How mixing bioactive legumes with grass impacts animal productivity ?

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INRA, UMR1213 Herbivores

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(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

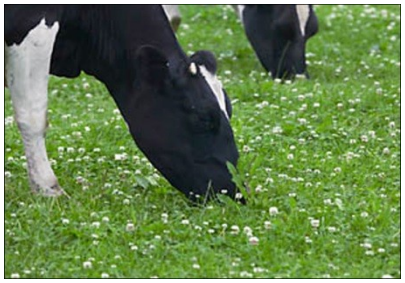
 Chemical fertilizers

Farm

 N self-sufficiency

Utilization of fodder legumes

Grazing



Conservation

Hay preparation

Leaves losses

Animal nutrition

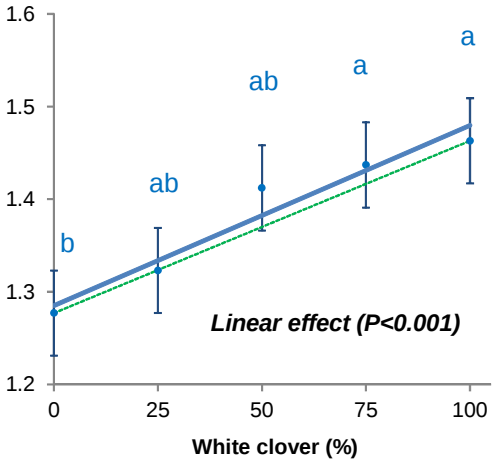
Unbalanced N & Energy

Grass – legume mixtures

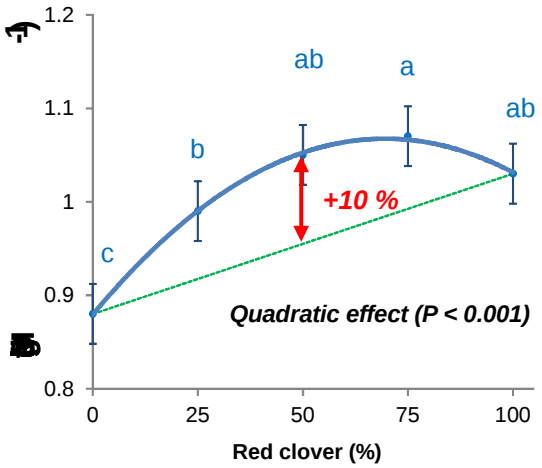
Benefits of grass-legume mixtures for animal

Daily intake of the digestible fraction (indicator of performances)

Ryegrass / white clover (fresh)

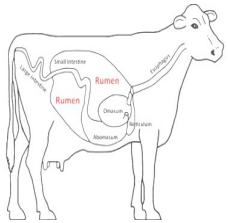



Cocksfoot / red clover (silage)

Niderkorn et al., 2014

Protein degradation during fermentation in silage and rumen



Plant Proteases

Proteolytic micro organisms

Peptides

Free Amino Acids

Ammonia

Protein s

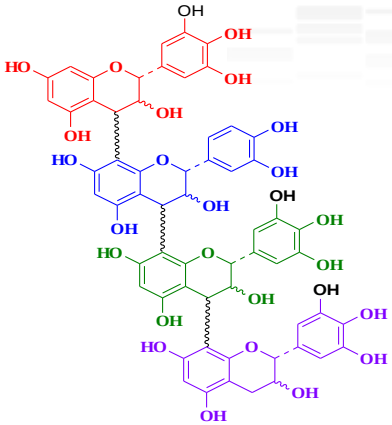
Amino Acids

Bioactive Legumes

Condensed tannins

Polyphenol oxydase

Condensed tannins (CT)



CT-Protein complex

Active in the silo and the rumen

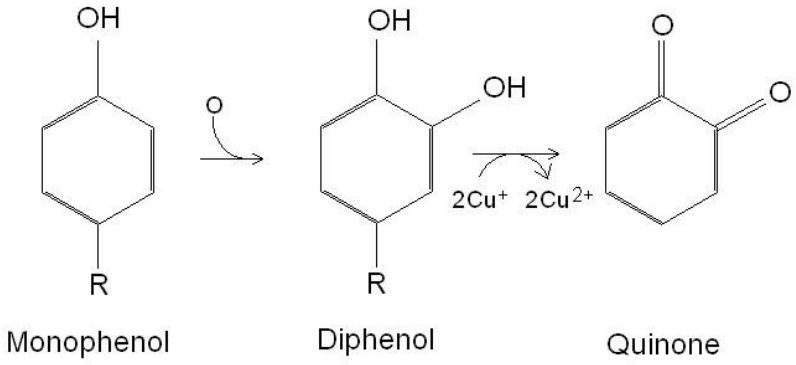
↘ Urinary N

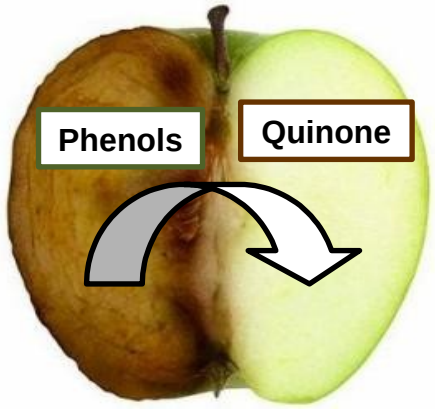
↘ CH4

+ 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

Hypotheses

- **Silage fermentation**
- **Protein degradation**

- **N use efficiency**
- **Animal performance**
- **Pollutant emissions**

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

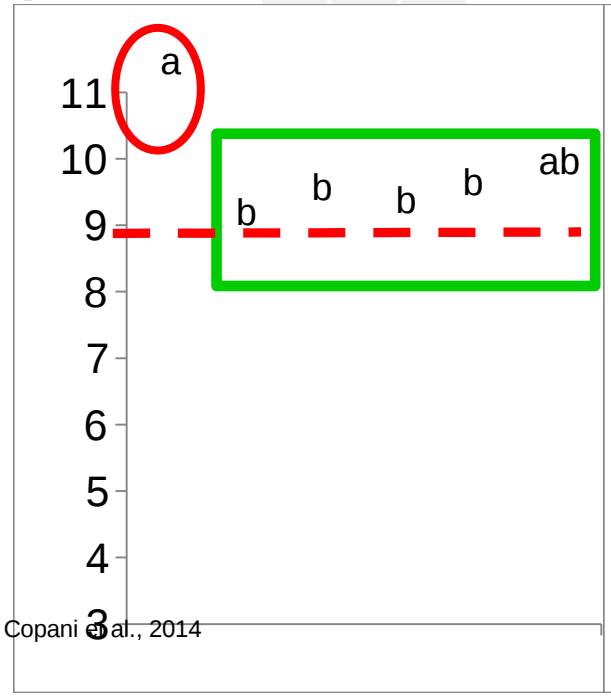
In vitro
18 small scale silos

Silage quality

- Fermentation
- Protein degradation

Silage quality - Acidification

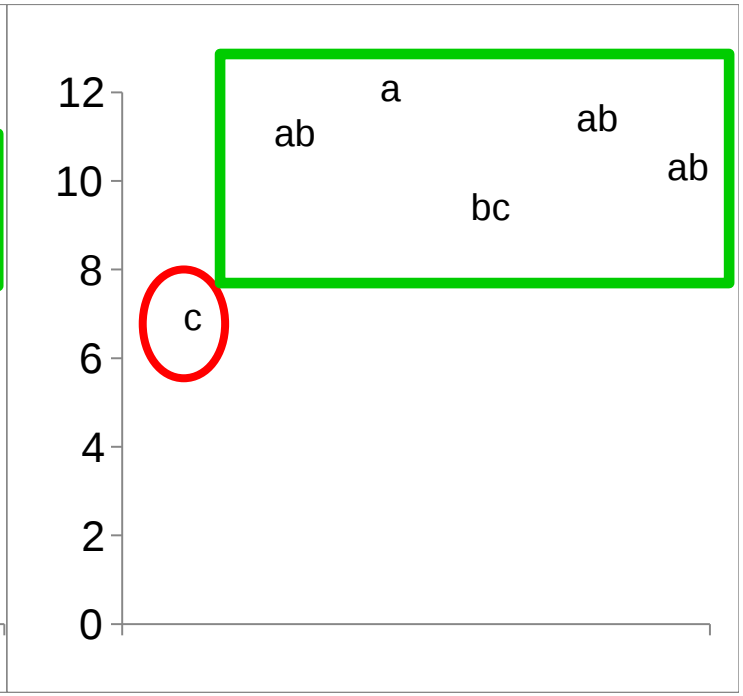
pH values



Copani et al., 2014

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

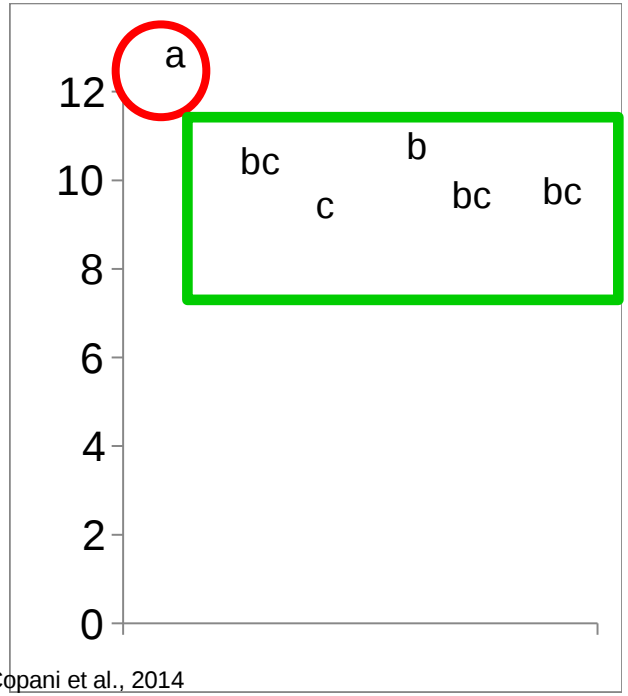
□pH

□ Lactic acid

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

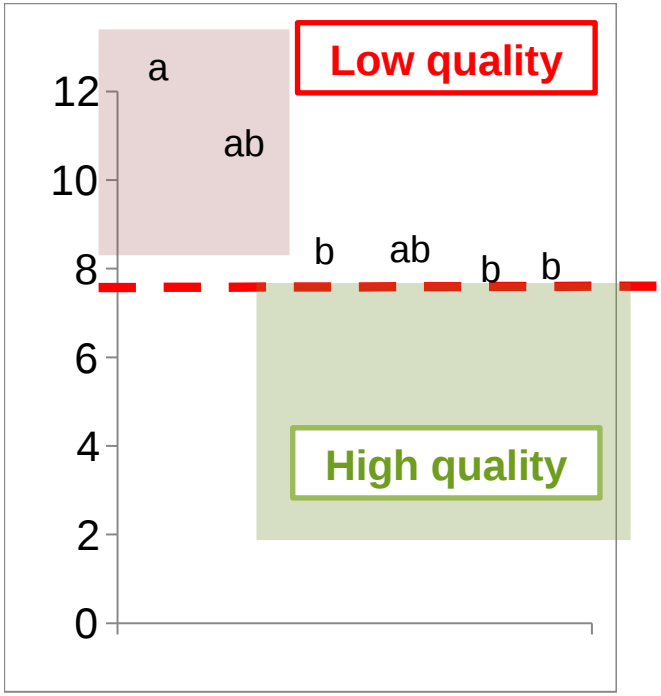
Silage quality - Protein degradation

Soluble N (% total N)



Copani et al., 2014

NH3 (% total N)



Bioactive Legumes

RC: better protein protection

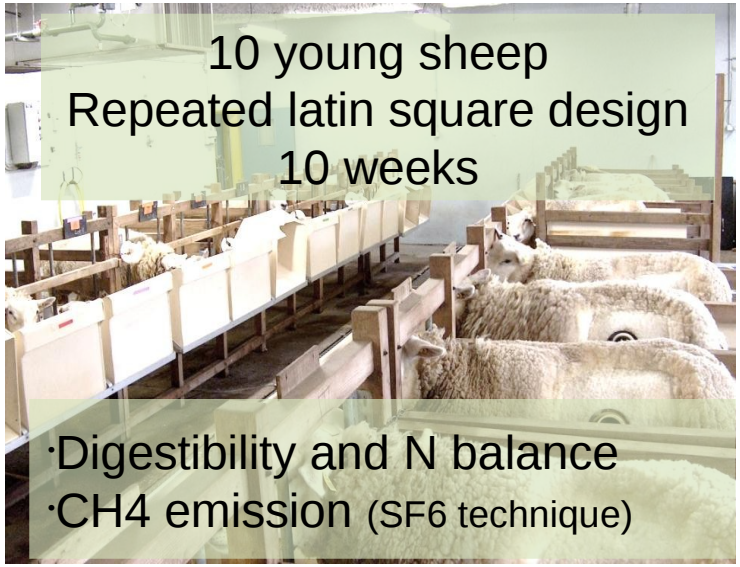
T: Timothy; SF: Sainfoin; RC: Red clover

In vivo trials

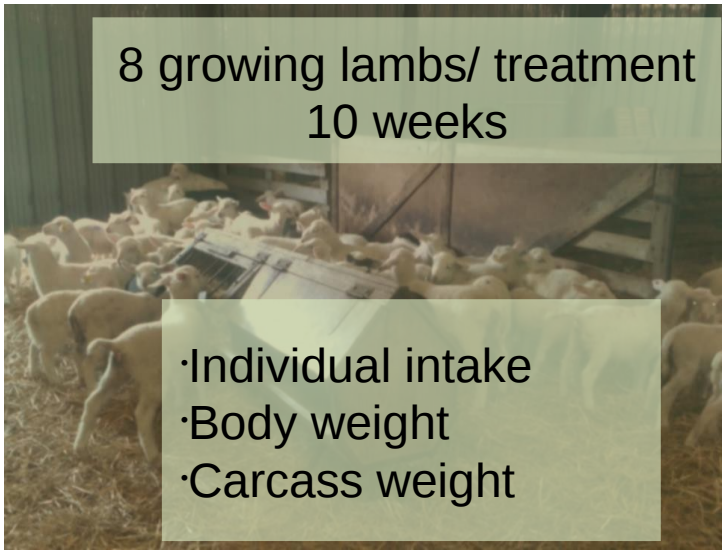
5 large scale silos

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

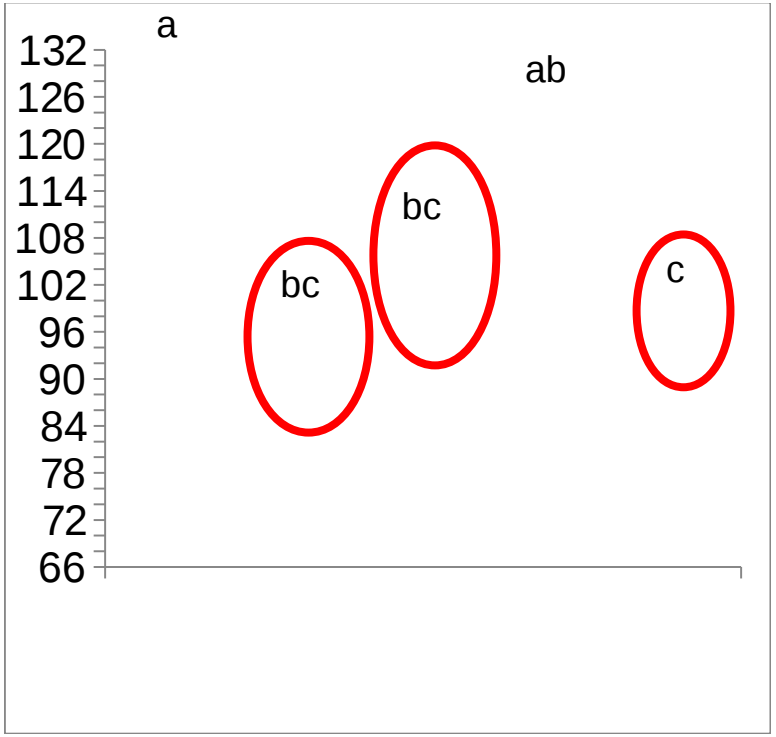
Digestion



Performances



Organic matter digestibility

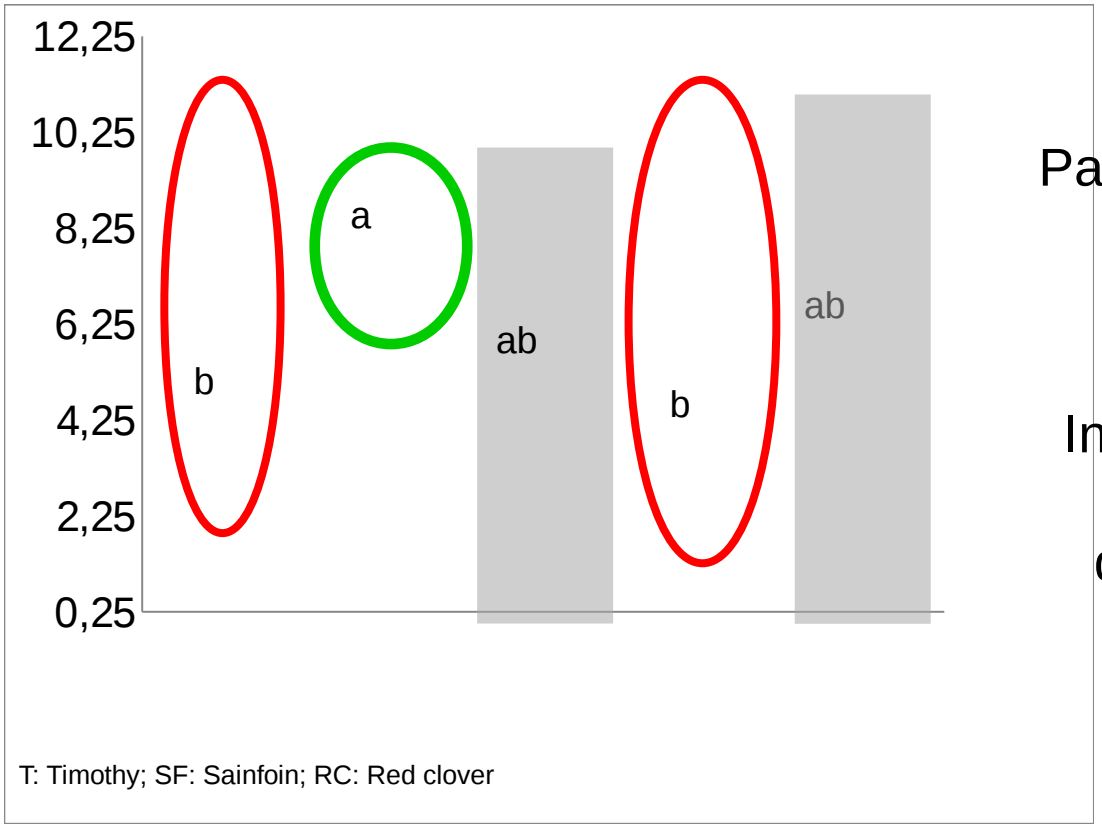


T: Timothy; SF: Sainfoin; RC: Red clover

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

N balance

N faeces and urine, g/g N intake



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

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

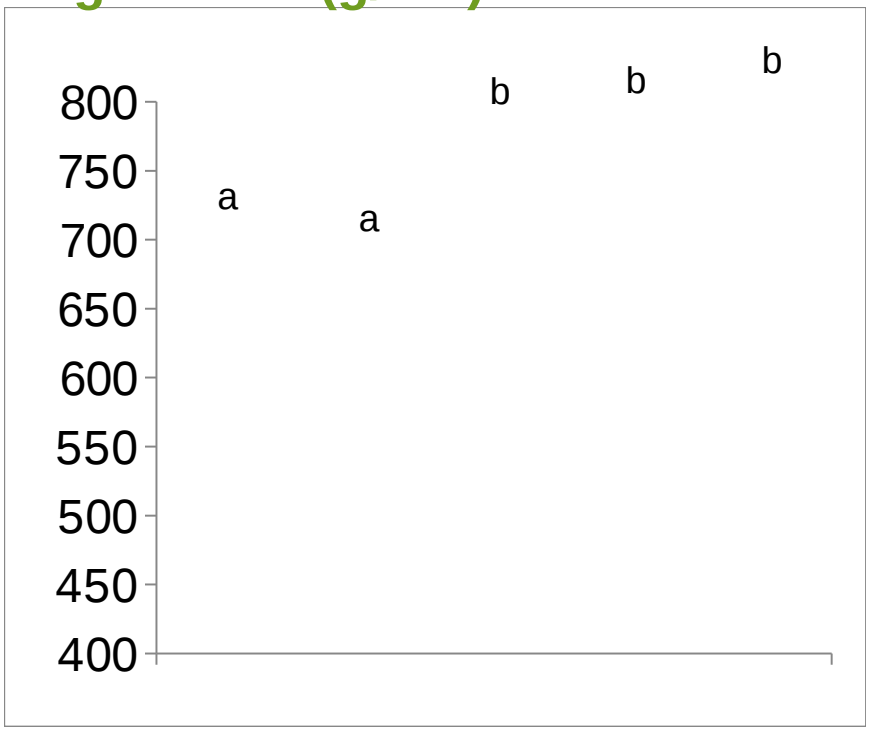
	T	T-SF	T-SF-RC	T-RC	SF-RC
CH4, g/kg DM intake	35.7 a	29.7 b	29.3 b	30.5 ab	27.2 b

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)



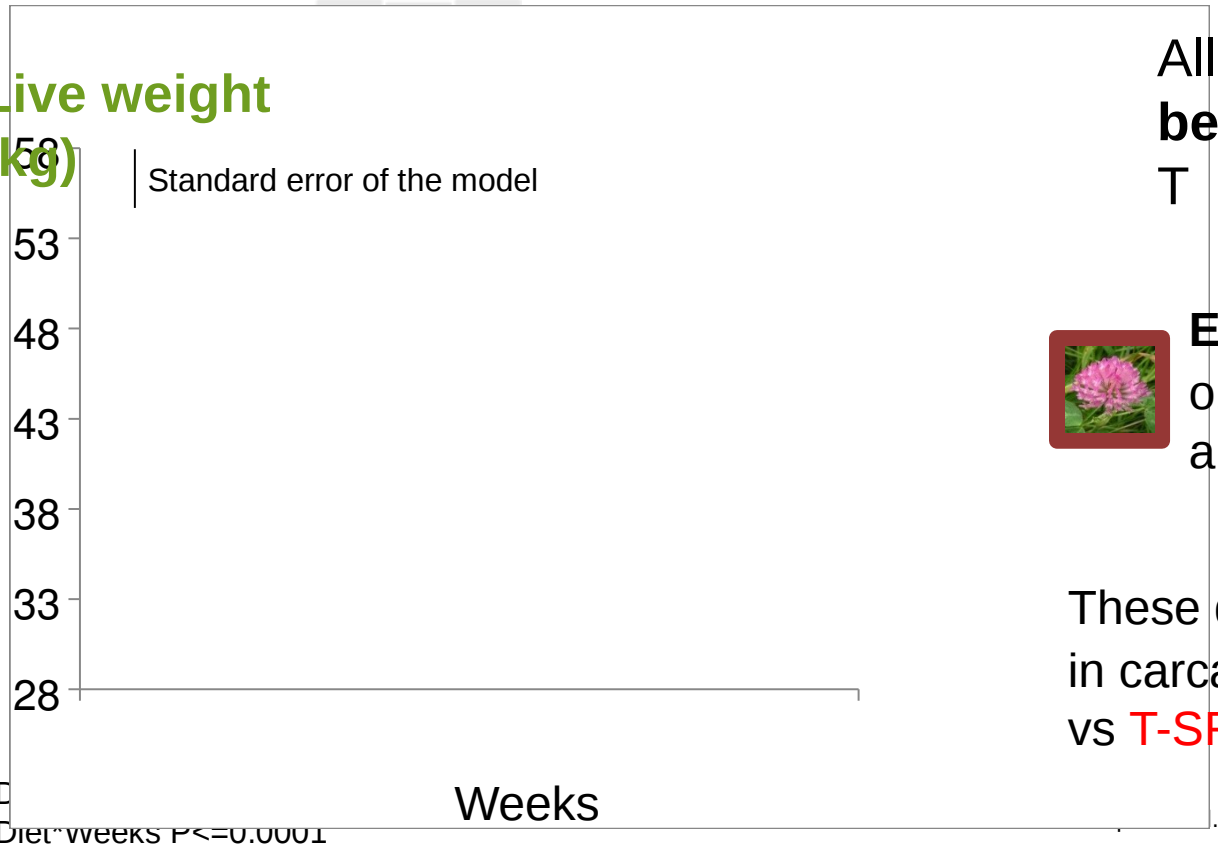
All silages containing RC were better ingested

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

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

Animal performances

Live weight (kg)



Diet*Weeks P<=0.0001

., 2015b

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)

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

Take home messages

Bioactive Legumes

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

Protein degradation

Silage Fermentation

=

Good Silage

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