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Natural Resources Institute Finland's Stakeholder Magazine

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Leia is Natural Resources Institute  
Finland's (Luke)  
stakeholder magazine,  
issued twice a year.  
Leia online: [www.luke.fi/leia](http://www.luke.fi/leia)

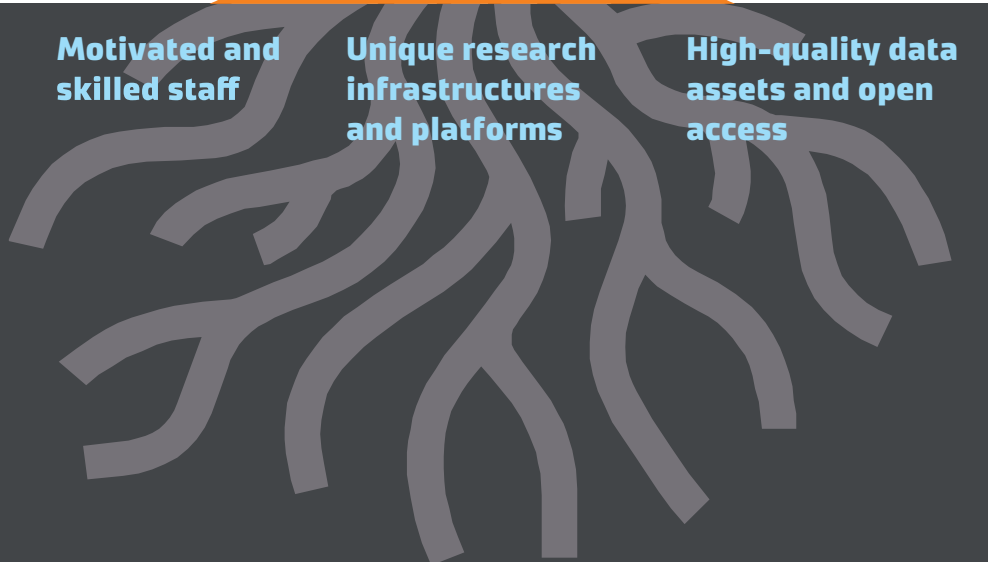
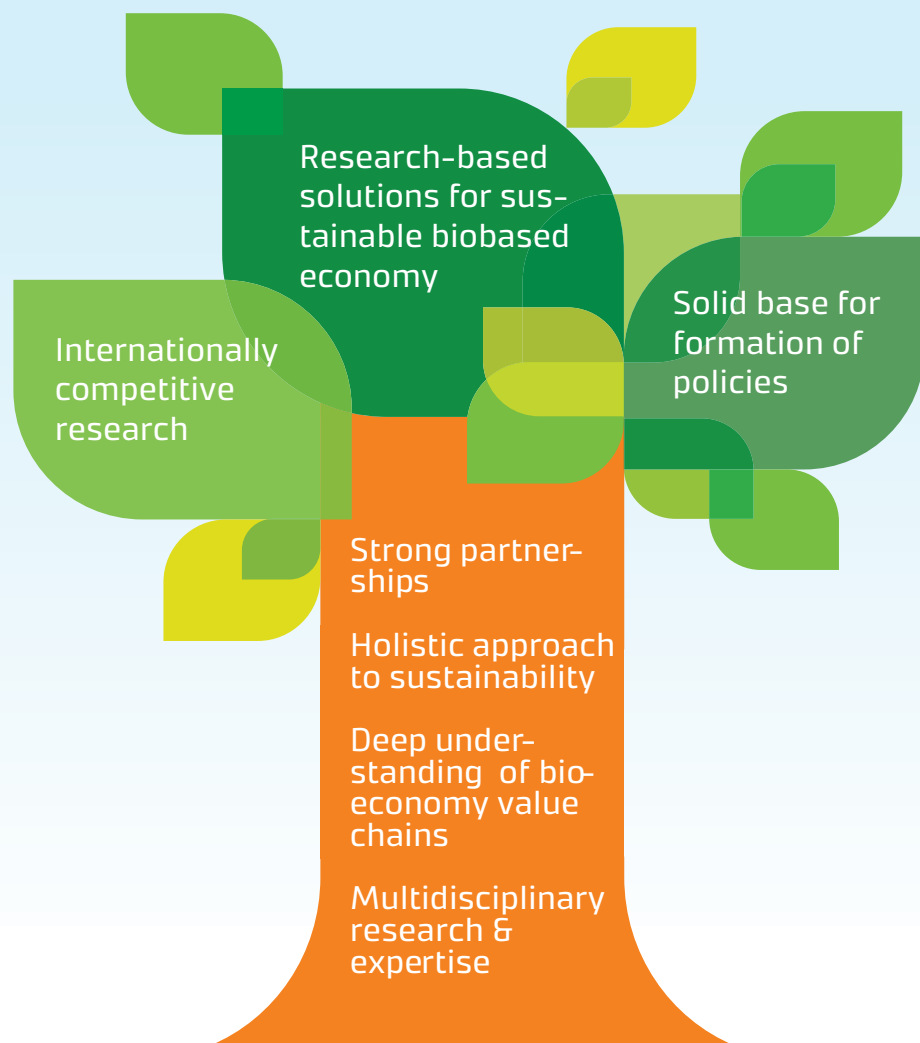
**Publisher:** Luke, tel. +358 29 532 6000  
[firstname.lastname@luke.fi](mailto:firstname.lastname@luke.fi)  
[www.luke.fi](http://www.luke.fi)

**Editor-in-Chief:** Mikko Salmi, Luke  
**Photo editor:** Ulla Ramstadius, Luke  
**Cover photo:** Shutterstock  
**Layout design:** MAK Media Oy  
**Printing:** KopioNiini  
**Paper:** Galerie Art Volume

4. volume  
ISSN 2343-0400 (print)  
ISSN 2343-0419 (online)

*Leia has been printed with plant-based  
ink on FSC-certified paper.*

Luke is a research and expert organisation that works to advance bioeconomy and sustainable use of renewable natural resources in order to promote well-being and sustainable growth.



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# It's all in the genes

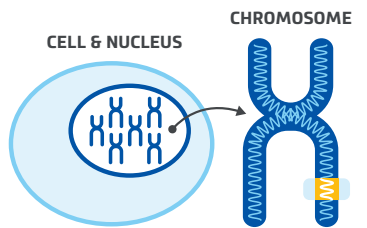
text: ANNE SALOMÄKI

Genome editing can help us find solutions to the global food crisis and prepare for the impacts of climate change. However, a recent EU court ruling might lead to innovative crop development slipping through the fingers of European producers.



Photo: Pixabay

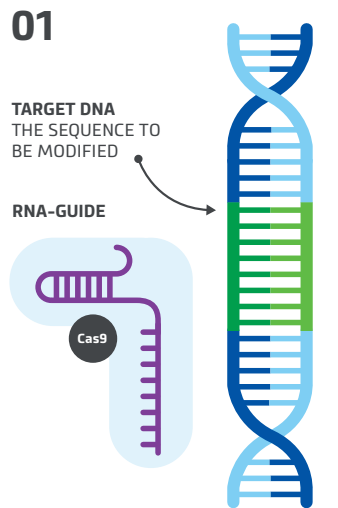
## Genome editing (CRISPR/Cas9)



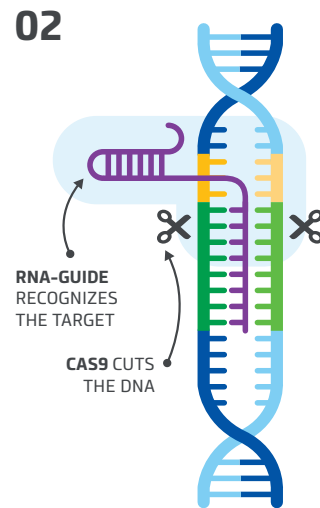
**GENOME EDITING**  
A small piece of the genome is modified at a pre-determined position. A similar change would be possible in nature.



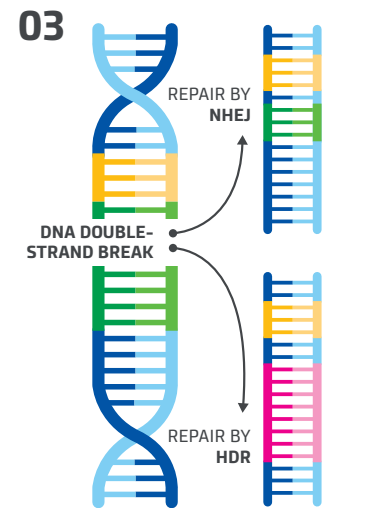
In **GENETIC MODIFICATION** (by gene transfer) the new gene (from a different species) gets usually inserted in a random position, which can affect the function of the gene itself or its neighbors.



Target DNA will be edited at a specific position determined by the guide-RNA. No foreign DNA is added to the target.



The RNA-guide brings the Cas9 to the matching position. Cas9 endonuclease enzyme cuts the DNA.



The break is repaired by either non-homologous end joining (NHEJ) or homology directed repair (HDR).

**A**n answer to the problems of global food production or a violation the natural order of things? Depending on whom you ask, the opinion on genome editing can vary from a dream come true to a sci-fi nightmare.

Genome editing refers to adding, removing, or altering small segments of the genome of an organism. Unlike genetic modification (GM), the method doesn't introduce foreign DNA to the genome, but instead makes changes of the sort commonly found in nature.

**Alan Schulman**, Research Professor at Luke, sees genome editing as nothing less than a way to help head off an impending global food crisis due to climate change. Currently, climate change is both accelerating the spread of diseases and causing rapidly changing and fluctuating growing environments, for which breeders need plant traits not found among their

current elite varieties, in order to avoid the risk of crop failures.

Precision breeding by genome editing could be used to generate crops with, for example, better nutritional value or reduced allergenicity, or to tailor crops to specific environments.

“Genome editing enables us to modify a particular gene that responds to drought or a virus, and make the plant resistant to that stress,” Schulman explains. “This not only protects our harvest but also provides us with a biological solution, as it saves us from using toxic sprays.”

The difference between editing and GM, Schulman explains, can be illustrated by how one changes the colour of a flower. To introduce an entirely new colour to the species, GM could add the gene for an enzyme from another species. When the genome is edited, the colour is changed by altering a gene already in the genome in a way that would be possible in nature, too.

### From tomato softness to cattle infections

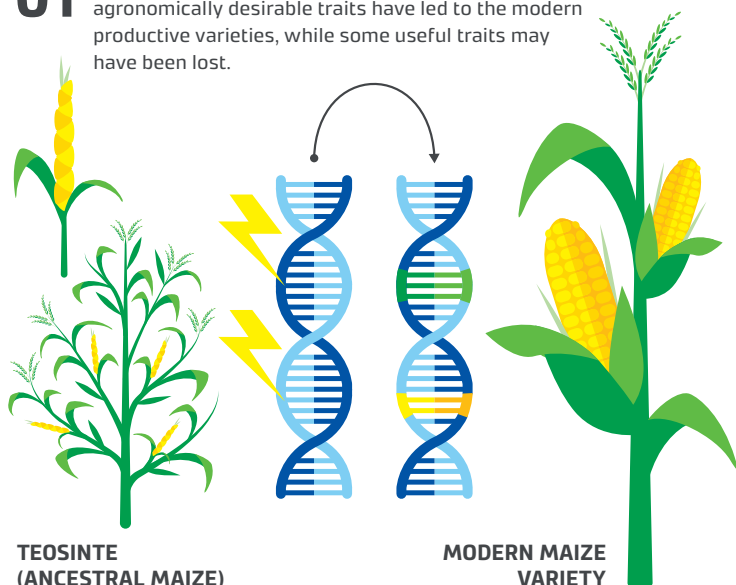
The technique applies to smaller issues than climate change as well. Schulman notes that if we know which part of the gene controls fruit softening, it can be modified easily and quickly to make the fruit last fresh for longer, helping tackle food waste.

Genome editing can also help improve both animal welfare and resilience. Luke's Research Professor **Johanna Vilkki** points out that knowledge revealed by gene editing in experimental cell lines on how certain gene variants make a cow resistant to infection could later be used in breeding decisions and would eventually lead to improved resistance in the population.

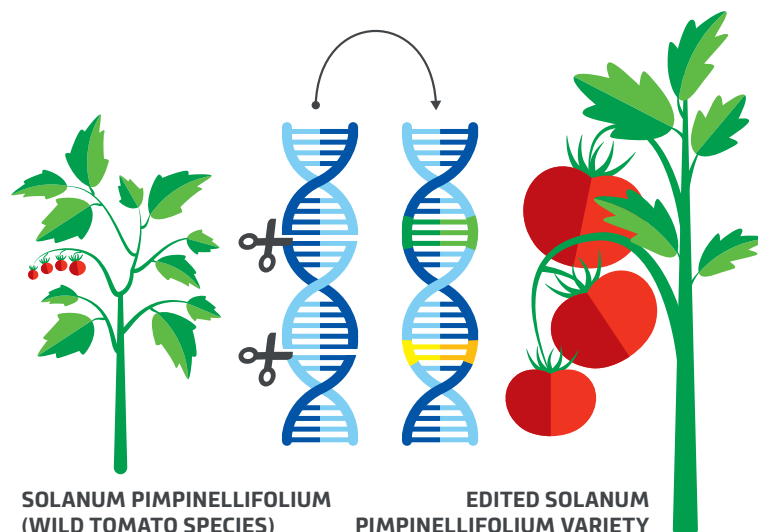
Both Vilkki and Schulman emphasise that the changes that occur through genome editing could just as well appear naturally; it would just take various generations and decades, particularly in the case of animals. Another problem is the

## Domestication by genome editing

**01** Natural mutations and selection in genes affecting agronomically desirable traits have led to the modern productive varieties, while some useful traits may have been lost.



**02** Known genes affecting main agronomical characteristics can be edited in wild relatives to produce a productive variety retaining old beneficial traits such as disease resistance.



uncontrollability of possible side effects, whereas genome editing is very precise, because it only affects the characteristic it's intended to.

Schulman thinks that the technique isn't fully understood by the public due to the way people tend to see DNA.

"When people say, 'it's in the DNA', they deem it fixed and unchangeable," he explains. "What they don't realise is that our DNAs change all the time, and that variations such as introduced by genome editing are common and natural."

### Dynamite instead of hooks and lures

What's hindering the development and implementation of genome editing in Europe is a recent European Court of Justice ruling. In July, the court decided that organisms obtained by modern forms of mutagenesis are not exempt from the Union's GM legislation. In practice, companies wanting to make use of genome

editing would have to go through the same risk assessment and authorisation processes as with GM.

Schulman and Vilkki believe, as do more than 75 European plant and life sciences research centres and institutes that have signed a position paper opposing the ruling, that comparing editing to modification is simply incorrect. GM gets a lot of bad press due to its perceived unpredictability, but both professors are adamant that as editing is both more precise and indistinguishable from the results of natural processes, it shouldn't fall under the same category.

Schulman compares the ruling to allowing fishing by dynamite but forbidding hooks and lures.

"With the older mutagenesis methods that aren't regulated by the EU, you mutate many genes at random to change one of them, which is like throwing an explosive in the water whilst trying to catch a particular fish," he describes. "Editing is

like fishing with a lure, using just the right bait for the kind of fish you're after."

The court's decision, as Schulman and Vilkki point out, makes it impossible for small companies to go through the costly processes. This gives only large corporations, like Monsanto, a monopoly in developing the method. The experts note that as the results of gene editing can't be tracked, the EU would need to de facto ban imports from countries allowing editing to ensure no such products enter the market.

Both Schulman and Vilkki hope to see the EU court revisit its decision and come up with a new regulatory framework – based on science. ■



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# Tree bark

– a treasure chest  
of useful materials

text: HEIKKI HAMUNEN

Tree bark is a versatile source of raw materials for the pharmaceuticals, cosmetics and food industries. Finland also produces bark suitable for organic products, as half the country's forests – close to 12 million hectares – are certified organic.







*Burning of timber and bark for bioenergy is the last alternative.*

**T**ree bark is an exceptionally versatile source of raw materials, its various layers providing different products.

“Bark contains anti-microbial and anti-oxidant compounds which could be used as preservatives, not to mention pharmaceutical compounds and ingredients which enhance the taste of food products”, states **Pekka Saranpää**, Principal Scientist at Luke.

In addition, bark provides raw materials for adhesives, insulating materials and even water purification, helping in removing impurities.

Despite this versatility bark has been largely neglected as a source of raw materials in comparison with cellulose fibres. Attention to bark’s usability has increased only since the start of the new millennium.

### Maximum wood utilisation

Behind the increasing interest in bark is the aim of resource efficient utilisation of forest biomass, in a greater variety of ways.

“The European Union wants to promote the cascading use of wood. Accordingly, the burning of timber and bark for bioenergy is the last alternative

when all other possible uses have been exhausted”, says Saranpää. Cascading use of wood is the smartest way to use a natural resource – directing it to high value use before it is reused, recycled and finally burnt for energy. Taking wood straight from the forest and burning it just doesn’t make sense if it can be used for other products first. In this way, the use of forest biomass is maximised, states Saranpää.

According to Saranpää, maximal use of bark products also complies with UN Sustainable Development Goals. Immediate action is demanded to combat climate change and implement sustainable production methods.

“By making use of bark the number of consumer products from renewable raw materials would increase. The tannin-polyphenols from conifer bark, for example, could replace the harmful phenolic compounds from fossil sources which are used in adhesives”, says Saranpää.

### Finnish organic bark

One of the advantages of Finnish bark for use in the food and cosmetics industries is that 12 million hectares of the country’s forested areas are already certified organic. These comprise one third of all the world’s certified organic forest areas including other wild collection and bee-keeping.

Finland’s largest certified organic forests lie in the north of the country. The forests there also have another advantage.

“North-grown trees have greater concentrations of stilbenes than those grown in the south. The more extreme the growing conditions, the more the trees contain these antioxidative compounds found in spruce bark”, says **Tuula Jyske**, Senior Scientist at Luke.

### Forest-flavoured ice-cream

Jyske’s job is to study how the useful compounds found in bark can be utilised by the food industry as additives and aromatics.

She co-ordinates the InnoTrea project, funded by the Academy of Finland, where scientists from various disciplines have studied, for example, whether the tannins extracted from tree bark prevent the oxidization of fats in reindeer meat. This could lead to improved preservation of meat products.

“We also tested whether the tannins might add some exotic flavour to the reindeer meat. Tannins are naturally found in wines for example, affecting their tastes too.”

Jyske’s team has also tested bark tannin extracts in co-operation with an ice-cream producer in northern Finland, the company hoping to find “a new forest-flavour” for its products.

“The results were promising. It seems that these extracts may be capable of

improving preservability of certain types of products, add aroma, and replace other preservatives, Jyske summarizes the first development test results.”

### Extractives disappear rapidly

Pekka Saranpää points out that extracts from wood and bark can replace almost any oil-based products. But the extraction of bark’s various ingredients and their refinement are a challenge.

“Up to 95 percentages of woody material is wood fibre, but in bark there is a tremendous range. Bark is full of all kinds of cell tissue, which makes its refinement challenging. When you start to break them down and derive extractives, reactions take place which are difficult to control.”

All the phases of the wood procurement chain, as well as environmental conditions, affect the rate at which the various bark extractives are lost. Debarking and chipping are the worst possible scenario in preserving valuable bark extractives-based biochemicals. If bark extractives are desired end-products, wood should not be debarked and chipped beforehand, instead these processes should take place just before feedstock utilization. This adds a new kind of challenge for the material supply chain.

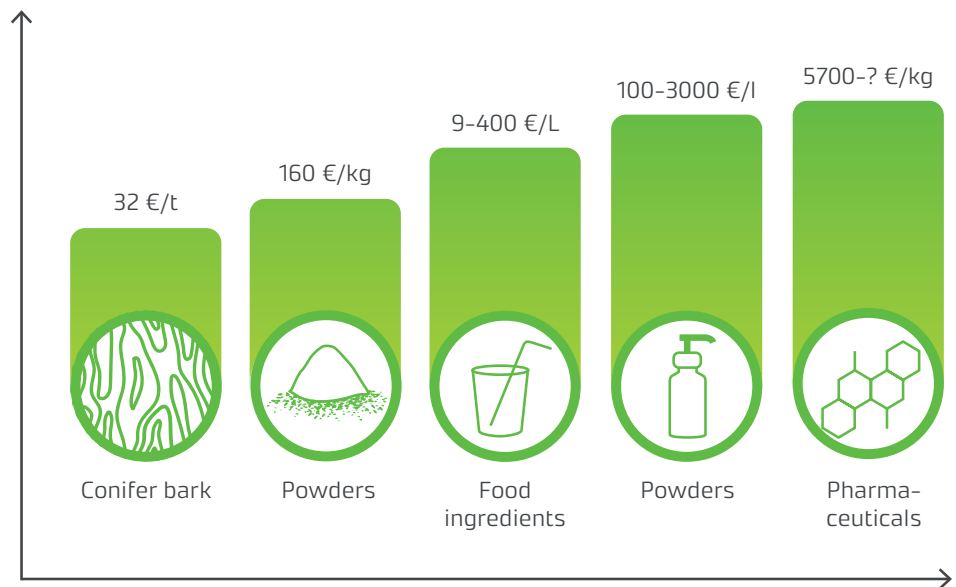
“The bigger the particle size of the stored bark, the better the valuable compounds are preserved in the material. For example, storing bark in piles, all the stilbenes disappear within four weeks”, says **Hanna Brännström**, Senior Scientist at Luke.

Brännström works on developing new delivery regimes for various types of forest biomass through Biohub – Forest Biobased business hubs – a co-operative project involving Luke and six other partners.

Despite the rapid degradation of some of the valuable components, winter conditions improve the preservation of others, as long as the bark remains on the trunk. Basically, fat-soluble compounds are preserved better than water-soluble ones.

“Raw materials are best stored frozen, or at least as cold as possible”, says Brännström. ■

## Development of added value



### PRICE DEVELOPMENT



▲ The value of tree bark multiplies when it's not burned but used as raw material for new products.

▼ Various stilbenes can be extracted from bark. The more extreme the growing conditions, the more antioxidative compounds the trees contain.

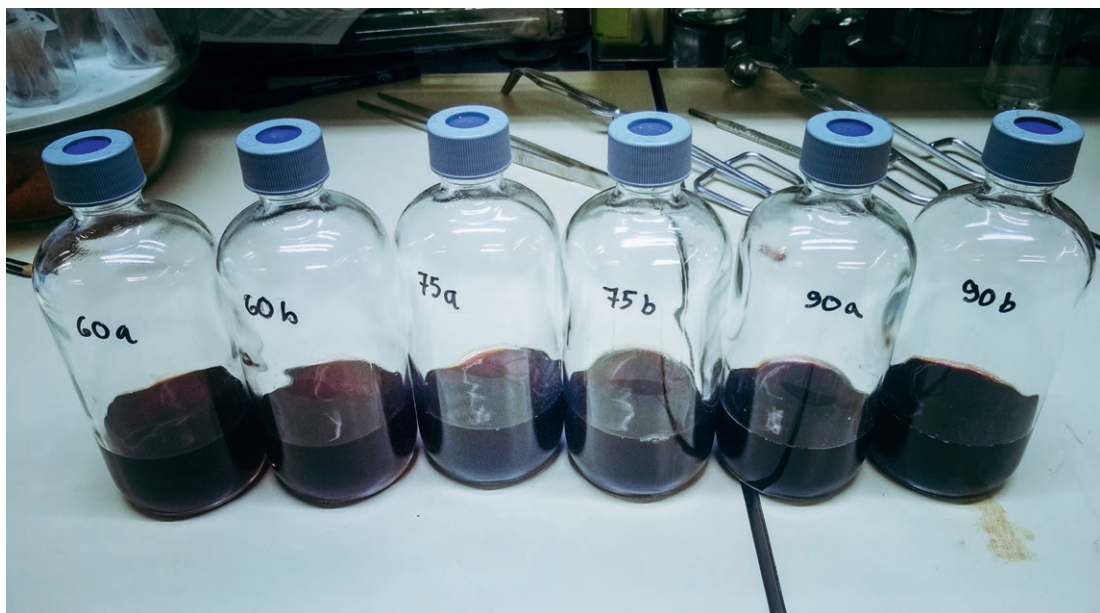


Photo: Risto Korpinen



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# Circular economy at its finest

text: KAISA I NIEMINEN photos: PASI LAAJALA

**Natural Resources Institute Finland (Luke) is studying best methods to cultivate the common duckweed in aquaculture facilities – and to use it as fish feed, closing the nutrient circle.**

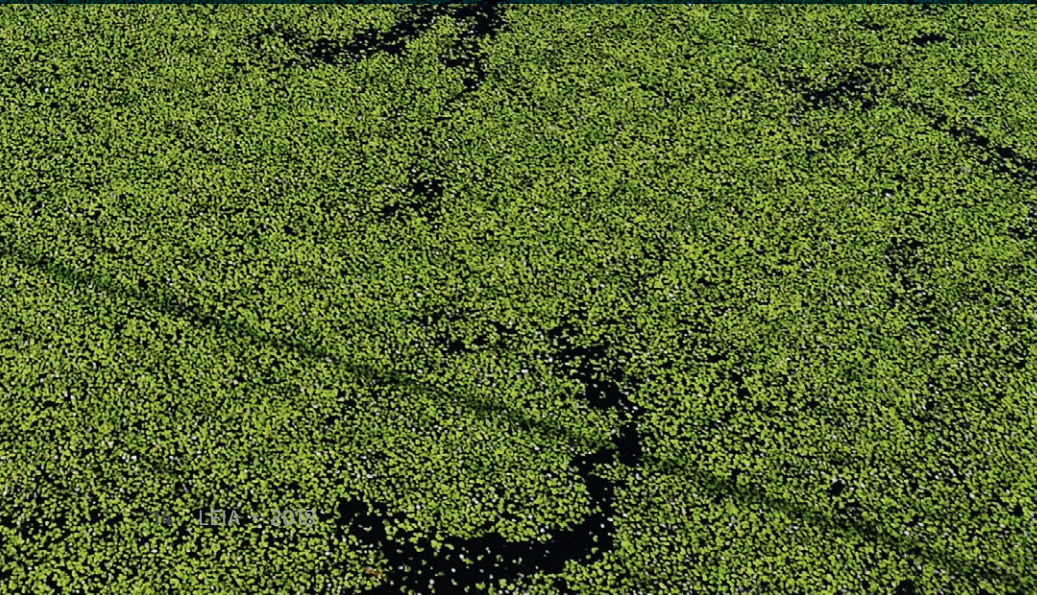


Photo: Shutterstock



### Common duckweed

- Free-floating aquatic freshwater plant
- Rapid grower
- Leaves are 1-8 mm long, root 1-2 cm
- Up to 45 % of dry weight is proteins
- Besides nutrition, can be used in waste water treatment or refined as fuel



▲ Pasi Laajala in the middle of his work.

◀ Lemna minor cultures in Taivalkoski are protected from birds.

**S**ustainable development of the growing aquaculture industry requires new means to decrease and compensate nutrient emissions. Common duckweed is a diverse plant which sequesters both nitrogen and phosphorus effectively. Thus, it may prove helpful in recycling nutrient in inland fish farming.

Common duckweed or *Lemna minor* is a small, floating plant which blooms in naturally eutrophic waters like ponds and ditches. Rich in protein, the plant is rather simple to grow and harvest, unlike algae. Thus, it is a perfect plant for cultivation in fish tanks or runoff waters of agriculture.

Traditionally, the Finnish aquaculture industry has been rather dependent on imported nutrients. Most of them come from animal feed; another alternative has been imported plant proteins, particularly soy and sunflower seeds. The country's self-sufficiency in fodder plants is only 25%, which means that a lot of imported nutrients end up in the environment and our nutrient balance.



▲ Collected lemna minor ready for freezer, waiting to be processed.

“When we recycle the nutrients in common duckweed as fish feed, imported nutrients can be replaced with domestic alternatives,” says **Pasi Laajala**, project manager of Luke’s Pikkuli project.

### Encouraging results

Pikkuli is joint project with a Finnish aquaculture company Kalankasvatus Vääräniemi. The aim is to study how the plant really manages in fish tanks. The start was promising, and the cultivation pools were soon full of light green culture. However, the nature gave its surprise earlier than expected.

“We estimated that birds could harm the culture only in the autumn, but a gold-eyeye family showed up for supper already in early-summer. We learned that some birds can land even in very small ponds to eat the plants. Now we have paid our dues and the cultures have been protected from airstrikes,” Laajala says.

### Lemna minor on a plate – or in the fuel tank?

Feed producer Raisioagro is an associate partner and a feed specialist in the project.

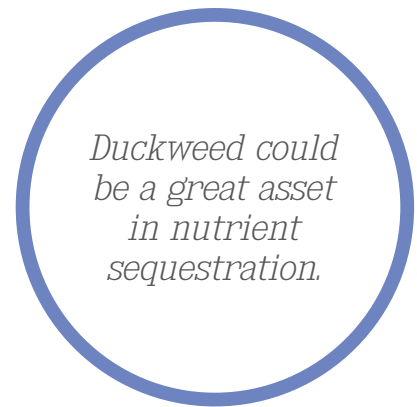
They are the only Finnish producer of fish feed, accounting for approximately half of the fish feed used in Finland.

“Our partnership with Raisioagro dates back many years. Together we have developed many new, sustainable feed products which are rich in nutrients,” Laajala explains.

But there could be even more to common duckweed than feed: in addition to protein, it contains good fat acids and carbohydrates, such as beta-glucan, which has positive effects to human health.

“The last use case would be to gasify the plant in a bioreactor or use is in the compost. Then the nutrients could circulate back to the fields, and the need for industrially made fertilisers would diminish,” Laajala points out.

“The side product, biogas, could then be used to heat up building or refined as fuel.” ■



EUROPEAN MARITIME AND FISHERIES FUND  
OPERATIONAL PROGRAMME  
FOR FINLAND  
2014-2020

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# Less harmful cow burps

text: ANTTI MIETTINEN photos: EETU AHANEN

Greenhouse gases in cow burps warm up the climate. To mitigate this effect, researchers at Luke study different feeding and breeding strategies to reduce the amount of methane emitted by cattle.







▲ Cutting the emissions of cattle could help slow down climate change substantially, says Ali Bayat.

*Cows are very valuable creatures. But we need to solve the methane problem.*

Year after year, Earth has hit new record high levels of heat-trapping greenhouse gases in the atmosphere. To avoid the most destructive effects of a warming climate, emissions of greenhouse gases need to be cut rapidly and in all sectors of our societies. Even cows play a role in this effort.

Ruminants like cows have an impact on climate because they burp a lot of methane, a potent greenhouse gas. As there are over a billion cattle in the world, cutting their emissions could help slow down climate change substantially.

Scientists at the Finnish Natural Resources Institute (Luke) are interested in what controls methane production in cattle.

“Cows are very valuable creatures. They provide high-quality food and necessary work power especially in poorer countries,” says Senior Scientist **Alireza Bayat** from Luke.

“But we need to solve the methane problem.”

#### **Nutritional interventions have potential**

Cows burp out around 95% of all the methane they emit. The rest come out from the other end of the animal.

The reason behind these emissions are microbes. They live in specialized compartments in ruminants’ stomachs and allow their host to digest feed very efficiently. The climatic downside of this collaboration is that the microbes do their

work in anaerobic conditions and produce methane as a byproduct.

Alireza Bayat and his colleagues study the effect of nutrition on these emissions.

“So far, nutritional interventions have been the most promising way to reduce emissions from ruminants. At Luke, we have tested strategies such as adding different fats and oils to the cows’ diets, and proven that they reduce methane emissions.”

Research is also ongoing on other kinds of feed additives that inhibit enzymes involved in methane production. Certain compounds have been found to reduce methane emissions from cattle by up to 60%, without adversely affecting the health and performance of the animals.

Bayat and his fellow researchers at Luke have also found that along with diet and microbes, individual properties of cows affect methane emissions.

“Our results do not let us make clear conclusions on a single most important factor in reducing the emissions,” Bayat describes.

“It’s a complex system that you can study from different angles. But we are a team – we complement each other.”

### Special chambers make the research possible

The research is conducted at a special facility in Jokioinen, Finland, where Luke has four metabolic chambers. They allow studying dairy cows’ energy metabolism and methane emissions with a ‘gold standard’ technique.

“The chambers have been used to generate invaluable data for scientific purposes,” Bayat says.

“By using them we can measure the cows’ energy expenditure and methane production under different experimental conditions.”

The metabolic chambers have been utilized for example to examine the effect of antibiotics on methane emissions, and test different dietary strategies on cows that emit low or high amounts of methane.

“Thanks to their transparent view and friendly conditions, the chambers do not affect feed intake and milk yield of the cows,” Bayat explains. “To my knowledge Denmark is the only other Nordic country with a similar facility.”

Luke also does international collaboration on the topic. Luke’s research and empirical evidence from the chambers have contributed to improving scientific models that predict methane emissions from cattle in different regions and under different nutritional conditions. ■



## Could breeding be used to cut emissions?

If methane production of cows has a genetic and heritable basis, breeding individuals that emit less methane than others could be used to mitigate emissions from cattle. However, this requires that lowering methane production does not negatively affect other important traits of the animal, such as milk production and health.

“Improving livestock genetically is cost-effective. If it works, it offers a potentially long-term and sustainable strategy to lower methane emissions from dairy cows,” explains Luke’s Senior Scientist **Enyew Negussie**.

Knowledge of the actual genetics behind methane production in cattle is only starting to build.

“Luke is one of the pioneers in this area of research. Since 2013, we have been collecting data and built a unique database of individual cows’ methane emissions and related traits. Realistic estimates of genetic parameters will soon be available,” Negussie says.

Negussie says breeding for efficient feed utilization is one of the most promising strategies to reduce emissions. He and his colleagues at Luke have worked on the topic in a joint Nordic project called FUNC (Feed Utilization in Nordic Cattle).

“Methane emissions are mostly determined by how much and what the animal eats. By breeding for feed efficiency, we can promote cows that eat less but produce as much or more milk than their peers. This reduces both methane emissions and farmers’ feed costs.”

Negussie emphasizes the importance of co-operation across scientific and national boundaries.

“The problem with methane emissions is multi-faceted, so collaborative work across different disciplines is needed to bring about a sustainable and long-term solution to it.”



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# Desire to experiment led to a groundbreaking product

**text:** HELMI MUHONEN

**A research team that had previously focused mainly on food products had to make a decision: should they jump onto foreign soil, from food to pet health products? The answer gave rise to a unique product – and a completely new way of utilising Luke's FoodPilot test hall.**

▲ The product target group, dogs, was a new challenge for the Luke team that worked with Vetcare.

**E**veryday life at the FoodPilot test hall of the Natural Resources Institute Finland (Luke) in Jokioinen, Finland includes food product development. When Vetcare and **Shea Beasley** approached Luke with a new challenge, Luke learned how to use the FoodPilot hall in a more innovative way. The target group of the product being developed were not humans, but Border Collie Denny and other dogs with sensitive stomachs.

Luke and Vetcare end up developing a groundbreaking product, the first functional food meant for dogs. The sour-milk product is already on the market under the name of Canius®.

## **It started with cheese**

Shea Beasley, Vetcare's Product Development Manager, is a microbiologist. The industry's circles are small, and Beasley was already familiar with MTT Agrifood Research Finland, one of the organisations that preceded Luke.

"MTT used to produce cheese which was incredibly good. We familiarised ourselves with dairy research through cheeses. When we were thinking about where we could find a small high-quality dairy that is able to make test products,

we thought about the excellent cheeses,” Beasley says.

Luke was the missing piece.

“We at Vetcare had the required bacterial strains and the idea, but we lacked technical expertise. Luke has expertise in both dairy and technology,” Beasley continues.

Beasley herself owns a dog with a sensitive stomach. At that time, dogs were given lots of sour milk to make their digestive system work better. However, it was the same sour milk that people drink.

“Evolution dictates what kind of microbes animals have in their systems. Naturally, there are differences between species,” Beasley explains.

Beasley’s idea was that beneficial microbes should be animal-specific, meaning that strains meant for dogs should be isolated from dogs. The sour milk for dogs that was created first and then the powder-form Canius® responded to this need.

### Stage: FoodPilot test hall

The FoodPilot test hall in Jokioinen was effectively and innovatively utilised. The premises have been approved by the food authority, which lends credibility to the product. Furthermore, the test hall has versatile process equipment and competent employees.

The hall could be used for heat treatment, fermentation, drying, packaging and shelf life tests. Testing in pilot scale reduced the risks connected with the transfer to actual production.

“One of the key challenges was changing liquid into powder and prolonging its shelf life to make the product commercially viable,” **Tuomo Tupasela**, Senior Scientist at Luke, explains the development stages of the product.

It was a product development project aiming at an EU license for the product. Effectiveness research was also performed. Luke was responsible for shelf life tests of a variety of semi-finished products. Some of these tests are still ongoing. In ad-



▲ One of the key challenges was changing the liquid product into powder and prolonging its shelf life, says Tuomo Tupasela.

dition, Luke developed bacteria identification methods.

The market for products and services for pets is growing.

Canius® has been on the market since 2017, and it is also sold outside Finland. The product has been approved by the European Food Safety Authority (EFSA). Luke’s expertise on what the approval of a product requires assisted in the acquisition of the license and the internationalisation. Furthermore, an internationally established research organisation made the product more credible.

Beasley praises Luke’s service-centred attitude. She mentions flexibility and good communication.

“Whenever it seemed that something was not going as planned, somebody from Luke contacted us. They also notified us immediately once the challenge had been overcome.”

“Whenever it seemed that something was not going as planned, somebody from Luke contacted us. They also notified us immediately once the challenge had been overcome.”

### Successful test

A desire to experiment and develop is the key, particularly in product development. However, the risk of failure is always present in an experiment. Taking the risk was

worthwhile. Feedback on the product from both veterinarians and dog owners has been very positive. In addition to creating a functional product, the participants learned something important.

“We have all the opportunities we need to further develop our expertise to reach more target groups. Cats are one of the potential target groups. This made us believe that we can go ahead with new raw materials and target groups with the expertise we already have,” Tupasela says.

Traditionally, the FoodPilot team’s raw materials have been milk- and egg-based, a tradition that stems from the times of MTT. Recently, also a fish challenge has been brought into the test hall. A new challenge requires the same kind of courage as the health product for dogs.

“We have studied the side streams of fish and how they could be better utilised. Therefore, it wasn’t difficult for us to start working with fish,” Tupasela says.

You will hear more about the fruits of the cooperation between Vetcare and Luke in the near future.

“We showcased our expertise and the customer was inspired and proposed another test together.” ■

*Recently,  
also a fish  
challenge has been  
brought into the  
test hall.*



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A close-up photograph of a hand holding a magnifying glass over a blueberry bush. The magnifying glass is held over a cluster of blueberries, which are in sharp focus. The background is a soft-focus green field of blueberry bushes. The overall scene suggests scientific research or a detailed examination of nature.

# Scientists adding twist of bio-economy to arctic policies

text: MARJATTA SIHVONEN

Climate change has turned the EU to look closely at the Arctic areas. According to Luke scientists, the decision makers should dig deeper in the possibilities of sustainable Arctic bio-economy.



Photo: Petri Jauhainen, Rodeo

One-third of Finland's area lies north of the Polar Circle, the geographical definition of the Arctic. The county of Lapland covers more than 100 000 square kilometres of sparsely populated land.

### Sustainability in the Arctic

When Research Professor **Sirpa Kurppa** from Luke talks about the Arctic bio-economy, she talks about livelihoods and future in Lapland, but adds a wider perspective. Kurppa describes her view

as a set of know-how and possibilities, in local and global scale.

“We should make use of the Arctic know-how in the whole Finland. Icebreakers and other systems functioning in cold conditions can be developed and manufactured in the whole country”, Kurppa points out.

To promote research-based knowledge about the Arctic, Kurppa and her research group published a policy brief for decision makers. Kurppa has an established career in agroecology and the focus of the Arctic

bio-economy brief is in the sustainable use of the northern nature.

The time for the research-based brief is suitable, as Finland is holding the chair of the Arctic Council until 2019.

“Finland took the chair in 2017 and since then, the focus has been on the technological issues concerning the Arctic seaway and oil and gas resources. That is why we should bring up the special natural circumstances and how to use them in a sustainable way in the future bio-economy”, Kurppa says.

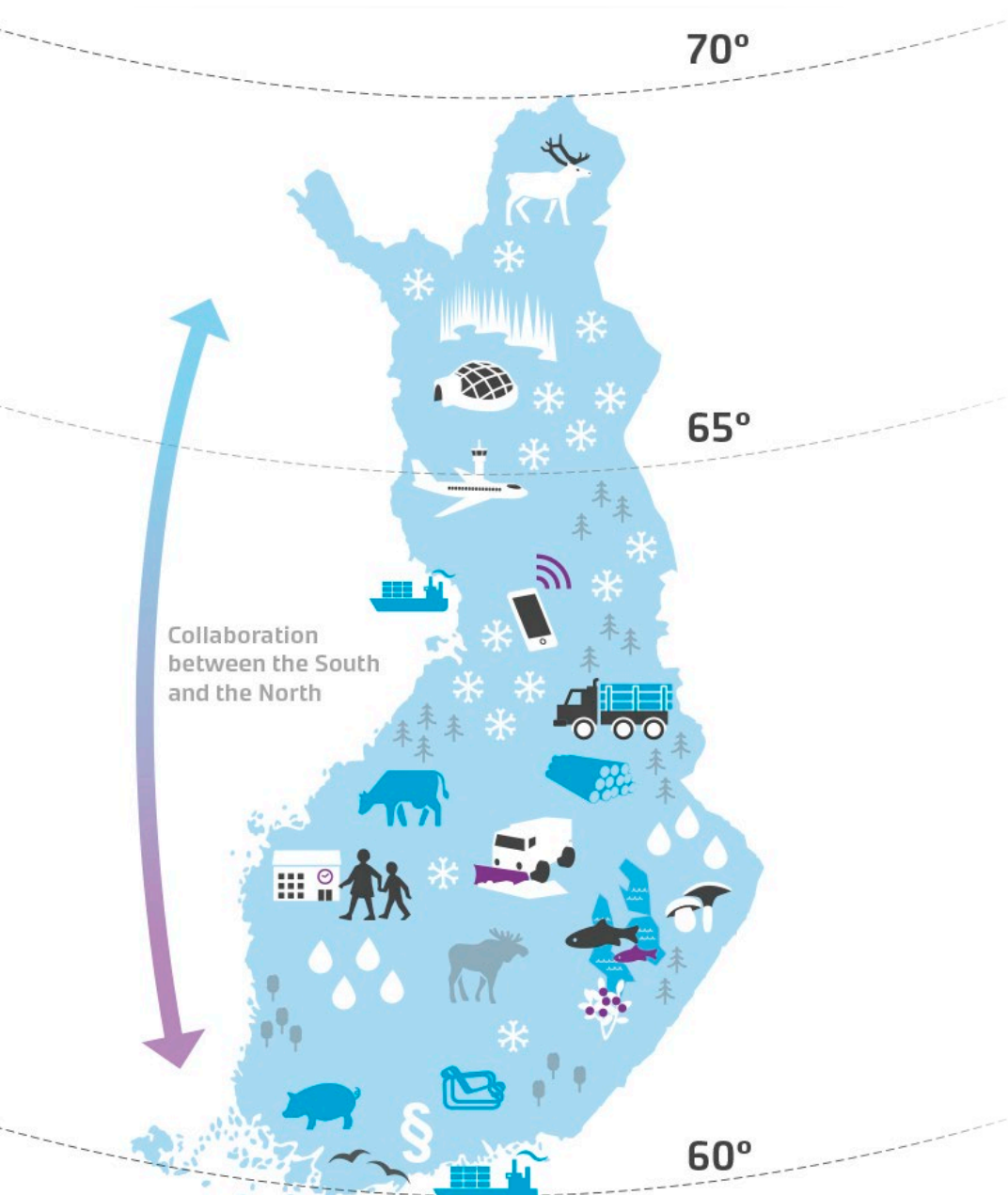
### Tourism belongs to bio-economy

Recently, Lapland and other Arctic areas have experienced a vast growth of tourism. According to the researchers, the future of tourism is now closely watched in all the countries of the Arctic region.

“Tourists are attracted here by the well-functioning society, the services, nature and a secure environment, even the darkness. These we should cherish”, Kurppa says.

Therefore, tourism is included in the bio-economy, as it is also based on the extreme natural conditions. Researchers have clarified how vulnerable nature can be used at different times of the year. The aim is to promote sustainable tourism and to maintain traditional land use.

“Tourism grows fast and Finns should now consider how to manage it in our own hands. There is a great danger that tourism will move into the hands of the global players. With mass tourism, the northern





uniqueness can be ruined in an instant”, Kurppa warns.

### Arctic food goes global?

As tourists are attracted by the Arctic Lapland, Lapland should seek its own way to the global market, scientists say. One of the aims of the policy brief is to export more Finnish products.

“Finland is the northernmost country where farming is practised in a large scale. Many companies already use Arctic in their brands and marketing. Our strengths are cleanliness, food safety and production where only small amounts of antibiotics are used. However, these same arguments are used by other countries”, says Researcher **Jaana Kotro** of Luke.

To access the global market with the Arctic brand, Luke scientists suggest co-operation of the whole Barents region, go-ahead innovations and, most importantly, knowledge about customers’ needs.

For this path, Luke scientists offer their practical help for decision makers as well as entrepreneurs in their out-reaching bio-economy projects. Kotro’s project “Arctic Food in Finland” is well on the way and offers free, research based material that companies can use in their marketing efforts. ■



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Photo: Antti Jokinen, Rodeo



## Reindeer entrepreneur Riikka Kenttälä: Future is for those who adapt

**Riikka Kenttälä**, 27, is taking over her family business in Levi, Lapland. I love to work with people and reindeer, says the young entrepreneur, who combines traditional reindeer husbandry with tourism.

Riikka Kenttälä’s winters pass with tourists. Together with her brother and parents, she takes both Finnish and international customers to trips with reindeer sledges.

“We also tell our guests about reindeer herding. In the future, I would like to take them reindeer round-ups, so they see what real life and work is like here”, Kenttälä says.

Tourists come to Kenttälä’s home farm, Sammuntupa, from all over the world. Regular visitors come from Central and Eastern Europe and Russia, growing numbers from Canada and USA, even from Australia and Singapore.

Kenttälä says she has not made any big marketing efforts, as the pressure of growing tourism is so strong.

“We have our facebook site and internet pages and a network of travel agencies in Finland, Switzerland and France. Many visitors love our old farm milieu and us just being ourselves. That is what our marketing mainly is.”

Sustainability questions are familiar to Kenttälä, especially in terms of space. In Levi area, the number of cottages and other free time facilities grows fast.

“All people do not like reindeer roaming free. I kind of understand that. We try to arrange our work so that the environment is not used excessively. But there is also Kittilä mine here, cottage owners, skiers, hikers. We all need space.”

In the future, Kenttälä is planning to sell her own reindeer meat at the farm.

“I have never thought about selling meat to Asia, because the demand is local. The problem is, there is no governmental financing instrument that would allow me to build premises for cutting meat.”

The biggest obstacle to Arctic entrepreneurs is how to get educated, skilful staff.

“We have had to take workers without any training in travel business and train them ourselves.”

It is autumn in Lapland and Kenttälä prepares for the busiest season of the year, Christmas. She hopes scientists and decision makers could help to solve the problem of summer season, as there would also be lots to see but less demand. However, the future looks good now.

“The demand for travel services has been so strong that it forces our business to grow and develop”, Kenttälä says.

# Best food in the world – and only Finns know about it

text: MARJATTA SIHVONEN

**Finnish food is pure, low in contaminants, nutritious and safe to eat. These are statistical facts, scientists say. The controversy is, Finns do not know how to sell their delicacy. Yet.**

Senior Scientist **Csaba Jansik** from Luke knows the Finnish food sector in and out. He is one of the leading experts in competitiveness of the European food chains. Recently, he has concentrated on international benchmarking of the EU food industry and especially the Baltic Sea area.

Jansik has dug deep into food production in the Baltic countries, Germany, Denmark, Sweden and compared their strengths with Finland. According to Jansik, the Finnish food sector has a lot to offer.

“We cannot compete in volumes with our benchmark countries like Germany or Denmark in pork or wheat with France. Our opportunities are in added value products. We should find their consumer segments in the global market.”

The problem is the Finnish tendency to curl up and not reach for the possibilities outside the domestic market. Jansik recalls a conversation with a foodstuff entrepreneur, who once took part in his study.

“He said Finnish food industry knows the Finnish consumer better than perfect. That is true. But the problem is, we should attract Estonian or German consumers and we start wondering: Are they so different?”

## To Russia and back

Finnish food export does have a long history: Russia was a close and familiar market, the quality of Finnish food was well known. Strong efforts at marketing or distribution were not needed.

Unfortunately, one could say. In 2014, the Crimea conflict and the resulted EU trade penalties left the food chain high and dry. Finnish dairy industry was hit especially hard.

“Our food sector had not invested in export. The domestic market is very saturated and very competitive. To grow there, you need to grab a piece of somebody else’s share.”

In 2017, Jansik and his colleagues published the report Critical Success Factors of the Finnish Food Chain. The report was written for Prime Minister’s Office, but it was not left to collect dust on governmental shelves. Jansik is pleased to see that the tide is starting to turn and, moreover,



it is turning to the direction the scientists recommended in the report.

“Our previous reports did get some attention, but the business tended to go back to usual. We are happy that this time the actions are really being taken.”

## Facts speak for themselves

The first main conclusion of the critical success factors report is that the Finnish food chain must improve its understanding about the market in the export destination countries. A simple advice and often repeated too, but there was a clear reason why it was taken now.

“It was a fruitful time to look at exports from a new perspective when Russia was closed. It is not that the Finnish companies are not interested in global export, they are, but no matter how big the company, it has to learn to know the market. Know-how does not come out of nowhere”, Jansik says.

The other main conclusions Jansik underlines are the strong need to raise the awareness of the quality of the Finnish food and improve the cooperation between the actors of the food chain.



To offer a helping hand from scientists, Jansik has coordinated a web project to help the companies. Food facts portal offers a huge amount of information and statistics about food production in Finland.

“Finnish production is very sustainable environmentally and ethically. We have facts to back this up. The aim of the web site is that the companies could use these facts and figures in their own narratives and marketing”, Jansik explains.

Food facts site has thirty themes and statistics from international open sources such as FAO, Eurostat, and EFSA. The information has been produced by more than fifty experts from twenty organisations. The site has been published in three languages and soon, the German version will be launched.

### Experts needed!

More and more concrete efforts are taken in the field. One important factor to improve is to get more professional personnel in the companies.

“We realised Finnish companies might have thirty people in domestic marketing,

but only one or two in export. We simply do not have enough experts who know food industry and export. However, the first intensive degree program is about to start. This is a big leap forward.”

Jansik points out of his window to Helsinki science campus, where the main building of Finnish Food Safety Authority Evira stands.

“They have also done an amazing job. Evira has an efficient export team, which offers training for small companies in legal issues. That is where they easily stumble, even when they have a buyer abroad.”

Evira is also working with WTO Sanitary and Phytosanitary (SPS) Agreements, which are the first requirement to export products into any new market.

“Denmark is years ahead of us in this, but we are getting there. We have managed to get the agreement to several new countries”, Jansik says.

### Arctic food – the brand of the future?

Luke scientists are also strongly involved in developing the Arctic food brand. It sounds good, connected with the images of pure nature, fresh air and cold, Nordic

scenery. However, is Arctic food something that consumers in the global market are interested in?

“We do not know yet. That is what we are going to find out in our new projects”, Jansik says.

The stakes are high and so are the aims. Business Finland, a national export promoting organisation, has prioritised Germany, Arab countries, South-Africa, Japan, China and India as the main target countries of the future. Jansik and his group are backing up the efforts with the new projects.

“We could sell almost any products, but at the moment, poultry has the biggest chances in the global meat market and oats in the corn market. I am now starting a project, where we develop added value for them on each step of the food chain”, Csaba Jansik says. ■





## A scientist and a navigator

text: MARJATTA SIHVONEN photo: HANNU FRITZE'S ARCHIVE

Research Professor Hannu Fritze often sits in his wooden sailing boat and works. For one of the leading experts of mire microbes, the beautiful archipelago, the lake and sea landscapes give peace and space to focus. When the mind rests, the best research ideas and applications come up.

**H**annu Fritze's pioneering career begun with a small failure. The German born scientist moved to Helsinki as a schoolboy with his parents. He wanted to study medicine, but as an immigrant, was denied a permission to apply.

The University of Helsinki accepted him to study biology, where he proceeded to research.

"Microbiology and genetics were rising fields at the time. I tried to find something between botany and microbiology and ended up specialising in microfungi."

Fritze's career paints an interesting picture of the global research questions of Northern ecosystems. Through the studies of environmental fallout and its effect on soil microbes, Fritze proceeded to forest nutrient cycles, acidification and heavy metal concentration in forest soils.

Funding from Academy of Finland and other major foundations have made Fritze's group grow steadily. He continuously emphasises that science is not a solo performance.

"This kind of work can't be done alone. Science grows from groups and collaboration."

The studies of methane cycles led Fritze and his group to mires. He focuses on Archaea, methane producing single-cell organisms, which, still for a while ago, were considered archaic forms of life.

"With the fast progress of microbiology, we now know that there are Archaea everywhere and that they are more developed than bacteria, for example."

*Bioinformatics,  
genomics and  
microbial ecology  
are the future of  
science.*

Microbes provide a huge repertoire of ecosystem services, such as the chemical cycles of methane. We might well see microbe based solutions to mitigate climate change. But first, more knowledge on the invisible world needs to be gathered.

"Currently, I'm investigating how the warming climate and reindeers affect the methane cycles of the mires in Lapland", Fritze says.

Even if the challenges were massive, the solutions could rely on the smallest of the small.

"Bioinformatics, genomics and microbial ecology are the future of science", Fritze predicts. ■



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# Englishman in new work

text: MIKKO SALMI photo: ERKKI OKSANEN

**Dr. John Kettle started as Luke's new Director for Customer Solutions and International Relations in 1 January 2019. Sustainable development close to his heart, Kettle wants to promote what is truly excellent at Luke.**



## **How do you see Luke's position and potential in international markets?**

To put it shortly, the potential is great. In this time of climate change, rapid population growth and biodiversity loss, there is a growing demand for the type of solutions that we offer. National and global challenges increase the need to look for the sustainable use of renewable natural resources to produce food, energy, products and services.

The circular bioeconomy is a huge opportunity, and for this purpose, we need research-based information to help businesses thrive sustainably. Finland has made the bioeconomy a national priority, and the "Bioeconomy Strategy" was launched some years ago. The strategy sets the course for a low-fossil carbon and sustainable economy that will improve the lives of citizens by generating new business opportunities and takes advantage of the renewable natural resources.

Luke plays a central role in developing this further based on our long traditions. We also have a strong link in our research programmes to the UN Sustainable Development Goals which are also on our customers' agenda and the agenda of the European Union (Horizon Europe program).

One of our key strengths is being a well networked interdisciplinary research institute and thus the opportunity to combine expertise in different fields to create added value solutions with high impact. Now our task is to make our offering visible and attractive for potential customers and partners within as well as outside Finland.

## **What kind of solutions or expertise in particular do you think would benefit our customers?**

Forest management is definitely one of them, and there our plantation simulators are of great help, too. Rearing and breeding dairy cattle is another key strength, as is cold-water fish farming. However as an interdisciplinary organization our offering is wide, of course, and we must use the diversity of our staff to customers' benefit as well as collaborate with other significant players where it gives mutual benefit.

## **Tell a little bit about your background. What have you done before joining Luke?**

I have been living and working in Finland for 12 years now. In Finland I have worked in various positions in sales and business development for example at VTT Technical

Research Centre of Finland and KCL. I came to Finland from Sweden, where I spent nine years working for SCA, and last millenium I worked in industrial research in the UK and have a PhD from the University of Plymouth.

## **What are you mostly looking forward to in your new position?**

The challenge: It will be a positive challenge to lead Luke's sales and international development and promote Luke's offering and solutions for global sustainability challenges. I wish to use my experience and work closely with other Luke staff to develop our customer work. As well as promoting what is truly excellent at Luke – and that's a lot of tasks!

## **Finally, would you like to share something about your personal life?**

I'm married to a Finn and a father of four kids. In my spare time, I like to read or go to the gym. As many have guessed I am from UK and have a working knowledge of Swedish but improving my Finnish language skills would be a good goal too. ■



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## Need to make complex decisions? – ask YODA

YODA (Your Own Decision Aid) has been developed for participatory decision processes with multiple criteria. It combines the perspectives of participating actors and their preferences with respect to selected, case-specific decision criteria.

There are two different versions of YODA, tailored for different decision-making situations: YODA project tool supports identification of one alternative that best meets the objectives of the participating actors, and YODA portfolio tool helps identify the best project portfolio.

“YODA helps in finding the best compromise solution in complex choice situations, when the views and criteria of the different actors are in conflict. It is a generic tool and has a broad application potential in land use planning, for example”, said principal scientist **Mikko Kurttila** from Luke.

[luke.fi/yoda](http://luke.fi/yoda)

## Doctoral Dissertation: Nutrition in the food life-cycle assessments

In her doctoral dissertation, Luke’s researcher **Merja Saarinen** develops and analyses ways to link nutritional aspects into life-cycle assessments (LCA) of food products. By carrying out this kind of assessment, sustainable food products can be defined.

The focus is at analysing the applicability of various functional units (FU) at a product and portion level. FU describe a function of the product against which impacts should be related to.

The nutritional FUs developed and analysed are the standardised meal, mass-based FUs for individual nutrients, and the nutrient indexes. The nutrient index approach combines nutrient index based on recommended nutrients with the separate index based on restricted nutrients.

In the common scientific and popular discourse, the message has been clear when reasoning for sustainable food consumption: one should avoid animal-based foods, particularly beef because beef has by far the greatest environmental impact. “According to the results of this dissertation, however, particularly beef, in addition to for example hemp seeds, would benefit from the inclusion of nutrition criteria in food LCA on a product scale”, Saarinen says.

“In summary, nutrition should be taken into account in versatile ways in the food LCA.”

## Key indicators for monitoring the progress of bioeconomy in the EU identified

The project MontBioeco identified and compared the different approaches within the EU member states to monitor the progress in a country’s bioeconomy. In close cooperation with national organisations in the member states, the project identified the existing national bioeconomy strategy, policy, the industries and activities that are included in the bioeconomy sector, the already existing and desired bioeconomy key indicators, as well as their respective data availability.

## Campaign provides information about nutrients for consumers

What can consumers do to help resolve the eutrophication problem? The Natural Resources Institute Finland (Luke) is participating in the Do You Pay it Forward? campaign, launched in June 2018. Its aim is to offer tips on how to make nutrient-smart choices.

Consumers mainly contribute to eutrophication through food and wastewater. The Do You Pay it Forward campaign offers advice on how to reduce the consumption of nitrogen and phosphorus and their adverse impact on watercourses by making smart food, recycling and water consumption choices and by minimising food waste. The main message of the campaign is: “You are part of the food chain – not its terminal point.”

The campaign will continue until the end of the year. So far, it has reached more than two million people, nearly 40% of all Finns. In addition to social media channels and newspaper articles, it has been visible at different events and at 1,200 bus stops around Finland.

Luke’s researchers have contributed to the campaign through their expertise in food waste, water-smart food choices and sorting.

[#doyoupayitforward](https://twitter.com/doyoupayitforward)





## Luke successful in employer rankings

Luke gained top positions in Universum's research on Most Attractive Employers 2018 in Finland. The research revealed Luke as the most appealing employer among young professionals in Finland in natural sciences. Among natural science students, Luke came in the runner-up position.

Luke's Vice President, HR **Tiina Melilas** tells, that Luke seeks to invest in working careers in all parts of the career path.

"In a knowledge based organization the most important resource are always the people. Luke gives opportunities to grow, whether you are still a student or an already established international specialist in your research field."

Want to join our team? Follow our Vacancies page!

[luke.fi/vacancies](http://luke.fi/vacancies)

Photo: Erkki Oksanen



## Luke and FAO increase cooperation in forestry, climate change and food security

Luke and FAO have agreed to increase cooperation in the key areas of sustainable forestry, the Sustainable Development Goals, climate change and food security. A memorandum of understanding signed in July sets out a plan of work that builds on an existing collaboration, significantly expanding its scope in terms of geography and vision.

Joint initiatives will take place at country, regional and global levels, with special focus on Ethiopia and Myanmar in the case of efforts to step up sustainable forest management and robust forest monitoring. FAO and Luke are already working together in both countries to bolster technical capacities in developing assessments on forests, with the goal of creating sound national forest policies and sustainable development and helping them to meet national and international requirements.

"Luke, with almost 100 years of forest inventory and monitoring experience, is an excellent partner for delivering the necessary support to the developing countries", said **Hiroto Mitsugi**, Assistant Director-General, FAO Forestry Department.

## DIABOLO tackles Europe's challenges with improved forest information

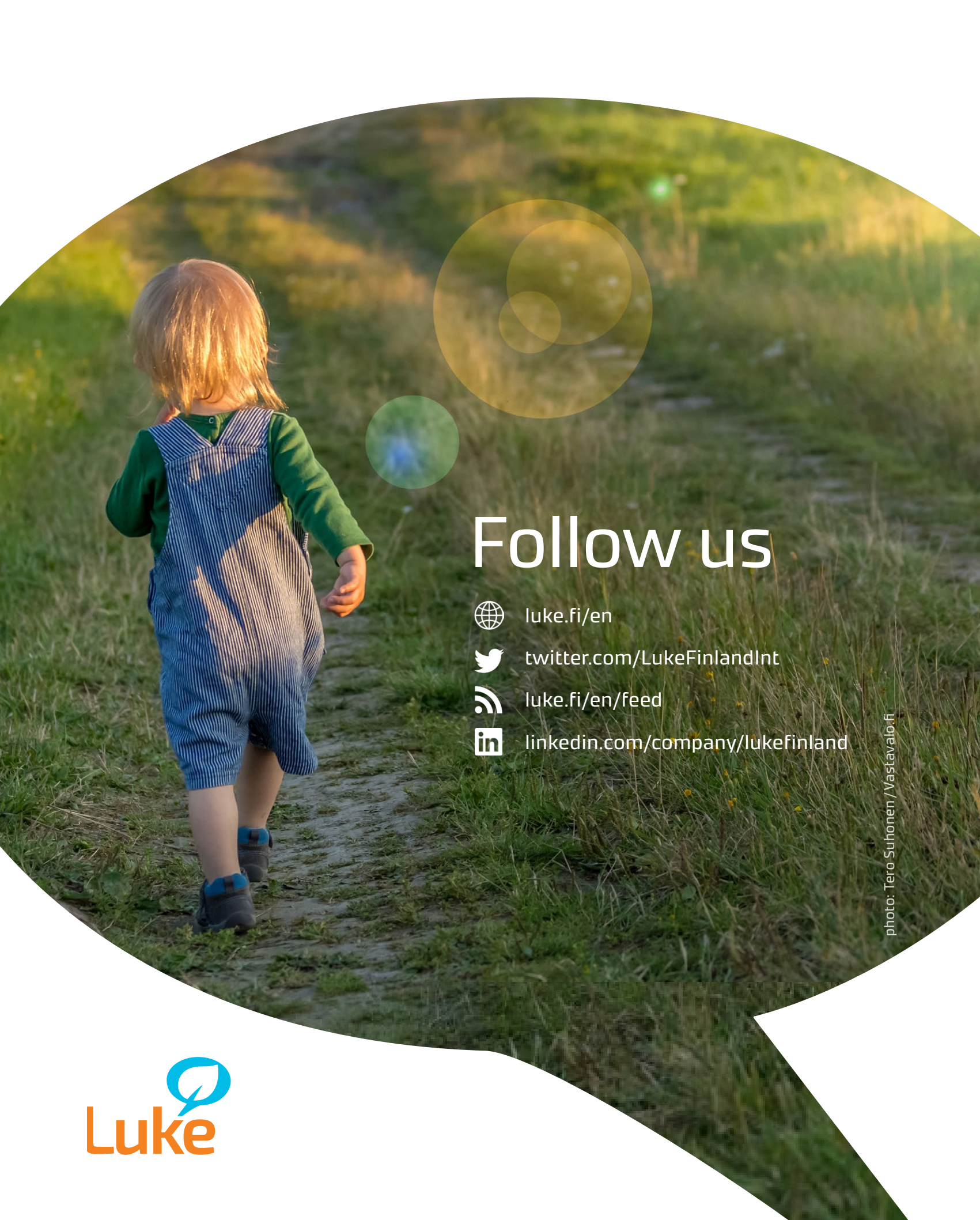
The DIABOLO project brings upgraded forest information for bioeconomy policies. Its' results and innovations will benefit all EU member countries regionally, nationally and at the European level.

DIABOLO has successfully integrated various remote sensing techniques and data from National Forest Inventories for multipurpose forestry. Indeed, DIABOLO's contribution to climate policies as well as other environmental policies is both timely and essential.

Coordinated by Luke, the DIABOLO project has brought together 33 partners from scientific institutions in 25 European countries. DIABOLO – Distributed, Integrated and Harmonised Forest Information for Bioeconomy Outlooks – has received funding from the EU Horizon 2020 research and innovation programme for 2015–2019.

DIABOLO will have its final conference in the beautiful national landscape of Koli, Finland, 12–14 February 2019.

[www.diabolo-project.eu](http://www.diabolo-project.eu)



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