

Biofuels or food? Quest for land poses a threat to poor women in Africa. [PAGE 4](#) ▷

Fishless fish feed. Farmed fish can eat mussels, fungi and rapeseed oil instead of fish meal. [PAGE 5](#) ▷

New species found. Extensive surveys have revealed 2,000 species new to Sweden. [PAGE 8](#) ▷

Shaping



THE FUTURE

SUSTAINABLE KNOWLEDGE FROM SLU

Taking on the challenge

Eskil Erlandsson
Minister for Agriculture

1 July 2009 – the date on which Sweden took over the Presidency of the European Union – marked the beginning of a highly interesting, albeit challenging, six-month period. As Minister for Agriculture, I could set the agenda and turn the spotlight on the issues of the future.

It is becoming ever more obvious that the future belongs to the green sector. People are increasingly interested in the way that food is produced, in animal welfare, and the way forestry and agriculture can play a part in creating the climate solutions of tomorrow.

The Swedish Government and I share a vision for the green sector – resources should be used, but not used up. On the basis of this vision I will be giving priority to three areas during the six months of the Swedish Presidency: sustainable fisheries, food and climate – the global challenge, as well as sound animal husbandry and healthy animals.

SLU – the Swedish University of Agricultural Sciences – will play a crucial role in these priorities. On the Government's instructions, the university is already working to reduce the effects of climate change, and is involved in a number of arrangements in conjunction with the Swedish Presidency. SLU's collective know-how and experience is of enormous value.

SLU is the principal actor in Sweden in the field of education and research on sustainable development in agriculture and forestry, and is also very important in relation to the community as a whole. I am proud to say that the university has much to offer when it comes to finding solutions to the major challenges we face today.

Taking on the challenge – this is the slogan for the Swedish Presidency of the European Union. It is my hope that the Swedish Presidency will impart inspiration, energy and knowledge that can be harnessed in the continuing efforts to achieve sustainable European agriculture, with sound food products and healthy animals. We must rise to this challenge. ■

“SLU's collective know-how and experience is of enormous value.”

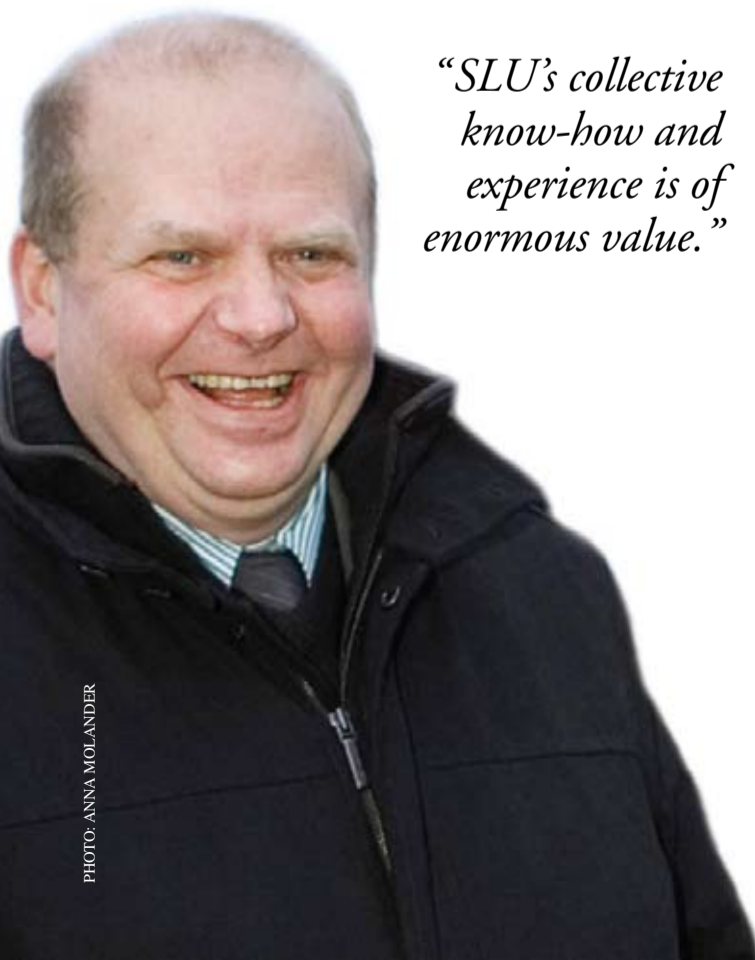


PHOTO: ANNA MOLANDER

Fossil fuels must be replaced



PHOTO: ISTOCKPHOTO

An energy shortage is a greater threat than the greenhouse effect, according to Professor Per-Anders Hansson at SLU. His vision is to make both motor fuel and mineral fertiliser from renewable raw materials from agriculture. [PAGE 3](#) ▷

Good life quality.

Chicken, pigs, horses and dogs all need more than just feed and water to be happy. Stressed or frightened animals may even represent a hidden cost to the farmer. [PAGE 5](#) ▷

PHOTO: PERNILLA PERSSON



Landscape for many purposes.

New wind turbines and energy forests change the landscape and create conflicts. Farm animals grazing in the park also arouse feelings, albeit mostly positive ones. [PAGE 4](#) ▷





PHOTO: ANDERS ESELIN

Sweden's boreal forests are used both by reindeer owners and by forest owners.

Better consultation on reindeer grazing

diss-epsilon.slu.se/archive/00001953

Camilla.Widmark@sekon.slu.se

Wherever there are natural resources and a number of interested parties, conflicts arise. One such example is found in Sweden's boreal forest region, used by reindeer owners and forest owners in parallel, although their aims diverge.

Researchers at SLU in Umeå point out that the existing consultative framework does not work well. Reasons for this include the scarcity of lichen, the unequal balance of power at consultative meetings, and the fact that the profitability of forestry has a much greater economic impact on nearby communities than does reindeer husbandry.

However, it would be possible to create a fairer consultative forum. If forestry representatives were to provide information about the timing and location of forthcoming felling operations, reindeer herders could graze these areas somewhat more heavily before felling took place, which would ease the pressure on areas of forest in an earlier phase of growth. Joint management would also work better if the two sectors knew more about each other's operations. A simple forum for dispute resolution will be needed if the two sectors cannot resolve their differences by way of consultation. ■



PHOTO: ASA GRIMBERG

Oat grains can store a large amount of oil.

Oil-rich oat grains in prospect

www.lti.slu.se/1

Asa.Grimberg@lti.slu.se

Cereal seeds store energy for the new seedling mainly in the form of starch and protein. Oat is unique among the cereals in storing high amount of oil in the grains and thus is a potential alternative crop to oil-seed rape as a renewable substitute for fossil oil.

Researchers at SLU in Alnarp have been examining the possibility of modifying the distribution of energy storage in the oat grain to increase the concentration of oil to give oil yields comparable to that of rape seeds. Oats were chosen because there are already varieties containing high levels of oil – up to 18 per cent of the grain by weight. This bodes well for the prospects of using plant breeding and genetic engineering to create varieties possessing the desired properties. It was found that an elevated level of carbon dioxide in the atmosphere, expected to occur in the future, did not increase the oil concentration in the oat grain. ■

Grass can heat houses in the north

www.btk.slu.se

Michael.Finell@btk.slu.se

The perennial plant reed canary grass (*Phalaris arundinacea*) is an alternative energy crop in northern Sweden, where *Salix* struggles to survive in winter. An SLU study has shown that in the northern Swedish county of Västerbotten alone there are 30,000 hectares of arable land that could immediately be sown with this crop; each hectare could supply a detached house with electricity, heat and hot water. Reed canary grass is currently cultivated on around 1,000 hectares of land in Sweden. Considerably more of this crop is grown in Finland.

The previous year's grass can be harvested early in spring, when the new shoots are still small. The result is a dry raw material that can be mixed with other fuels or compressed into briquettes and pellets. Studies are in progress at SLU to determine the fuel properties of this crop, differences between varieties and ways of optimising the cost-effectiveness of cultivation. ■

SLU in brief

SLU – Sveriges lantbruksuniversitet
– the Swedish University of Agricultural Sciences

Mission statement

"SLU develops the understanding and sustainable use of biological natural resources. This is achieved through research, education and environmental monitoring and assessment."

Vision

"SLU's vision is to be a world-leading Life Sciences university, characterised by: top-ranked research and educational quality, creativity and leadership within environmental monitoring and assessment and attractiveness as an innovative partner in the green sector."

Education, students and employees

40 educational programmes
3 600 full-time undergraduate students
700 postgraduate students
3 000 employees

Four main campuses

- Umeå
- Uppsala
- Skara
- Alnarp

Official address:
SLU, P.O. Box 7070
SE-750 07 Uppsala
Sweden

Further information:
Phone: +46 18 67 10 00
Web address: www.slu.se

Four faculties

- The Faculty of Forest Sciences
- The Faculty of Natural Resources and Agricultural Sciences
- The Faculty of Veterinary Medicine and Animal Science
- The Faculty of Landscape Planning, Horticulture and Agricultural Science



SLU during the EU Presidency

Five EU conferences at SLU Uppsala in 2009:

- Delivering Animal Welfare and Quality, 8–9 October
- Rural Areas Shaping the Future, 28–29 October
- EU Equus 2009 – The Future of the Horse Industry in Rural Areas and Society, 29–30 October
- Future Forest Monitoring in the EU. Providing information for multifunctional forest management, 11–12 November
- Sustainable hunting and biodiversity conservation, 15–16 December

www.slu.se/eupresidency/09



Camel's milk without water?

www.afb.slu.se

Kristina.Dahlborn@afb.slu.se

The camel is the domestic animal best able to survive without daily access to water. It can vary its body temperature from 41 degrees Celsius in the daytime to 35 degrees at night, which reduces water loss. The camel also has a special compartment in its stomach where large quantities of water can be stored.

Professor Kristina Dahlborn at SLU has been conducting research on camels since the 1980s. She is trying to understand their fluid and temperature balance. At present she is examining how dromedary milk production is affected when the animal goes without water for 16 days. Production remains unchanged for the first eight days, before then declining by half, as the dromedary loses 25–30 per cent of its body weight. ■

SLU – at the heart OF A DEVELOPING SOCIETY

It's all about creating a basis for a sustainable society. A holistic approach, interdisciplinary sciences and practical solutions are distinctive features of our work.

Soil, water, air, animals, fibre, forest and food – we are, in a broad sense, a university of life sciences. Climate solutions, sustainable urban and rural development, ecosystems and infectious disease control – all these fields are covered at SLU.

Our researchers and lecturers work at the heart of a developing society. They are engaged in issues that are topical and of central importance for the future.

The earth's resources are limited and climate change represents a tremendous challenge – one we are prepared to meet. We possess skills and know-how in many of the areas essential in the creation of sustainable global development. We are, and always have been, a university for the agricultural industries. Developments in the biosciences and the needs of the world around us have ensured that we also represent a source of knowledge for the entire community.

SLU's main task is to ensure that our education, training, research and environmental monitoring and assessment enable us to develop new knowledge and skills capable of contributing to an enhanced quality of life and good economic growth, in Sweden as well as the world at large. ■

LISA SENNERBY FORSSE
Vice-Chancellor



PHOTO: JULIO GONZALEZ

Fossil fuels in agriculture must be replaced:

“We can't wait for the optimal solution”

A substitute must be found for fossil oil and natural gas, according to Professor Per-Anders Hansson.



www.et.slu.se

Per-Anders.Hansson@et.slu.se

Motor fuels and artificial fertiliser needed by Swedish agriculture can be made from renewable raw materials produced by agriculture itself, according to Professor Per-Anders Hansson at SLU.

Professor Hansson is engaged in research on the future supply of energy for Swedish agriculture. He believes that an energy shortage is a greater threat than the greenhouse effect, but sees no major obstacles preventing agriculture from ultimately becoming self-sufficient in both motor fuel and artificial nitrogenous fertiliser.

But what about the greenhouse effect? Of course we must try to mitigate the greenhouse effect, but replacing fossil fuels is probably even more important. What I mean is that we can arguably manage to adapt to a degree of climate change. The effects of an energy crisis will be felt more directly, in the form of war, famine and a collapse in welfare. Quite simply, a substitute must be found for oil and natural gas.

You have estimated numerous environmental impacts resulting from the manufacture of fuels such as ethanol, methanol, biodiesel, biogas, hydrogen, RME, DME and so on, from various raw materials produced by agriculture. What should be done with all these comparisons? There are pros and cons with all systems, but it is important that we make conscious choices and avoid the worst options. I primarily look for alternatives that do not require large areas of land and that do not encroach on food production. It is also essential that we know the implications of our choices in terms of climate, environment, energy balances, eutrophication, acidification, etc. But we have to begin somewhere, and we cannot wait for the optimal solution.

There are large quantities of unused energy in manure and crop residues. Would it be possible to digest these raw materials and run tractors on the biogas produced? Biogas produced in this way will be important in the future, but it should probably

not be used primarily to run agricultural machinery. It is costly and difficult to store biogas, and it is best suited to systems where it is used fairly quickly. Peak use of agricultural machinery is very much in the spring and autumn. Vehicle use by bus and logistics operators varies less from season to season, and their vehicles can use central filling stations.

Where should the gas be produced then? Biogas can very well be produced locally, since a small biogas unit is almost as efficient as a large one. But on an individual farm it is better to use the gas for electricity and heating, since conversion for use as fuel should be done on a large scale. One option is to pipe unpurified gas to central units, where it can be purified and stored.

You also talk of “green artificial fertiliser...” Yes – motor fuels account for around a quarter of all energy consumption in Swedish agriculture, but the largest single item is actually artificial nitrogenous fertiliser, which accounts for one-third. But such fertiliser can also be produced using bioenergy. In theory, the natural gas that is currently used can be replaced by gas made by thermal gasification of biomass, e.g., straw. According to our calculations, one hectare of straw may suffice to produce 1,600 kg of nitrogen. What is needed now is commercial-scale gasification technology.

What are the obstacles to progress in the bioenergy field? The main obstacle is a low oil price – the risk is that development will stagnate. Germany has created an incentive by subsidising biogas. We saw in Sweden how development in new areas accelerated when the price of oil rose to 100 US dollars a barrel.

You often mention the phrase “a systemic approach...” Yes – one interesting example is biogas production of green reeds. In addition to energy, the process produces residuals containing plant nutrients and humus that does far more good on a field than in a eutrophied lake.

Can consumers influence developments? Yes – we can see that people are increasingly prepared to pay more for food with various forms of ecolabelling, which has also had an impact on manufacturers. Consumer behaviour may very well create a new niche for energy labelled and ecolabelled food. This could provide an impetus both for biofuels and for ‘green artificial fertiliser’.

TEXT: DAVID STEPHANSSON



Using straw instead of natural gas to produce ammonia can cut greenhouse gas emissions by 80 per cent.

Mineral fertilisers from gasified straw

www.et.slu.se

Serina.Ahlgren@et.slu.se

Ammonia for use in nitrogenous fertilisers is mainly made from natural gas. A system study performed by researchers at SLU and JTI in Uppsala has revealed the possibility of making ammonia from biomass in the form of straw or *Salix* instead.

Life cycle assessment methodology has been used to examine the emissions and energy use for the entire process of manufacturing nitrogenous fertiliser. Researchers have compared production methods, finding that greenhouse gas emissions can be cut by 80 per cent using the new gasification method. As yet, the gasification method is only at the pilot stage.

The researchers estimate that it is possible to produce about 4 tonnes of nitrogen a year from 1 hectare of *Salix*. This would produce enough nitrogenous fertiliser for 13 hectares of wheat. ■

Even better cultivars of Salix

vaxt.vbbsg.slu.se/Salix-biomass

Sara.von.Arnold@vbbsg.slu.se

Plant breeding has increased the yield of willow trees (*Salix*) on bioenergy plantations by 60 per cent over the last twenty years. Demand is likely to increase substantially both in Sweden and the rest of Europe.

The long-term goal of the *Salix* project at SLU is to develop breeding methods where selection with traditional methods is difficult or inefficient. Growth rate, resistance to leaf beetles and rust fungus, as well as tolerance of frost, drought and heat, are the main factors that have an impact on biomass production. The researchers are studying the way that different families of *Salix* use water and nutrients, and how well their leaves resist high temperatures. Resistance to rust fungus is being studied by monitoring the development of the disease and performing infection trials. The mechanisms of leaf beetle resistance are also being examined. ■



Leaf beetle resistance is one aim of *Salix* breeding.



PHOTO: INGRID SARLÖV HERLIN

Letting animals graze the land instead of using machinery also benefits the municipality.

Urban cows and wind mills arouse strong feelings

www.ltj.slu.se

Ingrid.Sarlov-Herlin@ltj.slu.se

Farm animals grazing in the park and new wind farms change the landscape and sometimes spark conflicts.

Dr Ingrid Sarlöv Herlin, landscape researcher at SLU in Alnarp, is examining ways of reconciling stakeholder interests.



Forests, pastures and fields close to urban areas are used by outdoor people, schoolchildren, farms and many others. These people either want more bridleways, well-preserved monuments, more biodiversity or a good financial return on forest, grazing animals and crops.

"One issue that interests me a great deal is how to reconcile these separate interests in a multipurpose landscape," says Ingrid Sarlöv Herlin at SLU in Alnarp.

She is doing much of her research in England, since English landscape researchers are highly knowledgeable about rural areas close to urbanisation. It is there that the idea of having grazing animals in urban areas originated.



Grazing the park grass. In a pilot project in Bulltofta Park in Malmö, in the south of Sweden, where animals were put out to graze on park land, it was found that the attitudes of city inhabitants changed from opposition to the idea before the animals arrived to approval once they were actually there. The animals were missed when they were moved to their winter quarters.

Advantages include financial gains – letting animals graze the land instead of using machinery is advantageous to the municipality. Bushes and trees are shaped by browsing, and biodiversity increases where animals have trampled the soil and left dung.

"Visitors to the park also have more to look at and children are given a chance to get to know real animals, such as a family of Charolais, including cows, calves, some heifers and even a bull," says Dr Sarlöv Herlin.

However, a few visitors think that the animals encroach on other park use. The risk of allergies is rarely a problem.

"Overall, getting closer to animals has been very positive and has enhanced community spirit among city dwellers."

Changing the landscape. Newly built wind turbines readily create conflicts and often arouse strong feelings. Local energy forests are another phenomenon resulting from climate change awareness that may alter the appearance of the landscape.

Dr Sarlöv Herlin has recently received a large grant from funds reserved for senior female researchers. Among other things, she will be studying how the burgeoning renewable energy sector is impacting the landscape, not only in purely technical terms.

She has just started her research in the leading research environment at the University of Sheffield in northern England. During her time there she will also examine how methods used in existing English landscape analysis could be adapted for Swedish purposes.

Committed to local environment. Comparisons with England are also a common feature of other projects in which she is engaged. Management of protected areas differs, among other things in that the emphasis in management of Swedish reserves is on protecting nature, whereas in England care is also taken to ensure that the local economy can be enhanced in rural areas.

"Efforts are made in protected areas in England to develop land use that is also of benefit to the local population, such as locally-produced food and bioenergy crops. Care is taken to ensure that minority groups and other stakeholders are engaged in management, thus creating a commitment to the local environment," explains Dr Sarlöv Herlin. ■

TEXT: NORA ADELSKÖLD

Better walking in farming regions

www.ltj.slu.se/8

Mats.Gyllin@ltj.slu.se

City dwellers need to get out into the countryside, even in flat country, where it is otherwise difficult to avoid asphalted highways. In recent years some Swedish municipalities have therefore paid landowners to create field headlands intersown with ley crops, allowing people to walk or ride along them. Trails of varying length and with specific destinations are a good idea, perhaps leading to a burial mound or a willow-clad ridge. These green corridors should also serve as habitats for a diversity of insect and plant life, and preferably as corridors along which animals can move unhindered.

Preliminary results from a project at SLU in Alnarp have shown that existing green corridors do not seem to have much of a favourable impact on biodiversity. However, biodiversity is greater where grass is not cut very often. Intersowing meadow plant seeds and planting trees and bushes are simple ways of improving conditions for biodiversity. ■



Biodiversity can be improved in the green corridors in lowland farming landscapes.

An intact landscape for animals

www.cbm.slu.se

Andreas.Seiler@ekol.slu.se

The road network creates barriers in the green infrastructure for animals. The more fragmented the landscape, the more difficult it is for populations to survive. In the end, fragmentation reaches a critical point and the animals disappear from the locality. As conditions worsen for animals, human recreation values decline. In several places in Western Europe road networks are already so dense and the landscape so fragmented that it no longer functions ecologically.

The situation is also serious around Sweden's major towns and cities. Scientists at SLU in Grimsö are looking for tools to identify problematic road distances and to assess what should be done to improve the present Swedish road network from an ecological viewpoint. A geographical pilot model showing the location of barriers for moose and roe deer is already in place. ■

Land quest bad for African women



PHOTO: JENNY SVINNÄS GILLNER

www.sol.slu.se

Linley.Karlton@sol.slu.se

Increasing demand for food and fuel places considerable stress on land and water, especially for poor women in Africa.

The food crisis of 2007–2008 arose when issues of climate change were high on the agenda in richer countries. It is estimated that biofuels accounted for 30 per cent of the increase in grain prices from 2000 to 2007. The growing demand for biofuels is partly a result of the EU "Climate and Energy Package", aimed at cutting greenhouse gases and energy consumption. Subsidies have provided an incentive for rich countries to engage in the production of ethanol or biodiesel crops.

To meet fuel, food and animal feed requirements, investors from rich nations require large areas of land. This quest for land has implications far beyond the economic crisis on Wall Street. Poor women in Sub-Saharan Africa bear the brunt of these new priorities. They are responsible for over 70 per cent of the food obtained for household use, yet they have very weak property rights to land, water and other natural resources. ■

Animals need quality time too

www.hmh.slu.se

Linda.Keeling@hmh.slu.se

Good animal husbandry is not just about reducing animal suffering and stress. Improving their life quality is just as important.

“We know little about how to measure pleasure among adult animals, but we know that play in young animals is a good sign. In order to play, animals must not be hungry, thirsty or ill, nor must they be experiencing stress or fear,” explains Linda Keeling, Professor of Animal Welfare at SLU.

For many years Professor Keeling has studied behavioural abnormalities in various kinds of animals, including chicken and pigs. In recent years she has also examined dog behaviour and the interplay between horse and man.

One common factor permeates all her research on behaviour and welfare: finding out why animals react as they do in various situations, and how they perceive those situations.

Not only in agriculture. Many think that the main shortcomings with regard to animal life quality only concern agricultural animals. But there are also pets that need a better quality of life in order to be happy.

“Before anyone buys a pet, they should consider carefully whether they will be able to give the animal the time and attention it needs.”

Professor Keeling emphasises that the first weeks in the life of most animals are particularly important. Animals that are in a stimulating environment and given company are better equipped to cope with difficult situations later in life. Studies at SLU have shown that chickens must have access to perches and some form of litter so that they can learn to use these resources in a more natural way later on. The suppression of these and other natural behaviour is one of the main causes of stereotypies and poorer welfare in a wide range of animals.

Ensuring that farm animals live in a healthy environment will not require costly building investments. More plentiful straw and more appropriate social groups may suffice to improve well-being.

“Animals that are not in a good state of mental health and consequently develop behavioural abnormalities represent a hidden cost to the farmer. Profitability may be jeopardised,” says Professor Keeling.

Happier is healthier. Earlier research concentrated mainly on remedying negative conditions such as disease, stress, pain, etc. Professor Keeling is now moving forward and focussing on the positive feelings that animals may experience. One example is the various expectations an animal may have to something positive. She has studied the manifestation of expectations in hens and dogs.

“The more we learn about animals, the more impressed we are about range of emotions they seem capable of experiencing. The result is a growing respect for animals,” she explains.

Professor Keeling’s research has increasingly taken account of our approach to quality of life in humans. Good welfare is more than the mere absence of suffering. There is another, positive dimension at the opposite end of the spectrum. This is where the question of feelings arises.

Animals cannot talk, but they do have body language, which can reveal how they react in various situations – just like human beings.

“By taking a closer look at the way animals behave in situations we perceive as positive, we can identify and confirm credible indicators. After that we can create tools to help us recognise when animals are happy or content in other situations as well,” says Professor Keeling. ■

TEXT: CARIN WRANGE

FACTS

SLU conducts research on care, disease, health and behaviour of domestic animals. Examples include:

- **Emotionality in dogs** – developing methods to measure emotional states and their significance in relation to the welfare of dogs.
- **Welfare Quality** – European research project on animal welfare in agriculture and at slaughterhouses.
- **Econ welfare** – a project addressing economic aspects of good animal husbandry.
- **Pig tail biting** – this combines behavioural research with epidemiology to examine the biological mechanisms underlying this behavioural abnormality.

Professor Linda Keeling has studied behavioural abnormalities in chicken and other animals.



Fungi and mussels acceptable in fish feed

www.lmv.slu.se

Jana.Pickova@lmv.slu.se | Eva.Brannas@vfm.slu.se

Farmed predatory fish (salmon, cod, etc.) need large quantities of food, which at present consists of wild-caught marine fish species that are endangered to varying degrees. SLU researchers have previously shown that much of the fish oil in the feed can be replaced by vegetable oils, such as rapeseed oil. When fish were fed with alternative sources of protein, for example, mussel meal and zygomycetes (a kind of filamentous fungi), they grew as well as did fish raised on traditional feed.

At present, half of both the fish oil and the protein in the feed can be replaced by alternatives such as mussels, zygomycetes and rapeseed oil without jeopardising the growth or health of the fish. One future scenario is an ecocycle in which mussel farming and fish farming are combined. The mussels ingest the algae that take in nutrients leaking from the fish farm and can then be ground down into meal for use as fish feed. ■



Mussel farming and fish farming can be combined in an ecocycle.

Right genotype of hens for organic eggs

www.huv.slu.se

Klas.Elwinger@huv.slu.se

Hen feathers contain sulphurous amino acids, mainly cystine. Cystine deficiency can be prevented by using a feed additive consisting of synthetic methionine, which is converted into cystine. However, this method is not open to organic egg farmers.

Researchers at SLU in Uppsala have shown that hens try to compensate for methionine deficiency by looking for feathers from other hens on the ground, or by eating greenery in the outdoor run. The Hyline genotype used the outdoor run much more than did Svenska Hönan, and the Lohmann Selected Leghorn, which is a very common genotype in Sweden, was particularly susceptible to feather plucking. Hyline hens that had not received any methionine additive in their feed spent more time outdoors in the runs, denuding them of all greenery in some cases. Thus, it is important to select the right breed for organic farming. This may also save a considerable amount of money on feed costs, since hens with sparse plumage need more energy. ■

Leptospira thrives in a humid climate

www.bvf.slu.se

Sofia.Boqvist@bvf.slu.se



The disease leptospirosis is caused by the *Leptospira* bacterium, which is capable of infecting numerous kinds of animal, including dogs, horses, cattle, pigs and rodents. Leptospirosis is also a zoonosis, i.e., it can be transmitted to humans. Since *Leptospira* thrives in places where the climate is humid, the disease may become more of a problem in Sweden if the climate here becomes warmer and wetter.

Leptospirosis is suspected of having caused impaired reproduction among pigs at a number of farms in Sweden. The disease is difficult to diagnose, however.

Leptospirosis is present among wild boar, which are suspected of spreading the disease to pigs kept outdoors. Researchers at SLU in Uppsala are now studying various serovars (strains) of *Leptospira*, as well as their occurrence and geographical distribution among wild boar and pigs kept outdoors. Preliminary results from the study show that the disease is found among both wild boar and pigs kept outdoors. ■

Measuring forest biomass from space

www.srh.slu.se

Johan.Fransson@srh.slu.se

The Biomass mission has been selected as one of three candidates for the next European Space Agency Earth science mission, launching in 2016. Johan Fransson at the department of Forest Resource Management at SLU in Umeå is leading SLU's participation in the project.

"If selected, the Biomass mission will determine the distribution and temporal changes of forest biomass on a global scale in a consistent manner. The data collected will advance our understanding of the carbon cycle and its role in controlling climate," says Johan Fransson.

The winning earth science concept will be selected in 2011. ■

Easier access to forest archives

www-nfi.slu.se

Anna-Lena.Axelsson@srh.slu.se

More than eighty years of forest data provides a basis for new research as well as for evaluating current Swedish forest and environmental policy. Anna-Lena Axelsson, researcher and Head of Section at the Department of Forest Resource Management, is leading a project to facilitate and broaden the use of historical data from the National Forest Inventory in Sweden (NFI), which started in 1923.

"By converting archive material from paper sheets into digital format, we are extending the series of data that is accessible to researchers in a wide range of disciplines. The material is currently being used to study changes in biodiversity indicators over time," says Anna-Lena Axelsson. ■

The pros and cons of stump harvesting

mvm.slu.se

Tryggve.Persson@ekol.slu.se

The stumps left in Swedish forests after felling are a resource that has hitherto been scarcely used to produce biofuels, even though these stumps represent more than 20 per cent of the biomass of coniferous trees.

At present it is difficult to say whether it is environmentally acceptable to harvest tree stumps on a large scale, since there are large gaps in our knowledge at all stages – from the logistics of grubbing up stumps to impacts on rivers and streams, biodiversity, forest production and carbon and nitrogen cycles.

For this reason SLU has now initiated a major research programme "Environmental effects of stump harvesting" on positive and negative impacts of stump removal. The research is intended to result in new recommendations on the types of stumps and habitats that should be excluded in the interests of sustainable stump harvesting, and how soil disturbance can best be avoided. ■

HEUREKA

A tool for multipurpose forestry

www.mistra.org/heurekaweb

Tomas.Lamas@srh.slu.se

Many analyses of carbon cycles are made in the context of climate, and this also applies to forestry. The focus is often either on soil or tree biomass, and only covers parts of a rotation period or certain forest management activities. But the Heureka research programme has now adopted an overall approach to carbon cycles in forests and forestry. Carbon binding in trees and soil as well as timber and biofuel production, recreational values, and biodiversity, can all be analysed using one and the same tool.

A number of comprehensive computer programs designed for different users and fields have been developed. Besides research and education, large and small forest companies, organisations and public agencies are expected to derive practical benefit from the tool in conjunction with maintenance of various kinds of forest values and multipurpose forest management planning. ■

Showing the way to sustainable forests



PHOTO: MICHAEL KVICK

www.futureforests.se

Tomas.Lundmark@esf.slu.se

The climate is changing and we don't know what the forests will be like in the future. Growing demand for timber, energy and recreational values further complicates the picture, and the decisions we need to take about forests and forestry are therefore difficult ones.



Not only Swedish forests. Much of the research is being conducted in the form of sub-projects. Here, researchers are engaged in traditional research on all aspects of sustainable use of the forest landscape.

The Center for Forest System Analyses and Synthesis is the unifying force in Future Forests. Its task is to perform scenario analyses and otherwise address complex research issues.

Future Forests is a Swedish research programme concerned with Swedish conditions.

"But whether we are in Sweden, Russia, Alaska or North Korea, coniferous forest and a northerly latitude are common factors. This means that the work we do and the conclusions we reach in Future Forests will also be of interest for much of the rest of the world, particularly bearing in mind climate change," says Professor Lundmark.

TEXT & PHOTO (PORTRAIT): ANDERS ESSELIN

FACTS

Future Forests is a research programme launched in 2009. Its annual budget is almost SEK 40 million and the programme is intended to last for eight years. The programme is being conducted jointly by SLU, Umeå University and the Forestry Research Institute of Sweden. It is being funded by Mistra (*the Foundation for Strategic Environmental Research*), Swedish Forestry and the universities involved. Some 40 researchers from a range of scientific disciplines, and around the same number of practitioners from various sectors of society, are engaged in the programme.

The aim of a major new research programme entitled Future Forests is to make it easier to take these decisions about the forest management of the future.

The programme is founded on the assumption that climate change, globalisation and growing consumption of energy and raw materials will increase demand for forest resources. We need to intensify forestry to extract more timber, paper and energy, without jeopardising biodiversity, recreation and other ecosystem services.

"The strength of the programme is that there are sufficient resources and expertise to be able to focus on the entire complex system, of which both ecosystems and man form a part. We will be able to study how we can use our forest landscape sustainably in the future," says Professor Tomas Lundmark, who is heading the programme at SLU in Umeå.

Thinned forest maintains the carbon sink

www.ekol.slu.se

Achim.Grelle@ekol.slu.se

Forest management has a major impact on the carbon balance. SLU researchers are using modern technology to monitor flows of carbon dioxide in the atmosphere above forests of various kinds. A forest growing normally in Sweden can absorb 5–10 tonnes of carbon dioxide per hectare and year. But when biomass is removed, both absorption and decomposition in the remaining forest change.

A common method of harvesting wood from the mature forest is final felling accompanied by soil scarification, where the ground is left with hardly any vegetation remaining. The carbon stock in the soil begins to break down, carbon dioxide is released into the atmosphere, and it takes many years before the new young forest has grown enough to become a net carbon dioxide sink.

When trees are blown down in a storm, all assimilating vegetation is destroyed and the ground is broken up by uprooted stumps, which can result in carbon dioxide emissions twice as high as those occurring after final felling. Unexpectedly, natural unmanaged woodlands close to Uppsala have also been found to emit 3–5 tonnes of carbon dioxide per hectare and year.

However, thinning or selective felling seems to have very little impact on forest carbon balance. Even though there are fewer trees per hectare, the remaining forest can absorb as much carbon dioxide as before thinning, since the growing biomass benefits from reduced competition. ■



PHOTO: SARA GRELE

After final felling of forest, carbon dioxide is released into the atmosphere.

Capturing images of wood fibres

www.cb.uu.se

Gunilla.Borgefors@cb.slu.se

It used to be difficult to image the fibre structure of paper and card. Wood fibres reflect light so well that it is impossible to study the internal structure of paper using a normal microscope. But for some years now it has been possible to produce high-resolution, three-dimensional images of the fibre structure of paper and other wood fibre composites using microcomputer tomography. The Centre for Image Analysis at SLU in Uppsala is developing methods of analysing various properties of such materials using these new imaging techniques.

With new analytical methods, materials like paper and card can be made stronger and their surface better adapted for printing. This may make it possible to make newsprint thinner without the paper tearing or the ink being visible on the wrong side. The methods can also be used in developing biocomposites of plastic and cellulose. The methods can also be used in developing biocomposites, i.e., a combination of maize-based plastic reinforced with wood fibres. These new materials are environmentally friendly and can become quite strong. ■

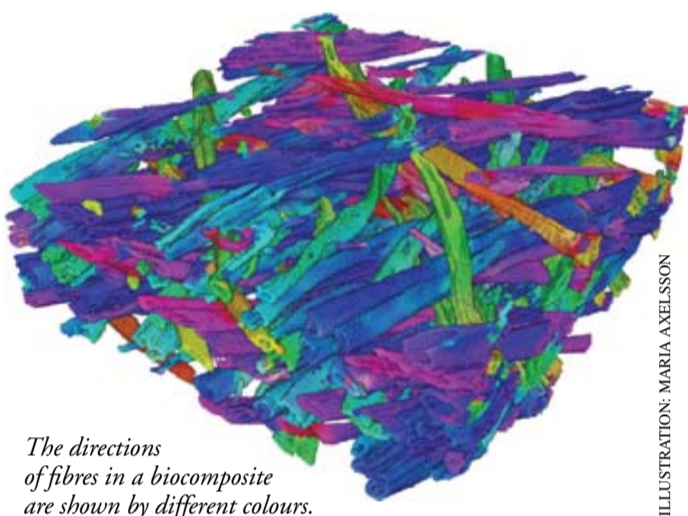


ILLUSTRATION: MARIA AXELSSON

The directions of fibres in a biocomposite are shown by different colours.

Bio-surfactants rescue tomato roots

www.lti.slu.se/3

Malin.Hultberg@lti.slu.se

Greenhouse tomatoes are often grown in closed recirculation (hydroponic) systems to minimise the leakage of nutrients to watercourses and the sea, and to economise on fertilisers. However, root pathogens in the algal fungi genera *Phytophthora* and *Pythium* can severely reduce crops of all greenhouse vegetables and ornamental plants.

Certain types of bio-surfactant, i.e. surface tension active components that are produced by some micro-organisms, have been found to control the spread of the fungi. Algal fungi have no cell walls and are therefore very sensitive.

Researchers at SLU in Alnarp are now studying the bio-surfactant-producing bacterium *Pseudomonas putida*, which is very easily propagated. It can grow and produce surfactants on a cheap growing medium such as used deep fat or motor oil. Hence, a biological component is produced at the same time as oil waste products are decomposed in an eco-friendly way. ■



PHOTO: NORA ADELSKÖLD

Root pathogens in greenhouse crops can be controlled in an eco-friendly way.



PHOTO: PROCORDIA

Healthier french fries using refined olive oil.

Refined olive oil best for deep frying

www.lmv.slu.se

Paresh.Dutta@lmv.slu.se

According to SLU researchers in Uppsala, potato chips and french fries contain decomposition products from phytosterols. Phytosterols are chemically related to cholesterol, whose decomposition products may be a contributory factor in arteriosclerosis and certain diseases. Concentrations of phytosterol decomposition products were highest in french fries from fast food restaurants, somewhat lower in potato chips and lowest in oven-cooked french fries. It has not been established whether the levels recorded are harmful to health, however.

The researchers found that refined (not virgin) olive oil was one of the most stable oils when heated. The other oils in the test were palm oil, sunflower oil and two kinds of rapeseed oils.

It was also found that the quantity of oxidation products from phytosterols in olive oil can be halved by adding vitamin E. Therefore, for healthier and better quality fried food products, refined olive oil can be recommended as an alternative for deep frying. ■



PHOTO: NORA ADELSKÖLD

Rosa rugosa is an invasive species in Sweden.

Invasive species costly to control

www.ekon.slu.se

Ing-Marie.Gren@ekon.slu.se

Rugosa rose, HIV, the rat and Iberian slug – over the years many alien species have been introduced in Sweden, deliberately or inadvertently. These “invasive” species have caused varying degrees of devastation in water, on land and among man and animals.

Researchers at SLU in Uppsala have estimated the cost to Sweden of thirteen invasive species. The total cost arising as a result of these species was between SEK 175 and SEK 565 per capita, which is on a par with the cost of the Swedish carbon dioxide emission reduction programme, or the action plan to combat eutrophication of the Baltic Sea.

Species introduced inadvertently, such as Iberian slug and the house mouse, account for at least three-quarters of the cost, whereas species originally introduced to be used in some way, such as giant hogweed, mink and signal crayfish only account for one quarter. The researchers compared the cost to Sweden for the thirteen species with estimated costs in eight other countries. The majority of costs in most countries have been incurred in the agricultural sector. ■

Chemicals impairing reproduction

www.cru.slu.se

Leif.Norrgrén@bvf.slu.se

Sterile seals, thinner raptor eggshells and lower sperm counts among men in the West. Substances causing hormonal imbalance resemble natural hormones so closely that they can fool the body. If male fish are exposed to chemicals resembling the female hormone oestrogen (from contraceptive pill residues, for example), they may start producing egg cells as well as sperm. This reduces the reproductive capacity of fish.

Phenomena jeopardising reproductive capacity are a serious threat to biodiversity. Some causal links, such as the effect of DDT on shell formation in birds' eggs, are known. But there are 100,000 chemicals and substances registered in the EU. As yet there is no information about the effect of most of them on reproduction. ■

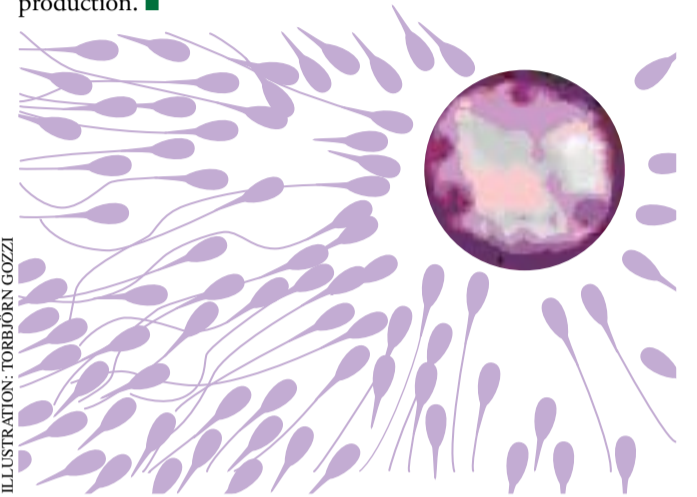


ILLUSTRATION: TORBJÖRN GOZZI

Substances resembling natural hormones can reduce reproductive capacity.

Wolves often killed by poaching

vilt.ekol.slu.se

Hakan.Sand@ekol.slu.se

A decline in fertility due to inbreeding among the Scandinavian wolf population is not the main threat to wolf numbers. Instead, poaching (illegal killing) is the prime culprit. Poaching has greatly slowed the increase in wolf numbers, but has not prevented it entirely.

Researchers at SLU in Grimsö, working with Norwegian wolf researchers, estimate annual mortality to have been 30 per cent during the period 1999–2006. It remained at 20 per cent in the 1990s. Poaching is responsible for around half of wolf deaths, while natural mortality, injuries from road traffic and legal hunting account for the remainder.

Poaching is likely to play a major part in population dynamics of wolves and other large carnivores elsewhere in the world. Scandinavian wolves do not seem to depart from this pattern. ■



PHOTO: BEAUTIFUL SWEDEN

Poaching, not inbreeding, is the main threat to the Swedish wolf population.

SOME MAJOR PROGRAMMES AT SLU

The Swedish Taxonomy Initiative

More species than ever before

www.artdata.slu.se/STI

Ulf.Gardenfors@artdata.slu.se

Sweden is the first country in the world to fully rise to the challenge of scientifically describing and naming its species.

Sweden probably has over 60,000 species of multi-cellular organisms. This is almost twenty times more than the number estimated by Linnaeus. But very little is known about how half of these species live and where they occur. Accordingly, the Swedish Species Information Centre at SLU has been instructed by Parliament to continue Linnaeus's work in the form of the Swedish Taxonomy Initiative.

To fill the gaps in our knowledge, a survey is being made of the groups of organisms about which we know least. Extensive surveys have been carried out both in the sea and on land. In just a few years almost 2,000 species new to Sweden have been discovered, of which 800 are new to science. But to learn more we must also better describe the species and the way they are related to each other. For this reason, the Taxonomy Initiative also gives financial support to taxonomic research.

When completed, the Encyclopedia of the Swedish Flora and Fauna will enable anyone to read about Swedish species. Numerous high quality illustrations, distribution maps and illustrated identification keys in both Swedish and English render the encyclopedia readily accessible to an international audience. Eight volumes have been published so far, with more to come.

Sweden may have been first, but in January 2009

Norway also launched a Taxonomy Initiative. The Governments of Norway and Sweden have signed an agreement to work together on unfolding and describing species diversity, and to promote their respective taxonomy initiatives. ■



PHOTO: MANTZ BERGGREN

The marine inventories have revealed the existence of two hundred new species.



Melanostoma mellinum.

ILLUSTRATION FROM THE ENCYCLOPEDIA OF THE SWEDISH FLORA AND FAUNA: ERIK NASIBOV

HagmarksMistra

Many species in semi-natural grasslands

www.hagmarksmistra.slu.se

Urban.Emanuelsson@cbm.slu.se

Semi-natural grasslands are among the most species-rich landscapes in Sweden. Their use for haymaking and grazing over many generations has resulted in very high biodiversity. However, the diminishing area of well-managed semi-natural grasslands means that many farmland species are declining in number; some of them are critically endangered.

HagmarksMistra is a broad interdisciplinary research programme, coordinated by the Swedish Biodiversity Centre at SLU during 2001–2008, whose aim is to promote sustainable farming systems for semi-natural grasslands of various kinds. Combining ecologically sound management with profitable production and enterprise models to maintain high biodiversity, while taking the management history and farmers' experiences and perceptions into consideration, have been key features of the programme. ■



PHOTO: ROGER SVENSSON

Grazing of grasslands over a long period has resulted in very high biodiversity.

ICON

Lubricant oils from crops

icon.slu.se

Sten.Stymne@ltj.slu.se

Our dwindling reserves of fossil oil mostly derive from vegetable oils, transformed under high pressure and heat deep in the earth's crust. Genetic engineering can be used to modify new oil crops, such as *Crambe abyssinica* and *Brassica carinata*, so that they produce wax esters instead of the usual triacylglycerol oils. These wax esters withstand heat and high pressure, and can therefore be used as a substitute for fossil oils as a lubricant in machinery etc.

The "Industrial Crops producing added value Oils for Novel chemicals" research project (ICON) has a total budget of SEK 100 million, of which SEK 55 million has been funded by the EU. 25 laboratories in 11 countries are being coordinated by SLU at Alnarp. ■

UPSC

Cutting-edge plant biotechnology

www.upsc.se

Ove.Nilsson@genfys.slu.se

Plants growing close together in unthinned forest, containers or nurseries react to the shady conditions. The shade causes them to quickly increase their production of auxin, a growth hormone that stimulates growth in the stem and inhibits the formation of lateral shoots.

Dr Karin Ljung at Umeå Plant Science Centre (UPSC) and research teams in the US, France and Argentina have been engaged in a joint project in which they have identified a gene responsible for conversion of the amino acid tryptofan into auxin. Their findings may have a bearing on plant production in forestry, agriculture and horticulture.

UPSC is a world-leading research environment in the field of plant biology. It is a collaborative centre for SLU and Umeå University. UPSC research covers a broad spectrum, from the cell and molecular biology of plants to the ecophysiology of forest trees. ■

ICE³

Pine moths fooled by smell of birch

ice3.se

Fredrik.Schlyter@ltj.slu.se

One of the projects in Insect Chemical Ecology, Ethology, and Evolution (ICE³) focuses on the host and non-host volatiles present in angiosperm dominated habitats and their effect on conifer insects. Researchers at SLU have found an olfactory active compound in birch leaves, which could be used to create a "fake" mixed forest. This would cause the pine processionary moth to attack pines less frequently in that area.

The aim of the extensive ICE³ programme is to study the modulation of insect response to chemical signals on physiological, behavioural, and ecological time scales. Methods range from molecular biology to landscape-scale manipulation of behaviour. The research is being conducted by the Chemical Ecology Group at SLU in Alnarp. ■



A compound in birch leaves can fool forest pest insects.

MicroDrivE

Smart biofuel production

microdrive.slu.se

Johan.Schnurer@mikrob.slu.se

Cellulose-rich plant biomass, e.g. crop residues from agriculture and forestry, is our largest renewable source of organic raw materials. However, the technology used to convert the biomass into biofuels must be improved.

The basic idea of the MicroDrivE research programme, led by Professor Johan Schnürer at SLU in Uppsala, is that micro-organisms can be used in a better way than at present. This may greatly improve the way we manufacture biofuels such as ethanol and biogas.

During biomass storage, an organism such as the yeast *Pichia anomala* can prevent the raw materials from being ruined by moulds, saving energy otherwise used for drying and simultaneously enhancing bioethanol yields. Pre-treatment with pressure, heat, acids and/or enzymes that break up large molecules further increases the yield from production of ethanol or biogas.

The researchers consider that all stages of the manufacturing process can be improved, including the ethanol and the biogas fermentation processes. The well known yeast *Saccharomyces cerevisiae* has been regarded as the best for fermentation, but, quite unexpectedly, the researchers have now found a new yeast species that works better. They have also identified new promising organisms for biogas production, and are also studying ways of using digestion residues as biofertiliser. ■



The technology used to convert biomass into biofuels can be improved by using the right micro-organisms.