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LEIA

Natural Resources Institute Finland's Stakeholder Magazine

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Natural Resources Institute Finland (Luke)



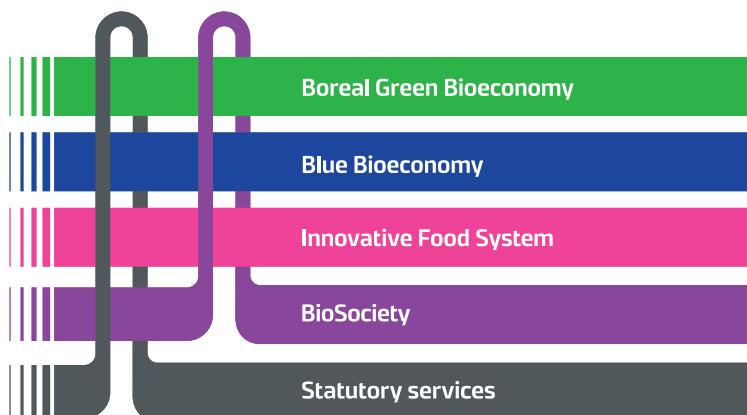
Global megatrends

Sufficiency of bio-based raw-materials — Global climate-change — Circular economy — Biodiversity and sustainability of natural resources — Blurring boundaries between industrial sectors — Population growth in developing countries — Population ageing in the developed countries

Our vision

Growth and well-being from sustainable bioeconomy.

Research focus



Strategic goals

	New biobased products and business opportunities		Regional vitality by circular economy
	Productivity by digitalization		Well-being from immaterial values
	Healthier food profitably		Evidence base for decision making

Our values

	Trust and transparency		Strength from collaboration		Customer orientation		Smart actions
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Our mission

Natural Resources Institute Finland is a research and expert organisation. The institute promotes bioeconomy and sustainable use of natural resources.

120 M€ Turnover

90 M€ Research & customer portfolio

30 M€ Statutory services

25 Locations in Finland

HQ in Helsinki

Present in 11 campuses with universities, research institutes and polytechnics

1300 Employees

research professors

650 researchers

ongoing research projects

Our research focus:
luke.fi/en/research/

Our business solutions:
luke.fi/en/services/



Beating the Paris Agreement: Can Finland become carbon neutral by 2045?

text: KRISTIINA MARKKANEN

Finland might become a leader in sustainability much sooner than expected. However, it takes a fundamental attitude change and ambitious scientific research to get there.



Photo: Keijo Penttinen/Vastavalo.fi



Finland is getting restless. The country doesn't want to wait until the end of this century to become completely carbon neutral as the Paris Agreement suggests. In early 2017, Finnish Minister of Agriculture and the Environment **Kimmo Tiilikainen** declared an ambitious goal to override that of the Paris Agreement: Finland will be carbon neutral by the year 2045.

Luke's President and CEO **Mari Walls** and Executive Vice President **Johanna Buchert** think that although challenging, this goal is within reach.

"Finland is a forerunner in environmental and natural resource issues. It has a strong industrial foundation and a thriving forest-based bioeconomy", Walls says.

"We have the will and the capabilities to make Finland carbon neutral. However, reaching this goal requires a fundamental change in both our economy and our mindsets."

Reaching this goal requires a fundamental change in both our economy and our mindsets.

Towards renewable natural resources

Basically, Finland needs to move from a system based on fossil fuels to one based on renewable natural resources in only a few decades.

Since a prominent chunk of our current business is still based on fossil fuel raw materials, this might not be an easy feat. Luckily, Finland has several assets that help achieve the goal at hand.

"Our population density is low, which means there's a lot of land and water for agriculture and forestry. We need to use these assets to create more value both in terms of economy and sustainability", Buchert says.

Finns have a long tradition in forest industry. We've used wood in construction for centuries. According to Buchert, Finland needs a bold design-driven approach to strengthen the way we build out of wood in the future.

"Wood should be a more prominent element in our infrastructure, not just in buildings but bridges and other construction as well. A very interesting topic in Luke's research is to investigate the potential health benefits of living and working in wooden houses and environments", Buchert says.

No research, no progress

Becoming carbon neutral is an ambitious aim that needs backup from ambitious researchers and new approaches from emerging businesses. Research can turn the dream of a carbon neutral country into reality.

"Solution oriented, interdisciplinary and open research is necessary. Researchers have to be able to communicate their findings widely and interact constructively with different experts in private and public organizations", Walls lists.

"Research isn't isolated from the rest of the society. It's a major tool that improves the understanding of the ecosystem and its concepts. One of these key concepts is a holistic understanding of sustainability."

This means that sustainability has to be understood as an entity that consists of economic, social and environmental factors.





"All these factors need to share the same objective. Research helps to maintain and reinforce the big picture."

"Whenever we meet a new challenge, we rely on research. It's what we use to solve problems and move forward."

This refers especially to research on carbon and how it's stored in the Finnish environment. How do our carbon reserves develop and where are they located? How can we store carbon in our soil?

"Soil and peat can either reserve or release carbon dioxide into the atmosphere. If we know how to manage carbon, it isn't just waste but also an asset", Walls says.

Interdisciplinary collaboration

Luke and its researchers are key operators in reaching the goal set by Minister Tiilikainen. The institute's position in the field of Finnish research stems from a long history and a solid track-record of internationally relevant research on natural resources.

"Our key asset is a thorough understanding of the forest ecosystem and the risks it faces. Furthermore, our research on soil, swamps and agricultural ecosystems support decision making in sustainability questions", Mari Walls explains.

In order to make Finland carbon neutral by 2045, researchers from different fields need to collaborate. And, as carbon emissions are a global phenomenon, international cooperation is required, too.

An endeavour of this size requires the input of, for example, educational and behavioral sciences just as much as that of environmental sciences. Knowing everything there is to know about carbon isn't enough. People's attitudes are a key factor in sustainability issues.

"Big changes don't happen, unless people really understand why they should start making different choices than before. Education is a part of this process. We have a great school system in Finland, but these fundamental climate issues should play a more significant part in it from early on", Walls says. ■



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How to become carbon neutral - A to do list

1. Replace current energy sources with renewable ones

Replace fossil fuels with biofuels and increase biomass production. Solar power, wind power and other renewable natural resources should be considered self-evident by now since they are at the core of the whole energy production system.

2. Rethink traffic

The current traffic system is responsible for a large amount of emissions. That's why we should rethink logistics and traffic infrastructures. Whether we're talking about solar cells or electric cars, clean traffic solutions require big investments in novel infrastructures that might not even exist yet.

3. Manage climate change risks

Climate change increases the risk of storms that wipe out whole forest. Storms and forest fires can lead to uncontrollable amounts of carbon dioxide emissions. Insects can do massive damages to the environment. In British Columbia, pine beetles have destroyed vast areas of forests as warm winters have increased beetle outbreaks. Interdisciplinary research is needed to manage these risks.

4. Diversify forestry

If we use more side stream forest biomass, we might later have the possibility to use larger forest areas for recreational activities than we do now. In addition to wood, forests offer other valuable raw materials like berries and mushrooms. Diversifying forestry also means diversifying tree species. Research provides useful tools that help to maintain and increase the diversity of Finnish forests, raw materials and processed materials.

5. Help corporations track sustainability

Corporations should have intelligent methods of tracking their carbon footprint and other sustainability factors. There's a need for better sustainability indicators. Big institutional investors could utilise this information when investing in carbon neutral businesses. Businesses that score high in sustainability rankings would gain a competitive edge. ■

A dense forest of tall evergreen trees, likely pines or firs, covering a hillside. The trees are closely packed, creating a dark green texture. The lighting suggests a bright day with some shadows from the trees.

Finnish know-how helps the world keep track of its forests

text: KRISTIINA MARKKANEN

photos: ERKKI OKSANEN

Forest resources assessment is one of Luke's crown jewels. In order to mitigate climate change, countries around the world need to keep a closer eye on their forests. Luke caters for this increasing need, most recently in Kenya.





Finland is one of the leading countries in forest resources assessment.

We have spent the last few centuries worrying about which disaster will eventually destroy our forests. First, everyone thought the biggest threat was burning tar. Then it was air pollutants, then greenhouse gases, and most recently carbon dioxide emissions.

As the needs and worries around forest resources evolve, Luke's forest resource research endeavours evolve and strengthen, too. They answer to an increasing demand for understanding forest resources all around the world from Kenya to Cambodia.

Quality comes down to experience, says **Kari T. Korhonen**, Leading Scientist in forest resource assessment at Luke.

"We have a long track record of continuous forest inventory operation, so we're on very solid ground today."

For nearly a century, Luke's researchers have observed Finnish forests and gathered information on tree density,

biomass and resources in general. This has helped to keep track of the structure, growth and ownership of Finnish forests, among other things.

As global demand for this expertise grows, Luke's research is becoming more and more relevant internationally.

"Finland is one of the leading countries in forest resources assessment. For the past ten years we've been a part of a strong European network of experts in the field, and collaborated with most European countries doing forest resources assessment, such as Austria, France and Germany", Korhonen says.

Helping the Kenyans

Experience in mathematical statistics has provided a sturdy skeleton for Luke's operation. It played an important role in a recent three-year cooperation project conducted in Kenya from 2013 to 2016.

The Improving Capacity in Forest Resources Assessment in Kenya (IC-FRA) project aimed to strengthen the Kenyan

partners' capabilities in forest inventory and monitoring, as well as to improve inventory methods in Kenya.

It resulted in a countrywide forest resources assessment plan and improved techniques for forest monitoring. Luke collaborated with the Kenya Forest Service, the Kenya Forestry Research Institute, the University of Eldoret and the Department of Resource Surveys and Remote Sensing.

"Current estimates of forest resources in Kenya are based on partial or old inventories. They lacked an efficient methodology for representative nationwide inventory, and their most recent national assessment dated back to the 1990's", says Project Coordinator, Researcher **Helena Haakana**.

"In a relatively short time, we strengthened their expertise in collecting and managing information on forest resources significantly."



The land of information technology

Finland is full of information technology experts with special know-how in forest inventory. Although Kenyans have a lot of advanced experience in information technology, the project helped them to put their experience to an even better use in forest assessment.

One of the key takeaways of the project for the Kenyans was a stronger skillset in, for example, statistical methods and applications related to forestry, such as satellite imaging.

“During the project, our Finnish-Kenyan team carried out a pilot inventory on five test areas, took soil samples, and mapped tree biomasses using satellite image interpretations. We used the information and a simulator developed by Luke experts for designing sampling for the national forest resources assessment”, Haakana explains.

In addition to satellite image analyses and the sampling simulation technique, the Finnish research team introduced

other digital measuring and assessment methods to their Kenyan colleagues.

“One of IC-FRA’s sub-projects included testing of laser scanning that aims to produce more specific information for local forest planning.”

These methods are only a small part of the technological expertise inside Luke’s walls. Ever since the 1990’s, forest inventory teams have used computers out in the field to extract high-quality on-site information on forest resources.

Later on, they’ve used things like satellite positioning device to locate the field plots accurately, as well as electric scissors for transferring tree diameters and locations automatically to computers.

“These technologies might not seem like a big deal for western researchers, but can help scientists in other parts of the world immensely”, Haakana points out. ■



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Long roots

Finnish forest inventory knowhow roots back to 1920s, when the first national inventory was carried out. Since then, the forest inventories have been done regularly every 5-10 years.

The work has paid off, and the forests are in good shape. According to the latest forest inventory published in June, there is 2.5 billion cubic metres of wood in Finnish forests, 110 million cubic metres more than four years ago. In Northern Finland in particular, the growth has been rapid.

While climate change is forming one of the biggest threats to our planet, the forest inventory data is more relevant than ever, giving tools for our decision makers to protect the environment and support sustainable business. ■



Answering to global needs

text: KRISTIINA MARKKANEN

In international cooperation projects, all learn from each other. A fact that proved true in a three-year project between Finnish and Kenyan forest researchers.



Kenyan research group ready to start the field work. Photo: Helena Haakana

The project improved the forest resource assessment capabilities in Kenya.

The project, Improving Capacity in Forest Resources Assessment in Kenya (IC-FRA), aimed at improving the Kenya Forestry Research Institute's capacity and system for monitoring forest resources. The project team faced many challenges, but the work paid off, and the results were rewarding.

"We managed to help to prepare a technical plan for a nationwide forest inventory. The project improved the Kenyan institutions' understanding on what it takes to produce up-to-date and reliable information on forests", says Project Coordinator, Researcher **Helena Haakana**, Luke.

Mbae N. Muchiri from the Kenya Forestry Research Institute is happy with the outcome.

"We were all theoretically and practically trained on planning, implementing and reporting a National Forest Inventory", Muchiri says.

"The project improved my colleagues' forest resource assessment capabilities and that of mine very greatly. Thanks to advanced training our team of experts can now plan, undertake and report a National Forest Inventory with minimal assistance."

As a result of this three-year cooperation, Kenya now has a complete proposal on how to conduct a nationwide forest resources assessment. However, Muchiri believes the research project was helpful also to Luke's experts and taught them a thing or two about different resources and conditions.

"There are some difficulties in assessing forest resources in the tropics in terms of, for example, difficult rain conditions and several different tree species. The Finnish researchers realized the difficulties of working with limited local resources, and were able to adapt to them."

The learnings from challenging conditions will most likely prove useful in the future. Most countries across the globe want to fight climate change and the interest in forest inventory has spread. Finland has a lot to offer as we keep on fighting the planet's biggest fight yet. ■



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Fish farmers set their sights on offshore areas

text: MARIA LATOKARTANO

New fish farms are being planned, with locations a distance away from the shelter offered by the coastline. How successful can fish farming be under the harsh offshore conditions?







Photo: Pui-Chung Lau

It is probable that fish will increasingly be farmed in offshore areas, even in Finland. This is because there are many other operators competing with fish farmers for the limited coastal waters.

Luke is in the process of investigating which maritime areas would be best suited for fish farming and the kind of technology that offshore farming would require. Such research is conducted in collaboration with enterprises in the industry.

“Establishing an offshore fish farming unit entails a significant planning process and investment. Our role is to help enterprises to minimise the risk of adopting a new operational environment”, says Luke’s Researcher **Markus Kankainen**.

Luke has collaborated with a fish farming enterprise called Laitakarin Kala from the very beginning.

“Luke helped us to find a location for fish farming, and we managed to find a suitable one off the City of Oulu. Our application for a license is now being processed by the Regional State Administrative Agency, and we hope that we will be able to start fish farming in the summer”, says **Timo Karjalainen**, CEO of Laitakari.

A buoy installed by Luke has gathered information on the conditions of the projected fish farming area. A device delivered by EHP-Tekniikka Oy measures the speed

of currents, water turbidity, conductivity, oxygen levels, temperature, and wind strength – in other words, some of the environmental factors that impact the success or failure of fish farming.

Such offshore areas have not been previously used for fish farming, so it was a mystery to us how temperatures would change and what the winds would be like, Karjalainen remarks.

“For example, the temperature of the sea water impacts the fish growth speed. If the farmer knows how the temperature of the water varies over the course of the year, he/she will find it easier to assess the size of the fry that should be introduced to the plant, including their feeding rhythm farmer can thereby assess the size of the fish and the date when they can be harvested.”

The Baltic Sea is a special environment

When the fish farmer has located a suitable farming site in offshore area, he/she faces the next problem: what kind of structures and devices will stand the conditions of the offshore environment.

“Compared with oceans, the Baltic Sea is an environment of its own where the conditions can be really harsh. Ice presents problems, and the Baltic Sea is also shallow in many places, in addition

to which the waves are choppy with sharp peaks”, Kankainen says.

Two solutions can be found to the problem presented by ice movement and storms: either the structures required by fish farming are returned to the shelter of the archipelago or they are submerged below the surface for the winter and during the storms.

Brändö Lax, located in Åland, is one of the biggest farmers of rainbow trout and whitefish in Finland. One of the fish farms of this company is located in the stretch of open sea between Åland and the Turku archipelago, where the company, Luke and the Finnish Environmental Institute have been engaged in collaboration in the development of offshore fish farming.

“We will vacate the plant in October, at a time when autumn storms begin, and will restore the farming framework to its original place in May”, says project coordinator **Pia Lindberg-Lumme**.

In the autumn, Lumme, along with another Finnish enterprise and experts at Natural Resources Institute Finland, will visit Canada in order to acquaint themselves with underwater fish farming system.

“If the structure will prove suitable for Finnish conditions, we might try it at our fish farming plant next summer.”



▲ Monitoring devices and cameras were installed in the fish-farming cage, both underwater and above the surface.

Photo: Markus Kankainen

> A buoy installed by Luke gathers data of the environment and conditions of a fish farming site. Photo: Jaakko Seppälä



Remote farming using cameras

Whether or not fish will be farmed underwater or close to the surface, one problem is yet to be solved. How will the monitoring of the fish farm and the feeding of fish should be organised?

"Out in the sea, the wind speed may be 20 metres per second, and the waves may be seven metres in height. In such weather, it is impossible to travel to the site with a boat, let alone that it is not a very cost-effective to travel 40 minutes one way in a boat on a daily basis", says **Jyri Luotonen**, CEO of Offshore Fish Finland Oy.

Offshore Fish Finland and Brändö Lax, working in collaboration with Luke, have investigated whether it is possible to remotely farm fish offshore.

"Our two fish-farming pools are fitted with an underwater camera, in addition to which there is a 360-degree camera above the surface. For data transfer, we leased a Sonera data link mast, via which camera images were transferred to our office in Brändö island with our own radio network", Lindberg-Lumme remarks.

Excellent image quality

"We will be able to monitor the net cages in different currents and weather conditions, and to see if seals harass the fish. The cameras also enable us to gather data on the feeding behaviour of fish", Lindberg-Lumme says.

As soon as the feeding rhythm of the fish has been clarified, their feeding can be correctly timed, and no feed will end up in the environment.

It appears that the construction of a fish-farming plant that is completely remotely controlled is possible. However, whether they will be constructed – and if so, what the schedule will be – is another question.

"The price will pose a challenge. Technology and structures suitable for offshore conditions are expensive, which means that production volumes in each fish farm site should be large", Markus Kankainen says.

"The other "simple way" option where not so expensive investment is needed is monitor and feed the fish from boat with human eyes. This could be a viable alternative if the working distances are not long and the volumes are relatively small. It is perfectly possible to construct net cages that will withstand offshore conditions, however the technical equipment are more vulnerable on heavy conditions in surface." ■



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How will rainbow trout fare if the climate warms?

At present, the best conditions for the farming of rainbow trout are found in Finland's southern sea areas. The further north one travels along the Gulf of Bothnia, the slower the fish's growing rate will be.

This is the current situation. However, how will it change if the course of climate changes over the next few decades?

This is one of the questions for which the SmartSea project seeks to find answers.

"If the sea water warms, the best production areas may be found in areas further north.

On the other hand, if one considers offshore conditions, a wide and deep expanse of water will not necessarily become excessively warm, enabling fish to find a layer with a temperature that is optimal for them", says Markus Kankainen.

Kankainen thinks that in the future we may farm different fish species and varieties compared to the current situation. One solution to anticipate change might be to improve fish populations so that they will withstand increasingly warm water temperatures. ■

Finnish rainbow trout swims in Vietnam



text: MIKKO SALMI

photos: PERTTU KOSKI/EVIRA

In early 2000's there was no cold-water aquaculture in Vietnam. Today, thanks to Finnish-Vietnamese cooperation, more than a hundred farms produce cold water fish for growing demand.

With over 3,000 kilometers of coastline, Vietnam has long lived from fish and other seafood, both cooked and raw. However, the traditional fish species like carp and tilapia are not safe to eat raw, which has created a growing demand for salmon and other imported fish.

In 2009, the demand led to founding of twelve cold-water fish farms in Northern and Central parts of the country. In just a few years, the amount has multiplied.

This would not of course be possible without a succesful development project and capacity building. Ran by Research Institute for Aquaculture No. 1's (RIA-1) unit Research Center for Cold Water Aquaculture (RCCA), Luke's and Evira's experience in fish and aquaculture research as well as breeding and new aquaculture technologies has been taken into good use.

"We started from scratch over ten years ago, with no real expertise in the field of cold-water aquaculture. Luke's ex-

perience in mild weather conditions, fish farming and selective breeding has been essential in bringing us where we now are", says Ms. **Tran Thi Kim Chi**, Head of Aquaculture Environment and Disease Unit of RCCA.

Traditional fish farming has evolved to new recirculation aquaculture systems (RAS), and computerized data acquisition devices help to control the breeding conditions. RAS technology is considered more environmentally friendly than traditional methods, but it is not a fast lane to success.

"Rainbow trout is a new cold-water fish in Vietnam, so there is still a lot of research to be done in order to develop its sustainable production."

A noble fish

The fish swimming in the Vietnamese tanks are of Finnish origin. Rainbow trout stream called JALO (noble in Finnish) has been selectively bred in Finland for over twenty years and has proven to be an excellent grower.



"According to our research, JALO is currently growing 50% faster and with 15% less feed than the base population", Tran says.

Selective breeding of farmed fish improves the profitability of the aquaculture business and the quality of the fish. The faster the fish grow and the stronger is their resistance to diseases, the better income they will bring to the farmer.

"Aquaculture could be seen as a process which consists of several modules: high-quality egg production, breeding, and the knowhow and technology of the actual aquaculture system", says Senior Scientist and expert in rainbow trout breeding Mr. **Harri Vehviläinen** from Luke.

"You can't be successful and support sustainability if there is lack of expertise in any of the modules."

Jobs and wellbeing

Ten years of cooperation has not only brought impressive results in terms of research and development but also laid a base for an entirely new industry sector in Vietnam.

"It has been estimated that cold-water fish farming now employs 10,000–15,000 people in Vietnam directly or indirectly, and the number is growing", says Vehviläinen.

New way of living has been particularly important for ethnic minorities who live in the mountains of northern Vietnam.

"Inland aquaculture has had a great impact on creating jobs for Mongs and Daos and helped them to increase their income", Tran says.

"Rainbow trout is a luxury product in Vietnam, and a farmer can get up to 20 euro per kilo of fish when sold directly to a restaurant."

Self-sufficiency in 2030

The fish farms produce approximately two million kilos of rainbow trout annually. It may sound like a lot, but the amount satisfies only half of the rapidly growing demand in a country of 95 million people.

"Ministry of Agriculture and Rural Development has set a goal increase the amount of farms and their productivity remarkably in the coming years to meet domestic need of cold-water fish entirely by 2030", Tran says.

"By then we should also be self-sufficient in egg and feed production – and hopefully we will have enough cold-water fish products for export, too."

To reach the ambitious goals, RCCA will soon develop long- and short-term development strategies in collaboration with international partners, such as Luke.

"Step by step, we will improve the farming techniques, breeding, environmental monitoring and disease control, and train the in order to develop the entire aquaculture industry sustainably."

"We have come a long way since early-2000's but there is still a lot to do and learn. But it will definitely be an interesting journey." ■

Cold water fish farming in Vietnam

- Finnish-Vietnamese cooperation started in early 2000s with feasibility study followed by capacity building in aquaculture technologies and building of RIA-1 pilot farm.
- In 2005, the first fish eggs were transported from Finland to Vietnam.
- The first pioneering private farms started operation almost hand-in-hand with development of pilot farm. In 2009 there were 12 farms in operation, and today over a hundred farms producing cold water fish.
- Rainbow trout, sturgeon and white fish are the dominant species. Almost two million kilos of rainbow trout is produced annually.
- In a survey, over 90% of respondents agree to the fact that fish farming has brought wealth to the region.
- Furthermore, fish farming has promoted the development of other services in the region, such as tourism and education.
- Cold water fish farming has a high priority in the national strategy. The country aims at self-sufficiency in production by 2030.



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Mushrooming ahead: Plant-based proteins give the economy a boost

text: KRISTIINA MARKKANEN photos: ERKKI OKSANEN

New proteins equal new products and new jobs. Luke's six-year ScenoProt research project aims to increase Finland's protein self-sufficiency and food security.





There's a growing market and a lot of global demand for sustainable proteins.

Finland is on its way towards becoming a future leader in alternative protein production. Our soil and weather conditions are optimal for edible mushrooms, beans and quinoa, and some of our innovators have recently come up with the groundbreaking "pulled oats" and several fava bean products that are both tasty and popular.

Alternative and less used proteins contain several important nutritional elements such as fibers, vitamins and folates, which a lot of people lack in their diets.

The cultivation and production of these proteins is environmentally sustainable and could even play a prominent part in hindering climate change. On top of these benefits, there's a growing market and a lot of global demand for sustainable proteins.

When it comes to making money out of plant-based and alternative protein products globally, we're not talking about thousands or even millions of euros. Plant-based proteins could create a market worth of roughly ten billion euros in 2018.

The market for edible mushrooms, one of the most potential proteins that Finland carries in abundance in its forests, is even larger: it's been estimated to be up to 22 billion euros. Products made out of plant-based proteins could create jobs and new export products for Finland in the footsteps of pulled oats.

Towards secure self-sufficiency

Luke taps into these opportunities with ScenoProt, a six-year research project running from 2015 to 2021. It aims to help replace traditional animal proteins with sustainable protein sources, such as

insects, edible mushrooms, quinoa, buckwheat or hemp, to mention a few.

The project is coordinated by Luke and its main goals are to increase food security and Finland's self-sufficiency in protein production.

Currently, our degree of self-sufficiency is around 26 percent and could be hitched up. Finland, like many other countries, relies on Brazil and its soy cultivation.

"There should be more options in Finnish cultivation in order to maintain and increase diversity of our fields. This would also help us be less dependent on soy and fertilizers", says **Anne Pihlanto**, Principal Scientist in the ScenoProt research project.

- < Global market for edible mushrooms is estimated to be 22 billion euros.
- > Alternative protein sources like quinoa are in growing demand.
- V Various plant-based protein products have already found their way to grocery stores.



"Less used Finnish proteins such as hemp and quinoa could be later utilised in further processing. And consumers are interested in them as well."

Increasing variety in consumer products

As a part of ScenoProt, consumer and market research agency Makery looks into how consumers react to new protein sources and foodstuffs and their market potential both in Finland and abroad. Right now, Finland has a lot of potential protein sources, the most promising ones being edible mushrooms.

Insects could be used as proteins as well but Pihlanto sees that there are a lot of challenges still to accept them as nutrition from both consumers and legislators. Also, we need more consumer products to get on top of the competition.

"It's not just about how much protein sources Finland produces locally, but also about consumer products. There are already many new products out there, but we still need to offer a wider selection. Variety could help us fill the gap", Pihlanto says.

This gap refers to Finland's position a few steps behind European protein

pioneers, such as the Netherlands and Germany. German researchers are rooting for lupines whereas the Dutch create products out of whey proteins.

In order to rise to their level, Finland doesn't have to invent something completely new. Pihlanto recalls an article she saw recently that dates back to the early 1900's. It claimed that quinoa grows well in Finland but has a bad taste. The article illustrates the fact that these alternative protein sources are not brand new, just not much used.

A hundred years later, quinoa is widely popular and we've learned to fix the taste, which probably wasn't too bad to begin with, by removing saponins. Saponins are soapy compounds found in beans, and toxic if digested in large portions.

Improving both business and health

Finland has the conditions to produce sustainable, high-quality proteins and the ability to create popular consumer products out of them. Now all we need is a little push.

"Our own protein production shouldn't be the default value, but how our proteins can be further processed. Or how we can



further process proteins produced by others", Pihlanto says.

Finland could produce different sorts of fish feed that could be used for example in Norway, a leading country of aquaculture. Endeavours like that require funding, networks and new business models such as platform economy.

How it will all work out, Pihlanto can't predict yet. However, she believes the ScenoProt research will play an important role in the end result.

Business potential aside plant-based proteins could improve the society in other ways as well. ScenoProt highlights especially the health benefits of these proteins.

"Increasing vegetarian food and regimens has clear effects on the climate. It reduces the environmental strain of food production and its emissions as well as the carbon footprint. It also has a lot of important health benefits in preventing type two diabetes and cancer", Pihlanto concludes. ■



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Burgers for the eco-conscious

text: MIKKO SALMI

Hesburger is a leading fast-food chain in Finland in terms of size. But they want to lead the way also in sustainability.

With over 400 restaurants in nine countries, Hesburger is a truly international company. Burgers are a massively competitive field almost in any part of the world, with numerous global chains and also niche players fighting for a market share.

As the climate change is continuously in the headlines, more and more consumers have become conscious about the green values. And companies need to respond. Hesburger, too, wants to do their share in the fight against the climate change – and let their customers have a clean conscious when enjoying a hamburger.

“For a long time already, we have diminished our company’s footprint by, for example, using solar energy and geothermal heating, and getting rid of unnecessary packaging”, says Vice-CEO **Jari Vuoti** from Hesburger.

"The climate change is one of the biggest threats to our planet, and Hesburger wants to reduce the carbon footprint of its own operations."

One measure in the fight, a visible one for the company's customers, is compensating the carbon footprints of some popular Hesburger products with emission reductions from voluntary emissions trading markets.

"The carbon footprints are compensated with Gold Standard certified projects, which aim to bind and diminish greenhouse gases in Ethiopia and Uganda by planting trees and promoting more energy-efficient cooking appliances", Vuoti explains.

Evolving field of research

For credibility and scientifically uncompromised results, it was important for Hesburger that the needed assessments were made by an independent, trustworthy partner. Luke conducted the research on selected products' life-cycle and assessed the carbon footprints.

For many years already, Luke's expertise and services in product life-cycles has been in great demand. However, carbon footprints for food products are a bit more recent, albeit a rapidly growing research area, says Luke's Key Account Manager and Senior Scientist **Juha-Matti Katajajuuri**.

"The carbon footprint assessments of restaurants, fast-food products and even diets are an evolving, interesting field in our research and related services."

"Earlier, our Life Cycle Assessment research and services have focused mainly on single products, but in this assignment for Hesburger we defined the climate impacts of an entire product family."

The ability to pinpoint the exact factors that have an impact on the carbon footprint in the food value-chain helps companies to plan their sustainability

Minimising our carbon footprint is one of the things expected from us.

strategies. Furthermore, with a growing demand for sustainably produced food, concrete, research-based actions for sustainability are a great addition to the marketing toolbox.

"We listen to our customers all the time, and minimising our carbon footprint is one of the things that are expected from us. Giving them an opportunity to make better meal decisions is our way of telling that we care for our customers but also the planet we are living in", says Jari Vuoti.

Good food in all aspects

When it comes to negative climate impacts, food production and the entire value chain of our everyday meals are second to only habitation.

"To be good, food needs to be responsibly sourced, produced and consumed, and healthy. Luckily, there is a lot of positive development in every part of the food value-chain from production to the plate", says Juha-Matti Katajajuuri.



Photo: Hesburger

But there is still a lot to be done, too. For example the level of food waste is still too high.

"Together with companies and other organisations throughout the food value-chain, we are developing new solutions for improving production techniques, maximising the use of by-products, and minimising waste in order to reduce the nutrient and carbon footprint attributable to production."

The aim is to find the best possible ways to mitigate the environmental and climate impacts of food production, maintaining the competitiveness of farming as well as the entire restaurant and retail sector and the food chain.

"No one can do that alone. We need research, companies and the public sector to work together", Katajajuuri concludes. ■



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Is Europe's agriculture and forestry under jeopardy?

text: INA ALA-KURIKKA

Greenhouse gas emissions have to be cut all over Europe. At the same time, we need to feed the world's growing population. How will the demand for sustainability affect forestry and agriculture? Pasi Rikkonen, Principal Researcher at Luke, answers to eight claims on the subject.





1. Efficient ways to reduce emissions endanger agriculture as an industry.

"Reducing emissions it certainly is a difficult situation for the agriculture industry. We need to consider the relationship between societal aims and the industry's requirements", **Pasi Rikkonen** says.

The EU's climate and energy packages encourage member nations to cut greenhouse gases by 20% by 2020, 40% by 2030 and 80% by 2050. Agriculture and forestry are both linked closely to environmental issues. Agriculture emits plenty of greenhouse gases, and forest clearings contribute to carbon emissions and destroy natural habitats.

The most powerful way to reduce emissions is to stop clearing land for fields. This creates a problem to farms aspiring to expand. Milk production, for example, demands for new organic soil from time to time because dairy farms need more space to spread the manure. Clearing is cheap and easy, and if it can't be done, it will restrict the production.

"Preventing farms from expanding can stop agriculture's economic growth", Rikkonen says.

Luckily there are options for the ban. Firstly, new technologies help to process manure more efficiently. Secondly, farms can optimize the use of fields that have already been cleared. The third efficient way is to adopt more environmentally friendly organic field practices.

"Every time a field is cleared, it releases emissions. Perennial plants reduce the need for clearings and the plants absorb more carbon."

2. Agriculture and forestry inevitably cause a lot of emissions.

There is no denying that EU's climate and energy packages are challenging for agriculture and food production. Rikkonen emphasizes that emission cuts can't be made at the expense of overall food production.

Nordic farms traditionally own the forests that grow beside their fields. Yet, in

political sense, agriculture and forestry are treated as two separate industries.

Rikkonen has a wild idea. What if farms could compensate for their carbon emissions? Plants are so-called carbon sinks because they absorb carbon from the atmosphere.

"Farms could take their greenhouse gas emissions into account and then grow perennial plants or trees to the estate."

3. The EU climate strategies force farmers to plant forest to their fields.

"In Finland alone, there are 250,000 acres of organic fields. But I don't think there is need to forest the fields that are in active use. Fields that are cultivated at the moment can be made as environmentally friendly as possible", Rikkonen says.

However, some fields might soon grow trees. And it wouldn't be the first time.

"Historically, fields tend to move. Forests and organic soil are cleared in areas where agriculture is concentrated. Elsewhere fields can be forested."

4. Farms have to produce their own energy in the future.

Many targets that are listed in the climate and energy packages urge to increase the use of renewable energy.

Quite recently, farms have started to search for new ways to produce energy. Options available are biogas, woodchip-based production of electricity and heating or hybrid systems such as solar electricity or geothermal heating. Renewable biomass such as manure or crop waste are also potential alternative energy sources for farms.

“Self-supporting energy sources have a lot of potential, but they still need to improve a lot. If renewable energy systems become fully functional, farms could produce energy for the whole region.”

However, building an own energy system for a farm takes a lot of time and money.

“But after a suitable system is found, the energy costs decrease, because farmers don't have to buy electricity or heating any more. In the future, farms might even be able to benefit financially from the energy structures by selling the energy they produce.”

5. Due to the climate change Nordic farms will have to produce more food for exports.

There is a global need to increase food production. Climate change will eventually move farming towards north, because the area close to the equator will get too dry.

“This means that in the long run, Nordic countries will have to increase their food exports. And more agriculture means more carbon emissions”, says Rikkonen.

“This development is not relevant in the next ten years, but eventually it will add up to the carbon emissions from Nordic agriculture.”

6. Emissions from producing and transporting food should be viewed as an entity in climate strategies.

The greenhouse gas emissions of agriculture and transportation are reported separately. Strategies to achieve package goals



are different for both of these industries. Transportation, for example, tries to move towards low-carbon motor technology and bio fuels.

Actions towards sustainable transportation naturally reduce emissions in food logistics. Rikkonen believes that both industries might benefit from a bigger picture.

“If agriculture and transportation were viewed as an entity, the entire food industry could improve.”

7. Technological innovations alone will be enough to reduce emissions.

The EU encourages member nations to develop low-carbon technologies. Rikkonen mentions a few examples of new technological innovations, such as novel ways to process animal manure or dry crops. Technologies in manure processing allow farmers to separate and save phosphorus, nitrogen and biogas. There are also new ideas on how to use renewable energy in old technologies.

“Technology already has all the answers and could solve environmental problems as long as they are put into practice. The lack of innovations and technologies is not the problem. The problem is how to harness these new solutions into action”, Rikkonen says.

When a technology starts spreading, new producers come to market and the costs drop.

8. Investing in new technologies is expensive.

Solar panels were expensive ten or fifteen years ago. Since then, technological development has made solar energy reliable and relatively low-maintenance.

“When a technology starts spreading, new producers come to market and the costs drop”, Rikkonen believes.

“Different technologies cost different amounts of money. But decisions to invest are not made in a void; governments can influence them with incentive schemes. People have to consider what is cost-worthy now and in the future.” ■



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Finnish arctic flavours take on the world

text: KIRA KEINI

The arctic climate causes many challenges for food production, but Finland has been able to turn these difficulties into a competitive advantage. Could arcticity be the flagship of Finnish food export?

Two decades ago, Finland faced a rough patch as to cultivation. The production prices and thus the profitability of crop cultivation collapsed when Finland joined the European Union in 1994. There was a desperate need for alternative perennial plants that Finland could export and profit from.

Little did anyone suspect that the solution to the problem could be caraway, a spice plant successful in Central Europe and North America. Nevertheless, it proved to do extremely well in arctic conditions. Actually, the history of caraway in Finland goes way back.

“Caraway has existed as a natural crop in Finland for hundreds, maybe even thousands of years. The Finnish perennial breed needs cold winters in order to flower the following year.

Caraway has really adapted to our climate”, says Senior Scientist **Marjo Keskitalo**, Luke.

Working together with Finnish caraway export companies since many years, Luke is the leading Finnish institute in the research of the crop. In this spice plant, Finland has found the market niche it hoped for: almost one third of all caraway consumed in the world is of Finnish origin.

Long winters can be a savior for crops

The success stories of Finnish arctic delicacies don’t stop there. The health benefits of oat, for example, have become so widely known around the world that Finnish oat mills struggle to keep up with the demand. In addition, Finnish forests are abundant with nutrient-rich forest berries, most of which end up for export.

But how do caraway, oat and forest berries survive in the arctic conditions? Most of Finland is north of the 60th parallel which makes it an arctic country. This implies long dark winters and short, chilly summers, which one might think aren’t the easiest starting points for cultivation.

In fact, within the same parallel you can actually run into permafrost. Luckily, Finland is blessed with the Gulf Stream that makes the climate more temperate.

Luke’s Researcher **Jaana Kotro** is working for a project that studies arcticity as the leading edge of food production. The project aims to improve the competitive edge and export of Finnish food. Kotro points out that arctic conditions actually give cultivation many advantages. Long snowy winters can save crops.

“The cold cleanses the production environment by killing pests. Snow protects the crops from frost in the winter and from strong radiation from the sun in the spring. This is crucial for the crops to survive in the harsh conditions.”

The growing season of the arctic area is short but full of light. Both natural and cultivated plants grow the faster the more there’s light. And there’s plenty of daylight: during the summer solstice up to 19 hours a day in Helsinki and the whole day up north in Rovaniemi.

Clean food comes from clean natural resources

Finland is known for its thousands of lakes, and the water resources are excellent both in quality and quantity. According to the Water Poverty Index created

by the World Water Council and UK's Center for Ecology and Hydrology, Finland is the world's richest country when it comes to water.

"We have unlimited clean water reserves, which is critical for product safety and quality. In Finland, we can assure that the water we use in the food production process is pure", Jaana Kotro says.

Water is not the only pure thing the Finnish nature has to offer. The cleanest air in Europe is measured in Finland, and chemical or nutrient accruals in soil are minimal, thanks to short cultivation seasons and the cold temperatures that eliminate pests.

According to Luke's Research Professor **Sirpa Kurppa**, sustainability is a driving force in the Finnish arctic food production.

"The amount of green infrastructure in Finland is 85 percent, which means that almost the entire surface area is in its natural state. We have to be able to secure food supply for future generations and preserve the specificity the arctic gives to Finnish food. We cultivate during only one third or fourth of the year, use very few chemicals and respect the principles of the circular economy."

Research is the key

The success of arctic food production comes down to the processes. Know-how and research are the key.

"The Finnish integrity applies also for food production. The traceability of the production chain is extremely good because of systematic documentation in every phase. That's how product safety and reliability are achieved, which in turn adds value to the products", Jaana Kotro says.

Traceability is also one of the things that make Finnish caraway production unique in the world. The export companies keep the batches from different cultivators apart so that quality features can be registered and samples taken from each batch separately.

Kotro thinks this know-how should be exported around the world.

"The knowledge we have regarding cultivation, animal husbandry and food production is unparalleled. A good example is the fact that salmonella is practically nonexistent in our food production. We have carefully planned operational models that everyone involved is committed to follow."

Arcticity gives Finnish food a significant competitive advantage that needs to be communicated to the world better and louder than before. Caraway, among others, could be one of the flagships of Finnish arctic food. ■



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Chairman of the Arctic Council

Starting from May 1, 2017, Finland is the chairman of the Arctic Council for the next two years.

The key themes of the two year period include mitigating and adapting to the climate change and promoting sustainability.

Furthermore, the goal is to strengthen the cooperation and maintain the stability in the Arctic area.

The chairmanship is coordinated by the Ministry of Foreign Affairs together with other ministries and stakeholders.

The members of the Council include Finland, Sweden, Norway, Denmark, Iceland, Russia, Canada, and the United States.

Oat is the king of arctic cereals

Oat does extremely well in Nordic climate and succeeds even in Finland's northernmost cereal fields. As healthy eating habits have become more and more popular, the demand for oat products is higher than ever.

If there's one cereal that is trending around the world right now, it is oat. Innovative oat products are taking over the market: oat milk, pulled oats and gluten-free pure oats are just a few examples of the new delicacies in the field.

Considering the rise of veganism and healthy eating, it is not surprising. Oat is rich with dietary fibre and vitamin E. It is also known to lower blood cholesterol and diminish the risk of cardiovascular diseases, obesity, diabetes and colon cancer.

Luke's Senior Scientist **Elina Kiviharju** finds the productisation of oat a positive development.

"We should promote the health benefits of oat even more. There is room for expanding and differentiating the range of oat products in the market."

The demand for Finnish oat around the world is indeed high. Oat mills have had to expand in order to respond to world's craving of the cereal. Finland is one of the biggest oat exporters in the world.

Surprisingly, in Finland the majority of oat ends up as animal feed.

"Here only about ten per cent of oat is used in food products. There's a lot of potential in this field and we should turn it into reality", Kiviharju says.

Finnish oat research is one-of-a-kind

Oat prospers in the arctic conditions. The Finnish refined oat cultivars get through the short growing season and absorb the light of summer's interminable days. Finnish oat is known as pure, blond and healthy. As is the case with many other crops, the winter helps to keep the plant diseases in control, which decreases the need for pesticides.

"Oat might be a small cereal in other parts of the world but here it has a major role. It has adapted to our growing conditions and survives well even in the northeast cultivation areas of Finland", Elina Kiviharju explains.

The Finnish know-how in the study of oat is extensive. Research has been done in, for example, the genetics, cultivation and disease resistance of the crop.

"We have more research tools than ever, and genomic understanding has taken huge leaps forward in the last few years. Now, if ever, is the time to invest in researching oat." ■



Curiosity and collaboration drive biodiversity researcher

text: KRISTIINA MARKKANEN photo: ERKKI OKSANEN

After twenty years of researching ecosystems Luke's biodiversity expert keeps on digging into the overall processes that make or break our environment. Raisa Mäkipää wears many hats in her line of work and enjoys doing it.

In the past... I've always been fascinated about how ecosystems work, and the multiple services they provide. I've been studying these subjects for more than 20 years. There never was a singular thing that pushed me towards researching biodiversity and ecosystem processes. My research career has been more like a chain of small steps, small revelations, that has taken my work forward.

To me, a career as a researcher isn't about big moments or great successes. It's more about building on top of the work and methods of other researchers and being content with what I can bring to the table. I'm very happy if I can come up with a piece that can help others finish a bigger puzzle. If someone else feels they can reach the stars partly thanks to my work... wow, that would be great!

At the moment... I'm studying the functions of fungi that inhabit decomposing trees. Because there are less and less decomposing trees in Finnish forests, forest biodiversity has decreased. This affects all the species that depend on decomposed trees for nutrition or habitat.

Although people are aware of all this, there's still not much research on the ongoing processes in these decomposed trees: How the loss of species influences decomposition? What factors affect how fast wood decomposes? Where does the nitrogen that is essential to the process come from? I'm interested in the overall ecosystem processes and how biodiversity and environmental factors affect them.

In addition to biodiversity issues, I'm studying the effects of climate change and how to mitigate it. Actually I have quite a lot going on. My research touches for example on how tree species and afforestation affect carbon sinks. I have different roles in different research projects: in some I work as a manager, in others as a researcher. If we went through every single project I'm involved in we'd be here for days!

In the future... the world has to learn how to utilise natural resources in an ecologically and economically sustainable way. Mitigating climate change is one of the most important issues right now and in the future. The way we do things now

will not take us very far. Climate change is such a big problem that no amount of work and research will suffice to solve it. There will always be room for new solutions and ideas.

My goal is to work on solutions that improve the sustainable use of natural resources in the field of agriculture and forestry. For example, I want to find out what we can do in forests and fields to reduce carbon emissions, and how we can maintain biodiversity in them.

Two things have driven me thus far and will continue to do so in the future: curiosity and cooperating with fellow researchers. Working and succeeding together is very rewarding. I'm looking forward to interacting with other researchers on new research topics and widening my networks in the future. ■



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A food scientist's dive into the blue bioeconomy

text: KRISTIINA MARKKANEN photo: EETU AHANEN

Pirjo Mattila is one of the world's most cited food scientists. Due to the opportunities it presents for collaboration and learning something new, she is enticed by the blue bioeconomy.



You are a food scientist, but since 2016 you have been deeply involved in research within blue bioeconomy. How did you end up changing your research topic?

"Fish and sea creatures have always interested me. The blue bioeconomy is a fascinating and inspiring new thing for me. I get to learn plenty of new in my work. In my research career, I have mainly studied the compounds and flavonoids of berries and vegetables. I have studied vitamin D in fish, but fish is an animal, and very different as a matrix compared to berries. I am interested in everything that we have not yet discovered about fish. Making use of fish that we often consider low-value, such as the Baltic herring, is particularly interesting to me."

What kind of research have you done on the blue bioeconomy?

"I have been working as a principal scientist since 2016 in a research module that seeks value-added products from the aquatic biomasses. We conducted a report on the markets of value-added products based on the blue bioeconomy and the fo-

cal points of research. In the future, I will be working on low-value fish, particularly the Baltic herring and cyprinids, as well as their side streams in an innovation programme funded by the European Maritime and Fisheries Fund."

"The goal of the programme is to get the Baltic herring into the kind of form that is more appealing to people. At the moment, it is not very popular due to its smell, for example. Baltic herring produces a lot of waste that could be put for better use. Currently, it ends up in the trash or as feed, but if useful substances such as proteins and minerals were extracted from it, it could be refined into products. For example, protein powder or a food supplement made from the fish oil could be produced."

What kind of added value does your background as a food scientist bring to research within the blue bioeconomy?

"The most added value is gained by combining traditional fish know-how, technological know-how and the chemical know-how related to food science. Then, one plus one equals more than two. In blue

bioeconomy research, this combination in particular has worked well, because I have been able to combine my own expertise with that of other experts. All the know-how of Luke is combined in this research."

What kind of collaboration has been done in your research module? Who should be collaborating?

"Collaboration has been the guiding star of our research. The experts on the primary production of fish, hydroponics and the fishing industry have put their wise heads together in the research. We have also got food experts and biologists on board, so we are diverse team. Furthermore, we are building a network outside of Luke, and currently we do research collaboration with VTT Technical Research Centre of Finland and the University of Turku. In addition to our Finnish network, we would like to expand our collaborative efforts abroad and into the business world." ■



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Luke hosted the FAO GFRA 2020 Expert Consultation

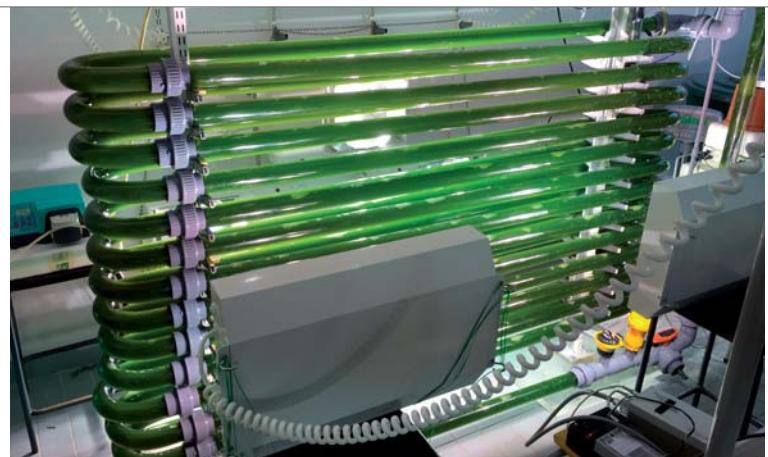
Over 70 experts from over 25 countries, International organizations, processes, academia and non-governmental organizations met at the FAO Global Forest Resource Assessment 2020 Expert Consultation (GFRA EC 2020) on 11–16 June, 2017 in Joensuu, Finland.

“The main goal of this Expert Consultation was to set-up the scope for the next global assessment reporting process in 2020 and to agree on standard definitions to ensure increased consistency of reporting across countries, organizations and processes”, said Principal Researcher and leader of the Finnish National Forest Inventory, Dr. **Kari T. Korhonen**, Luke.

The FAO Global Forest Resources Assessments are published every five years presenting the current status and recent trends for about 40 variables, covering the extent, condition, uses and values of forests and other wooded land, with the aim of assessing all benefits from forest resources.

The GFRA Expert Consultation was financed by the European Commission, FAO, the Finnish Ministry for Foreign Affairs and the Finnish Ministry of Agriculture and Forestry. Luke was responsible for the coordination of the Expert Consultation.

“The first GFRA Expert Consultation was held 30 years ago in Kotka and it was a great honour to welcome FAO to Finland again in 2017, this time to Joensuu”, says Research Scientist and the GFRA EC 2020 Liaison Officer **Markus Lier** from Luke.



Unlocking the added value of algae

NordAqua (Towards Versatility of Aquatic Production Platforms: Unlocking the Value of Nordic Bioresources), a Nordic project coordinated by the Molecular Plant Biology Unit of the University of Turku, is seeking new commercial applications from micro and macro algae. In particular, algae have interesting potential for bioenergy, the chemical industry, food production and pharmaceuticals development.

NordAqua aims to find commercial applications for algae by isolating valuable components from biomass, for example. Another aim is to increase entrepreneurship related to the blue bioeconomy by providing scientists with training and encouragement in entrepreneurship.

Luke contributes to the project with its expertise in greenhouse and biochemical know-how, and their linkage to algae research. Key areas of Luke's expertise include the identification, isolation and purification of bioactive compounds.

“A greenhouse is an extremely favourable environment for year-round algae research and the development of new business, because the full range of key growth factors such as light, temperature and nutrients can be found there”, says **Kari Jokinen**, Principal Research Scientist, Luke.

www.luke.fi/en/projects/nordaqua/



Drones in the air

Luke, National Land Survey of Finland, University of Jyväskylä and VTT Technical Research Centre of Finland have started a joint project to develop better equipment, applications and data processing for remote sensing. The DroneKnowledge project aims to lay ground for rapid development of business involving drones.

A revolutionary technology for precise and efficient production of spatial data, drones are used for, for example, targeted fertilisation or identification of vermin in agriculture, water quality measurements, forest inventory measurements and built environment measurements. An example of new equipment being developed is a more affordable spectral camera, which can be used within water quality control, identification of tree species and precision agriculture.

“With a spectral camera, we can, for instance, optimise fertilisation or evaluate the best time for harvesting grass”, states Researcher **Jere Kaivosoja** from Luke.

Barley genome cracked – a scientific breakthrough

A ten-nation consortium, including Luke has made a breakthrough in sequencing the complex barley genome, two times larger than the human one. In a ten year research project, the genome was sequenced and assembled using an array of state-of-the-art methods.

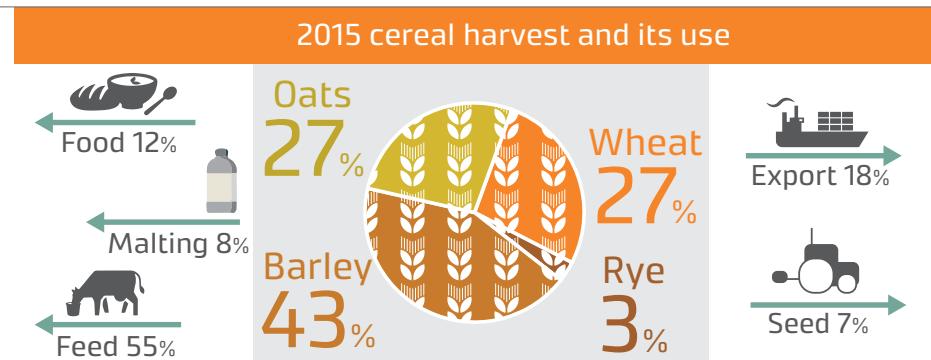
"For the first time, scientists can now locate all genes precisely in the genome and analyze complex gene families that play a key role in malting and resilience. The barley genome sequence also highlighted regions vulnerable to genetic erosion and will help breeders recover genetic diversity in their crop improvement efforts", explains Research Professor **Alan Schulman**, Luke.

"The science community is now a step closer in meeting the challenge and being able to develop barley that can maintain high yields in a changing environment to safeguard our food security", Schulman concludes.

A chromosome conformation capture ordered sequence of the barley genome, is reported in Nature, volume 544, number 7651.



Photo: Veikko Somerpuro



Infographics: Jouni Hyvärinen

Finland's food and natural resources statistics in one volume

The statistical e-yearbook of Luke is available online. The yearbook contains the key statistics of Finland's food and natural resources in one volume, covering food and agriculture, the forestry sector, and fish and game.

The publication also includes information on prices, profitability and foreign trade. The longest time series date back to the 1920s.

The e-yearbook is linked to the up-to-date statistics database, which allows users to create their own tables and graphics and save searches. The e-yearbook is available free of charge.

stat.luke.fi/en/



Photo: Eeriki Oksanen

A new service puts biomass to the map

Biomassa-atlas (Biomass Atlas) is a new open source service which collects the location data of biomasses under one, single user interface.

Developed by Luke, the service enables calculations of the amount of biomass in a given geographical area, as well as examining the opportunities and restrictions to utilise the biomass.

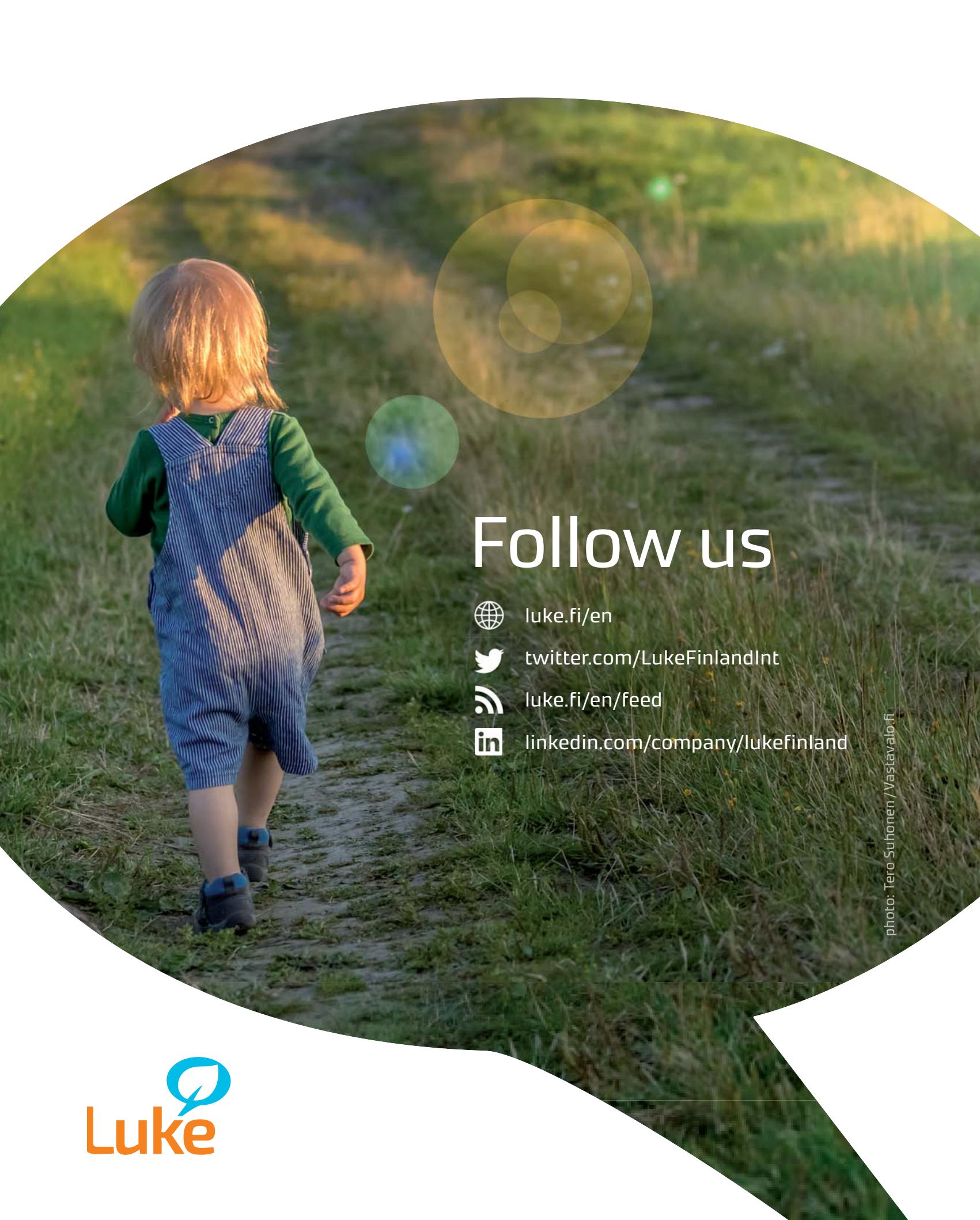
The biomass data is planned to support investment decisions and sustainable use of natural resources, for example, and even to help decision-makers to do sustainable energy politics. International version of Biomass Atlas will be built in Baltic Forbio project, which starts at autumn 2017 and exports the Biomass Atlas concept to Baltic sea countries.

www.biomassa-atlas.fi

Upcoming events

- 20.9. Nordic-Baltic Water Business Cooperation, Turku
- 25.9. International Scientific Conference of Hardwood Processing, Lahti
- 28.11. Conference on Non-Timber Forest Products and Bioeconomy, Rovaniemi
- 14.-15.12. Bioeconomy Investment Summit, Helsinki

More information: Luke.fi/en



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photo: Tero Suhonen / Vastavalo.fi