



Opportunities and limitations in use of clovers as N-source in organic farming systems in Norway

Ievina Sturite

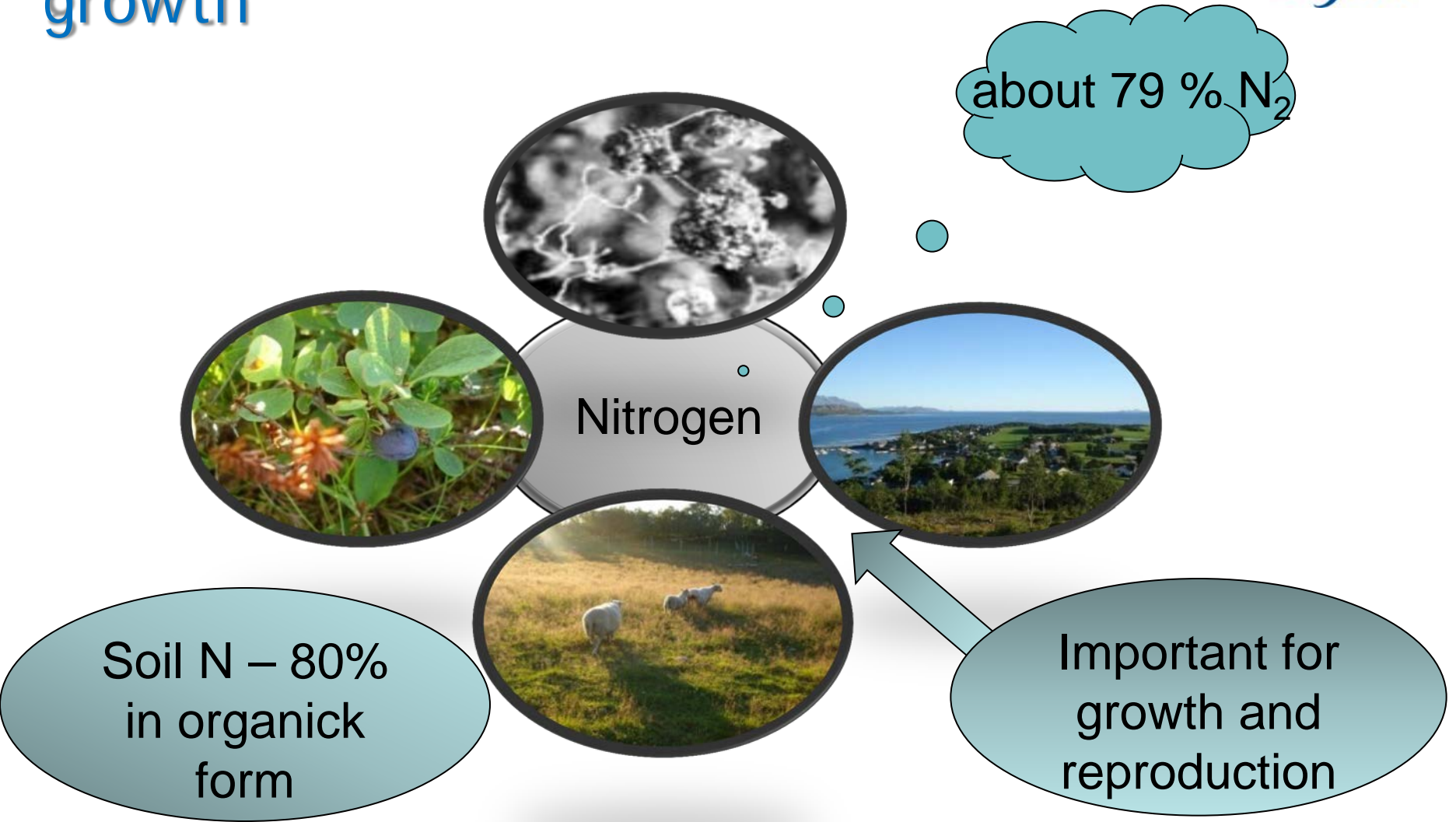
Norwegian Institute for Agricultural and Environmental
Research, Norway

Presentation overview

- Nitrogen (N) – a key nutrient for plant growth
- Clovers contribution to plant-soil system during the growing season
- Off season losses
- What is a fate of lost nitrogen?
- Conclusions



Nitrogen (N) - a key nutrient for plant growth

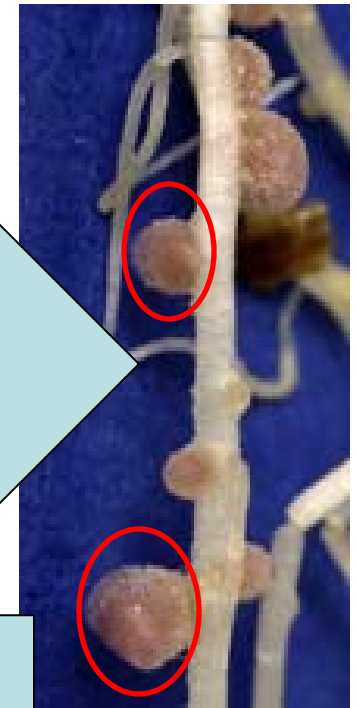


N-fixing plants



in symbiosis
with bacteria
Rhizobium

80% N



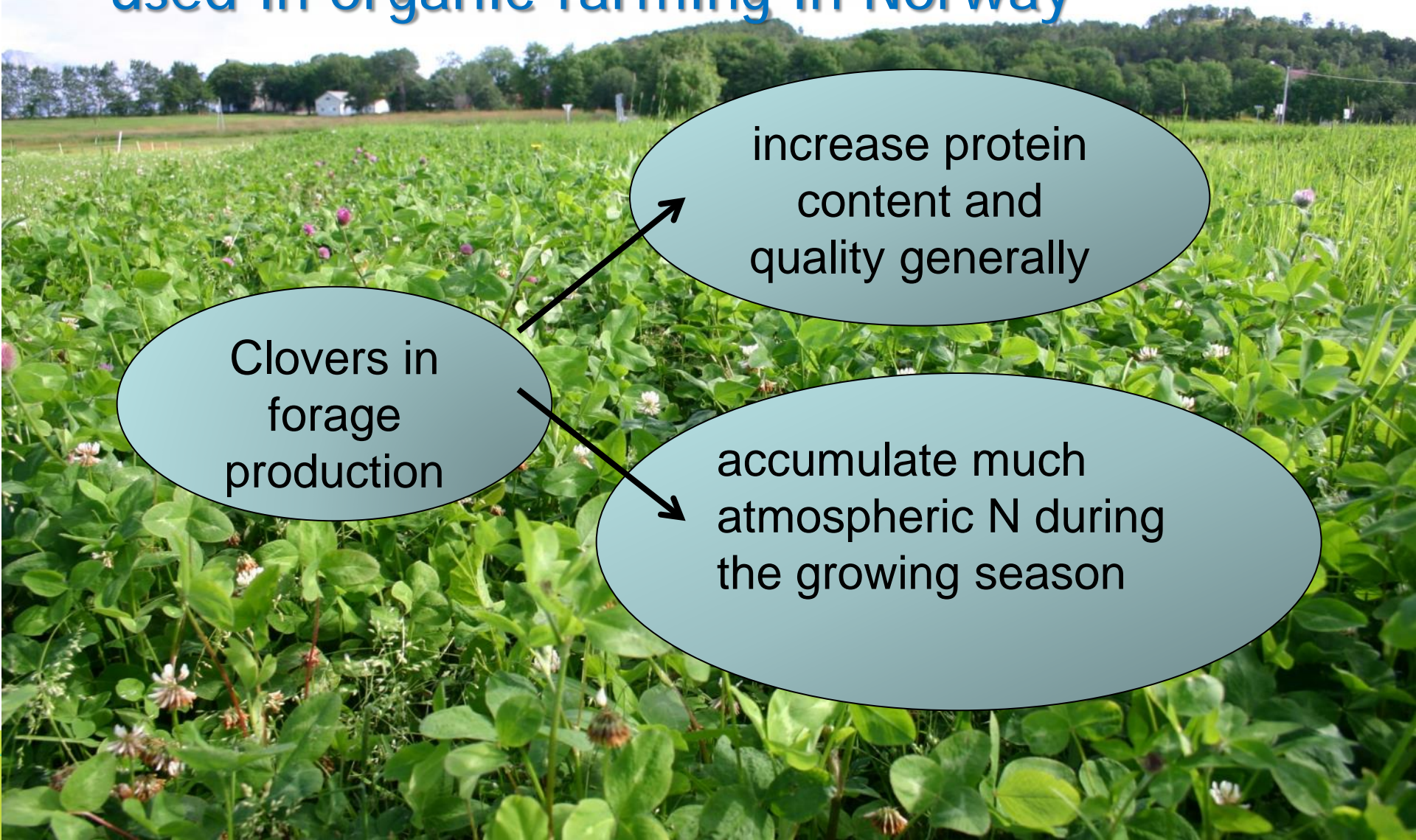
N-fixing plants

N₂ fixation is the second most important biological process on earth

~ 175 MT N₂ is fixed globally each year, accounting for almost 50% of all the N used in agriculture



White and red clover are main legumes used in organic farming in Norway



Clovers in forage production

increase protein content and quality generally

accumulate much atmospheric N during the growing season

30% clover in
seed mixture



100-130 kgN/ha



Tjøtta
Research
Centre in
Northern
Norway

N-content in clover

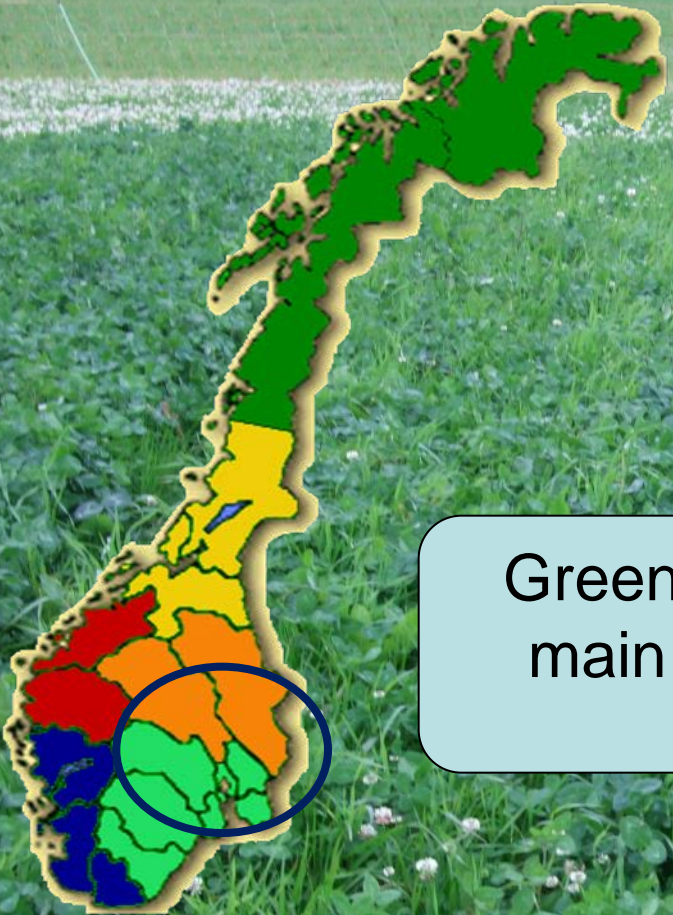
clovers accumulates much atmospheric N during the growing season.

N concentration in herbage ranging from 2.4 to 4.6% of dry matter

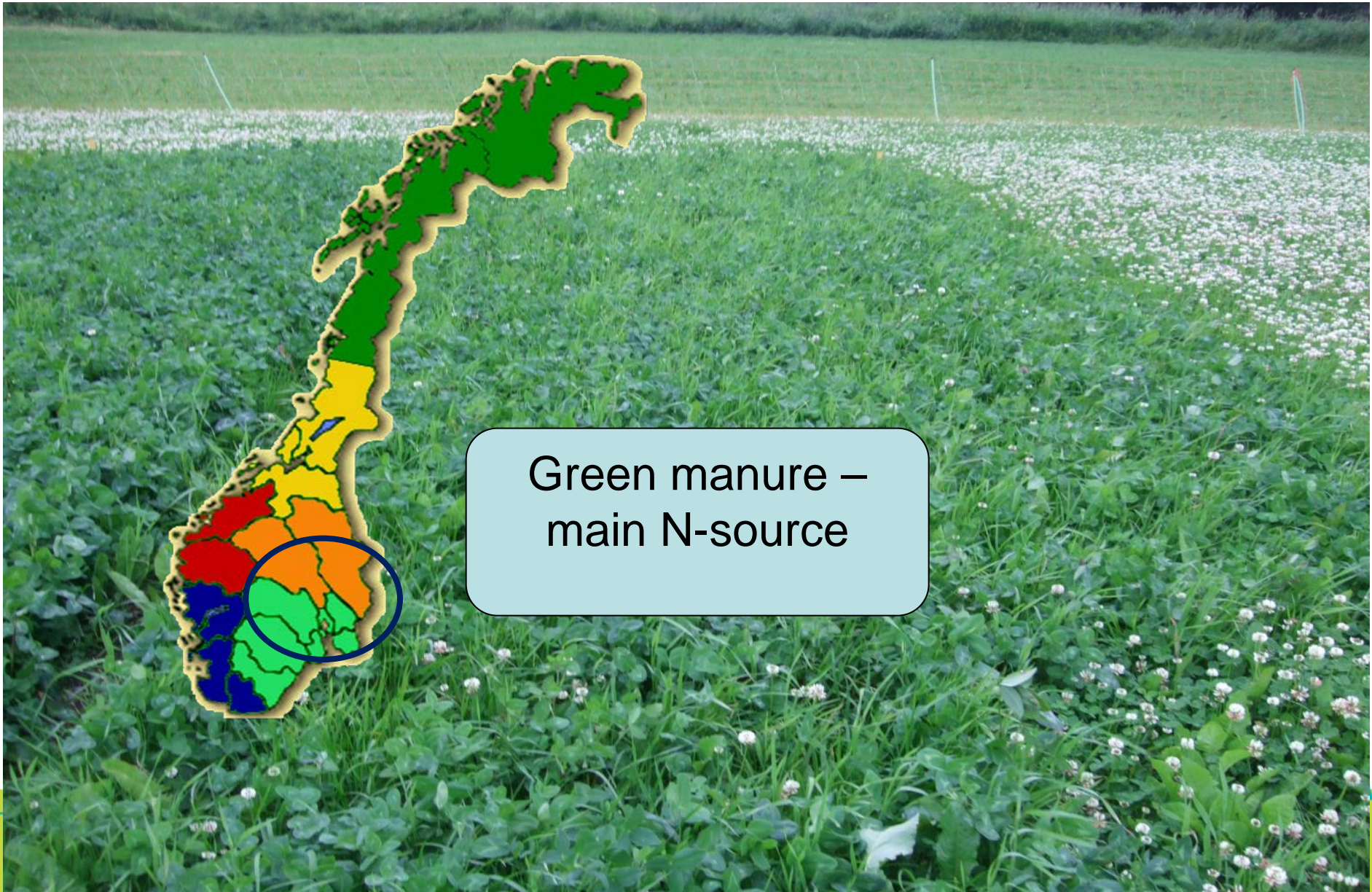
Much of this is returned to the soil via

- ✓ rhizodeposition
- ✓ decomposition of leaves , stolons , roots and nodules
- ✓ grazing animals

Stockless organic crop rotations in Norway



Green manure –
main N-source



Clovers contribution to plant-soil system during the growing season



Apelsvoll Research Centre in Southeast Norway



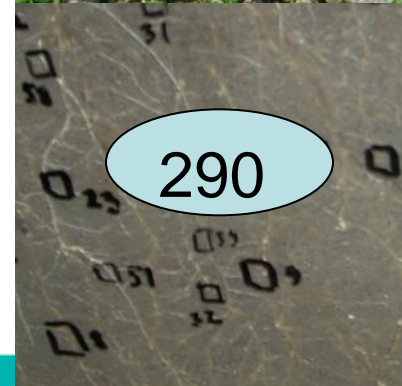
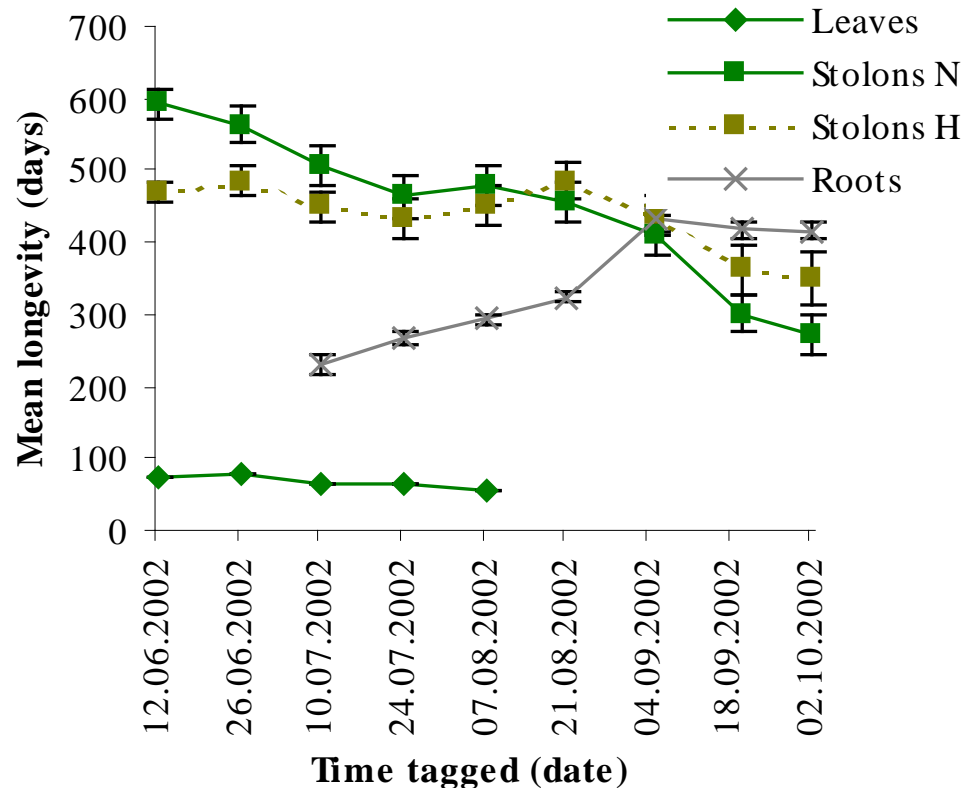
CV "Snowy"



Clovers contribution to plant-soil system

during the growing season

Longevity of white clover plant organs



For non-harvested plants



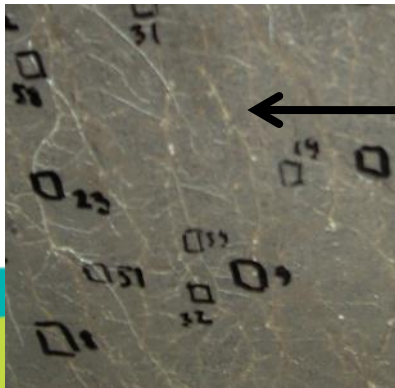
Calculated



60% of the leaves turned over within the growing season



30% of total stolon length was died at the end of the second growing season

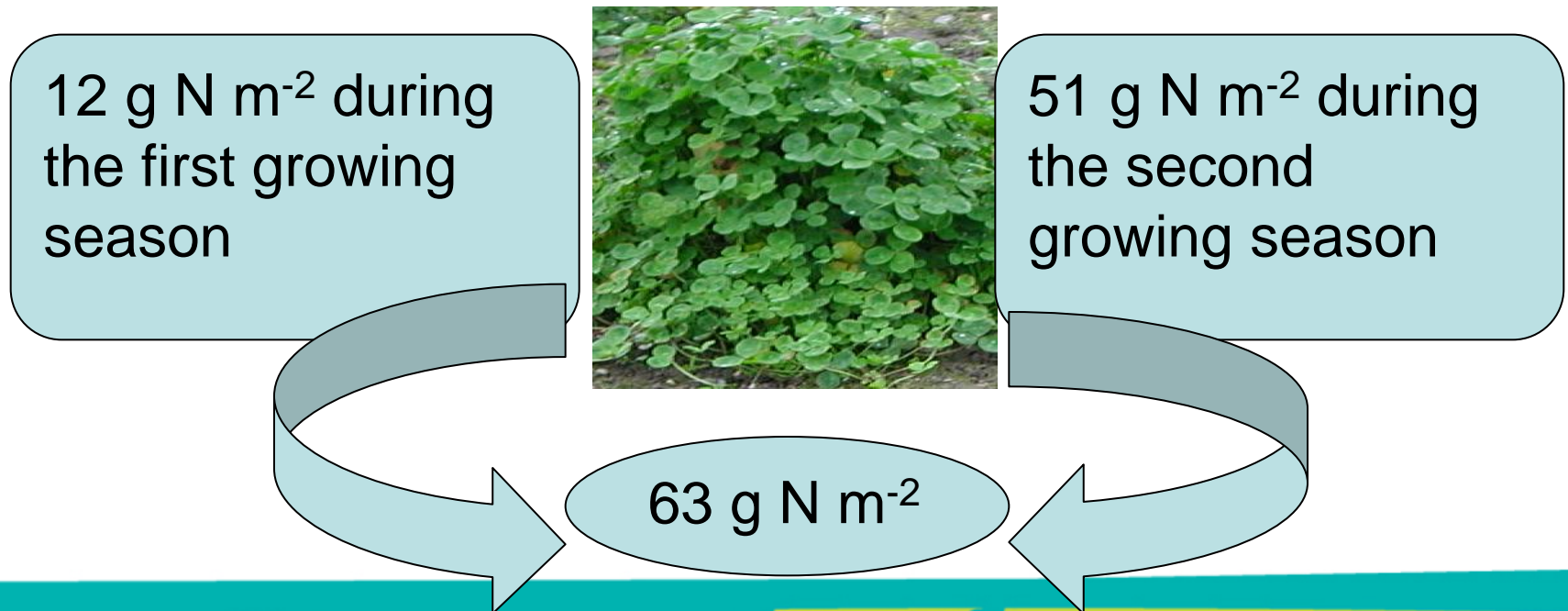


9% and 54% of tagged root sections turned over during the first and second growing seasons

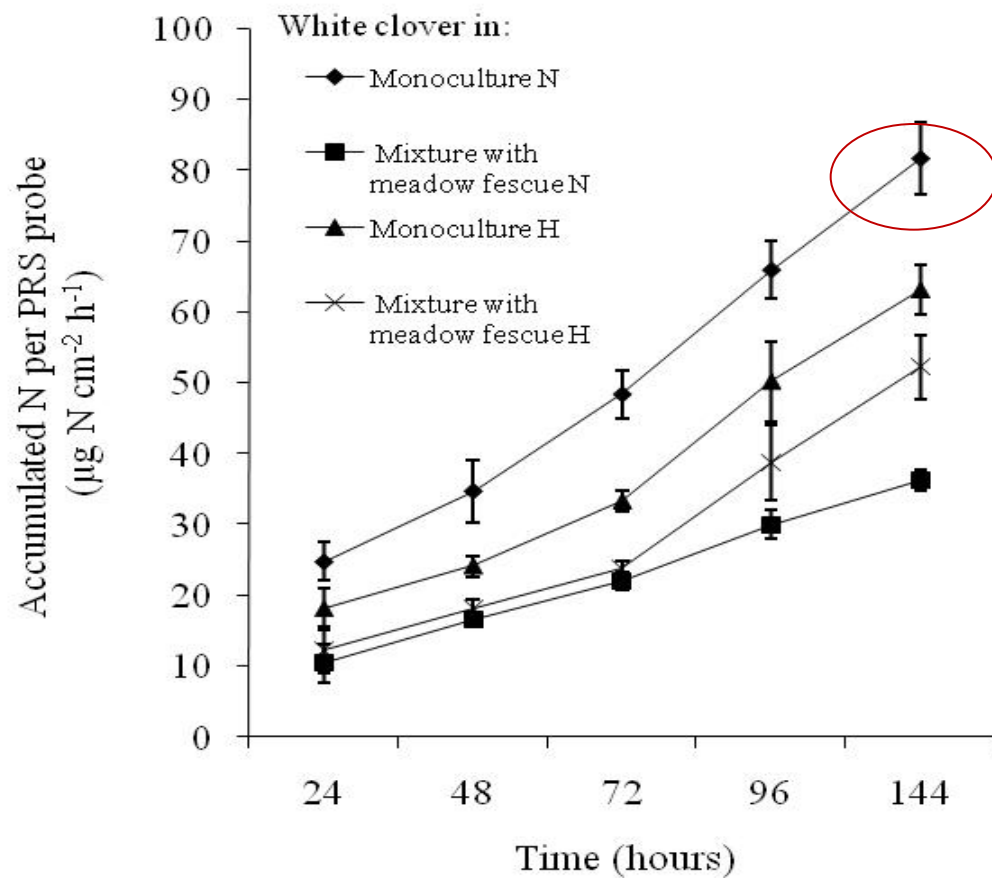
Clovers contribution to plant-soil system during the growing season

The gross input to the soil-plant system

If taking the turnover of all plant organs into account, then undidected N from plant tissue would amount



Plant available N measured with PRS™ probes




Northern climate

- Relatively short growing season (may- september)
- Low temperatures during the growing season
- Long winter

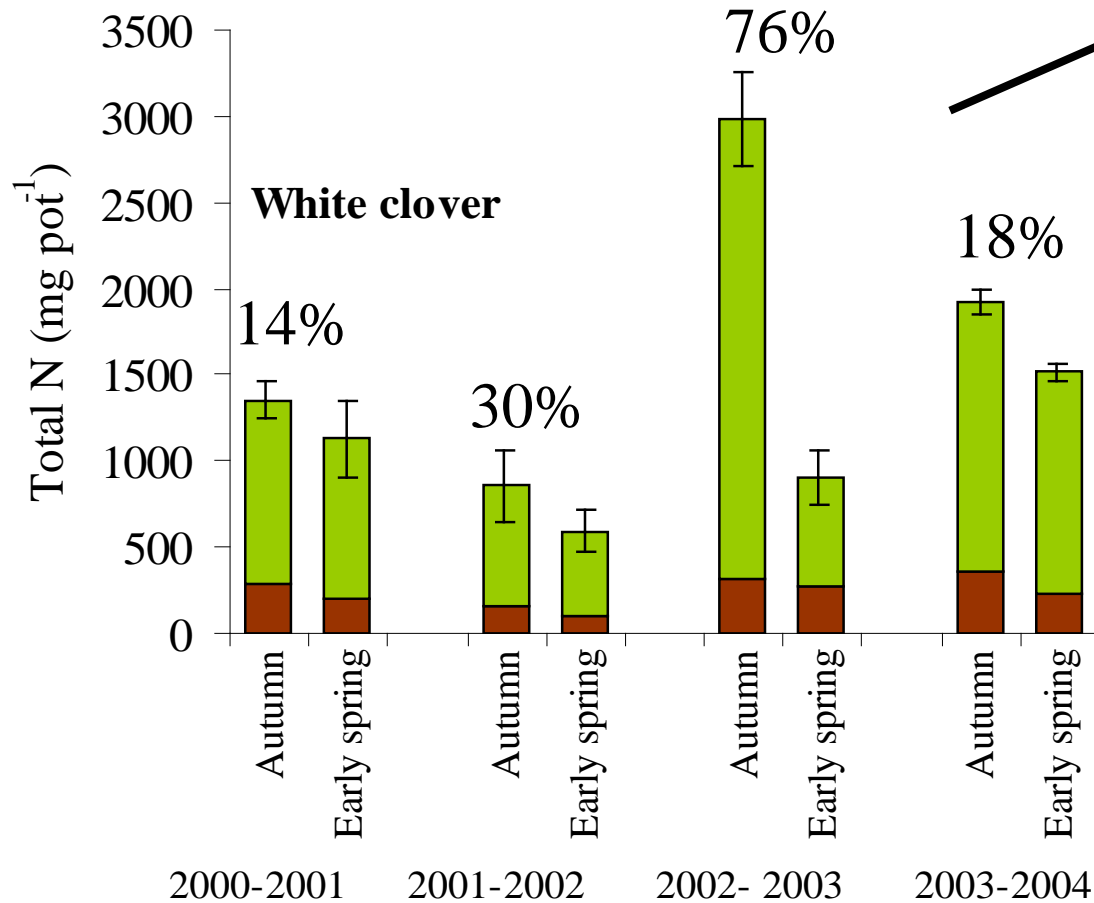




A photograph of a flooded agricultural field. The foreground is dominated by a large, shallow pool of greyish water that has inundated the crops. Patches of green and brown vegetation are visible through the water. In the middle ground, a metal structure, possibly a gate or signpost, stands partially submerged. The background shows a line of trees and several buildings, including a prominent red brick building and a white house, under an overcast sky. A light blue oval with a black border is superimposed over the center of the image, containing text.

What happens with clover and nitrogen during the winter?

Off-season losses



on the average
35%

This represents a loss of production resources that affects the following main crop yield

Off-season losses

In autumn



60 kg N /ha

80%

In early spring



12 kg
N / ha

Might lead to
negative N- balance
in the farm



Fate of lost N

- The amounts of inorganic N in soil just after snowmelt were small

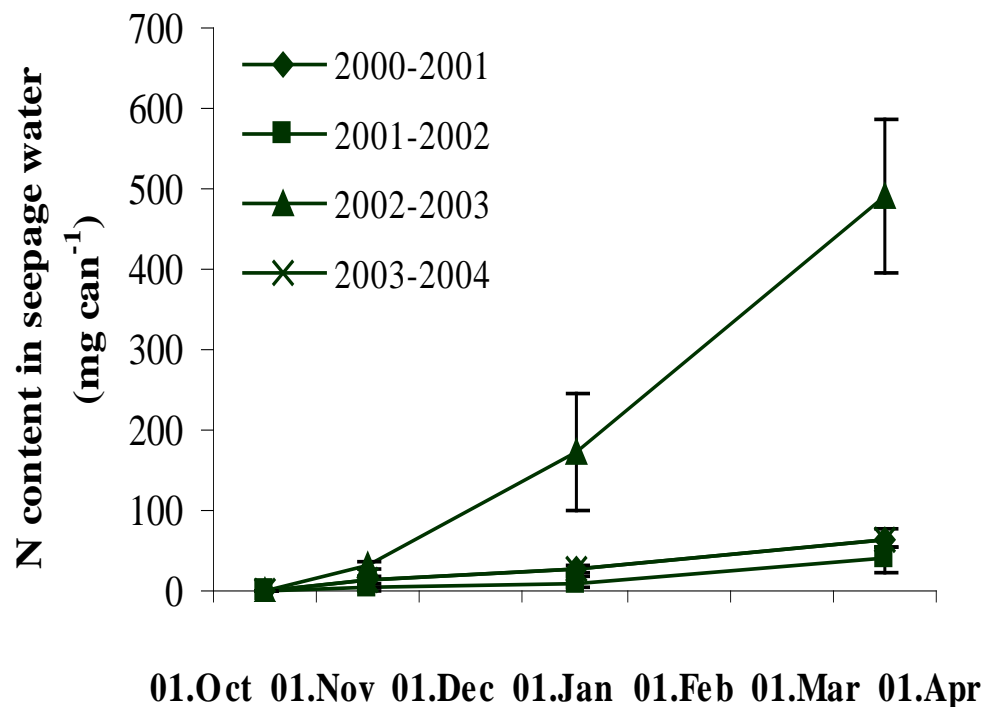
- N uptake in PRSTM (plant root simulator probes) was minimal

suggesting that N from degraded tissue may have been lost



Fate of lost N

Recovery in seepage water



- Between **19-42 %** of foliage **N losses**
- Pulses of N and P occurred primarily during snowmelt

Surface runoff =
20 kg N /ha (if N
losses 80%)

Gaseous
emissions

N_2O-N

NH_3-N

The water quality in early spring

52% NH_4-N 83% PO_4-P

45% organic N

3% NO_3-N

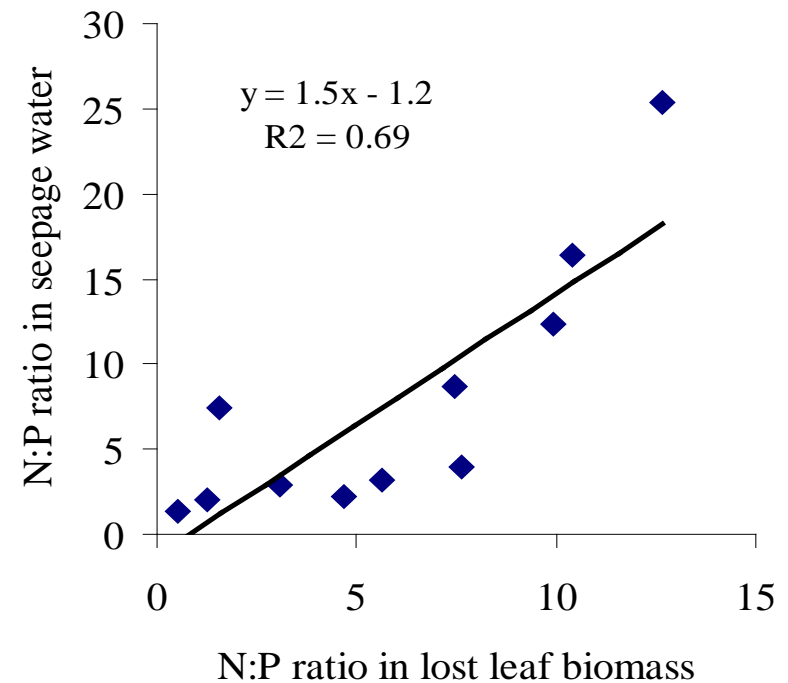
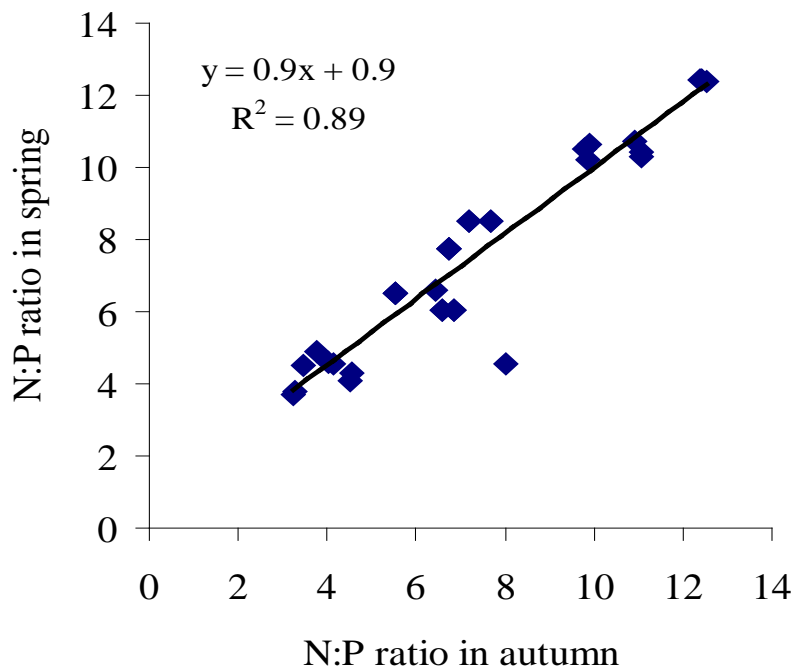
↓
eutrophication of
fresh waters and
shallow seas

reduction in biological
diversity of natural
ecosystems

and global warming

Fate of lost N

N:P ratio in leaf biomass and in seepage water



As P can not be lost as a gas, this suggest that gaseous N losses were moderate

Fate of lost N

Carbon (C) content in seepage water

2 - 6 %

Biological consumption of
plant derived C ?

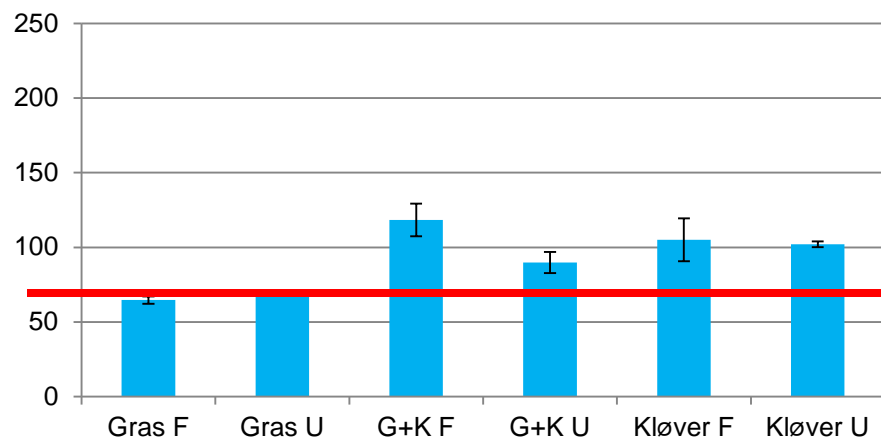
Modelling showed that microbial immobilisation also could explain the relatively low recovery rates of N and P in seepage water until the spring

N₂O emissions during the winter

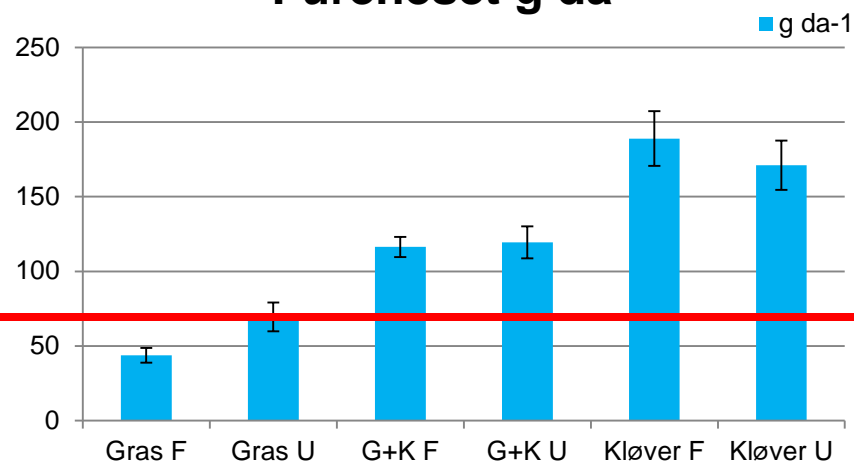


Off season N₂O emissions

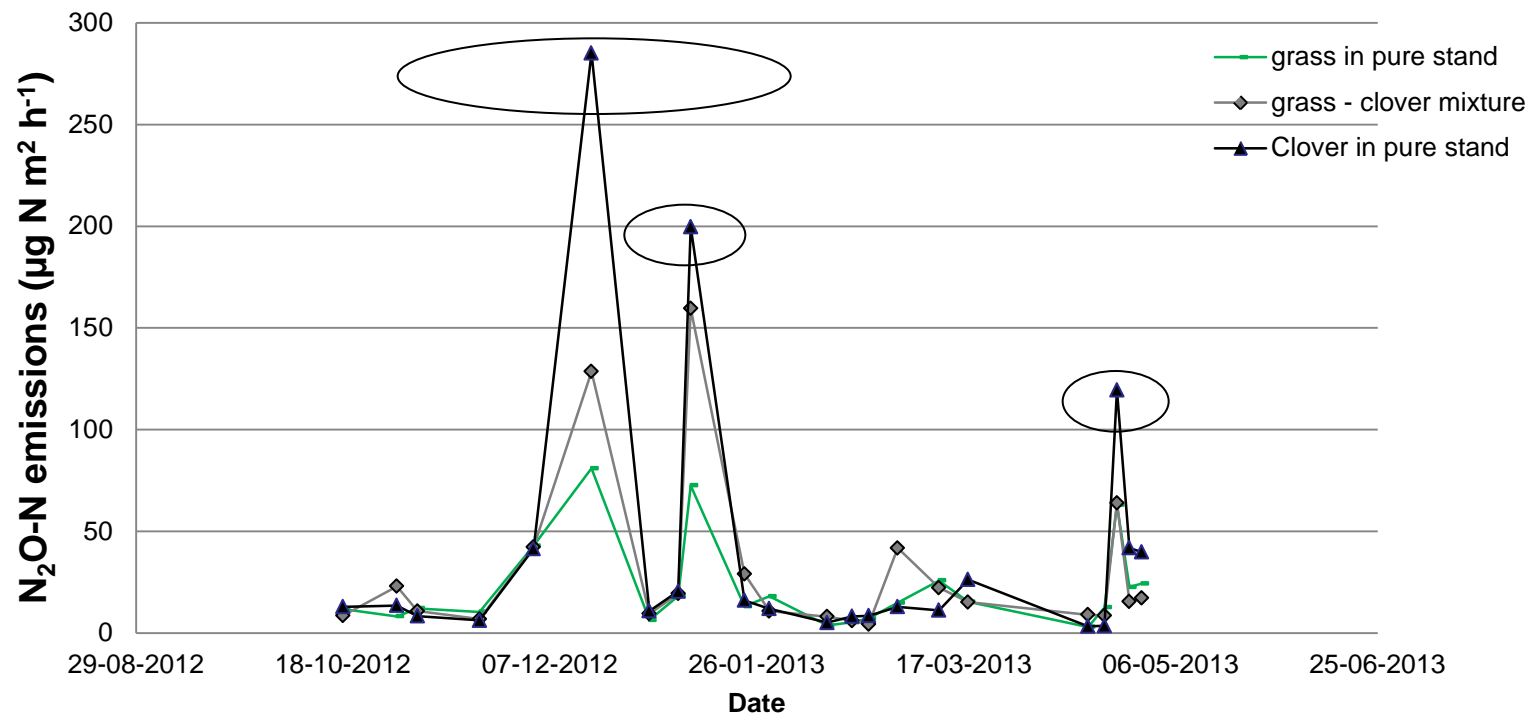
Tjøtta g da⁻¹



Fureneset g da⁻¹



Winter 2012-2013, Tjøtta



Conclusions

- Dying and dead clover tissue, particularly leaves, are an important source of readily available N for new plant growth, but
- A high portion of clover N residing in the leaves in late autumn might be lost during the winter while N stored in stolons and roots are much better conserved
- Winter losses vary considerably from year to year, dependent on the prevailing climatic conditions
- Lost N might be at risk of further transport out of the soil-plant system, however,

Conclusions

- Only one-third of the winter losses are found in melt water in spring
- Gaseous N losses are moderate
- There are some indications that N that was unrecovered could have been immobilised by a cold-adapted microbial community
- There is need for more knowledge on how microorganisms affect and control biogeochemical cycles during the winter in northern climate

Thank you for your attention

