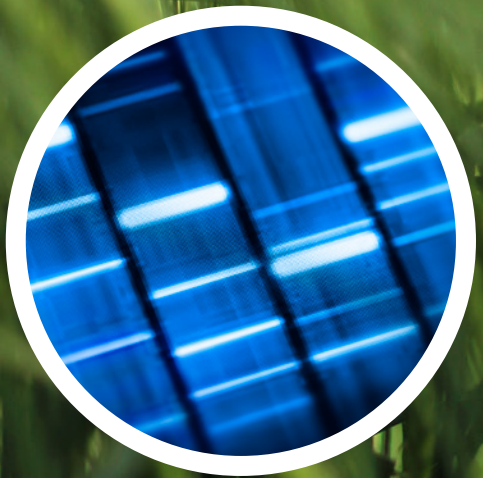
Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Mistra Biotech
Annual Report 2013

MISTRA Biotech

Mistra Biotech, Annual Report 2013

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MISTRA
The Swedish Foundation for Strategic Environmental Research

SLU

The world faces major challenges associated with our environment, human use of natural resources and our impact on our surroundings. The Swedish Foundation for Strategic Environmental Research (Mistra) plays an active part in meeting these challenges by investing in the kind of research that helps to bring about sustainable development of society.

This is done by investing in various initiatives in which researchers and users make joint contributions to solving key environmental problems. Mistra's programmes cut across disciplinary boundaries, and the results are intended to find practical applications in companies, public agencies and non-governmental organizations. For more information, vistit www.mistra.org.

Chair's preface

Board meetings consist of a lot of administration, including yearly reports, budgets, communicating with our funding agency Mistra and our host SLU, and so on. All of this is important, and our discussions are both interesting and pleasurable. But for me personally, the most interesting part of the board's work is the meetings that we have with the scientists in Mistra Biotech. We usually meet with representatives of one of the component projects in connection with each board meeting, and I am convinced that all members of the board find these presentations very interesting. We rarely have time to dig deeply into a specific area or project during regular board meetings, and I have learned a lot during each of these special presentations. I would like to share three observations that I have made so far.

First, during these presentations we have met people from nearly every continent. SLU is a truly international workplace that attracts professors, postdocs, and graduate students from all over the world. This is essential for the success of Mistra Biotech just as it is for the other research projects at SLU. Obviously, Sweden can only retain its strong position in science if we continue to be an attractive and open nation where people from all parts of the world feel welcome.

Second, it is gratifying to see what competent and dedicated researchers we have in our programme. Together, they represent top-level knowledge in an impressively wide area of fields covering the natural and social sciences and the humanities. I also want to emphasize the value of the meetings that occur between the researchers coming from different projects. These meetings contribute much to the programme's development and provide new thoughts and ideas for the programme. I especially want to mention the "Mistra Biotech week" in Falsterbo last autumn where the board participated for part of the time.

Third, it is clear from the presentations of our researchers and from my discussions with many of them that what drives them is not just increasing knowledge for its own sake. They want their research to make a difference in practice by providing better protection of the environment, sustainable agriculture, and healthier food on our tables. Their goals and aspirations fit in very well with the objectives of Mistra Biotech but also the objectives of Mistra, and this bodes well for the future.

Inger Andersson
Chair of the Board

« Inger Andersson, Chair of the Mistra Biotech Board.

Not a new technology any more

It has now been forty years since eleven American researchers, headed by Paul Berg, wrote a letter to the journal Science in 1974 proposing that scientists should "voluntarily defer" two types of experiments with biologically active recombinant DNA molecules. They did so because there was "serious concern that some of these artificial recombinant DNA molecules could prove biologically hazardous".

In my view, they were right. Given the state of knowledge at the time, the potential hazards of this new technology needed to be carefully evaluated and a moratorium on the new technology was justified. A careful evaluation was performed, and the moratorium was lifted at the Asilomar Conference on Recombinant DNA in February of 1975. Scientists resumed their experiments, applying safeguards that they had agreed upon. Twenty years later, Paul Berg (then a Nobel Laureate) and Maxine Singer (another leading biologist) wrote a retrospective paper rightly concluding that the new technology had revolutionized biological science. Moreover, this had been achieved without any of the harmful effects that they had feared twenty years earlier. They wrote:

> *"Literally millions of experiments, many even inconceivable in 1975, have been carried out in the last 20 years without incident. No documented hazard to public health has been attributable to the applications of recombinant DNA technology. Moreover, the concern of some that moving DNA among species would breach customary breeding barriers and have profound effects on natural evolutionary processes has substantially disappeared as the science revealed that such exchanges occur in nature."*

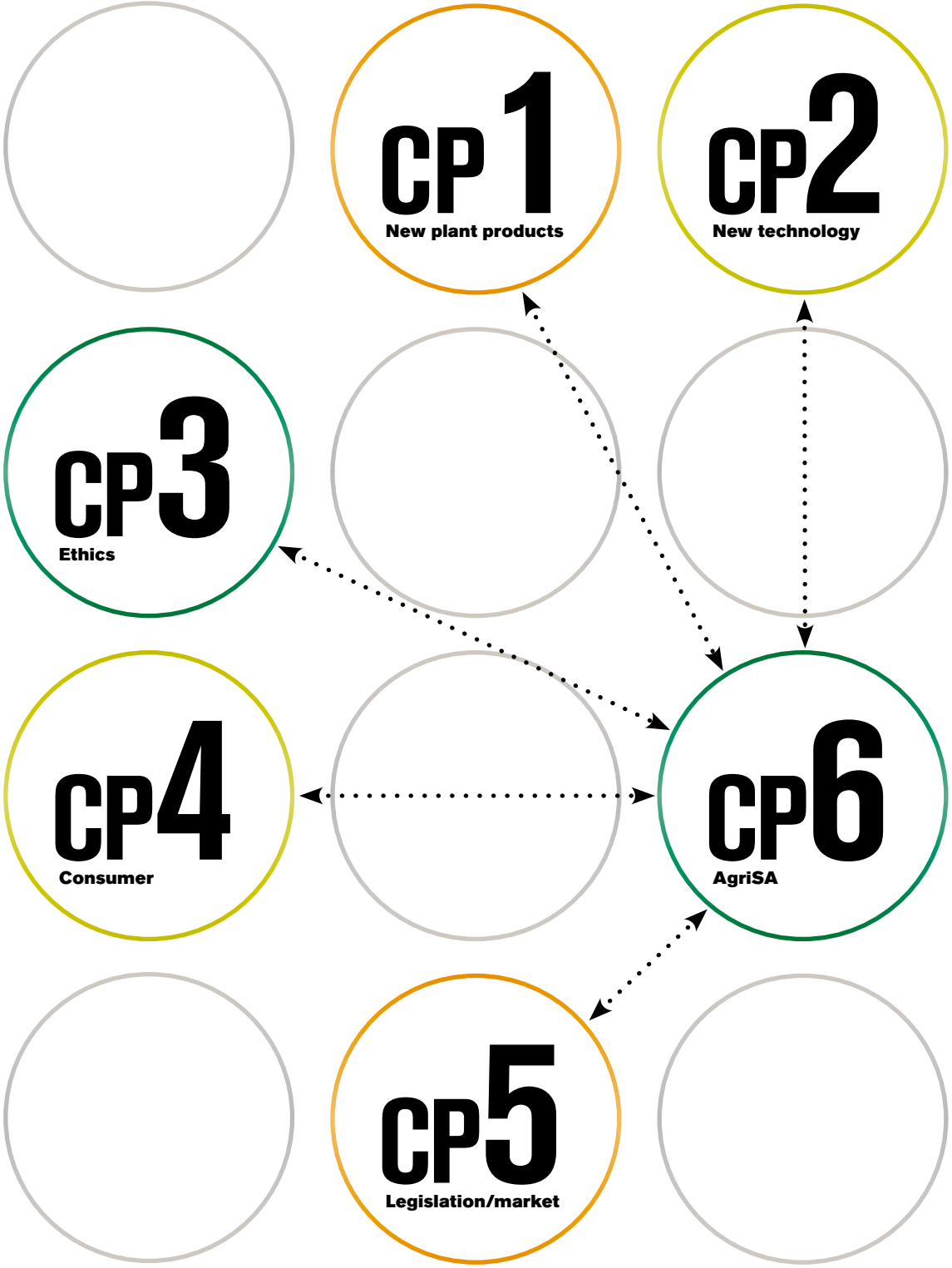
Berg, P & Singer MF (1995) The recombinant DNA controversy: Twenty years later. *Proc. Natl. Acad. Sci.* 92: 9011-9013

In the forty years that have passed since the letter in Science by Berg and his colleagues, our knowledge in genetics, plant and animal biology, and ecology has increased dramatically. Experimental procedures that were steps into the unknown in 1974 are now well understood, both chemically and in terms of their effects on the organism. We also have practical experience from using biotechnology on a large scale. About 12% of the world's agricultural area is dedicated to genetically modified crops. Genetic modification, in agriculture and elsewhere, is no longer a new and untested technology. The uncertainties that justified the 1974 moratorium have been replaced by in-depth understanding of the technology, its mechanisms, and its consequences.

In spite of this, we still have a legislation that has its focus on the uncertainties that prevailed forty years ago, rather than those of today. This needs to be rectified. Today's knowledge in genetics, plant biology, and ecology needs to be used to its fullest extent in the assessment of new crops and cultivars. We also need to use science to identify the uncertainties that we have in front us, so that we can focus on them rather than on those that we have behind us.

Sven Ove Hansson
Programme Director

« Sven Ove Hansson, Professor in Philosophy at the Royal Institute of Technology (KTH) and Guest Professor at the Department of Crop Production Ecology, SLU.


CP 1
New plant products
CP2
New technology
CP3
Ethics
CP4
Consumer
CP6
AgriSA
CP5
Legislation/market

Mistra Biotech

Mistra Biotech is an interdisciplinary research programme focusing on use of biotechnology for sustainable and competitive agriculture and food systems. Our vision is to contribute to the processes that will enable the Swedish agricultural and food sector to produce an increased amount of high-quality, healthy food at moderate costs with less input, decreased environmental impacts, and healthier crops and livestock. The goal is sustainable production systems from ecological, social, and economic perspectives. We perform research in both the natural and the social sciences.

Our research in the natural sciences is aimed at utilizing the potential of agricultural biotechnology to contribute to more sustainable food production with healthier products and fewer environmental impacts. With ability comes responsibility, and we take the concerns that have been raised about potential negative effects of biotechnology applications on human health and the environment very seriously. For us, safety, control, and transparency are essential regardless of which technology is used.

Our research in the social sciences has its focus on the social, economic, and ethical aspects of the use of biotechnology in agricultural production. We study consumer attitudes and behaviours related to the use of agricultural biotechnology for food products and investigate issues related to governance and regulation in the Swedish agri-food system. Our social research has a strong focus on sustainability issues and on the perspectives of stakeholders in the food production systems.

The research in Mistra Biotech is organised into six component projects (CPs). Five of these focus on the following research areas: new plant products, new technologies, ethics, consumer attitudes, and legislations/markets. The results from these CPs are integrated into the sixth CP called the Centre for Agriculture and Food Systems Analysis and Synthesis (AgriSA).

Mistra Biotech involves over 50 researchers. Most are at SLU, but some work at KTH, Lund University, and other academic institutions. The programme includes international cooperation with Aarhus University, the University of Edinburgh, and other institutions. Mistra Biotech is funded by Mistra with 10 million SEK per year from 2012 to 2015. The programme can apply for phase-two funding for an additional four years. SLU co-funds the programme, matching the Mistra funding with a further 10 million SEK. Many companies, agencies, and organisations also support the programme with their knowledge, experience, and valuable feedback. Lantmännen SW Seed AB also contributes financially with a sum of 50,000 SEK per year.

« The research in Mistra Biotech is organised into six component projects (CPs). The results from CP1-CP5 are integrated into the sixth CP called the Centre for Agriculture and Food Systems Analysis and Synthesis (AgriSA).

Increased knowledge about the genome (the whole genetic set-up) can improve breeding in both crops and livestock.

We use the term "biotechnology" in a wide sense that includes (but is not limited to) the use of genomic technologies, selective breeding, biomolecular markers, and genetic modification as well as technologies for cell and tissue culture and for animal cloning.

CP1 PLANT BIOTECHNOLOGY FOR INNOVATIVE PRODUCTS

In this project we are developing the wild biennial species *Lepidium campestre* (field cress, also known as field pepperweed) as an oil and catch crop. A catch crop is one that is sown under cereal crops during the spring and harvested the following year with the aim of reducing soil tillage and mitigating nutrient leaching. Using both genetic modification (GM) and non-GM techniques enables us to compare the effects of different breeding methods on the improvement of important agronomic traits. The main targeted traits are increased oil content and quality, increased seed yield, and reduced pod shatter (i.e., seed drop before harvest), which causes huge losses in seed yield.

To reduce reliance on fertilizers and pesticides in barley and potatoes, our work focuses on making nitrogen use more efficient and improving pathogen resistance.

We focus on health issues by developing a potato with a low glycaemic index, breeding for high oleic acid oil in field cress, and analysing the structure and properties of starch from different types of barley. The quality of starch is of great importance in both human food and animal feed, but the starch can have different properties depending on granular size distribution, composition, and the chemical structure of the individual starch components.

Contact: *Li-Hua Zhu, li-hua.zhu@slu.se*

Collaborations:
Lantmännen, SW Seed AB
Lyckeby Starch
Swedish Rural Economy and Agricultural Societies, Kristianstad
The GenePool Ashworth Laboratories, University of Edinburgh
Prof. Lars Østergaard, John Innes Centre, UK
Prof. Thordal-Christensen's group, Copenhagen University

CP2 NOVEL MOLECULAR BREEDING TOOLS

Most economically important traits in crops and livestock that influence either product yield or disease resistance are complex traits governed by many genes and their interactions with environmental factors. Traditional breeding approaches use pedigree information and statistical tools to estimate the proportion of variation that is due to heritable factors, but these methods treat the genome as a "black box". Today's new technologies facilitate genome sequencing at a fraction of the original costs. We are developing methods and tools for the use of whole genome sequence data in breeding – that is, selecting plants and animals based on information about the entirety of their DNA instead of just looking at specific genes. Because traits in plants

are often largely dependent on environmental factors, the need to implement these factors into selection tools presents challenges for molecular breeding. Similar challenges also provide opportunities for improved use of molecular breeding tools in cattle. We are also investigating the potential to use information about proteins – the products of the genome – in breeding in order to screen for and select suitable plants and animals at an early stage in the breeding process.

Contact: *Dirk-Jan de Koning, dj.de-koning@slu.se*

Collaborations:
Lantmännen, SW Seed AB
Viking Genetics, Skara
SciLife Laboratory, Uppsala
Aarhus University, Denmark
MTT Agrifood Research, Finland
Edinburgh Genomics, University of Edinburgh, UK

CP3 ETHICS

The debate about ethical issues in biotechnology and its applications is deeply polarized. Despite extensive literature on the ethics of technology in general, there is a shortage of studies carried out in close collaboration with the scientists who actually develop these technologies. Therefore, much of the debate is insufficiently informed by recent developments and is rather sweeping in character. Also, few applications of ethical technology assessment involve new biotechnologies, and even fewer take into account the potentially positive environmental and health impacts of agricultural applications of biotechnology in a systematic way. We hope to provide a structured method of making this debate less polarized so as to allow everyone to better understand each other's arguments.

Contact: *Karin Edvardsson Björnberg, karin.bjornberg@abe.kth.se or Per Sandin, per.sandin@slu.se*

CP4 CONSUMER ATTITUDES

Why do consumers act as they do? What are the driving forces behind attitudes and behaviours when it comes to food produced using agricultural biotechnology? What is our perception of risks and trust? We hope to reach a better understanding of the underlying consumer-related issues that will play an essential role in the acceptance and use of any application of agricultural biotechnology in Sweden. The research in this component project focuses on in-depth studies of the driving forces behind consumer attitudes and behaviours related to the use of agricultural biotechnology for food products. The project explores the psychological foundations of technology acceptance, risk perceptions, choice, and trust among members of the general public in their roles as consumers.

Contact: *Carl Johan Lagerkvist, carl-johan.lagerkvist@slu.se*

CP5 SWEDISH COMPETITIVENESS

The economic and regulatory environment in which firms operate has a direct effect on their ability to produce, and to adopt, new technologies. Firms produce innovations when they have the ability to commercialize their products or services at a profit.

The profitability of an innovation depends on the degree to which firms are able to capture the economic benefits generated by their innovations. We analyse the structure and governance of the Swedish agri-food system and the national and international regulatory environments. We also explore Sweden's capacity to produce and distribute innovative products and processes, the constraints on this capacity, and the impact of all of this on the Swedish economy.

Contact: *Konstantinos Karantininis, karantininis.konstantinos@slu.se*

CP6 CENTRE FOR AGRICULTURE AND FOOD SYSTEMS ANALYSIS AND SYNTHESIS, AgriSA

The work in AgriSA focuses on whole production systems and stretches across disciplines within the human, agricultural, natural, and social sciences. AgriSA is a hub where the information and results from all Mistra Biotech projects are processed and where overall syntheses are made and communicated to stakeholder groups. AgriSA is also a platform for collaboration between researchers involved in Mistra Biotech's CPs and other researchers. The aim of this work is to understand and facilitate the implementation of sustainable food production using biotechnology as a tool.

Contact: *Lotta Rydhmer, lotta.rydhmer@slu.se*

Complex debate, not only an issue in biotechnology

Alarik Sandrup has worked in the field of bioenergy for many years, previously at the Federation of Swedish Farmers (LRF) and now at Lantmännen. During those years he has followed and participated in the sometimes intense debate over biofuels. At the same time he has followed similar debates about sustainability and food-related biotechnology.

– The differences and similarities in these debates can show us much about creating constructive dialogue, especially that tolerance, facts, and reconciliation are factors that promote successful discussions.

For example, Alarik has noticed that in most discussions of big changes in agricultural production both proponents and opponents seem to follow similar patterns. Biofuel and GMO (genetically modified organism) debates are often technically complex, and debaters tend to get even more technical the further the discussion proceeds.

– Lacking an overview of the complexity of different academic and political areas leads only to a discussion where the participants talk past each other, comparing apples to oranges. Discussion is drawn away from the actual subject matter by general opinions, for example about poor people's rights, shifts in power, land use, globalization, food security, and transitions to a market economy. Resistance against biotechnology and GMOs might be based on scepticism against a globalized market rather than against biotechnology as such.

Several influential actors – governments, international policy makers, farmer's organisations, the food industry, and NGOs – are involved in both biofuel and biotechnology, a factor that Alarik believes is playing a part in the debate. Oil and gas companies and the automobile industry are also important players that have large, but discrete, influence in the debate about biofuels.

– The biotech debate differs from the debate on biofuels because of the greater involvement of the scientific community and large plant breeding companies. Common for the debates are that businesses, scientists, and politicians are coming together on a question that is complex, detailed and of high economic importance, and which tends to cause emotional reactions.

What can be learned from the debate on biofuels?

– In Sweden, the debate on biofuels has been rather balanced, not leading to the extremes we have seen in other countries. This is partly due to the Swedish conditions, including plenty of arable land and positive experiences from the transition to bioenergy for electricity and heat production, and the fact that the leading NGOs have not been campaigning for the sake of campaigning but because they have wanted to have a constructive dialogue.

What have Lantmännen, as a supporter of sustainable biofuels, done to facilitate this dialogue?

– Lantmännen has focused on the relevant facts and communicated on a level that is relevant for the target group. I think that our focus on communication and collaboration have been very important for the positive view of biofuels in Sweden.

Historically, the debate about GMOs and biotechnology has been rather narrow, concentrating mostly on natural science issues. Here Alarik thinks that Mistra Biotech can contribute to a broader and more nuanced and constructive discussion about several questions and aspects in the area.

– Mistra Biotech is doing important work focusing on communication and ethics as a broader interdisciplinary approach.

What are the challenges for agriculture in Sweden?

– Swedish agriculture is facing major challenges due to increased global competition and declining production in several important production sectors. A wide range of constant improvements are required to reach a positive agricultural development. Gene technology offers major opportunities for improvement in profitability, competitiveness, and sustainability for Swedish agriculture and Lantmännen. New technologies can best be introduced and accepted with science based, constructive, and broad communication. Here also Mistra Biotech plays an important part.

« Alarik Sandrup, Director of Government and Public Affairs, Lantmännen Energi.

Field cress - a new oil crop?

Of the about 7000 species of plants that have been cultivated for consumption, only about 30 crops provide 95% of human food energy needs today. Globally, more than 60% of our energy intake comes from four crops: rice, wheat, maize, and potatoes.

Most of our crops were domesticated thousands of years ago, including emmer wheat in 9000 BC, barley in 8500 BC, rice in 8000 BC, and maize in 7000 BC.

Throughout history, a number of plants have been grown for their oil – both for consumption and for industrial use – and recently for biofuel. Palm and soybean produce by far the largest shares of vegetable oils consumed today, followed by rapeseed and smaller volumes from sunflowers, peanuts, and cottonseed. Among these, the only economically viable oilseed crop in Sweden is rapeseed. Rapeseed was first grown for use as a lubricant and lamp oil, but nowadays rapeseed (or canola as the edible variety is called) is considered a healthy food oil due to successful breeding in the early seventies. Two Canadian researchers managed to reduce the level of bad-tasting glucosinolates and an unhealthy fatty acid named erucic acid.

The demand for plant oils for food and biodiesel is expected to increase steadily in the coming 20 years. However, the potential for increasing production from the existing oilseed crops in Sweden is limited, mainly due to a limited number of oil crops and their low winter hardiness.

The late Professor Arnulf Merker of SLU identified *Lepidium campestre* (field cress) as a promising species for domestication. It is a biennial species with an upright stature, synchronous flowering, an average of about 30% more yield than the winter oilseed rape, and maybe most important, a cold-hardiness that allows it to grow even in the northern parts of Sweden. Field trials have shown that field cress has no problem overwintering as far north as Umeå. In the same trilas, only 2% of the rapeseed and 60% of the turnip rape survived. Besides its cold-hardiness and oil-rich seeds, field cress is biennial making it a suitable catch crop that can be sown under cereal crops during spring and produce seeds for harvest the following year. This will reduce tillage and nutrient leaching because the field cress will cover the otherwise bare soil. Nutrient leaching causes groundwater contamination, especially with intensive use of nitrogen-based fertilizers and tillage. Also, unlike many other catch crops, field cress has shown a positive effect on the seed yield of companion crops such as barley.

However, some of its properties must be altered in order for the species to be an economically viable oil crop. The oil content of its seeds is about 20% compared to 45% in winter rapeseed, and the oil consists of about 25% erucic acid. Erucic acid is an anti-nutritional fatty acid, and EU regulations have set a maximum limit of 5% erucic acid in food oils. Additionally, the oil is high in polyunsaturated fatty acids (PUFAs) that are very prone to oxidation which makes the oil rancid quickly and thus restricting its use in the food industry. Solving the problems with oil content and quality is only one step on the way toward a high-yielding oil crop because the seeds must also be harvested. Field cress possesses a most unfavourable trait, pod shatter, that causes seeds to fall to the ground before harvest and can result in a loss of up to 50% of the seeds. A plant's ability to distribute its mature seeds is essential in the wild, but such a trait is useless if you are a farmer trying to harvest as many seeds as possible.

One of the projects in Mistra Biotech (CP1) is to develop a field cress that is virtually devoid of erucic acid and has significantly reduced PUFAs (linoleic and linolenic acids) but is very rich in oleic acid. This is desirable because the demand for oxidation-stable oils that are high in oleic acid has increased drastically in the food industry recently due to the negative health effects of hydrogenated plant oils. (You can read more about this on page 15 and onwards.)

« A field cress seed peeking out from the open pod. The ability to distribute mature seeds is essential for a plant in the wild, but difficult to handle if you wish to harvest the seeds in an efficient way.


Lepidium
N094-2

In this report we present some of the results from Mistra Biotech's second year, some not published yet. Sign up for our newsletter on www.slu.se/mistrabiotech to follow our achievements.

Domesticating field cress

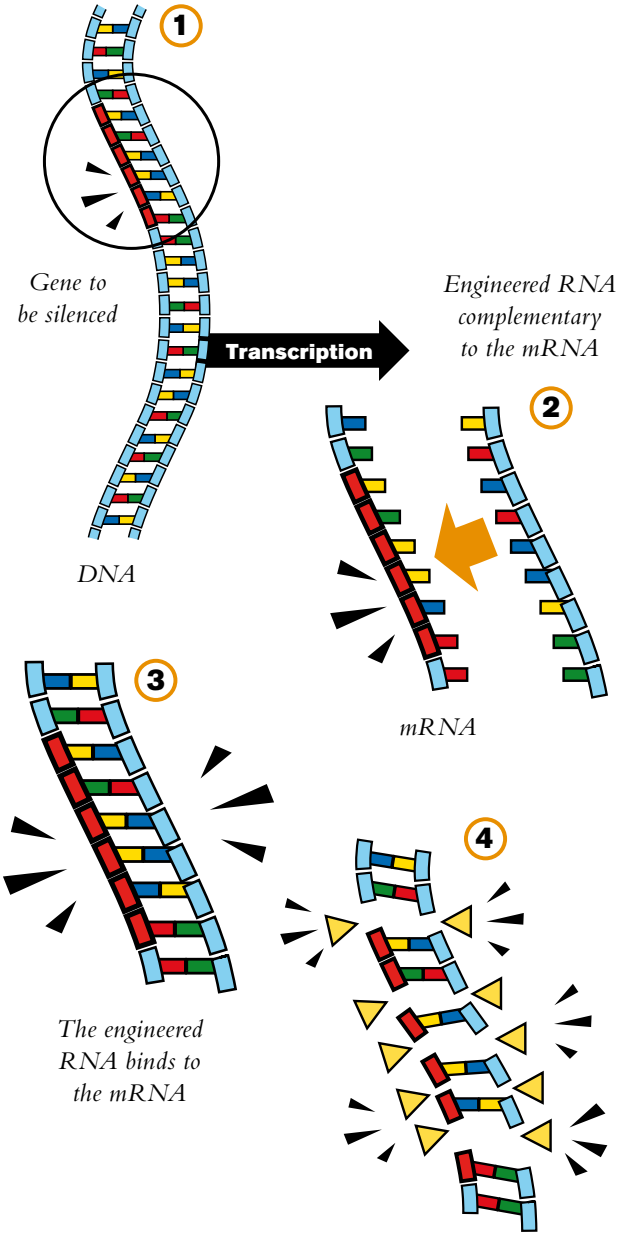
Contact: *Li-Hua Zhu, li-hua.zhu@slu.se*

In their work with field cress (*Lepidium campestre*) Li-Hua Zhu's group uses both genetic modification and non-GM techniques. This enables them to compare the breeding methods' effects on the improvement of important agronomic traits like oil content, oil quality, seed yield, and pod shatter. Synchronised maturity and root growth are also monitored in their trials. In parallel with the trait improvements, they also grow the field cress in trials together with cereals in order to develop an improved catch-crop cultivation system.

Improving traits through genetic modification

To improve oil content, the researchers have transferred different genes proven to increase oil content from *Arabidopsis thaliana* (thale cress) into field cress. So far, all the genes used have resulted in some increase in oil content. The results are not conclusive yet because the transgenic lines are still heterozygous (meaning they have different alleles of the target gene).

They are also trying to increase the levels of the healthy oleic acid (a mono-unsaturated omega-9 fatty acid) in the oil by turning off the genes coding for specific enzymes that otherwise make longer, less-healthy fatty acids such as PUFAs and erucic acid. This is done using the so-called RNA interference (RNAi) technique. When part of a target gene sequence that produces RNA that complements the plant's own single-stranded mRNA is inserted into the plant, the mRNA becomes double-stranded. This double-stranded RNA is cut into small pieces by a specific RNA-cleaving enzyme thus preventing the RNA from being translated into a protein. Here they used the sequences of two genes from the field cress itself to perform the RNAi experiment. The oil analysis in the first generation seeds has shown that the oleic acid content increased dramatically from 10% to over 70%



The principle of RNA interference (RNAi) is used to prevent specific genes (for example genes involved in production of fatty acids) from being expressed by stopping mRNA from being translated into a protein. A gene that codes for a RNA strand complementary to the gene's mRNA is transferred into the genome. The two RNA strands pair up and form a double-stranded RNA. In plants mRNA normally only exist as single strands and double-stranded RNA is quickly degraded by the cellular enzymes that protect the plant against viruses.

« A great number of field cress plants have been studied in greenhouse trials.

Harvest of one of the field cress trials at Lanna, south of Lidköping.

of the total seed oil and that the contents of PUFAs and erucic acid decreased considerably. (read more about the oil content and quality below)

The researchers have also used the RNAi technique to reduce pod shatter. Here they used a gene from field mustard (*Brassica rapa*) that has been shown to down-regulate the pod-shatter gene in *Arabidopsis*. They have now tried to use the equivalent gene in field cress for the same purpose. In the first generation, at least two transgenic lines had much lower rates of pod shatter and the other lines showed moderate reduction compared with the wild type plants. Zhu and colleagues are continuing the screening and selection for the desired traits in the most promising lines.

Improving traits by crossings and selection

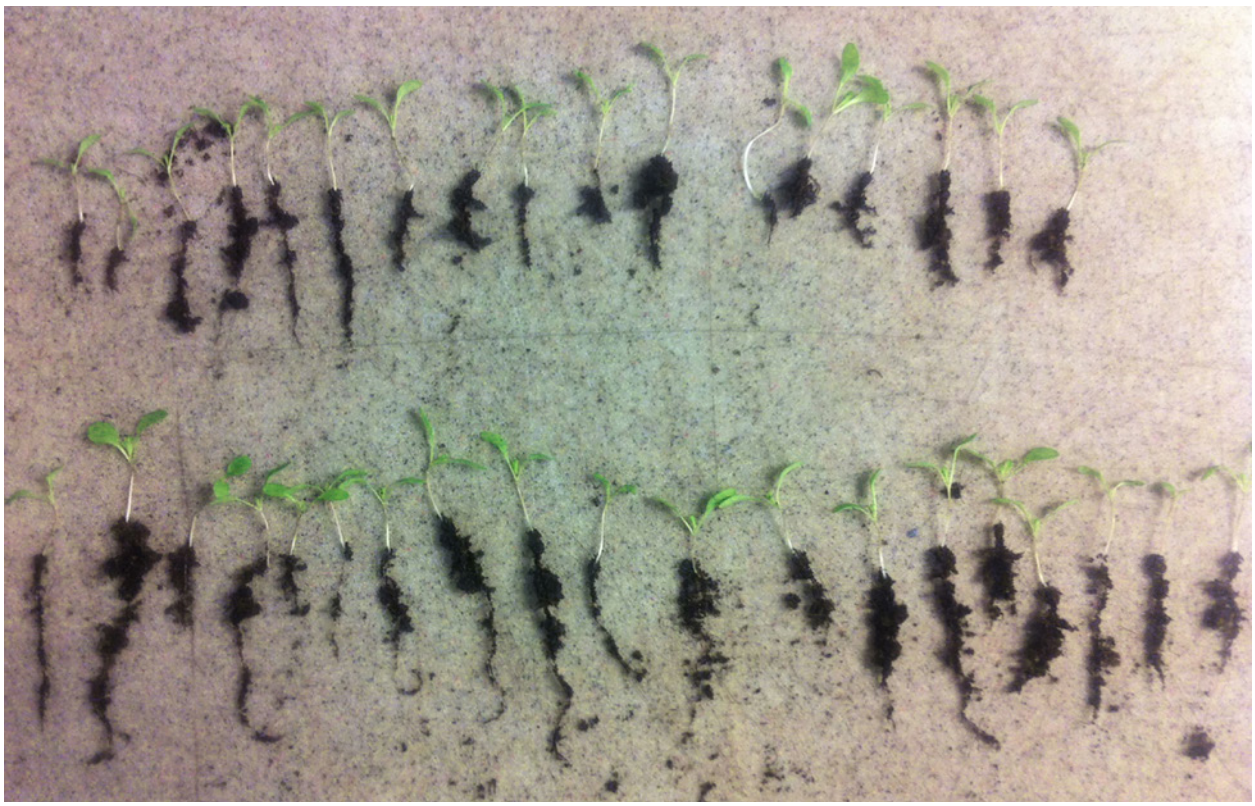
The researchers have searched for field cress plants with desirable traits in all regions of Sweden where field cress is reported to grow, ranging from the southern tip of the country up to Gävle, and the from west coast to the east coast including the islands of Öland and Gotland. Along with samples from gene banks and botanical gardens, these collected materials have been used in crossings and selections to improve a number of traits, especially reduced pod shatter.

They evaluated 1,600 plants and the genotypes representing 36 populations for various desirable traits, including the progenies of genotypes selected from a field evaluation in 2012. Crosses between lines with different genotypes results in very large genetic variation in the second generation (F2). Such large variations in the F2 population is needed to find out where on the chromosomes different genes are located. Zhu and colleagues performed hybridizations between different *L. campestre* genotypes with extremely high rates of pod shatter and genotypes with low rates of pod shatter, and these resulted in successful crosses that will be used to map populations and develop genomic tools.

A large number of inter-specific crossings (i.e., between species) were also made between *L. campestre* and *L. heterophyllum*. The 600 different F2 hybrids have been evaluated and phenotyped for various desirable traits, and of those 200 plants have been selected for further evaluation of their ability to regrow as perennials. Some F2 hybrids actually produced higher seed yields than the best *L. campestre* lines, and the best of their progenies will be evaluated in 2014. The F1 and selected F2 plants of these inter-specific hybrids were backcrossed with the best *L. campestre* genotypes in order to develop superior genotypes. New *L. campestre* x *L. heterophyllum* F1 hybrids were also generated through hybridization of selected genotypes of the two species in order to produce superior hybrids. Inter-specific crossings were also made between *L. campestre* and *L. graminifolium* as well as between *L. campestre* and *L. draba* in an effort to increase the oil content and to reduce pod shatter in field cress (*L. campestre*). The results from those crossings have yet to be analysed.

Oil content and quality

Each vegetable oil has a characteristic stability against oxidation depending on its fatty acid composition. The content and composition of other minor lipid components such as PUFAs are responsible for oxidation and off-flavours in fried food. Oils rich in PUFAs should be minimized for deep frying because they lack oxidative stability. However, from a nutritional point of view oils with high amounts of monounsaturated fatty acids



Many organisms, especially plants, produce biochemicals that influence the growth, survival, and reproduction of other organisms. This is called allelopathy. In crops it means that they can lower the competition for space, water, nutrients, and light. In intercropping systems, like our field cress/cereal system, allelopathic crops can cause problems by supressing the other crop. To understand more about how the field cress responds to the cereals, the researchers performed a small test in which barley was planted one week before the field cress. The picture shows the plants after another 10 days. The upper row of field cress plants were grown together with barley (cultivar Waldemar), and these plants had almost 50% shorter roots when grown together with barley compared to when they were grown by themselves. However, the allelopathic effects seem to differ significantly for different barley cultivars.

(MUFAs) or PUFAs are desired because of their negative correlation to chronic degenerative diseases. Thus, a frying oil low in PUFA and high in MUFA (i.e. oleic acid) would provide an almost ideal frying oil in terms of both stability and health.

Two lines of the field cress bred for oil content showed slight increases in total seed oil content from about 22%–24% to about 27%–29%. Those lines have been selected for further breeding along with three genotypes of the recently collected populations because they had a relatively high oil content of 22%–24% (the goal is 30%). The researchers also analysed seeds from greenhouse trials and field trials of various field cress accessions. There was a wide variation in total lipid contents (18%–27%), but we detected only small variations in the distribution of fatty acids. PUFAs and MUFAs were the dominating fatty acids, ranging from 21% to 25% and from 35% to 37%, respectively, and the proportion of erucic acid was also high (21%–25%). The level of cholesterol was remarkably high in all samples compared to most other oil seeds. Studies will continue with additional samples in order to determine the natural variations of the analysed components within *L. campestre* before they go on to analyse samples from crossings.

Vegetable oils have very different properties depending on their fatty acid composition, for example health and cooking properties.


canterbury
SILVER FERNS

Animal geneticist hoping to speed up plant breeding

Contact: *Elisabeth Jonas, elisabeth.jonas@slu.se*

Elisabeth Jonas, or Lisa as she is more often called, grew up on a pig and crop farm in Rhineland-Palatinate in western Germany, and as long as she can remember she enjoyed working in the fields and in the piggery. The choice to study agricultural sciences and to specialise in animal sciences was, therefore, an easy one. After earning a degree in Agricultural Sciences at the Rheinische Friedrich-Wilhelms University in Bonn, Germany, she started to work toward her doctoral degree at the Institute of Animal Science in the Department of Animal Breeding and Husbandry at the same university.

– My farming background was useful because I had additional practical knowledge and the opportunity to take weekend work breaks on the farm.

After earning her doctoral degree in 2006 and spending one year as a postdoc at the Institute of Animal Science, Lisa obtained a position at the University of Sydney where she stayed for 4 years before the Mistra Biotech programme got her to move to Sweden two years ago. Now she holds a postdoc position at the Department of Animal Breeding and Genetics at SLU Ultuna.

– It is nice to work in a larger research context because I had become very focused on my own work during my previous position. The collaboration with different research fields has broadened my horizons and offered me a good overview of the project within a larger research context.

In her research, Lisa is focused on the introduction of novel breeding tools in crops. Why did you switch from animals to plants?

– Before, my work was focused on the identification of the genetic background of various traits such as growth, milk yield, and inherited defects in pigs and sheep. So working in this project is a new challenge for me. I hope my strong background in animal genetics and breeding can be an asset in the project and that I can transfer my knowledge into crop systems.

Her role in the project (CP2) is to try to develop applicable methods and models that will allow the use of molecular genetic markers in crop breeding programs. Similar selection tools are currently used in livestock breeding and are promising because they also aim to improve the health and welfare of animals.

– If such molecular genetic markers can be used to improve selection choices in crop breeding, the goals of the breeding programme can be reached in less time and with lower costs. With the currently predicted global population growth over the coming decades, food production needs to be increased in a sustainable manner. I am hoping that my models and methods will contribute to improved crop breeding.

Genomic selection in plant breeding?

Contact: *Elisabeth Jonas, elisabeth.jonas@slu.se*

Selection based on genomic information, often called genomic selection, is a recently developed concept that aims to use genetic markers across the whole genome as a selection tool in breeding programmes. Genomic selection is a so-called "black box" approach because associations rather than knowledge of the biological functions of genes are used. This technique has been developed from previous marker-based techniques and became useful when genotyping became more affordable. Today this method has been integrated into dairy cattle breeding programmes and is being tested in other livestock and plant species.

In the process of crop breeding few favourable plants are being selected among numerous lines. Selection starts at early stage of the development and is based on measurable traits during those stages, often visible information such as height or colour. However, the genetic progress for traits measurable at later stages (for example, increases in yield) is predicted to be low, compared to more accurate assessments of phenotypes and information showing high correlation with the final traits, such as the breeding value. Therefore, many plant-breeding companies aim to integrate genomic information into their programmes. Furthermore, numerous studies using simulated and empirical data have been published, often promising high reliabilities when using breeding values based on genetic markers, so-called "genomic breeding values".

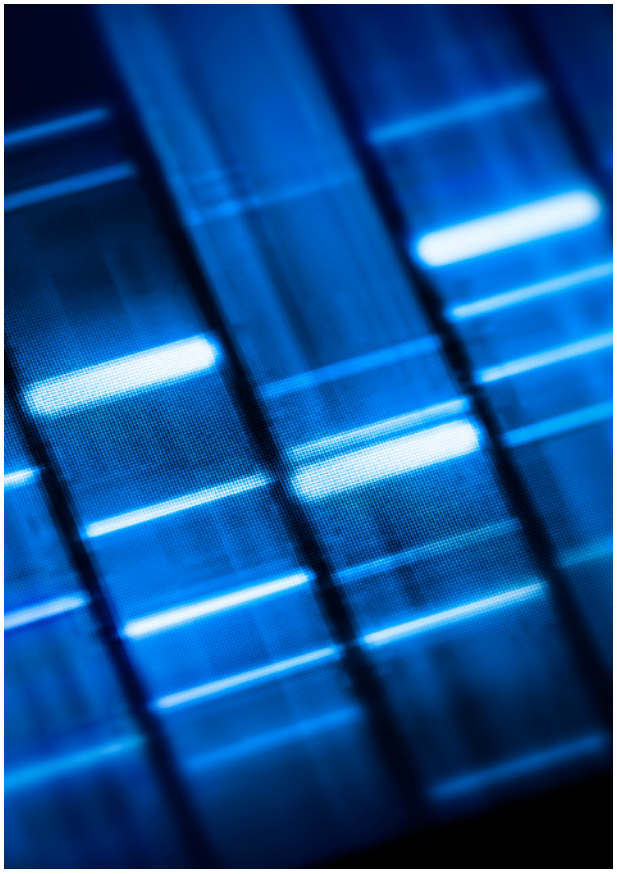
But how realistic are those assessments? In a paper by Elisabeth Jonas and Dirk Jan de Koning, they conclude

« Elisabeth Jonas, Postdoc at the Department of Animal Breeding and Genetics at SLU.

that in many approaches genetic markers can be used as an additional tool with a better predictive value compared to some of the current selection steps in a breeding cycle. Genomic selection has been proposed to both provide a more accurate estimate of genetic merit as well as to shorten the generation interval. At present, however, strategies to shorten the breeding cycle are rarely discussed.

Jonas and de Koning emphasise that a functioning collaboration between geneticists, farmers, breeders, and seed producing companies is needed to integrate novel approaches for improved breeding into realistic breeding schemes. Also, because there is a huge difference between cattle breeding and plant breeding, methods successfully applied in the former have to be carefully considered for the latter.

Jonas, E., & de Koning, D.J. 2013. Does genomic selection have a future in plant breeding? Trends in Biotechnology 31: 497–504.



Due to technological developments, genetic analyses can now be performed for a fraction of the cost compared to 20 years ago.

Improving nitrogen uptake

Contact: *Torgny Näsholm, torgny.nasholm@slu.se*

Nitrogen fertilization is a cornerstone of modern agriculture, but crop plants use only a portion of the total nitrogen in the applied fertilizers. This results in significant amounts of nitrogen that are lost via leaching, thus polluting lakes, rivers, and oceans. Moreover, some of the nitrogen in the applied fertilizer is converted into the potent greenhouse gas nitrous oxide (N_2O), and this accounts for a large part of agriculture's contribution to global greenhouse gas emissions. Crops that use nitrogen more efficiently require less fertilizer, and developing such crops would enable lowering the amount of nitrogen leaching from the soil while at the same time improving crop production.

Torgny Näsholm and colleagues have used recent advancements in the understanding of how plants acquire organic forms of nitrogen and applied them to crop plants. With the help of gene technology, one can directly modify an existing cultivar by introducing a target gene of interest while maintaining other beneficial traits in the cultivar unchanged.

In an attempt to increase nitrogen uptake in common agricultural crops, the researchers have transformed barley with genes for nitrogen uptake transporters from thale cress. Three of the GM lines were selected for a field trial in which they injected solutions of labelled amino acids into the field plot in order to measure the amino acid uptake. Some transgenic rapeseed and transgenic potato lines were also transformed with the same genes from thale cress and evaluated for nitrogen

"crop plants use only a portion of the total nitrogen in the applied fertilizers"

uptake. The new genes did not seem to change the amino acid uptake in the potatoes, but the transgenic barley and rapeseed had an increased amino acid uptake efficiency compared to the non-GM plants. Evaluation of different GM lines are continuing.

Governance and innovative crops

Contact: *Konstantinos Karantininis, karantininis.konstantinos@slu.se*

Konstantinos Karantininis and Li Feng have done various studies on the governance and organization of the vertical and horizontal transactions that occur among various agriculture industry participants, and that are relevant to the adoption and use of innovative crops such as GM plants. Governance refers to the assortment of payment schemes, incentives, allocations of property, and decision rights that form the basis of economic transactions.

Innovations require the coordination of multiple industry participants and cannot be achieved through the efforts of one player. Co-specific investments from various independent industry participants are needed. Karantininis and Feng developed a hold-up model showing how multiple parties in the vertical food chain (farm input suppliers, farmers, and buyers of the farm produce) have to invest in transaction-specific assets that are necessary for an innovative agricultural product to be brought to market. A hold-up problem occurs when parties refrain from cooperating efficiently due to concerns that their own profits will be reduced by other parties' bargaining power. Karantininis and Feng consider two ways to prevent this problem. One solution is that the potentially opportunistic party takes on the other parties' investment costs as a credible commitment to the completion of the exchange. The other solution is vertical or lateral integration of business operations (e.g., a merger between two seed providers) that would improve the bargaining power of the consolidated parties and reduce the risk of market failure.

The researchers found that in products such as GMOs, key parameters that determine the choice of governance are specific assets, property rights, and risk. When assets are highly and asymmetrically specific and the final product is bound by strict delivery contracts, one among the relevant organizational forms could be a new-generation cooperative in which the supply of the primary product is also bound by fixed delivery obligations. Empirical research shows that the farmers who have chosen such cooperatives tend to be more homogeneous than those who have chosen investor-owned firms, and the farmers feel that these cooperatives offer better ways to deal with production risk and price uncertainty.

Challenging the arguments

Contact: *Payam Moula, payam.moula@slu.se*

Payam Moula left his hometown of Linköping two years ago to become a PhD student at the Royal Institute of Technology (KTH) and Mistra Biotech. As part of the ethics project (CP3) he is surrounded by other philosophers, but he also has close contact with researchers in other areas of the programme.

– Working with natural scientists is different and exciting. I very much appreciate the opportunity to work as a part of a large research programme with people doing research within the natural sciences. My research is dependent on empirical questions, for example: What is a GMO? How does a GMO differ from a non-GMO? What does the empirical research say about the effects on humans, livestock, and environment when genetic modification is used? These are questions that I as a philosopher am not working on so it is important to have empirical researchers to collaborate with.

Payam has an almost completely philosophical background with both a bachelor's and a master's degree in philosophy from Linköping University. His master's thesis focused on collective responsibility, presently a rather hot topic within ethics. But he is not all about philosophy; sports and a strong interest in politics take a fair share of his time as well.

In Mistra Biotech, Payam's research revolves around tools and methods that can help people to reason ethically on issues and on the notion of human hubris and GM crops. But how does philosophical research work?

– As ethicists, we do research mainly by studying what others have written on a subject and then making an analysis of the arguments and concepts used. We try to make our own point and back it up with strong arguments. Biotechnology is a controversial topic, and I believe that the ethical aspects of it are crucial to work on from a societal standpoint. It is important that the research and use of biotechnology is ethically correct and that people are able to get information and to evaluate their own arguments based on different ethical aspects.

For Payam, it is not only researchers within controversial topics that need to consider the ethical aspects of their work.

– I believe that it is important for a democracy that ethics is part of the research so that publicly funded program can acquire legitimacy and be ethically scrutinized.

Ethics, or moral philosophy, is a branch of philosophy that involves the study of moral concepts and ideas like right and wrong action, good and evil, justice, benevolence, duty, and so on. In applied ethics, analysis of real-world cases from specific areas (for instance medicine or environmental conservation) are in focus.

Evaluating ethical tools

Contact: *Per Sandin, per.sandin@slu.se*

The issue of biotechnology in agriculture involves many ethical issues such as the value of nature and naturalness and the moral status of species. Sometimes instead of discussing the issue we talk past each other because we do not understand the other person's viewpoint. We might also not be fully aware of how committed we really are to the issue at hand.

Ethical tools are devices for facilitating such deliberation, reasoning, and decision-making about ethical issues. They might, for instance, consist of computer games that help the users to clarify their own ethical standpoints or of meeting formats that help a group of decision makers to arrive at an ethically well-founded decision.

There are a number of such tools available. Until now, however, there has been a lack of clear criteria for evaluating them; that is, what makes an ethical tool a good one, and how can we choose among different tools? In a recent manuscript, Payam Moula and Per Sandin critically reviewed existing suggestions for how ethical tools are to be evaluated. Among other things, they argued that one particular proposal for evaluating ethical tools based on the concept of "ethical soundness" is unhelpful. Instead, they suggest that the quality of an ethical tool is decided by its purposiveness, i.e., how well the tool achieves its intended purpose(s). Just like regular tools, such as hammers, shovels, and scalpels, a good ethical tool is one that fulfils its purpose. The purposes of ethical tools differ, and thus the quality criteria should differ as well. Moula and Sandin present a categorization of such tools and the assessment criteria for each:

1. All ethical tools can be judged on the crucial qualities of *comprehensiveness*, or how well a tool includes all relevant considerations, and *user-friendliness*.

Payam Moula, PhD student at the Royal Institute of Technology (KTH). »

2. For tools that have the goal of reaching a decision in a democratic context, the criteria of *transparency, action guidance*, and *justification of decision-supporting mechanisms* are important.

3. For tools with the aim of engaging the public, *procedural fairness* is crucial. Procedural fairness ensures that the use of the tool, if used by a group, is carried out in a fair and justified way. Several such tools have been used in the assessment of biotechnology in Europe.

Moula and Sandin also note that the scope of use for an ethical tool is limited to a single moral community (a group of people who share basic norms and values) and that this feature is frequently overlooked. Tools are typically unhelpful if the users of the tool disagree too much about some fundamental value issue. If a group of discussants have a completely different view on whether naturalness is a morally relevant consideration, some tools might be of limited use. Thus future research should focus on identifying criteria for the scope of an ethical tool's applicability and the limits for its successful application.

EU consumers not that negative about GMO

Contact: *Sebastian Hess, sebastian.hess@slu.se*

Even after decades of use, the biotechnological modification of food products is still controversial and the conditions in which consumers accept such modifications are still not well understood. Therefore, Sebastian Hess and colleagues performed a meta-analysis of the scientific literature. In total, 1,673 original questions posed to respondents in 214 different surveys were meta-analysed. Their results showed that the questions suggested the tone of the response; a question with positive (negative) connotations about biotechnology tended to be associated with positive (negative) responses. Studies in the EU asked more often about

A moral community is a group of people who share basic norms and values. Ethical tools are difficult to apply if the users have different views on some fundamental value issue.

perceived riskiness or moral concerns than studies in other countries. However, when this was controlled for the results showed that, on average, EU consumers appear no more averse to biotechnological modification of food than other consumers elsewhere in the world.

Consumers' evaluations of biotechnology were largely insensitive to the type of food product. Stated benefits of biotechnological modification of food did not produce any significant positive reaction unless health-promoting features were incorporated. Price discounts, increased production, and various perceived risks induced negative evaluations of the technology.

"Studies in the EU asked more often about perceived riskiness or moral concerns than studies in other countries"

Perceptions in the Swedish food supply chain

Contact: *Karin Edvardsson Björnberg, karin.bjornberg@abe.kth.se*

Based on policy documents and semi-structured interviews with representatives of five organizations active in producing, processing, and retailing food in Sweden, Edvardsson Björnberg and colleagues investigated how those key actors in the Swedish food supply chain perceive the concept of agricultural sustainability and the role of biotechnology in creating more sustainable agricultural production systems.

Biotechnology can affect the sustainability of agricultural production systems depending on how the concept of agricultural sustainability is put into practice. According to some researchers, biotechnology, including transgenic varieties, could make the world's agricultural production systems less sustainable from an environmental point of view through, for example, gene spread or increased invasiveness. It could also make the world's agricultural production systems socially less sustainable if the regulatory system that develops in parallel with the introduction of GM varieties prevents socioeconomic development among certain segments of the population. However, biotechnology could also contribute to making our agricultural production systems more sustainable, for example, by making nutrient use more efficient or by reducing the land area needed for agriculture. These are important aspects because competition over natural resources, including land, is increasing due to population growth and changes in climate. Arguably, there is nothing inherently or manifestly unsustainable about biotechnology. As pointed out by some of the informants in this study, it all boils down to particular applications and the environmental, social, and economic risks that those applications involve. There is growing scientific evidence that, if put to use wisely, biotechnology can indeed yield significant environmental benefits.

The lack of precise action-guidance provided by the concept of agricultural sustainability, especially in relation to the use of biotechnology, does not mean that the concept has no policy relevance. However, it does make the concept vulnerable to "hijacking" by actors who have an interest in manipulating the concept to correspond to their own political agendas. How the concept is put into practice and which sustainability discourse is prevalent at a particular point in time is largely the result of a struggle between different actors. The actors who are strong in the debate also have the opportunity to make their particular sustainability discourse the dominant one in planning, decision-making, and public debate.

The study revealed the influence of external actors on the policy process and the resulting conceptualization of the sustainability concept. In Sweden, the current dominant discourse says that biotechnology is not part of sustainable agriculture, at least not when it comes to food for human consumption. This is clear from the policies of the organizations participating in this study. Although a majority of the interviewed organizations claim to have a positive attitude toward new technologies in general and admit that genetically engineered crop traits ought to be assessed on a case-by-case basis, they categorically reject adding food products containing GM varieties to their assortments. Thus, the perceived role of biotechnology in creating sustainable agricultural production systems is somewhat ambiguous. Our interview data

suggest that the prevalent agricultural sustainability discourse has been largely shaped by consumer attitudes and pressure from strong environmental organizations.

The sensitivity of anti-GM campaigns generally increases as one moves further down in the food supply chain from production to retailing. Among the organizations that participated in our study, LRF appeared to be the least sensitive and the food retailers the most sensitive to anti-GM campaigns. This might be because of organizations' susceptibility to changes in consumer behaviour (choice). Consumer behaviour can change easily and rapidly, sometimes overnight, as a result of political campaigns and media coverage. Although they affect all actors in the food supply chain, these changes in consumer behaviour have a much more direct impact on food retailers than on an organization like the LRF.

Shaping our food – an overview of crop and livestock breeding

Contact: *Anna Lehrman, anna.lehrman@slu.se*

Do you wonder about how breeding of animals and crops actually works? What is a gene? How come cows produce so much milk? What is the difference between "mutagenesis" and "genetic modification"? Are there any GM crops other than herbicide-tolerant soy? Who decides which kind of crops you are allowed to grow? We hope you will find the answers to those questions and many more in the book *Shaping our food – an overview of crop and livestock breeding* written by Anna Lehrman and colleagues in Mistra Biotech. It includes sections on the history of domestication and genetics, today's plant and animal breeding, breeding methods, contemporary production using GM plants and livestock, rules and regulations for breeding and for production based on genetic modification, the economic value of genetically modified crops, and ethical views on breeding. Special efforts have been put into illustrations and explanations of the latest methods in biotechnology. An English version (pdf) can be downloaded from our homepage, and a Swedish version will be available both as a pdf and paper copy in 2014.

www.slu.se/mistrabiotech/shapingourfood

Communicating gene technology – walking on eggshells...

Do you wish to know more about Mistra Biotech, or would you like to know who to contact about any of the related topics? Anna Lehrman, the communication officer of the programme, is always more than happy to help. Anna works closely with the programme director Sven Ove Hansson and the deputy programme director and project manager of AgriSA, Lotta Rydhmer. But what does she actually do?

- It is really a mix of different tasks! For example, I write the external newsletter and reports; arrange lectures, seminars, and workshops together with the researchers; follow the debate in different media; and keep an eye on new scientific papers. I also write an internal newsletter for the researchers connected to the programme to get information about meetings and conferences, learn about what happens within the programme, and find out what is going on outside of their academic circles. I know how difficult it can be for a researcher to just keep up with what is published in the scientific literature even within one research field, so I try to brief them on what is published in the lay media. This is also done through our homepage. If you want to know what's being written on the topic of agriculture and biotechnology, sign up to the RSS-feed to subscribe to the updates. But keep in mind that we can only post a small sample of everything that is being published.

What are the challenges in communicating the research done in Mistra Biotech?

- Apart from the common issue in science communication; explaining complicated things so that everyone can understand them, the challenge is to inform people about an area in which mistrust in science is common. A challenge in all science communication is that many people have little understanding of the scientific process and how scientific results are evaluated. In some areas, including biotechnology, the Internet is flooded with all kinds of "truths" posted by self-appointed experts, often spiced with a touch of conspiracy. The "real" experts, the scientists, have little time to respond to all of these inaccuracies and sometimes feel hopeless when the response to scientifically valid results is "Well, that's your opinion." It is understandable that many people do not know what to believe, given the information flow, but I think that many misunderstandings about science can be dispelled if people are given access to better information.

The discussion about biotechnology, and especially GMOs, involves many subjects and issues, including the environment, food, legislation, trade, and a general mistrust of science. What part can Mistra Biotech play in this jumble of issues?

- First of all, I hope and believe that our research brings interesting and relevant results. But I also hope that Mistra Biotech will become known as a trustworthy knowledge hub for questions regarding breeding and biotechnology, and what those tools might bring to the development of sustainable food production systems.

With a PhD in entomology that involved agricultural, molecular, environmental, and sociological aspects of genetically modified crops, Anna is well aware of the sometimes overheated debate surrounding the GMO topic.

- Well, if you need a conversation starter, then GMOs are a good choice. The problem is that you might spend the whole evening on the same subject. But this is also what makes it interesting, I am happy to work with something that many people care about.

« Anna Lehrman, communication officer at Mistra Biotech.

Per Sandin (CP3) during his talk "Etiken, politiken och tekniken" at the seminar "Växtförädling 3.0 – ny teknik och gamla lagar" at The Royal Swedish Academy of Agriculture and Forestry.

The geneticist Anna Johansson and the ethicist Helena Röcklinsberg during one of many discussions at the "Mistra Biotech- week".

Activities

14/1 E. Ivarsson talked about her work with transgenic plants in Mistra Biotech at the college Spyken, in Lund.

23/1 Mistra Biotech workshop "Sustainability in future food production systems - Can biotechnology make a difference?" at SLU, Ultuna.

13/2 Mistra Biotech was represented at the seminar "Växtförädling – en livsviktig verksamhet" at the Swedish Parliament.

18/2 Presentation of Mistra Biotech when the Thai delegation (Department of Rice, The Ministry of Agriculture and Cooperatives) visited SLU, Ultuna.

27/2 S. Stymne gave a presentation and provided information about Mistra Biotech at "Jordbruks och trädgårdskonferensen" at SLU, Alnarp.

13/3 S. Stymne was invited as speakerat the conference "Rachel Carson & Ruth Harrison 50 years on" at the Biodiversity Institute in Oxford, UK.

14/3 L. Rydhmer and J. Sundström were invited to talk about genetic alteration of livestock and genetically modified crops, respectively at Skara Senior University.

11/4 P. Sandin presented "Mistra Biotech - de etiska aspekterna av genteknik vid livsmedelsproduktion" at the Swedish network for GMO and food.

17/4 P. Sandin was invited to give a presentation "Biotek-grödor och verktyg för etisk analys" at the Swedish Genetechnology Advisory Board.

25/4 P. Sandin presented "Etiken, politiken och tekniken" at The Royal Swedish Academy of Agriculture and Forestry seminar "Växtförädling 3.0 – ny teknik och gamla lagar".

29/4 P. Sandin presented "Två kulturer, eller att samtala om risker – erfarenheter av möten med studenter från olika discipliner" at The Swedish Risk Academy, Stockholm. (Per was awarded The Swedish Risk Academy's Special Prize to Promising Junior Researchers 2013)

28/4-1/5. Poster "Fatty acid profile and minor lipid components in the oil of some selected germplasms of *Lepidium campestre*" presented by S. Madawala et al., at the 104th American Oil Chemists' Society Annual Meeting & Expo, Montréal, Canada.

14/5 I. Åhman lectured about the gene revolution at the network for medical laboratory scientist in Skåne.

14/5 Mistra Biotech Nutrition Workshop for project leaders and invited researchers working on food, nutrition, and human health, discussed possibilities for breeding for healthier food.

18/5 Participation and information material at the Fascination of Plant's day in Lund.

10-13/6 Poster "Genetic improvement of *Lepidium campestre* using gene technology" presentation by E. Ivarson et al., at the European Plant Genetic Resources Conference, NordGen, Alnarp.

14-16/6 P. Moula presented "Hubris and the promethean sin in discussions on nature and technology". P. Sandin presented "What environmental ethicists can learn from bioethics: professions and 'killer apps'", and K. Edvardsson Björnberg gave a keynote presentation "From Hausväterliteratur to modern agricultural biotechnology: Past, present and future directions in environmental philosophy" at the Swedish Congress of Philosophy, Stockholm.

26-27/6 Mistra Biotech was represented in the SLU stand at the agricultural fair Borgeby Fältdagar.

17/7 C.J. Lagerkvist presented the results from "Consumers' Evaluation of Biotechnology in Food Products: New Evidence from a Meta-Survey" at the International Summer Labs at the Hochschule Osnabrück, Germany.

4-6/8 S. Hess presented "Consumers' Evaluation of Biotechnology in Food Products: New Evidence from a Meta-Survey" at the Annual Meeting of the Agricultural and Applied Economics Association (AAEA) in Washington D.C.

Emelie Ivarson (PhD student in CP1) at the agricultural fair "Borgeby Fältdagar"

28-30/8 M. Dida Geleta presented "Development of *Lepidium campestre* as a perennial oil crop through domestication" at the FAO Expert Workshop on Perennial Crops for Food Security, Rome.

5/9 C.J. Lagerkvist presented the results from the meta-study and Klaus Grunert gave a talk about "Consumer concern about food processing: When and why?" at a seminar on consumer acceptance of food processing technologies at the University of Copenhagen.

4-7/9 K. Karantininis and S. Hess' paper "Cross-Atlantic differences in GMOs: A Media Content Analysis" was presented at the conference European Consortium for Political Research, Bordeaux.

4/10 Mistra Biotech lunch seminar with Nicholas Kalaitzandonakes in collaboration with Future Agriculture "The evolving structure of the global agrifood biotech industry and implications for future innovation" at SLU, Ultuna.

10/10 Mistra Biotech workshop "A never ending battle – understanding resistance biology for sustainable agriculture" in collaboration with Plant Link, SLU, Alnarp.

16/10 M. Andersson presented her work on the amylose-potato and discussed GMO legislation at the Gene Technology Advisory Board.

31/10-1/11 C.J. Lagerkvist presented the results from the meta-study at the Nordic-Baltic GMO workshop "Socioeconomic impacts of GM-cultivation" in Riga.

6/11 Mistra Biotech lunch seminar with Anita Lundström, Swedish Environmental Protection Agency, in collaboration with Future Agriculture, "Generationsmålet och miljökvalitetsmålen - hur lyckas vi?" at SLU, Ultuna.

14/11 S.O. Hansson presented "Reglering av bioteknik ur etisk synvinkel" and S. Stymne "Bioteknologi för bättre miljö" on the theme "Bioteknologi för Miljö och hälsa"at The Royal Swedish Academy of Engineering Sciences (IVA).

18/11 C.J. Lagerkvist and Per Sandin gave talks at Lantmännen's internal theme day "GMO –Attityder och Etik" in Stockholm.

19-20/11 Visit by Mikayla Keen from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) including meetings at the Swedish Radio, Mistra and the Gene Technology Advisory Board

28-30/11 P. Moula gave a talk "The hubris in claiming hubris" at the Asia-Pacific Society for Food and Agricultural Ethics (APSAFE) Conference, Bangkok.

Panel discussion with Erik Andreasson (SLU), Lars Råberg (Lund University), Inger Åhman (SLU), Lise Nistrup Jørgensen (Aarhus University), Anna-Liisa Laine (Helsinki University), and Göran Magnusson (DuPont) during the seminar "A never ending battle – understanding resistance biology for sustainable agriculture".

Helena Siipi (Univ. of Turku) talked about "Is genetically modified food unnatural?" at the workshop "Ethical issues in new biotechnology in agriculture". Dane Scott (Univ. of Montana) focused on "Freedom of cropping and the good life: moral philosophy and the deep conflict between the organic movement and the biotech industry over cross-contamination".

Paula Persson, Pernilla Tidåker, Karin Edvardsson Björnberg, and Nils-Ove Bertholdsson (all from SLU) at the workshop "Sustainability in future food production systems: Can biotechnology make a difference?".

Lunch seminar with Nicholas Kalaitzandonakes (University of Missouri) on the subject "The evolving structure of the global agrifood biotech industry and implications for future innovation".

Mistra Biotech in the media

NEWSPAPERS/WEB

New Insights (22/4) "Oil plant and catch crop in one"

New Insights (22/4) "Challenges in a Dutch professor's life"

Lantmannen nr 3 "Hon öppnar dörren mot framtidens odling"

Land Lantbruk (10/5) "Hennes arbete hindras av EU-reglerna"

Landet runt (5/6) "Företagen flyr Sverige men GMO-forskningen fortsätter"

Epoch Times (19/6) "EU at a GMO Crossroads"

Epoch Times (22/6) "Européer inte mer negativa till GMO än andra"

Kristianstadsbladet (24/6) "Inga bin får komma åt GMO-kålen"

Land Lantbruk (27/6) "Skilda världar i synen på framtidens växtskydd"

ATL (11/9) "Negativ attityd till gmo en myt"

Miljöaktuellt (12/9) "Ny studie: EU-medborgarnas skepsis till GMO är en myt"

Livsmedel i fokus (12/9) "GMO-motståndet i EU mindre än man trott"

Jordbruksaktuellt "Frågan avgör uppfattning om GMO"

FreshPlaza (17/9) "EU consumers less negative about GMOs than previously believed"

Science 2.0 (19/9) "Europeans are less negative about GMOs than portrayed"

FoodCulture.dk (24/9) "Europæere er ikke mere kritiske over for GMO"

MarkLynas.org (22/10) "Scientists challenge Swedish government over funding of Golden Rice trial vandalism"

UNT Debatt (22/10) "Ska Sida sabotera matforskning?"

Riksdag&Departement (5/11) "Svenskt bistånd stöttar risbråk"

RADIO

Klotet, Sveriges Radio (22/5) "Ogräsresistens: Är det gengrödan eller felaktig användning av bekämpningsmedel som är boven i dramat?"

Vetenskapsradion (27/5) "Svensk vildpotatis kan stoppa besprutning"

Hallandsekot (27/5) "Diskussionen: För eller emot GMO-grödor"

Vetenskapsradion (28/5) "Genmodifierade djur på väg ut från labbet"

Morgonpasset, Sveriges Radio (30/5) "Kan zombies bli förkylda?"

Vetenskapsradion (5/6) "Eko-lantbrukare håller dörren stängd för GMO"

Sveriges Radio (22/10) "Biståndspengar går till vandalisering av forskning"

Sveriges Radio (25/10) "Svenskt bistånd betalar för både forskning för och motstånd mot GMO"

The Mistra Biotech Newsletter reaches over 1100 Swedish and international recipients, informing about our research and upcoming events.

Do you want to join?
Send an e-mail to mistrabiotech@slu.se.

Publications

SCIENTIFIC

Forabosco, F., Löhmus, M., Rydhmer, L. & Sundström, L.F. 2013. Genetically modified farm animals and fish in agriculture: a review. *Livestock Science* 153: 1-9.

Forabosco, F., Sundström, L.F. & Rydhmer, L. 2013. An algorithm for the identification of genetically modified animals. *Trends in Biotechnology* 31: 272-274.

Hess, S., Lagerkvist, C.J., Redekop, W., & Pakseresht, A. 2013. Consumers' evaluation of biotechnology in food products: new nvidence from a neta-nurvey. Agricultural and Applied Economics Association 2013 Annual Meeting, August 4-6, 2013, Washington, D.C.

Ivarson, E., Ahlman, A., Li, X.Y. & Zhu, L.H. 2013. Development of an efficient regeneration and transformation method for the new potential oilseed crop *Lepidium campestre*. *BMC Plant Biology* 13:115

Jonas, E., & de Koning, D.J. 2013. Does genomic selection have a future in plant breeding? *Trends in Biotechnology* 31: 497–504.

BOOKS/BOOK CHAPTERS

Hansson, S.O. 2014. Food labelling. In: Thompson, P.B., Kaplan, D.M., Millar, K., Heldke, L., Bawden, R. (Eds.), *Encyclopedia of food and agricultural ethics.* Springer

Hansson, S.O. 2014. Food risks. In: Thompson, P.B., Kaplan, D.M., Millar, K., Heldke, L., Bawden, R. (Eds.), *Encyclopedia of food and agricultural ethics.* Springer

Hansson, S.O. 2014. Occupational risks in agriculture. In: Thompson, P.B., Kaplan, D.M., Millar, K., Heldke, L., Bawden, R. (Eds.), *Encyclopedia of food and agricultural ethics*. Springer

Sandin, P. 2013. Naturalness, artifacts and value. In: M.J. de Vries, S.O. Hansson & A.W.M. Meijers (Eds.), *Norms in technology*. Dordrecht, Springer, pp. 207-221

OTHER

Hansson, S.O. 2013. Jordbrukets bioteknologi – behovet av store vidsynthet/ Agricultural biotechnology – the need for less myopic perspectives. *Sveriges utsädesförenings tidskrift* 2013:1

Lehrman, A. & Alexandersson, E. 2013. Future of plant biotechnology in Europe (workshop summary). *Sveriges utsädesförenings tidskrift* 2013: 1

Hansson, S.O. & Weih, M. 2013. Busting the myths about GMOs in agriculture. Public Service Europe

Sandin, P. 2013. Vilka krav kan och bör vi ställa på genmodifierade livsmedel? *Dietistaktuellt* 3: 22-23.

Weih, M. 2013. Global food security and ecological sustainability. Public Service Europe

Researchers

EMPLOYED AND ASSOCIATED RESEARCHERS

CP1: Plant biotechnology for innovative products		Department
Alessandro Nicolia	Researcher	Plant Breeding, SLU
Anna Källman	PhD student	Food Science, SLU
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Carolin Menzel	PhD student	Food Science, SLU
Emelie Ivarson	PhD student	Plant Breeding, SLU
Erik Andreasson	Deputy project leader	Plant Protection Biology, SLU
Henrik Svennerstam	Researcher	Forest Genetics and Plant Physiology, SLU
Iftikahar Ahmad	PhD student	Forest Genetics and Plant Physiology, SLU
Inger Åhman	Researcher	Plant Breeding, SLU
Kristine Koch	Researcher	Food Science, SLU
Lena Dimberg	Researcher	Food Science, SLU
Li Hua Zhu	Project leader	Plant Breeding, SLU
Mariette Andersson	Researcher	Plant Breeding, SLU
Mattias Holmlund	Research engineer	Forest Genetics and Plant Physiology, SLU
Mulatu Dida Geleta	Researcher	Plant Breeding, SLU
Paresh Dutta	Researcher	Food Science, SLU
Per Åman	Researcher	Food Science, SLU
Roger Andersson	Researcher	Food Science, SLU
Samanthi Madawala	PhD student	Food Science, SLU
Sandra Jämtgård	Post-Doc	Forest Ecology and Management, SLU
Sten Stymne	Researcher	Plant Breeding, SLU
Torgny Näsholm	Researcher	Forest Ecology and Management, SLU
Ulrika Ganeteg	Researcher	Forest Genetics and Plant Physiology, SLU

CP2: Novel molecular breeding tools		
Aakash Chawade	Post-Doc	Immunotechnology, Lund University
Anna Johansson	Researcher	Animal Breeding and Genetics, SLU
Christina Dixelius	Researcher	Plant Biology and Forest Genetics, SLU
Dirk-Jan de Koning	Project leader	Animal Breeding and Genetics, SLU
Elisabeth Jonas	Post-Doc	Animal Breeding and Genetics, SLU
Erik Bongcam-Rudloff	Researcher	Animal Breeding and Genetics, SLU
Fernando Lopes Pinto	Post-Doc	Animal Breeding and Genetics, SLU
Fredrik Levander	Researcher	Immunotechnology, Lund University
Jane Morrell	Researcher	Clinical Sciences, SLU
Lars Rönnegård	Deputy project leader	Animal Breeding and Genetics, SLU
Mulatu Dida Geleta	Researcher	Plant Breeding, SLU
Monika Brandt	Researcher	Animal Breeding and Genetics, SLU
Patrice Humblot	Researcher	Clinical Sciences, SLU
Rodomiro Ortiz	Researcher	Plant Breeding, SLU
Zeratsion Abera	Researcher	Plant Breeding, SLU

CP3: Ethics		
Helena Röcklinsberg	Researcher	Animal Environment and Health, SLU
Karin Edvardsson Björnberg	Project leader	Philosophy and History of Technology, KTH*
Payam Moula	PhD student	Philosophy and History of Technology, KTH*
Per Sandin	Deputy project leader	Crop Production Ecology, SLU

CP4: Consumer attitudes towards biotechnology		
Ashkan Pakseresht	PhD student	Economics, SLU
Carl-Johan Lagerkvist	Project leader	Economics, SLU

Jacob Lund Orquin	Post-Doc	Business Administration, Aarhus University, DK
Joachim Scholderer	Researcher	Business Administration, Aarhus University, DK
Klaus G Grunert	Researcher	Business Administration, Aarhus University, DK
Sebastian Hess	Researcher	Economics, SLU

CP5: Swedish competitiveness

Christopher Kevin Ansell	Researcher	Political Science, University of California, USA
Konstantinos Karantininis	Project leader	Economics, SLU
Li Feng	Post-Doc	Economics, SLU
Sevasti Chatzopoulou	Researcher	Society and Globalisation, Roskilde University, DK
Torbjörn Jansson	Researcher	Economics, SLU

CP6: AgriSA - Centre for agriculture and food systems analysis and synthesis

Alessandro Nicolia	Researcher CP1	Plant Breeding, SLU
Anna Lehrman	Communicator	Crop Production Ecology, SLU
Anna-Karin Kolseth	Researcher	Crop Production Ecology, SLU
Barbro Ulén	Researcher	Soil and Environment, SLU
Christina Dixelius	Researcher CP2	Plant Biology and Forest Genetics, SLU
Elisabeth Jonas	Post-Doc CP2	Animal Breeding and Genetics, SLU
Flavio Forabosco	Researcher	Animal Breeding and Genetics, SLU
Helena Röcklinsberg	Researcher CP3	Animal Environment and Health, SLU
Håkan Marstorp	Researcher	Soil and Environment, SLU
Jan Bengtsson	Researcher	Ecology, SLU
Jens Sundström	Researcher	Plant Biology and Forest Genetics, SLU
Karin Edvardsson Björnberg	Project leader CP3	Philosophy and History of Technology, KTH*
Konstantinos Karantininis	Project leader CP5	Economics, SLU
Li Feng	Researcher CP5	Economics, SLU
Li Hua Zhu	Project leader CP1	Plant Breeding, SLU
Linnea Asplund	PhD student	Crop production ecology, SLU
Lotta Rydhmer	Project leader	Animal Breeding and Genetics, SLU
Maren Emmerich	Post-Doc	Microbiology, SLU
Mariette Andersson	Researcher CP1	Plant Breeding, SLU
Martin Weih	Researcher	Crop Production Ecology, SLU
Mulatu Dida Geleta	Researcher CP1/CP2	Plant Breeding, SLU
Nils-Ove Bertholdsson	Researcher	Plant Breeding, SLU
Payam Moula	PhD student CP3	Philosophy and History of Technology, KTH*
Pernilla Tidåker	Researcher	Crop Production Ecology, SLU
Per Sandin	Researcher CP3	Crop Production Ecology, SLU
Sara Hallin	Researcher	Microbiology, SLU
Sevasti Chatzopoulou	Researcher CP5	Society and Globalisation, Roskilde University, DK
Stefan Marklund	Researcher	Clinical Sciences, SLU
Sten Stymne	Researcher CP1	Plant Breeding, SLU
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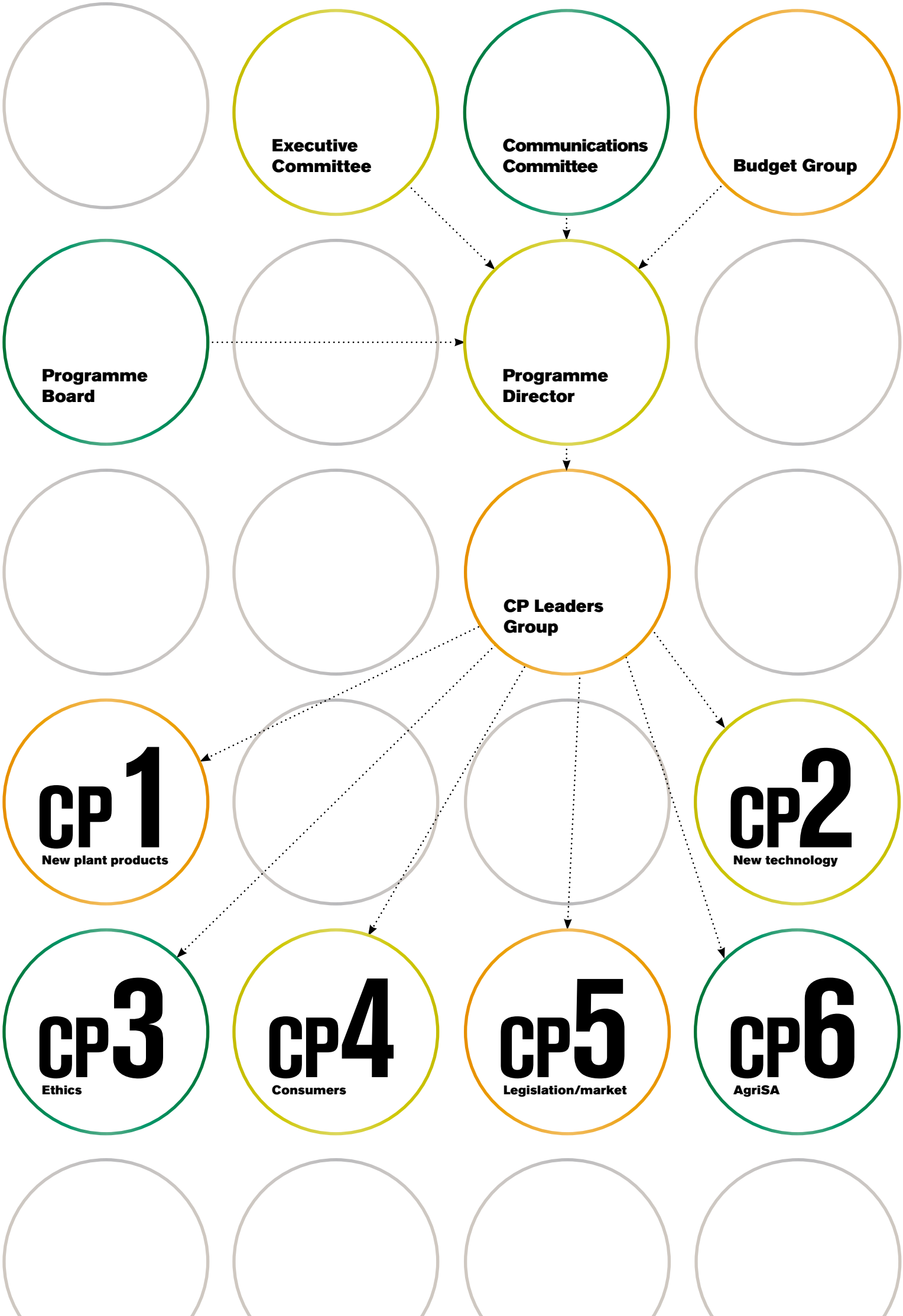
Executive Committee
Communications Committee
Budget Group
Programme Board
Programme Director
CP Leaders Group
CP 1
New plant products
CP2
New technology
CP3
Ethics
CP4
Consumers
CP5
Legislation/market
CP6
AgriSA


MISTRA
Biotech




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