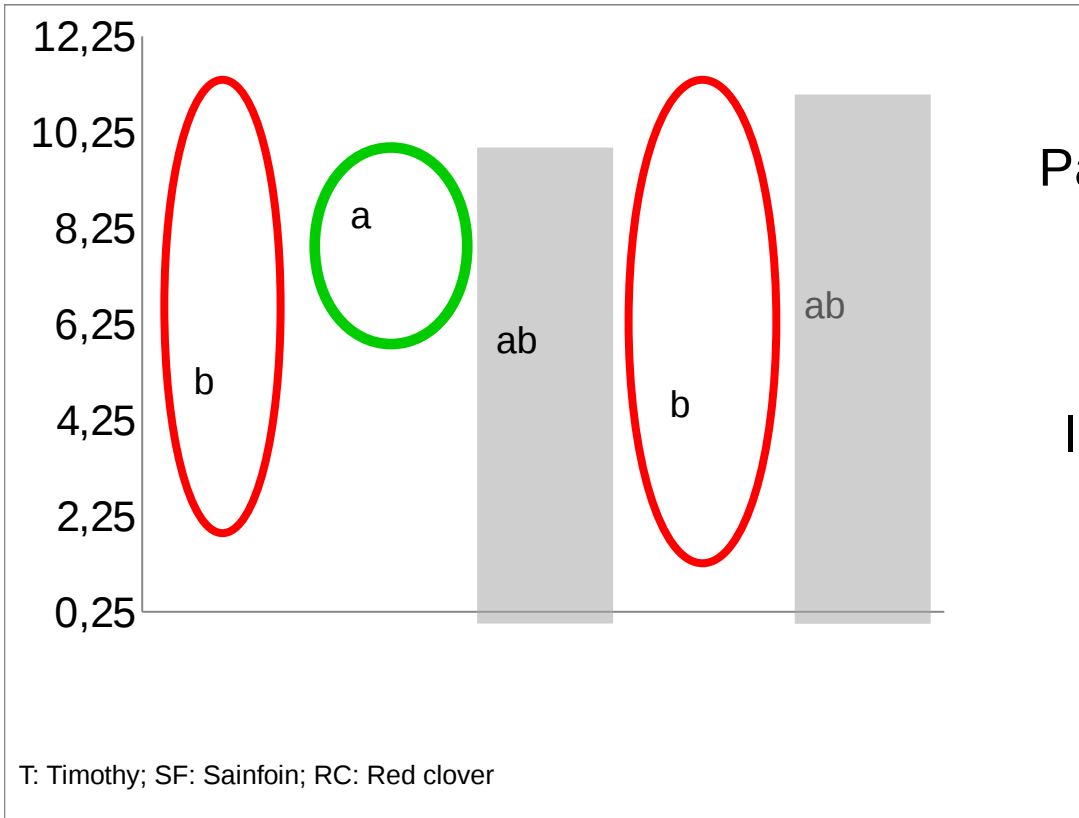


T: Timothy; SF: Sainfoin; RC: Red clover

Inclusion of SF reduces OM and fibre digestibility compared to pure T

N balance

N faeces and urine, g/g N intake



T-SF:

Pattern of N excretion directed towards faeces

Indicates that the CT-protein complexes are not totally dissociated post ruminally

(Theodoridou et al., 2012)



CH4 emission

	T	T-SF	T-SF-RC	T-RC	SF-RC
CH4, g/kg DM intake	35.7 ^a	29.7 ^b	29.3 ^b	30.5 ^{ab}	27.2 ^b



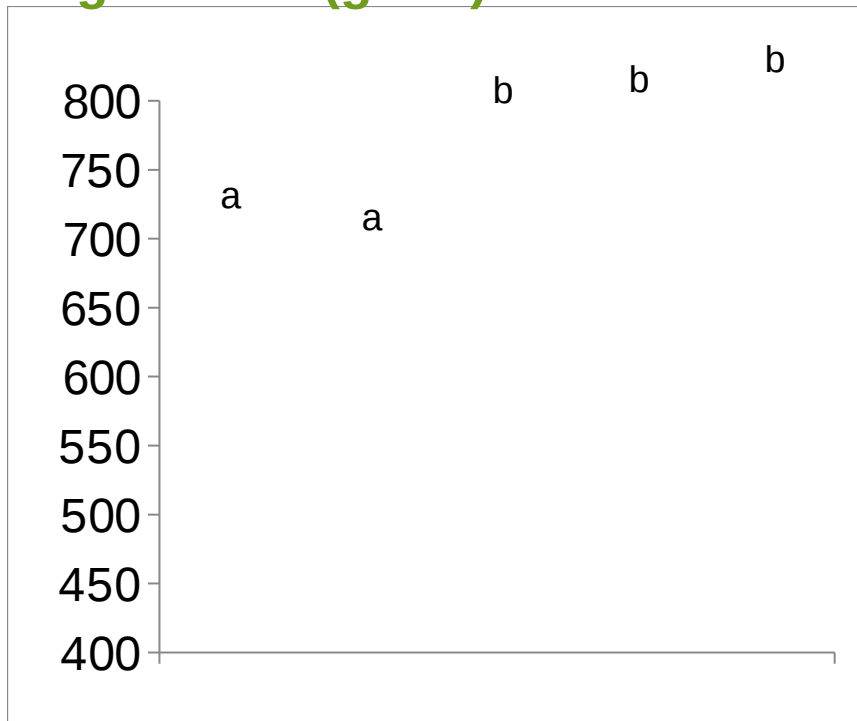
All the mixtures including SF led to the lowest CH4 emission than pure T



The slight difference is probably due to CT-complexation with proteins in the silos (less available in the rumen)

Animal performances

Silage intake (g/DM)



All silages containing RC were better ingested

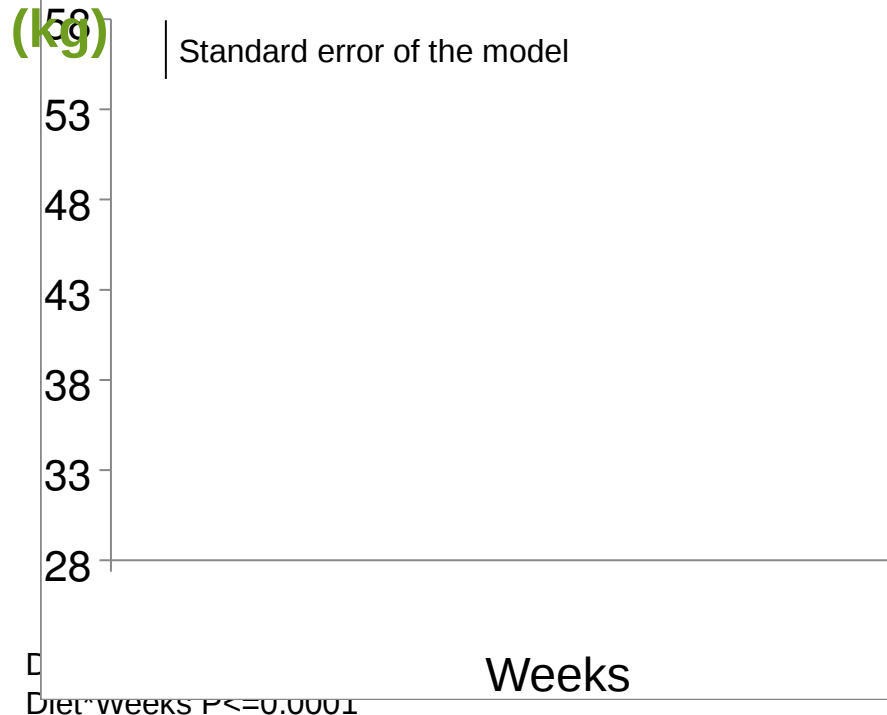
T: Timothy; SF: Sainfoin; RC: Red clover

Fibre content and lower digestibility of SF may have impaired animal intake

Animal performances

Live weight

(kg)



All RC-including silages:
better growth than T-SF and
T



Extreme average daily gains
observed for **T-RC (235 g/d)**
and **T-SF (145 g/d)** ($P=0.001$)

These differences were reflected
in carcass weights (**T-RC: 20,5**
vs **T-SF: 17,2 kg**) ($P=0.001$)



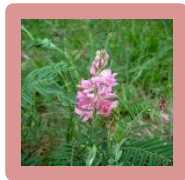
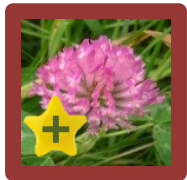
., 2015b

T: Timothy; SF: Sainfoin; RC: Red clover



Take home messages

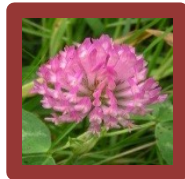
Bioactive Legumes



Protein degradation

Silage Fermentation

=



RC appears to be **more effective** than **SF**

Take home messages



Inclusion of SF **reduces** OM and fibre **digestibility** compared to pure T

T-SF vs T and T-RC

Pattern of N excretion directed towards faeces

CH₄ emission

SF-containing silages led to the lowest CH₄ emission, significantly lower than pure T

Performances

All RC-including silages: better intake and better growth than T-SF and T



**Thank you for your
attention**