



10th CIRCUMPOLAR AGRICULTURE CONFERENCE

New thinking about local agriculture in the circumpolar Arctic
— Best practices, innovations and perspectives

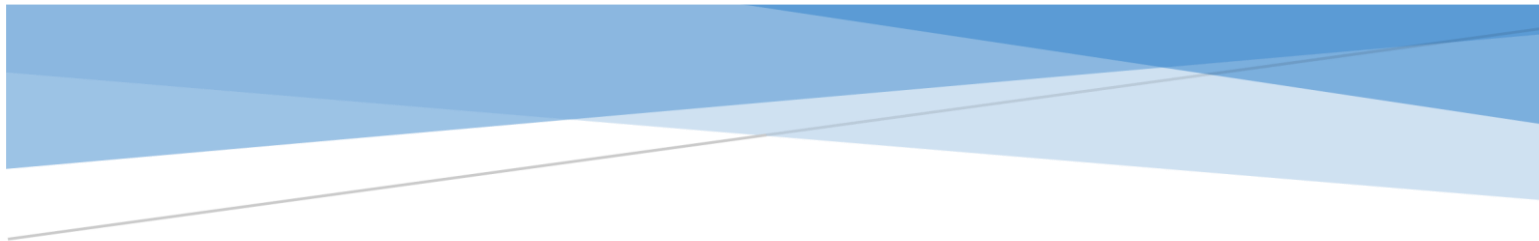


ABSTRACT BOOK



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Preface

Welcome to the 10th Circumpolar Agriculture Conference 2019 to Rovaniemi, Finland!

The conference will address the role of agriculture in different parts of the Arctic region, and discuss its topical challenges and opportunities, including implications of climate change and food security.

The goal of the conference is to highlight a bottom-up approach and new thinking of local agriculture, food production and rural development in the northern areas. In recent years, local foods, natural products and small-scale production have been on a rising trend worldwide. In this conference, we want to emphasize the potentials of local small-scale production, specialization and the natural products sector in the Arctic by giving voice to both research and practical examples. The sessions will highlight among others best practices and local solutions in the utilization of animal and plant resources, climate change and land use, northerly adapted breeds, reindeer herding, small-scale farming, and non-timber forest foods such as game, berries and mushroom.

The conference will address the high quality of arctic foods, their local profitability and business opportunities. The importance of food security and sustainability in different regions and countries will also be discussed.

The conference is tenth in the line of international conferences organized within the framework of Circumpolar Agricultural Association (CAA) which is currently chaired by Finland. The local organiser is the Arctic Centre at the University of Lapland in cooperation with Natural Resources Institute Finland and several local institutions in Lapland. The Circumpolar Agriculture Conference is one of the events organized during the Finnish Chairmanship of the Arctic Council.

It is a great pleasure to have this conference for the first time in Lapland with such a high amount of colleagues and friends from all arctic countries!

I wish everybody a very interesting conference and lively discussions!

On behalf of the local organisers,

Päivi Soppela

Circumpolar Agricultural Association, President

10th CAC, Program Director

KEY1

Local agriculture and vital rural areas

Hilkka Vihinen

Natural Research Institute Finland (LUKE), Helsinki, Finland

Changing climate, as well as economic and political position of the Arctic region set challenges to both agriculture and to the vitality of rural areas. In the future we may face both very centralized, economic systems and decentralized, local markets. However, hybrid solutions are also possible, as centralized systems realize the gains of mass production, while decentralized systems can utilize resources more accurately and holistically. As to local agriculture, on the one hand short local chains contribute to the density of the fabric of regional economy and to the wider resilience of rural communities. On the other hand, resourceful and vital rural communities are able to transform their relationship with their environmental resource base in a manner that enhances their ability to adopt just, inclusive and sustainable approaches with respect to local resource. In the face of a new programming period, what are the messages from the Arctic region to rural and agricultural policy?

Hilkka Vihinen works as a Research Professor in Natural Research Institute Finland (LUKE). She works with issues related to rural policy, agricultural policy, regional policy, EU-policies, rural communities, entrepreneurship and resilience and circulation economy. Her special competences are politics of agricultural policy, rural policy, regional policy and administration studies.

Constraints to the Adoption of Agricultural Technologies in Northern Regions of Canada

David Natcher

University of Saskatchewan, Saskatoon, Canada

Over the past decade important advancements have been made in the development of new technologies designed to enhance agricultural production in the Canadian north. Some of these technologies include, hydroponic systems, agridome facilities, innovative greenhouse instrumentation and low-cost designs, and computer-controlled LED lighting systems for year-round fruit and vegetable production. These technologies have great potential for alleviating food insecurity by providing a source of healthy and affordable foods for northern communities. For their part, Federal and Territorial Governments have directed considerable financial resources to help make these technologies available. Notwithstanding their potential, it has yet to be determined what constraints may exist that would limit local adoption of these new technologies. Research conducted in other food insecure regions of the world have long found that despite the great potential for technological advancements to improve food production capabilities, there are often unforeseen cultural, economic, political and policy constraints that limit technological uptake. In this presentation I will review some of the innovative food producing advancements that have been introduced in northern Canada and will draw attention to the potential constraints that may hinder adoption. By way of conclusion I will encourage greater collaboration between technological developers, social scientists, and the communities who are most directly affected by the success or failure of these efforts.

David Natcher is a Professor in the Department of Agriculture and Resource Economics at the University of Saskatchewan (Canada). Dr. Natcher holds a Research Chair in Arctic Food Security and serves as the Canadian representative to the International Arctic Science Committee's Social and Human Working Group and the Arctic Council's Social, Economic and Cultural Expert Group (SECEG).

KEY3

Nomads: Outcasts or masters? Legitimation of the nomadic lifestyle in the Republic of Sakha (Yakutia)

Uliana Vinokurova

Arctic State Institute of Culture and Art, Yakutsk, Russian Federation

The Arctic region is an infested area where severe cold prevails: permafrost over much of the land, ice in the ocean and extremely low air temperatures. The human culture under cold conditions can be described as mobile because only movement can guarantee life. The essential link between human culture and the cold environment has created a nomadic lifestyle. At present it has been displaced outside the legal bases of the sedentary life. As a result, nomadic peoples lack access to lands. Legal regulation of land relations proceeds from the philosophy of a settled way of life. Nomadic peoples are being prevented from the opportunity to own the appropriate land resources for reindeer breeding, livestock breeding, horse breeding, hunting and fishing. They are being deprived of their ancestral lands. The nomad becomes an outcast in his home country.

Since 1992, the Parliament of the Sakha Republic (Yakutia) has started the process to provide legitimacy for the nomadic lifestyle. These Laws recognize that the nomad of the Yakut Arctic is a master of the ancestral lands. The laws legitimize the nomadic lifestyle of indigenous peoples within the limited legal competence of regional legislation. I will speak at the conference about these restrictions and how they affect the life of the nomad.

Uliana Vinokurova is a Director of the Centre of Circumpolar Civilisation and a Professor of the Arctic Academy of Science, Arctic State Institute of Art and Culture in Yakutsk, Russia. She holds PhD in sociology and psychology, and is an author of more than 400 publications. She is an author of the scientific discovery "The phenomenon of existence of the Arctic circumpolar civilisation", revealing the bases of resilience in the Arctic, the specificities of polar cattle breeding, and mutual assistance as a universal law of relationships in natural environment.

Uliana grew up in a rural area and her father was the chairman of the collective farm. She has worked as a cattle-breeder in her younger years, so she knows agricultural work since her childhood. She has participated in the creation of several regional legal documents, concerning agricultural sector. She is one of the co-authors of the laws of the Republic of Sakha (Yakutia) "On the Protection and Use of the Gene Pool of the Yakut Cattle", "On Rural Education", "On the Nomadic Family", etc.

Recently, she has been actively involved in the preservation of sacred places, human resilience in conditions of global climate change and industrial development. Her particular research interests are the issues of Arctic pastoralism with the focus on local animal breeds and food practices in the cold climate.

Economical aspects, possibilities and challenges of reindeer herding in Finnish Lapland

Anne Ollila

Reindeer Herders' Association, Rovaniemi, Finland

Reindeer herding is a central cultural part of many Arctic communities. In Finland, it is impossible to even imagine Lappish or Sámi culture without reindeer. Reindeer is an unique Arctic animal, having plenty of special biological properties vital for surviving in the harsh Arctic areas. No wonder that reindeer has gained such a central role in our culture, and as a source of living in our communities. Reindeer herding is among the oldest livelihoods still practiced widely in the Arctic areas. Especially during the last few decades, we have also learned to think and use reindeer more as a source of profitable business, of course with a strong respect of real reindeer culture. Nowadays, reindeer herding is more than a living culture. It is also a vibrant livelihood. Despite of that, people are commonly not used to think reindeer herding as an economical activity having great impacts in local and national cash flows and employment. Meat production and processing, and tourism, are the main lines of reindeer business in Finnish Lapland. Both have had a period of strong growth in last five years, and are still growing well. This creates a lot of new economical possibilities for reindeer herders to maintain their living traditions and livelihood. At the same time there is growing demands of industrial land use, growing numbers of protected carnivores, growing concerns of climate change, and other big threats to be faced. There are also keys to cope and stay great. We need to use them wisely.

Anne Ollila works as a Director of the Reindeer Herders Association, in Rovaniemi, Finland. She holds PhD in sociology and has studied future visions of young people in rural versus urban areas. She is a member of a reindeer herding family, owns reindeers herself, and practices real life reindeer herding work as much as possible.

Agroforestry and non-wood forest products

Inger Martinussen¹, Arne Bardalen², Bjørn Egil Flø³, Anne Linn Hykkerud¹, Birger Vennesland²

¹NIBIO, Tromsø, Norway. ²NIBIO, Ås, Norway. ³NIBIO, Trondheim, Norway

Agroforestry can be defined as sustainable and multifunctional land-use systems where trees are managed together with agricultural crops or livestock on the same piece of land. In the northern periphery area, agroforestry has a long history with woodland grazing, reindeer husbandry and gathering of different non-wood forest resources such as herbs, mushrooms and berries. Traditional agroforestry has gradually disappeared during the 20th century with the intensification of agriculture and forestry. Currently agroforestry systems are gaining new interest, not only from farmers but also from politicians, as this practice can possibly contribute to a more sustainable way of agricultural production. In the northern periphery area, the benefits of agroforestry practices can be manifold not only promoting traditional practices, but also novel systems with the use of new technology. In addition, agroforestry has environmental benefits as a method for conservation and enhancement of the biodiversity, improved nutrient cycling and water quality and to support carbon sequestration by increasing the soil humus.

Here we present an overview of agroforestry practices in the Nordic countries and the use of non-wood forest resources with the emphasis on wild berries.

Inger Martinussen works as a Head of Department/Head of Research in Norwegian Institute of Bioeconomy Research / NIBIO. Her expert areas are plant physiology/molecular biology, wild berries, herbs, antioxidants, breeding, plant secondary metabolites, metabolomics.

How research can stimulate product development

Margrét Geirsdóttir

Matís, Reykjavík, Iceland

Matís is an Icelandic government owned, non-profit, independent research company, founded in 2007 that pursues research and development aligned to the food and biotechnology industries as well as providing Iceland's leading analytical testing service for public and private authorities.

For years, Matís has been in close collaboration with the food industry in Iceland and helped both big and small companies in developing their products.

An overview will be given over the connection between Matís research, to spin-off companies as well as examples of procedures for product development. Historically, as fishing is a vital part of the Icelandic economy, a big part of Matís research has been in that field. In recent years, especially with fast expanding tourism in Iceland as well as online sells, local and small-scale agricultural production has been a growing part of Matís work. A special focus will be on success stories that can be used as examples to stimulate new thinking about local agriculture in the circumpolar Arctic.

***Margrét Geirsdóttir** is a Project Manager at Matís – Icelandic Food and Biotech R&D. She has been working at Matis – previously Icelandic Fisheries Laboratories – from 1998 where her main research areas have been utilization of fish proteins from underutilized raw materials, extraction, functional properties, hydrolysis and bioactive properties. She works in the interface of research and industry, having experience of collaboration between research and spin-off enterprises in developing new products such as dairy products.*

Food security in Northernmost Sweden from a Sami cultural perspective

Lena Maria Nilsson

Umeå University, Umeå, Sweden

Today, the European North is generally considered a food secure area, which is an area where “all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life”. However, this state is to a large extent dependent on food import. Especially in Sweden, the level of food sovereignty is low and since the entrance into the European Union in 1995, on rapid decline. In 2017 all political parties of Sweden agreed on a new national policy for food security. The key concept is market orientation. The aim is to increase the food production sector in relation to the consumers’ demands and to increase the product value of local foods.

Significant for the traditional lifestyle of Northernmost Sweden 100 years ago was the strong interconnection between the food strategies of indigenous Sami and settlers in a system based on knowledge and relations. I will discuss to what extent it is possible to apply traditional Sami knowledge on foods and food systems of Arctic Sweden on policies aiming at food sovereignty today, in a Northern Europe with rapidly increasing climate change. My aim is to review the National food security strategy of Sweden from a Sami cultural perspective focusing on the questions: How much traditional food may be produced and harvested? How much is available, within and outside the common trade system? And how safe are these foods from a nutritious and food safety perspective, when also considering potential effects on climate change?

Lena Maria Nilsson works as a Senior Researcher and Research Coordinator at Arctic Research Centre at Umeå University. Her main research interests are food security, public health and temporal changes in Arctic lifestyle factors from a food security perspective and as triggers of low-grade inflammation and common uncommunicable diseases. Keywords: aboriginal food; nutrition; carbohydrate restriction; coffee; public health; epidemiology; genetics; epigenetics; food security; indigenous people; climate change.

KEY8

The Evolution of Circumpolar Agriculture: 1st to 10th Conference - Past, Present & Future

Randy Lewis

Canada Circumpolar Agricultural Association, Whitehorse, YT, Canada

The Past: 1992 - Founding & Hosting 1st Circumpolar Agricultural Conference

In the early 1990's the only available research on agricultural best practices were from below the 60th parallel. Through active participation in Alaska and Yukon's agricultural industry, we recognized the need for research and development of indigenous and arctic agricultural products, supplies and practices.

From Sept. 28th - Oct. 2nd, 1992, the 1st Circumpolar Agricultural Conference was hosted in Whitehorse, Yukon with the theme "Opportunities in Diversity to Meet Global Change."

Conference planning and research identified the need to make the conference serve as a catalyst for action. "To showcase success and formalize the transfer of circumpolar technologies and information among participants." What did we create, where did we go, what have we learned?

The Present: 10th Circumpolar Agriculture

Today, "Indigenous Seeds/Plants", "Arctic Food Security", "Indigenous People's Local Products and Projects" and "Climate Change" are used in day-to-day discussions and development of best practices, with ideas, technologies and solutions being applied and understood on a global scale around the north. We will examine leading programs in: (a) northern studies & community development (b) water, soils, plants, and animals (c) engineering, technology and innovation and economic trends and impacts. What are our successes? What's driving us today? What are the challenges?

The Future: An Invitation to a Circumpolar Conversation

Exploring the future together in a new global world with enhanced communication, impacts on communities and industry, and rapidly changing arctic environments. Where are we going? What can we learn from each other?

Randy Lewis is co-founder and partner of R.L. Resource Management, co-founder of the Circumpolar Agricultural Association (CAA) and Canadian vice-president of the CAA. For more than twenty-five years, he has managed projects in community, environmental land use planning, and northern development; combining Yukon First Nation history, culture and traditional knowledge into community development, training and capacity building into the projects.

SESSION 1. What's up in Arctic agriculture?

1.1

An overview of current state of growing food in Alaska

Debasmita Misra, Arthur Nash

University of Alaska Fairbanks, Fairbanks, USA

Alaska is a food insecure state because 95% of its food is imported. However, Alaska has abundant land and water resources that could be utilized for arable production, with the actual acreage increasing annually due to climate variability, i.e., with longer frost-free growing seasons and thawing of permafrost. Various combinations of environmental systems and field production techniques can extend the season and produce high-quality fresh crops that can replace products imported to Alaska. Such practices will promote more local self-reliance, reduce dependence on imports, and minimize our environmental footprint. Recently, Alaskan agriculture has developed production systems tailored to Alaska's thin, acidic soils with limited native fertilizer production and its corresponding higher cost. Most consumable foods are grown with transported top soils such as in gardens, high tunnels and greenhouses. Growing in a controlled indoor environment with hydroponic towers and spectrum lighting has been experimented in which cost effective renewable energy has been utilized for year-round production. Field crops have been also attempted during summer. Recently, strong local interest in gardening has been increasing. Food plants, herbs, and fruit trees have been planted in the many outdoor gardens, window boxes, greenhouses, and small home hydroponics gardens. These activities have generated interest in community gardens to increase local access to fresh produce in many parts of Alaska. This presentation will highlight the current growing practices across the climate gradient from the Arctic to the Sub-Arctic and Southern Boreal Rainforests of Alaska and attempt to provide thoughts on future of Alaskan agriculture.

The food security of Russian Arctic cities as an integral part of their sustainable development

Daria Sidorova

Lomonosov Moscow State University, Moscow, Russian Federation

The problem of food security in the Arctic zone is related to many social and economic issues such as low population density, traditional lifestyle of indigenous population, limited transport infrastructure and high cost of food. The Russian Arctic is a sparsely populated but highly urbanized area where more than 90% of people live in cities. It can be divided into 2 large parts: European and Asian. The development of agriculture in the European Arctic started in the Middle Ages to meet the subsistence needs of first settlers. In Asian northern regions, it appeared in the Soviet period to support the mining industry. Agriculture at high latitudes faces many obstacles including severe climate, environmental vulnerability, impact of global warming, but there are traditional industries, adapted to the arctic conditions and modern technologies that can make it efficient. The Russian Arctic is an industrial region where almost 20% of oil and 80% of gas are extracted. High revenues enable investment in local agriculture but still the produced amount of food is not enough, imported products are cheaper and so many cities are considered to be food-unsecured. Thus, the purpose of this survey is to create a typology of Russian Arctic cities based on a level of their food security and to elaborate a pool of recommendations (political, economic and ecological) for each type that can improve the situation.

Finnish farmers' climate change views – threats and possibilities for future agriculture

Jaana Sorvali^{1,2}, Janne Kaseva³, Pirjo Peltonen-Sainio¹

¹Natural Resources Institute Finland, Helsinki, Finland. ²University of Helsinki, Helsinki, Finland. ³Natural Resources Institute Finland, Jokioinen, Finland

Agriculture will face severe challenges due to climate change. Variable and unpredictable weather, extreme weather events together with new pest and disease outbreaks will severely affect agricultural production. For Finnish agriculture, climate change will also bring possibilities as the growing season lengthens, if the risks are managed properly. As agriculture is also a source of greenhouse gases and on the other hand agricultural land has a great possibility to mitigate climate change as a carbon sink, farmers will have to adopt new practices and policy to follow up on these developments. All new policy measures aiming to mitigate climate change and adapt to the changes will have to be implemented at the farm level making the farmer a key figure in climate change action. Our study focuses on farmers' climate change views and the acceptability of climate change mitigation and adaptation measures. 4401 farmers in Finland answered a standardized e-mail survey in spring 2018. The farmers answered questions about their views on climate change, perceptions of climate change related risks and possibilities, understanding of greenhouse gas sources in agriculture, responsibility and capacity in climate change mitigation and adaptation action and views over climate change policy. Statistical and qualitative methods were used for analysis, and the results help us understand the problematics of climate change from the farmers' perspective. The study also offers knowledge for climate change policy, making it possible to take the farmers' views into consideration when planning future policies.

SESSION 2. Local agriculture in the Arctic – challenges and opportunities

2.1

Unique plant genetic resources for agriculture and horticulture in the North

Elina Kiviharju¹, Marja Uusitalo², Antti Hannukkala²

¹Natural Resources Institute Finland, LUKE, Jokioinen, Finland. ²Natural Resources Institute Finland, LUKE, Rovaniemi, Finland

Finland is one of the Northermost countries in the world to practice agriculture, thanks to the warming effect of the Gulf Stream. Well-adapted plant material is in the key role for successful and sustainable cultivation in the fields and in the gardens. The Finnish National Genetic Resources Programme for Agriculture, Forestry and Fishery, covers plant genetic resources of cultivated plants and their wild relatives, and is enhancing their conservation and sustainable use according to the tasks and priority activities defined in the FAO's Global Plan of Action (2nd GPA, 2012). Plant accessions originated from Finland are conserved in the field gene banks (Luke and other actors) and in the seed gene banks (NordGen).

Climatic conditions vary considerably within Finland due to its length. For the Northermost part, the most suitable crops are barley, oats, forages and potato. The potato cultivar "Lapin Puikula", which has EU's Protected Designation of Origin (PDO) status, is an excellent example for successful commercializing of a North/Arctic production. The use of adapted horticultural plants is contributing through attracting tourists and visitor, landscape gardening and concepts of green care and healing gardens to the well-being of the people and the North economy. Inquiries carried out in the Finnish Lapland supports this. It is important to identify and evaluate the most Northern plant diversity and develop innovative ways for their sustainable use, to benefit the North bioeconomy and to ensure their safe conservation for the next generations.

Can we grow barley in the north?

Anne-Maj Gustavsson¹, Sigridur Dalmannsdottir², Ilevina Sturite³

¹SLU, Umeå, Sweden. ²NIBIO, Tromsø, Norway. ³NIBIO, Tjøtta, Norway

The Arctic areas are characteristic with short growing season and marginal temperatures and therefore less suitable for cereal cultivation. However it would be positive with increased production of cereals by several reasons. The first is increased proportion of home-grown feed, but other reasons are better crop rotations in this forage grass dominated area, and that cereals can be used to increase the security in feeding ruminants to cover a shortage of forage from grass leys because of for example out wintering or drought. Cereals are very flexible and can, depending on the harvesting time, be used in different ways. To cover a shortage of ley forage it can be cut as a whole crop between heading and early dough stage, or it can be used as a grain crop when harvested at maturity. In this project we have investigated how day length and daily mean temperature affects dry matter growth and phenological development of barley at four locations, Umeå (63°N) and Ås (63°N) in Sweden and Tjøtta (65°N) and Tromsø (69°N) in Norway in two years (2017 and 2018). Thereafter we have used modelling to analyse the possibilities to grow barley to maturity using weather data from 1961-2016 (55 years) at the four sites. We are presenting the variation in (a) time for start of the vegetation period, (b) growing conditions during the season, and (c) the change in the length of the growing season to show the effects of climate change on the possibilities to grow cereals. The project is supported by Botnia-Atlantica programme.

Community greenhouses in the High Arctic - producing food north of 66 Degrees

Raygan Solotki

Community Garden Society of Inuvik, Inuvik, Canada

The Inuvik Community Greenhouse is located over 100 km north of the Arctic Circle in Inuvik, Northwest Territories, Canada. It was founded in 1998 by a small group of volunteers who took over the hockey arena that used to be a part of Grollier Hall – a residential school that closed in 1996. The mandate of the greenhouse is to “Foster Community Through Gardening”. In 2015, thanks to funding from the territorial government, a full time executive director position was created. This was to not only assist in creating financial stability for the Inuvik Greenhouse, but to create opportunities for the seven communities of the Beaufort Delta – Tuktoyaktuk, Paulatuk, Ulukhaktok, Aklavik, Fort McPherson, Tsiighehchic and Sachs Harbour to develop their own small community gardens and start to focus on possibilities of agriculture to assist with food security in the high arctic. For 2 years, the Executive Director flew in and out of those communities, attempting to instill a sense of interest and ownership in the greenhouses that were built. However, it was realized that the model was not working. Instead, a program was created to bring a champion of the gardening program to Inuvik to learn the skills required – and hire them to become community greenhouse coordinators. In 2016, an average of 25-30lbs of produce was grown in each community. In 2017, the amounts jumped up to 100-400lbs per community. This was seen as such a success, that four other communities in the Northwest Territories adopted this model of “train the Trainer”.

Global Village Gardener for the North: Year round sustainable indoor gardening for the circumpolar region

M.P.M. Nair¹, Elena Benic², Karen Tanino²

¹LLT Plants, Grasswood, Canada. ²University of Saskatchewan, Saskatoon, Canada

Since homes and schools are heated, the limiting factor to producing plants under natural light on windowsills is not heat, but light. Over 55 crops/cultivars were screened under Low Light (LL) at the University of Saskatchewan. This project identified promising plants for indoor home windowsill production and under canopy crops at a commercial greenhouse. *Brassica japonica* cv. 'Kyoto' mizuna showed highest potential for immediate commercial adoption: a) productively used wasted shaded space between tomato plants, b) can be repeat-harvested over time, c) can simply be added to existing salads, pastas, dishes by chefs for diversified fresh flavour, d) needs no additional care with no apparent pests, e) germinates and grows under cool temperatures of January/February, f) has a more consistent biomass. However, homeowners are less focussed on uniform, high productivity. Thus, the following are also recommended for indoor windowsills: *Brassica rapa* ssp. *narinosa* (Tatsoi), *Perilla frutescens* 'Crispa' (Shiso), tomato (*Lycopersicon esculentum* 'Donna' and 'Heartbreaker'), Thai red and 'Pink Ruby' *Amaranthus*. *Amaranthus* red and 'Pink Ruby' cultivars. After 38 years of breeding, a LL tolerant lemon and lime were developed: 'First Canadian' lemon and 'First Canadian Golden' lime, producing up to 12 – 15 commercial size lemon fruit/plant in a 15-cm pot on the windowsill. Microgreens are also an important first step introducing growing and consuming fresh greens. Collectively, these low light adapted plants have potential to introduce children to the idea of growing and eating tasty horticulture crops year-round since plants can be grown indoors during the school term in the classrooms.

Greenlandic agriculture facing climate change: Challenges and opportunities

Jesper Overgård Lehmann¹, Mogens Humlekrog Greve¹, Troels Kristensen¹, Mette Hjorth Mikkelsen²,
Jørgen Eivind Olesen¹, Peter Aastrup³

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Towards the end of the current century, climate change is projected to extend the growing season in southern Greenland with up to two months, and farmers already experience more frequent and more severe droughts and storms. Southern Greenland is home to 35-40 farmers, 1,100 ha of arable land and around 250.000 ha of permanent mountain pastures. Sheep are the most important livestock, but few farmers are now raising beef cattle or reindeer. The most important arable crops are forages for feed, but some farmers are successfully growing potatoes. Greenlandic livestock production depends on summer grazing. There is a need for updated knowledge on how to tackle the impact of summer droughts and indicators on livestock stocking rate in mountain areas as well as an analysis of the area-specific suitability of sheep, cattle and reindeer. An increased growing season will allow for higher forage yields, but droughts will be an increasing challenge, and both irrigation and nutrient management needs more emphasis. A longer growing season may allow for new varieties and types of fodder and cash crops as well as an improved synergy between livestock and arable land use. However, more severe winter storms may increase the risk of asphyxiation of crops by layers of ice. Finally, the agricultural sector is an important part of local culture, history and identity in southern Greenland and may play an important role in developing the local tourism industry. Hence, climate change pose challenges but also create new opportunities for increased production of quality food.

SESSION 3. Looking to the past for future: Northern native breeds of domesticated animal species

3.1

NordGen's conservation project of the Nordic Dark Bee: From evaluation to selective breeding

Michelle Sunding¹, Bjørne Dahle², Lars Kirkerud³, Linn Groeneveld¹, Mervi Honkatukia⁴

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³Norwegian Brunbielag, Rena, Norway. ⁴NordGen - Nordiskt Genresurscenter, Ås, Norway

The Nordic Genetic Resource Centre (NordGen) is an institute that contributes to secure the broad diversity of genetic resources linked to food and agriculture through conservation of genetic resources.

NordGen Farm Animals published a report on the conservation status for the Nordic dark bee (*Apis mellifera mellifera*) - the first honey bee subspecies that colonized the Northern European region. In the report, international working group concluded that the characterization of populations is needed for exchange of purebred material and to development of breed specific management techniques in the conservation actions.

Previously, breeders have used morphological traits to reveal hybridization, but its reliability have been contested. Lately, molecular methods have shown more reliable results. With more accurate and cost-effective molecular tools, results can be used to assess the purity in future breeding programs. The aim of this project was to collect samples from suspected pure and hybrid colonies of dark bees. Samples were characterized both morphological and genetically. The morphological analyses were done by Norwegian brunbielag in Norway. Here the cubital index, discoidal angle, Hantel index, and the color of the rear body were measured. DNA marker data were used to estimate the introgression level within the bee populations. By comparing the results of the morphological and genetic methods, the reliability to distinguish hybrids from purebreds can be assessed. This could be used to construct breeding recommendations in the future to get a more effective procedure for securing the purity, and thereby, the conservation of the Nordic dark bee.

Whole genome resequencing of northern Eurasian native cattle breeds

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Northern Fennoscandia and the Sakha Republic in the Russian Federation represent the northernmost regions on Earth where cattle farming has been traditionally practiced. In these northern-Eurasian regions, indigenous cattle breed: Finncattle and Yakutian cattle have adapted to harsh climate conditions. These breeds are currently endangered and it is important to genetically characterize and conduct conservation work. In this study, we present the first whole-genome sequencing results for 15 individuals (five in each breed) of the native Eastern Finncattle, Western Finncattle and Yakutian cattle. We examined the demographic history, genetic diversity and unfolded loci under natural or artificial selection. On average, we achieved 13-fold genome coverage after mapping the sequencing reads on the bovine reference genome (UMD 3.1) and detected a total of 17.45 million single nucleotide polymorphisms (SNPs) and 1.95 million insertions–deletions (indel). Yakutian cattle displayed a higher level of within-population variation in terms of number of polymorphic SNPs and observed heterozygosity than the two Finnish breeds. This is in contrast to the previous microsatellite study where the Finnish breeds were clearly more diverse than Yakutian cattle. In addition, Yakutian cattle showed genetic distinctiveness. We identified a number of genomic regions that have been under selection and may have affected by positive selection for the northern and arctic environments, including genes involved in diseases resistance, sensory perception and cold adaptation. The identified SNPs, indels and selective sweeps region in our study can serve as useful genetic resources in the conservation of native cattle breed in northern and subarctic environment.

The Northern Finncattle – the cow that almost disappeared. Arctic adaptation, folk strategies and state politics

Päivi Soppela, Nuccio Mazzullo

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This paper discusses the case of the Northern Finncattle, a local breed of Lapland that is well-adapted to the Arctic climate, but produces little milk compared with commercial breeds. The displacement of Northern Finncattle was very rapid due to their large losses during WWII, and the breed became almost extinct in 1960's. Now we can observe state efforts to save the Northern Finncattle, which is still an endangered breed (ca. 850 cows). We focus on a paradox in the state politics that first created policies to develop intensive agriculture across the nation at the expense of losing the Northern Finncattle breed, only to rediscover it as Finnish a heritage later on, while starting programs to preserve national breeds. For this study, we have drawn from the experiences of breeders whom we have interviewed in the past few years (Arctic Ark). Among several motives that have surfaced, there is the concern of cattle tenders of not having received due respect for their breeding practices. Until recently, efforts of Northern Finncattle breeders' have been belittled, and state policies have aimed to influence their breeding choices towards greater milk production. Although the milk yield of Northern Finncattle is lower than commercial breeds, the milk has many superior properties suited well eg. for cheese production. Furthermore, these cows are an excellent example of sustainable farming in the Arctic with their modest but diverse food consumption and suitability for outside forest grazing. The Northern Finncattle milk has a great potential for novelty dairy and farm products. There are positive signs of revival of the husbandry in Lapland, particularly among young farmers.

Animal's social life: Decline and revival of the Arctic cow

Anna Stammler-Gossmann

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Two 'Arctic sisters', Lappish (Lapland, Finland) and Sakha (Sakha Yakutia, Russia) cattle represent an exotic breed of a high genetic distinctiveness, outstanding tolerance towards freezing temperatures, modesty in the care taking, fat- and protein rich milk content, and subscribed exceptional intelligence.

However, due to their weaker yields as compared to mainstream breeds, local species did not fit into the 'high-quantity' concept of the national economies during the started industrial development of the Soviet North and after the WW2 in Finland. Nowadays classified as an endangered breed, Lappish and Sakha cows gain their revival. Tracing the complex relations between animals and humans in the North this paper proposes to evaluate how changing symbolic and embodied representational status of an animal in/and of the society shapes the attitudes towards it.

“Cows as reindeer”- an interdisciplinary account of human-animal adaptation to the Arctic North

Nuccio Mazzullo, Päivi Soppela

Arctic Centre/University of Lapland, Rovaniemi, Finland

The reindeer has a long adaptation history but short domestication in the Arctic while the cattle has an opposite one. This paper reports from an interdisciplinary research, conducted by a team of anthropologists, biologists and geneticists, in Finnish Lapland (Arctic Ark) among Northern Finncattle farmers and reindeer herders by combining scientific and local knowledge. Its aim was to find links between animal tenders' selective practices and relevant traits of their animals and their genetic counterparts. The results show that breeding strategies in Northern Finncattle have been successful in their adaptation to northerly extreme conditions. In both cases, with Northern Finncattle and reindeer, similar patterns are found showing similarities between adaptation traits and selection practices. In the case of Northern Finncattle breeders, we learned that breeding choices have not necessarily been targeted at increased production of milk and meat, but aimed at making cows more independent and versatile in their food choice while remaining smaller, lighter and more responsive in their behaviour than dominant commercial breeds. In its current shape, Northern Finncattle is still able to find fodder in the forest and swamps by itself, while the other breeds would not be able to access the same areas. The results support the view that the farmers' and reindeer herders' traditional knowledge of their environment, animal selection, and desired animal characteristics are crucial to support a sustainable animal husbandry in the Arctic conditions. The research also includes the study of the Finnhorse, and draws on comparison across the Russian and European Arctic.

SESSION 4. Best practices and applications in local food systems

4.1

Local food and consumers' buying groups: the case of food circles in Oulu Region

Kirsi Korhonen, Toivo Muilu

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De-globalization of food markets appears as a discourse of alternative food networks and one example of them are different kinds of food cooperatives such as food buying groups. Although food cooperatives are not a new phenomenon there is a scant reference towards them in the alternative food and ethical consumption literatures. However, they could offer much especially in terms of historical context, future lessons for growth in the sector and consumer motivation and ethics involved in buying groups.

The aim of this study was to evaluate the viability of “traditional” consumers' buying groups in Oulu Region by studying their structure and changes in their stability over a 5-year period. The main data consists of an electronic survey data from 15 different food circles and interview data from eight frontmen or otherwise active members in food circles (both gathered during 2013 and 2014). In addition their current status was inquired in the fall of 2018 via email or phone.

According to the preliminary results, the average duration of food circle participation was 3.66 years and on average, the respondents ordered products via food circles almost 9 times a year. The operation time of active food circles interviewed ranged from 1 to 20 years and a couple of them had formal rules and membership fees. Very different modes of action were felt to work however one of the biggest problems seemed to be too many subscribers in relation to organizers. Two food circles had already closed down before the interviews.

Future possibilities for food digitalization in Finnish Lapland

Dele Raheem

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The Finnish Lapland's ambition to combine tourism and sustainable development will gain from the positive adoption of digital technology within the food sector in the nearest future. There is a need for the food system in the region to respond to the current trends by consumers globally. The presentation of this topic reviews the relevance of digitalization that results from sharing big data and how it can help to minimize the environmental impacts of food processing, and ultimately improve sustainability. I will draw largely from the experience gained from the ongoing "Digital architecture as a roadmap for food business operators in Finnish Lapland" project at the Arctic Centre. The opportunities that are offered by digital technology in predicting consumers' trends are expected to make local food business operators more efficient, sustainable and transparent. It is expected that the adoption of food digitalization will open up market accessibility for the locally produced food products in local communities. The application of algorithms, sensors, and consequently the development of related apps in the food sector are likely to have major impacts in the region. In this presentation, a synopsis on food industrialization, how to meet the demand of consumers and the impacts of Industry 4.0 on food processing will be highlighted.

Farming as a Form of Healing

Derrick Hastings¹, Katie English²

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Farming has connected us to the earth for many generations. As we follow the patterns of the season and adapt our practices to the different and changing climates.

Over the years as farmers and Farm/Garden managers in Dawson city Yukon, we have experienced the healing benefits that Farming can offer to those who struggle with mental health, F.A.S.D and other health issues in our community.

Farming can play a key role in northern communities health and social programming. Bringing people on to the land to reconnect, learn new skills, eat food that they grow and be a part of creating a more sustainable food secure system. We can create holistic farms through the growth of medicinal plants, organic produce and local meats. As well as developing and distributing organic food boxes that get delivered weekly to community members. Each week focusing on what's in season and providing healthy recipes on what to make with the produce in each box. All the while creating symbiosis between enriching our community with quality food and rehabilitation/healing through farming/gardening.

Included in this idea is also the health of our local northern economies. We are working towards creating a local bartering system to help benefit the health of our local economy. Different individuals and businesses can partake and exchange (barter their goods and services for others goods and services.) We can build a network and a local currency. As was once done in the past.

Pirursiivik Project: Greenhouse & social arts in Inukjuak, Nunavik

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¹Makivik Corporation, Kuujuaq, Canada. ²Makivik Corporation, Inukjuak, Canada. ³One Drop, Montréal, Canada

The Pirursiivik (Place to Grow in Inuktitut) Project is an ongoing greenhouse and social art project in the Inuit community of Inukjuak, Québec. Pirursiivik Project is a project created in partnership between Makivik Corporation, the Inuit land claim corporation of Nunavik, and the One Drop Foundation. The project's main objective is to contribute to improving health through a greenhouse and social arts. The Project aims to set a precedent for true community engagement and co-development to positively impact employment, water and food security, as well as cultural pride.

Through our paper, we showcase the community engagement processes which have been followed thus far to ensure wide community buy-in for a greenhouse, notably with the use of social arts. In Nunavik, many past projects have not been sustainable because of the 'white elephant' syndrome when large infrastructure projects are not locally rooted in existing institutions. We will show the results of this engagement, our achievements and our learnings.

Pirursiivik is a partnership between North and South. A Place to Grow, both from a physical perspective (plants) and from a spiritual perspective. We show how a greenhouse initiative can become a channel for discussions to bridge Inuit ways to connect with the land and Western ways for growing and economic development.

Utilizing locally grown biomass for school heat, remote electricity and year round growing at -50°C

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Alaska is the United States only polar state and the Interior only borders Canada, the Arctic Ocean and the Bering Straits. With the sharp increase of heating oil prices in Alaska this past decade, and with no substantial tax base for many Alaskan school districts to levy from, many districts have no recourse to recoup lost revenues for educational delivery without considering a cheaper fuel source for combined heat and power for their schools. Three Alaskan school districts just a few hundred kilometers south of the Arctic Circle have successfully switched to burning woody biomass, which has for some resulted in cutting fuel costs by at least 50%. This has also helped in with teacher retention, job creation, local sustainability, increased energy security, and in some cases food production and horticultural skills as gains for students. Beyond the harvest equipment and biomass feed stock, what community 'capitals' or assets did these locations that made the switch, have? This presentation of schools which made a transition from imported oil to harvesting local biomass looks at them from the point of view of education sustainability and overall community development. It also looks at some of the challenges from being in extreme arctic conditions and small villages.

SESSION 5. Climate change and land use – implications for Arctic agriculture

5.1

Arctic entomology under climate change: Implications for agriculture in the North

Ingeborg Menzler-Hokkanen¹, Heikki Hokkanen¹, Brynja Hrafnkelsdottir², Agnes Brosset³, Shuxuan. Jing⁴, Daniela Weber⁵, Raluca Herascu⁶, Leo Laaksonen¹, Ahmed Mohammed Aldow⁷, Bendik Ferkingstad⁷, Leena Lindström⁸, Bjarni Sigurðsson⁹, Guðmundur Halldorson⁹

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Climate change is occurring faster in the Arctic than elsewhere in the globe, and we are already witnessing its consequences. Warmer temperatures could benefit agricultural production at high latitudes, but can also facilitate insect pests. These complex interactions need to be considered when designing sustainable agricultural practices in the North. In our presentation the focus will be on pest management: The main points in our presentation are:

- 1) Little is known about the dynamics of insect populations in the arctic areas, including pest species and their natural enemies. The same applies to other ecosystem service providers such as pollinators and soil invertebrates. It is known that pest species are expanding their ranges towards the poles. This raises the question of how vulnerable Arctic areas are.
- 2) Pollination of crops, which require insect pollination, in the North is not well understood.
- 3) Northern agriculture is in transition. There is a need to find a way to promote agriculture in the north with respect to its identity/characteristics, and to use the unique conditions as a chance for niche marketing (super foods).
- 4) Sustainability of Arctic agriculture is the goal so that we can ensure food security.

The northern expansion of ticks in Sweden – increased risk for animal and human health?

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The ongoing interdisciplinary CLINF-project (www.clinf.org) has focus on the effects of climate change on the geographic distribution and epidemiology of human and animal infectious diseases in the Nordic region and Russia. In this region, reindeer herding is an important agricultural industry and play a pivotal role for the Arctic communities' culture. Climate change affects people, animals and the environment. The present study is aimed to investigate the northern expansion of ticks in Sweden and the risk for increased incidence of tick-borne diseases, mostly zoonoses, in this area. Reindeer is one species that can be highly threatened by these new infections since they are immunologically naïve towards them. The tick collection has been achieved by a citizen science study, where the public have sent ticks found feeding on humans or animals, to the National Veterinary Institute. Approximately 4500 ticks have been collected during June to October 2018. Currently, morphological species identification and analysis of tick-borne pathogens performed with Fluidigm (a microfluidic system that makes it possible to analyse each sample for a wide array of pathogens by PCR technique) are being done. Then results will be processed and presented. With new knowledge regarding the expansion of ticks and tick-borne diseases, we aim to suggest measures to minimize the tick-borne diseases in animals and humans in the North.

Climate change-driven dramatic increase in perennial forage yields at Rovaniemi in 1980-2017

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The yields of timothy (*Phleum pratense*), meadow fescue (*Festuca pratensis*) and tall fescue (*Festuca arundinacea*) increased dramatically in 1980-2017 at Rovaniemi (Apukka, 66°58'N, 26°01'E), with the increase in the temperature sum. We report data from the official variety trials for 1980-2017. Swards 1 to 3 years old were included in the data.

The annual DMY of timothy was 3128, 4668, 8385 and 9352 kg DM/ha in the periods (P) 1980-1989 (P1), 1990-1999 (P2), 2000-2009 (P3), and 2010-2017 (P4). The 1st cut yielded 1792, 2166, 4008 and 4473, and the 2nd cut 1337, 2503, 4378 and 4879 kg DM/ha, respectively, in P1-P4. Tall fescue was included in trials from P2. Its high 2nd cut yields (4245, 5271 and 6640 kg DM/ha) resulted in high total DMYs 6488, 8924 and 11062 kg DM/ha on P2, P3 and P4, respectively. The cultivation technology (e.g. fertilizers) changed little during the study period. However, the date of the 1st cut was about 10 days and that of 2nd cut about one week earlier on P4 than on P1. The Tsum increased by about 200 dd during 1980-2017, as predicted by climate change models for RCP4.5.

The results indicate a strong impact of climate change on DMY of perennial forage crops in the northernmost areas of Scandinavia. It is crucial to maintain the capacity to document climate change-induced changes in primary production at the Circumpolar area to facilitate follow-up measures on practical farming and forestry.

Inclusive land use planning in Finland

Kirsi-Marja Korhonen

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Key to sustainability of the natural resource management in the Arctic is to provide local people and interest groups possibilities to influence the use, management and protection of their living surroundings. Access to traditional use of natural resources, such as berry picking, fishing, hunting, use of plants for handicrafts, food and fodder, need to be ensured. All Metsähallitus forestry areas are managed as multiple use forests and new methods to develop forestry planning towards inclusive planning are introduced.

Reindeer herding is a traditional livelihood in Lapland which has been practiced by both the Sámi indigenous people and Finns for centuries. The reindeer herding co-operatives are given an opportunity to influence on all logging-, soil preparation and road construction plans as well as touristic routes. Negotiations with reindeer cooperatives are performed regularly. Several agreements between Metsähallitus forestry and the co-operatives have been made on logging restrictions and set aside areas.

Practicing sustainable forestry forms the economic and social backbone of the areas in Northern Finland. It is one of the vital sources of livelihoods for the communities in these areas. Land use decisions as well as decisions concerning the use of natural resources are essential. For this reason, both forestry practices as well as an inclusive, responsible and participatory approach to planning need to be state of the art.

New opportunities in southern Greenland call for integrated planning for securing sustainability

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Southern Greenland is undergoing significant changes with implications for agriculture, industry and tourism. Climate change, market opportunities, technological advances and a renewed focus on the cultural and historical heritage of southern Greenland create new business opportunities.

South Greenland is the only real agricultural area with sheep farming as the most important, whereas vegetable production and reindeer farming are gaining importance. New opportunities for agricultural production will open in southern Greenland with climatic warming, if management can be adjusted to deal with climatic extremes such as droughts and frosts.

Two mining projects are under development, but neither have received exploitation license yet. Recently, UNESCO approved a World Heritage Site – Kujataa - for its cultural Landscape with mixed farming, fishing and hunting communities, and this will likely create new tourism opportunities.

The new extensive and varied use of the South Greenland landscape calls for integrated planning instruments to ensure that agriculture, industry and tourism can exist side by side, while maintaining nature, biodiversity, and securing cultural and historical heritage.

Sustainable management of the southern Greenland landscape requires careful mapping of natural resources, human activities and future development options. Such mapping should be based on a combination of fieldwork and remote sensing.

Recently, AMAP issued a report on “Adaptation Actions for a Changing Arctic”. The report includes adaptation options related to Greenland agriculture. The talk will include reflections on the suggested adaptation actions and the sector strategy.

SESSION 6. Reindeer herding as a means of livelihood - preconditions and applications

6.1

Sequencing of reindeer (*Rangifer tarandus*) genomes: Insights into evolution, domestication and adaptation

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Semi-domesticated reindeer (*Rangifer tarandus*) have pivotal economic, societal and cultural value for indigenous people and pastoralists in northern and subarctic regions in Eurasian. Currently, there exist several semi-domesticated and wild *Rangifer*-populations, the taxonomic status of which has been actively debated. To examine genetic diversity, domestication history, taxonomy and adaptation, we deep-sequenced and de novo assembled one reindeer genome, resequenced 23 other *Rangifer* sp. samples. Genomic DNA of a 1-year-old Finnish male reindeer was sequenced at high coverage (100X) on the Illumina HiSeq2500 and 4000 platforms. The genome assembly, annotation, and orthology analysis were conducted using a robust bioinformatics pipeline. In the resequencing approach, 23 semi-domesticated and wild reindeer and caribou were sequenced (10X) and the data were subjected e.g. for the principal component analysis. A total of 300.5 Gb of clean data was assembled using SOAP denovo resulting into 256,454 scaffolds (N50 = 502 Kb) with cumulative scaffold length of 2.66 Gb and spanning 90% of the estimated (2.9 Gb) genome size of reindeer. Using a homology based approach the reindeer genome was predicted to harbor 27,332 protein coding genes, 98% of which were functionally annotated. The resequenced animals grouped into two main clusters: northern European and northern Russian/northern American. Our findings suggest that there have been at least two domestication events in the history of reindeer.

My way, your way, best way – how to collect and spread the best practices among reindeer herders

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Reindeer herding is strongly seasonal and regional work. Many of the herders work in the local abattoirs and slaughter the reindeer in autumns. Legislation on food safety and animal welfare regulates reindeer slaughter. Besides the professional skills, the abattoir workers need regular, up-to-date education that includes the best practices from various reindeer abattoirs. During the peak season, their possibilities to visit other abattoirs are limited and hence the best practices hardly spread. In autumn 2017, we visited 16 reindeer abattoirs and filmed over the various ways to perform reindeer slaughter. The leading expert on reindeer slaughter hygiene provided an educational material and we extended this manuscript with videos to a series of short films describing the slaughter work. We showed the films in educational events to the herders working in an abattoir to spread the best practices. The material highly interested the herders and encouraged them to discuss the improvements in their work and in their abattoir. According to feedback on educational events, the herders found it useful to see the various, good ways of work; and their own work from the big screen. Incorrect working methods were detected and corrected during the process. This kind of collecting the best practices works well in the highly seasonal and local work, makes it easy to spread, and provides an excellent teaching material for the schools.

Testing a new electronic warning system to prevent collisions between cars and farmed reindeer

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NIBIO, Tjøtta, Norway

The loss of farmed reindeer by collisions is an increasing problem. During 2017, 514 reindeer were killed by the northernmost railway track in Norway, costing more than 5 million NOK. Many mitigation measures have been tried, of which 2 m high deer fences are the most effective. However, these are very expensive and animal passages are needed. As a supplementary measure to fences, an electronic system aiming at warning the driver of reindeer being close to the road is developed and tested thorough the Interreg-project AnimalSense.

A total of 235 collars with radio transmitters (805.15.4 866 MHz) were mounted on adult female reindeer during March-April 2018. All animals were located in a collision hotspot area (4.5 km) along the E6 motorway at Saltfjellet, Norway. A total of 41 signal receivers were mounted on road sticks alongside the road. When a reindeer with transmitter was within 50 m proximity to a road stick, the receiver started blinking with an orange light.

Saltfjellet Reinherding District lost 15 reindeer in the test area from December 2017 until test start. No reindeer, neither with or without transmitters, were hit by cars during the test period. However, the supervision log documented that 25 % of the receivers became defect after a while, most of them due to battery shortage.

The test showed that the electronic warning system is promising, but improvements are needed to achieve optimal function of the receivers. A new generation transmitters and receivers were tested at Saltfjellet during November-December 2018.

Reindeer ownership among the Skolt Sami

Panu Itkonen

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This presentation starts its analysis of Skolt Sami reindeer ownership by going through some historical changes in it, including the strong centralization during last decades and its consequences for Skolt Sami culture. Despite the changes, reindeer herding is still an essential element of Skolt Sami culture. However, several things can threaten it. One possible threat would be that the Skolt Sami could lose the ownership of reindeer to representatives of other groups, like Finns. Therefore, I ask: Should Skolt Sami reindeer ownership be better protected than it is today in Finland? Moreover, what kind of protection for reindeer ownership would be beneficial for the culture and how could it be justified? Here we come across the key confrontation between the possible preference of Sami peoples' rights and equal rights between all citizens. The same dilemma is central in the discussion about Sami peoples' rights to land and natural resources. The objective here is to form suggestions that could help to solve the question of protection in the case of Skolt Sami reindeer ownership. When these suggestions have been formulated it would be interesting to see, if similar principles could be applied to other livelihood cases as well.

Tourism, representation and compensation among Dukha reindeer herders in Mongolia

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Increasingly, tourists visit Dukha reindeer herder camps, a small group often characterized as primitive and disappearing, in the east and west taiga of northern Mongolia. Currently, the year-round entry of tourists to Dukha camps is unregulated; the timing and context of these encounters, including compensation and accommodation, unpredictable. Some herders leverage dominant cultural and social capital and it is suggested change their migration patterns, gaining more visitors and more opportunities to earn cash. However, while visits bolster the local economy, these cross-cultural contacts may disrupt traditional socio-cultural identities, migration patterns, and egalitarian norms. This qualitative, interpretive study used guided, open-ended interviews (N=30), a modified pile sort and participant observation to examine reindeer herders' perceptions of tourist visits and gift giving. Additional interviews with tourists (N=32) and Mongolian guides (N=5) were conducted. Results show that overall the Dukha most involved with tourists have a positive attitude toward their visits. As tourists generally stay only one to three days, negative outcomes vis a vis gifts, cultural misrepresentations and economic compensation, currently appear minimized. Nevertheless, resentments among the Dukha and between the Dukha and tour operators occur when unequal benefits are perceived or when tourists egregiously violate traditional norms and values. As visits increase, aiding and creating Dukha owned and controlled economic and ethnographic initiatives could reduce adverse results.

SESSION 7. Arctic foods, their profitability and business opportunities

7.1

Arctic quality - the effect of high latitude growth conditions on quality of food products

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Agricultural production in Northern Norway (Nordland, Troms and Finnmark counties, 65-71 °N) is restricted by a short growth season and low growth temperatures. However, due to long daily photosynthetic periods, plant production is possible. These unique growth conditions, may affect the quality of food and fodder products differently from other climates. A review of studies related to such Arctic quality, show effects on both sensory and phytochemical quality for some products. Within brassica vegetables, a northern climate may affect physical attributes (coarser buds, broccoli), and reduce glucosinolate content and bitterness (broccoli, swedes). In carrots and swedes, where total sugar content seems unaffected, northern growth conditions still give more sweet taste due to lower contents of bitter compounds. On the other hand, carrots from a northern climate typically have lower content of carotenes, and less colour compared to higher growth temperatures. Results also show that low growth temperatures result in more crispiness, juiciness and fresher tasting swedes, broccoli and carrots. Wild berries tend to have higher contents of some antioxidants in a northern climate, but site-specific variations in growth conditions may have equal influence. Within domesticated berries, some species may taste sweeter (strawberry) and others less sweet (black currants), showing different responses to the climate. For strawberry and raspberry, low temperatures tend to reduce red colour strength. Studies of climatic or geographic effects on quality in potatoes, herbs, fodder crops and meat and milk products are currently too limited for conclusions on unique northern qualities.

Success factors ensuring good animal welfare in Arctic beef production

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In order to meet the demand for beef in Norway, beef producers are encouraged to utilize rangeland resources. However, increased production must follow high standards of animal welfare. This study aimed to identify success and risk factors affecting beef cattle welfare under harsh conditions in the Arctic and the mountainous regions in Mid-Norway. Visits and interviews of 30 farmers with high beef management standards were conducted in order to map: (1) pasture use and out-wintering, (2) housing conditions, (3) management, and (4) calf rearing. Particularly, we were asking for success and risk factors affecting animal welfare. In conclusion, the most important factors to ensure good animal welfare were: Farmers that spent time with their animals and had a good overview of all animals at individual and herd level; to utilize available rangeland pasture in summer; to offer loose housing with generous space per individual; to socialize young calves to humans; to be able to restrain single individuals and to give assistance with colostrum intake, if needed.

Dairy agro tourism based on the Icelandic breed of cattle

Thorgrímur Einar Guðbjartsson

Rjómabúið Erpsstaðir, Búðardal, Iceland

There are less than 700 dairy farmers in Iceland and out of them are 5-6 doing agro tourism based on the Icelandic cow. The increase of tourism in Iceland has pushed the milk-production from the herd, up sky high. Tourists are interested in the food production of the country they visit each time, as they look for local produced foods to taste and try.

As sustainable is one of the most important thing to look into, when you buy your food, people are very interested in how each country makes its food.

In our business we aim for introducing three things to our customers: the cow breed, the cows diet and production of their crop as well as how the people of Iceland stored / preserved their food for winter, were skyr is one of the most important method in Iceland.

In my speech I will give you a little knowledge about the Icelandic cow, its roots, production, what is known as a difference in the Icelandic milk. How we harvest and feed the animal before and today as well as the story behind skyrmaking and how all this has become the basis of my business in Rjómabúið Erpsstaðir.

Value chain perspective to increase production of cereals in the Northern Periphery Region

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Increased temperature and a prolonged growing season provide new opportunities for growing cereals in the north, in a previously marginal area. By adapting a value chain perspective, economic, political and environmental factors must align to develop a new cereal industry. In the period 2015-2018, the Northern Periphery and Arctic Programme supported a project on cereal cultivation and utilization in Northern Norway, Iceland, Faroe Islands, Orkney and Newfoundland.

Cereal cultivation in the northern regions is challenged by a cool, short growing season. However, the use of early maturing varieties is crucial for a successful production in such marginal areas in addition to an increased experience and knowledge about cereal cultivation amongst farmers. Knowledge, and investments, are also inputs needed to build up local northern value chains for food, drink and feed through milling and malting. However, supported by national policies, local food and drink companies are asking for sustainable local raw materials, realising the market opportunities are good concerning products for both locals and tourists.

It is concluded, that the northern regions can be successful with cereal production, and might become an even more important region for cereal feed, food and drink in the future, supporting increased sustainability. However, the production will face problems due to increased precipitation and variable climate, high investments in knowledge and machinery for profitable processing in addition to challenges with competitive market conditions. More research is needed throughout the value chain to assure quality cereals and products from the northern region.

Time for a Boreal Agricultural Research Network to ensure sustainable development of an emerging agrifood sector in the North

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The current food production regions risk substantial reduction of agricultural productivity by 2100 due to accelerated climate change. However, the boreal region also undergoes drastic changes allowing for a significant geographical shift of crops and cropping systems by 2100. These divergent scenarios linked to climate change objectively set up the stage for a northward expansion of larger scale agricultural systems. This will affect current farming practices and related social structures while opening the region to new opportunities and create new challenges. This raises critical social questions, superimposed on a need for strong natural sciences to support a coherent advisory system for a sustainable agricultural expansion in the boreal region. Nevertheless, the research to support the management of this northward expansion is yet to be developed to the point where it can meaningfully contribute to agricultural management in the boreal region with its distinct edaphic, hydrologic and solar radiation dynamics. Most of this expansion occurs, by necessity, on lands converted from their natural states creating a dynamic system that requires tailored management alternatives and political decisions that are hardly supported by the current body of knowledge. We must accelerate the applied research in support of these developments and there is an obvious need for a cohesive agricultural research network that integrates natural sciences, social sciences and policy development across the boreal region. A first step is to establish a knowledge exchange platform that allows communities, farmers, scientists and policy makers to examine and timely respond to challenges unique to boreal agriculture.

SESSION 8: Arctic food security and sustainability

8.1

Hidden Harvests: the role of self-provisioning in food security initiatives

Ivan Emke

Memorial University, Grenfell Campus, Corner Brook, Canada

Many studies of food security focus on commercially-grown food, sold through mainstream marketing outlets (grocery stores, etc.). However, food access options in rural and remote regions are much more diverse. Indeed, there are numerous examples of a range of self-provisioning activities (gardening, gathering, hunting, fishing, animal domestication, as well as sharing networks) which significantly affect local diets in such regions. Thus, the evaluation of food security levels in rural and remote regions is both incomplete and inaccurate at best.

To cite one example, the vast majority of local red meat on the island of Newfoundland (Canada) is from the regulated moose hunt. The amount of protein from this annual harvest dwarfs any other red meat production, but it is not included in most calculations around food security. In Labrador, seal and caribou harvests are not included, nor is there significant consideration of the role of berries or fish. As a result, policy suggestions for increasing food security rarely include explicit suggestions about increasing self-provisioning as a way to meet targets.

This paper begins to address this situation by analysing the data around the levels of food self-provisioning in Newfoundland and Labrador, the changes in these activities over the past century, and the potential cultural and food production benefits that would come from an increased focus on local and personal production. In the end, the goal is to outline the benefits of taking serious account of self-provisioning behaviour in the drive to increase local and regional food security outcomes.

First we eat: Food security north of 60

Suzanne Crocker

Drift Productions, Dawson City, Canada

What would it look like in 2019 if you banished all grocery store food from your home and fed your family only food that could be grown, raised, hunted, fished, or foraged in your circumpolar community? No salt, no baking powder, no sugar, no oil, no vinegar, no condiments, no caffeine.

Suzanne Crocker, a retired physician, decided to find out by experimenting on her own family in Dawson City, Yukon, Canada – a remote community of 1500 indigenous and non-indigenous people at 64 degrees North, 300 km south of the Arctic Circle.

Her personal challenge quickly became a community collaboration. Necessity bred creativity. Coltsfoot ash became salt. Nasturtium seedpods became pepper. Rhubarb juice became vinegar. Dogwood berries provided pectin. Juniper berries provided yeast. Fish liver provided Vitamin D.

In the process, Suzanne gained a better understanding of some of the choke points and possible solutions for food security in the North: local feed, fertilizer, breeding and over-wintering issues in local agriculture; storage and distribution issues for local food systems; sustainable harvesting; making use of all parts of the animal.

Suzanne monitored her health parameters, costs and her family's consumption over one year. She extrapolates to see what it would take if her entire circumpolar community of 1500 were to become food self-sufficient. Would it be feasible? Would it be sustainable?

Suzanne shares her experience and her findings through a captivating presentation that celebrates the bounty of food the North can provide through the land and the resourceful people who live here.

Four Arrows Regional Health Authority Inc. - Indigenous food sovereignty and indigenous language: Language is health

Byron Beardy, Raquel Koenig

Four Arrows Regional Health Authority Inc., Winnipeg, Canada

Four Arrows Regional Health Authority (FARHA) has become the leader with issues surrounding all of Manitoba, Canada's First Nations Food Security. FARHA has become the first point in contact because of their work and will continue to work towards increasing food security for First Nations communities in Manitoba towards restoring our food sovereignty.

This presentation will give a brief overview of FARHA's First Nations Food Security Program and a survey of the community-based projects across Manitoba Canada's northern First Nation communities, ranging from raising backyard chickens and turkeys, gardening, traditional practices and creating a local food enterprise.

With FARHA's work, we want to reignite the fire within our people to reconnect with their food systems and incorporate historic and cultural food practices.

It is the vision of FARHA that for food security to be resolved, it is First Peoples who must take the lead in the development of a First Nations Food Security Strategy. We will share our First Nations Food Strategy Model and our work to date, which includes a First Nations Food Security Education and Awareness Campaign. Indigenous food sovereignty is a timely and important response to food insecurity and the loss of language, ceremony, and other impacts related to colonialism. It goes beyond food to ensure that people and the land are connected and that cultural and traditional teachings can guide and protect our food systems. Byron will also discuss his understandings of the connections of land-based language in the context of food from an indigenous lens. "I no longer see myself torn between two worlds, but rather as a lifeline between them".

Focus on food security, sustainability, local agriculture, local foods as a tourist attraction

Mary Cheney

Rivendell Farm, Whitehorse, Canada

Our isolated territory has only two roads to bring up all our consumer goods. Any closure due to flooding or a forest fire causes the territory to be out of fresh milk within three days. Years ago we would still have most of our other groceries available as most grocery stores had an attached warehouse and there was a wholesaler who had a huge storage unit. These warehouses no longer exist. All produce comes in once a week and if it isn't on the shelf it isn't available. Few local farms are large enough to be able to supply grocery stores on a regular basis.

The price for vegetables has barely risen in the past 30 years, yet the cost of everything else has increased by 300% or more. The smaller producers have to get creative about their sales and their advertising. My farm had many changes over the years the largest change came recently when it was decided to use Local Foods as a Tourist Attraction.

The farm charging admission, the gardens were full of signage describing the crop, how it is grown and in what meals you might use the produce. We added a few games and toys to keep people amused and started booking family gatherings and weddings. Also hosting children and tourists and two a feast of the farm diner. These efforts helped keep the farm viable.

Local Food Strategy for Yukon, Canada

Randy Lamb

Yukon Government, Agriculture Branch, Whitehorse, Yukon, Canada

Agriculture is relatively young in Yukon and plays an important and growing role in our economy and communities. \$4.3 million in farm income is now being generated annually.

Since earliest beginnings when farms fed the gold seekers of 1898, Yukon farmers have worked with northern soil and climate restrictions to grow as much food as possible, yet we remain dependent on our globalized food system.

The Alaska Highway opened in the 1940's to impact the agricultural sector by transporting food supplies more cost effectively from southern producers. The mainstay of the agriculture sector remained as hay production.

Within the last two decades, Yukon agriculture has diversified into increased local meat, egg and vegetable production. More recently, there has been increased concerns over the importance of local food, food sovereignty and improved self-reliance.

While many Yukoners enjoy a variety of fresh imported foods year-round transported up the Alaska Highway, our fragile dependency on 'Outside' food resulted in empty supermarket shelves with the brief closure of the highway in June 2012.

To address these concerns, the Government of Yukon released the **Local Food Strategy for Yukon** following two years of research and consultation with public, industry and First Nations stakeholders.

The 5-year local food strategy sows the seeds for long-term development of the agriculture sector, enhanced food security and increased access to local food for Yukoners.

Having now completed the second year of our strategy, we plan to present the actions in the strategy, the successes and challenges so far.

SESSION 9: Arctic bioeconomy and technical innovations

9.1

Transition to green, sustainable and competitive bio-economy in arctic villages

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This project was aimed in creating a model for new type of green bio-economy for peripheral rural areas. The purpose of green economy modeling is to promote the bio-economy of case areas through the sustainable exploitation of ecosystem services. A decentralized, sustainable and competitive approach to the transition to a green economy is based on network thinking and the sustainable use of natural resources now and in the future. The sector specific analysis was taken further to symbiosis modeling. Bio-economics cannot be based solely on sector-specific approach (food, energy or tourism), but must be cross-border in different supply and entrepreneurship sectors, combined with the different markets/demands of bioeconomy. In the case of massive financial outflow of purchasing fossil energy, we started with extensive transformation of the energy supply, in the case villages. Presenting ideas and operating models for the use of new energy and transferring knowledge to the community was a challenging task. Major changes in technology alone require that the community receives new information from a trusted source, acquiring this knowledge, reorganizing processes, and creating new products or services. Villagers' concern about the future of the village and the survival of the village motivated them to joint meetings and discussions. The transition from fossil energy to self-produced bioenergy also opened more possibilities for other businesses for villagers. Sustainability was the driving theme in planning these new products, services and businesses. Energy self-sufficiency was the first major contributor to the changing future activities and image of the village.

Co-substrates to farm-scale biogas plant

Satu Ervasti

Natural Resources Institute Finland, Luke, Rovaniemi, Finland

Decentralized renewable energy production could be increased in sparsely populated areas as in Lapland. Biogas production by anaerobic digestion (AD) is an established technology producing nutrient rich digestate and energy as a form of methane gas. Livestock farms could have AD process as a natural part of their business because there is forming a lot of suitable feed; manure. Still, there are only few farm biogas plants in Finland due to the profitability challenges.

Cattle slurry is a good base substrate for AD-process because it is formed all year round with uniform properties and it has good buffer capacity and mineral balance. Co-substrates can increase the methane yield remarkably compared cattle slurry feed alone. Characteristics wanted from co-substrate are a high proportion of greases or carbohydrates, high VS (volatile solids) concentration and easy availability with low logistic costs or other expenses.

To evaluate the exact benefits of the new co-substrate materials biochemical methane potential (BMP) test can be used. BMP test is a laboratory assessment where maximum volume of methane derived from anaerobic breakdown is measured. BMP can be tested simultaneously from various substrates which makes the testing effective. In our study we scanned the possible co-substrates characteristic for Lapland, for example side streams from reindeer meat production, fishery and food industry, and planned substrate specific BMP-trials for them. From the base of the BMP test results benefits of co-substrates in farm-scale can be evaluated.

Prospects of using remote sensing for monitoring forage production in northern Norway

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Grassland cultivation for animal feed is the key agricultural activity in Northern Norway. Stable local feed resources for milk and meat production are vital for the economy and sustainability of farmers in this region. Although growing season has become 1-2 weeks longer during the last 30 years, grassland yields seem to have declined, probably both due to more challenging winter weather conditions and changed agronomy practices. Monitoring these trends is challenging, as there are no good statistics on grassland yields in Norway. Better information on yield variation at field and regional levels can provide improved knowledge on links between yields and agricultural practices, soil and climate. Remote sensing technologies can be used to estimate a wide range of parameters of grassland swards, but calibration is important. We used hand-held sensors and sensors mounted on unmanned aerial vehicles (UAVs) to estimate grassland yield in farmer's fields. Preliminary results indicate that remote sensing data can provide coarse estimates of yield in cultivated grasslands of different ages and composition. More data is needed to improve calibration. We also explored use of satellite data to estimate areas and amounts of winter damages. We found local patterns and regional extent of winter damages could be estimated reasonably well given good training data in the region. This can be used for future years when winter damages occur, but is dependent on cloud-free satellite images within a key window of time, and on good ground truth that can be used as training data.

Suggestion for a remote sensing based monitoring of grassland growth on the Circumpolar area

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In the climate change scenarios Nordic areas face a rapid increase in temperature leading to substantially higher temperature sum in growing season also due to a longer growing season. Forage yield results from 1980 to 2017 from Rovaniemi, Finland, show a dramatic increase. It indicates a strong impact of the occurred climate change on practical farming. Close monitoring of the changes taking place on the areas of most rapid change would be highly valuable to predict the practical changes to occur on the main production areas later on. The current research station network is unfortunately rather thin to carry out the monitoring task alone. The studies of the Finnish Geospatial Research Institute and the Natural Resources Institute Finland (Luke) have shown that using machine learning technique for estimation of canopy height and biomass of grass swards utilizing multispectral photogrammetric camera data provided accurate biomass estimates of the grass swards, and the method could be developed as a low-cost tool for practical applications. Grassland production is the backbone for agricultural production on the circumpolar area. We suggest that a grassland growth monitoring network should be established which would utilize remote sensing methods to facilitate close follow up of grassland growth at the Circumpolar area. Research stations would produce reference data by their field trials (which would be imaged by drones), and drone imaging would be carried out on partnership farms on various locations to provide yield data from vast range of circumstances.

How a mobile app is changing the way we conduct variety trials

Heidi Rader

University of Alaska Fairbanks, Fairbanks, USA

In 2017, I released a mobile app called Grow&Tell. The app is designed to harness the collective efforts of gardeners and farmers everywhere to share what grew well where they live. This is important in a state like Alaska where we have diverse and drastically different climates. Since we don't have the resources to conduct variety trials in most of the state, we need the help of gardeners and farmers to share what grows best where they live. But the mobile app is not limited to Alaska, anyone in the world can use it. The app can be used to rate varieties in terms of taste, yield and how easy they are to grow and also record other information about a variety, including when it was planted, if it was grown outside or in a greenhouse, if a season extender was used, when it was harvested and how much was harvested. This information is then roughly correlated with location and is available for other gardeners who use the app. The amount of data on vegetable varieties can increase exponentially as more gardeners, farmers and citizen scientists use the Grow&Tell app. More importantly, this data will be available for any location in the world.

P1

How farms are managing in Finnish Lapland? Present and future perspectives

Rauno Kuha, Ville Hallikainen, Antti Hannukkala

Natural Resources Institute Finland, Rovaniemi, Finland

Milk and meat production has a long tradition in the north. Indicated by raw material production, Lapland is self-contained only with production of milk, sheep, reindeer and turnip. As measured by consumer products, self-sufficiency is only met with reindeer meat, turnips and sheep's meat. In east and north, the decline in farms has been major compared to the southwestern area.

Milk production emerged as a production line where profitability and liquidity were better than in other production lines. The respondents of all the production lines indicate that funds are, reasonably well sufficient for running costs and daily livelihoods. On the other hand, the investment of the company's income financing is not sufficient.

Farmers' resources are their own mental well-being and the parental support from other farms. The continuous growth of production and the maximization of profit were not regarded as worth pursuing. It is important for entrepreneurs to have financial sustainability, profitable business and financial independence.

The skills of farmers' in Lapland are quite high. This was reflected in the design, the use tracking programs and as a separate job for tasks requiring special expertise. Public sector actors and public infrastructure play an important role in farm operations

Respondents were asked if they had a chance to influence on price, quality and quantity of their farm's products. In that respect the responses were thought-provoking. The respondents feel that their chances of influencing the price of their products were poor. This was particularly evident in cattle farming.

Climate change – a chance or a threat to food security in Arctic? Scientific discourse analysis

Katarzyna Marzęda-Młynarska

Maria Curie-Skłodowska University, Lublin, Poland

There is obvious relation between food security, agriculture and climate change. In publications devoted to the Global South the negative co-relation dominates. Climate change is perceived as a main factor responsible for growing food insecurity. Especially negative consequences are visible in the context of agriculture. Food security in Arctic region, however, is achieved by other means than farming. The presentation aims to investigate how the problem of food security is framed in the scientific discourse on climate change in Arctic since the establishment of ICCP, and what approach dominates: positive – climate change can improve food security in Arctic region (new opportunities for agriculture) or negative – climate change can contribute to food insecurity (deterioration of access to traditional means of food security).

Agricultural advisors need practical knowledge about diverse crops, plant diseases and soil health to support farmers coping with climate change

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Climate-smart agriculture can be defined as an approach for transforming and reorienting agricultural systems to support food security under the new realities of climate change, it aims to increase resilience and resource use efficiency in agricultural production systems (Lipper et al. 2014).

Agricultural advisors are key actors tailoring climate-wise solutions at farming system level. An online-based survey was conducted about information needs of agricultural advisors related to climate. Survey was sent by email to all 575 Neuvo2020-advisors in Finland in 2017.

32 advisors answered (6 %). Nearly 60% of respondents considered that climate change mitigation and adaptation is already part of advisory work and the rest considered that it will be in the future.

Advisors wish more information in following themes: diversifying cultivated plants and cultivars, coping with unusual weather conditions, protein self-sufficiency, and management of plant diseases, pests and weeds.

When assessing information needs of farmers, two thirds of respondents agree that farmers would need more climate change related information in management of plant diseases and pests, crop rotation, ways to improve soil health, management of peat soils, using biological nitrogen fixation and protein self-sufficiency.

Survey was part of "Climate-wise solutions for the countryside" -climate change communication project in Finland. The project was run by Natural Resources Institute Finland, funded by EAFRD and Finnish Ministry of Agriculture and Forestry and taking place over 2016-2018. Project e.g. arranged several workshops and webinars for rural actors in Finland.

Emission of greenhouse gases from agriculture in Greenland – is it a problem?

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Today, the Greenlandic agricultural sector only accounts for 2 % of the total greenhouse gas emission, which is low compared to e.g. Canada, Iceland and Finland. However, improved growing conditions followed from climate change allow for an expansion of the agricultural sector. The Government of Greenland has a vision to develop the agricultural sector in order to cope with an increasing demand of meat products and to support the self-sufficiency production.

Today, the Greenlandic self-sufficiency regarding food is relatively low, and the exports from farming account for 0.1 % of the total national export. Since 1993, the import of meat products has more than doubled. The above, are all arguments, which support the vision of increasing the Greenlandic livestock production; however, this will leads to increased greenhouse gas emission.

Denmark has ratified the Paris with territorial exclusion in respect of Greenland, which mean that Greenland is not bounded by emission reduction requirements. However, from a global environmental point of view, does it matter where the meat is produced – is it better to import meat than to produce the meat in Greenland? Change in emission of greenhouse gases is only one issue among many that must be taken into account in the decision of developing the agricultural sector in Greenland. There is pressing need for clarify and identify what current and future roles agriculture can play for the Greenlandic society, and the relation between food, food production and cultural identity.

Endogenous potential in regional development at the Arctic border region between Finland and Sweden - views of the EU and municipalities

Paula Tulppo

Arctic Centre, University of Lapland, Rovaniemi, Finland

In promoting regional development, one or more actors participate in the development of a certain region and influence it, based on actor's own values. How the discourses about local resources in the Arctic border region between Finland and Sweden meet at the EU and municipality level? This will be analysed in the presentation.

Today promoting regional development is multidimensional and pluralistic discussion between aims, visions and experiences, related to future and development. It requires environmental, economic, cultural and social factors to be taken into account simultaneously. Essential are development activities to create conditions, where different structures of interaction and local communities have been simultaneously taken into account. Today development activities are directed especially to strengthening of region's own endogenous potential to develop, which includes capacity to control local resources and create new resources, produce local innovations and mobilise the resources and competences of the region into same direction. It is essential that new branches and other significant actors are able to born and grow based on the region's endogenous factors.

How the endogenous potential is seen and how different views meet, when scrutinizing them in two levels, in municipalities of the Finnish-Swedish northern border region and in the EU's cross-border cooperation programme Interreg A Nord, which the border region is part of? This will be analysed in the presentation. Research material consists of public documents of the EU's cross-border cooperation programme Interreg A Nord and the public documents of Finnish municipalities in the border region.

Diverse membership, expanding sector, vast territory: How an Agricultural Association keeps innovative and relevant

Jennifer Hall

Yukon Agricultural Association, Whitehorse, Canada

The Yukon Agricultural Association (YAA) is an industry association that has fostered the growth of Yukon's agricultural sector since the early 1970s. YAA works hard to stay relevant and innovative in order to represent the interests of Yukon farmers who live in rural communities across a vast territory, and whose businesses range in scope and scale. What are some lessons learned?

1. Promote online and digital communications

YAA communicates almost exclusively using online platforms: via email, social media and its website. YAA hosts the online Yukon Farm Products and Services Guide which is used by government agencies, chefs and consumers. A current project is the online publication of reports about Yukon agriculture, which will be complete by January 2019.

2. Seek clear strategic focus

To guide and focus decisions that are made by stakeholders with a range of interests, YAA board of directors uses a five year strategic plan with clear action areas – communications, membership incentives, advocacy, infrastructure and governance.

3. Develop transparent and trustworthy relationships

Most importantly, YAA acts as a vital communications hub by nurturing relationships with a network of stakeholders. YAA has facilitated farming forums in rural communities to ensure that farmers in remote regions have access to current information about the sector. Representatives attend meetings about ag-wildlife conflict, food safety, policy development and agri-culinary initiatives. YAA meets regularly with the Yukon Food Network, Tourism Industry Association and Yukon Chamber of Commerce; joint events are planned and relevant news is communicated back to YAA members.

Promoting ecosystem services for summer and wellness tourism in Lapland

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Nature-based and rural tourism depend on ecosystem services. They could be better engaged in the development of tourists' summer activities and wellness products in Finnish Lapland in order to promote year around tourism. The project called "Novel green spaces and wellness services for tourism resorts" was carried out 2015-2018 in a co-operation with Natural Resources Institute Luke, Kittilä municipality and local tourism companies.

Nine models for the product development of tourism were produced. A method for creating the network of green spaces was introduced as one of the models. It helps land-use managers to acknowledge the areas and trails that are valuable due to their wellbeing benefits to summer tourists. The models also involved for example establishment of the arboretum for the specimens of native tree species, the cultivation areas for wild herbs, mushroom and berries and the use of biochar in landscaping (green roof and meadows).

The models were based on the scientific knowledge on health and well-being benefits of nature and resource efficiency in landscaping. They were created and tested in the Levi nature-based tourism resort in Kittilä, Finland. The pilot-plots were monitored during the project. A handbook and videos that introduce the models were published.

Various local enterprises may utilize the green spaces in production of local raw materials (food, wellness industries and programmed services (tourism industry), as well as tourists and local residents in their outdoor recreation. Furthermore, the introduced methods may serve companies that produce environmental services.

Preparing the northern plant nurseries for the growing demand

Maria Uusitalo

Natural Resources Institute Finland, Luke, Rovaniemi, Finland

The growing of cities, tourist resorts and mining business increases the public demand of landscaping practices in the northern peripheries. Based on our research study, domestic and foreign tourists prefer accommodation in natural surroundings in Finnish Lapland. This favors the use of wild plant species in landscaping of tourism resorts. Other inquiry focusing on future trends in landscaping business showed us that public buyers in Northern Finland favor winter-hardy species.

Since woody plants are used in significant volumes in public green spaces, winter-hardiness is the necessity. This was learnt in the visit of Finnish nurseries to Kiruna town, which is being moved to a new site due to the mining (“deformation”).

As the nurseries of Northern Finland are few in number and focus mainly on household customers, they are not quite ready to fulfill the new demands. For a nursery to attend to a public tendering, it usually produces plant species in too small volumes or selection.

The anticipation decreases nurseries’ financial risks when expanding production. The becoming landscaping projects of public buyers in Northern Finland were introduced to the nurseries in a similar meeting to one, in which the cross-national cooperation was initialized with potential Swedish customers. In the promotion of local economy, Luke cooperates with Society of Finnish Nurseries, Oulu University, OSAO and Lappia Vocational Colleges.

We also provide new climatically-adapted woody ornamental and native species for the producers and organize workshops with the help to establish business liaisons and to attract new entrepreneurs to the nursery business.

Comparison of AI algorithms in forecasting flowering and maturity time of barley in Alaska USA

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In this paper, we used Tree and Support Vector Machine (SVM) models and the Alternative Crops datasets of barley (*Hordeum vulgare*, L. cv. Otal) from 1991 to 2016 in Fairbanks, Palmer and Delta Junction areas in Alaska to forecast the timings of crop flowering and maturity. The timings of flowering and maturity were divided into, Early, Normal and Late. Early group was the flowering or maturity date earlier than that of the lower boundary of 95% confidence interval, Normal group in the 95% confidence interval and Late group later than the upper boundary of 95% confidence interval. The climate data were monthly temperature from May to July, daily temperature from June to the mid of July, monthly cumulative precipitation of May, June and July. The model results showed that SVM models outperformed the Tree models. The accuracy for the forecasting timing of flowering from Tree models was 88% for training datasets and 68% for validating datasets while the forecasting from SVM models was 90% and 80%, respectively. The accuracy for the forecasting timing of maturity from Tree models were 80% for training datasets and 78% for validating datasets while the forecasting from SVM models was 90% and 78%, respectively. The Tree models and SVM models also showed that temperature contributed more to the forecasting the timings of flowering and maturity than precipitation. Our results indicate that both Tree models and SVM models provide a promising technique in forecasting the timings of flowering and maturity of barley.

Malting and brewing from local grain grown in the Northern region

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In the Northern Periphery Region like Northern Norway, Orkney, Iceland, Newfoundland and Faeroe Islands, it can be challenging to grow malting barley to conventional specifications. Summer temperature may either fluctuate or remain low. Combined with unstable or mostly long rainy periods this often results in very variable grain quality which again affects malt quality (e.g. content of protein, kernel size and germination rate). For malting, grain is harvested as dry grain with a low moisture content (around $\leq 22\%$) and dried down to about 13% for storage. As the barley growing region in the North is largely located in high-rainfall coastal areas the moisture content at harvest will often be higher than 22%, thus increasing the risk of damage to the kernels at harvesting.

The standard criteria for malt are aimed at achieving an optimal yield in brewing, but they do not necessarily exclude the use of barley/malt, which do not meet these criteria.

In the present study, we have tested the kernel and malting quality in a number of barley varieties grown in the Northern region. Furthermore we have also tested if the usage/yield of grain for malting and brewing can be increased by adapting the malting process to suit the more variable quality of the grain produced in northern areas.

We have so far no reason to believe that it is not possible to grow and brew from malting barley grown in The North.

Finnish caraway: is place of cultivation critical for high quality?

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Caraway (*Carum carvi* L.) is one of the most important spice crops worldwide. In Finland a record ~27.000 hectares were cultivated in 2018, and there is a strong focus on export to over 40 countries, with holds on about 20-30% share of the global market. Caraway has proven to be one of the most profitable crops and has become a 'hit' crop in Finland.

Caraway seeds oil is mostly made of two volatile compounds: limonene and carvone, which are of importance for the food and pharmaceutical industry due to their fragrance, flavor, antioxidant and antimicrobial properties. In Finland, the long summer days offer a unique light environment that fosters caraway seeds of high quality. A great proportion of Caraway cultivation occurs from the South tip of Finland at 60°N latitude, upwards along the West coast and Central Finland up to 63°N latitude.

Caraway cv. 'Record' and cv. 'Konczewicki' were cultivated in 2017 by contract farmers and seeds handled and supplied by TransFarmOy. Seed samples were from different locations to represent a gradient of latitudes: 60°- 62° North latitude. Volatiles analyzed and identified using head-space solid-phase micro-extraction (HS-SPME) and gas-chromatography mass spectrometry.

Our results show variations in Finnish caraway oil quality across locations. Volatile compounds ratio is shown for 5 locations showing that in Finland caraway oil has consistently more carvone than limonene, in contrast to what is reported for other Nordic countries.

Best management practices for hay production in Yukon

Kristine Ferris

Yukon Government, Whitehorse, Canada

Hay has historically been and remains the principal crop grown in the Yukon, with 1,930 hectares in production on 62 farms according to 2016 census data (Yukon Agriculture State of the Industry Report 2013 to 2017). Despite many years of hay production, there was a lack of documentation regarding best management practices (BMPs) for maintaining healthy, productive hay fields in the Yukon. Work was completed in the summer and fall of 2018 to gather data on hay production in northern climates via a literature review, as well as interviews with local hay producers. This work was compiled in a Best Management Practices document for the Agriculture Branch at Yukon Government.

Barley varieties for Arctic regions

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The Arctic areas are characterised with short growing season and marginal temperatures and therefore less suitable for cereal cultivation. In Norway, the breeding activities for this region were terminated in early 1980ies, while in Iceland, Finland and Sweden the breeding programs are still ongoing. In recent years, the interest for local barley cultivation in the Arctic areas has increased and there is a need to help farmers to identify the most suitable varieties for animal feed and food. Moreover, the knowledge on how the varieties with different origin perform in coastal and continental northern climate is also of great importance. The objective of our study was to assess adaptability of barley varieties originated from Iceland, Finland, Norway and Sweden to Arctic areas. The field experiments were established at two locations in Sweden – Umeå (63°49'N) and Ås (57°21'N) and at two locations in Norway - Tjøtta (65°49'N) and Tromsø (69°38'N) in 2017 and 2018. Barley varieties originating from all the four countries and differing in earliness, were sown at all four locations. The plant developmental stages was recorded, grain water content was measured from early grain maturity until harvesting and grain yield was assessed. Preliminary results suggest that early maturing varieties may be harvested with low water content thereafter dried and stored as dry barley. The grains of late maturing varieties contained up to 40% water or more at harvesting time. Use of wet grain in animal food is also discussed. The project is supported by Botnia-Atlantica programme.

Using life cycle assessment methodology to measure environmental performance of storing crimped grain in big bags in comparison to established methods

Niklas Frände, Yvonne Dahlbäck, Nina Åkerback, Katrin Asplund

Novia University of Applied Sciences, Vaasa, Finland

Grain cultivation in the Northern areas of Scandinavia and Finland suffers from different challenges than areas further south – most notably a shorter growing season and a generally wetter climate. Today most grain is dried before storage, which is very energy-intensive. The silage technique of storing grass in packages (round bales) has showed that field crops produced in these regions can still compete very well compared to the south. Similarly, crushing grain while still wet (just after harvest), and storing it in a sealed package means that the grains can be harvested at a significantly higher water content but still keep excellent nutritional value. This technique is already well-established, but by using smaller packages than the current 50+ meter storage tubes – in this case large, airtight storage bags – a greater flexibility in trade and usability of the harvest can be achieved.

The purpose of the ongoing Wet Grain in Package (2017-2019) project is to increase the profitability of grain cultivation in the Nordic area. Novia UAS will use life cycle assessment methodologies to measure the environmental performance of the big bag system, compared to traditional drying of grain and crimping grain in plastic tubes. A scenario reflecting local conditions for the three different systems are being developed and data is collected from a local perspective.

Equipment for storing wet grain in package

Hans Arvidsson

RISE SMP Swedish Machinery Testing Institute, Umeå, Sweden

Equipment for storing wet grain in package.

Storage technology for grass forage has gone from drying it in field to storable moisture content to store it wet in the form of silage. As a result, the costs are reduced and the quality of the forage has increased. The silage technique has been developed into several varieties that fit both large and small farms, and also allow for sale of ensilaged forage in the form of unit packs (round bales).

Cereals grown in the northern areas are predominantly focused on animal feed, as the growing conditions are not suitable for bread cereals. In addition, these areas are net importers of grain, but often have an excess of forage areas.

If you store the grain wet, you can win the corresponding benefits (earlier harvested for a better climate and better economy).

In a Interreg program (Botnia-Atlantica) we (Sweden, Finland and Norway) in the project "Wet Grain in Package" cooperate to develop a system for packing, storing and handling the wet grain in unit packages. This will fit smaller farms and can be used for trading. The economy of grain cultivation would be improved and excess areas could be used for grain cultivation, it will also reduce grain imports to the region and overall a better economy for agriculture in the region.

The project also includes parts related to cultivation, cultivation model, life cycle analysis, and development of pricing support in the trade of "wet grain packages".

Wet Grain in Package - Cost structure analysis of dried grain versus wet grain in bag and wet grain in tube

Mikael Ehls

Novia University of Applied Sciences, Vasa, Finland

Grain cultivation in the Northern areas of Scandinavia and Finland suffers from worse growing conditions than areas further south – most notably a shorter growing season and a generally wetter climate. Today most grain is dried before storage, which is very energy-intensive. The silage technique of storing grass in packages (round bales) has showed that field crops produced in these regions can still compete very well compared to the south. Similarly, crushing grain while still wet (just after harvest), and storing it in a sealed package means that the cereals can be harvested at a significantly higher water content but still keep excellent nutritional value. This technique is already well-established, but by using smaller packages than the current 50+ meter storage tubes – in this case large, airtight storage bags – a greater flexibility in trade and usability of the harvest can be achieved.

The purpose of the Wet Grain in Package project is to increase the profitability of grain cultivation in the Nordic area. To aid in establishing said profitability, a cost estimator (calculator) was developed to show the different cost structures of traditional grain drying versus wet grain in bags and wet grain in tubes. The user can input data according to situation and see how the costs develop for the different alternatives. Preliminary analysis suggests that the wet grain alternatives make financial sense even at very low water contents – the tube-option is by far the cheapest, but it does not allow the producer to move or trade the grain.

Wet grain in package

Hans Arvidsson¹, Niklas Frände², Mikel Ehre²

¹SMP Svensk Maskinprovning, Umeå, Sweden. ²Novia University of Applied Sciences, Vaasa, Finland

"Wet grain in package" is a project within Interreg Botnia-Atlantica which is a cross-border cooperation programme financing projects between Sweden, Finland and Norway. Through collaboration across national borders the programme contributes to increased capacity for innovation, strengthened business sector, developed natural and cultural heritages and improved communications in east-west direction.

The aim of the "Wet Grain" project is to increase the profitability of grain cultivation in the program area. The goal is that the project will have developed an energy saving, cost and environmentally effective system to pack, store and manage crimped grain at high water content. To facilitate the introduction of the system, the project will have developed models for maturity (harvest time) and trade. In order not to create a waste problem, the project will also have developed a model for an environmentally friendly and resource-saving way to take care of the packing material. The project shall also by LCA-analysis have reported how the system affects the environment compared to established methods

Insect pollinators of haskaps (*Lonicera caerulea*) in Yukon, Canada

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Recently, the Yukon has seen a large growth in agricultural activity. Crops of commercial interest for local consumption and the export market include domestic berries, especially haskaps. However, information on the pollination of these crops in our northern climate is not well understood. To begin addressing this knowledge gap, I looked at food habits of farm bees in southwest Yukon. Two methods were used to gather information. Firstly, solitary bee houses were installed; the occupants and associated pollen were identified. Secondly, I counted the insect pollinators on haskap flowers. Results from the solitary bee houses show that cavity nesting bees collect a wide variety of pollen, including pollen from haskaps. Pollinator counts of haskaps indicated that bumblebees (*Bombus* spp.) were significantly more common than domestic honeybees (*Apis mellifera*), other bee species, syrphid flies, and butterflies even though the early timing of flowering meant that bumblebee populations were at the lowest in their annual cycle. The number of bumblebees per haskap flower was comparatively high relative to numbers reported elsewhere in Canada. The ability of bumblebees to be active in cool temperatures and the proximity of the plantations to natural ecosystems can explain the prevalence of bumblebees in this study. For crops that rely on insect pollinators, having native flora and fauna close by can be beneficial. In Yukon, it is still possible to support insect pollinators by maintaining natural areas in among and within agricultural land. Such undeveloped lands are, at present, typical of agricultural landscapes in subarctic Canada.

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What can we learn from ancient civilizations for a sustainable agricultural soil management in arctic regions?

Katja Wiedner¹, Steven Polifka¹, Bernhard Zimmer², Michael Balhar³

¹Martin Luther University Halle-Wittenberg, Halle (Saale), Germany. ²Arktisk Terra Preta AS, Gibostad, Norway. ³Sustainable Environmental Solutions Consulting UG, Halle (Saale), Germany

The predicted temperature rise for circumpolar regions in the upcoming decades will provide a great potential for crop production. However, increasing air temperatures may have negative impacts on soils e.g. such as humus degradation, increased nutrient leaching or soil compaction. Suitable soil cultivation practices are therefore indispensable in order to prevent soil degradation for a long-term food security. Some ancient civilizations, which faced comparable challenges, were able to create soils, highly fertile till the present day. For instance, many archaeological sites dated back to the Viking age show deep black soils with an unusual high fertility. Investigations showed that these soils still contain e.g. high nutrient (P, N) and soil organic matter stocks as well as a high nutrient retention capacity. Stable isotopes ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$), SEM-EDS, FT-IR and molecular markers like Δ^5 sterols, bile acids, black carbon were used in order to identify and characterize soil input materials. The data revealed that human and animal excrements, organic waste and pyrogenic biomass are the main inputs. The composition and properties of the ancient soils can presently be achieved by the closure of regional material cycles. This includes the disposal and collection of arising biomass e.g. from households, farms, or operations producing biomass waste, its composting and final its application to soil. Ancient knowledge combined with intelligent management of biomass material flows will reduce the environmental impact through agricultural intensification and ensure fertile soils with long-term carbon sequestration potential which is the basis for the welfare and sustainable development of (rural) communities.

Towards more sustainable arctic agriculture by recycling nutrients

Asta Kietäväinen

University of Lapland, Rovaniemi, Finland

Agricultural sustainability means farming without degrading the environment or the resource base whilst maintaining economic profitability and social stability. When striving towards sustainable agronomy, a possible solution is nutrient recycling. Phosphor resources are limited on earth, and waste and sludge that are rich in P should be recycled back to farmland. The need for nitrogen fertilizers can be reduced by utilizing legumes' nitrogen fixation and thereby also decrease GHG emissions, as nitrogen industry is an energy dependent sector.

In this paper I am discussing means to reduce mineral fertilizing, even so optimizing crop productivity by replacing mineral nutrients by slurry application and legumes' nitrogen fixation, and possibly complement them by sewage sludge as it is rich in P.

Two experiments were arranged in Rovaniemi in 1990's; nitrogen fixation was studied by mixed crop of hairy vetch and barley, and fertilizing effect of slurry was experimented on mixt crop. Results showed that nitrogen fixation can replace nitrogen fertilizer in mixed cropping, but some extra nitrogen is needed for legumes to start intensive growth and fixation in spring in arctic areas. Slurry can replace mineral nitrogen as starter to legumes. As heat-treated sewage sludge (ds more than 90 %) has minor soluble N and much P, it would be worth to study it as a starter N for legumes. By the same time, it increases organic matter and C to soil. More sustainable and self-sufficient agriculture in arctic can be reached by crop legume mixture and recycling slurry and sewage sludge.

Soil Amendment with biochar for the enhancement of soil fertility and crop productivity in Labrador

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The main soil related problems that hinder crop production in Happy Valley-Goose Bay (HV-GB), Newfoundland and Labrador, Canada are high acidity, sandy soil texture, low cation exchange capacity (CEC), and low water and nutrient holding capacity. A number of multi-year experiments were conducted to evaluate (i) whether application of biochar could alleviate the limitations mentioned above when applied singly or in combination with fishmeal and chemical fertilizers (ii) the macro and micro nutrient supplying capacity of biochar (iii) effects of biochar rates on crop productivity, soil health, and greenhouse gas emission. All experiments were set up on permanent layouts and the treatments were repeated in randomized block designs. Canola and beet were grown as test crops.

Biochar applied singly (without other nutrient source) was unable to support crop establishment, growth and biomass production. Similarly, mineral fertilizer or fishmeal only treatments also were unable to produce satisfactory yields. However, combined application of biochar and fertilizer or fishmeal enhanced crop establishment and growth and thus, produced significantly higher crop yields. Biochar application rates up to 80 t C/ha were found to increase soil pH, SOM (soil organic matter), CEC, soil moisture content (both gravimetric and volumetric), and the availability of number of plant nutrients (Ca, K, S and Mn) at the topsoil (0-15 cm). However, the advantages of applied biochar diminishes over years suggesting onetime application of biochar may not be enough to provide long-term beneficial effects on soil quality and crop productivity.

**Abandoned agricultural soils of the Russian Sub-Arctic on the example of Salekhard city,
southern Yamal**

Ivan Alekseev, Evgeny Abakumov

Saint Petersburg State University, Saint Petersburg, Russian Federation

In 1920s, systematical and very intensive studying and exploitation of natural resources of Far North of Russia has been started. Due to the development of industry and growth of the population, necessity in localization of food support products was growing intensively and arable soils became typical component of the subject of study. Nowadays, however, almost all the former agricultural lands are abandoned or exposed to various anthropogenic activities from time to time. Abandoned agricultural soils in sub-urban territories of Salekhard were studied with the aim to evaluate the alteration of soil morphology and chemistry under agricultural practices and to clarify its specificity in case of permafrost-affected soils. Predominance of sandy textured parent materials was found as one of the main reason for favorable agricultural using of land in the north of Western Siberia in previous years. Soil organic carbon content depended mainly on the character of current land use and varied significantly in the studied soils. Most of the soil samples showed the highest levels of nutrients in topsoil horizons. Former arable horizons were stable in time in terms of morphological features and agrochemical state. In spite of the high level of soil acidity, content of nutrients in anthropogenically affected topsoils was still high after 20 years of abandonment. This indicated that agrosoils with relatively high fertility of arable topsoils could exist during long time in case of sandy textured parent materials.

This study was supported by Saint Petersburg State University, grant "Urbanized ecosystems of the Russian Arctic: dynamics, state and sustainable development".

Compost as a sustainable tool for closing regional biomass cycles

Steven Polifka, Bruno Glaser, Katja Wiedner

Soil Biogeochemistry, Martin Luther University Halle-Wittenberg, Halle (Saale), Germany

Food supply in arctic regions is strongly dependent on imports. Regionally adapted concepts are thus indispensable in order to guarantee affordable food of high nutritional quality produced in an environmentally friendly way. However, arctic regions show highly diverse natural landscape conditions. Especially soil is very limited and/or often characterized by a high acidity and low nutrient stocks. Furthermore, in some regions open land agriculture is nearly impossible due to the harsh climatic conditions. Greenhouses are a convenient alternative for food production. In every case, there is an urgent need for growing media and sustainable fertilizers. The development of regionally adapted concepts is thus urgently needed in order to capture available biomass for multiple use and closing regional biomass cycles. Composting seems to be an interesting possibility in order to produce sustainable substrates for greenhouses and fertilizers for open land agriculture. Compared to mineral fertilizers, compost increases water holding capacity, nutrient retention and soil carbon stocks and prevent soil degradation. Furthermore, local composting and food growth will create jobs, people are independent from world market price for mineral fertilizers and able to produce high-quality food in a sustainable manner. Our investigations showed, that amino acids and nitrogen as markers for food quality, are positively affected in plants when grown on soils treated with compost. We will present potential and ways of an efficient use of biomass in arctic regions and its importance for social, agricultural, environmental and economic issues.

Compost – A potential substrate for circumpolar agriculture and the required quality standards

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The application of compost in circumpolar agriculture and greenhouses is of high interest due to different reasons.

Compost acts as a substitute for mineral fertilizer which guarantees independency of local farmers from the global market for mineral fertilizer. The use of biomass from households, companies, farms etc. for composting reduces waste in line of a sustainable use of resources.

Compost increases or maintains soil fertility and has potential for long-term carbon sequestration in soils and, last but not least, compost can be created decentralised and may act as plant substrate in greenhouses where no soil is available. However, the input materials and the compost production as well as the final compost need quality standards in order to guarantee an environmental-friendly, harmless and marketable product.

The quality standards for compost differ internationally whereby new challenges must be faced such as (micro)plastic contamination, “biodegradable” bags etc. Besides national regulations, additional compost quality certificates on a voluntary basis might be an interesting benefit for producers and users. However, small-scale production sites or producers for closing their own material cycles need also simple tools in order to obtain a high quality substrate.

The talk will give an overview about the required criteria but also present ideas for small-scale producers in order to estimate the quality of their composts.

Regional economic effects of reindeer based production –building up analysis method and data base

Marja Knuuttila¹, Jukka Tauriainen², Eero Vatanen¹

¹Natural Resources Institute Finland (Luke), Mikkeli, Finland. ²Natural Resources Institute Finland (Luke), Seinäjoki, Finland

The economic impacts of the reindeer husbandry are expected to reflect to a wide range of the regional economy in Northern Finland. The economic development of the meat based reindeer husbandry is monitored annually on the profitability bookkeeping system maintained by Natural Resources Institute Finland (Luke). In this project, the local economy importance of reindeer husbandry will be examined more comprehensively by combining the business economics and the input-output analysis to take into account both the direct and indirect effects of the reindeer based production. Indirect production effects include the production of the local firms providing goods and services to the reindeer based production chain. Besides to meat production the reindeer herders earn their livelihood from other reindeer based production sources. This project involves expanding data collection to include also incomes from the reindeer herders' reindeer based tourism and direct sales of meat. In addition to production by reindeer herders also production by specialized meat processing firms are included. Delivery of the reindeer products in food services and food trade further promotes production locally. Data on reindeer husbandry is provided by the reindeer owners association. Observations, interviews with complementary inquiries afterwards and existing statistical data sources are needed to complement the data needed in the analysis. The boundaries of the reindeer owners' association differ substantially from the municipalities used in regional economic effects calculations which pose further challenges in collecting data. The method and collecting the data base is tested in three municipalities in Northern Finland.

Loitering reindeer and agriculture – conflict management with man's best friend

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Reindeer have right for free grazing in reindeer herding area. However, the herders must prevent the damages for agricultural land. Fencing the areas are effective, yet not always possible way to keep reindeer away. Using dogs to drive out reindeer is an efficient way to prevent damages to agriculture. Moreover, working dogs in reindeer herding is a tradition, although nowadays almost absent in some co-operatives. To demonstrate the importance of dogs we will perform field tests in Salla co-operative. We study the differences in reindeer behaviour when moving them with dogs or without dogs; and using different types of dogs (chasing or herding type). We compare the results using GPS data: how effectively reindeer leave and afterwards avoid the test areas. The tests include the economic comparison on the work needed, and we assume economic benefit in using dogs instead of human resources. Benefits and a dog training guide written in the project encourage the herders to use dogs. Efficient prevention of damages caused by reindeer facilitate good co-operation with the livelihoods in reindeer herding area. The reindeer herding dog population and culture gets stronger and the human resources in reindeer herding can be used in a more effective way. Using the dogs in agricultural land protection could help in re-introducing the partially lost tradition.

Mobile application prevents farming damages caused by reindeer

Karoliina Majuri

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The use of natural pastures forms the basis of profitable reindeer herding. Reindeer have a right to graze freely despite the land ownership. However, the cooperatives must prevent the damages to farming caused by reindeer. Building fences around the fields is the most effective way, although not always possible. The farmer needs to give an alert to the cooperative when (s)he notices reindeer on agricultural areas. Cooperative must drive the reindeer out promptly. In particular, the distant fields are difficult to survey for a farmer and for a herder, and sometimes the herders difficult to reach. The cooperative often have only some spots with reindeer damages, and the closest herders work overtime when driving out the reindeer. A mobile phone app facilitates easy, fast and accurate solution to make an alert on reindeer to the cooperative. Moreover, a farmer can use the app for alerting, providing information on the fields (such as harvest times and the reindeer-tempting stages of farming) and the herders will know when to survey the fields more effectively. An alert reaches all herders simultaneously and the closest one can drive out reindeer and reset the alert. Data on work needed can be stored and used in preventing the crop losses in the future. The new, effective mobile tool facilitates better cooperation for the livelihoods.

Feeding habits of reindeer in Yakutia

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Republic of Sakha Yakutia is among the regions of Russia with the highest number of domestic reindeer. Two species of reindeer are bred in the region – Evenk and Even reindeer. Reindeer herding farms are located in different climatic zones (mountain-taiga, tundra, forest-tundra, forest). The most important adaptive feature of this animal, unlike other members of the deer family, is the ability to cope well with feeding on lichens. The feed diet of domestic reindeer includes more than 440 species of plants, and wild deer - no more than 120 species. It is established that unlike wild reindeer, domestic reindeer eats much more lichen - up to 50 species of lichen. In the winter, the basis of the feed diet of domestic deer is lichen (70-85%). In the spring, the main reindeer food are sedges, pumice, grains, buds of willows, dwarf birch, and lichens occupy 15-30% of the diet. In the summer, the nutritional role of lichens is reduced to 8%, but domestic deer continues to eat them in small amounts. In the late-autumn period, as the summer green fodder withers, lichens again begin to prevail in the diet of reindeer. The most eaten species of lichen are reindeer lichen (*Cladonia rangiferina*), *Cladonia forest* (*C. sylvatica*), *Cladonia stellate* or Alpine (*C. stellaris*), glomerular *tsetrariya* (*Cetraria cucullata*), *tsetrariya snow* (*C. nivalis*) and *tsetrariya Icelandic* (*C. islandica*). The diet also includes epiphytic lichens, which are higher in nutritional value than *Cladonia* and *tsetraria*, as they contain up to 8% protein and 9% fat. In the autumn season the diet of deer includes about 15-20 species of mushrooms. The most palatable deer mushrooms are: *boletus* (*Leccinum scabrum*), red-capped scaber stalk (*Leccinum guericum*), *Suillus luteus* (*Suillus luteus*), *volnushki* (*Lactarius* sp.) and *russulas* (*Russula* sp.).

Intramale variation in reindeer sperm head size – a pilot study

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The aim of our study was to reveal intramale variation in reindeer sperm head area. According to the postcopulatory sexual selection theory intramale variation in sperm size is smaller in species with more intensive sperm competition between males.

Epididymal spermatozoa were collected from three slaughtered males (male A: 2.5; B: 4.5; C: 2.5 years old, resp.). Air dried smears were stained with the Feulgen technique to reveal sperm nuclei. Nucleus area of 100 spermatozoa per male were measured with ImageJ software (version 1.52a). Statistical analysis was done with R Commander (version 2.5-1). Intramale variation was expressed as the mean % \pm SD of the sperm head area coefficient of variation (CV).

Sperm head area was significantly larger ($p < 0.01$) in male B (mean \pm SD $15.21 \pm 1.55 \mu\text{m}^2$) than in A ($13.95 \pm 1.97 \mu\text{m}^2$) or C ($13.89 \pm 1.82 \mu\text{m}^2$). The intramale variation of the sperm head area CV was $12.48 \pm 1.67\%$, which is approximately three times larger than the corresponding values reported for red deer.

Our preliminary results indicate larger intramale variation in sperm head size in reindeer than in red deer, which could mean, according to the present theory, less intensive postcopulatory sexual selection. However further studies on larger number of males will be needed.

The work was supported by the NordForsk-funded project ReiGN in Russia.

**Collection and cryopreservation of epididymal semen in the semi-domesticated reindeer
(*Rangifer tarandus tarandus*)**

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⁴Natural Resources Institute Finland, Inari, Finland. ⁵Norwegian University of Life Sciences, Ås, Norway

The aim was to develop a protocol for collection and cryopreservation of epididymal semen in the reindeer. Six male reindeer ranging in age from 1.5 to 4.5 (2.5 ± 1.1 , mean \pm SD) years were transported from round-up to a slaughterhouse, and slaughtered on two successive days, three males per day. At slaughter, testicles inside the scrotum were cut from the body, placed into open plastic bags and transported to the laboratory. Organs were allowed to cool down to room temperature (+22 °C) before processing. Semen was collected from caudae epididymidae using a 100 µl pipette and pipetted into an Eppendorf tube containing 1.5 ml of Steridyl semen extender. After analyzing sperm motility and concentration, semen was extended to a final concentration of 100 million sperms/ml. Extended semen was equilibrated in a cold room to +5 °C and loaded into 0.25 ml straws. Straws were frozen in liquid nitrogen vapour for 10 minutes and stored in a liquid nitrogen tank. The following day one straw per male was thawed and post-thaw motility was evaluated. Before cryopreservation, sperm motilities ranged from 20 to 90 % and sperm concentrations from 42 to 335 million sperm/ml. Number of straws varied from 6 to 40 per male. Semen of one male was not cryopreserved. Post-thaw motilities varied from 20 to 60 %. In conclusion, the applied protocol can be considered useful as it preserved at least 50 % of the initial sperm motility. The work was supported by the NordForsk-funded project ReiGN in Russia.

How to increase utilization of the Northern Finncattle's milk in local production

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The Northern Finncattle, or the Lapland cattle, is an endangered local breed that produces a high-quality milk although less than dominant commercial breeds. In LAPPARI project, we investigated the possibilities to increase the utilization of Northern Finncattle's milk in northern dairy farms. The investigation included a survey to all cattle owners in Lapland and its neighbour provinces, a survey of consumers and use of statistics. The survey of cattle owners reached 23 Northern Finncattle owners; nine of them were from Lapland, 11 from North Ostrobothnia and three from Kainuu. Northern Finncattle were usually kept in farms with other breeds and their amount was small. A total of 345 Northern Finncattle (cows and bulls of all ages) were found; 84 of them in Lapland, 254 in Northern Ostrobothnia and 7 in Kainuu. This is ca. 42% of total number of registred purebred Northern Finncattle in these provinces (Faba 2017). The milk of Northern Finncattle as a raw material was reasonably available but its utilization was challenged by relatively small amounts per farm, a lack of separate collection and long transportation distances. The best model for milk processing was seen as a small-sized dairy nearby that would buy the Northern Finncattle's milk, or a larger dairy that could separate the Northern Finncattle's and other cows' milk. There was a growing interest in this breed and its products, both among the farmers and consumers, and the restaurant and tourism entrepreneurs. The survey also indicated that the Northern Finncattle requires its own brand. The breed is particularly low in numbers in its home area, Lapland, and its revival there deserves special actions.

Good feeding, good eating, good living with: Human-animal adaptation to the Arctic environment

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Feeding practices of domestic animals in the Arctic are critical determinants of human-animal adaptation to the harsh climatic conditions. Three local breeds of animals in the Russian Arctic (cow, horse and reindeer) represent a stunning example of a perfect human-animal adjustment to the feeding challenges: Long winter period, freezing temperatures, short time for grazing and availability of pasture as a low cost forage source, icing over of pastures and high cost of the additional feeding. The poster offers an overview of materials collected during the fieldwork in different regions of the Russian North.

Yakut Laika as indispensable helpers of a person in the North

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The Yakut Laika is an ancient native breed of dogs, bred by the indigenous peoples of the North-East of Russia. These dogs were used by humans for hunting, in reindeer herding and for transportation of heavy loads. The average speed on the road at long distances amounted up to 10 km / h. On a good road, a team of 12–14 dogs carried up to 1 ton of cargo for an unlimited time, on an off-road road - no more than 500 kg. Laika helped their host in the hunt for arctic fox, seal, bear. Yakut Laika spend the whole year in the open air; they dig a hole in the ground to cool down during the hot summer or escape into the water from the mosquito harassment. In the winter, they seek for a shelter under the snow and, curled up in deep snow holes, covering the face with a shaggy tail. Among distinctive characteristics of the breed are a good instinct, keen eyesight and excellent hearing. The Yakut Laika is a universal dog, adapted to the Northern climatic and living conditions, human needs. In the taiga zone of Yakutia, Laikas were used only for hunting, while the sled dogs were kept in the tundra zone. Dogs of this breed are very friendly to people and are famous for their particular vigilance and guarding abilities. At the same time, they are distinguished by their silence - they bark only when necessary. Currently, the Yakut Laika is very popular in the North and is very rare in other regions of Russia. There are only a few nurseries and breeders in Russia: in Yakutsk, Novosibirsk, Krasnodar, Bryansk, Tver and Moscow. All of them, except the Yakut nurseries, were established in the last two years. In order to revive the endangered Yakut hunting Laika in the Republic of Sakha (Yakutia), 3 basic nurseries have been created. These places are in the focus of a study on biology and ecology of the Yakut Laika and selective activities.

Traditional fishing in Arctic Yakutia

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The peculiarity of the natural conditions of Yakutia plays an important role in the formation of economic activities of the population. A significant number of rivers and lakes is a favorable condition for the development and preservation of traditional fishing. According to the historical data from the XIX century, each Yakut family consumed from 340 to 480 kg of crucians and other freshwater fish a year. Seine was fished in autumn and early winter. In the early spring, the carp was caught in the lakes. From the early spring until the autumn Yakut people ate fresh fish. In 1925 the consumption rate was 225 kg per inhabitant. Fishing in the waters of Yakutia reached the highest point in the fish catch in 1942-1945 - more than 10 thousand tons of fish per year. In following years, there was a decrease and stabilization in catch at the level of 8000 tons of fish per capita. It did not exceed 7-8 kg until 1990 and 4-5 kg over the last decade of the twentieth century. Since 2008, the average total catch is about 5.0 thousand tons per year. Currently, more than 89% of commercial fish catch is produced in the lower reaches of large Northern rivers and lakes of the Arctic zone of Yakutia. The main part of this catch consists of whitefish species, which are valued for their fat and protein content, culinary and taste qualities. All fishing activities are seasonal and are related the spawning season. So the main catch is made in summer and autumn, in winter ice fishing is conducted. The main reasons for the uneven production of fish in recent decades are the transition of enterprises to market relations and the collapse of large fishing organizations, which led to the emergence of small enterprises engaged mainly in the fishing of valuable whitefish, which are in a high demand. In addition, the reduction in fish production was affected by such reasons as the reduction of fish resources and anthropogenic pollution of rivers and lakes.

Noble crayfish (*Astacus astacus*) in Northern Finland - a lost chance or bright future?

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Noble crayfish (*Astacus astacus*) is indigenous to Southern Finland. It was first introduced to Lapland in 1930s. Beside commercial value, noble crayfish has also important role in freshwater ecosystems and in recreational crayfishing. In Finland annual catches have decreased from around 20 million individuals to around 4 million from the beginning of last century. The dramatic collapse has been caused by the spread of crayfish plague (*Aphanomyces astaci*), the introduction of non-indigenous signal crayfish (*Pacifastacus leniusculus*) and changes in the aquatic environment. Signal crayfish coexists with crayfish plague and it is unlikely that these two crayfish species could coexist at same lakes and rivers.

Stocking of signal crayfish has been illegal in Northern Finland and the cold climate seems to be unsuitable for the species and thus it has not been spread to Lappish waters. However, many important noble crayfish populations have been lost in Lapland due to the crayfish plague. For example important populations at Kemijoki river watercourse have been lost during last two decades. In the beginning of 2000 the annual catch was about 200 000 individuals, worth of around 500 000 euros.

Climate change will open new possibilities to stock noble crayfish to further north. This could open new commercial and recreational possibilities for crayfishing. Crayfish farming could also be a business opportunity in future in Northern Finland.

The application of prognostic modeling in the study of flu A in a population of wild birds on the Taimyr

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Every year a huge number of migratory birds arrive in the Arctic zone of Russia. The territory of Taimyr is characterized by the presence and nesting of more than 140 species.

Serological analysis indicates that "Taimyr" birds on the paths of their migrations constantly meet with the influenza A virus. The studies were carried out on the territory of Taimyr (AAAA-A18-118021990006-9). To compile prognostic models, statistical reporting on infectious diseases over several years was used, based on the theory of fuzzy sets, taking into account the identified factors contributing to the emergence of disease outbreaks.

To predict the epizootic situation of influenza A in the wild bird population some factors were chosen in the form of input linguistic variables: the number of migrating birds, the degree of pathogenicity of influenza A, the degree of susceptibility of the bird species to influenza A, the distance of migration from wintering sites to nesting sites, the degree favorable migration paths, climatic factor, habitat factor. A dependent variable, subjective probability, was also introduced as a generalized incidence rate of birds.

Based on the processing of expert information, a logical-linguistic model is obtained.

Analysis of the data showed that under favorable conditions for the development of epizooty, the probability of occurrence of the disease is 0.8 (80%), and with a maximum effect of negative factors for the virus, the probability of epizootic is 0.07 (6.67%) in the range of values of "average / above the average" and 0.73 (73.3%) in the range of "average".

Local level green economy indicators

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Green economy, Bioeconomy and Circular Economy are mainstreamed in academia and policy making as key sustainability avenues. Green economy acknowledges the underpinning role of all ecological processes and is more inclusive of some aspects of social dimension at local level. (D'Amato et al. 2017.) However, the amount, quality and scalability of indicators for measuring green economy is still new and there is a need for effective and versatile methods and tools (e.g. indicators) on moving towards more sustainable future. Green economy indicators, developed in the project, are to measure and verify the green economy transition process in the Lapland area and are categorized for energy, food and tourism sectors taking into account Lapland regional scale features. The system level indicators were also developed and combined into more comprehensive symbiosis thinking formats between energy and food sector as well as between tourism and ecosystem area capacity. The preliminary work for indicators was done in previous project and now we developed indicators further by developing green economy framework with three paradigms (resource efficiency, ecosystem resilience and social equity) and sustainability dimensions (ecological, economic and social) and reflecting these green economy indicators to this framework. Moreover preliminary development work of tourism indicators meeting the ecosystem boundaries was developed. In addition we present the socio-demographic indicators presenting the total area level baseline for human and demographic potential. Indicator values are to be reflected to the changes in area level socio-demographic indicators in order to find correlations between system level green growth and area level changes.

Widening arctic bioeconomy - potential of biochar and compost as a growth layer for the cover system of mine tailings

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Recyclable organic waste materials e.g. compost and biochar are nowadays progressively used for soil improvement and carbon sequestration in horticulture and landscaping. Mine tailings represent a source of toxic pollutants, mainly heavy metals, which may spread to the surrounding areas. Recently, biochar and compost have been suggested to be used also in closed mine tailings to enhance their phytostabilization and being a long-term and cost-effective rehabilitation strategy to promote the establishment of vegetation and to reduce the risk of pollutant transfer. Mining industry is constantly growing in Finnish Lapland and also a lot of wooden raw material from abandoned farm fields and forest logging residues are available for biochar production. However, information about the feasibility of those materials as a growth medium layer in mine tailings and their effects on the vegetation restoration, reforestation success and leaching of pollutants is scarce, especially in the boreal climatic conditions.

We examined the physical and chemical properties of three kinds of cover layers: 1) forest till soil, 2) forest till soil added with composted sewage sludge (CSS) (10%) and 3) till soil + CSS (10 %) + (10 %) biochar (Norway spruce) in the large scale lysimeter study in the Rautuvaara mine tailings site. Effects of various cover layers on i) the properties of leachate water (pH, oxygen content, moisture, redox potential, metal and nutrient concentrations) and ii) vegetation (Scots pine, willow and grass mixture) success (growth, covering area, chlorophyll content, concentrations of metals and nutrients) will be investigated during the next two growing periods.

Biochar, compost and fiber clay as growth media for the cover system of mine tailings – widening arctic bioeconomy

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Recyclable organic waste materials are progressively used for landscaping, soil improvement and carbon sequestration. After ore-extracting activities mine tailings need landscape reclamation to reduce environmental risks. Information about the feasibility of recyclable waste materials as a growth medium layer for the cover systems of mine tailings and their effects on vegetation restoration is scant especially in the boreal climate. We examined the physical and chemical characteristics of two biochar types (spruce and birch), fiber clay (waste paper sludge), composted sewage sludge, tailings soil and forest till soil as well as their properties as in varying mixing proportions on plant growth (Scots pine, dark leaved willow, red clover, red fescue and maiden pink) during one growing period in a greenhouse.

Non-oxidized tailings provided poor plant growth. Coarse and dry fiber clay showed also poor seed germination and plant growth. All media without compost additive showed relatively poor growth indicating the lack of nitrogen. Root and shoot growth was greatest in pure compost. Compost with birch biochar showed slightly poorer growth than compost with spruce biochar; likely due to its coarser structure. In general, the growth and vigour of plants decreased from spruce > willow > red clover > red fescue to maiden pink. Forest till soil and biochar proved to be the most suitable growth media for the cover systems of mine tailings when added with compost or another nitrogen source. Norway spruce, willow cuttings and red clover are the most feasible species to be grown on boreal tailings covers.

Nutrient cycling of urban and rural waste in biofertilizers from biogas plants in the subarctic

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Sustainable agriculture needs efficient methods to recycle nutrients from consumers to producers. Residues from biogas production, biofertilizers can be useful. In field experiments, the most common crops in northern Sweden, barley and grass/clover ley were grown and experimentally fertilized with biofertilizers or different amounts of ammonium nitrate in a randomized design. Liquid fertilizers from household waste or a dairy factory waste stimulated barley and grass growth more than ammonium nitrate. However in the ley the clover in the could not compete with the vigorous grass and thus the total yield of grass/clover ley was the same for all fertilized treatments. Granules of sewage sludge coated with urea and KCl, did not have a significant effect on yield of barley. Also nutrient uptake in the barley with undersown ley was stimulated by the liquid biofertilizers. Unfortunately uptake of Cd was also stimulated one of the years, but the concentrations were one order of magnitude lower than the EU-limit for fodder. The risk for contamination of watercourses by nutrients and heavy metals was assessed by sampling of soil water and surface water from fertilized plots. We found no increased concentrations of any nutrients or heavy metals in soil water. In October, the surface water had higher concentration of ammonium-N in water from plots that were fertilized with liquid biofertilizer, but in November this risk of nitrogen leaching was reversed and both nitrate and total nitrogen were lower in water from biofertilized plots than from plots fertilized with ammonium nitrate.

Launching FRESH - The Food Research, Enterprise, and Sustainability Hub

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One of the biggest global challenges of the 21st century will be feeding year 2050's world population of nine billion people, within the competing contexts of constrained resources, environmental pressures, and changing lifestyles; all exacerbated by effects of climate change. Resulting internal and external demands on northern food systems are expected to increase, but thankfully, innovative food systems research is taking place across the Circumpolar North. Unfortunately, few of these efforts are truly collaborative, which results in the duplicative expense of valuable time, energy, and funding.

The Food Research, Enterprise, and Sustainability Hub (FRESH) provides a novel support system for transdisciplinary, Circumpolar food systems research - encompassing education, enterprise, community engagement, and policy development. FRESH adopts a transdisciplinary structure with a translational focus to support productive collaborations and communication among distinct stakeholders, and proposes a multi-pronged approach to tackle the barriers that delay the research-to-application process by shortening the literal and figurative distance between research and practice professionals, educators, learners, industry, and policy experts. Our approach is facilitated by technological platforms and community engagement to move research out from the university setting swiftly into proof-of-concept environments along the entire spectrum of inquiry – from inspiration, to ideation, to implementation.

Professors Liz Snyder of University of Alaska, Anchorage and Rachael Miller of Alaska Pacific University will lay out the FRESH strategic plan, contextualizing why Alaska is an optimal launchpad for this effort, and conclude with a call for partnerships and actionable collaborative research interests.

Mobile license for non-timber forest products

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In Finland everyone can gather wild berries and mushrooms any place for free under the traditional Finnish legal concept known as everyman's right. For collecting other forest foods and non-timber forest products collector needs landowner's permission. State owns 1/3 of Finland's forest surface area and majority of these areas are in Lapland. Metsähallitus as a state-owned enterprise is managing these areas as a goal to offer possibilities for the different livelihoods of bio economy. Usage of forest products is a traditional way of living for the locals. Also forest foods enterprises have a growing market globally. For support local enterprises and individuals Metsähallitus offers easy-access permission by selling licenses as a mobile phone service. In the beginning the license was created for getting a Christmas tree, but soon extended to many other forest products. For nature-product enterprises in Lapland we also offer information about forest fertilization in the state-owned land. This makes enterprises possible to offer products with organic food certification for their customers.

Production of functional and specialized food products for healthy purposes from Arctic raw materials for indigenous people and newcomers

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The novelty of the study is the construction of complex food physiologically functional systems (CPPS) consisting of medicinal arctic plant material, succinic acid, mineral salts and rapeseed phospholipids. The resulting complexes have good digestibility, technological advantages.

Rape phospholipids, in comparison with sunflower, have greater resistance to oxidation due to their high content of oleic acid (up to 71%), which causes the appearance of surface-active, emulsifying, water-retaining, antioxidant, functional and technological properties.

Using CPFFS in the design of the FRP and SPP allows the development of food products with preventive or curative properties. For example, from sub-products of the 1st category of the deer of the north, several valuable food products that enhance muscle tone have been developed, contributing to the improvement of the digestive and cardiovascular systems.

Developed recipes and technologies for the production of flour and confectionery products based on local arctic raw materials, which can enhance the physiological effect on the body, with membranotropic, antioxidant, immunomodulating properties.

Developed from the Arctic berries (Latin *Émpetrum*, *Rubus chamaemorus*, *Vaccínium myrtíllus*, etc.) in frozen, dried form, in the form of canning products (jam, jelly, puree, jam, juices, compotes, marmalade, etc.), suitable for children's or therapeutic nutrition in pre-school and school educational organizations, hospitals.

The technology of obtaining the FPP for the population of the Arctic on the basis of beekeeping products is developed: honey, bee pollination, pergola, royal jelly, containing complex of substances necessary for the vital activity of the human organism under extreme conditions and increasing its stress resistance.

Fungi's future role in Finnish forest management

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Fungi play an important role in most Eco systems and with a targeted use they can open new business opportunities for forest owners and others.

Suomen Agrometsä uses Fungi to increase profitability and ecological health of a forest by growing edible and medicinal mushrooms on live trees and stumps. These methods of growing mushrooms are passive and easy to implement in a forest management plan to create new income streams. These methods are especially valuable for the Nordic countries where wood growth is very slow.

We also have a 2 hectare outdoor mushroom farm in Karjalohja where we grow mushrooms on wood logs and one cooperative test farm in Rovaniemi where we grow mostly edible mushroom for restaurants and markets.

Further we cooperate with a sustainable forestry company (TUOHI), the university of Oulu and LUKE on a variety of projects including testing various native high value mushrooms and the role they can play in forest management. Furthermore we are connecting with markets for these high value mushrooms both domestically and internationally and we are innovating new ways to use fungi (for example working with beer brewers and wine producers).

Mushrooms offer a wide variety of possibilities and opportunities for businesses, private people and the environment. Suomen Agrometsä has made it to its mission to further explore these paths together with our business partners and costumers to create a healthier and more profitable forest for all to enjoy.

Our presentation would focus on these possibilities for the use of fungi.

Sustainable cultivation of Sundew (*Drosera rotundifolia*) for high value products on drained low-productive peatlands in Finland

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Round-leaved sundews (*Drosera rotundifolia*) have been used traditionally as cough medicine. They contain naphthoquinones which are pharmaceutically active compounds. The dominant naphthoquinone is 7-methyljuglone. They contain also flavonoids such as quercetin. Round-leaved sundew is a small, carnivorous perennial plant growing mainly on nutrient-poor peat bogs. They are collected from natural mires in Northern Finland and sent to Switzerland for production of herbal syrup. In the middle-Europe they are protected. Sundew cultivation method was developed already 20 years ago by Galambosi in Finland. Nowadays it's implemented in paludiculture in Germany. Cultivation of sundew on drained nutrient poor peatlands in Finland would improve its availability and boost commercialization and development of new high-value products.

In our pilot project in Northern Satakunta region, Western Finland, we have conducted sundew inventories and sent questionnaires to the local land owners to find out landowners interest and the suitability of the drained nutrient poor peatlands for sundew collection. We have a small scale preliminary seeding experiment with sundew on recently harvested Sphagnum moss area, where the top living moss layer of 30cm above the peat layer has been harvested for growing media purposes. These areas are favorable for sundew propagation also without the seeding due to the lack of competition before the other mire plants take over the area. We have also developed a method to reproduce sundews vegetatively in lab aiming to accelerating the biomass production process. To analyze 7-methyljuglone from sundew extracts both natural and vegetatively reproduced sundews we have applied HPLC-method.

AgriAbility- an attempt to help with Alaska's food insecurity with its disabled residents!

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A number of disabled Alaskans are interested in farm work. Alaska has a high proportion of military members within the state, and many disabled military return to Alaska desiring to work on farms upon completion of their service to the country. With Alaska having a very high level of food insecurity, there is demand for agricultural workers and expansion of farming within the state. The U.S. Department of Agriculture has granted over three quarter of a million dollar for disabled people to explore opportunities in agriculture here in Alaska over the next four years. Yet, there's a need for services to the disabled to create a pathway of employment and increase disability awareness within the state. While there are a few agencies and organizations that provide general information and assistance to people with disabilities in Alaska, these services are not readily available in rural areas where much of the agriculture and horticulture occurs. Most of these organizations are unfamiliar with occupations in agriculture. Many disabled persons do not know where they can go to obtain access to assistive technologies or workplace modification services. Even with these challenges, this project will aim to provide quality assistance to both rural and urban residents in Alaska toward: 1) increasing disability awareness, 2) educating individuals with disabilities on agriculture, 3) providing referrals of available services and resources, and 4) assisting individuals and families in implementing modifications and needed assistive technologies.

Food waste prevention and management as a part of sustainable food chain - focus on restaurants and retail

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According to studies made by Natural Resources Institute Finland (Luke), the total annual food waste in Finland is between 400 and 500 million kilos of which about 17-20% originates in food services and about 14-18% in the retail sector. The importance of reducing food waste has been widely taken into account in Europe and according to the EU policies one of the key targets is that the generation of food waste is reduced by 30% by 2025.

Utilization of surplus food as a part of circular economy (YLIKE) project implemented food waste measurement periods and campaigns in 11 different institutional kitchens and private restaurants in Northern Ostrobothnia in 2017-2018. Food waste was categorized by its origin to kitchen waste, service waste and plate leftovers. Preliminary results show that amount of food waste was reduced by the project target 30% by means of active monitoring and management, and various customer and staff campaigns. Most of the food waste was caused by service waste but it could be effectively reduced e.g. by adjusting the amount of served food at the end of the lunchtime.

The project also investigated the situation of food waste management in the retail sector through ten interviews. Most of the interviewees reported that the amount of waste has reduced significantly recently due to discounts, development of ordering systems, and longer opening hours of retail stores for instance. According to the interviewees, food donations given to organizations offering food aid has also increased and helped to reduce food waste.

Waste to Food: A solution for tackling persistent pollutants, preventable diseases, and arctic food scarcity

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Hazardous industrial toxins such as DDT, PCBs, and methylmercury from big industry end up to the Arctic via oceanic and atmospheric transport. Due to its geographical location, the Arctic acts like a sink to store these pollutants where they persistent in the environment and eventually get into the local food chains. The consumption of the local and nutritious traditional foods, such as seal, is a major source for these contaminants amongst the Arctic Peoples - as the short food chains of the north coupled with the high in lipid tissues in arctic animals directly leads to the biomagnification and bioaccumulation of toxins through the food chain. It has been measured and observed since about the early 1980's that the Arctic Peoples have elevated levels of these toxins in their bodies, which are indicators for serious health risks such as birth defects. However as health organizations and researchers pressure the current strategy of phasing out the contaminated traditional foods, cheap-processed western foods have been phased. This is not a true solution as it is cost ineffective and also in turn swaps diseases for western preventable diseases, such as diabetes.

An alternative model is proposed: a semi-closed loop system that combines anaerobic digesters with indoor farms in a semi-closed. In this report, a feasibility study is conducted of this concept in Longyearbyen, Svalbard that inspired by a pilot study at Clarkson University in the United States for indoor cold region farming.

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