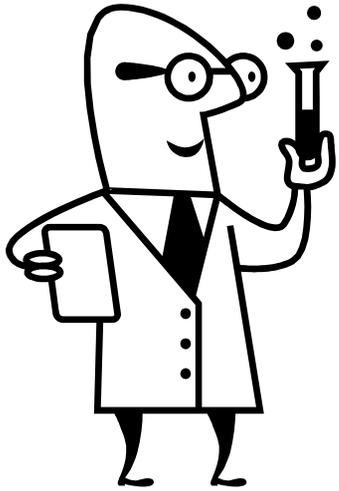


# N supply in stockless organic cereal production under northern temperate conditions. Undersown legumes, or whole-season green manure?

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# Outline



- **Background**
- **Aim**
- **Experimental design**
- **Cereal yields**
- **N balance**
- **Conclusions**



# Background

- Large and increasing demand for organic cereals (food and fodder)
- Main challenges for organic cereal production:



Soil structure



Nutrient supply,  
especially N

(Perennial)  
Weeds



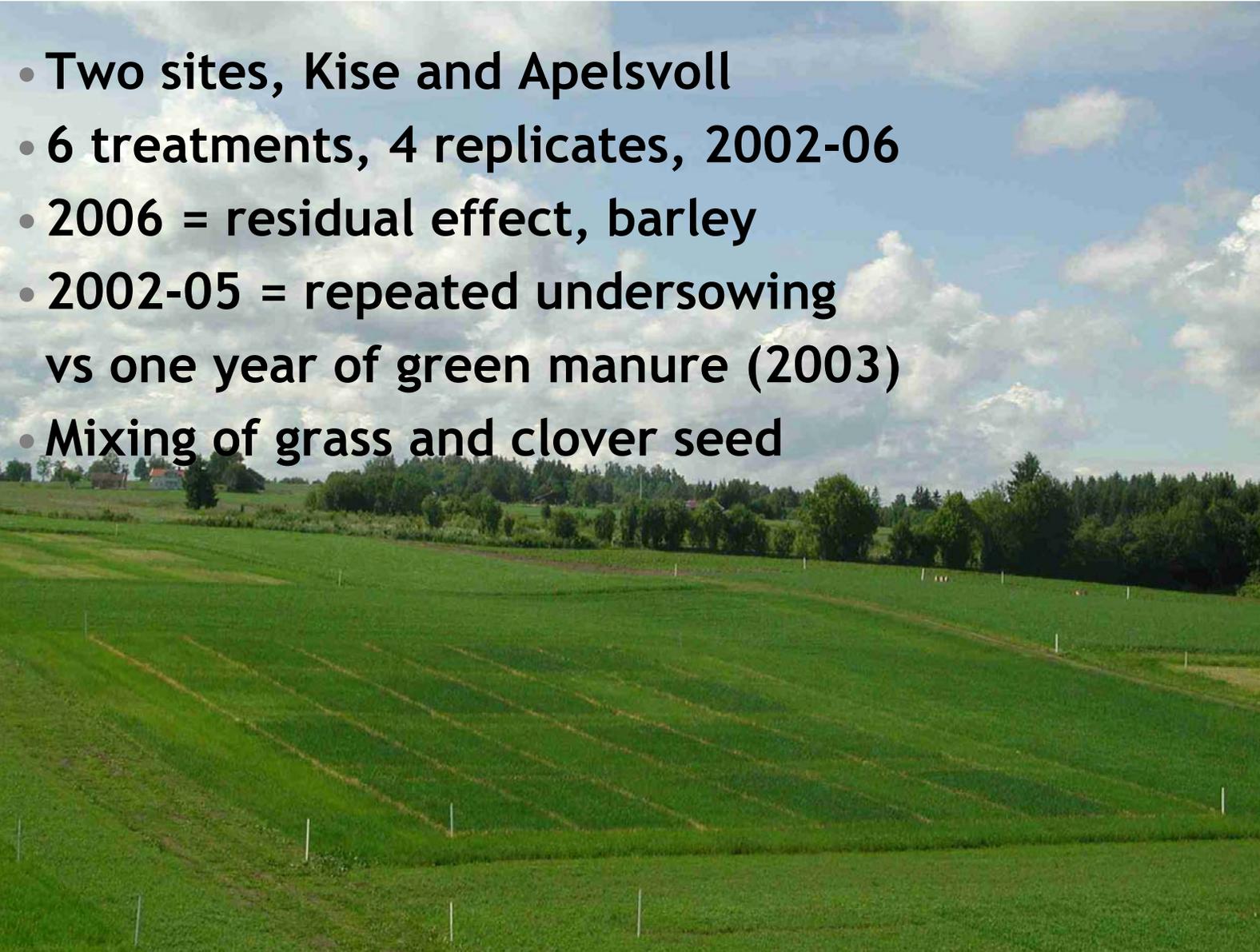
# Aim

- Is repeated undersowing of clover in cereals a well functioning green manuring strategy for commercial grain production on stockless organic farms?



# Experimental design

- Two sites, Kise and Apelsvoll
- 6 treatments, 4 replicates, 2002-06
- 2006 = residual effect, barley
- 2002-05 = repeated undersowing vs one year of green manure (2003)
- Mixing of grass and clover seed



Treatment	2002 Oats	2003 Spring wheat	2004 Oats	2005 Spring wheat	2006 Spring barley
0 Control, weed harrowed					
1 Control					
2 Undersown ryegrass	Ryegrass	Ryegrass	Ryegrass	Ryegrass	
3 Undersown clover	Red clover	White clover	Red clover	White clover	
4 Undersown mix	Red clover and ryegrass	White clover and ryegrass	Red clover and ryegrass	White clover and ryegrass	
5 Green manure mix	Red clover and timothy	Red clover and tim., ley			
6 Green manure red clover	Red clover	Red clover, ley			

No text = only cereals. Yellow = cereals. Clover = green. Undersown species = text.

# Records

- Yields of cereals and straw

- Aboveground biomass (AGB)

  - weeds

  - undersown crop(s)

  - cereals

*Recorded in early spring (end of April) - Mid Summer (early July) - harvest (early Sept.) - late autumn (late Oct.)*

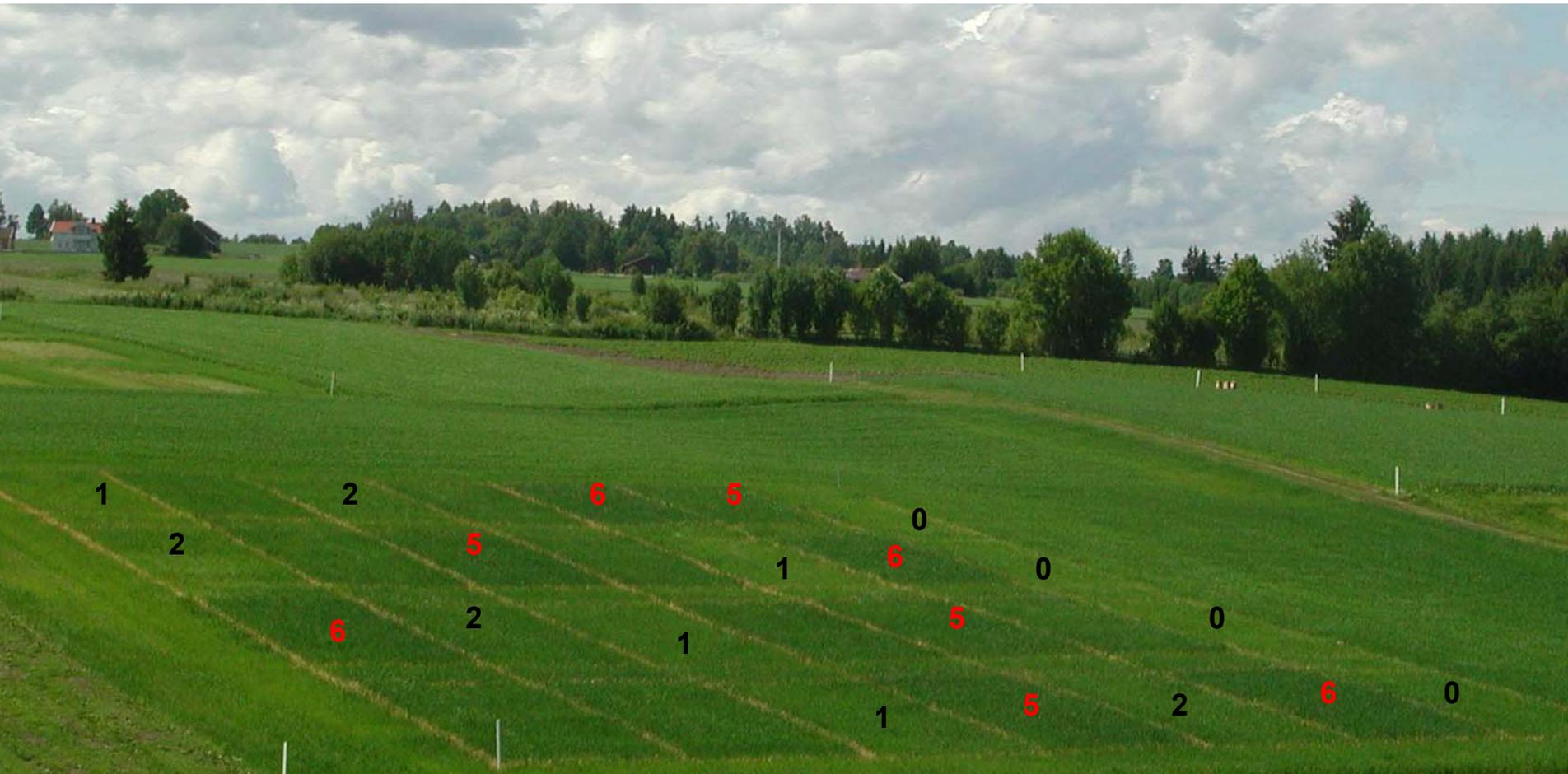
- NPK in AGB, % of dry matter (DM)

- Mineral N in soil ( $N_{\min}$ )

*Early spring and late autumn*



Field at Apelsvoll, June 2004. Photo Trond M. Henriksen.



Treatment 0: Weed harrowed, not included in main experiment.

Treatment 1: No undersowing, tr. 2 ryegrass undersown.

Treatment 5, 6: Red clover ley 2003, established 2002.

# Cereal yields



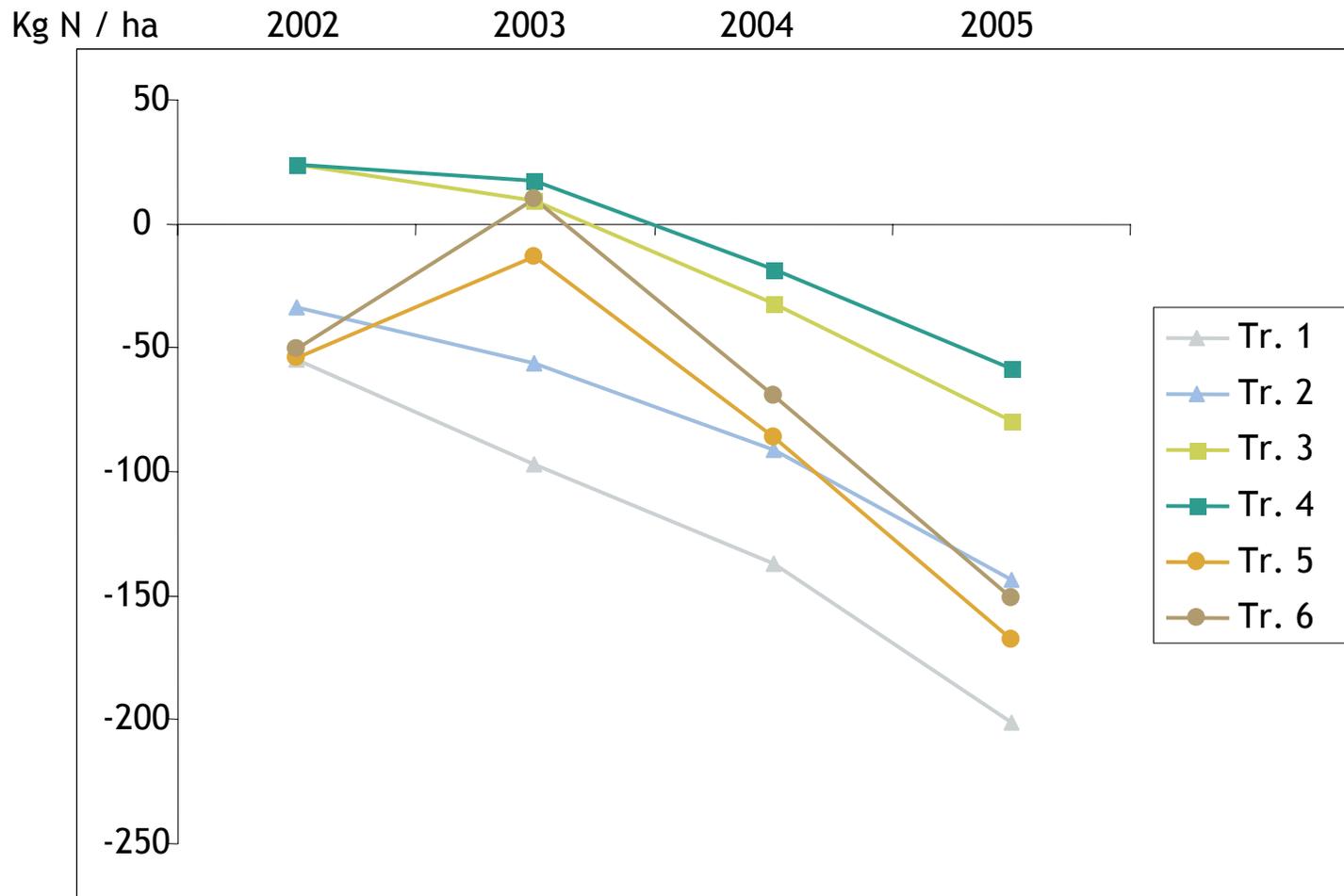
Tons ha<sup>-1</sup> (15% water), average for both sites

Treatment	Starting year, 2002		Average 2003-05		Residual effect, 2006	
	T / ha	Relative %	T / ha	Relative %	T / ha	Relative %
1	2.98 a	100	2.96 a	100	1.51 a	100
2	2.83 a	95	3.06 ab	103	1.71 a	113
3	2.53 a	85	3.86 b	129	1.99 a	132
4	2.69 a	90	3.76 ab	127	1.99 a	132
5	2.68 a	90	3.17 ab	107	1.73 a	114
6	2.65 a	89	3.23 ab	109	1.62 a	107

Within year or period, yields with different letters (a, b) are significantly different ( $p < 0.05$ ).



# Accumulated N balance

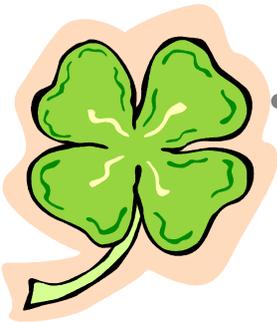


N balance = kg N in AGB of undersown green manure in late October x 1.25 minus kg N in cereals removed in September. Average for both sites.



# Conclusions

- Considerable effect of green manuring, on average 30% larger yields the year after undersowing of clover
- Yield increase comes in the subsequent year
- One year out of four with clover ley gives a large yield increase, but not enough to compensate one year without cereal yields
- Combine whole-season green manure and undersown clover? Be aware of phytopathological risks! (nematodes, fungi, beetles)
- Without weed harrowing, undersowing increases the weed biomass. Combined harrowing and undersowing is desired.
- Negative accumulated N-balance - cereal yields removed more N than the green manure produced



# Modifications



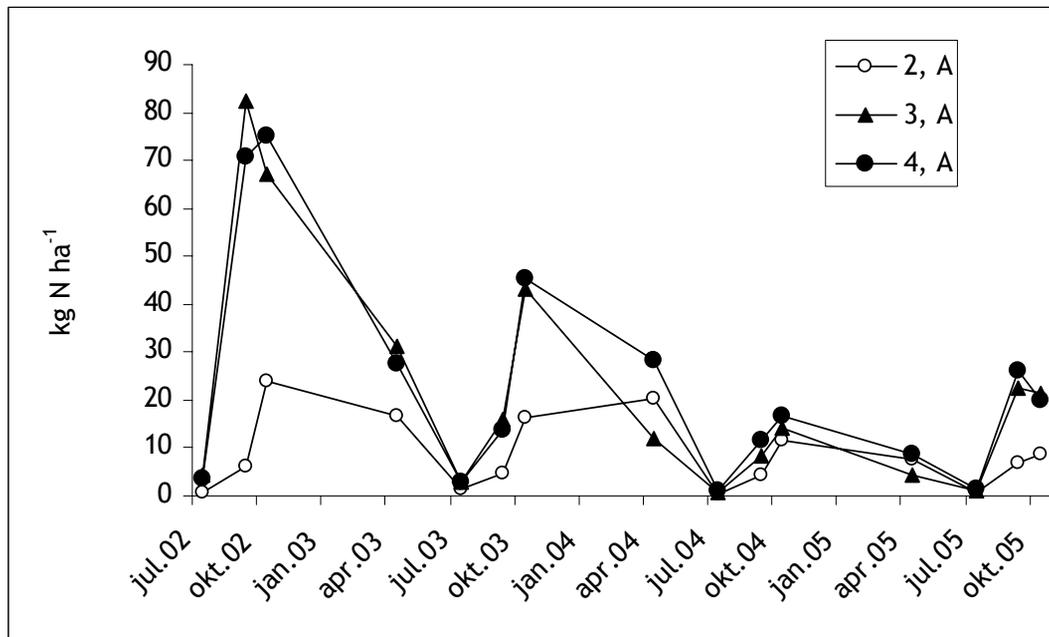
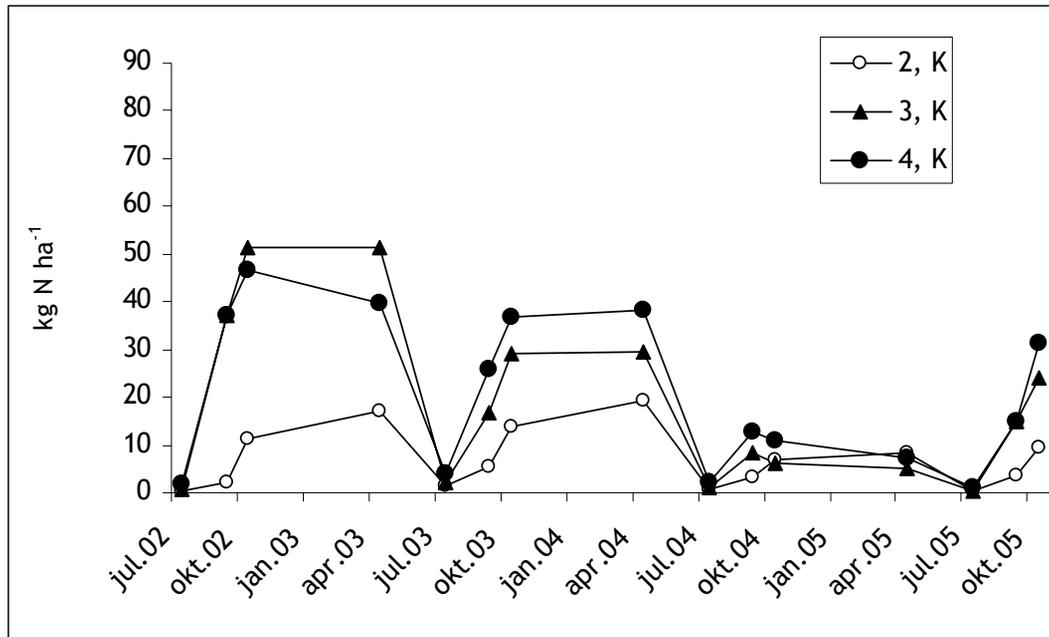
- May low to medium concentrations of soil P and K decrease the potential of N fixation?
- Can we accept a larger part of the crop rotation used for green manure (e.g. 2 years of clover ley, 3 years of cereals = 40%)?
- If no, what can be an acceptable source of N for organic stockless farms?
- Suggestions: Meat and bone meal, human urine





Thanks  
for your  
attention





Kg N ha<sup>-1</sup> in AGB of undersown ryegrass (2), clover (3) or clover+ryegrass (4) at Kise (K) and Apelsvoll (A)

