Can milk composition analysis predict grass content in rations?

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Personal background

- MSc Grassland science and plant breeding, WU
- Professional career:
  - PhD research: grass seed production 1984-1991
  - Associate professor of Grassland Science 1991-2011
  - Independent scientist since 2011
- Active interests: research and publishing, guest lectures, consultancies, etc.

Outline

- Review paper
- Milk composition and profile of fatty acids (FA) in cows' milk in relation to feed.
- 'Pasture-milk' premium for farmers in NL; authentification/verification desirable.
- Can milk composition give markers for pasture-fed cow milk and dairy products?
- Comparison of various studies on feed composition, grazing and farming system effects on FA, triacylglycerol (TAG), and phytanic acid (PA)

Lipids in forage

- Forages for ruminants:
  - Summer: fresh grass, herbs
  - Winter: silage (grass, maize, other), hay
- Fatty acid composition of grass: mainly unsaturated fatty acids

Cow lipid intake via forage

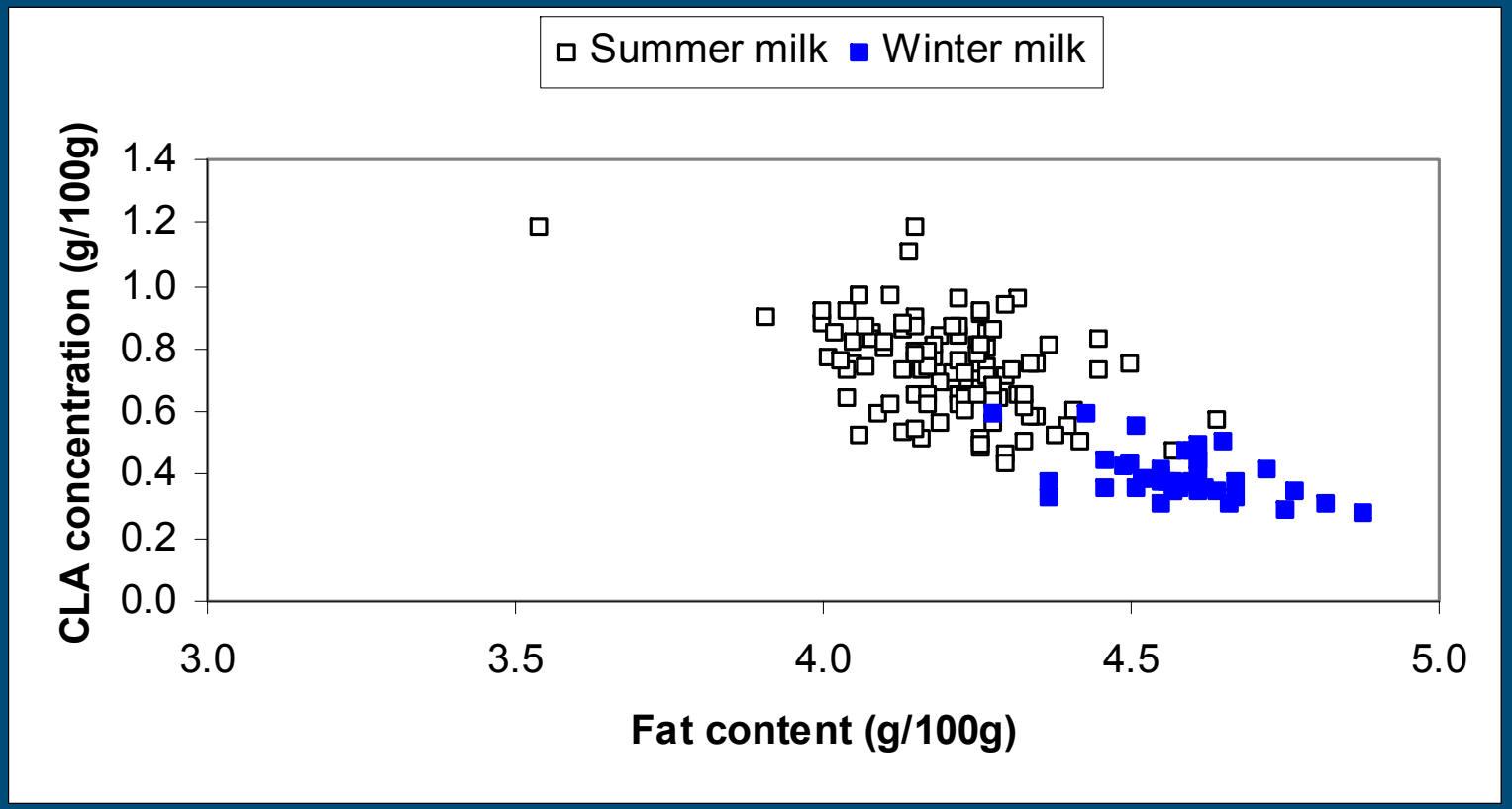
- Low quantities of fat in DM, but intake is significant:
  - At 15 kg DM intake and 3 % fat in forage DM: 450 g fat/d for cows
  - With 70% C18:3, 315 g C18:3/d is ingested with fresh grass
  - With15% C18:2, 68 g C18:2/d is ingested with fresh grass
  - Total 383 g PUFA ingested per day from forage for cows

  (Elgersma et al. 2004, An. Feed Sci. Techn. 117: 13-21)
- C18:3 and C18:2 are substrates for microbial bio-hydrogenation in the rumen and precursors for PUFA in milk

Milk composition (milk fat content)

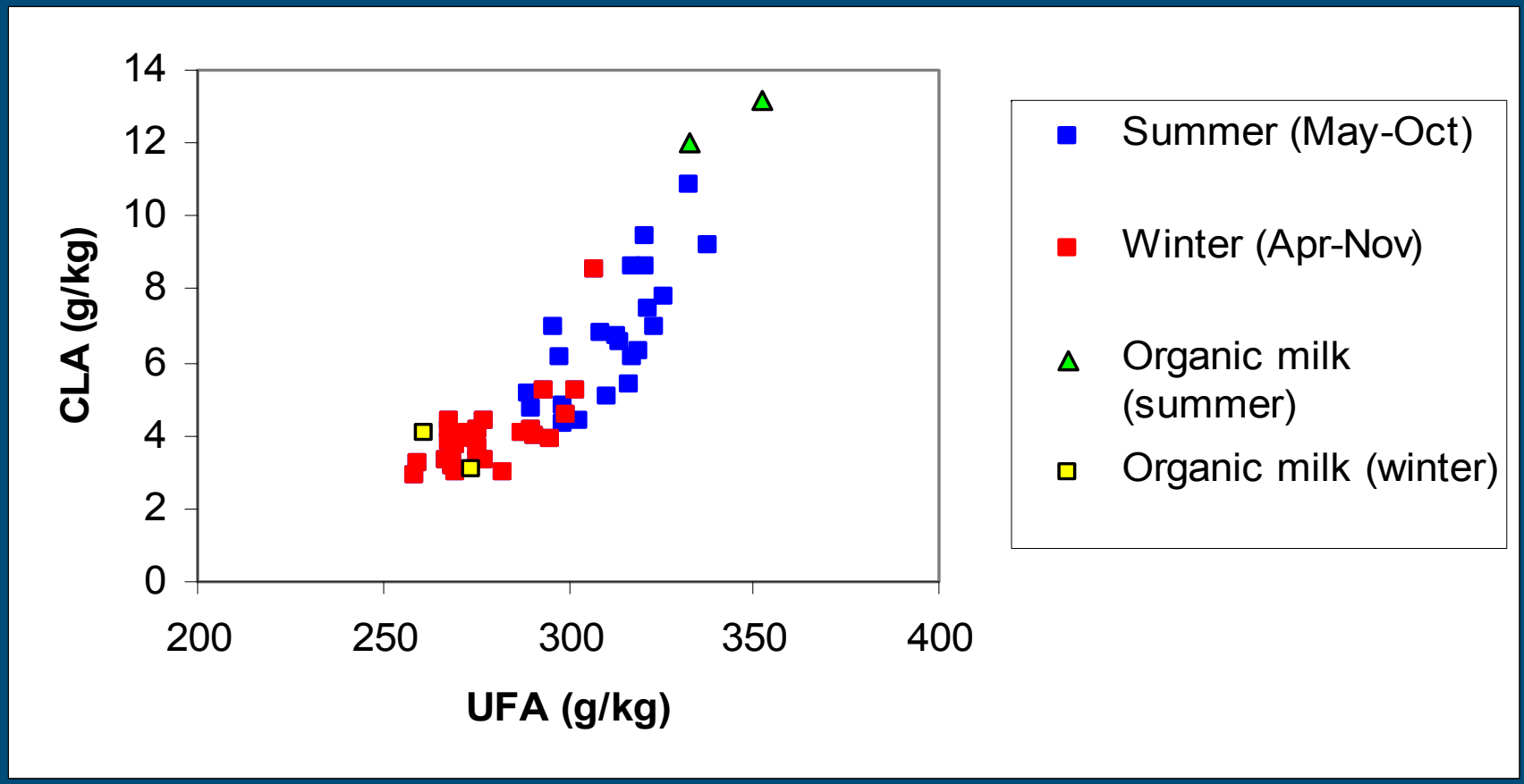
Lower milk fat content in summer with fresh grass.

Negative relation milk fat content – CLA concentration.



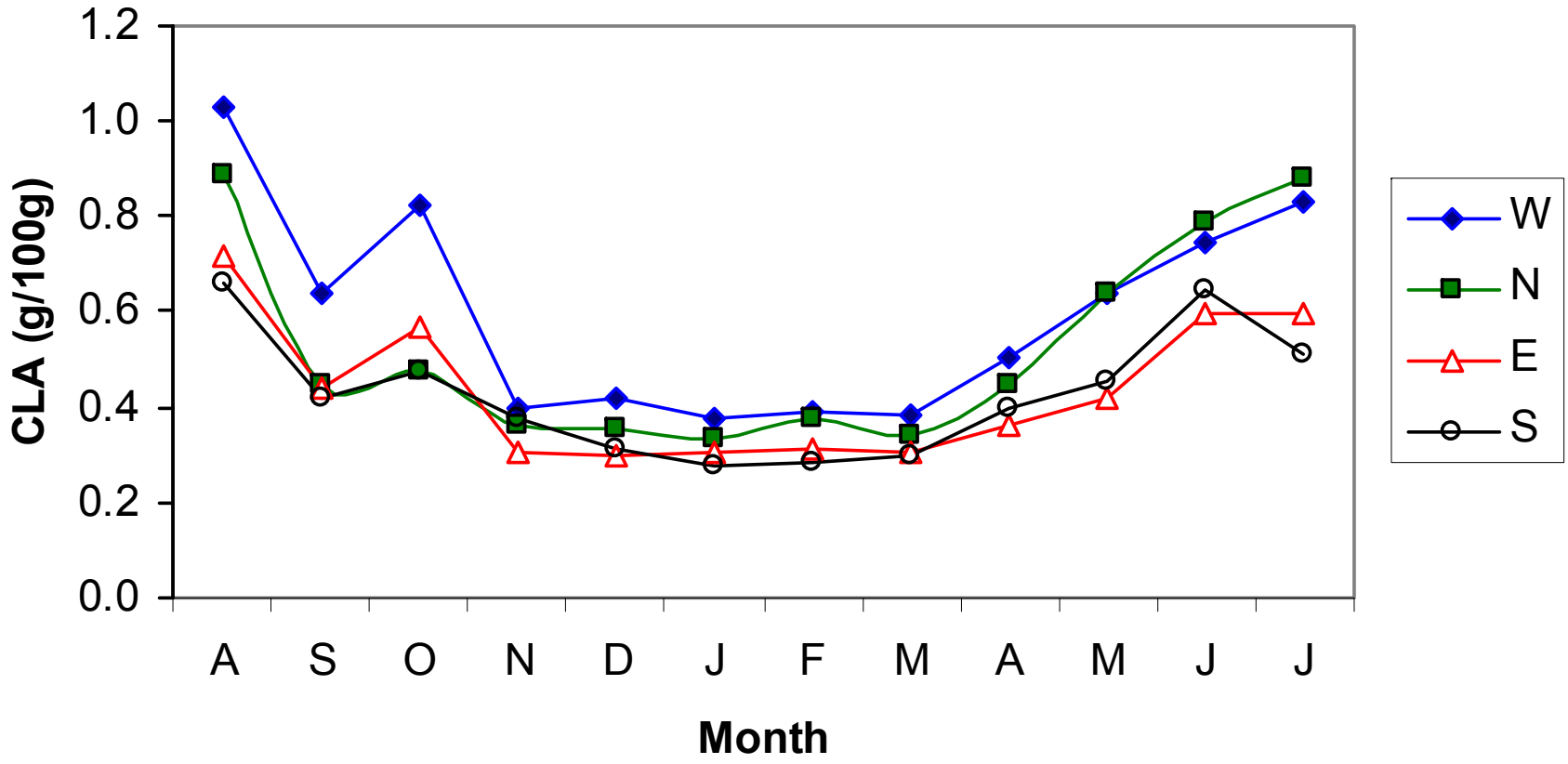
Relation CLA – UFA

Pooled milk, sampled monthly ; conjugated linoleic acid (CLA) and total unsaturated fatty acids (UFA)



Elgersma et al. 2006

Seasonal and regional effects on CLA in Dutch milk



EAAP 2013

Recent results from The Netherlands

Capuano e.a., Rikilt-WUR, 2014

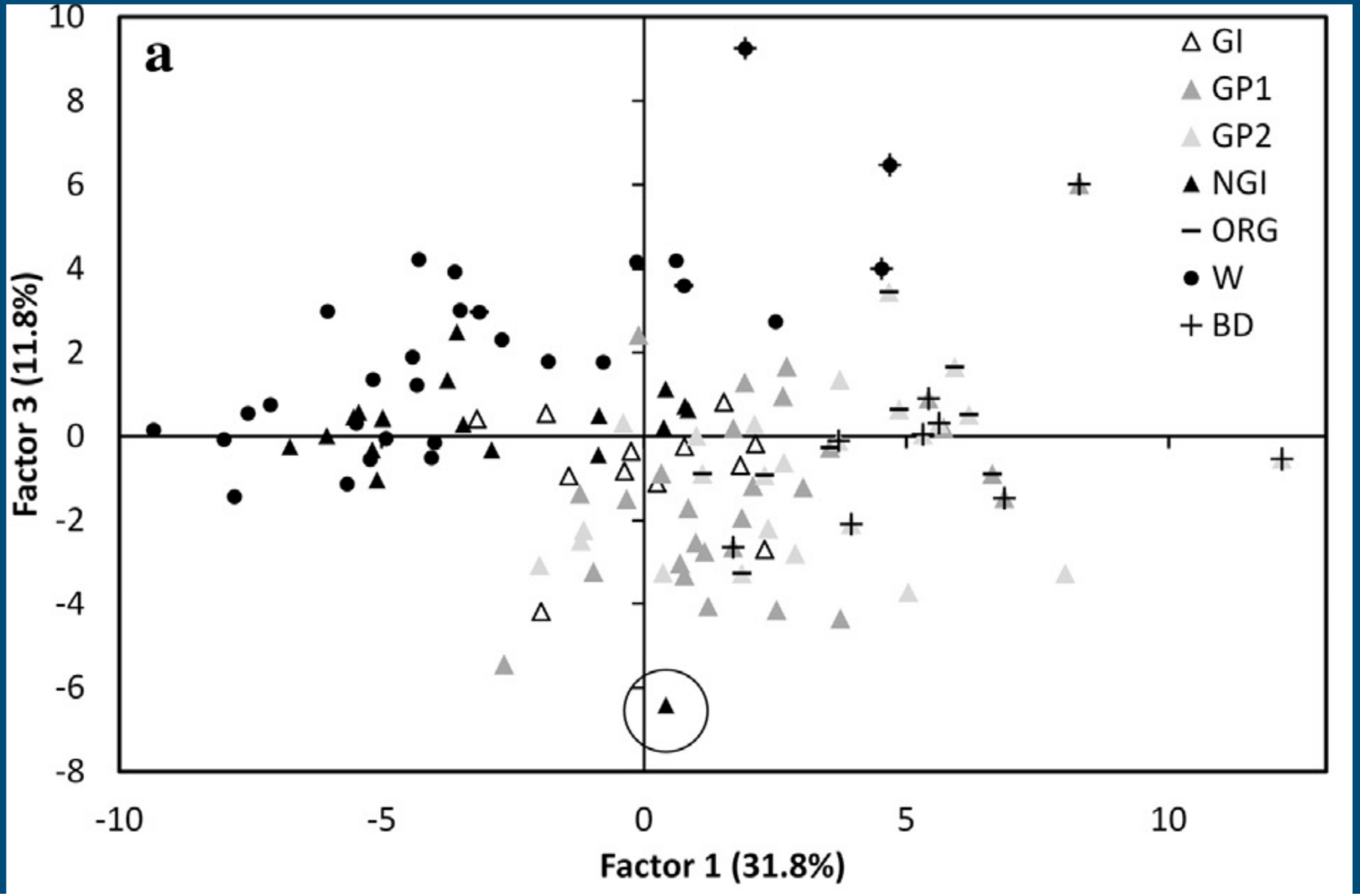
FA profiles - Food Chem
Triglyceride profiles - Eur Food Res Techn
Phytanic acid – Int Dairy J

NG, no fresh grass;
GI, cows indoors with cut fresh grass;
Pd, pasture daytime;
Pd+n, pasture day + night;
Org / BD: Pd+n in an organic (Org) or biodynamic (BD) farming system

30 farms sampled in April, May, June/July and February

Contrasts for indoor / outdoor, contrast for fresh grass in diet

FA profiles, PCA scores



FA profiles, PCA scores

Contrasts:

Fresh grass - no fresh grass

Organic/BD milk : tendency but no discrimination based on FA; overlap with conventional grazing systems

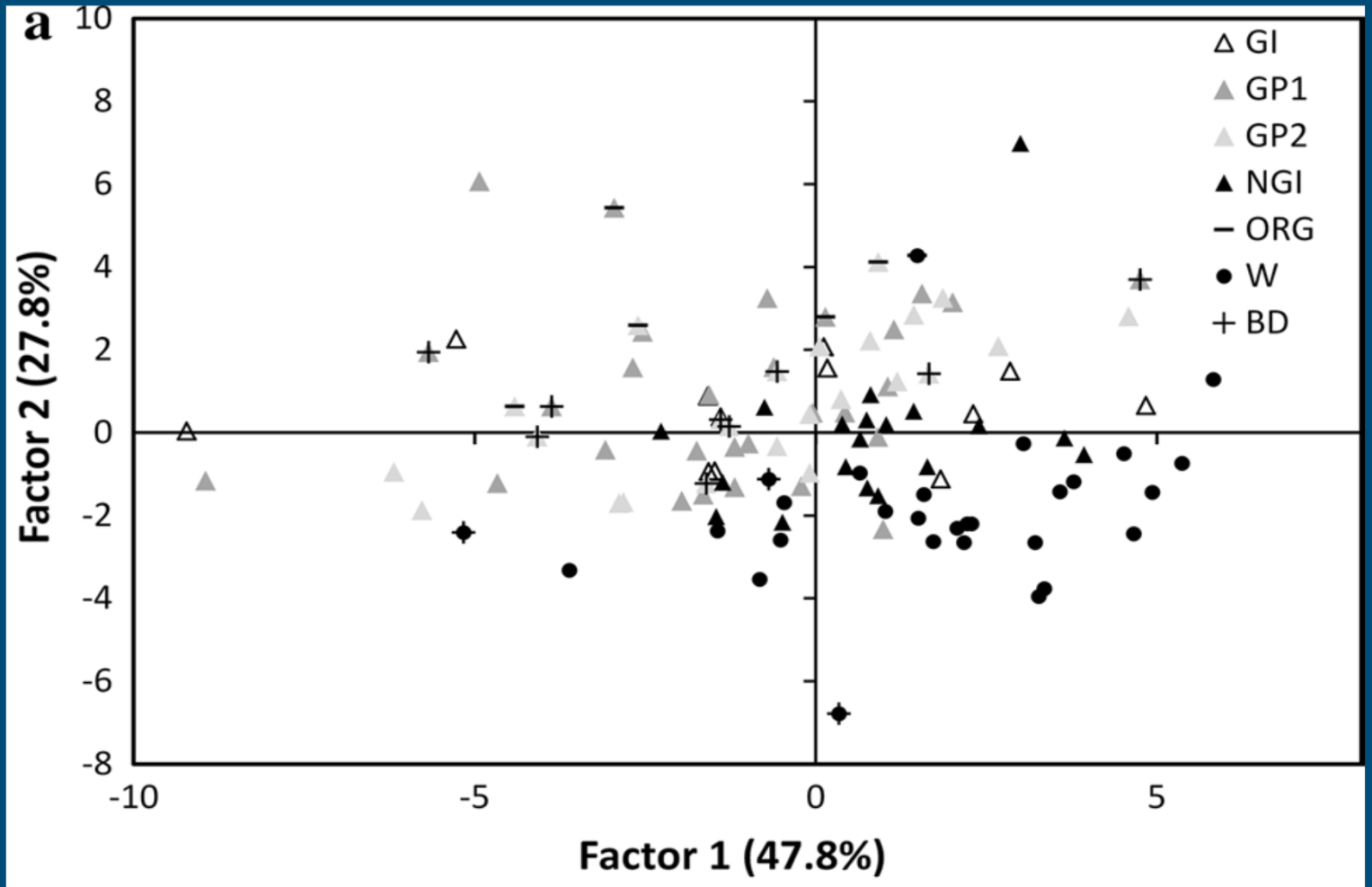
‘Grazed milk’ authentification: no discrimination possible based on FA, overlap with ‘grass indoor’.

Pasture-based milk only differs from indoor systems without fresh grass

Triglyceride profiles, PCA scores

Contrast: no grass (Winter, No Grass Indoor) – grass in diet

Not suitable to distinguish milk from grazing, organic or BD farming systems



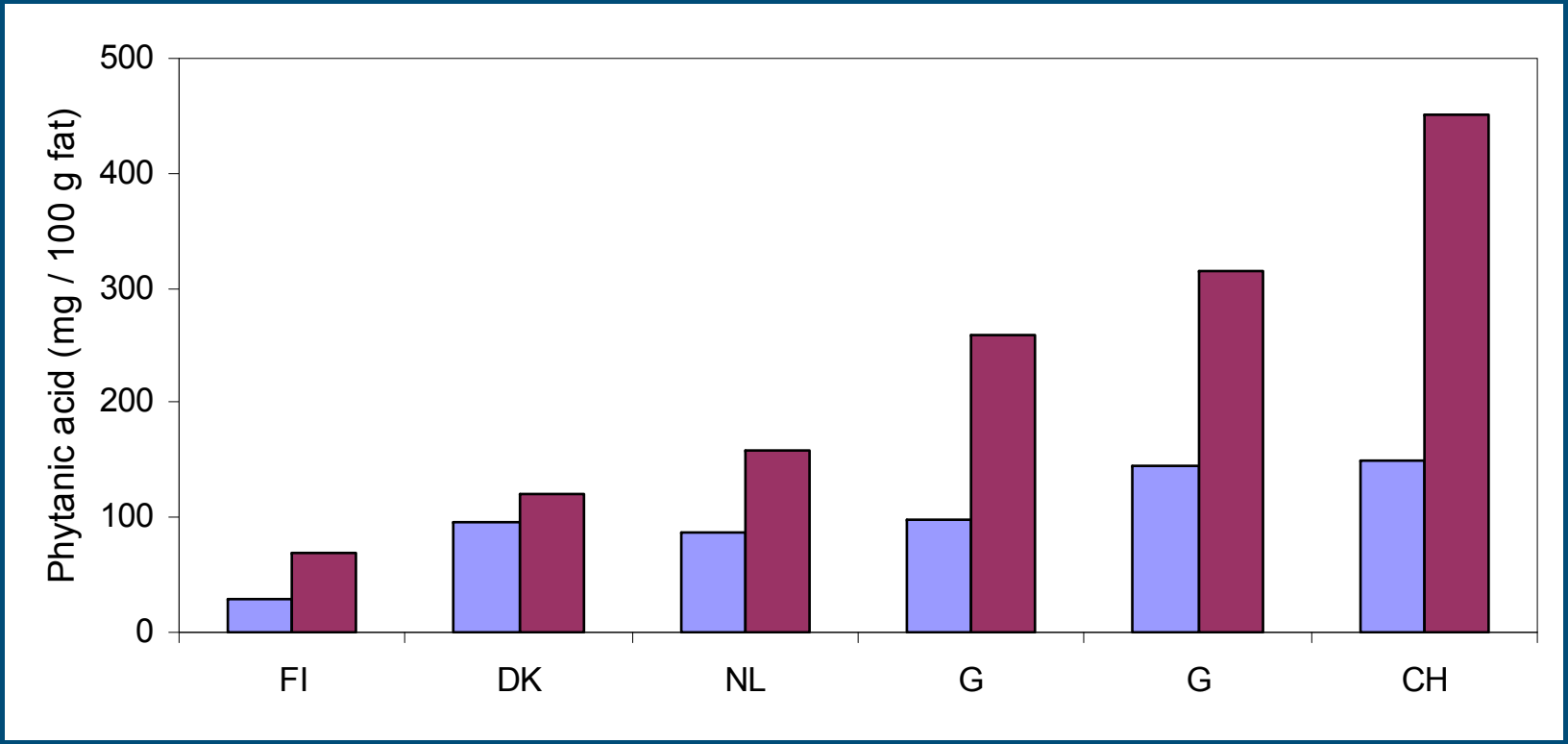
Phytanic acid (PA)

Phytanic acid is a branched-chain FA, produced by bacteria from enzymatic degradation of chlorophyll in the rumen.

PA content in milk depends on phytol from feed.

Is total PA in milk directly related to intake of green feed items? Could it be used as a marker for grass-fed cow milk?

Comparing phytanic acid (PA) across Europe



Minimum and maximum PA contents in cow milk, reported in 6 studies across Europe

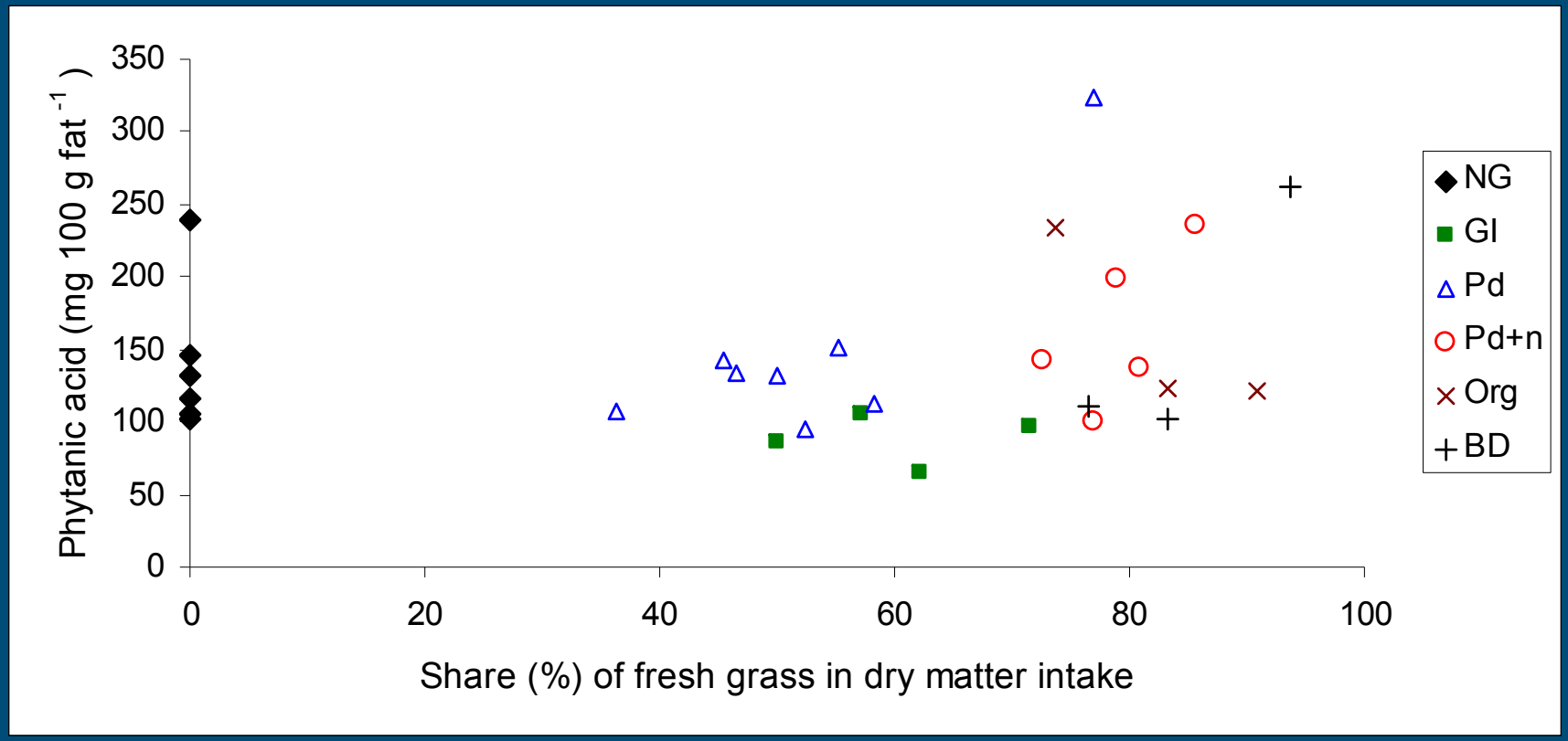
Phytanic acid (PA) in milk across Europe

- Germany:
  - PA with mixed ration: 98 – 116 ; with hay 153; with grass silage 259 mg / 100 g (Schroeder et al. 2012, Eur Food Res Techn 234: 955-962)
  - PA with 50% green fodder 146; with 87.5 % green fodder 314 mg/100g (Schroeder et al. 2011, Eur Food Res Techn 232: 167-174)
  - PA twice as high in summer as in winter (Baars et al., 2012, Org Agric 13-21)
- Switzerland (Leiber et al. 2005, Lipids 40: 191-202)
  - PA with mixed ration of hay, grass silage, maize silage and concentrates 150, with only fresh grass 450 mg/100g
- Finland (Vanhatalo et al., 2007, Eur J Lipid Sci Techn 109, 856-867)
  - PA with red clover silage (60-70) and grass silage (30)

PA in milk, related to diet, season, breed..

- Denmark: (Che et al., 2013)
  - PA higher in Sept (n=5, 121) than in May (n=5, 96 mg / 100g)
  - PA not related to breed
  - PA not related to intake of green feed
- The Netherlands: (Capuano et al., 2013)
  - PA not different with grass or no grass in cows' diet
  - PA content in June on average 146 mg/100 g milk fat
  - PA lower with stall-fed cut fresh grass (n=4) than with grazing (n=17): (88 vs 158 mg/100g)

Results from The Netherlands



Phytanic acid in individual raw farm milk samples was **not related** with proportion of fresh grass in the cows' diet.

NG, no fresh grass; GI, cows indoors with cut fresh grass; Pd, pasture daytime; Pd+n, pasture day + night; OB, Pd+n in an organic (Org) or biodynamic (BD) farming system. (Based on data in Capuano et al., 2014, IDJ 35: 21-24)

Diastereomers of phytanic acid

C 7 and C 11 are R configurated, as in phytol. C 3 can be either R or S, as result of biohydrogenation of oxidized phytol.

Two diastereomers exist: 3R,7R,11R (“RRR”) and 3S,7R,11R (“SRR”)

Share of RRR has been investigated

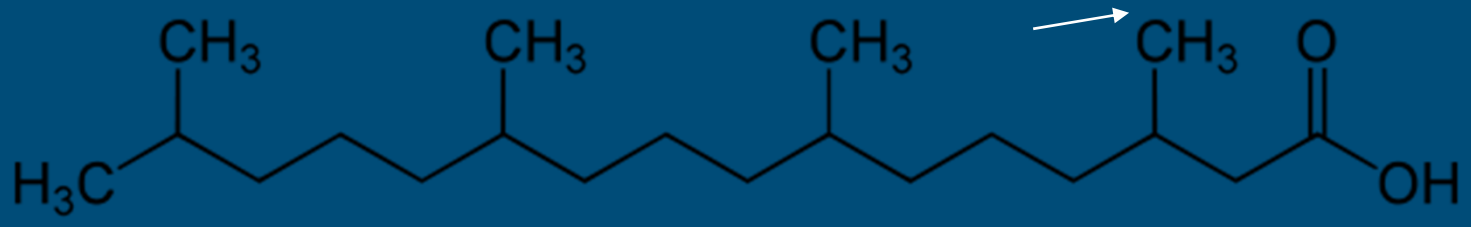


Figure 1. Structure of phytanic acid; the methyl group of carbon 3 (numbered from the carboxyl end) can exist in either an S or R configuration.

Results from Denmark

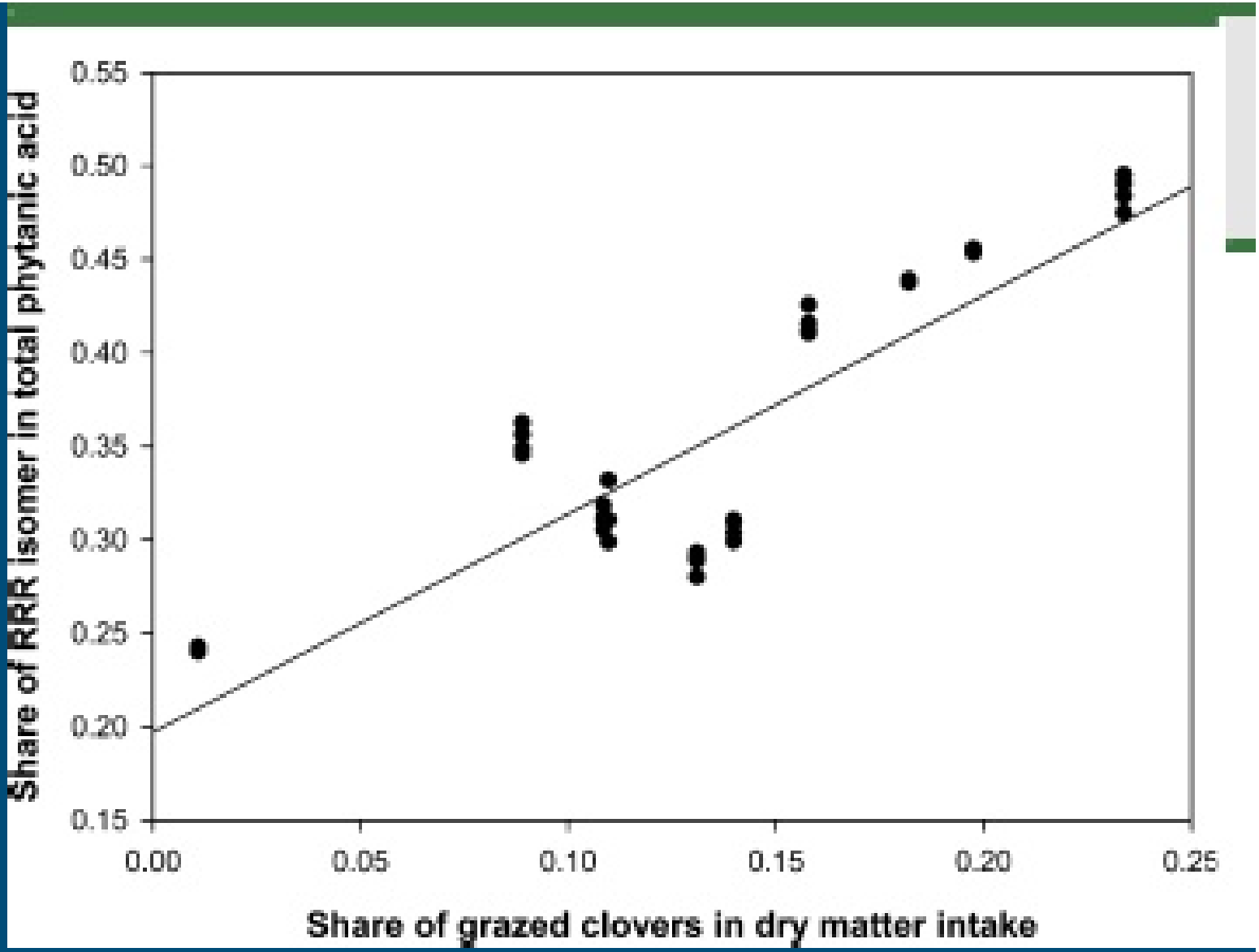
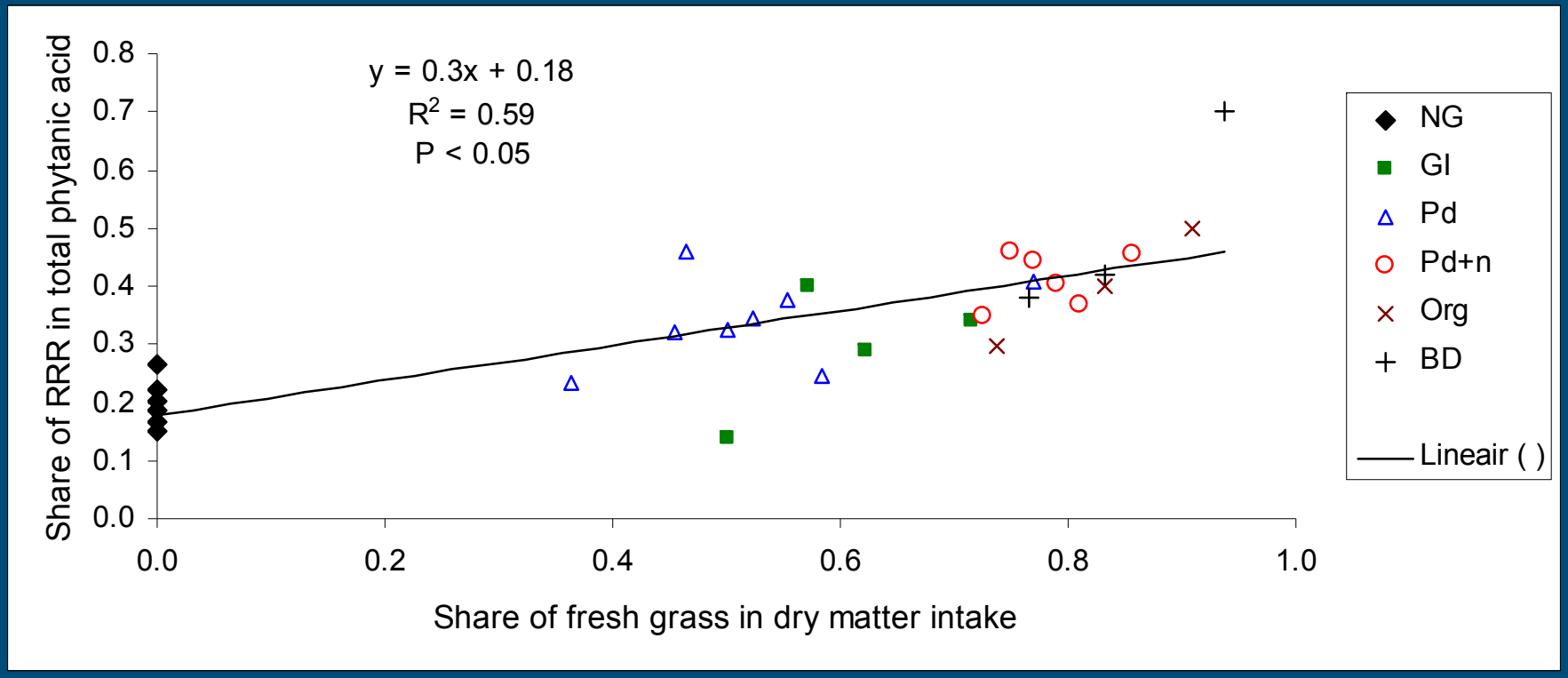


Figure 1. Share of RRR in total phytanic acid in relation to the share of grazed clovers in cows' DM intake. (Che et al., 2013, J Agr Food Chem 61: 225-230)

Results from The Netherlands



Share of RRR in total phytanic acid in individual raw farm milk samples related to the proportion of fresh grass in the cows' diet.
NG, no fresh grass; GI, cows indoors with cut fresh grass; Pd, pasture daytime; Pd+n, pasture day + night; OB, Pd+n in an organic (Org) or biodynamic (BD) farming system (Modified from Capuano et al., 2014, IDJ 35: 21-24)

Conclusions

- Milk fat higher in winter but not suitable as only marker
- FA content and FA or TAG profile related to green feed in ration, but not suitable as only marker
- Milk of grazing cows not different from cows fed grass indoors
- Large variation in phytanic acid (PA) contents across countries
- Relation PA with fresh grass not always found; total diet is important
- RRR isomer share was related to proportion of clover (DK) and of fresh grass (NL) in cows' diet

Thanks to:

Participating farmers

M.K. Larsen and colleagues, Aarhus University, DK

E. Capuano and colleagues of Rikilt Institute of Food Safety, WageningenUR, NL

Thank you for your attention

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