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Optimizing grass silage quality for green biorefineries

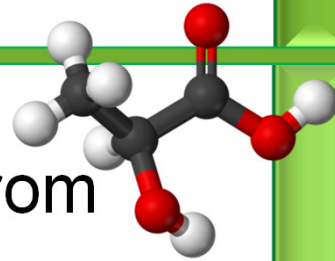
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Why to get excited about a Green Biorefinery using ensiled grass as the raw material?



- There is potential to increase the biomass production from grasses in certain areas
- Currently grass is used mainly to feed ruminants and horses
- By biorefining, multiple products can be produced including feeds for monogastric animals and industrial use
- Local feed, protein and energy self sufficiency increases
- Ensiling grass allows efficient harvesting and all-year round supply of raw material using existing technology
- Ensiling may potentially act as a pretreatment for the biorefining process



Simple example of a green biorefinery concept



Grassland production

Harvesting and preservation of grass

Typically the first step is a mechanical liquid solid separation

With this study, we wanted to see how silage quality affects it



Mechanical fractionation

Liquid fraction

Liquid feed for pigs

Solid fraction

Biogas & fertilizers

Feed for ruminants

Two plant materials were used

- Two forage species from plots grown on the same field were used:
 - A pure timothy (*Phleum pratense*) sward (Grass)
 - A pure red clover (*Trifolium pratense*) sward (Clover)
- The forages were harvested on 24 August 2016
- Second cut with a regrowth since previous cut of 70 days
- No wilting
- Precision chopping with farm scale machinery



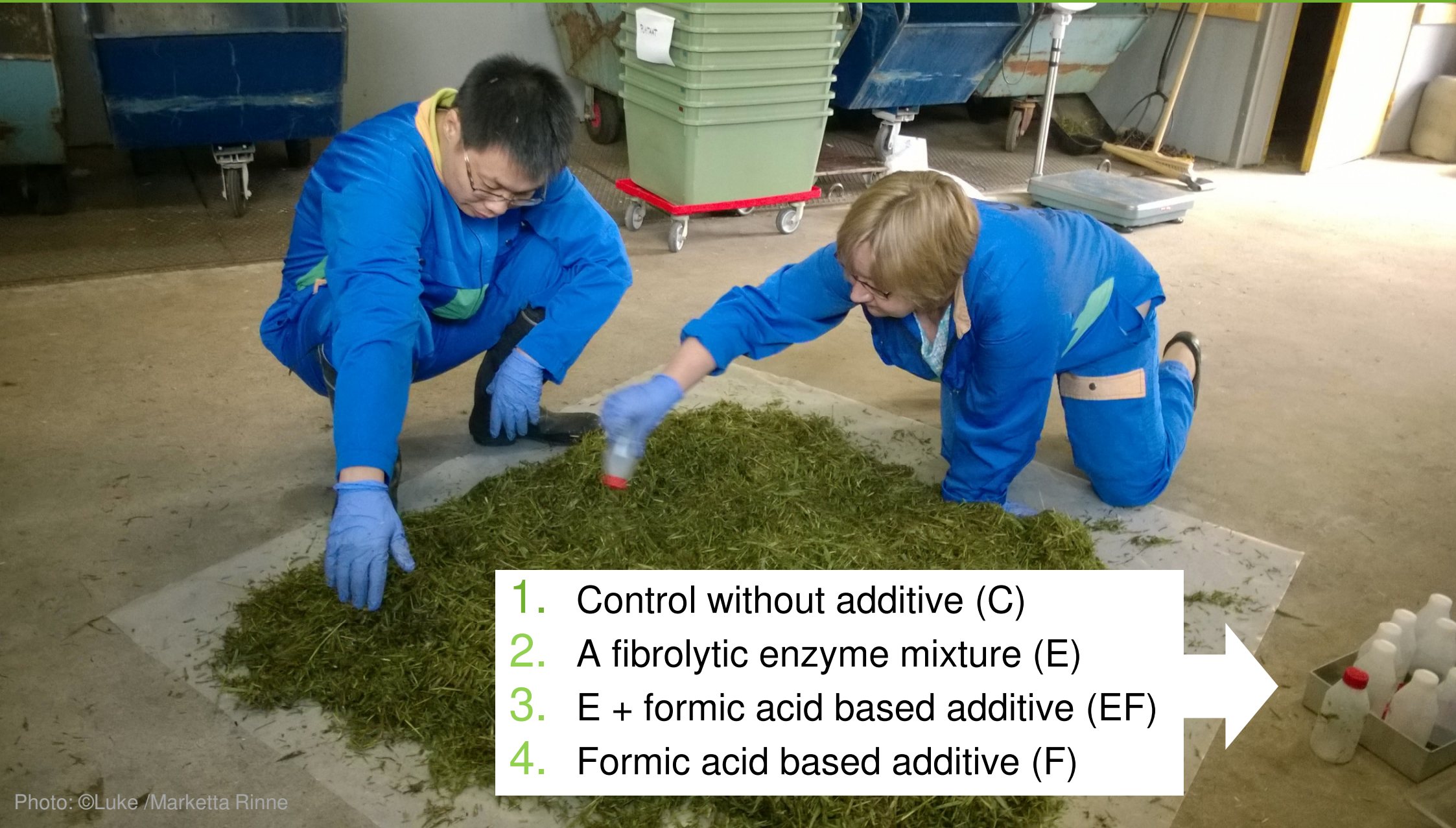
Photos: ©Luke /Marketta Rinne

Weather conditions at harvest were humid. The raw materials were not optimal (low DM of red clover, low CP of timothy...).

	Timothy	Red clover
Dry matter (DM), g kg ⁻¹	210	129
Buffering capacity	4.4	11.2
<i>In vitro</i> OM digestibility	0.628	0.599
In DM, g kg ⁻¹		
Ash	59	89
Crude protein	78	176
Sugars	170	60
Fibre (NDF)	592	485



Four silage additive treatments were used to modify the fermentation during the ensiling period



Silages were ensiled in pilot scale using three replicate silos per treatment and stored in room temperature protected from light



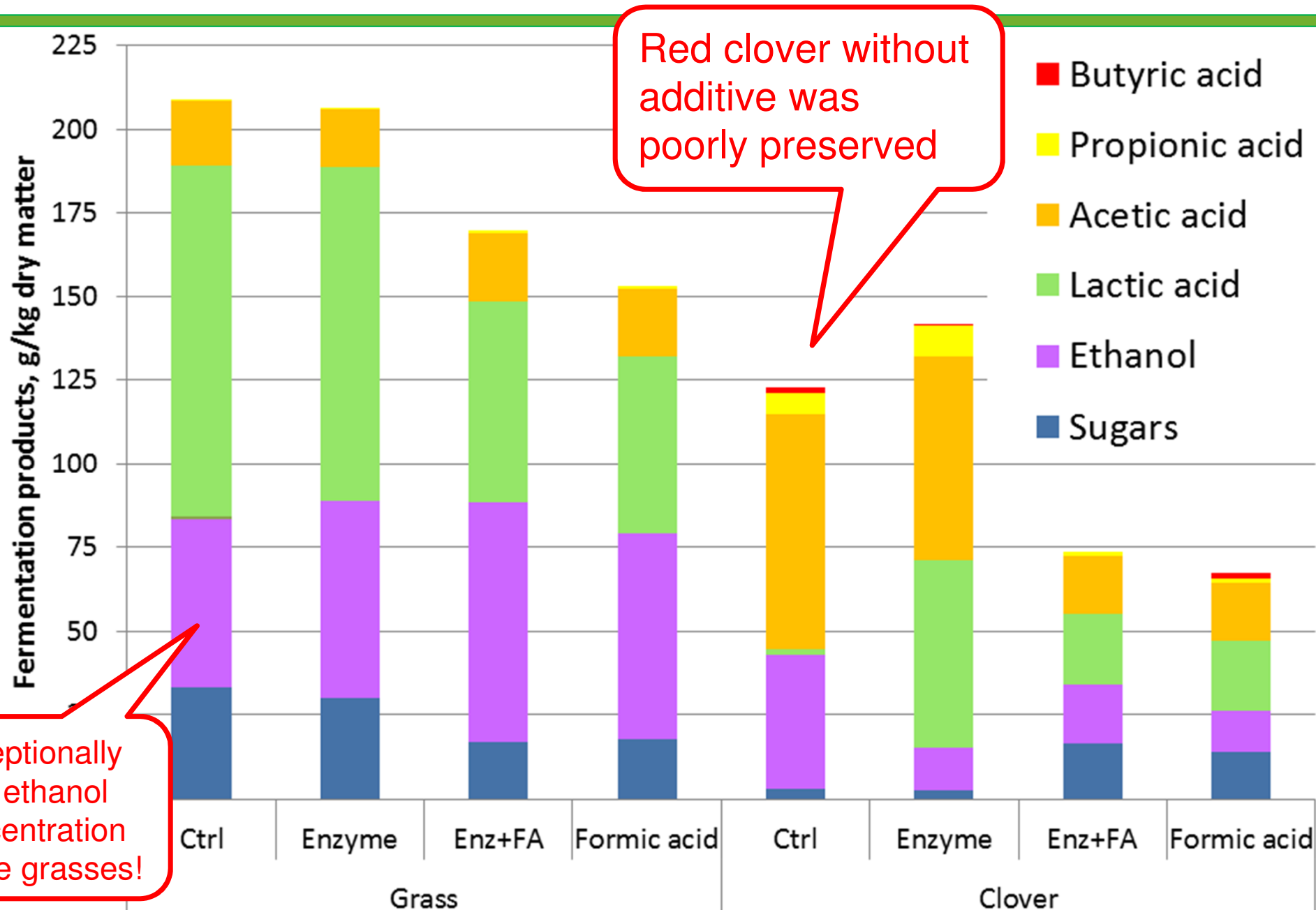
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The silos were opened after a 92-day ensiling period



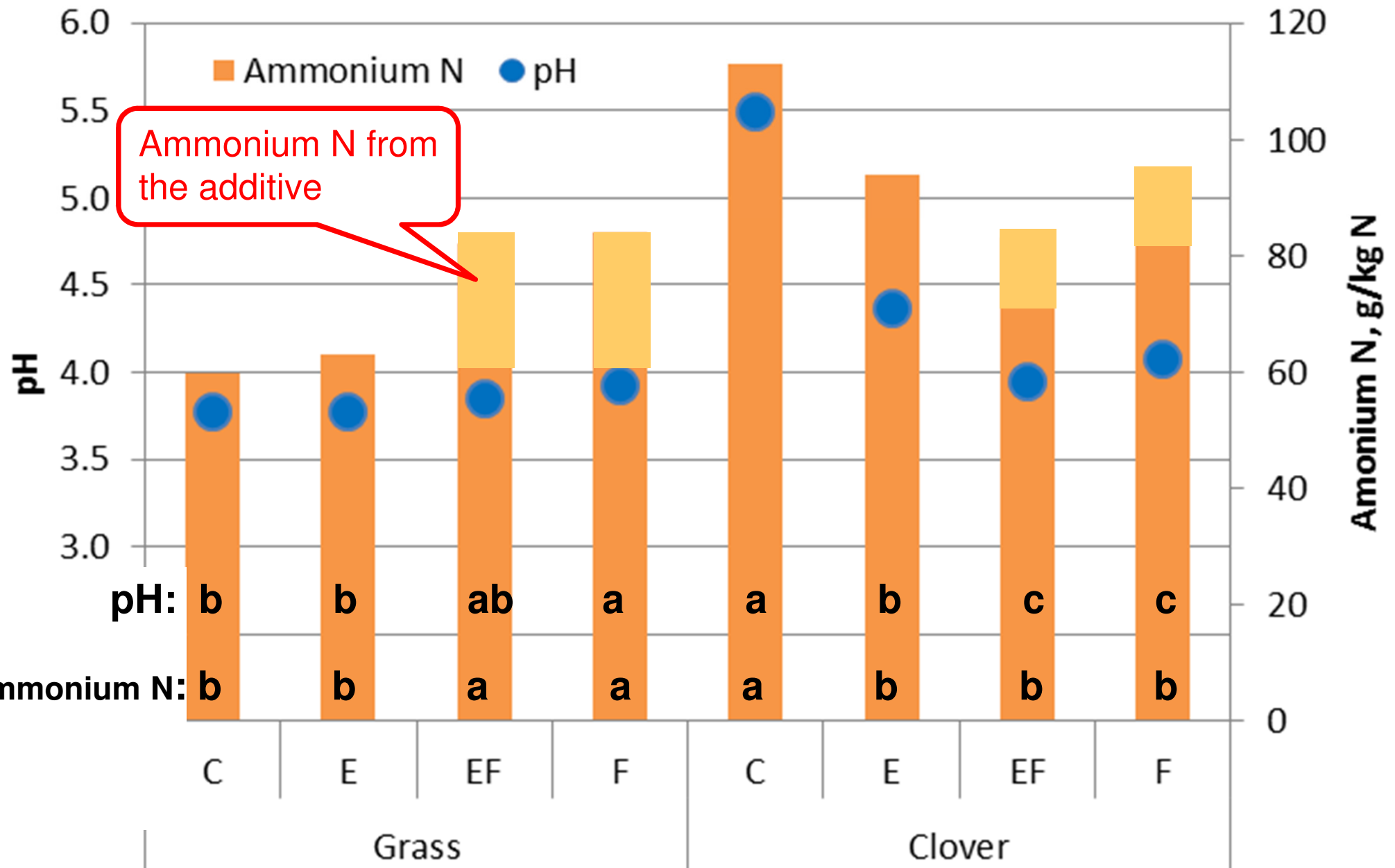
Formic acid restricted fermentation in both raw materials

Enzyme improved the fermentation quality of red clover



Combining enzyme and formic brought no additive effect

Additives NS	Timothy	Red clover
Silage DM, g/kg	209	139

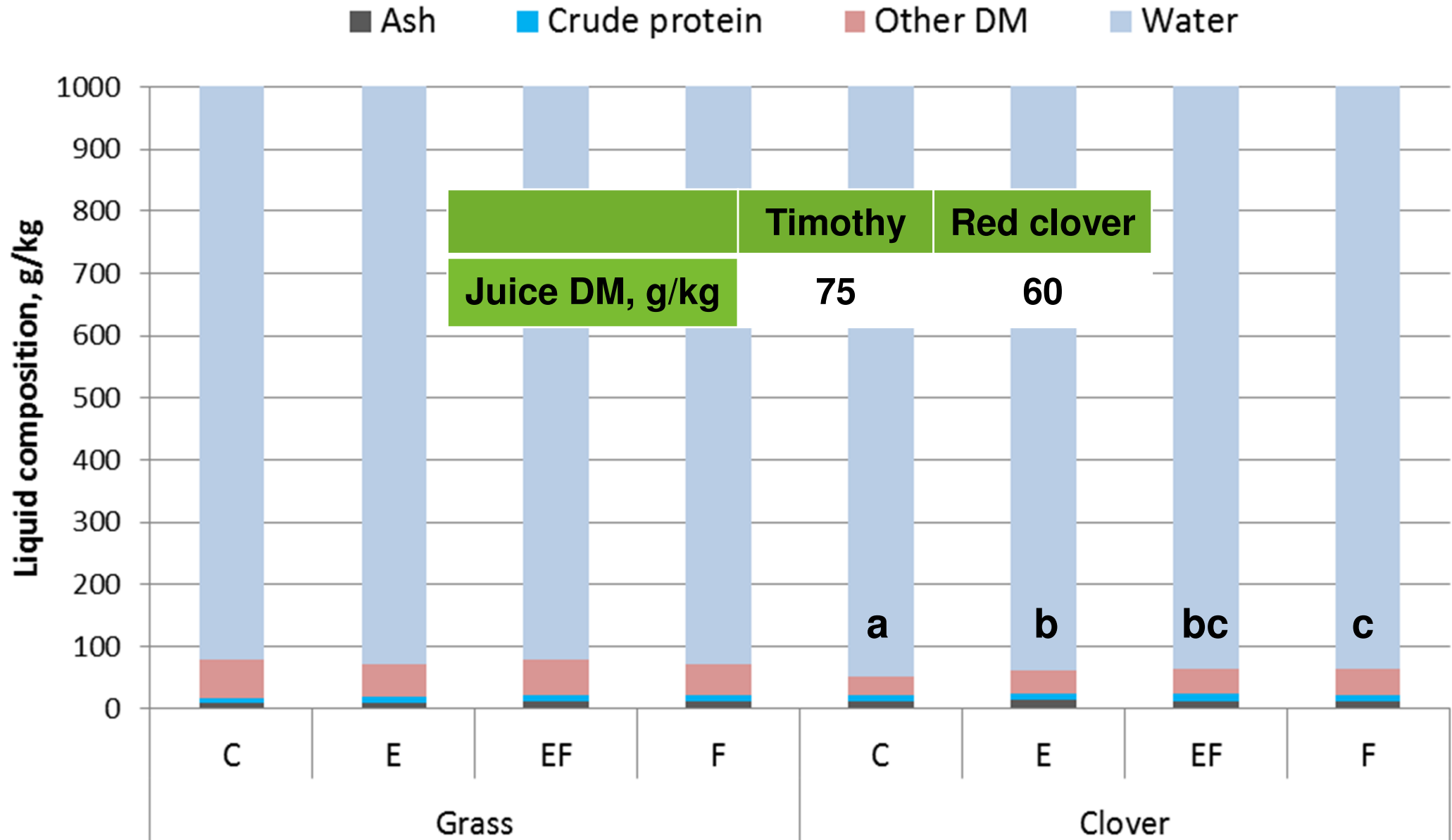


A double screw juicer was used for the mechanical liquid – solid separation in lab scale



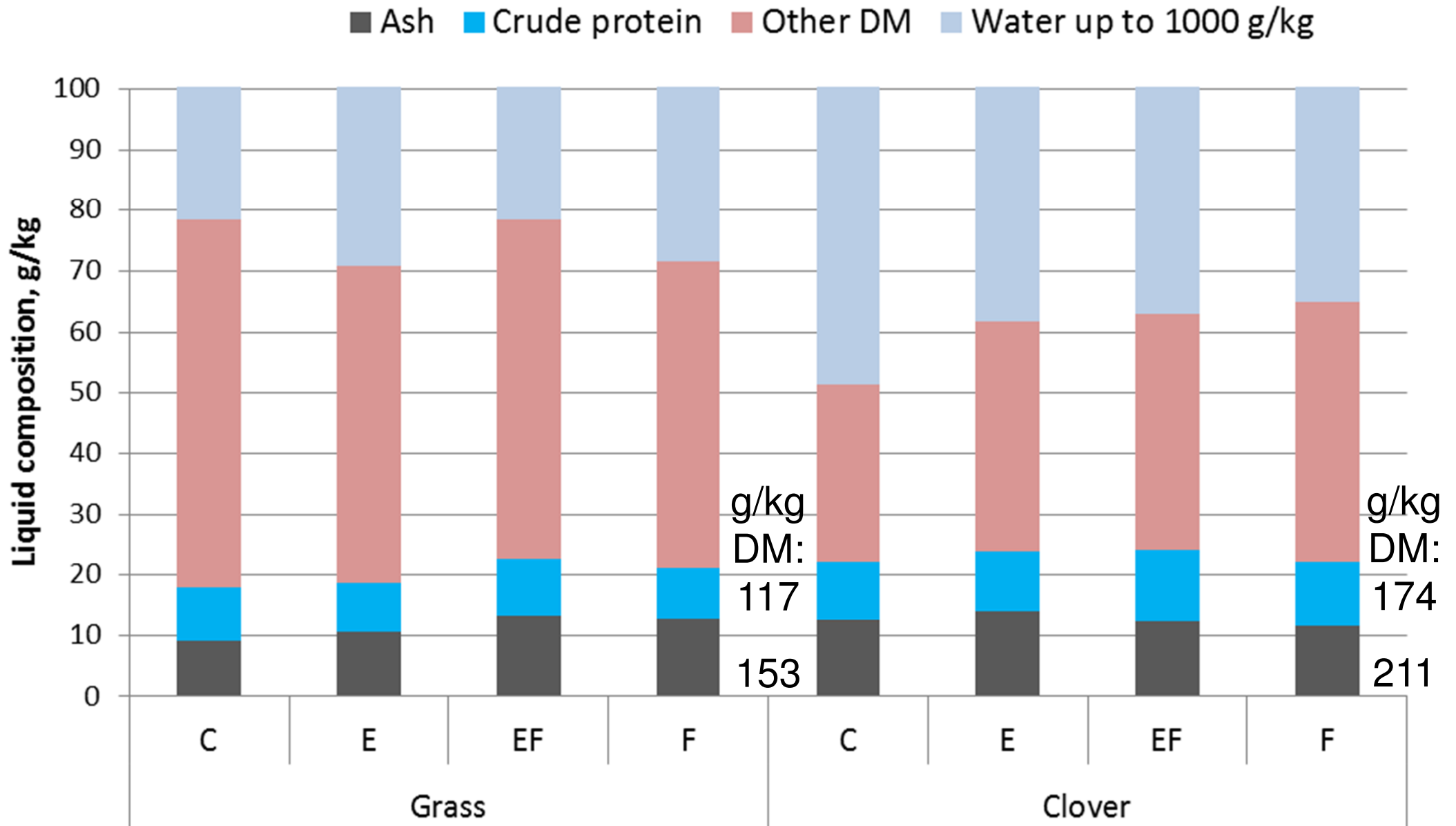
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The dry matter (DM) concentration of the juice was lower than in our previous experiments (often over 100 g/kg)

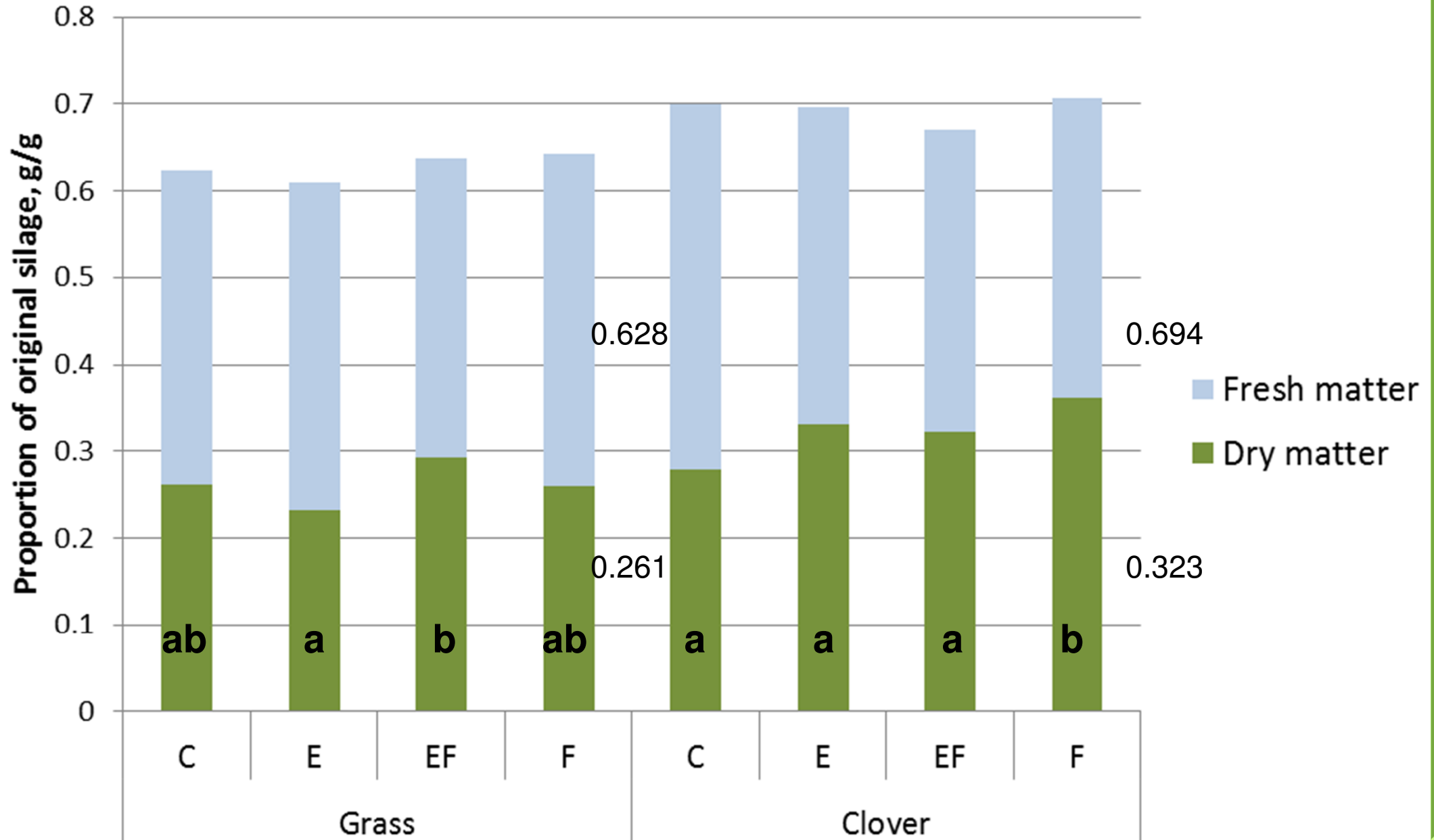


Besides protein, the liquid has high mineral and fermentation product contents

Fermentation end products (lactic and acetic acids), ethanol, sugars, formic acid (if added)...



Additive treatments did not affect liquid yield significantly, but there were some benefits in dry matter yield of enzyme (E) and/or formic acid (F) treatments although effects were not very consistent.



Grasses or clover for a biorefinery?

- Both are potential raw materials
 - Legumes typically have lower DM and higher protein concentration
- Clover as a legume has the advantage of being able to fix atmospheric N_2 to the system
 - Decreases the costs and environmental load related to mineral N fertilizer production and transport
- Grasses can be used as efficient utilizers of manure nutrients
 - This may be a benefit e.g. for a pig farm with limited field area for slurry spreading



Good fermentation quality is always a benefit

- Controlled fermentation means less dry matter and nutrient losses during preservation and better stability & quality of products
- Fibrolytic enzymes as additives show certain potential in increasing the DM yield from grass silage and may improve silage fermentation quality in challenging preservation conditions, but the magnitude of the effects is rather small and not consistent
- Formic acid as an additive restricts fermentation and preserves water soluble carbohydrates and protein / amino acids in the raw material, and seemed to increase DM yield in the liquid phase



Ensiled grass is an interesting, variable and versatile raw material for a Green Biorefinery



28TH GENERAL MEETING OF EUROPEAN GRASS- LAND FEDERATION

Meeting the future demands for grassland production, 22-26 June 2020, University of Helsinki, Finland

**Welcome to EGF
meeting in Helsinki**
on 22-26 June 2020

Welcome to the 28th General meeting of EGF in 2020 that will be hosted by University of Helsinki in Helsinki Finland. The last General meeting in Finland was organised in Lahti in 1992 (14th General Meeting: Sustainable production from grassland). The 28th General meeting gives delegates the first hand opportunity to see and experience how today's state-of-the-art practices in grassland and ruminant production are utilised in Finland to produce milk and beef products that have been ranked as one of the highest quality products in the world. The meeting is also the stage for you to represent and hear about the recent advances and novel approaches in grassland research. Registration and call for submissions will be opened during 2019.

