SOLID participatory research from Denmark: Use of herbs in pastures for dairy cows

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Summary

Semi-structured qualitative research interviews were conducted with eight organic dairy farmers (producers and shareholders of Thise Dairy Company), in which they shared their experience with growing herbs on grass fields on long-term basis for both grazing and silage production. Growing herbs implied some challenges: most herbs have a low competitiveness in relation to grasses and clover, their coverage is reduced rapidly from year to year as their survival during winters is low, and the seeds are quite expensive compared to grass seeds. Despite these challenges, the farmers continue to grow herbs year after year - constantly experimenting with optimizing the growing methods and seed mixtures. The motivations behind this were that they wanted to offer their animals a varied diet, they can see that the cows like the herbs, and sometimes even prefer them to grasses and clover, they believe in an increased mineral-uptake through the herbs, and that the herbs might have some medical effects on parasites. All in all, they trust that they are doing something good for their animals by offering them herbs in the feed.

Plant coverage analyses were done at seven farms, two of which had participated in previous projects having one 100% herb field each. The plant coverage analyses could be combined with the results of plant coverage analyses from the two previous years. The development of the two fields had turned out very differently: one had been spontaneously invaded by 6% wild herbs, 25% rough blue grass (poa trivialis) and 26% white clover (Trifolium repens), and ribwort plantain, red clover, caraway, lucerne and yarrow (sown). All other sown herbs had disappeared. The second pure herb field was now covered 50% by Lucerne, and besides this, caraway, red clover, ribwort plantain and very little chicory and salad burnet. In both fields, birdsfoot trefoil, yellow sweet clover, Sainfoin and starflower never established although the originally seed mixture had a quite high content of their seeds. The plant coverage analyses of the fields which were one to six years old, generally, dandelions, grasses and clover dominated and Lucerne became dominating. Among the herbs, only chicory and caraway was found after 5-6 years.

A literature survey was undertaken with focus on Danish studies, and 17 studies were in-depth reviewed with focus on pasture characteristics and qualities as well as milk composition, yield and content, and potential effects on animal health.

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1 Aims and Research question

The overall aim of this research was to give recommendations regarding the use of herbs in pastures under Danish climatic and farm conditions. To do this, we summarise and investigate current practical on-farm experiences and research results on the use of herbs in pastures for dairy cows through answering the following intermediary research questions:

- What motivates Danish organic dairy farmers to use herbs in their pastures for dairy cows, how do they use it, and which experiences do they have using it over a period of some years?

- How do herbs survive and establish in long term pastures used for grazing at organic dairy farms?

What does Danish research on use of herbs in grass fields show regarding the characteristics of the pasture (e.g. mineral content), the establishment of herbs in the pasture, the effects on milk yield and milk quality as well as animal health?

2 Background

2.1 Farm Background

Organic farmers have shown an increasing interest in growing herbs in their pastures because they potentially can have health benefits, positive influence on the milk and the milk yield, and contribute to the variety and 'naturalness' of the pasture, among others by offering the cows a variety of different tastes and additional micro minerals and other substances. A few farmers have had herbs in their fields during many years, and have obtained long term experiences, while other farmers hesitate because they have heard about some of the challenges related to growing herb (Smidt & Brimer, 2005). Some of these challenges concern competition with other plants, surviving drought and winters and ensiling/harvesting methods.

2.2 Research Background

At a workshop for Danish organic dairy farmers which took place in June 2012 as a part of the SOLID-project, several farmers discussed the need for collecting long term experiences with using herbs on pastures. There was especially focus on the survival of herbs in long-term pastures because it was a wish to prolong the number of years between ploughing with the aim of reducing CO2 emission (related to machinery) and building up carbon deposition in the soil. Obviously, it is not an option to investigate 'long term effects' of the use of herbs in a short research project, but the Danish SOLID partners, Aarhus University and Thise Dairy Company, decided that the SOLID project offered the possibility to contribute to a valuable knowledge sharing between the farmers through interviews with those who had long-term-experiences they wished to share. In addition, research has been conducted in Denmark during many years regarding the use of herbs in grass fields, and this research could be summarised and feed into the process of finding recommendations and directions for the future regarding the use of herbs in pasture.

3 Methodology and data collection

3.1 Identification of the farms for interview

An invitation was sent to all dairy farmers (75) delivering milk to the private organic dairy "Thise". Anybody who would like to share their experiences with growing herbs in grazing systems or for hay or silage production were asked to contact us. Eight farmers responded and they were all interviewed during October 2013. Seven farmers were visited and interviewed at their home and the interview was supplemented with a plant cover analysis of relevant fields to describe the actual distribution of herbs in the fields, and one farmer was interviewed over phone. The interviews were semi-structured; they were based on an interview guide and were subsequently analyzed. The farmer interviews and plant coverage analysis were conducted in September-October 2013, and the literature survey took place in February-April 2014.

3.2 Description of the plant coverage analysis

The plant coverage analyses were conducted to know more details on the state of the grass-fields of interviewed farmers, and to identify potential patterns related to species, survival and development of the botanical composition of the crop. The botanical composition of herbs, grasses and legumes in relevant fields were analysed visually by describing how may % of the ground each species covered in a square of 0.5 m2. Such a square was analysed in each of at least two randomly chosen sites for every hectare of the field. The size of the smallest fields was 2 Ha. In small or more heterogeneous fields, one to two additional sites were analysed for every hectare.

3.3 Literature survey

Seventeen Danish studies were selected which represented research on herbs – although few of them were focused on animal health and welfare using herbs. They covered the following aspects regarding the use of herbs' effect on: 1) yield and forage quality, 2) milk yield and quality, 3) animal health, and 4) biodiversity and CO2 storage, in the dairy industry. The literature study is described in the report: 'SOLID participatory research from Denmark: Use of herbs in pastures for dairy cows: Farmers' experience, pasture coverage analyses, and literature survey of Danish research results', which can be found on Organic Eprints: http://orgprints.org/28754/7/28754.pdf.

3.4 Time scale

August 2013 to March 2014.

4 Results and Discussion

4.1 Interviews study of eight farmers

4.1.1 What motivated the farmers to start using herbs?

Half of the farmers started using herbs 14-18 years ago when they converted into organic production. As far as they remember their decision about using herbs was not influenced by advisors; they just wanted to offer their animals a more varied feed with different tastes. Some farmers had noticed that their cows preferred to eat trees and wild species of herbs if offered,

rather than the grass which was available in the field in abundance. Other farmers emphasised that mineral supplementation was a reason because they perceive especially herbs with deep root systems like chicory to draw up minerals from deeper soil-layers. A third reason given by farmers was the expectations of medical effects of using herbs e.g. against parasites and against ruminant bloat/ tympanitis.

Milk producers of Thise dairy company have a long tradition for cooperating with Aarhus University in research projects. Four of the interviewed farmers started using herbs when they took part in such projects, while a fifth project-farmer had already used herbs for many years. One project had aimed at investigating the cow's mineral uptake from herbs, their preferences for different herb-species and the competitiveness of the herbs. It took place in 2006-2007 where 10 different herbs were sown broadcasted together with grass-seeds to establish a mixed herb-grass field (Søgaard et al., 2010). On one of the farms this field had not been ploughed since then, but there were only very few herbs left except clover. The other project focused on the effect of feeding with pure herb silage (without grasses) on the content of fatty acids in the milk, and on three farms a pure herb-field was established in 2011, and they still existed on two of the farms in 2013. All farms except one had used herbs in all pastures since they had been involved in the research projects. On farm not using herbs anymore the herbs were poorly established in the field, the crop was too open and the yield too low compared to the costs for seed. This farmer wanted to wait sowing herbs again in the field until more cost-effective methods would be developed.

4.1.2 Farmers make their own experiments with herb mixtures

The famers who started using herbs on own initiative 14-18 years ago have over years tried different compositions of herbs. One herb which has been used continuously is Chicory (Cichorium intybus). This herb normally establishes quit well in the field, the cows like it, it is believed to have a medical effect on parasites and on ruminant bloat and to have a high mineral content. Herbs like dill and parsley have been tried but given up again. Dill had a poor re-growth after harvest or grazing and parsley germinated very slowly, lost competition with other herbs, and never really established in the field. These very experienced herb-farmers continue to develop their methods and experiment with different mixtures. That is also the case for the two farmers who took part in the research projects by Karen Soegaard in 2007. In this specific project, seven different herb-species (chicory (Cichorium intybus), ribwort plantain (Plantago lanceolata), caraway (Carum carvi), salad burnet (Sanguisorba minor), birdsfoot trefoil (Lotus corniculatus), chervil (Anthriscus cerefolium) and sainfoin (Onobrychis viciifolia) were sown. These two farmers both continued using herbs in all pastures, although just one (chicory) or a few species are used now.

4.1.3 Farmers use what is currently on the market

The herbs currently chosen by the farmers seem to reflect which herb-seed mixtures which are available on the market. Most farmers use these mixtures which include herbs like chicory, Sainfoin, ribwort plantain, caraway, dill (Anethum graveolens), birdsfoot trefoil and salad burnet. The farmers however know that some of the species often establish very poorly in their pastures, and if they had the possibility they would have adjusted the balance of herb species in the mixture. Some farmers add other herbs to these mixtures like alsike clover (Trifolium hybridum) while others choose just to add chicory seeds to the traditional grass-clover seed mixtures. The three fields with pure herb-culture which were established on three farms in 2011 during a research project by Petersen (2012 & 2013) with the aim of studying the content of fatty acids in milk when the cows were fed pure

herb silage. The seeds sown on these fields were a mixture of 11% lucerne (Medicago sativa), 2% red clover (Trifolium pratense), 12% birdsfoot trefoil, 8% yellow sweet clover (Melilotus officinalis), 12% chicory, 24% salad burnet, 12% ribwort plantain, 12% caraway, 2% yarrow (Achillea millefolium) and 5% starflower (Borago officinalis). Lucerne is considered a herb in most trials, because it is not a part of a traditional grass mixture.

4.1.4 Farmers' experience that some herbs are better 'survivors' than others

Farmers had experiences with some herbs surviving better than others. Herbs like chicory, caraway, Lucerne, red clover and ribwort plantain are relatively large plants with deep roots and they both have a high competitiveness the year the pasture is established, and they are also the best survivors in a long term- perspective. Herbs like Lucerne and ribwort plantain seem better suited for cutting than for grazing and chicory and caraway seem to be the only plants able to survive grazing over several years. However, in general, farmers told that all sown herbs had difficulties surviving the winters, their occurrence were markedly reduced every year and barely existing after 3-4 years.

Farmers also experienced that in very dry periods, herbs coped better with drought than grass. Especially deep rooted herbs like chicory, lucerne and alsike clover had a remarkable drought resistance. Several farmers experimented with keeping their herb/grass pastures for more and more years before ploughing. The oldest pasture was 6 years old.

4.1.5 Sowing herbs broadly versus in stripes

Almost all interviewed farmers used herbs in all of their grass-fields, both fields used for grazing and for silage production. They either buy seed mixtures including herbs or they mix herb seeds with grass and clover seeds before sowing and in that way the herbs are broadcasted all over the fields. Only one farmer was sowing the herbs in 30 cm broad stripes for every 4th meter. He had observed that in this way the survival of the herbs was increased because the competitive pressure from grasses and clover was decreased. Most other farmers considered also to try herb-stripes in the pastures to increase the competitiveness. Some planned regular stripes all over the field while other farmers planned broad stripes at the edge of the field. To improve competitiveness and survival of the herbs, some of the interviewed farmers had added and increasing amount of herb seeds pr. ha.

4.1.6 Herb fields were not used for hay, but silage production worked well

The herb fields were normally never used for hay production because the dry leaves crumble away if they are handled more than once. Only one farmer had made hay one time on a field dominated by lucerne and in a period with stable sun and warm weather.

Silage production seems to work well except in one of the pure herb fields without grass. Here the leaves from chicory fall to the bare soil when cut, and when they dry they get sticky and difficult to pick up without soil. In this way the silage quality is markedly reduced due to soil contamination. In the other pure-herb field a cover of low grasses (poa annua) had established from the seed bank in the soil, and in this field there were no problems with soil contamination because the chicory leaves were carried up by the grass cover.

4.1.7 The cows enjoyed eating herbs

All farmers reported that their cows were happy to eat both fresh herbs when grazing (except the old tough stems of chicory) and silage made from herb-grass fields. Only the silage including sticky chicory and soil was disliked by the cows. Some farmers had the impression that especially in the

springtime the cows preferred herbs and leaves from bushes and trees in hedgerows before grass. The farmer who established bands of herbs on the pasture described how the animals could stand in rows grazing primarily these stripes of herbs.

4.1.8 Farmers perceived herbs as contributing to good animal health

The farmers were asked whether they had noticed any effect from use of herbs on the health of their cows. Since there had not really been a before-after situation for many years, they were not able to see any difference. They all stated that they generally perceived their cows to be very healthy.

Cows which had taken part in the herb-silage project only got the pure herb-silage for 3-4 weeks, which was not enough to observe any difference on their health. Several farmers were convinced that the herbs contributed to the mineral supply of the cows. One interviewed farmer had not given other supplementary minerals to the cows the last six years – and had not experienced any negative effects. One farmer had many years ago a high prevalence of ruminant bloat in his herd. He solved that problem by exchanging red clover by alsike clover and adding caraway to the herb-seed mixture. In general the believed health-related effects on the cows and the fact that the cows seemed to enjoy the herbs were the main reason for the farmers to continue sowing herbs in the grass fields.

4.1.9 Seven of the eight interviewed farmers would use herbs in the future

Seven out of eight farmers stated that they planned to continue using herbs in their grass-fields, despite the facts that 1) herb seeds are quite expensive, 2) they do not have very obvious proves for the effect on the cows, and 3) growing herbs implies a lot of challenges in terms of survival of the herbs. All farmers constantly adjusted their way of growing herbs to improve the outcome. All farmers could mention one or more suggestions to further research, see box 1 below.

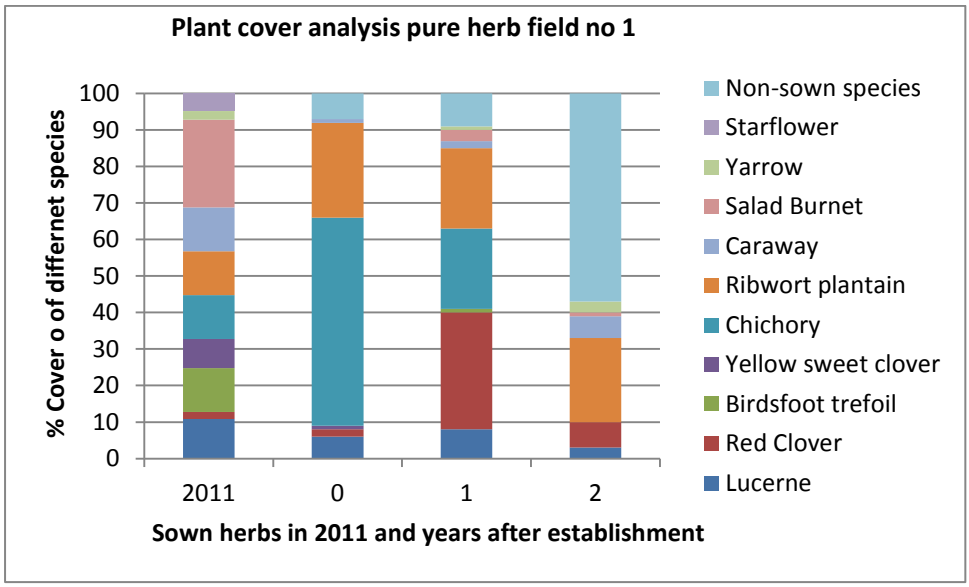
- The effect of feeding herbs on the health and reproduction of the cows
- Methane emission from feeding different herbs
- Developing growing methods improving the survival of herbs
- Development of herbs with higher competitiveness
- Herbs resistance to drought, heavy rain, frost etc.
- Effect of red clover on reproduction
- Development of other chicory types more suited for silage-production
- Development of seed-mixtures and growing systems suited for extensive production and heavy machinery
- Optimal time for sowing and cutting herbs
- Developing her mixtures with higher and more stable yields.
- Effect of chicory on gastro-intestinal helminth infections

Box 1. Farmer suggestions for relevant research on herbs in pastures for grazing and silage.

4.2 Plant coverage analysis

4.2.1 Research results from project at two Danish organic Thise farms

Of the three pure-herb fields which were a part of Petersens research project in 2011-2013 (Petersen 2012), one field was ploughed after two years, but the last two fields still existed on two of the visited farms. A plant coverage analysis was performed after the interview and compared to the plant cover analyses performed in 2011 and 2012 as a part of Petersens project. The figures below show that the development of the two fields turned out very differently. The field placed in the northern part of Jutland (no 1) had in 2013 been spontaneously invaded by 6% wild herbs, 25% rough blue grass (poa trivialis) and 26% white clover (Trifolium repens) probably originating from a seed-bank in the soil. Of the originally sown herb (column to the left) were the following species left: 23% ribwort plantain, 7% red clover, 6% caraway, 3% lucerne and 3% yarrow. The other sown herbs had disappeared.



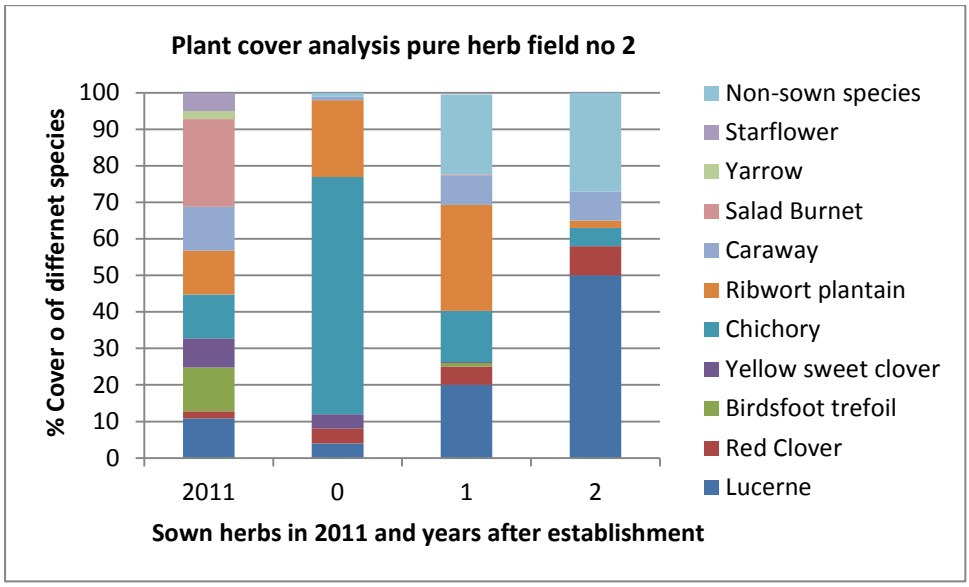


Figure 1 a & b. The results of 3 years plant coverage analyses of pure herb fields on two farms, of which the analysis done in the first two years was done in a research project by Petersen et al.

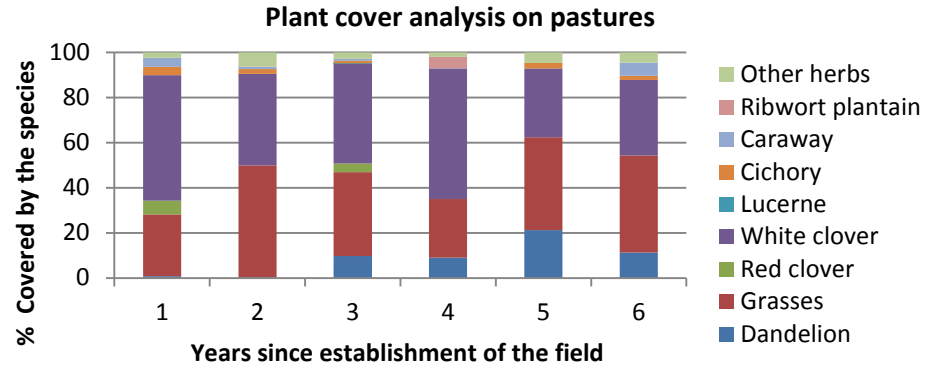
(2012) and the analysis in last year was a part of this project. The left bar shows the original seed mixture.

The other pure herb field placed in the central part of Jutland was in 2013 very open (cut two weeks before the plant analysis was performed). It was covered 50% by the dominating lucerne and beside that a coverage of 5% caraway, 4% red clover, 2% ribwort plantain and <1% chicory and salad burnet. In both fields, birdsfoot trefoil, yellow sweet clover, Sainfoin and starflower never established although the originally seed mixture had a quite high content of their seeds. The bar "2011" at the left in the two figures below shows the original composition of the seed-mixture.

4.2.2 Plant coverage analysis done on seven farms, Sep.-Oct. 2013

On the seven farms that had still herb-grass-fields plant coverage analyses were performed on all relevant fields meaning one to six fields on each farm. The findings mostly confirmed the statements from the farmers, and it also confirmed findings in previous Danish studies. Grasses and white clover were dominating all over in different balances, and only ribwort plantain, chicory and especially caraway survived several years in the grass fields although more and more scarce. While the sown herbs diminished from year to year the wild herbs became more and more abundant – on pastures especially dandelion, different thistles and curly dock. On the fields used for silage production the grown herbs covered a much higher percentage and seemed to survive better. Especially in one field, lucerne was very dominating. The figures below show the average cover% of 10 pastures with an age of one to six years after establishment, and five fields used for silage production, with an age of one to two years after establishment. Only chicory and caraway were found in 5-6 year old pastures and only with a few specimens on each field.

Plant coverage analyses were done at seven farms, two of which had participated in previous projects having one 100% herb field each. The plant coverage analyses could be combined with the results of plant coverage analyses from the two previous years. The development of the two fields had turned out very differently: one had been spontaneously invaded by 6% wild herbs, 25% rough blue grass (poa trivialis) and 26% white clover (Trifolium repens), and ribwort plantain, red clover, caraway, lucerne and yarrow (sown). All other sown herbs had disappeared. The second pure herb field was now covered 50% by Lucerne, and besides this, caraway, red clover, ribwort plantain and very little chicory and salad burnet. In both fields, birdsfoot trefoil, yellow sweet clover, Sainfoin and starflower never established although the originally seed mixture had a quite high content of their seeds. The plant coverage analyses of the fields which were one to six years old, generally, dandelions, grasses and clover dominated and Lucerne became dominating. Among the herbs, only chicory and caraway was found after 5-6 years.



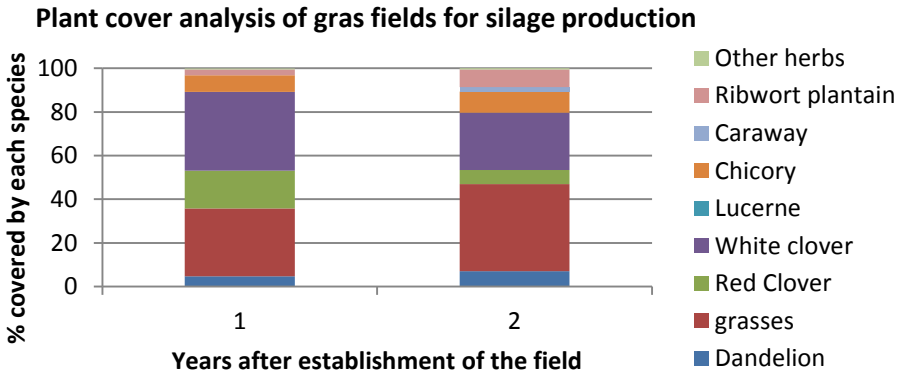


Figure 2 a & b. Results of plant coverage analyses on 10 fields at seven farms, at two-six fields per farm, over a six year period (Fig. 2a) for grazing and over a two year period (Fig. 2b) for silage production.

4.3 Short summary of literature study

A literature survey was undertaken with focus on Danish studies, and 17 studies were in-depth reviewed with focus on pasture characteristics and qualities as well as milk composition, yield and content, and potential effects on animal health. The focus areas of the different types of research was very different and complex, and the larger report can be found here: http://orgprints.org/28754/ .

The following points can be drawn out of the research conducted under Danish conditions:

- The annual herbage yield was found highest in Lucerne, ribwort plantain and birdsfoot trefoil, and lowest in perennial grass.
- In many studies, the yield was not found to be affected by or in different mixtures.
- Yield of fields with herbs was generally bigger from grazed plots, compared to cutting of the plots.
- Some mixtures, e.g. with 10 and 13 species of grasses, legumes and herbs had better performance compared with the standard mixture of perennial ryegrass, white clover and red clover.
- Proportions of herbs in the field changed a lot over time, e.g. a growth season or a couple of year. This varied with cutting frequency, seed mixture, and other factors.

- Herbs in grassfields have several competitors, and should be sown and plantet at times where they could have advantage over e.g. stronger grass types.
- Herbs influenced fat composition in milk in different ways, e.g. chicory lowered the urea content in milk.

5 Conclusions/Recommendations

- Ruminants like herbs, and farmers who have herbs in the grass fields did it very much because they could see that the cows preferred herbs.

- Sowing herbs in stripes seem a viable strategy, making it relatively easy to re-establish in a long-term grass field.

- All (non-poisonous) herbs – also those which establish themselves and in some cases are considered 'weeds' – can potentially have some beneficial effects on the cows and their health and welfare, the milk, and / or the biodiversity on the field. This generally encourages many types of plants, grasses and plants in pasture, and discourages plain mono-cultural grass fields. It also points to a more explorative approach to develop strategies to keep more robust herbs, treasure those which naturally grows on fields, instead of focusing on expensive seed mixtures of herbs which have difficulties in competing on many pastures. For example, Birdsfoot trefoil, yellow sweet clover, Sainfoin and starflower were all identified as herbs which were difficult to grow.

- Silage making seems to be a better option than hay making based on herbs, under Danish and similar conditions.

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