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Performance and beef quality of growing bulls offered whole crop legume-cereal and alsike clover silages

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Outline

- Background
- Objectives
- Materials & methods
- Results
- Conclusions

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Background

- 1) Alsike clover is an interesting alternative forage crop
 - Well suited to acidic, organic soils
 - 2) Producing whole crop small grain cereal silages provides an opportunity to improve the efficiency of forage production for ruminants under Northern European conditions
 - Cost effective, wide harvest window, high yield, benefits in manure spreading and ley re-establishment ect. ect.
- Especially in organic farming systems using different clovers is a conventional approach and annual legumes are often sown with cereals
 - Nitrogen fixing, soil improvement effect ect.
 - Legumes can enhance the nutritional quality of the cereal whole crop silage
 - However, there is paucity of published information:
 - a) on performance,
 - b) carcass characteristics
 - c) meat quality
 - of growing bulls when grass silage is replaced by whole crop legume-cereal or alsike clover silages

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Objective

Our objective was to determine the effects of silage plant species:

- whole crop legume-cereal silage vs. grass
- alsike clover silage vs. grass

On growing beef bulls:

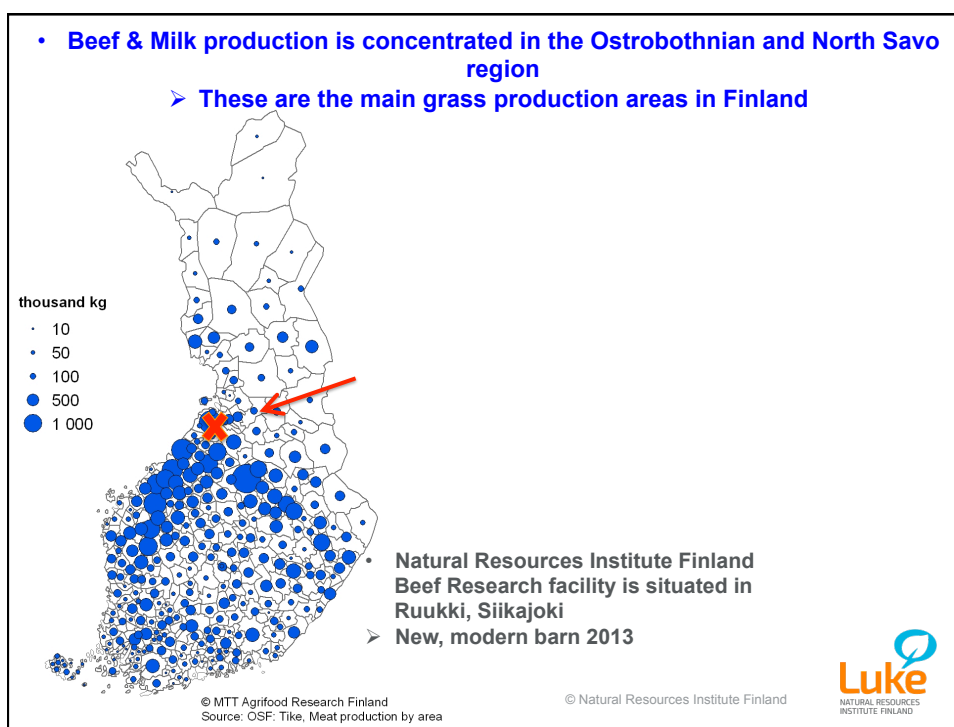
- Aberdeen Angus
- Nordic Red

On the production traits:

- on animal performance
 - ✓ intake, growth, carcass characteristics
- beef quality
 - ✓ pH, marbling, drip loss, shear force, colour, sensory analysis
- beef fatty acid profile

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Materials & methods 1

- **The experiment comprised in total:**
 - ✓ 50 Aberdeen Angus bulls
 - ✓ 50 Nordic Red bulls
 - Four five animal pens / treatment
 - Two pens of each breed / treatment
- The feed intake was measured and recorded with GrowSafe feed intake system
 - Each pen contained two GrowSafe feeder nodes
- During the experiment, the bulls were housed in an uninsulated barn
 - ✓ Peat-straw mixture was used as bedding
 - ✓ Space allowance / bull 10.0 m²

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Materials & methods 2

- The grass silage was the regrowth from a timothy (*Phleum pratense*) sward (TS)
- Alsike clover (*Trifolium hybridum*) was harvested at flowering state (AS)
- Two legume-cereal mixtures:
 - ✓ Faba bean (*Vicia faba*) + wheat (FW)
 - ✓ Pea (*Pisum sativum*) + wheat (PW)
- All silages were preserved in bunker silos & treated with formic acid based additive

| Feeds | | | | | |
|--------------------------------|------|------|------|------|--------|
| | TS | AS | FW | PW | Barley |
| Dry matter (DM), g/kg feed | 289 | 295 | 277 | 269 | 883 |
| Crude protein, g/kg DM | 129 | 164 | 154 | 174 | 107 |
| NDF, g/kg DM | 580 | 450 | 465 | 427 | 210 |
| Metabolisable energy, MJ/kg DM | 10,1 | 9,6 | 9,7 | 9,7 | 13,2 |
| Digestible OM in DM, g/kg DM | 629 | 603 | 608 | 608 | 821 |
| pH | 3,96 | 4,10 | 3,79 | 3,98 | |

- The crude protein content was 19 % higher in FW, 35 % higher in PW and 21 % higher in AS than in TS
- TS had 4 % higher ME content than the whole crop legume-cereal silages
- TS had 5 % higher ME content than the alsike clover silage

Materials & methods 3 – Total Mixed Ration

- The composition of the diets were:
 - All the TMRs had 650 g/kg forage and 350 g/kg cereal in the DM
 - The cereal was rolled barley
 - The TMR was offered for the bulls *ad libitum*

| | TMR (65:35) | | | | |
|---------------------------------------|-------------|---------------|------|------|------|
| | TSB | TASB 50:50 | ASB | FWB | PWB |
| Dry matter (DM), g/kg feed | 378 | 381 | 385 | 365 | 356 |
| Crude protein, g/kg DM | 121 | 133 | 144 | 138 | 151 |
| NDF, g/kg DM | 451 | 408 | 366 | 376 | 351 |
| Metabolisable energy, MJ/kg DM | 11,2 | 11 | 10,9 | 10,9 | 10,9 |
| Digestible OM in DM, g/kg DM | 696 | 688 | 679 | 683 | 683 |
| Protein balance in the rumen, g/kg DM | -2 | 7 | 16 | 11 | 22 |

- Due to differences in composition of the experimental silages the FWB, PWB, TASB and ASB rations had 9-25% more crude protein than the TSB
 - Protein over feeding?
 - In all rations the PBV value fulfilled the Finnish recommendation for growing cattle (PBV above -10 g/kg DM for animals over 200 kg LW)

Materials & methods 4

Statistical model included:

- the effects of **diet, breed and their interaction**
- the effect of the **slaughtering batch**
- the effect of pen was used as an error term when differences between treatments were compared because treatments were allocated to animals penned together
- initial live weight as a covariate in the model
- **Differences between the treatments were tested using orthogonal contrasts:**

Feeding experiment 1:

- 1) Breed (Ab vs. Nordic Red)
- 2) Diet (Grass silage diet vs. WCLC-silage diets)
- 3) Whole crop legume-cereal silage diets (Faba bean vs. Pea)

Feeding experiment 2:

- 1) Breed (Ab vs. Nordic Red)
- 2) Linear effect of alsike clover inclusion
- 3) Quadratic effect of alsike clover incl.
- 4) Linear interaction between breed and alsike clover incl.
- 5) Quadratic interaction between breed and alsike clover incl.

Since the interactions between breed and feeding treatments were not statistically significant, the interactions are not presented

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Results 1 – Duration, liveweights & age



- **The Nordic Red bulls weighed in average 115 kg less** than the Angus bulls in the beginning of the experiment
- **The final live weight was in average 104,6 kgs higher for the Angus bulls**
- The duration on the experiment was in average **49 days shorter for the Angus**
- **PWB diet tended to shorten the duration of the experiment (P=0,02)**
- There were no differences in the slaughter age

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Results 2 – Feed intake

| | Angus | | | | | Nordic Red | | | | |
|---------------------------------|-------|-------|-------|-------|-------|------------|-------|-------|-------|-------|
| | TSB | TASB | ASB | FWB | PWB | TSB | TASB | ASB | FWB | PWB |
| Dry Matter, kg/d | 12,20 | 12,45 | 12,01 | 13,40 | 12,15 | 10,95 | 10,87 | 10,97 | 12,33 | 10,44 |
| DMI, g/kg live weight | 20,5 | 21,0 | 20,4 | 22,6 | 20,5 | 22,6 | 23,2 | 23,0 | 25,2 | 23,1 |
| Metabolizable energy (ME), MJ/d | 136 | 136 | 131 | 143 | 132 | 123 | 119 | 120 | 132 | 113 |
| Crude protein, g/d | 1457 | 1635 | 1707 | 1840 | 1834 | 1317 | 1432 | 1561 | 1688 | 1565 |

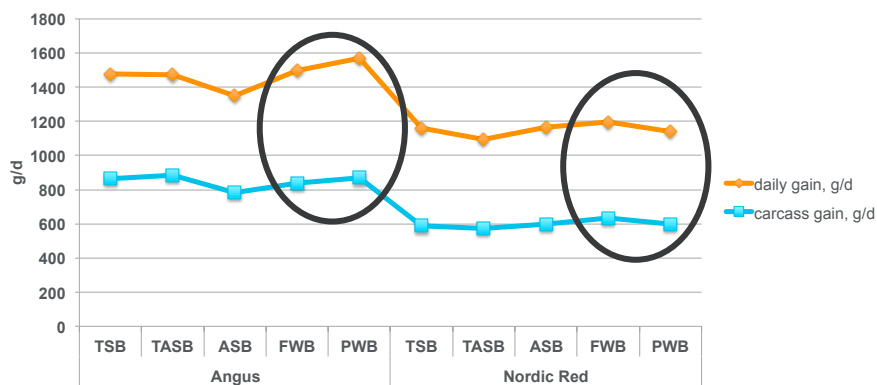
- The total **DMI** of the **Angus bulls** was **12 % higher**
 - **Daily ME and CP intakes were higher for Angus bulls (exp 1. P=0,005; exp 2. P=0,003)**
- **DMI relation to LW was 11 % higher in the Nordic Red bulls (exp 1. P=0,01; exp 2. <0,001)**
- **The FBW diet tended to increase DM and energy intakes (P=0,006)**
- CP intake were higher with whole crop legume silage and alsike clover diets (exp 1. and exp. 2 <0,001)

Results 3 - Feed conversion

| | Angus | | | | | Nordic Red | | | | |
|-----------------------|-------|------|------|------|------|------------|------|------|------|------|
| | TSB | TASB | ASB | FWB | PWB | TSB | TASB | ASB | FWB | PWB |
| Kg DM/kg carcass gain | 13,9 | 14,3 | 15,6 | 16,1 | 14,1 | 19,4 | 19,7 | 19,0 | 19,8 | 17,9 |
| MJ ME/kg carcass gain | 151 | 156 | 174 | 172 | 154 | 211 | 216 | 212 | 212 | 194 |
| g CP/kg carcass gain | 1688 | 1845 | 2188 | 2223 | 2154 | 2236 | 2499 | 2636 | 2714 | 2641 |

- There were no significant differences in DM or energy conversion rates when replacing timothy silage with alsike clover silage
- **CP conversion reduced linearly with increasing alsike clover inclusion**
- ✓ **The PWB diet tended to increase feed efficiency of the bulls (<0,001)**
- ✓ **The FBW diet tended to reduce the feed efficiency of the bulls (<0,001)**
- ✓ **Angus bulls used 4,36 kg less feed DM and needed 47,6 MJ less feed energy for 1 kg carcass gain** than the Nordic Red bulls
- ✓ Angus bulls were in average 23 % more efficient in converting the feed to carcass gain than the Nordic Red bulls
- **The bulls could not utilize the additional protein obtained through feeding**

Results 4 – Daily gain & Carcass gain



Angus: live weight vs. carcass gain:

➤ 1473,4 vs. 847,4 g/d

Nordic Red: live weight vs. carcass gain:

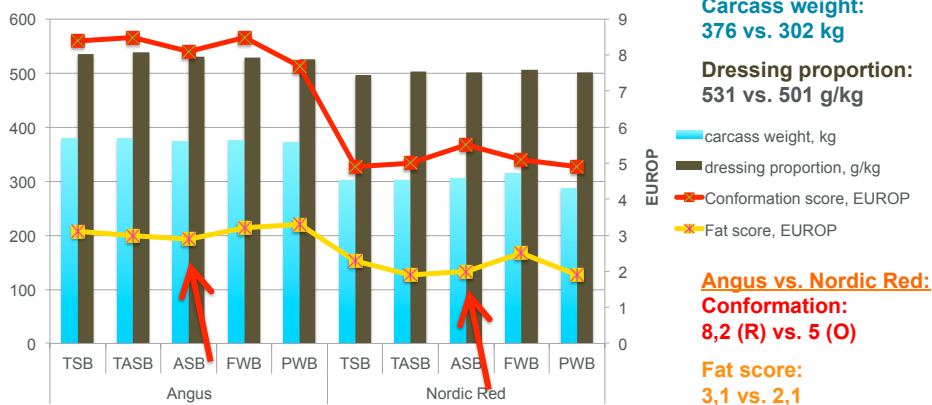
➤ 1151,6 vs. 598,6 g/d

- ✓ Angus bulls grew faster
- ✓ Trend for slightly better growth with WCL silage diets (P=0,16)
- ✓ **No treatment differences**

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Results 5 – carcass traits



Angus vs. Nordic Red:

Carcass weight:
376 vs. 302 kg

Dressing proportion:
531 vs. 501 g/kg

Legend:
■ carcass weight, kg
■ dressing proportion, g/kg
■ Conformation score, EUROP
■ Fat score, EUROP

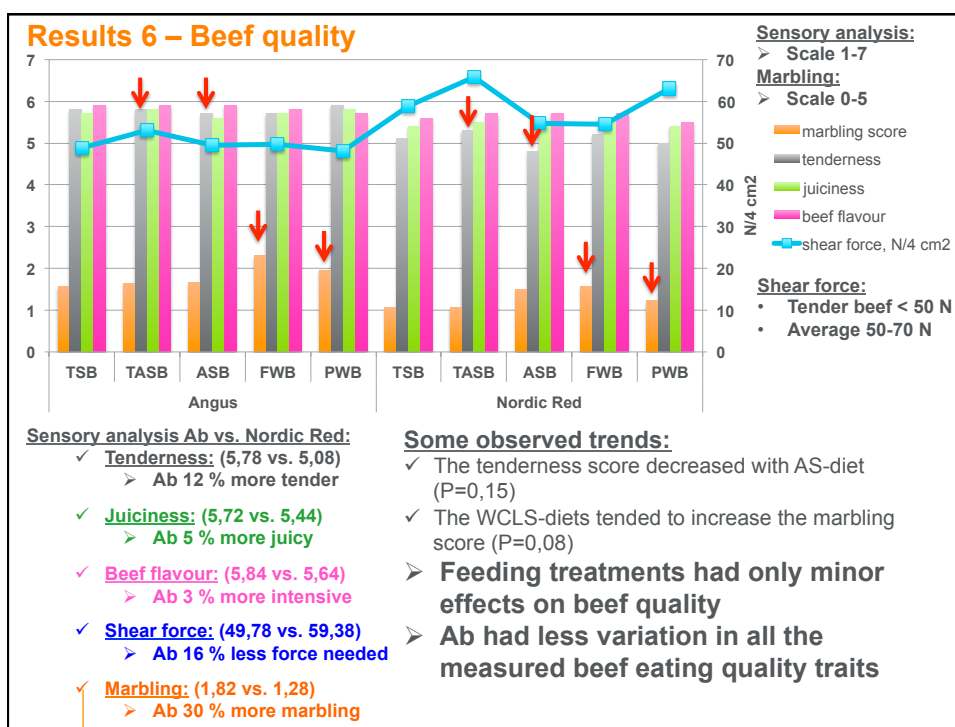
Angus vs. Nordic Red:

Conformation:
8,2 (R) vs. 5 (O)

Fat score:
3,1 vs. 2,1

Some observed trends:

- With AS diets the bulls had slightly poorer carcass weight and conformation class (P=0,14)
- The carcass weight of **FWB bulls was 9 % higher than the PWB bulls** (P=0,02)
 - The conformation score of FWB bulls was also higher (P=0,04)
- **Carcass fat score tended to decrease when replacing TS by AS (P=0,07)**
 - **Might be associated with the enzyme polyphenol oxidase > plant selfprotection** (Lee et al. 2007)
 - **Results in lower level of dietary lipolysis in the rumen > prerequisite for biohydrogenation of unsaturated fatty acids** (Lee et al. 2009)



Results 7 - Fatty acid profile

| | Angus | | | | | Nordic Red | | | | |
|---------------------------------|-------|-------|-------|-------|-------|------------|-------|-------|-------|-------|
| | TSB | TASB | ASB | FWB | PWB | TSB | TASB | ASB | FWB | PWB |
| Saturated fatty acids, % | 45,92 | 44,33 | 44,11 | 46,00 | 46,10 | 42,44 | 43,29 | 44,52 | 43,71 | 45,33 |
| Monoun saturated fatty acids, % | 46,27 | 47,20 | 47,72 | 46,90 | 46,40 | 48,99 | 48,99 | 47,41 | 48,36 | 46,02 |
| Polyun saturated fatty acids, % | 6,71 | 7,52 | 7,38 | 6,24 | 6,57 | 7,53 | 8,18 | 7,89 | 7,00 | 7,71 |
| n6/n3 fatty acid ratio | 3,01 | 2,90 | 2,91 | 3,20 | 3,10 | 4,33 | 4,31 | 4,12 | 4,29 | 4,49 |

- The loin samples of the **Angus bulls contained a higher proportion of saturated fatty acids (<0,001)**
- Angus bulls tended to contain lower proportion of mono- and polyunsaturated fatty acids compared to the NR bulls
- **The n-6/n-3 fatty acid ratio of the Nordic Red bulls was 30% higher than the corresponding value of the Angus bulls (<0,001)**
- **AS diet tended to produce beef with lower n-6/n-3 fatty acid ratio**
 ➢ **The effect was even more pronounced in Nordic Red bulls (P=0,23)**

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Conclusions

- At fixed 500 days slaughter age **breed differences were observed:**
 - ✓ in growth
 - ✓ carcass traits
 - ✓ beef quality
- The results indicate that Aberdeen Angus bulls produced beef with a lower n-6/n-3 fatty acid ratio compared to Nordic Red bulls (more healthier)
- **Replacing moderately digestible timothy silage by whole crop legume-cereal silages or alsike clover silage in the diet did not have any remarkable effects:**
 - on animal performance
 - carcass characteristics or
 - beef quality of the growing bulls
- **The possibility of protein over feeding should be taken into consideration in ration planning with high CP legume forages**

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