Sveriges lantbruksuniversitet - SLU
Fakulteten för landskapsarkitektur, trädgårds- och växtproduktionsvetenskap

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The domestication of field cress *(Lepidium campestre)* as a new oil crop and the development of its genomic tools and resources

The demand for edible oil crops is increasing due to global human population growth, and there is a need to replace fossil oils with renewable plant oils in order to combat global warming. These require multiple-fold increase in plant oil production globally. Domesticating new oil crops is an attractive approach not only to increase vegetable oil production but also to provide desirable oil quality and environmentally friendly alternatives to industrial commodities. Field cress *(Lepidium campestre),* a biennial species in the family Brassicaceae, is selected for domestication as a future multi-purpose oil crop based on its desirable characters such as winter hardiness, industrial quality seed oil and potential for high seed yield. It is being domesticated with a long-term goal of introducing highly productive winter-hardy and pod shatter resistant biennial and perennial cultivars. In order to achieve this goal, the domestication process was started with the use of diverse seed samples obtained from gene banks as well as newly collected seed samples from different regions in Sweden. Using this resource, significant progress has been made in terms of improving major traits that include perenniality, pod shatter resistance and seed yield. Breeding lines that have one or more major desirable traits have been developed through breeding methods that involve cross-pollination between different plants (genotypes) of field cress as well as between field cress and closely related species.

Modern plant breeding involves combinations of different approaches that include traditional plant breeding methods and use of DNA markers for selecting plants with desirable traits (marker-assisted selection). The use of DNA markers can help speed up the process of domestication of field cress by allowing the selection of plants that bear desirable traits without going through the process of collecting phenotypic data. Advanced DNA sequencing techniques called RAD-sequencing and Genotyping by Sequencing were used to develop DNA markers and related genomic tools and resources for field cress. Through these methods, short DNA sequences that represent various regions of all chromosomes as well as DNA markers called single nucleotide polymorphism (SNPs) were obtained. The DNA sequences were used for the development of another type of DNA markers called microsatellites. Partial sequences of several genes that regulate pod shattering, oil content, perenniality and flowering time were also identified through comparative analysis of DNA sequences of field cress and *Arabidopsis*. Thousands of DNA markers were used for genotyping more than a thousand plants. The combined analysis of the traits and the DNA markers of these plants through a method called genome wide association studies will lead to the identification of markers that are associated with target traits. DNA markers that are associated with desirable traits will be used for marker-assisted selection.

Cluster analysis on field cress genotypes representing different populations using microsatellite markers suggested lack of clear geographical differentiation among

populations. The analysis also showed the presence of significant genetic diversity within Swedish field cress populations that can be explored for identification of superior genotypes bearing desirable traits. The analysis of these markers in other *Lepidium* species revealed their high rate of transferability to species closely related to field cress and, hence, are potentially useful in marker-assisted selection that involves hybridization among these species. Crossing field cress with other closely related *Lepidium* species is important to introduce new desirable traits. In line with this, our genomic analysis revealed that *Lepidium heterophyllum* is the closest species to field cress that can produce viable and fertile hybrids. Hence, this species is the primary target for hybridization with field cress as a source of new desirable traits. Overall, effective breeding methods used in domestication of field cress will also be applied in other crops; and the success in field cress domestication will promote the idea of domesticating new crops around the world and hence highly significant. Together with SLU colleagues who are conducting research that promote the domestication of field cress, concerted efforts will be made in bringing breeding companies, farmers and industries on board so that large-scale production of field cress as a crop can be realized in Sweden and beyond.

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Swedish apples on the market all year round - is it possible?

In Sweden, orchard productivity and fruit storage potential are very low, while consumption of apples is relatively high. Three major defects limit storability in Swedish apples and downgrade them on the market; poor coloration, high susceptibility to physiological disorders and low resistance to fungal decay. Unfortunately, research on improving postharvest handling of fruit still attracts insufficient attention, despite the economic importance of this issue and its influence on public health. To improve the competitiveness of Swedish fruit and supply the market with unique fruit quality all year round, a long-term scientific strategy should be developed. The most important results of my research, which are presented in this lecture, are highly appropriate as an active part of this strategy. They include recommendations on new orchard management techniques with important impacts on tree productivity and on the ability of fruit to withstand pests and diseases, introducing resistant cultivars and advanced storage technology, and development of safe anti-pathogen materials.

Due to increased concerns about the negative impact of pre- and post-harvest chemical treatments on human health and the environment, new challenges have emerged and have led to development of some orchard practices that enhance storage potential without risks to human health. I have devised a novel orchard management system, comprising a combination of better light intensity, appropriate tree architecture, an optimal fertilisation regime and new weed control methods, in order to improve productivity, accumulation of anthocyanins and resistance to various diseases. I have examined dozens of apple cultivars in organic orchards and have recommended sixteen of these for industrial use and over twenty for commercial production. However, new cultivars with high resistance to the most important diseases are still required. As part of pre-breeding research, I have assessed levels of resistance in the germplasm to both natural infection and artificial inoculation of apples with *Penicillium expansum* and *Neofabraea perennans*. This revealed great inter-cultivar variation, a negative correlation between susceptibility to blue mould or lenticel rot and fruit initial firmness, a negative correlation between this susceptibility and ripening date, and a positive correlation between susceptibility and softening during storage.

Opportunities to extend fruit shelf-life also include the use of new storage technology. I have determined the optimum harvesting date and suitable atmosphere conditions for fifteen apple, ten plums and two pear cultivars in Sweden using an advanced storage method (ultra-low oxygen). Fruit aroma deterioration due to low oxygen was avoided with this method. I have also applied a non-destructive maturity index (DA meter) to replace the classic indices and identify the best storage strategy and markets for traditional and new apple, pear and plum cultivars. In addition, I have investigated the effects of these technologies on fruit bioactive compounds with antioxidant properties.

To develop safe anti-pathogen materials, I will continue working to identify the most important fungi causing damage to organic fruit and to formulate various control methods for these, e.g. heating by warm air or warm water and tree spraying or fruit dipping with alkylresorcinols or various essential oils such as thymol, eugenol and lemongrass oil.

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Christina Lunner Kolstrup, institutionen for arbetsvetenskap, ekonomi och miljöpsykologi

People working in the animal world – an environment shaped by humans

Agriculture is one of the most hazardous sectors world-wide. Farm workers are exposed to serious work-related accidents and injuries caused by demanding and hazardous work with machinery, chemicals and animals. My profound interest in my life as a researcher is to promote health and safe working conditions and improve the physical and mental health of those working in agriculture, especially in livestock production.

Livestock production in developed countries has undergone major structural and technical changes in recent decades. Today, the majority of farm livestock are raised in intensive human-designed production systems. Traditional family farms with small herd size and integrated crop and livestock production involving a range of different work tasks have decreased in number, while farms with large numbers of animals and advanced technical and mechanised livestock production methods are becoming increasingly common. This transition has changed the daily work of farmers and farm workers and constitutes a challenge concerning their physical and psychosocial working conditions and health.

In my past research, I have examined the working environment of farmers and their health, with specific emphasis on musculoskeletal disorders (physical aches and pains in different body parts) and risk factors in the development of these disorders. I initially focused on the farm population working with cows, pigs, horses and reindeer in different production systems and in different countries. However, agricultural occupational health and safety comprises more than just the physical issues. It is also important to gain a broader and more comprehensive understanding of the psychosocial working conditions of farmers and the effect on their mental health and wellbeing, as these issues are not fully understood and accepted in agricultural and rural settings and in different agricultural groups. Therefore, I started to focus more on the psychosocial issues and especially the external stress factors that farmers cannot individually influence, such as weather, statutory regulations and the global economy. I found that more than 50% of farmers often experience stress related to government regulations and negative attitudes from governmental officials and society. Based on this, my colleagues and I are now studying how and in what way farmers are affected by the regulatory burden in agriculture. We are quantifying the time and costs of government-related work burdening farmers, seeking to identify challenges and opportunities for conducting competitive and profitable businesses and analysing how this affects farmers' mental health. Mental stress is a known cause of ill-health. We are looking at whether advanced farm technology and automated systems (e.g. milking robots on dairy farms and high-tech equipment on crop farms) could constitute a mental health challenge for farmers. Farmers are also facing other challenges such as attracting qualified employees for farm work. We have developed a new perspective by studying motivating factors (such as fun at work, wage levels, working with animals, good leadership, colleagues and personal development) that are important for farm workers and students choosing to stay in the sector, and how employers rate these factors.

Besides conventional farmers, there are other groups in agriculture facing severe challenges relating to occupational health and safety when working with various types of livestock under different climate, topography and cultural conditions. At the moment I am studying the working conditions, health and safety of reindeer herders in Northern Sweden.

While farms in many developed countries are highly mechanised, operate on a large scale and tend to grow crops in monoculture, farming in many developing countries is much more labour-intensive, non-mechanised and integrates crop and livestock production. These differences have a significant bearing on the levels of risk of injuries and diseases and farmers' health. I recently assessed agriculture-related occupational health and safety issues in one such country by studying attitudes and awareness of health and safety among Ugandan farmers.

In future work, I would also like to adopt a holistic perspective on health in the farming population. Body and mind go hand in hand, and acknowledging the rich picture of integrating psychosocial and physical health issues is vital for human wellbeing. I wish to broaden this perspective and extend my occupational health and safety research to all people in rural areas who are involved in agriculture in some way. The work environment, risk factors and agriculture-related health issues differ between production systems and countries. Interventions to reduce acute and chronic injuries and accidents causing considerable suffering for individual and costs to society are very important in order to improve the physical and mental health of our farming population.

In my lecture, I give examples of my research on physical and psychosocial working conditions in different productions systems and countries, and how these affect physical and mental health in different farming populations working with different types of livestock.

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Madeleine Granvik, institutionen för stad och land

Planering och mat - trender och tendenser i Sveriges kommuner

Det ”hållbara samhället” studeras ofta utifrån ett urbant perspektiv - hållbar stadsutveckling, hållbar stadsbyggnad, den hållbara staden, den förtätade staden - avskilt från forskning om landsbygdsutveckling och primärproduktion i åkrar och skogar. Drygt hälften av världens befolkning bor idag i urbaniserade områden och urbaniseringen fortsätter, vilket är ett argument för att fokusera på staden. Men, detta innebär samtidigt att den andra hälften av befolkningen bor på landsbygden. Det finns en risk att urbaniseringen för med sig en gradvis förstärkning av urbana perspektiv, vilket gör att livsvillkor i urbana miljöer tenderar att bli norm i samhället. Dikotomin stad och landsbygd är olycklig i ett planeringsperspektiv då den ”hållbara staden” är beroende av sitt omland. Idag finns anledning att se både staden och landsbygden som livsavgörande miljöer för de utmaningar vi står inför, inte minst gällande livsmedel.

Trender och tendenser visar idag att befolkningsmängden i världen fortsätter att växa och att konkurrensen om den odlade marken ökar. Den svenska jordbruksmarken är väsentligt mycket mer produktiv än världsgenomsnittet, samtidigt är Sverige ett av världens mest importberoende länder gällande livsmedel. Men, det senaste decenniet kan vi se en utveckling i Sverige att intresset för närodlade livsmedel har ökat bland konsumenter och livsmedelskedjans olika aktörer. Samtidigt minskar antalet aktiva lantbruk stadigt och de bästa åkermarkerna exploateras i allt högre utsträckning för byggnation. Min forskning handlar om planering och mat i en svensk kommunal planeringskontext. Huvudfokus är att studera kommuners synsätt, policy, strategier, motiv och praktiskt arbete, dels för att främja arbete för att utveckla lokala livsmedelssystem, dels för att bevara jordbruksmark. Några slutsatser är att det generellt finns ett intresse för närodlade livsmedel och att arbete sker såväl inom fysisk planering, upphandling och logistik. Frågan om jordbruksmarkens värden är mycket komplex. Samtidigt som det finns uttryck för att vilja bevara jordbruksmark så är det inte självklart att det finns en policy gällande det och inte heller att det visar sig i praktiken.

Exempel på möjliga frågor och områden för kommande forskning:
-*Hinder och möjligheter för kommunen som organisation att driva utvecklingen av lokala livsmedelssystem*. Hinder och möjligheter i den interna kommunala organisationen, sektoriell isolering, brist på kontakter och samarbeten mellan olika förvaltningar, roller och intressen; lagstiftning/policy; hinder och möjligheter i samverkan med externa samhällsaktörer.
-*Kommuners arbete med jordbruksmarkens värden*: produktionsvärde, rekreationsvärde, kulturhistoriska värden, landskapskaraktär, energi, tillgång till lokala råvaror, framtida försörjningsvärde mm.
-*Kommuners tolkning av Miljöbalken kap. 3 § 4,* hur tolkas formuleringar som ”viktiga samhällsintressen” och ”brukningsvärd jordbruksmark”.
-*Följa upp Miljömålsberedningens förslag* - iom arbetet med en långsiktig nationell strategi för en hållbar markanvändning – om att lagtext om jordbruksmark bör bli tydligare och skarpare.

-*Studera jordbruksparker som organisationsform*, hur fungerar dessa utifrån ett planering och förvaltningsperspektiv, samt utreda hinder och möjligheter med att införa jordbruksparker i svensk kontext.
-*Lokala och regionala livsmedelssystem i ett beredskapsperspektiv*, vilket ansvar och vilken roll skulle kommuner kunna ha i en svensk livsmedelsberedskap.
-*Studera hur svenska kommuner förhåller sig till den nationella livsmedelsstrategin*, vilken roll ser den nationella nivån att den kommunala nivån har i arbetet för att implementera en nationell livsmedelsstrategi, vilken roll uppfattar kommunen att den har i arbetet, finns glapp/krockar gällande förväntningar och uppfattade roller; vilka frågor ges företräde i regionala och lokala livsmedelsstrategier, vilka tidsperspektiv anges och vilka aktörer förväntas bidra i implementeringsarbetet.

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Märit Jansson, institutionen för landskapsarkitektur, planering och förvaltning

"If it were all perfect, it wouldn't be a ghost forest" – Urban open space development for children and other users

Urban open spaces are the most accessible outdoor environments for many. They are therefore of major importance for everyday outdoor recreation, play and health. Several processes form open spaces over time and affect their usability. After planning, design and construction, the maintenance and ongoing development through strategic management often has a strong effect on content and quality. Many different actors might be involved in contemporary open space management, but user involvement has proven to be a challenge. It is uncertain how the organization and performance of management activities can actually best benefit different groups of users.

Since the views of urban open spaces vary between individuals and also between groups, different perspectives are needed when developing these spaces. One group to which I have paid particular attention in my research is children. Children are often very dependent on the accessibility and quality of nearby spaces and they generally have different approaches to those spaces than adults. Despite this, open space development does not always consider children and they are rarely heard or included in consultation processes.

When interviewing children, I have also let some of them show and describe outdoor places they use. The results obtained through this method tend to challenge the common approach to management and planning. Children particularly look for variation in open spaces, including in the level of management. If everything is well-planned and well-kept, where can children find "ghost forests" and other exciting places that they can make their own? In similar ways, other user groups and different landscape professionals have their preferences. Increased dialogue and participatory activities might be an important step to increasing green space managers' understanding of user needs – also in times with limited resources.

In my lecture, I describe my research examining the socio-physical qualities of urban open spaces and their use and development through management and planning. This includes children's perspectives on green spaces such as school grounds, playgrounds and neighbourhoods. Other related perspectives are issues of vegetation development for perceived safety, historical developments of open spaces and current challenges such as urban densification. In my current and planned future studies, I compare the views of children and other users of urban open spaces with the views and possibilities of landscape professionals such as managers and planners. This will hopefully make a valuable contribution to more sustainable built environments, where landscape professionals increasingly contribute to make children and others thrive.