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Abstracts

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- LRF Västerbotten (Farmers' Organisation / Västerbotten County)
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The paper deals with the resources, peoples, agricultural activities, potential for agricultural growth and includes impediments for growth. Involvement of the northerners is highlighted regarding future decisions on agriculture and food. The role of governments is discussed insofar as future development is concerned. Emphasis is placed on "communications" and the value of "people learning from people" and sharing experiences regarding agricultural activities. A brief history of the Circumpolar Association is outlined and includes the 1991 to the present time period, and some comments on the future of the Association. The author's views on Canada's policy on the North is presented and opportunities for utilization of this policy by members is included. The paper deals with an explanation of the University of the Arctic and the possibility of usage of this medium for northerners involved in agriculture and food production.

Innovation in the rural context
- Lessons from research in Iceland

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A snap shot of rural Iceland and Icelandic agriculture

The population of Iceland is just over 290.000, of which over 62% lives in the capital city (Reykjavík) and the surrounding municipalities[1]. The remaining 38%, or 180.000 people, live in towns along the coast, small urban centers as well as in sparsely populated farming communities. In accordance with international definitions, Statistics Iceland defines *urban areas* as a cluster of houses with at least 200 inhabitants and with a distance between houses generally not more than 50 meters. *Sparsely populated areas* are by this definition inhabited areas which are not urban. According to this definition, just over 21.000 Icelanders live in areas that are considered sparsely populated, which equals just over 7% of the Icelandic population[2].

Most areas of Iceland, apart from the capital region, have experienced considerable out-migration in the last few decades. The highest out-migration numbers are seen in Westfjords region (about 24% of the population in the period 1980-2002) and in the Northwest region and the East Iceland (a decrease between 9 and 13%). Respectively the population of the capital region has grown considerably in the same period (about 50%).[3]

Employment by industry sectors in Iceland has changed in accordance with the development of other industrialized societies. Technological advancements have

[1] Statistics Iceland. 2003. Landshagir. Reykjavík, Statistics Iceland.
[2] Statistics Iceland. 2003. Landshagir. Reykjavík, Statistics Iceland.
[3] Statistics Iceland. 2003. Landshagir. Reykjavík, Statistics Iceland. [AND] Statistics Iceland. 1997. Landshagir. Reykjavík, Statistics Iceland

led to a decrease of employment in the more traditional sectors such as agriculture, fisheries and fish processing, while employment in various services, including tourism, has expanded. Although agriculture is not today one of Iceland largest sectors in regard to proportional contribution to the country's GDP[4], Iceland is self-sufficient in the production of meat, dairy products, eggs and to a large extent also in the production of certain vegetables. Although currently only about 4% of the Icelandic workforce is employed in agriculture[5], some agriculture exists in all lowland areas around the island, and the industry is still the backbone of local economies in most of the sparsely populated areas of the country. Many people are also involved in farming although receiving their main income from other sources.
Currently there are about 3.300 farms in Iceland[6]. The number has somewhat decreased in recent years, with a trend towards fewer and larger operating units. Icelandic farms are, nevertheless, still fairly small on an international scale, and most units are run as family-farms. Icelandic farms are usually highly mechanized. The income of farmers is rather low compared to other occupational groups[7]. There are however considerable differences between different branches of agriculture.

Traditionally, as well as presently, agriculture in Iceland is based largely on livestock farming. Cattle farming (milk and beef production) is by far the biggest branch within Icelandic agriculture, with aggregate turnover of 8,7 billion ISK[8] in 2002 or 47% of the total turnover of Icelandic agriculture[9]. Sheep farming is next in line with a turnover of almost 4,1 billion ISK and a 22,1% share[10]. The most common form of farming in Iceland is the so-called mixed animal husbandry, which usually consists of a mixture of cattle and sheep farming. Specialization has, however, increased significantly in recent years. A considerable number of farmers now raise pigs, poultry or horses, or produce eggs or vegetables exclusively. In the most sparsely populated areas, such as the Westfjords and the some parts of East Iceland, agriculture is mostly limited to sheep farming.

Since the interior of Iceland mostly consists of barren highlands, glaciers, and lava fields, only around 15.500 km2, or 15,5% of the total land area of Iceland, is arable. Of this area only around 1.500 km2 have been cultivated (1,5% of the total land area)[11]. Apart from growing of potatoes and a limited range of vegetables, farmers in Iceland mostly concentrate on the cultivation of perennial grasses for hay and silage. Conditions for grain growing are difficult due to the short summers and cool climate, although barley is cultivated for animal feeding in some parts of the country.

Milk production in Iceland is controlled through a governmentally run quota system where quotas are freely tradable. Milk is also the only agricultural product that official price administration applies to. Sheep meat production (mutton and lamb) used to be based on production quotas. However, sheep farmers do not need a quota for producing anymore, although the previously-used quota system is put as basis for

[4] According to Statistics Iceland, agriculture accounted for 1,4% of Iceland's GDP in the year 2003.
[5] The Farmers Association of Iceland. 2004. Icelandic agricultural statistics. Reykjavík. The Farmers Association of Iceland [only available in Icelandic].
[6] The Farmers Association of Iceland. 2004. Icelandic agricultural statistics. Reykjavík. The Farmers Association of Iceland [only available in Icelandic].
[7] Statistics Iceland. 2003. Meðalatvinnutekjur eftir landshlutum, atvinnugreinum og kyni 1998-2003. Statistics available on line at http://www.hagstofa.is.
[8] Exchange rate: ISK / 87 = Euros
[9] The Farmers Association of Iceland. 2004. Icelandic agricultural statistics. Reykjavík. The Farmers Association of Iceland [only available in Icelandic].
[10] The Farmers Association of Iceland. 2004. Icelandic agricultural statistics. Reykjavík. The Farmers Association of Iceland [only available in Icelandic].
[11] The Farmers Association of Iceland. 2004. Icelandic agricultural statistics. Reykjavík. The Farmers Association of Iceland [only available in Icelandic].

dividing up direct state support payments between farmers. Producers of certain vegetables also receive some direct state support payments. Exporting of agricultural products in Iceland accounts for a very small proportion of the industry's total turnover, although it has increased somewhat in the last few years. Exporting is almost entirely restricted to sheep-, fox- and mink products.

Changes in the legal and quasi-legal environment concerning agriculture in the last decade or so have generally focused on increasing efficiency of production, the relaxation of production and price control, as well as on liberalizing import control in connection with Iceland's EEA-membership and the WTO-agreement[12]. Also some policy efforts have been targeted towards diversification of the industry. Official grants are now available for a broader range of production and agricultural activities. Development efforts have also aimed at encouraging utilization of resources such as fishing in lakes and rivers, collecting eider-down, drift wood, etc. Fish farming and tourism are also industries that farmers have increasingly got involved in for the purpose of supplementing their income[13].

The research topic: Innovation in the rural context

The contemporary discussion on innovation, in the context of regional economic development, commonly focuses on densely populated, technology-advanced regions and/or university centers. Less attention has been paid to the role of innovation in economic development of rural and/or peripheral regions as well as to innovation within traditional or mature industry sectors, such as agriculture. Rural regions tend to be more economically disadvantaged than their urban counterparts and generally deal with greater challenges in terms of sustaining economic viability and enhancing future development[14]. It is a common myth that this situation is partly caused by specific cultural features that are likely to be found in rural locations (e.g. pessimism, skepticism and a lack of entrepreneurial spirit). These features are believed to have a hindering effect on innovation[15].

Until recently there has been limited evidence available in Iceland on the actual level of innovation activity in rural regions as well as on the role of socio-cultural features in innovation environments. However, the University of Akureyri Research Institute has now carried out a project aiming at:

- *Measuring innovation activity among businesses (including farm operations) in two rural regions.*
- *Exploring the appearance of three selected socio-cultural factors among the public in the same regions (hereafter referred to as community morale).*
    - *1. Optimism: Perceptions of future prospects for economic development.*
    - *2. Attitudes towards novelties: Perceptions of general attitudes towards original and/or new ideas and the level of encouragement towards innovation.*

[12] The Farmers Association of Iceland. 2004. Icelandic agriculture. Information available on line at: http://www.bondi.is/landbunadur/wgbi.nsf/key2/icelandic_agriculture.
[13] Sigurgeir Thorgrimsson, the director of the Farmers Association of Iceland. [year missing]. Agriculture in Iceland. Article available online at: http://www.bondi.is/landbunadur/wgbi.nsf/key2/mhhr5ajd7s.html.
[14] See e.g. von Meyer. 1997. "Rural employment in OECD countries: structure and dynamics of regional labour markets" in Bollman and Bryden (eds.) 1997. Rural employment. An international perspective. CAB International. Oxon UK.
[15] See e.g. Bryant. 1989. Entrepreneurs in the Rural Environment". Journal of Rural Studies. 5, 337-348 [AND] Cécora. 1999. Cultivating grass-roots for regional development in a globalising economy. Innovation and entrepreneurship in organized markets. Ashgate Publishing Ltd. Aldershot Hants, England.

3. Tradition for entrepreneurship: Perceptions of tradition for participation in business activities and entrepreneurship (including farm operations).

- *Exploring the relationship between innovation activities among businesses and the appearance of socio-cultural features in the same regions.*

The two regions, that were studied, are characterized by a fairly narrow economic base where primary industries (agriculture and fisheries) are of key importance. Both regions lack a major urban center and include a mixture of sparsely populated farming communities and small towns. Data gathering was in the form of surveys that were mailed to businesses (including farming operations) and to the public in the regions.

Selected research findings

Below are some of selected findings of the research project:

- The results of the survey among the public in the two selected rural regions show that community morale, in regard to the three selected socio-cultural factors, is significantly more negative in sparsely populated areas than in urban centers.
- The results of the same survey also show that farmers express the most negative views among all occupational groups, hence the most negative community morale seem to exist among farmers.
- Overall fairly few communities can be regarded has possessing a very positive community morale, in regard to the selected factors. However, community morale varies considerably among different communities even within the same region and between communities in very close geographical proximity with each other.
- The results of the survey among businesses (including farm operations) in the two selected rural regions show that approximately one out of four businesses has been active in innovation in the past 24 months. A significant difference could not be found between different industry sectors. Turnover was found to have considerable effects on innovation activity as innovation activity generally increases with higher turnover.
- The results of the business survey show that a vast majority of the farmers, which responded to the survey (80%), regard future prospects of their industry as very or somewhat hindering for innovation activities at their farms in the next 12 months. A significant difference can be found among firms in different industry sectors in regard to views towards this issue.
- The findings show that there is not a significant difference between the innovation activity levels of firms that are located in areas with positive or negative community morale (based on community morale indexes). However, if the interaction between the age of firms and the index of the area they are located is explored, the results show that innovation activity of mature firms[16] is affected by the community morale to a considerable extent. By raising the community morale index, a firm belonging to the mature group is much more likely to have participated in innovation activities. Hence, innovation activity of firms is only affected by the community morale if the firm has reached a certain level of maturity.

[16] Firms that have been operating for more than 10 years.

- The results of the business survey show that business representatives in sparsely populated areas generally perceive a lack of support and encouragement on behalf of the public in their community as more hindering for innovation than their counterparts in urban settings. 58% of the business representatives from the sparsely populated areas perceive this factor as very or somewhat hindering for innovation activities, while 33% of their urban counterparts indicate such views.

Conclusion

The overall results of the project indicate that sparsely populated communities (farming communities) are facing considerable threats. These threats are posed by negative community morale, fairly high degree of pessimism among representatives of the key industry, i.e. farmers, and the possible negative effects of the unfavorable morale on future innovation activities in these communities.

The relationship between the community morale and innovation activities supports the argument that innovations do not originate as isolated phenomena, but are affected by the interaction of people and shaped by the environment they take place in. This calls for raising awareness of possible unconventional measures for facilitating innovation, e.g. therapeutic programs for encouraging positive or proactive thinking or constructive identity building among certain groups, for example occupational groups such as farmers. In that context it is also important to discuss the possible roles of different actors in planning and development efforts.

The differences in community morale between neighboring communities indicate that we should be aware of overgeneralizing about the status of rural regions and communities. It also suggests that each rural community might require tailored approaches to the planning of efforts to strengthen community morale and the innovation environment in general. It seems reasonable to argue that the appropriate platform for such tailored approaches is the local level and that the role of local groups and grass root movements should be put at the center. These results, however, call for the attention of a broad range of interest groups, not only at the community level but also at the regional and national levels, e.g. representatives of industry associations, as well as various state organizations that have to do with industry-specific issues or rural and regional development in a broad sense.

Growth and innovation in Arctic agriculture, experiences from Northern Norway

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Handelshögskolen i Bodö, Norway

This speech gives us an introduction to the past, present and futures within the development of the agriculture farming industry in Northern Norway
Areas that will be addressed:

A description of the future farmer – Who is he and how does he see the farm develop?

Discuss which new-evolving decisions that have to be made in order to make the North Norwegian farm an attractive place of work?

Give an assessment as to which developing resources available in North Norwegian agriculture industry.

What is the means necessary as to stimulate quick innovative processes within arctic agriculture?

Regional changes in socioeconomic structures in rural Finland: a GIS approach

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and
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This paper presents a GIS (Geographical Information System) based approach for analysis of rural change in Finland. Traditional analyses on changes in human actions in rural areas are based on administrative divisions, like municipalities or provinces. These areal typologies are the most commonly used tools for comparisons of spatial structures both in national and international statistics, like those employed by the OECD and Eurostat. The empirical examples presented in this paper are based on "georeferenced data" which is taken here to imply data sets that are tied to specific geographical locations by means of base map coordinates and are therefore independent of administrative boundaries. One square kilometre grids based on Finnish base map coordinates have turned out to be small enough for accurate regional comparisons and big enough to include adequate number of inhabitants for statistical analyses. Data used here is collected annually by Statistics Finland from population registers. The practical outcome of this work is that very substantial structural changes are seen to have taken place within the rural areas of Finland as a consequence of the upheavals of the recession in the early 1990s. The population of the sparsely populated areas declined constantly in spite of the increase in population over the country as a whole, and primary production lost its leading position throughout the rural areas, so that it can no longer be said to serve as a defining characteristic of rurality in either a conceptual or a functional sense.

Animal production as an important factor for development of economics in the extreme North

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Necessity in further development of natural resources in the Russian circumpolar requires to renew and improve a food base. This is not only economic importance. Attachment of the inhabitants in these regions and recruitment of new population including the rural one, are also of a great geopolitical importance. Recently a full value of human nutrition decreased sharply here. The diet of an average statistical northern inhabitant composes 50% to 60% on account of animal protein content, and 75% to 80% on account of energy level, of the nutritional standards approved for

population in the Central Russian regions. This is connected with reduction in the cattle and poultry numbers as well as a decline in milk and egg production. It is necessary to develop a local production of milk and eggs because the produce brought from the central regions are characterized by a lower nutritional quality. Successful development of dairy husbandry depends on a nutritive base available which is formed in the circumpolar zone both of brought concentrate feeds (grains) and indigenous annual and perennial grasses. In the Magadan Agricultural Research Institute, the milk production technology has been developed which includes the effective methods for creation of meadows for the various purposes. Indigenous grasses which we have introducted are used to from meadows. Seed breeding of these grasses has been organized in a coastal zone of the Sea of Okhotsk in the Magadan region. The most promising among them are Alopecurus arundinaceus, Beckmania syzigachne, Arcragrostis arundinacea and Arctagrostis latifolium.

Milk production technology in the North through creation of such forage lands, hayfields and pastures as well as using the fish processing wastes in the coastal regions, opens the new possibilities for providing population in northern latitudes with milk and dairy produce. Poultry breeding for egg supplying should be located in the Extreme Northern regions where a transport scheme does not provide their quick delivery to a consumer, for example Chukotka and the Magadan region and come others. It is necessary to organized poultry feeding here so that the produce (eggs) obtained become rich with biologically active substances (vitamins, omega-3- and omega-6-unsaturated fatty acids and missing trace elements).

Topicality of creation of a biochemical model for agrolandscapes development in the Russian circumpolar regions

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The circumpolar regions of Russia are unique in geochemical respect because they are characterized by availability of a wide range of ore-bearing rocks determining in turn a relatively high content of trace elements (lead, zinc, arsenic, copper and rarely, nickel and chrome) in plowing horizons of soils in the natural ecosystems. Ecological situation becomes complicated under influence of the anthropogenous factors appearing in local environmental pollution with heavy metals. A current stage of mining development of the territory in the Magadan region is characterized by a large-scale technogenical load with a differential effect on all the biosphere components. An influence of technogenesis increases many times with the unfavorable geological endogenous and exogenous processes which are typical of the region, and often becomes irreversible under a low integral stability of the ecosystems.

The sources of pollution are mining and ore dressing enterprises including the mines and pits, barren rock banks and tailing dumps. Effect of these sources is a serious danger for ecosystems and human health because a population's activity is concentrated mainly in lowlands and by the slope feet along river valleys, near the fresh water sources and the huge tracts of thawing lands. Process of an agricultural

use of soil resources in the region is accompanied by changes in their trace elements composition and contamination of the enrichment horizons with toxic element concentrations which are not typical of a plowing part of a profile.

Currently, soils used in agricultural production in the Russian circumpolar regions can be classified into 2 categories, by the toxic element content in them:

- moderate dangerous pollution
- high dangerous pollution

Agricultural technologies used are not balanced ecologically and do not account the features of natural geochemical background, resistance of soils to chemical affect, an influence of trace elements on productivity and ecological safety of arable lands.
In this respect, a topicality of creation of the complex technology is obvious for management of ecologically sound agricultural production, a clear demarcation of a possible use of these or those arable soils depending on biophil elements content and toxic concentrations of trace elements in them. This technology should also include the possibilities to predict a biochemical condition of arable soils in the region with taking into account the effect of many anthropogenous factors. Creation of a biochemical model for agrolandscapes development should be taken as a principle of noted technology considering a specific character of the region examined.

Recent developments in Greenland agriculture

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Greenland Agriculture, with 53 full-time farms and around 10 part time farms, is probably one of the most marginal agricultural areas in the world. In the last decade the agriculture in Greenland has gone through a positive technical development, with a production stabilising at the “Neqi” slaughter house around 20000 – 25000 lambs a year, and good hay crops, compared to earlier years. But economically the development has not been so promising, and the farmers and the slaughter house has experienced increasing problems up through the 1990’s.

Nunalerinermut Siunnersorteqarfik/Greenland Agr. Advisory Service, on behalf of the Greenland Homerule, has analysed the economy, and the conclusion in an agricultural reform, initiated by the Homerule Government, was that the Greenland farmers would need larger direct subsidies and a more cost-efficient production.

Community Supported Agriculture (CSA): Supporting farmers; building community

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Aurora Mountain Farm, owned and operated by the Rudge family, is located 40 km from Whitehorse in the Takhini River Valley. Whitehorse is located at 60B 43' North of the equator and has an elevation of 640 meters above sea level. This area gets very little precipitation (averages less than 270 mm per year) and temperatures can reach –

45°C n the winter. These, combined with a very short growing season (about 800 growing degree days), are the challenges that must be overcome when producing for 14 weeks of CSA vegetable deliveries.

Aurora Mountain Farm has met these challenges in a number of ways. Ground covers combined with row covers allow seeding 4 – 6 weeks ahead of normal. Soaker hoses along with other innovative irrigation techniques are used in conjunction with mulching to conserve water. Wind fences and shelterbelts maximize snow accumulation for winter protection as well as increasing water supplies for summer watering. Row covers are designed to be easily moveable yet resistant to being blown around by the wind.

After growing vegetables for local farmer's market sales for a number of years, in 2003, Aurora Mountain Farm started to sell vegetables and other farm products in a new way. A CSA (community supported agriculture) connects farmers with consumers in a positive way. Members of our CSA pay for their seasonal produce by March before the season's production starts. This enables us to invest in new equipment, seeds, etc in time to get a good start on the growing season. Consumers benefit having delivered weekly to their door; freshly picked produce, free range eggs, along with value-added products like cheese and preserves. CSA members participate in farm visits and really get to know the farm and the family that produces the food they're eating.

The development strategy of Sakha Republic in force of geo-economical paradigms

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The world experience testifies that country succeeds only in those branches, that compliment to the historically determined conditions and national character. The positive effect of the geo-economical strategy is the symbiosis of economical, ecological and ethnic culture.

The main problems of the socio-economical development of the Sakha Republic (Yakutia) are considered in a separation from each other.

As a part of the development strategy of Sakha Republic would be realization of the geo-economical tendencies by creating ethno-economical model. The model could be constructed on the basis of ethnic technologies – reindeer husbandry, horse breeding, fishery, furs animal breeding. Ideological thesis will become: "Ethnic-economy is a new stimulus to preservation of indigenous people culture". Thus, we prevent transformation of ecological crisis in cultural. We form equal in rights attitude to a Nature, we form ecological mentality.

The role of USDA-ARS in the agricultural development of Alaska

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The Unites States Department of Agriculture (USDA) first established an Agricultural Experiment Station in Alaska in 1898. From 1898 to 1932 several research locations were established in the State and in 1932, the USDA research program was transferred to the University of Alaska. The USDA returned to Palmer, Alaska in 1948 to work on agronomy, soils, pest management, dairy, agricultural engineering, and horticulture. The USDA Agricultural Research Service (ARS) was created in 1953. The USDA Palmer unit set the basis for modern agricultural production in Alaska. Many of the small grains potatoes, and forage varieties used in Alaska were developed by the ARS program. In 1985 the USDA Unit was moved to the main University of Alaska Campus in Fairbanks for research on minimum tillage and wind erosion; only three USDA positions remained in the State. During the decade of the 90's, the unit's mission evolved to study the effects of climate change, carbon storage and crop residue management, methane consumption by grassland in the arctic, and carbon dioxide effects on crops yield. The unit developed management practices to eliminate wind erosion in interior Alaska, especially in the Delta Junction. The USDA ceased research operations in Alaska in November 30, 1994, but returned to Palmer in 1998 to work on arctic germplasm in collaboration with the State of Alaska Plant Material Center. Additional personnel were added and the management Unit was moved to Fairbanks in 1999. During 2001 the Palmer germplasm Unit became a worksite of the USDA Fairbanks unit. The new Unit focused research on ecology and management of grasshoppers and on germplasm adapted to arctic regions. Research on fish byproducts was added to the Units mission in 1999. The grasshopper project was expanded to include work on Integrated Pest Management (IPM) and a new project on virus free potato was added to the Units's mission during 2002. The IPM project research mission includes invasive weeds, insects, biological control, and diseases of important crops in Alaska. Since 1998, USDA-ARS in Alaska has expanded from two to fifteen research positions in 2004; two locations, Palmer and Fairbanks, and collaboration with several state agencies. Currently the mission of the unit is: 1. To improve the understanding and control of invasive plant pests, plant pathogens, weeds of agricultural importance in subarctic cropping and Alaskan natural systems, 2. To collect and preserve important arctic plant germplasm resources, 3. To develop virus-free potato germplasm, and 4. To develop effective and economical utilization of fish processing byproducts. Since it establishment in Alaska USDA-ARS released more than 40 cultivars of potatoes, barley, raspberry, and grasses. The research of USDA-ARS has enhanced productivity, profitability and environmental quality of Alaska's farming and fishing industries and natural resource areas by reducing threats posed by wind and water erosion, invasive insect pests, weeds and pathogens through research and technology transfer resulting in the introduction of new and innovative IPM strategies suitable to northern latitudes, increased utilization of seafood byproducts, and collection, conservation, and characterization, of germplasm adapted to arctic and subarctic environments.

Creative Centers – a place for smallscale idustrial strength and ability in the countryside of Finnmark County

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In Finnmark county we plan to build four creative centres located in to four different municipal countryside areas. The aim of the project is to:

Gather creative "forces" into cooperation on a mutual arena.

Create living rural areas, with good opportunities for developing small-scale industrial establishments.

Working together creative centres, local entrepreneurs and governmental authorities can maintain contact as well as exchange experiences with one another for mutual benefits.

Production of reindeer meat in Alaska

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Reindeer (*Rangifer tarandus tarandus*) were introduced to Alaska in 1891 to provide stable food supply and economic development for Alaskan Natives. During much of its history reindeer were primarily managed for subsistence purposes but during the last 20 years efforts have been directed at establishing a commercial meat industry. Currently, reindeer meat can enter the market place in one of three ways.

First, state regulation allows Alaskan Native producers to sell field slaughtered, non-inspected carcasses to local retail outlets. Under these regulations reindeer can be field slaughtered if ambient air temperature is less than 0o C and there is snow on the ground. But the market potential for this product is limited because it cannot be added to other meat products i.e. sausage, cannot be sold to restaurants or exported out of the state.

Secondly, extensively managed reindeer herds on the Seward Peninsula and Nunivak Island will be able to slaughter reindeer under inspection requirements in the near future. Inspected, free range reindeer meat is to be sold in both upscale domestic and international markets.

Thirdly, forage and cereal grain production in Interior, Alaska is being be used to intensively manage reindeer in farm settings. Grain and pasture fed animals are trucked and slaughtered in facilities meeting inspection requirements. Slaughtering of animals on the road system is less constrained by environmental factors than that of extensively managed operations so products can reach the market on a more continual basis.

The influence of the three production scenarios in Alaska on meat yield and quality and consumer acceptance is largely unknown. To reach the goal of producing a high-quality, marketable product, and further developing the Alaskan reindeer meat industry it is therefore essential for producers in Alaska to know the effect of handling methods, diet, the optimal time of slaughter for different animal categories and the best ways of processing and packaging the meat products.

In Sweden, various quality attributes of reindeer meat from grazing animals as well as reindeer fed commercial grain-based feed mixtures (pellets) have been studied. If the natural pasture resources are limited, carcasses from fed animals have a superior quality (better grading scores and higher meat content) compared with reindeer grazing natural pasture. Animals in good physical condition will have enough glycogen (energy) in their muscles at slaughter, which has important implications for meat shelf life, tenderness, color and water-holding capacity. The energy levels in the muscles at slaughter is also very much dependent on the pre-slaughter handling of the animals. Gathering, herding, selection and road transport of reindeer can certainly affect muscle energy levels and thereby ultimate meat quality. Generally, it is of benefit - for both meat quality and animal welfare reasons – to minimise the stress the reindeer are exposed to prior to slaughter. Feeding changes the flavor and chemical composition of the meat. Meat from pellet fed reindeer has a milder flavor and higher content of saturated fatty acids compared with grazing animals. The changes in fatty acid composition related to diet will also influence the quality of processed reindeer meat products. There are possibly several pre-slaughter conditions that could be improved for reindeer, which would lead to more consistent meat quality. For an optimal quality of fresh and processed meat products, the diet related differences in flavor and lipid composition in the meat should be acknowledged by the reindeer meat industries.

The challenge for us is to develop research projects that address the unique needs of the Alaskan reindeer meat industry in a number of production settings. By drawing upon the knowledge gained from research in Scandinavia we can begin to generate the data that will be essential for Alaskan producers to create yield, quality and processing standards for their meat production operations.

Problems of preventive maintenance of reindeer illnesses in conditions of Yakutia

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The stable development of reindeer-breeding deters the infection and noncontagious illnesses. There are brucellosis, necrobacteriosis and other illnesses registered in conditions of Yakutia. In such condition actual the elaboration of effective extreme measures of strife and specific preventive maintenance, and also environmental sanitation and health protection of people are considered.

The perennial experience of strife with brucellosis of reindeer demonstrates, that the application of common measures is low-effective. In previous years were tested agglutinogene, soft-agglutinogene alive vaccines from strains 82 and 19, 104M and 61. However, for some reasons (heightened reactgene, long-term preservation in a blood of vaccine-induced antibodies) these vaccines do not find practical use yet,

limiting by production-line testing only. Besides in the result of withdrawal by "savages" of domestic reindeer, the alive vaccine strains fall in wilderness, that according to our opinion, is undesirable. Hence from above-stated, we consider expedient working out of ecological secure inactivated vaccines with biologically active matters boosting a natural resistance of reindeer organism.

The necrobacteriosis has widespread occurrence among the reindeer the intensity of which in many respects depends on natural-climatic conditions of year. In condition of Yakutia the strife with this infection contamination is carried out, basically, by the application of zoo-hygienic measures, directed on protection of animal from influence of unfavourable environmental factors, increase of a natural resistance, and also usage of prolonged antibiotics.

Last years the inactivated emulsin-vaccine having as well therapeutic properties (by Y.D. Karavaev, I.G. Machakhtyrov, 1999).

The grave problem is the bronchopneumonia oftuguts (young reindeer). It is necessary to test and to offer antibacterial drugs and immunomodulating factors for the preventive maintenance of respiratory illnesses. We carry out the approbation of microbial drugs – probiotics. Probiotics should be accessible, effective and economically justified.

It is necessary to elaborate the prescriptions of mineral-vitaminized premixes with immunomodulating factors and probiotics with allowance for condition of an immunobiological reactivity and geochemical state of environment for the increase of a natural resistance of reindeer.

The main reviews and directions of researches on reindeer-breeding

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Yakutsk Scientific Research Institute of Agriculture is one of large scientific establishments on agrarian problems on the North East of Russia and head coordinator of NIOKR in Republic Sakha (Yakutia). Main directions of scientific researches of YNIISKH are: the substitution of the forms of managing in reindeer breeding, improvement of methods of selective-pedigree work and technology of supporting and feeding of reindeer. The working up the methods of struggle and preventive maintenance parasitic, infectious and non-contagious illnesses of animals, development of microbe preparations, technology both organization of reindeer-breeding and group on parasitology.

The employees of Institute develop a system of reindeer-breeding management, program of pedigree work, technologies of creation of a sown pasture and production of winter-green forages, measure of preservation of increase,. treatment and preventive maintenance of young deer's illnesses, necrobacteriosis, herpes, helminthiasis, echinococcosis and alveococcosis. The biology of hypodermic and naspharynxal gadflies of reindeer is investigated and the measures of struggle with them are developed. A new vaccine against reindeer's brucellosis had been approved. The recommendations for preparation of reindeer horns are offered. The

features of epizootic process on deer's brucellosis, epizootology of main helminthiasis of reindeer, wild animals of the Far-North of Yakutia are investigated.

In the Institute the new direction of researches - development of microbe preparations from "local" strains of microorganisms are obtained. The biological properties of microbes-antagonists are picked out and researched. The patents of new strains of microorganisms had been obtained. The possibility of use some strains in preventive maintenance of illnesses of animals is proved.

The reindeer herding as one of the ways of ecologically stable use of resources in the north-east part of Russia

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Cultivation of northern breeds of reindeers is traditional occupation for the indigenous people of Russian North. The antic experience has allowed them to develop ecologically safe system of the northern reindeer herding. However, in the last decade the amount of them is steadily reduced in Northeast of Russia (Sakha Republic (Yakutia)). In a taiga zone of Yakutia in 50-th of XX century the small amounts of reindeers successfully contained, but this days it was absolutely disappearing.
On our deep thought a reserve resource of reindeer amount increasing in Northeast of Russia is development of domestic reindeer herding in a taiga zone on the basis of modern technologies and achievement of scientific and technical progress. Restored and not used pasture in taiga zone of Yakutia allows to contain without any damage up to 50 thousand reindeers.

Since 1999 in the Yakutsk State Agricultural Academy (YSAA) the development ecologically safe and economically effective technology of reindeer cultivation in taiga zone of Yakutia is begun. We have tried to adapt for conditions of a taiga zone of Northeast of Russia the technology of reindeer herding in ‘khoral’. In 2003 the project "Family reindeer farm" was realized. The project provided making of experimental model of family reindeer farm (family from 3-4 men) for the 300 heads of reindeers in ‘khorals’ in conditions of the Central Yakutia. The farm should answer the modern social requirements: autonomous power station and own mini manufacture of reindeer products. The realization of this project pay special attention to ecological safety (sustainability): influence of reindeers on vegetation and animals was studied. In result the optimum sizes of the fenced territories for herding in the summer and winter period were offered and duration of pastures using is determined. The successful realization of the given project has allowed to study adaptation the ‘evenk’ breed of reindeers to conditions of the Central Yakutia. The economical profit and sufficient ecological safety of northern reindeers technology cultivation has shown on ‘khorals’ in taiga zone of Northeast of Russia.

Overview of research in reproductive biology of reindeer and musk ox

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The goal of the Reproductive Biology Program at the University of Alaska Fairbanks involves the accomplishment of research in applied reproductive management of farmed muskoxen and reindeer. The discovery and implementation of new management efficiencies enhances the sustainable production of these agricultural species in the north. In Alaska, muskoxen are raised for production of fine wool, qiviut, and reindeer are raised for production of meat and antlers. Research in reproductive management enhances understanding of the biology of these two species and offers improved productive efficiency through timing of breeding, increased fecundity of breeding cows, improved bull management and producer safety, decreased length of calving period and improved calf survivability. Completed studies have examined basic reproductive physiology and endocrinology as well as the application of bull introduction combined with, or independent of, the application of exogenous hormone protocols for estrous synchronization in reindeer and muskoxen. These studies have demonstrated timing of onset of the breeding season in muskox and reindeer, the extent of estrous cyclicity and the onset of anestrus in reindeer, and the determination of steroid hormone profiles throughout pregnancy in reindeer. Sustained, elevated endogenous progesterone (P_4), identifying the presence of a functional corpus luteum, indicated the mean onset of ovarian activity in muskoxen as 1 September and in reindeer as 15 September. The introduction of a bull following sexual segregation hastened the onset of the breeding season, resulted in greater synchrony of estrus and a shorter calving period in both species compared to previous harem management routines. Estrous synchrony has also been accomplished utilizing commercially available hormone protocols including controlled internal drug releasing devices (CDIR) and prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$). High rates of estrous synchrony and fertility during one-week harem periods were accomplished with both protocols and subsequent calving periods ranged from five to ten days in both species. Using radiotelemetric estrous detection combined with endocrine data to determine to precise time of mating has demonstrated gestation lengths of 211±3.0d in female reindeer bred at 1.5 yr old, 221±0.8d in mature female reindeer, and 245±1.1d in mature female muskoxen. Forthcoming studies will examine the effects of a synthetic progestin feed additive, melengestrol acetate (MGA), on sexual and aggressive behavioral attributes, fertility, and antler development in rutting reindeer bulls. In addition, studies examining the relationship of reproduction to leptin and thyroid hormone in female muskoxen and reindeer have received funding and will be undertaken in the near future. Research accomplishments by the Reproductive Biology Program at the University of Alaska Fairbanks are increasing knowledge of muskox and reindeer husbandry and are leading to enhanced and sustainable production of these northern species in livestock settings.

Future challenges for the traditional northern horse breeds

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The traditional northern horses have been of the outermost importance for the every day life of the people of circumpolar areas. They were used for riding, transportation, in addition to all kinds of agricultural works. Since the technical revolution in agriculture, many horses have turned to be unemployed animals. This has lead to serious problems, not only for the individual horse, but also to more critical situations for the whole breeds. The selling prices have gone down, and as a result many breeders have lost interest for further breeding of these excellent horses.

Modern society has given us extra spare time to do other activities than work. Sports and travelling are important and popular activities in our modern societies. Horse riding and competitions in horsemanship are gaining arena again in people's interest. Nowadays there is more time spending for activities of leisure compared to earlier day's short brakes from heavy hard work. However, we must solve a greater problem that exists to day, we have very few people that can manage the traditional horsemanship and bring such knowledge and scales ahead to new groups of people and future generations.

Northern horses are rather small, easy to satisfy and calm by nature when compared to horses bred for military purposes, industry, big scale agriculture, trotting and horse racing in more southern areas. People, who want to use a hors rather for fun than work, will look upon characters of the northern breeds as attractive scales. Today young people learn horsemanship at schools, in contrary to their ancestors who picked the knowledge up during work at home. In many countries horses have been used in physical, sociological and psychological therapies. Because of their calmness, the northern horses are well suited for teaching at schools as well as for therapeutic situations. The attractive temperament is the most prominent character of the northern hors. Therefore, the future challenges for the northern horses must be seen in connection to developments of our modern societies. Focus on our horses may also influence the market prices positively.

Quality in horse-tourism in Iceland

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The presentation is based on a three-year research and development project about quality in horse-tourism in Iceland. The Rural Tourism Department of Hólar leads the project, which is sponsored by the Center for the Icelandic Horse and The Icelandic Travel Industry Association.

The research is conducted in businesses offering horse rentals and riding tours in Iceland. In the first phase the view of the owners to their company and their business environment, was investigated through in-depth interviews and a survey. In the second phase the expectations and opinion of the guests of the service they received was solicited by a survey.

The project also involves a development phase that is giving education and feedback to the people working in this business. The aim is to make them more capable of giving their guests the best service that is possible and also to help them to run their companies in a profitable way. To do so, they have been offered workshops about security of guests, marketing and other relevant things. As a result of the project a handbook has been written. The handbook is meant to be a guide to managers and other staff in this business to help them to put more quality to their service and to run their companies in a profitable way, as well as with environmental awareness and according to law and regulations.

We believe that the experience of working methods in this project, that is research and development combined in a single project, can be a useful tool in rural areas and do therefore like to promote this project to an audience interested in rural studies, rural development and entrepreneurship.

The importance of forage quality in dairy and beef production in northern regions

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Ruminants are unique thanks to their capacity to utilise feedstuffs with a high fibre content. In a near future the use of locally produced feeds (e.g. forages) in dairy and beef production will increase for reasons such as ethical, animal health, environmental, milk quality and economy.

In dairy cow and beef cattle rations, forages are the most important source of digestible fibre. Thus forage fibres are very important to meet the energy requirements of the animal. A physiology of good function is a major prerequisite for high forage intake. At the same time the function of the rumen must be at an optimum. Feeding of optimal amounts of forage fibre with suitable degradability creates a good structure and an optimal rumen passage rate.

The feed value of the forages is critical for the possibilities to manage "effective" dairy and beef production. High feed-value of the forages fed is necessary to reach the level of feed intake needed to meet the energy requirements by high yielding ruminants. The most important quality factors of the forages are high digestibility and correct rate of degradability, because both these factors are important in feed intake regulation. It is possible to take advantage of the great variation in digestibility and fibre degradation rate of our forages by accurate choice of cutting time, plant material and process of ensiling.

Use of different plant parts to study N_2 fixation with ^{15}N techniques in field-grown red clover (*Trifolium pratense* L.)

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Red clover, *Trifolium pratense* L., is the dominating forage legume in northern Sweden. The clover-grass leys are harvested twice a season, a first cut in late June and a second cut in mid-August. We used two isotope based methods to study N_2 fixation from spring until first harvest, from first to second harvest and from second harvest until first frost in autumn. Our experimental plots were in neighbouring fields carrying a first year ley, a second year ley and a third year ley. For the ^{15}N isotope dilution (ID) method we added small amounts of ^{15}N-nitrate to experimental plots. When applying the ^{15}N natural abundance (NA) and the ID method we used the non-legumes in the plots, essentially *Phleum pratense* L. together with *Festuca pratensis* L., as reference plants. Leaves (laminae), stems including petioles, stubble, and roots were analysed separately. ID and NA gave similar values for pNdfa (proportion of N derived from air). It ranged from 0.6 to 0.99 with lowest values in roots and highest in leaves. Equations were constructed so that pNdfa in a single plant part could predict pNdfa in whole plants, thus avoiding the work to analyse both roots and above-ground plant parts.

Twelve years of organic and conventional farming at Öjebyn

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To investigate the production potentials in organic farming, specific methodological aspects need to be considered. Firstly, to understand the integrated patterns of nutrient flows and to utilise plant nutrients in a sustainable way, studies need to be on a realistic, full farm scale. Such case studies of farm situations now represent a new type of agricultural research. Secondly, to quantify the various aspects of organic farming, comparisons have to be made with corresponding conventional systems. Such comparisons can be made experimentally by comparisons between the two systems managed on the same farm with repetition in time or space to verify scientific criteria. The repetition in space is often difficult to achieve on this scale, which only leaves the alternative with repetition in time, requiring long-term experiments.

The experimental station, Öjebyn, is situated 5 km north of Piteå on the coastal plains of northern Sweden, 65° N 22° E. The yearly mean temperature is +2.1°

C and the total average precipitation is 500 mm. The station has a total area of 170 ha suitable for production of forage, barley, potatoes and vegetables.

The aim of this paper is to report twelve years of results to develop organic food production in the north of Sweden. Two farming systems based on organic and conventional principles were compared in a full-scale study. Apart from milk and beef, also potatoes and vegetables are produced for the local market. The feeding plans are based on feed produced in the two systems. The project started in 1988 when organic farming was introduced on half the total area of the research station. The first recording of crop-yields was done in 1990. The milk recording started in the autumn of the same year. Two separate cowsheds, similarly equipped for 50 dairy cows, were available. The herds get their feed from specific fields. Manure and urine produced are returned to the respective fields.

Dairy production in the north of Sweden

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The arable land in this region are about 300 000 ha - which means 11% of the total arable area of Sweden of about 2,8 milj ha. The area of northern Sweden is about 50% of the total area of the country, which means that only about 2% of the total area of northern Sweden is arable land. The relatively short growing season makes the number of crops possible to grow relatively few. However the climatically conditions are extremely well suited for the production of fodder crops. Almost 90% of the arable land in the north of Sweden is thus used for production of fodder crops for the animal production such as forage and cereals. Almost all cereals produced are used for animal feeding.

Agriculture in northern Sweden is heavily dominated by dairy production. The number of dairy cows is about 50 000 cows. The farmer's income from dairy production is about 2/3 of the total income from agriculture. Second most important is beef production mainly based on calves born in the dairy herds. The production of milk and beef are in good agreement to the number of people living in the area.

The Nordic climate also results in other specific advantages. In combination with a relatively low mean temperature, the many hours of sun during the summer will result in the production of high quality forage with very high digestibility, which means high animal feed intake.

Thus there exist unique possibilities for the future and as a result of that the over-all objectives of tomorrows scientific research and development are to investigate production systems which make it possible to:

- Produce high quality food-products with an arctic profile for human consumption.
- Evaluate sustainable production systems
- Increase the profitability

Human health protection in the natural centers of brucellosis in the Russian North

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The most part coast (67 %) of the Arctic Ocean is situated in the Russian Federation territory, where a main direction of economic activity is the reindeer-breeding. The reindeers are main and sometimes unique transport facility for the inhabitants of tundra, as well a source of raw materials for making dwellings, clothes, footwear, domestic appliances and instruments of labour. The conservation of health and life of native population, satisfaction of its necessities of life depends on ability to survive in severe conditions of North, where the snow lays 200-220 days in the year, average winter temperature - 26 °C (several days up to -50 °C), and summer - +10 °C, therefore the reindeers constitute the integral part of life of northern peoples.

In the reindeer-breeding are used a gregarious stockkeeping of reindeers which there is a possibility full and opportunely to realize the complex of veterinary measures. The shortcoming of gregarious stockkeeping are the unsystematic multiple usage of pastures, dense stockkeeping of herd, that can make for infection of reindeers by infectious and parasitogenic diseases, including dangerous to the man. The special place among zooanthroponosis occupies the brucellosis.

Natural nidal of brucellosis, maintenance epizootic and epidemic processes are conditioned by presence of a source of an infection among a wild population of reindeers and also a reservoir of pathogenic brucellosis, which can be predatory mammals.

For protection of human health from brucellosis in the natural centers northern reindeer-breeding is developed and successfully realized the system of antibrucella measures which are including diagnostic and specific preventive-treatment. The diagnostic researches carry out laboratory serological and bacteriological methods with scope of livestock up to 20 % of herd. For an immunization of reindeers are used living vaccines under the special scheme of injection.

The carrying out of veterinary measures has allowed improving from brucellosis of herd of reindeers in the majority regions of Russia, to save a stable prosperity during the last several years and to protect the population of North from infection by the brucellosis.

Field peas in beef cattle diets

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Field pea (*Pisum sativum* L.) production is rapidly expanding throughout the Northern Plains region of North America. This cool season legume is popular as a rotation crop with cereal grains. The increasing pea production will provide greater amounts of

peas that will be available for livestock feed. Peas are harvested as dry grain or grown for forage, usually in combination with oats or other cereal grains. Peas are one of the most nutrient dense grains that can be grown in northern latitudes. Peas contain 23-25% crude protein and .30 Mcal/kg energy, both significantly greater than barley. Peas have been used successfully in both ruminant and non-ruminant diets. Beef cattle rations may be the greatest potential market volume in North America, although peas will have to compete economically with many other feedstuffs. Several research projects at North Dakota State University have indicated that peas fed as a grain are very palatable, digest rapidly and thoroughly in the rumen, and produce animal performance equal to or greater than other feeds tested. This research agenda includes digestion studies, multiple creep feeding trials, feedlot finishing experiments, and cow supplementation projects. More work is underway in determining processing requirements of peas for optimum performance in creep feed, feedlot, and cow supplementation. Considering the nutrient density and palatability, peas may best be utilized in rations where intake is limited, such as creep feed or for stressed calves in post-weaning diets. Peas also are an excellent supplement in high forage cows diets. This grain legume can be used in all beef cattle diets where protein and energy are required, given economically competitive pricing. Pea straw is also useful as a forage in maintenance and growing rations for cows, bulls, and calves. Growing peas as grain or forage may reduce off-farm expenses and improve animal performance for northern livestock producers.

Wet grain in bag

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Storing grain dry is the most common way. The farmers has a long tradition and know how with the dry system, so why go for another system? In the northern part of Scandinavia there is some problem with the dry system as:

Harvesting season is short (few days and few hours a day) which gives expensive harvesting.
Normally harvesting is done at high moisture levels.
Drying to storable moisture levels is expensive.

Since the grain often is used for feeding cattle it is not needed to dry. It could instead be stored wet and feed wet.

Storing grain wet in bag gives several advantages. The harvesting season starts earlier, this will give longer days and better weather. This will give more hours on the combine and less cost for harvesting. Storing grain wet in bag will also give cost effective storing with high capacity. The environment will be less affected since less oil is needed.

The possibilities to store grain wet in a bag is studied in a common study between Sweden and Finland within the program "Interreg Kvarken Mittscandia" (founded by EU, Österbottens Förbund och Länsstyrelsen Västerbotten).

A comparative life cycle assessment of drying and crimping grain

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The aim of the work has been to find out the environmental impacts of two different methods of storing grain. The two ways of storing grain that have been compared are drying grain in a dryer and crimping grain in a plastic tube. In a northern climate, grain is usually harvested with a high moisture content. In such a case crimping represents an attractive storage alternative. The method that has been used for finding out the environmental impacts is called Life Cycle Assessment (LCA). A Life Cycle Assessment finds out the environmental impact of a product's entire lifetime and the result is presented in five different environmental impact assessments: global warming, acidification, eutrophication, ozone depletion and photochemical ozone creation. The conclusion you can draw from this work is that crimping grain in a plastic tube is better for the environment according to the five environmental impact assessments.

Plastic foil for crimping grain

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The aim of the research has been to determine the most suitable type of plastic foil for grain crimping. In a northern climate, grain is usually harvested with a high moisture content. In such a case crimping represents an attractive storage alternative. One of Europe's largest plastic film manufacturers, Rani Plast, has been active in the project. The project started by narrowing the foil type candidates down to one suitable foil: a three-layer PE-LLD and PE-LMD foil. Due to the three-layer structure it is possible to combine characteristics from different materials, as well as to use different colours in the layers. Tests have then been conducted in both laboratory and field to determine the optimum thickness and colour. The thicknesses range from 150 to 280 μm while the colour alternatives were transparent, white and black/white. In the laboratory, the

films have been subject to tensile, shear and impact tests, both as new and as used. Outside the laboratory, practical aspects such as sealing, packing and general storage capabilities have been tested. A larger storage test where bags of wet grain were stored outside over winter has been carried out. A number of external factors affect the foils, e.g. the sun's UV-radiation, frost and wildlife. The results are especially interesting when looking at the impact of colour on storage results. As a conclusion we are able to give recommendations to farmers as to what kind of foil to use when crimping grain.

Festulolium - a new grass for the North?

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Festulolium is defined as hybrids resulting from the crossing of a species of the genus *Festuca* with a species of the genus *Lolium* (*Festuca* spp. x *Lolium* spp.). In the national Official List of Varieties it is described as 'x Festulolium' and the names of the species used in the hybrid should be mentioned. The two genera are closely related and hybrids can be made between several species. Marketed cultivars range from allotetraploids containing the complete genomes from two species to introgression cultivars with just a small chromosome piece from one species in the others genome.

The two genera *Festuca* and *Lolium* possess different characteristics. While the *Lolium* species generally have high yielding capacity, good fodder quality, can tolerate frequent cutting, but have weak resistance to winter stresses and drought, the *Festuca* have better wintering ability and resistance to drought, but lower fodder quality. Cultivars of *Fesulolium* should combine valuable agricultural characters from the two genera. Most breeding work is concentrated on introgression of resistance genes from *F. pratensis* and *F. arundinacea* to *L. perenne* and *L. multiflorum*. Transfer of drought tolerance from *F. glaucesens* to *Lolium* spp. is also conducted.

The EU-project SAGES (Sustainable grasslands withstanding environmental stresses), just terminated, should contribute with new technology and new breeding tool kits to the breeders for developing cultivars of *Festulolium*. Introgression plants containing resistance genes with connected genetic markers should be identified and a model system for marker assisted selection should be developed. The project was in cooperation between scientific and commercial partners in The United Kingdom, France, Poland and Norway.

Festulolium is considered to be an interesting grass in many European countries, especially in areas with drought and winter stresses. Under Norwegian conditions, *Festulolium* have shown high yielding capacity and good fodder quality, but rather low wintering ability. 'Paulita' (*L. multiflorum* x *F. pratensis*) is the only cultivar listed in Norway; in addition 'Felina' (*L. multiflorum x F. arundinacea*) is doing well in official tests, but is still not sufficient winter hardy. Lack of winter hardiness in these cultivars is depending on the genetic background of the parents used in the hybridisations. Therefore, a Norwegian breeding program for *Festulolium*

was set up some years ago, where the goal is to develop cultivars more adapted to Norwegian wintering conditions. The most winter hardy cultivars of *Lolium* is used in hybridization and in backcrosses and more hybrids of the combination *L. perenne* x *F. pratensis*, using Norwegian meadow fescue, are been produced. The first candidate cultivars have entered the official tests.

Growing barley on the Northern edge - History and development of barley cultivation in Iceland

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Iceland is located in the North Atlantic Ocean just south of the Arctic Circle. The climate is a cool maritime climate with fairly cool summers and mild winters.
The history of settlement dates back to the year 874 when Norse settlers sailed across the Atlantic in search for a peaceful home away from the increasing conflicts of the Viking era. The settlers were farmers who brought their farming culture along with them to this desolate island. Archeological data supports written documentation of barley cultivation in Iceland in the first centuries of settlement. As the climate became colder, barley cultivation became a struggle and by the end of the 14th century barley was no longer grown in Iceland. Few attempts were made to restore the cultivation in the 18th and 19th centuries but they were all in vain.

More than 500 years passed until Icelanders started growing barely again in 1927, but on an experimental scale only. The area of barley increased until 1965 but a cold period from 1965 to 1980 terminated most of the cultivation. The "barley revolution" began in 1981 on the south coast and took off after 1990. Today barley is grown in all parts of Iceland and has become a substantial part of feed for dairy cows, beef cattle and pigs reared in Iceland. In 2004 the estimated number of growers is around 500, most of them dairy farmers but also pig and sheep farmers. For the last ten years the area of barley has increased from few hundred hectares to over 3000 ha in 2004. The annual production is close to 12.000 tons, which is 20-25% of the annual domestic demand for barley.

The barley cultivation has been supported with research and breeding at the Icelandic Agricultural Research Institute, which works closely with farmers and the advisory services. New promising cultivars from Scandinavia as well as Icelandic breeding lines have been tested on different locations throughout the country and small trials have been laid out in new areas to test local conditions.

This innovation in Icelandic agriculture has increased farmers' interest in cultivating the land. It has resulted in better quality feed for animals as barley is grown in rotation with perennial grasses. The social effects of the barley cultivation within the farming community are also considerable as it is something new and exciting and has served as a foundation for communication and cooperation among farmers within as well as across regions. The barley cultivation has therefore played a role in supporting the rural communities of Iceland in this era of out migration from rural Iceland and ever-diminishing role of agriculture in the nations economy.

Optimizing irrigation and nutrient inputs to Yukon crops

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A trial on optimizing irrigation and nutrient inputs was initiated in 2002 with collaboration from the Pacific Agri-Food Research Centre in Summerland, BC. The purpose of the trial is to examine best management practices for fertilizing and irrigating Yukon berry crops. By applying only as much water and fertilizer as is needed, water resources can be conserved and the risk of nitrate leaching can be reduced.

The key to minimizing water use is to have a clear understanding of how much moisture is used by the plant, how much is transpired through the leaves and how much is lost through the soil. Using various crop monitoring technologies, information on soil moisture and evapotranspiration is computed to automatically apply the fertilizer and water in required amounts.

An atmometer (evaporation meter) takes readings throughout the day and sends the data to a CR-10 datalogger. This datalogger computes values for evapotranspiration and sends a signal to a relay that turns on the water pump for a specific amount of time on each separate line. Fertilizer is applied according to specific fruit crop recommendations during every irrigation.

Another datalogger is located in the middle of the strawberry plot and compiles data from moisture sensors and temperature sensors beneath the plastic mulch. Examination of this data provides assurance that the system is functioning properly and helps determine soil moisture levels. All the data is downloaded onto a laptop computer once a week.

This trial will help determine the usefulness of new technologies in Yukon applications. Our hope is that some of these new techniques could be applied to other Yukon field crops such as potato, grain and forage crops.

Seed potato production – benefits from a northern climate

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A low infection risk in a cool climate gives an opportunity to produce seed potatoes nearly free from aphid born viruses and late blight in northern regions. From this reason, organic seed potato production is now established in the northernmost regions. In addition, northern growth temperatures, and not day-lengths, may affect the physiological quality of the seed tubers. This occurs through the after-effects (next season) on sprout and stem number per plant, vigour, length of growth cycle, and production capacity.

Although not fully understood, differences between ”northern” and “southern” seed tuber performance, are most likely caused by differences in physiological age.

Physiological age is the stage of development of a tuber, dependent on chronological age, growth history and storage conditions. In contradiction to the general opinion, results from laboratory studies at Holt show that immature "northern" tubers may have a higher physiological age than "southern" tubers at harvest. However, our field studies show that vigour and yield potential of tubers originating from regions with different growth temperatures do not differ significantly under Norwegian conditions.

Impact of management on invertebrate populations in Icelandic grassland

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The management of grassland in Iceland is mostly composed of draining (if needed), soil tillering, followed by annual fertilization, one or two hay-cuttings and sometimes spring and/or autumn grazing. These hayfields are permanent and in this study the surface living invertebrates in permanent hayfields and permanent unmanaged pastures were compared. Surface invertebrates were collected for one year (May 1996 to May 1997) in pitfall traps on three hayfields and three similar pastures at the Experimental Farm, Modruvellir, North-Iceland. Acari and Collembola, only identified to family level, dominated in number of specimens collected. Of collected specimens 48% belonged to Collembola and 40% to Acari. Identified were 44 species of Diptera and Coleoptera, 22 of Araneae, 13 of Hymenoptera, 5 of Hemiptera and Lumbricidae, 2 of Pulmonaria and 1 of Ophiliones, Plecoptera and Thysanoptera.

Acari (mites) were most active in early summer and were significantly more numerous in hayfields than pastures and this was mainly described to Astigmata and Prosigmata, while Cryptostigmata and Mesostigmata decreased with hayfield management. Dominating specie is the prostigmat mite *Penthaleus major*. **Collembola** (springtails) on the other hand were most active in late summer and early fall and their total number was reduced by management, mainly Isotomidae, Entomobryidae and Onychiuridae. Total number of **Coleoptera** (beetles), dominated by Staphylinidae, Cryptophagidae and Carabidae, was reduced by management. Only *Omalium rivulare*, along with some rarely catched species, seem to be attracted to hayfields. Some species (*Atheta atramentaria*, *A. fungi*, *A. melanocera*) were most active in early summer, while other species (*Oxypoda islandica*, *Quedius boops*, *Q. fulvicollis*) culminated in fall. The total number of **Araneae** (spiders), dominated by *Erigone atra* and *Tenuiphantes mengei*, was similar in hayfields and pastures. The number of all species was reduced by management except *Erigone atra* and *E. arctica* which flourished in hayfields. *Erigone atra* composed 46% of the spider population and was mainly active in spring, *Tenuiphates mengei* both in spring and fall and *Allomengea scopigera* in fall. **Ophiliones** (harvestman, only species *Mitopus morio*) was reduced by management and also number of trapped **Hymenoptera** (hymenopterans) and **Diptera** (true flies) was higher in hayfields than pastures.

Carrot (*Daucus carota* L.) yield and quality in the North

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Carrot is a crop with very slow growth and development during the first 6-7 weeks from sowing. There has not been demonstrated any exact indices for a mature stage of the storage root. The growth will continue as long as the climatic dry matter conditions permit dry matter accumulation. The potentiality for the final root yield depends on both genetic characteristics and on the ability to develop green leaves early in the season, when the irradiance is favourable for the photosynthesis. The genetic constitution (variety) determines the time course for the development and hence for the final root yield.

A relative late sowing, low temperatures and a short growing season in the north produce smaller carrots and lower root yields than under warmer conditions in the south. But low temperatures during the first weeks of root elongation may develop for long taproots, which have the potentiality of producing high root yields in warm seasons, or when temperature-ameliorating techniques like sheet covers are used.

Low temperatures give sweet carrots, due to high proportions of hexoses in relation to the total sugar content, and to low contents of bitter-tasting compounds like terpenes and phenols. Carrots from the north may be characterised as "sweet and juicy" because of low bitterness (and a low dry matter content). The carotene content and the (orange) colour strength are, however, lower under cool than under warmer growing conditions.

Bitterness is related to a high growing temperature (> 20°C) or to stress conditions the plants have experienced (drought, root damages, wounds, mechanical breakages etc.).

The temperature also influences the shape of the carrots. Higher temperatures give shorter and more cylindrical root form than low temperatures do. An optimal temperature for high yields and a good quality seems to lay around 12-15°C

Examples will be given from 4-5 varieties of carrots grown on altogether 14 field trials on eight geographical sites of Norway between Lyngdal (58.17°N) and Alta (69.9°N) during the years 1996-1999. Total root yields higher than the average (42.3 t per hectare) was achieved also at two of the four sites in northern Norway (Fauske and Kvæfjord), of which in average ¾ of the yield was graded as marketable, based on their size and appearance. The root size, the root yields and the number of plants varied considerably between sites. The root yields also varied between varieties. No interactions could be calculated to detect eventual different variety effects on the different sites.

Among the quality characteristics considered (root size, proportion marketable roots, allover performance, colour strength, sweetness, bitterness, terpene flavour, juiciness, the contents of total carotene, total sugars, dry matter, glucose, fructose, and the proportion of hexoses (glucose + fructose) in per cent of the total sugar content) the clearest site effect was demonstrated in the colour strength, carotene content and in the terpene flavour and the bitter taste sensory scores, all of them being highest in the south.

Variety effects were detected for yield level, yield grading, bitter taste, total carotene content, fructose content, proportion of hexoses of the total sugar content. The varieties Panther, Newburg and Napoli got the highest total root yield, whereas Yukon had highest marketable grading and the highest marketable root yield. The colour strength and the carotene content of the roots were highest in Newburg, and lowest in Duke. The fructose content, the proportion of hexoses of the total sugar content was also highest in Newburg, and lowest in Napoli.

The data did not permit an analysis of any interaction between site and variety. The range between varieties varied considerably from site to site for many of the yield and the quality characteristics.

The varieties Newburg, Napoli and Yukon are likely to achieve relative high root yields and a root quality preferred by consumers, which may be obtained by growing them on suitable soils in the north as well as in the south of Norway.

Current knowledge and research priority for the development of a cloudberry culture in Canada

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Harvested peatlands cover a relatively large area in Québec, approximately 6000 ha, which is almost the same area as in New Brunswick. The peat of the abandoned sites becomes oxidized which leads to a diminution of the remnant soil quality (Waddington & McNeil 2002). Restoration techniques that permit the recovery of a Sphagnum peatland ecosystem after four or five years have been developed (Rochefort et al. 2003). However, it would be interesting to add to these techniques the farming of a marketable species such as cloudberries, which grows naturally in Sphagnum peatlands. In this manner, we could include an added value to the peatland restoration. This would also create profitable agricultural activities in regions where agriculture is restricted, such as the Côte-Nord or the Acadian peninsula. Cloudberry farming experiments on harvested peatlands were started two years ago in Norway and Finland, however, much work still remains before a commercially feasible crop can be achieved. In this presentation, we will expose the logic at the base of the research goals, which should be prioritized in Canada :

1. The development of cloudberry agricultural techniques on mined and natural peatlands;
2. The assessment of the environmental impacts of these two agricultural practices;
3. The determination of the mycorrhizal function in the mineral nutrition of the cloudberry and its interactions between Ericacea;
4. The selection of clones which are both productive and rich in antioxidants.

Rochefort, L., F. Quinty, S.Campeau, K. Johnson & T. Malterer. 2003. North American approach to the restoration of Sphagnum dominated peatlands. Wetlands Ecology and Management 11: 3-20.
Waddington, J. M. & P. McNeil. 2002. Peat oxidation in an abandoned vaccum extracted peatland. Canadian Journal of Soil Science 82: 279-286.

Pollination and fruit set in cloudberry (*Rubus chamaemorus* L.)

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Introduction

Three main factors are influencing the pollination and fruit set of cloudberry;

- The plant species
- The insect populations
- The weather conditions

These three factors are strongly interacting to each other. However, we will try to analyse each of them, and thereafter discuss how there are interacting or involving on each other – from pollination to fruit set.

Results

- *The plant species*

Deals primarily with the distribution between the females and the males. However, in this factor is also including the genetic difference among genotypes of females regarding the number of pistils and thereof a different potential to give bigger berries, and among genotypes of males regarding the number of steamens and thereof a different potential to give enough of pollen. In a pollination research in a greenhouse, where we used different per cent of males for a similar number of females, the best result was obtained when using ca. 20 per cent males – if there were enough of bumblebees at place.

To get a good result of pollination and fruit set the optimum distribution between the two sexes are 80 : 20, for females and males, respectively.

- *The insect populations'*

Despite an optimal distribution between the two sexes, if there are to little of insects – the pollination and fruit set will be reduced. In the greenhouse experiment mentioned, we observed ca. 50 per cent better pollination and fruit set when using ca. 50 bumble bees compared to using ca. 30 bumble bees.

- *The weather*

Despite a optimal plant community (balanced number of the two sexes) and enough of insects, the weather can reduce the result dramatic.

If the air temperature is too low, between 5 – and 10 ° C, only a few insects are able to fly and it gives reduced pollination and fruit set.

Similarly, if the weather is rainy and cool under the flowering period, it gives often a break of the pollination going on and it gives high per cent of rather small fruits and thereof reduced fruit crop.

Discussion and conclusion

The results show that good pollination and good fruit set on cloudberry is effected of three main factors, the plant, the insect, and the weather. Each of the three factors are strongly influencing on the other. For example, a cool and rainy weather gives few insects, a few insects gives a low pollination rate, and a low pollination rate gives reduced fruit set. If only one of the three factors is failing, the pollination and the fruit set will be reduced. The most common situation is that all three factors are a bit

reduced, and the results are often medium. Very seldom all three factors are optimal – and a top result is therefore very seldom.

In order to increase the result, we can start cultivation of the field.

- To optimize the females/males distribution, planting of propagated cultivars of the two sexes can be done.
- To get stronger plants, fertilizing using NPF fertilizers is possible.
- To place insects (bumble bees) in the field under flowering can raise the pollination.
- Weather conditions may be changed if putting up shelters against the wind, and to build frofiles of the cultivated field in order to increase the middle temperature.

Conclusion

The three main factors influencing the pollination and fruit set of cloudberry are the plant it self, the insect population, and the weather. The three factors are strongly influencing on each other. Most common is that all factors are a bit reduced – giving a medium result of pollination and fruit set. The three factors may be bettered during commercial cultivation of the field.

The role played by resource limitations in restricting fruit production in cloudberry.

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Cloudberry is a commercial berry that represents an important asset for northern populations in Scandinavia as well as in Eastern Canada. Cloudberry is essentially harvested from wild populations. There are now some attempts to domesticate this plant but many factors still strongly limit fruit yield. For one thing, flowers are frost sensitive that strongly restricts fruit production. Pollination is also sometimes deficient. Fruit size is variable but can be greatly increase by selection of clones or cultivars. However, there are still some intrinsic limitations that are due to the way this plant allocate its resources. For the last nine years, we have been studying some of these internal factors that are limiting cloudberry fruit production. Because of its huge investment in rhizome production, cloudberry does not seem to have enough resources to produce numerous and large fruits. There is on average only one stem every 1.2 m of rhizomes in natural peatlands, and only one quarter of them bear a flower. Furthermore, many fruits abort during the summer, even when pollination has been successful. From a series of experimental manipulations in natural and exploited peatlands, we concluded that there was no apparent competition between the nearby rhizome and the fruit for carbon and other resources. Carbon reserves located in the

rhizome would apparently supplement the carbon from leaf photosynthesis during fruit development. As many stems are non-floral, we also studied their contribution during fruit development. We labelled the carbon fixed by either a floral or a nearby non-floral stem and determine the amount of radioactivity located in the fruit. The allocation of carbon to the fruit from the floral stem is about 50 times higher than the amount of carbon coming from non-floral stems. Furthermore, it seems that the floral stem is dedicated to its fruit until maturation is completed with very limited carbon going into the rhizomes during this period. It thus appears that floral stems barely produce enough carbon to sustain fruit development and that they rely on carbon reserves in the rhizome to allow complete fruit development. Therefore, when photosynthesis is restricted for a few days (cold or cloudy weather), and if carbon reserves are not sufficient, the fruit will most probably abort.

Since cloudberry grows in very poor nutrient environment, we expected mineral nutrition to be another factor limiting fruit production. However, our data as well as data already published brings little support in favour of a mineral deficiency or limitation as being the main cause of fruit abortion. We suspect that nutrient limitation, especially phosphorus limitation, would act indirectly by limiting carbon export towards the fruit. Further studies are underway to explore this possibility. There is still research required to improve cloudberry yield. Apart from selecting highly productive cultivars, it would be very useful to establish the proportion of rhizomes and stems – both floral and non-floral – that could maximise fruit production. Thereafter, the cultural practices that allow such allocation patterns to occur in the field will need to be identified in order to improve and stabilise fruit yield in cloudberry.

Cold climate composting

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Our project successfully developed an economic method for converting raw chicken manure into a safe and sanitized compost (free of pathogens and weed seeds) meeting CCME guidelines for category A compost. The project stemmed from the need to find an environmentally sound and inexpensive way for our local chicken barns to deal with their wastes and provide an alternative to the current practice of disposing the untreated manure directly into the environment. The method made use of locally available materials and should work well in any northern region. The process could probably be adapted to the composting of other manures. Since our northern soils are very low in nutrients, especially nitrogen, the product should prove beneficial as a soil enhancer, and we hope to be able to market it to local gardeners.

The project was carried out over three summers. The initial attempts using sawdust and manure in different ratios did not generate enough heat to meet the CCME guidelines, as the composting temperatures were either too low or could not be maintained for a long enough period. We then attempted to retain more heat by covering the piles, but that was also unsuccessful. When we started monitoring oxygen levels, the tests revealed that the oxygen levels of the piles were too low for thermophilic microbial action. Attempts to improve aeration made by adding pipes were also unsuccessful. In the final stages of the study, local supplies of sawdust became unavailable, so we tried substituting straw and peat soil for the sawdust. We

found that high composting temperatures could be readily achieved and maintained in the straw piles, and that their oxygen levels were high. However, the straw had a tendency to dry out, and required more work to turn and water. The straw also took a long time to break down and did not provide an appealing looking end product. With the peat soil, the composting temperature was too low as the oxygen levels were deficient.

The results we were hoping for were finally achieved when the straw and peat soil were combined with the chicken manure. The straw improved the aeration of the pile, while the peat soil served to retain the moisture and provide a rich, dark color to the product. The product was tested and met the standards required for category A compost. We also found that with this combination, high composting temperatures could be generated in late September, and maintained even when the ambient temperatures dropped below 0 degrees Celsius. Although our study was concluded at this point, it appears that composting by this method could be initiated in the late fall, and carried over into the early winter months.

Recent outbreaks of avian influenza in Canada and other regions of the world raises issues about what should be acceptable practice in the disposal of poultry waste. Direct disposal of poultry wastes into the environment in our region attracts flocks of ravens and gulls as well as wolves and foxes. Such practice carries the risk of poultry diseases being transmitted to wild migratory flocks and transported elsewhere. Our composting process could play a role in reducing or eliminating this risk.

Climate change and tree growth; bud dormancy in Northern tree species is enhanced by elevated autumn temperatures

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For tree species at northern latitudes, close synchronization of the annual growth-dormancy rhythm with the local climatic conditions is a prerequisite for survival. Rapid changes in climate can be expected to disturb this synchronization and, as a consequence, growth and survival of trees could be affected. Photoperiod has a key function in timing of growth cessation and cold hardening in northern tree species and this critical process is less affected by changes in temperature climate. On the other hand, initiation of new growth in the spring is primarily controlled by temperature. Before bud break can take place, trees have to be exposed to chilling for breaking of bud dormancy and for temperature conditions required for growth initiation. These responses have been extensively studied, also in respect to expected changes in temperature climate. However, induction of bud dormancy has not been studied to the same degree and the effects of temperature on the development and depth of bud dormancy are not well known. The purpose of this study was to determine the effects of temperature treatments applied during bud development on dormancy in birch (*Betula pubescens* Ehrh and *B. pendula* Roth.) and Norway spruce (*Picea abies* (L.) Karst.).

Experiments were carried out in the phytotron of University of Tromsø under controlled conditions using seedlings of several ecotypes. Seedlings were initially

grown at 18°C and bud set was induced by 12-h photoperiod (SD) treatment. After bud set, seedlings were transferred to various temperature treatments (9, 12, 15, 18 and 21°C) under SD. Induction of bud dormancy was monitored by following bud flushing and growth after transfer to 24-h photoperiod (LD) at 18°C. Chilling requirement was studied in seedlings exposed to SD for 8 (Norway spruce) or 10 (birch) weeks before chilling.

In both species of birch, dormancy was induced most rapidly at 15-18°C, and particularly at 9-12°C induction of dormancy was significantly delayed (Junttila et al. 2003). After a prolonged SD treatment, chilling requirement increased significantly with increasing temperature applied during the SD period. Temperature effects on development of dormancy were basically similar in all ecotypes studied, but in general the northern ecotypes entered dormancy faster than the southern ones.
The rate of bud break was negatively correlated with temperature applied during bud development in Norway spruce as well. This effect was highly significant even after chilling for six weeks. Rate of bud break varied between the studied nine ecotypes of Norway spruce, but they all responded similarly to the temperature treatments applied during bud development. Contrary to birch, prolonged SD treatment did not induce complete bud dormancy in Norway spruce; above 50% bud break at 18°C in LD was observed in all treatments even without any chilling treatment.

Increased temperature during late winter and spring will result in an earlier bud break and this may increase the risk for damages due to late frost spells. The present results, and those reported by Heide (2003), show that such situation is in part counteracted by a climatic warming during late summer and early fall, which will increase the chilling requirement and delay bud flushing.

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Crop diversification in the highlands and islands of Scotland - Initial studies by The Agronomy Institute at Orkney College

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With a land area of about 39,000 km^2, the Highlands and Island (H&I) covers about half of Scotland, although its population of 372,000 is only about 7% of the national total. The area includes a large part of mainland Scotland and more than 90 populated islands or island groups like Skye, Orkney, Shetland and the Outer Hebrides. Very little of the land area is used intensively and about 45% is considered unsuitable for forestry or agriculture. Nevertheless, agriculture is a significant part of the H&I economy, employing 24,000 people and in some areas, like Orkney, over 10% of the working population. Its total agricultural output is valued at about £258m per annum, with about 87% of this from livestock production and 13% from crops. The importance of farming and crofting (small-scale farming) for the survival of H&I communities is widely recognised but diversification is considered to be a major priority for the sector.

In recent years, agricultural research relevant to the H&I has been neglected because most research organisations are based near the main urban centres like Aberdeen, Perth, Glasgow and Edinburgh from where it is difficult and costly to implement projects in the H&I. Against this background, UHI Millenium Institute has been developed - a project to bring a university to the H&I and consisting of 15 partner colleges and research institutions, mostly located in the H&I. In addition to providing college and degree level courses, many of these partners have, or are developing, research capabilities in specific areas. Orkney College, for example, is concentrating on agronomy, archaeology, geophysics and cultural studies.

The Agronomy Institute (AI) opened at Orkney College in June 2002 to provide a new crop-based research and development facility for the H&I. Its main research priority is to assist agricultural diversification and rural development in the area by identifying alternative crops and related commercial products. This is being done by a research programme which includes college-based trials screening potential crops, on-farm trials with promising crops and projects on specific plants and topics involving both growers and end-users. The crops being investigated fall into a number of themes identified through a study of the markets for alternative crops: specialist cereals, fruits and berries, extracts and flavourings, biomass and biofuels, specialist oils and on-farm protein crops. Funding from various sources within the H&I has been obtained for projects investigating specific crops - Bere barley (a barley landrace), biomass (willow and poplar) and biofuels (rape, linseed and sugarbeet) - and for other topics relevant to the AI's aims. These include studies of the use of plant-based ingredients by the H&I food and drink industry, market-related research for Arnica and fruits and berries and the identification of commercialisable wild plants in Unst in Shetland. As a result, the AI is rapidly gaining recognition within the UK as a centre for research and development into northern crops. Amongst its priorities for the future, the AI would like to develop collaborative links with similar organisations in other northern countries.

Adding value to beef production in the north

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The economy of northwestern Quebec is based on the exploitation of natural resources such as mining, forestry and agriculture. Agriculture is mostly devoted to dairy and beef production. Beef production is concentrated in the cow-calf sector relying heavily on locally grown forages. Over the years, this sector has developed an expertise in the production of quality calves that are sold to southern feedlots. Cost of production is low mostly because of the availability of highly nutritive forages, cost of land ownership, and the adoption of management practices adapted to the climate of the area. The next step would be to increase the value of this production with all parts

of the value chain being established in the region to increase business opportunities. An opportunity study has identified that it would be possible to produce a young steer (350-450 kg) fed mostly with milk from the dam and forages without the use of hormones and ionophores, which are actual consumer demand. To support the producers in the development of this new market, a project was launched where "production standards" have to be produced, the commercial aspects have to be developed and the market evaluated.

The development of "production standards" commands research projects to define specific technical aspects of the production. Research projects have been grouped under three different themes: 1- forage production; 2- forage conservation and 3- management, nutrition and meat quality. The first phase of the project has concentrated on determining the effect of hormones and ionophores on beef production and meat quality. During the growing phase, hormones and ionophores increased average daily gain (ADG) by 13% and improved feed conversion by 15%. The addition of soybean meal up to 500 g day-1 did not compensate for the hormones and ionophores effect. During this nutrition phase, hormones and ionophores increased the financial gross margin by 25%. During the finishing phase, the addition of rolled barley increased intake and ADG with an overall positive effect on feed conversion. However, the addition of rolled barley (70% DM basis) produced a better carcass in less time with 100% of carcasses being graded A or better. Addition of hormones and ionophores increased all parameters with or without the addition of barley. Nevertheless the financial gross margin was negative for all treatments. It is clear that the exclusion of hormones and ionophores from the ration will decrease profitability. Therefore, new strategies must be developed to compensate for this loss.

Renewal of grassland without ploughing by wet sowing techniques, with special attention to establishment of clover in the plant stand

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In the years 2002 - 2004 different equipment were tested for wet sowing of seeds of grass and clover mixed into cattle manure in grassland. The purpose was to establish a content of clover suitable to supply the meadow with nitrogen in organic farming and to increase the protein content in the yield.

Materials and methods

In 2002 the sowing/fertilizing was carried out with a disc moulder (Kaweco) and equipment for stripe sowing at the surface (Agromiljø) on an area with graded surface towards open ditches. Both methods were tried to perennial ryegrass, red clover and a grass/clover mixture.

In 2003 four experiments were established, in Bodø on sandy and on peat soil, near Stavanger on sandy soil and near Bergen on peat soil. The plant species on the areas before sowing were timothy on both fields in Bodø, old mixed grass sward near Bergen and mostly perennial ryegrass near Stavanger.

Before sowing the old grassland was crossharrowed 0, 4 and 8 times with a weed harrow to open the soil for the seed, the other experiments were harrowed 0, 3

or 6 times in one direction. The sowing was carried out with a row moulder from Agromiljø. This machine also was used to simulate the stripe surface spreader by lifting the discs. In addition sowing with an ordinary sowing machine with discs was carried out after fertilizing at all places, and in Bodø also with a Tume cutter and sowing machine.

All four experiments were sown with 5 kg ha-1 red clover, and with the same amount of red clover and 20 kg ha-1 of perennial ryegrass. The experiments were given 20 tons ha-1 of cattle mixed manure with about 7 % DM, at one experiment the fertilizer was mixed with water 1:1 and given in double amount.

The sprouting and number of clover plants were registered by weekly counting at the plots during three weeks, at first harvest and in autumn. The sprouting of ryegrass was difficult to observe, and not systematically registered. All experiments were harvested two times, first cut after heading of dominating grass and second cut in August or September.

Results/conclusions

The field sown in 2002 gave best establishment of new plants after the surface stripe sowing. In second cut the content of red clover altered between zero and 40 %, depending on the yield of established grass, which was highest in the middle of the slope and lowest along the open ditches. In 2003 the yield of all sown species were higher than in the sowing year. In second cut the red clover content was up to 80 %, white clover up to 15 % and perennial ryegrass up to 10 % of DM.

In the new experiments in 2003 the surface sowing in manure gave faster sprouting of red clover than moulding, but not significant more plants at autumn. The ordinary sowing machine gave the highest number of clover plants in all four experiments. The Tume machine gave the same number of clover as the two wet sowing treatments at peat soil and a number in the middle between the mixers and ordinary sowing machine.

Only the experiment near Bergen with old grassland gave significant better establishment of red clover after treatment with weed harrow, but at all experiments the grass yield at 1st cut was reduced.

In the autumn the number of clover plants were much reduced at the two experiments in Bodø, mainly because of drought damages of the young plants in July. The experiments on Vestlandet had sufficient precipitation during the summer, and 100 - 200 clover plants per m2 at the end of the season.

The most important factors for establishment of clover seems to be limitation of nitrogen supply to the established grass, and sufficient water supply until the new plants are well established.

Early first cut seems to give faster and better establishment of clover in grassland than medium or late first cut.

The combined sowing of seed and manure is a cost effective system with very high capacity (120-150 m3 h-1) when joined with tube to the dung-stead. This is specially important in spring, where the farmer often has a short time from the soil is ready for traffic to the plants are too high for manure fertilizing.

Development of a vaccine for preventive measures and treatments Trichophysis « Trichovac - 2»

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Questions of specialization in such branches of veterinary medicine only still start to be investigated while in phytopathology specialization pathogene to macroorganism is on the first place. Studying of specialization solves theoretical questions (systematization) and practical questions (selection of steady grades).
Hence, systematization of a pathogenic mushroom on a line depending on affected kind of macroorganism. It is revealed that *Trichophyton verrucosum* split to the varieties defeating only a certain kind of a macroorganism, in particular *Trichophyton verrucosum* – reindeer.

Composition of the vaccine
The liquid alive vaccine for preventive measures and treatments of Trichophysis horned, small cattle and deer includes an antigene of strain of mushroom culture *Trichophyton verrucosum* № 145, selected from goats, 4-5 % salt solution NaCl, adjuvant gel hydrate aluminium 0,5-0,6 ml. on everyone of 100 ml. vaccines. A distinctive part of the given vaccine is that it contains an antigene strains of mushroom culture selected from northern deer *Trichophyton verrucosum* №507 "Yakutia" (unlike «Trychovac-1», containing strains № 478, selected from northern deer).

Ratio of components
Prepare a mix of an antigene of culture of mushroom strain *Trichophyton verrucosum* № 145 All-Russian Institute of Experimental Veterinary, selected from goats and culture of mushroom strain Trichophyton verrucosum № 507 «Yakutia № , taken in equal ratio with final concentration 60-100 mln. microconidium in 1 ml of 4-5 % of solution NaCl, with the same adjutant, as well as TRYKHOVAC 1.

Both vaccines can be prepared in a dry kind. In this case antigenes homogenize by distilled water and subject to lyophilous drying. Thus, both in liquid and in dry vaccines add 100 units of penicillin and streptomycin on each ml of the mix of antigenes. At working off of the dozes entered to different kinds of animals (horned catlle, reindeer, sheep, goats) it was necessary to have the latest group of the vaccine. With this purpose homogenate was spilled on bottles and frozen. As required a bottle with a vaccine was defrozen and added necessary components. Frozen homogenate is well saved, almost not losing viability immunogenic cells.

The technological cycle of an alive liquid or dry vaccine (LTF-130, TF-130, S-P-1, MENTAVAC, etc.) will consist of 7 cycles: preparation of the placement and the equipment (2-3 days), washing and sterilization of utensils (3 days), preparation of a nutrient medium (96 days), preparation of matrix culture (20-25 days), measuring and homogenization of mushroom weight and the shop control of mushroom suspension (15 days), then planting homogenate by physiological solution up to working concentration, packing up on 200 ml. and rolling up by aluminium колпачками. The storage period is 3 month TF-130.

The problem of our researches is to develop such technological cycle which allows to prepare a vaccine repeatedly within one year in necessary amounts, avoiding a long technological cycle, reducing it to 1 day. So, for example for production a liquid alive vaccine Trychophysis of horned cattle, sheep, goats and reindeer on 5 thousand dozes cultures № 145 and № 507 "Yakutia" are grown and mixed in equal ratio and spilled on 15 - 20 ml in bottles and freeze.

Vitamin contents of North Swedish forage

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There is a growing interest for vitamins in animal production. Many studies show clear connections between different health aspects and vitamin status.

In most concentrates and mineral feeds synthetic vitamins have been added in rather high amounts, to avoid the risk for underfeeding. But maybe this is an unnecessary cost and also a risk for contaminating the environment with unnatural substances? Or are there too little of some of the vitamins as compared to the needs? In ruminants the essential vitamins are A, D and E, which cannot be synthesized by the animal itself.

It ought to be important to know how much vitamins the animals get in their daily feed ration. However, feed tables are often based on relatively old studies, not always using the plant species, varieties and methods for harvesting and storing that are common nowadays. There also could be suspected some differences in vitamin content depending on latitude. It is also known that the vitamin content of forage is affected by storing conditions e g temperature and time of storage.

A study is conducted to increase our knowledge of the level and variation in vitamin content of common North Swedish forages of today

Samples are taken from 10-15 different silages during two years. There are big bale silages and forage from bunker silos, also from first and second cut and from four different places. This will give us a picture of the natural variation in common forages. Samples are collected in the field shortly before harvest, in the beginning of the feeding period and in the last week as the silage is used.

The vitamin content of the samples is analyzed, as well as energy, protein and fibres, also some acids and other hygienic measurements. Hopefully we can find that some of these other parameters give a good hint of the vitamin content, as vitamin analyses now are too expensive for farm use.

Preliminary mean values of the first vitamin analyses:

	Alfa-tocopherol, mg/kg DM	Beta-caroten, mg/kg DM	ME, MJ/kg DM	CP, g/kg DM	NDF, g/kg DM
Green forage at harvest, 14 samples	62 (40-92)	42 (22-67)	10,8 (9,5-11,7)	143 (104-169)	492 (401-569)
Silage in the beginning of storing, 4 samples	31 (18-58)	18 (9-40)	10,7	140	477

Effect of maturity in timothy on silage quality and animal performance in lambs and dairy cows

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This study was conducted to monitor the effect of harvest time (plant maturity) on the fibre content and quality of forage and evaluate the influence of this on the intake ability of lambs and dairy cows. Intake ability depends on a number of factors, such as the animal itself (lactation, growth etc), the feed (chopping, fibre content, taste etc) as well as climate, time of year and so on. Here we have focused on the NDF (Neutral Detergent Fibre) content of the feed ration, its degradability and how this affects forage consumption.

The silage constituted to 90% of grass, mostly timothy. It was harvested the 16th(E), 20th(M) and 26th(L) of June with a precision chopper and stored in bunker silos. Degradation characteristics were analysed with an in vitro gas production (GP) system. Data describing the cumulative GP were fitted to an equation and from the degradation model the time for maximum fractional rate of GP (T-max) and the maximal fractional GP rate (R-max) were estimated. Potential degradability of NDF (NDFD) was determined after 72 h of GP incubation. The harvest procedure resulted in clear differences between the silages (Table 1).

Table 1. Chemical composition and degradation characteristics of the silages.

Silage	% DM	MJ ME /kg DM	CP g/kg DM	NDF g/kg DM	NDFD g/kg NDF	T-max h	R-max h^{-1}
E	31,8	11,9	170	478	893	7,68	0,130
M	25,8	11,4	137	541	851	7,80	0,128
L	26,2	10,6	114	597	778	8,53	0,115

In the sheep experiment we used 39 group fed ewe lambs. The lambs had free access to the silage. To avoid intake differences depending on varying protein content, groups M and L received some soy meal. The experiment was designed as a Latin square with three 3-week periods, where all groups in turn received each silage. Intake of 15 dairy cows was also measured. The cows had free access to silage and also concentrates, based on earlier milk yield. On average the feed ration consisted of 40 % concentrates. The effect of silage quality on animal intake and lamb growth is shown in table 2.

Table 2. Daily intake of DM and NDF (kg/100 kg LW) from the total feed ration, and live weight gain (LWG, g/day).

Silage	Lambs			Dairy cows	
	DM	NDF	LWG	DM	NDF
E	3,09	1,43	152	3,60	1,40
M	2,68	1,33	124	3,50	1,49
L	2,35	1,23	76	3,29	1,50
sign.	***	*	***	*	ns

The experiment shows how digestibility is reduced when harvest is delayed. Especially the fibre fraction gets more undegradable, which leads to lower feed intake and slower growth in lambs. The effect in dairy cows was smaller, due to lower silage part of the ration and also due to the higher rumen capacity in larger animals.

Diversity, infectivity and N_2 fixation efficiency among *Rhizobium leguminosarum* bv. trifolii genotypes isolated from three clover species

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The diversity of *Rhizobium leguminosarum* bv. trifolii strains in nodules of clover (*Trifolium*) species is known to be large, but little is known about differences among *Trifolium* species in their selection of *Rhizobium* strains. An indigenous *Rhizobium* population was sampled from root nodules of alsike clover (*Trifolium hybridum* L. cv. Stena), red clover (*T. pratense* L. cv. Betty) and white clover (*T. repens* L. cv. Undrom) grown within an area of 15 x 15 cm in the field in northern Sweden. Ten *Rhizobium* isolates from each host species were identified based on DNA data (ERIC-PCR genome fingerprinting) which revealed large genotypic diversity among the isolates. There was no indication of host-related grouping of the isolates. Six different isolates, two from each host species, could all induce root nodules on the three *Trifolium* species. Plants grown for two months in the greenhouse with N2 in air as the only N source showed a large variation in shoot N content depending on which *Rhizobium* isolate that was used as inoculant. The results indicate that *T. hybridum*, *T. pratense* and *T. repens* can become infected with the same *Rhizobium* strains, but the N_2 fixation efficiency may vary considerably among different *Trifolium-Rhizobium* combinations.

The balance between potassium and other minerals and crude protein in forage can have a big impact on animal health

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If the silage has more than 3 % potassium in the dry matter, the fertilization should be reduced or the leys harvested at a later growing stage. This because high potassium levels may result in more treatments and higher culling rate due to a worse animal

health. Harvested silage with such high potassium levels should be fed together with another forage to milking cows and not fed at all to dry cows. With calcium levels beneath 0.6% it seems wise to consider such changes if potassium exceeds 2.5 % in the forage dm. With imbalances between K and the minerals Ca, Mg and P or crude protein (CP) in the forage there can be risks for negative impacts on the animal health even if the potassium level looks okay. Therefore you have to be observant at different mineral quotas and try to correct the balances in the total feed ration with supplemental feeding, but without exceeding recommended levels of phosphorous and crude protein.

In order to reduce the risks for milk fiver, retained placenta and other disorders around calving time, the cows should be kept in a way that makes it possible to feed them with forage suitable for their special nutrient needs during the last weeks of the pregnancy.

During lactation forage with more than 0.6 % Ca may have positive effects on the dairy cow health, but during the dry period it seems better to feed the cows with late cut grass dominated forage with less than 0.6% Ca.

The above are some conclusions from a study about mineral content in forage and relation ships with milk yield and animal health in 487 herds with in total 15601 dairy cows in northern Sweden. Analysis results from one year's forage cuts were then combined with farm data about milk production and animal health from the following feeding year.

Table 1. Total treatments for all noted health disorders and mastitis and milk yield in relation to potassium and calcium content in forage.

Potassium, g/ kg dm	<20		20-25		25-30		>30	
Calcium, g/ kg dm	<6,2	>6,2	<6,2	>6,2	<6,2	>6,2	<6,2	>6,2
Total treatments; % per cow	52,8	48,7	52,5	53,9	60,8	57,2	65,1	54,9
Mastitis treatments, % per cow	26,2	24,6	26,3	28,2	34,1	28,0	35,0	34,7
Milk yield, ECM kg per cow	8239	7971	8459	8442	8643	8552	9006	8882

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Table 2. Forage analysis intervals associated with reduced number of treatments for health disorders in relation to feeding during lactation and dry period.

Ca, g /kg forage dm	K	P	K/Mg	Ca/p	K/(Ca+Mg)	K% x RP%
< 6,2 during lactation	14-24	2,8-3,0	17-22	1,2-2,0	2,0-3,0	22-32
> 6,2 during lactation	24-27	2,8-3,2	16-22	2,9-3,2	2,5-3,0	33-41
< 6,2 during dry period	19-23	2,3-2,8	23-40	2,5-2,6	2,7-2,8	10-16
> 6,2 during dry period	15-20	1,6-2,0	7-17	1,9-2,1	1,5-1,6	14-18

Table 3. Total treatments for health disorders in relation to number positive intervals in table 2 the individual forage analysis fit. Max 5 for lactating and 3 of 6 possible for dry cows. Relative scale.

No of positive intervals Ca, g/kg forage dm	0	1	2	3	4	5	6	100= % treatments per cow
< 6,2 g during lactation	100	82	73	67	64	65	-	59,2
> 6,2 during lactation	100	92	81	71	60	55	-	48,4
< 6,2 during dry period	100	87	79	57	-	-	-	18,2
> 6,2 during dry period	100	83	71	59	-	-	-	23,3

Fatty acid contents in forages and its effects on n-3 fatty acids and CLA in beef and dairy products

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Milk is a valuable source of nutrients providing energy, protein and essential minerals and vitamins. Milk is also an important fat source in human diet in many countries. Even if dairy products only provide 15-25 % of the total fat in human diet, they provide about 25-35 % of the total intake of saturated fatty acids. The content of saturated fatty acids in many ruminant products is considered to be associated with cardio-vascular disease and cancer. However, milk and meat are also sources of unsaturated fatty acids, particularly omega-3 fatty acids and conjugated linoleic acid (CLA). These fatty acids are on the contrary considered to be beneficial constituents in the human diet. CLA is a component of milk fat that may have positive effects on human health and disease prevention. CLA has been shown to have multiple health benefits at as small amounts as 1 % or less of the diet. Ruminant products, such as milk and meat, are among the richest natural sources of CLA and they are an alternative to oily fish as a source of omega-3 fatty acids.

During the summer month there is a decline in fatty acids in grasses and that is followed by lower levels of PUFA and CLA in the milk. Cows fed grazed grass have in general elevated CLA concentration in the milk fat, especially at turnout when the grass has higher levels of linolenic acid. Forage maturity seems to be an important factor affecting the CLA content of milk fat. Milk from cows offered legume silages generally contain higher levels of polyunsaturated fatty acids that are regarded as beneficial for human health (linoleic acid, conjugated linoleic acid and □-linolenic acid). When comparing different legume silages, the concentration of linolenic acid was highest in the milk from cows fed red clover silage and a low level of concentrates.

Finishing cattle on pasture leads to enrichment in n-3 fatty acids at the expense of n-6 fatty acids. Increasing the forage proportion in a concentrate-grass based diet increased the n-3 fatty acid content in intramuscular fat linearly with increased amount of forage in the diet. No effect was observed in the total n-6 content but the increased grass intake caused an increase in the CLA concentration in intramuscular fat.