Evaluating competitiveness of clover-grass as a resilient feed production option in Finland

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Outline

Promoting clover-grasses*) and implications at the agricultural sector level in Finland

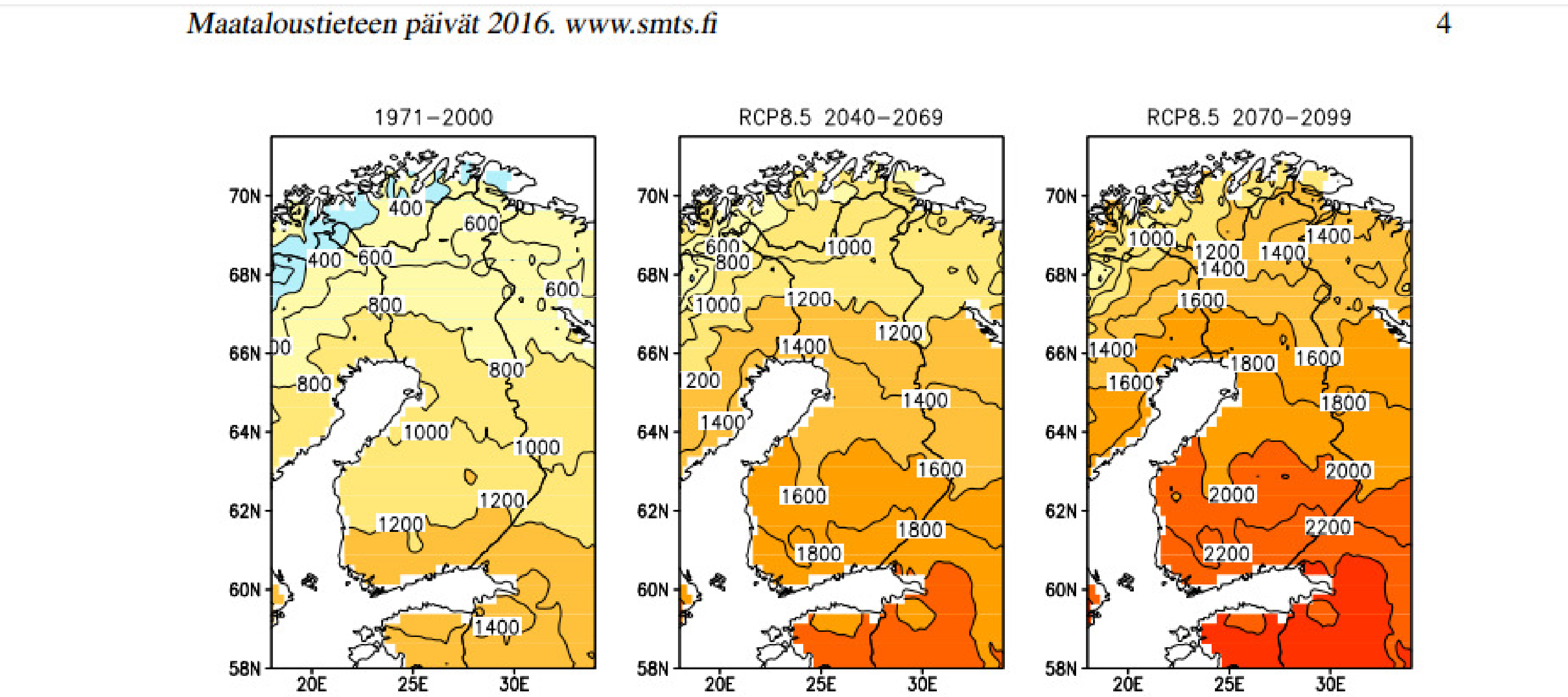
1. Introduction
2. Area of clover grass
3. Partial equilibrium economic sector model
4. Clover grass in economic model
5. Results
6. Conclusions and discussion

*)Clover-grass = forage mix, 50% hay seed and 50% clover seed: symbiosis between clover and hay

1. Introduction

- Clover-grasses address the following objectives:
  - Decreased input use (N-fertilization), reduced dependency of inorganic N => reduced GHG emissions
  - Possibility for increased protein content of silage, reduced dependency on purchased protein feed supplement (home grown proteins, resilience)
  - Better utilisation of farmland in the context of climate change in the north: Higher T - improved N fixation
  - Compatible with sustainable agriculture and sustainable intensification: more output with the same inputs / the same output with reduced (non-renewable) inputs
- In contrast: Shifting to silage maize increases N fertilisation
  - Major shift from grasslands to silage maize in e.g. Denmark

Climate change increases temperature sums (degree days) - causing problems and potential benefits



Farm level benefits and costs of clover-grass

- Clover-grass mixes
  - Improved feed quality, increased DM intake of dairycows (5-10%), improved animal health, quality of milk (cheese)
  - Nitrogen fixation, reduced purchases of inorganic N
  - Longer harvesting period, reduced timeliness costs

  - Downside:
  - higher water content of silage,
  - high Ca-content of silage feed, not suitable for non-lactating cows
- Source: Lüscher A., Mueller-Harvey I., Soussana J.F., Rees R.M., Peyraud J.L., 2014. Potential of legume-based grassland-livestock systems in Europe: a review. Grass Forage Sci. 2014 Jun;69(2):206-228.

Objective and questions to be answered

- The objective of this study is to **evaluate how cultivation and use of clover-grasses as a feed could be promoted**
- How much more land area could be allocated under clover-grass if clover-grass premiums, reduced cost level, fertilizer tax, or increased yield levels of clover-grass were implemented?
- Clarify and conclude **how much clover-grasses can be increased** by using reasonably inexpensive policies and other measures, without increasing the overall budget of agricultural support payments, while keeping dairy and cattle production economically viable
- What are the main messages of this study to further analysis concerning clover (other N fixation crops) under climate change?

2. Current area of clover-grass in Finland

(1000 Hectares)	2008	2009	2010	2011	2012
Pasture	81	79	77	75	73
Dry hay	103	86	106	103	95
Conventional grass silage	379	353	336	348	380
Conventional clover-grass silage	32	42	52	55	35
Organic grass silage	35	43	46	48	49
Total clover-grass silage	67	85	98	103	84

Source: calculations made in Luke, Lehtonen, H. & Niskanen, O. 2016. Promoting clover-grass: Implications for agricultural land use in Finland. Land Use Policy (2016), pp. 310-319. DOI:10.1016/j.landusepol.2016.09.005

Intensity

- Increasing manure spreading costs: MAX 50 kg soluble N/ha of clover-grass (otherwise hay dominate clover)
- In conventional (intensive) production manure nitrogen limits clover cultivation
- Organic farms have more extensive production in terms of livestock per hectare

2014	Hectares	LU	Ha/LU
Conventional production	644626	590401	1.09
Conventional animal with organic crop production	50241	43846	1.15
Organic animal and crop production	52822	37348	1.41

Yield of clover-grass forages

- Finnish official variety trials determine i.e. yield potential and quality of new varieties which are brought to markets.
- The average dry matter yield potential (2007-2014) of pure Timothy swards was 10370 kg, for pure Meadow fescue swards 10135 kg.
  - Fertilization for perennial grasses was 100 kg N per ha for first cut, 100 N kg for second cut and 30 kg for third cut, which corresponds fertilization limits under current environmental policies
- Pure Red clover swards reached 6318 kg yield
  - Clover swards fertilized with 40 kg N for first cut and 20 kg N for second cut.
- **We assume** 70-75% dry matter yield for clover-grass mixtures when compared to intensively fertilized grassland
  - N fertilisation of 50kg soluble N/ha for clover-grass mixtures
- Clover-grass based forage production implies higher work input and also larger land area, due to lower DM yield + manure spreading

Partial equilibrium economic sector modelling

- DREMFIA (Dynamic multiregional sector model of Finnish agriculture
  - A recursive dynamic model with endogenous investment and structural change
- ”Current situation is equilibrium”: consumers and producers have found a utility maximising consumption and production levels
  - All changes to equilibrium need economic incentives or policy actions
  - Equilibrium is changed if prices or policies are changed
  - Clover-grass ”competes” with all other crops in feed use and land allocation
  - Consumption is relatively inelastic to price changes
- Exogenous EU level prices of inputs and outputs play a role
  - Imported protein feed supplements – oilseed cake
  - Domestic prices of agricultural commodities follow EU prices, but are not identical
  - Significant differences between member states do realise: producer prices of milk
  - Input prices follow closely EU level prices

The role of economic modelling in this study

- The DREMFIA sector model*) has been validated to replicate the observed price and production development of the main agricultural commodities 1995-2013
- The model was used to evaluate to what extent clover grass cultivation could be promoted using support payment per ha, as well as reducing cost per ha, under different prices of agricultural products and inorganic nitrogen

*) A recent example in Lehtonen, H. 2013. Sector-level economic modeling as a tool in evaluating greenhouse gas mitigation options. Acta Agriculturae Scandinavica, Section A – Animal Science, Vol. 62, No. 4, 326-335. http://dx.doi.org/10.1080/09064702.2013.797011.

Clover-grass in the economic model

- Clover grass in feeding imply an increase in feed intake per cow (Kuoppala et al. 2009; Dewhurst 2003) of 5-10%
- Slightly higher protein content in clover-grass than in grass silage feed
  - Estimated 15 % higher (Luke Feed tables)
- Yield estimated to be 75 % from the yield of intensive grass silage yield - A conservative estimate based on 3-year rotation
    - Clover grass yields are clearly lower than the intensive hay grass yields at the first year (due to low N fertilisation, 50 kg soluble N / ha)
    - There is little difference between clover grass and hay yields in the second year
    - Clover grass yields somewhat lower again at the 3rd year
- Cost of cultivation 14 % lower per ha than the cost of intensive hay grasses
  - Less fertiliser and harvesting costs of clover grass
  - Higher cost per kg DM
  - Advantage is <u>lower cost per hectare</u>, which can be attractive only if area is not restricting and area based supports remain

Clover-grass in economic model (cont.)

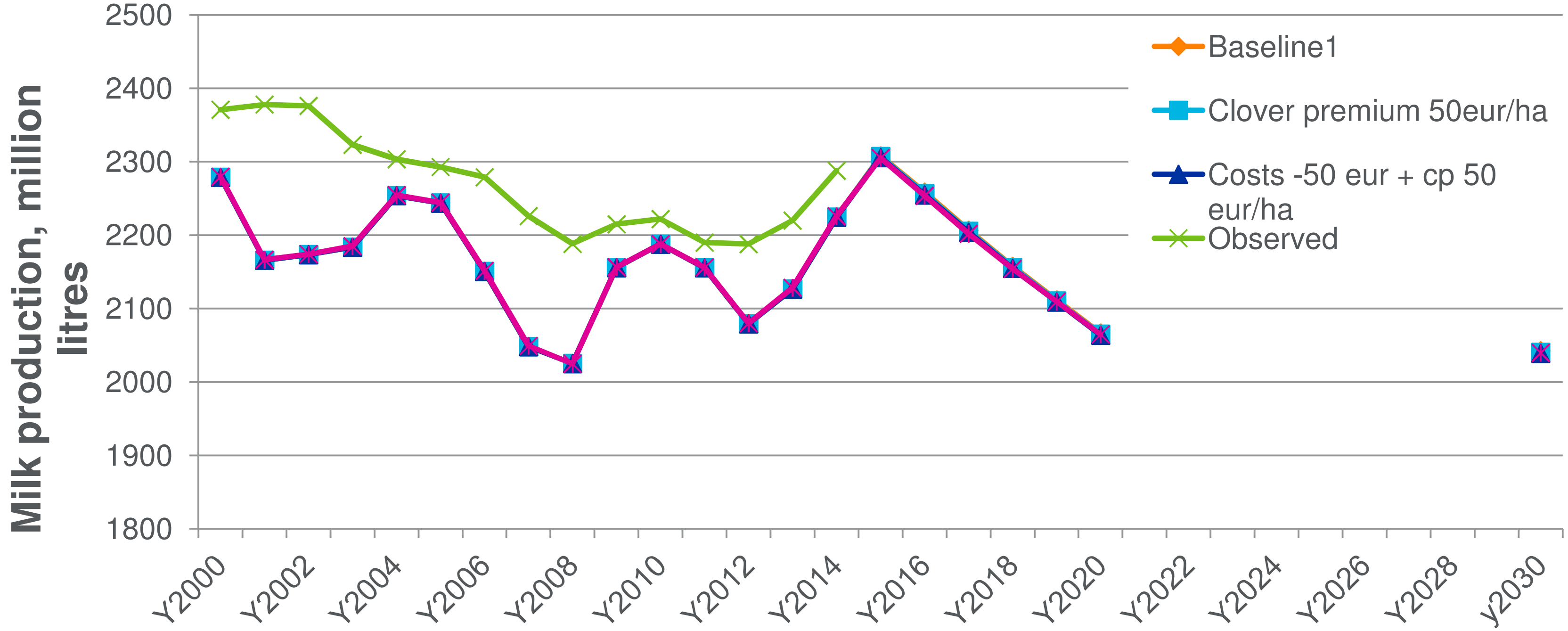
- Clover-grass is assumed to be fed for **dairy cows** (no upper limit, but not outside lactation period), **fattening bulls** and **suckler cows**
- The cost level (labour and miscellaneous costs) of clover grass have been slightly modified to replicate the ”real” level of clover grass area and feeding use
- The equilibrium solution path shows first decreasing (2000-2006) and then increasing use of clover grass 2007-2014) and again decreasing (2015-2020) use of clover grasses in the baseline
- Real prices of feeds 2016-2030 from OECD-FAO Agricultural Outlook 2015

Policy options evaluated under two baselines

- Baseline 1: Business as usual
  - Milk price appr. 36 c/litre 2015-2020-2030
    - Not anymore 42-44 c /litre as 2011-2014
  - Other prices: past averages (averages from the last 5 years are close to OECD FAO Outlook prices 2015-)
- Baseline 2: High price scenario
  - 20% higher crop prices
  - 10% higher meat prices
  - 5% higher producer prices of milk 38 c/litre

Milk production with baseline1

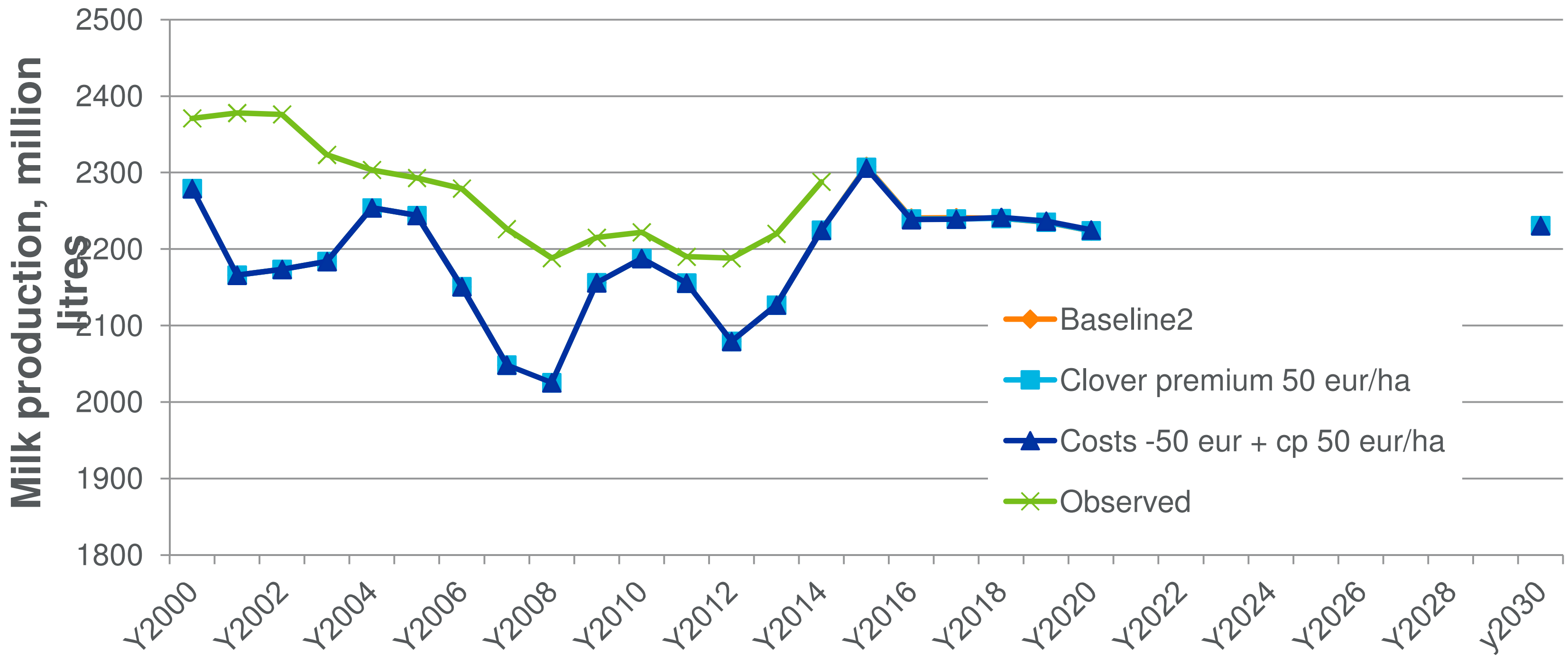
- Low milk prices cause decreasing milk production
- Small premiums or cost reductions have no effect



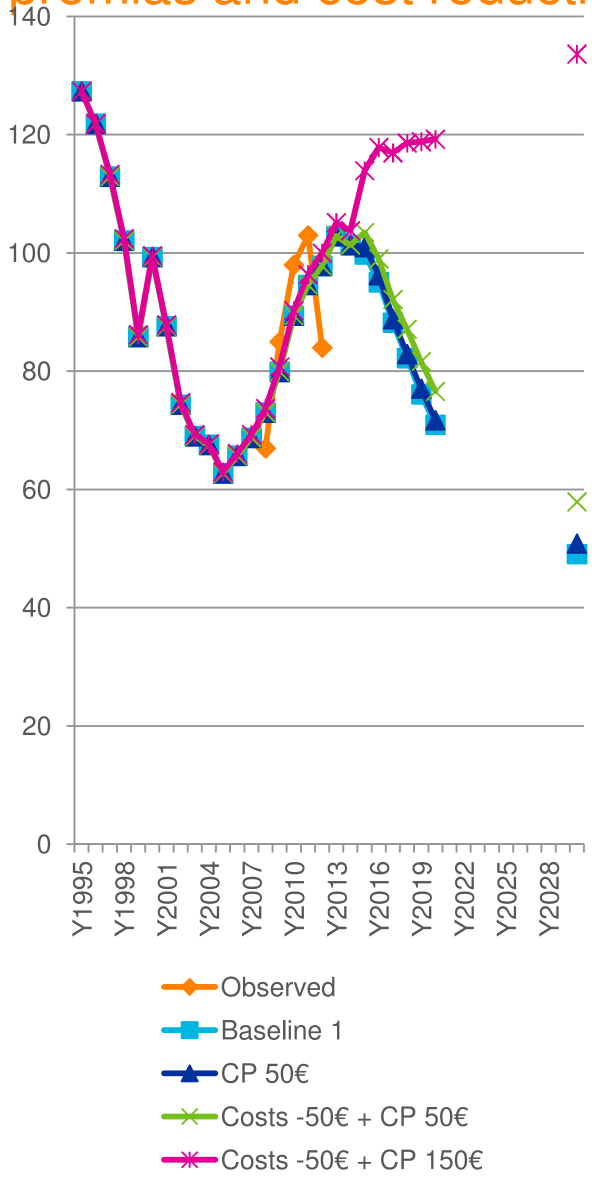
Addition of clover grass option to the model resulted in less milk production in early 2000 compared to the observed, but close to ”correct” production 2009-2015

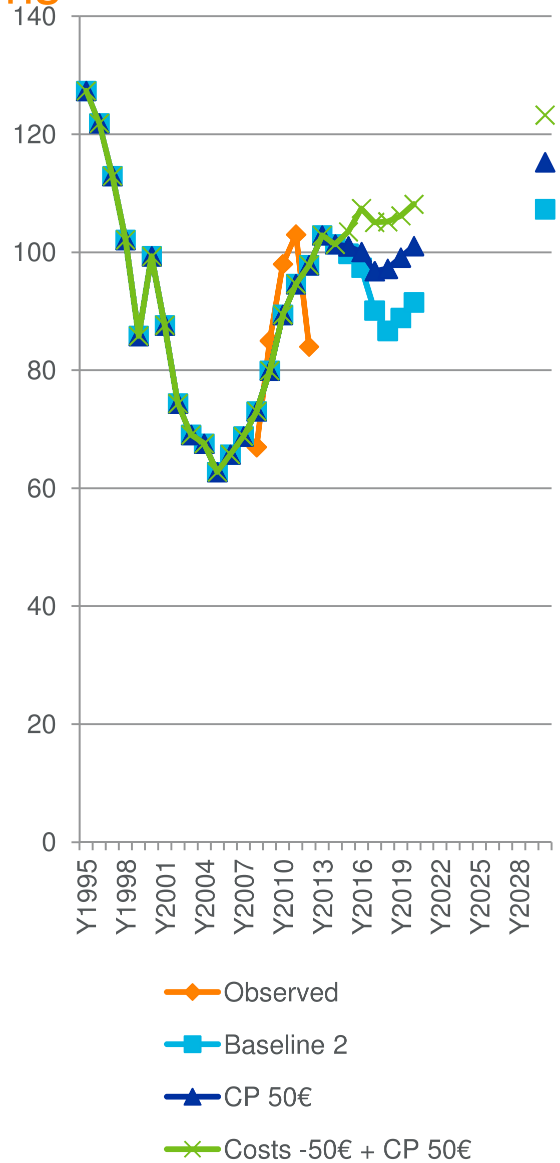
Milk production with baseline2

- Higher prices can maintain milk production
  - Milk prices and slightly improved productivity growth sufficient to cover feed costs – stable milk production



Clover-grass areas (1000 ha) in baselines 1 (left) and 2 (right) under clover-premias and cost reductions





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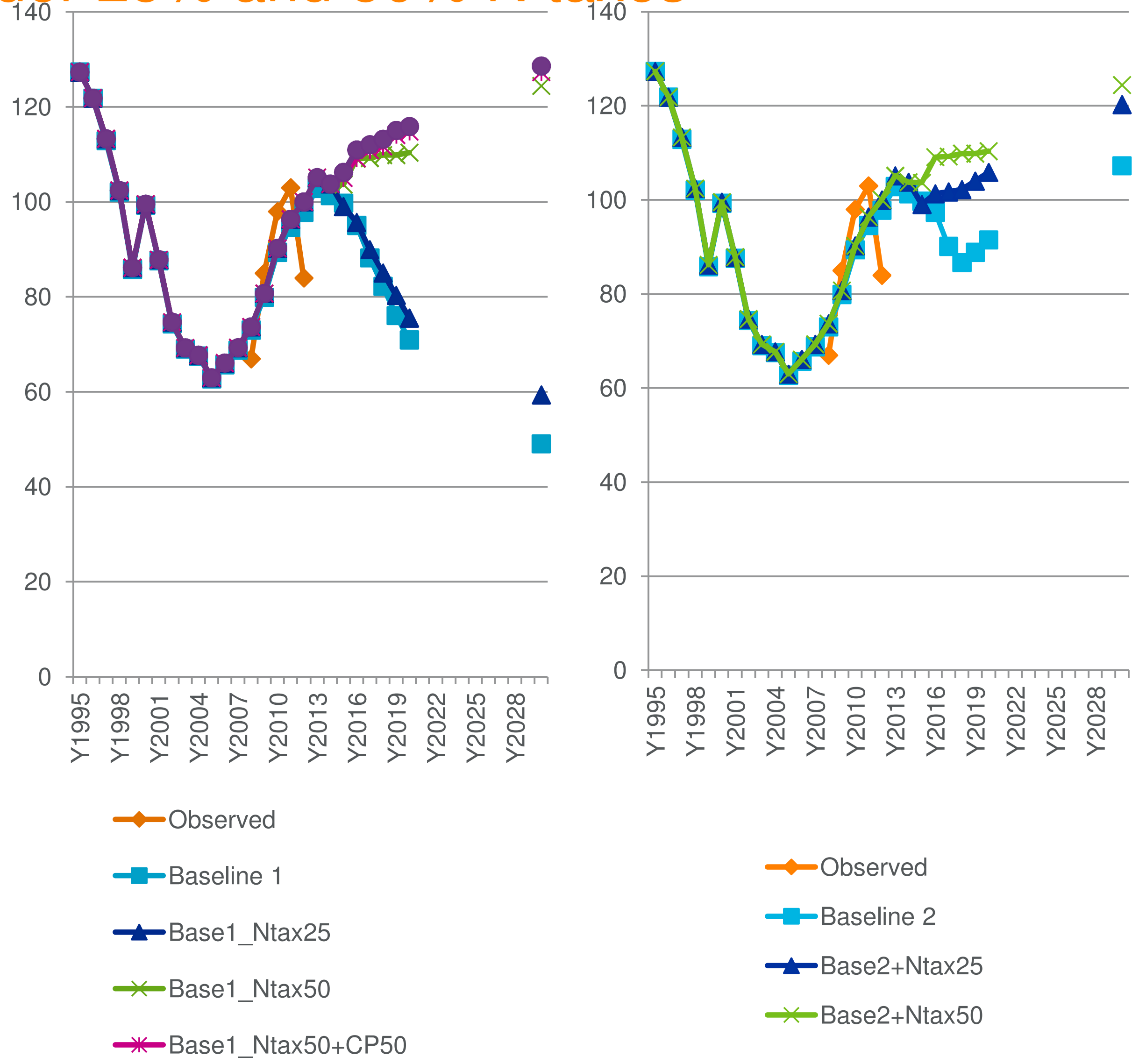
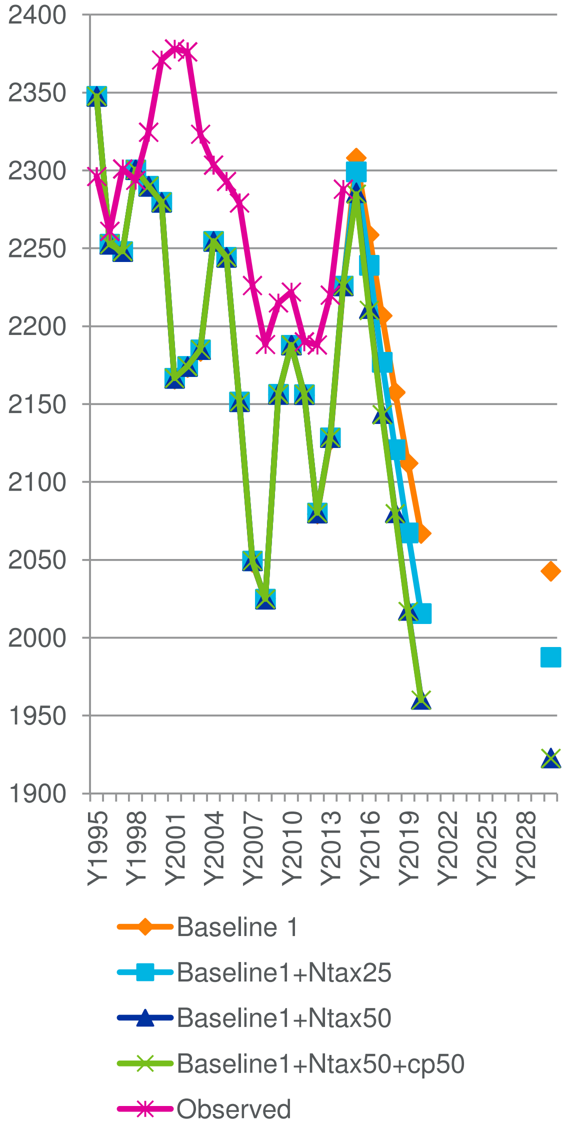
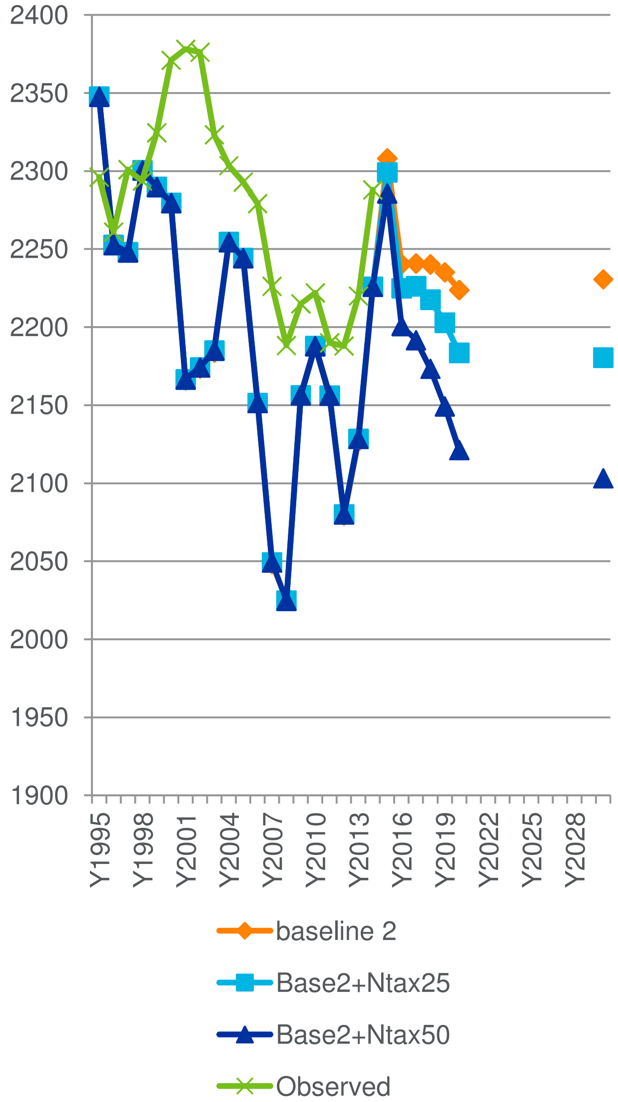
Clover-grass areas in baselines 1 (left) and baseline 2 (right) under 25% and 50% N taxes

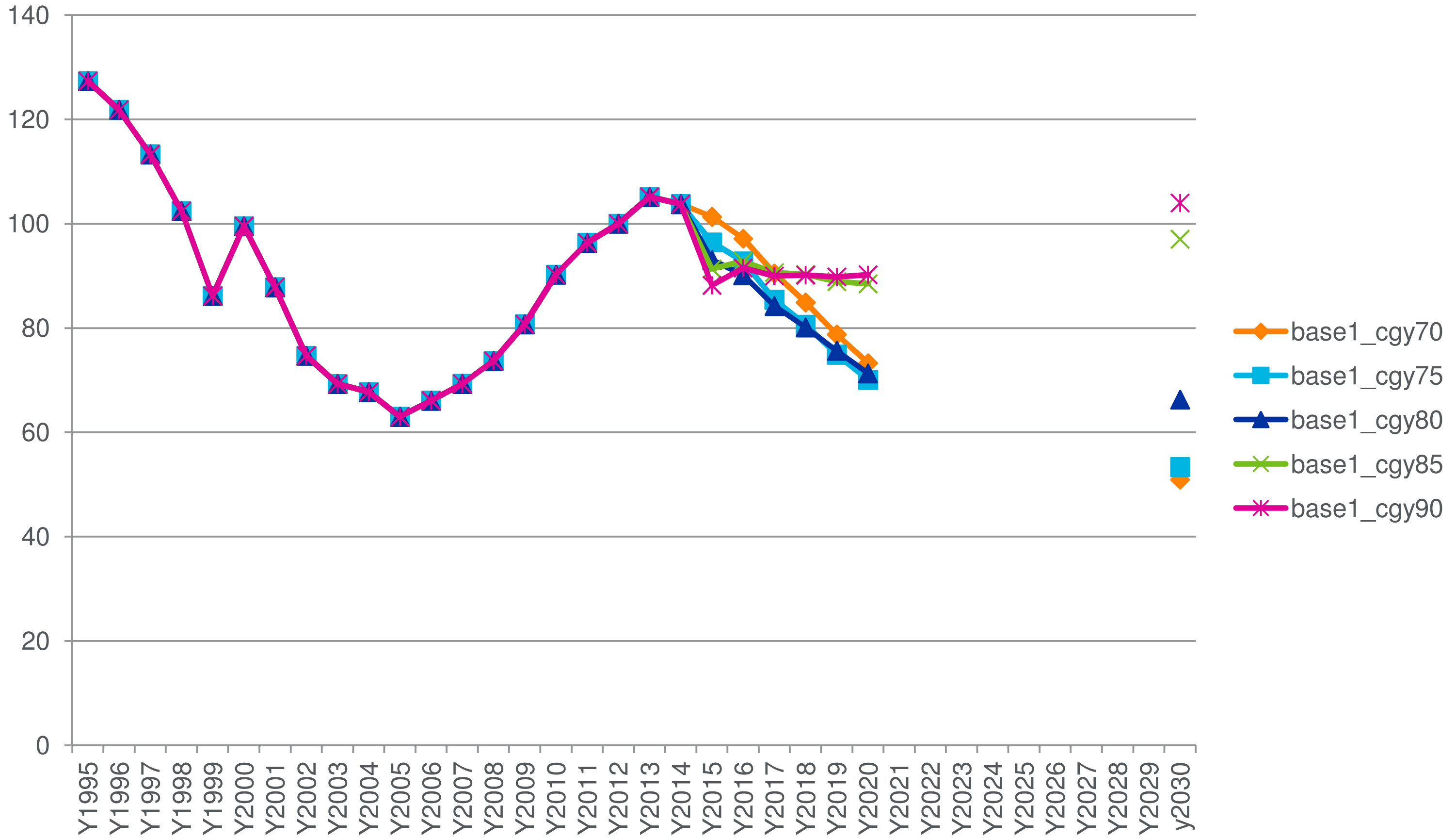


Milk production volume in baseline 1 (left) and 2 (right) under N taxes 25% and 50%

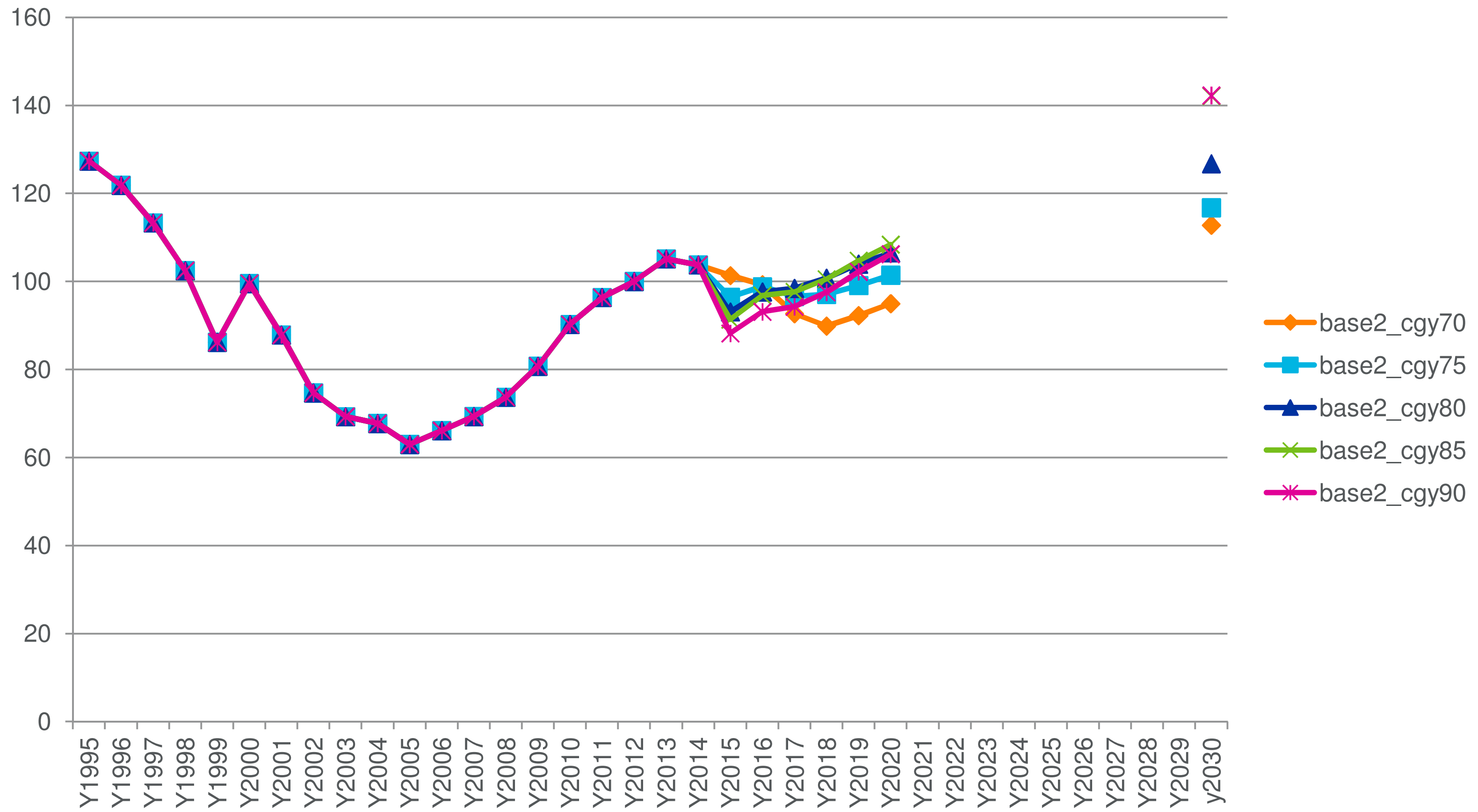




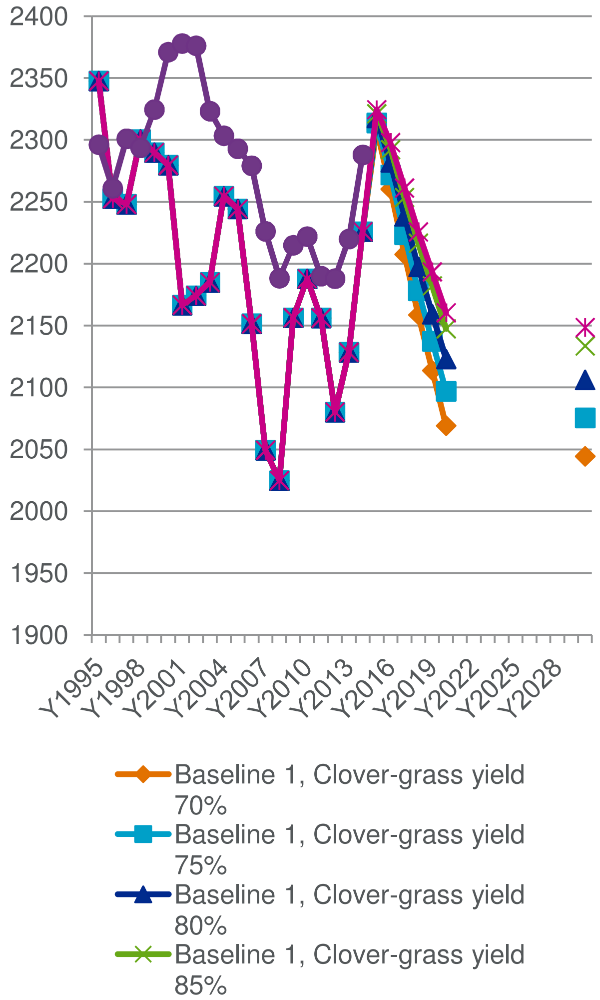
Clover-grass area (1000 ha) at different yield levels of clover-grass (% compared to the yield of intensive hay grass silage) in baseline 1 (low milk prices)

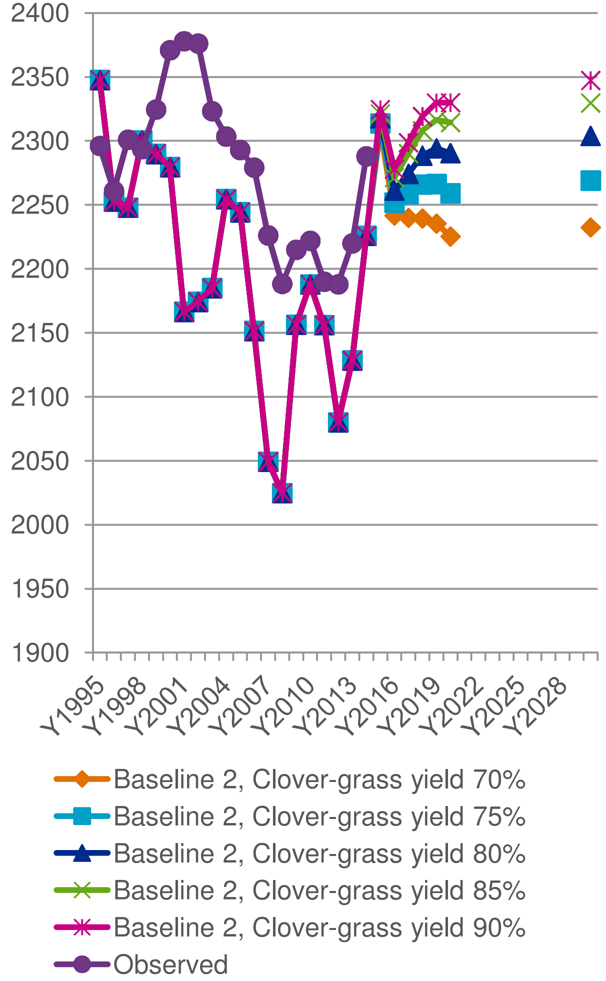


Clover-grass area (1000 ha) at different assumed yield levels of clover-grass (% compared to the yield of intensive hay grass silage from 2016) in baseline 2 (moderate milk prices)



Milk production volume (million litres) in baseline 1 (left) and 2 (right) under different C-G yields





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Take home messages

1. Small cost reductions in clover-grass cultivation, or clover-grass premiums, **may or may not** increase clover cultivation
   - Their effectiveness is **<u>uncertain</u>** and subject to prices
2. N tax is effective, but is not a suitable policy action in current financial situation of farms (milk crisis 2015-2016)
3. However, the results suggest that a 25% higher N price lead to significantly higher clover grass area and a small reduction ín milk output – with no cost reductions or extra premiums!
4. To increase clover cultivation, **price ratios** should be adjusted!
5. If **increasing clover -grass yield**, a robust increase in clover grass areas may realise, with small benefits for farm economy and overall production – **How much more clover grass yield could be attained at low costs**? A topic for further discussion and analysis!

It is likely that warming climate will increase yields of clover-grass, and more than yields of hay

- White clover as a percentage of total herbage production in mixture with grass was estimated by Topp and Doyle (1996) to increase from 32% to 46% for a 2° C temperature rise
- According to Topp and Doyle (1996), annual yield and the percentage of white clover in the harvested material were significantly increased under the increased temperatures predicted under global warming.
  - Increase in the first-cut white clover yield was due to the earlier start to the growing season due to global warming
- Schenk et al. (1997) found that the CO2-related increase in seasonal yield amounted to 16–38% for white clover monocultures, 12–29% for mixed swards and 5–9% for ryegrass monocultures. The white clover content of all swards was significantly enhanced by elevated CO2.

Other conclusions

- Potential of increasing clover grasses is limited
  - All manure must be spread – logistic costs increase if low levels of N/ha
  - Dairy cows need easily digestible energy and protein and their dry matter intake is limited
  - Significant increase in clover-grass area requires larger land area for dairy farms
- Increasing clover yields seems to be the most recommendable approach if the area of clover-grass and its use as a feed is a target
  - It may be possible through e.g. wider spread of good practices and new clover cultivars
- A 50% increase of clover-grass in the use of feed **at the farm level** (from average levels) is possible without risking milk yield level or agri-environmental regulations.
- A 25-30% of all grass under clover-grass mixes seems feasible **at the sector level**, especially if agricultural input prices are still increasing
- An interesting combination of LI promoting measures could be a combination of a nitrogen tax and increasing the yields of clover-grass
- FULL ANALYSIS of clover-grass competitiveness requires explicit results of clover-grass symbiosis under climate change, including also yield variability!

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Silage maize is continuously tested, improved and used by some farmers in North Savo region – even though in little scale !!!
It is possible that benefits of clover-grass remain little utilised.

Photo: Petri Lappi, Luke/North Savo

Thank you!

For further information

Lehtonen, H. & Niskanen, O. 2016. Promoting clover-grass: Implications for agricultural land use in Finland. Land Use Policy (2016), pp. 310-319. DOI:10.1016/j.landusepol.2016.09.005

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