Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

The Cropping System Platform 2015-09-30

The SLU road map for cropping/forestry system research

The Subject Committee for Cropping Systems, including Göran Bergkvist (chair), Erik Steen Jensen (vice chair), Tomas Lundmark, Urban Nilsson, Lars Mogren , Thomas Kätterer and Pär Aronsson (secretary), are responsible for the activities within the Cropping System Platform and for the production of a SLU road map for cropping/forestry system research.

SLU workshop on cropping and forestry systems at Krusenberg in January 19-21, 2015

The SLU road map for cropping/forestry system research is based on the outcomes of a workshop held at Krusenberg, Uppsala, 19-21 January, 2015, and considering an inventory made by Björn Andersson, SLU. The aim of the SLU workshop at Krusenberg was to define a strategy and road map for future research on cropping systems, in agriculture, horticulture and silviculture, at SLU. The strategy should involve the link between different scales (plant-soil, field, farm, landscape) and time perspectives, and be relevant for agriculture, horticulture and silviculture. It should also depict how producer and consumer knowledge and values are integrated. Finally it should describe how this would lead to enhanced socio-technical innovation of systems and transition to more sustainably managed cropping systems. To give inspiration to all participants, the workshop started with oral presentations. Four international researchers and one SLU researcher, selected for their excellence, presented their view of cropping system research in relation to the instructions given by the committee of the . The invited researchers were, *Marie-Hélène Jeuffroy*, senior researcher INRA-AgroParisTech, *Lee Allen*, professor emeriti North Carolina State University, US, *Martine Dorais*, researcher, Agriculture and Agri-Food Canada, *Kurt-Christian Kersebaum*, professor ZALF, Germany and Professor *Henrik Eckersten*, Department of Crop Production Ecology, SLU. Finally, *Ann-Therese Albertsson*, Swedish Transport Administration and BIM-alliance was invited to give an inspirational talk about the concept BIM that has revolutionised the construction sector, but is largely unknown in an agricultural/horticultural/silvicultural context. Building information modelling (BIM) refers to a way of working, that is, the process of creating and using one or several building information models in building or construction. The participants of the workshop were the speakers, committee and 18 invited

participants from SLU, representing relevant departments at the Faculty of Forest Sciences, the Faculty of Natural Resources and Agricultural Sciences and the Faculty of Landscape Architecture, Horticulture and Crop Production Science.

The workshop first treated the general perspective, without considering prerequisites at SLU. The second section of the workshop served to identify suitable SLU actions in relation to the general perspective. The following sections in this document contain an interpretation by the committee of the conclusions from the workshop. Many aspects were lifted in the workshop and we in the Committee has been taken on the task to interpret them in a way that we think is useful for the further progress in cropping system research at SLU. We apologize for not including all perspectives that were lifted at the meeting and for making interpretations that might not fit with the original intension.

General perspectives on cropping systems research

Aims of cropping system research

There was a general agreement that one aim of cropping system research is the development of productive and sustainable cropping systems. The sustainability aspect was developed by several of the groups, e.g. long-term provisioning of ecosystem services, optimization of multiple criteria/functions of cropping systems that minimize environmental impact and lead to sustainable practices, or provide knowledge for understanding and optimizing the ecosystem services we want. Thus, the long-term ability of cropping systems to produce high and stable yields in a changing climate, and with less inputs (sustainable intensification), the importance of considering multiple ecosystem services, and minimizing the effect on surrounding ecosystems should be considered.

Furthermore, the sustainable use of natural resources should include socio-ecological and socio-technological aspects. Cropping system research should include farmer/manager values and priorities for enhanced innovation and emphasize the importance of external drivers such as consumers, public and climate. This perspective includes aspects of quality of services. Thus a sustainable development perspective must also include economical and sociological aspects. Risks, opportunities and flexibility issues also relate to this.

Cropping system research needs to consider different scales, address complexity, functions and feed backs, trade off should be identified and handled, and systems need local adaptation, e.g. many types of cropping systems should be considered, like boarder zones and urban agriculture.

Cropping system research should make use of advances in other sciences.

We conclude that the aim of

What research needs to be strengthened?

The first common theme mentioned by all groups was the need to develop interdisciplinary and transdisciplinary research as this is expected to lead to synergies and innovation. Related to the transdisciplinary aspect is that most groups highlighted the need for increased stakeholder involvement in research. Several groups pointed out the importance of empirical knowledge on cropping systems, and did consider it important to develop methods on how to use this kind of expert knowledge in research. It was pointed out that improved communication within the food system (the whole system associated with food production, trade and consumption) regarding cropping systems issues is required.

The second common theme amongst the groups was that modelling capacity needs to be increased. Models must be applied at an appropriate scale. Improved modelling of impact of extremes, risk assessments, long-term effects, pest and diseases is required. According to one group there are fundamental similarities between models of agricultural and forest systems, but communication between models used in forest and agro-systems should be improved. We need to be able to consider different spatial and temporal scales, especially field and landscape scales, i.e. land use. Tools for decision making, economic models that could take e.g. property rights effect on investment, environmental and human value aspects into account are required. Ideally, everything would be connected in a frame-work that that could be used in research, as decision support tool and to assess systems. An important point was that we need to gather and analyse large data sets to synthesize knowledge from different systems.

The third common theme relates to the improved knowledge on the interactions between ecosystems and compensation or trade-off between ecosystem services. Related is also the need to better understand each system to be able to improve it, e.g. improving existing cropping systems and design new ones with improved functions.

Another point that came up was that we need to improve our ability to implement genetic and biological knowledge, and take advantage of knowledge on the interactions between genotype and environment at the cropping system scale. Related to that is the need to have a broader approach to traits that might be useful in the future (breeding).

We conclude that (more) inter- and transdisciplinary research, including stakeholder involvement are needed in the design and assessment of cropping and forestry systems. Such strategy will also enhance the likelihood of innovation and implementation of knowledge. Furthermore, a land use perspective, including both internal functions and interactions among system, and to evaluate the system from multiple goals, is required. Models at

appropriate scales need to be developed and/or connected in one framework. Research with the aim to take advantage of advances in biological sciences in cropping system context is needed.

Which are the key components of a road map for research?

It is important to bridge disciplines and to involve stakeholders in a collaborative manner. Researchers need to be trained in research methods that are interdisciplinary and involve participatory action and learning. Several groups also point out the importance of modelling competences, with staff recruited from different disciplines, as a component of successful research.

Some groups also point out some administrative issues as important, e.g. to have a culture of collaborative research (including stakeholders) and money incentives for collaboration. One group suggests that university administration need to be involved early to facilitate communication between disciplines. Inter-disciplinary groups including senior level researchers are a key according to one group.

Other components that were considered important for a road map were the identification of strengths and weaknesses (SWOT) and relevant research tasks.

We conclude that inter- and transdisciplinary research involving stakeholders, an encouraging environment for collaborative research and relevant research tasks should be key components in a road map for research on cropping systems. We also conclude that young researchers need to be trained in research that involves stakeholders, e.g. farmers.

What kind of knowledge and research program is required to achieve the aims and enhance socio-technical innovation/adaption?

There was emphasis on the importance of stakeholders, both in formulating the aims and as partners in research and implementation. It is the task of a university, i.e. SLU, to take leadership in solving problems that are addressed by society. Therefore, researchers from different disciplines need to develop their competence to involve stakeholders in the research process, e.g. in participatory learning and action research. To improve the competence within participatory research, achievements in outreach need to be valued and tools are needed to encourage and value socio-technical innovation.

Enhanced integration among disciplines is important according to the groups, including a common framework that acts as a link between different models and data from different disciplines. The framework should be at the level of land use and connect ongoing initiatives, within Sweden and abroad.

The research program should have a long-term perspective. The framework cannot be built and implemented in a short project.

Basic model development, good data and inclusion of new techniques are other things that were considered important.

We conclude that stakeholders should be involved in cropping systems research to make use of knowledge and enhance the likelihood of innovation. There is a need for a common framework and the building of the framework should have a long term perspective.

SLU action

Which potential synergies exists between horticultural, forestry and agricultural cropping system research and how can these synergies be explored? Is "land use" a useful concept?

The groups agreed that the systems have much in common. The same processes are active in all systems; we use similar models and methods in general, similar management systems and work with similar stakeholders. We are familiar with the landscape scale, both rural and urban areas are included and we deal with big data sets. The different systems may be present in the same landscape where they are interacting.

The synergies can be explored by identifying strengths and weaknesses of different disciplines and by arranging targeted workshops to identify level of advancement/effective methods in distinctive fields and potential for synergies.

In education we could use “team teaching”, i.e. courses including students and teachers from different disciplines, both trans-disciplinary courses and basic courses.

Another way to explore synergies is to conduct case studies with participatory research and involving all relevant disciplines. One group suggest a bottom up approach to form a platform where stakeholders, social and natural scientists can meet to articulate questions. We have to be aware of that disciplines have different language and concepts and we need a strategy to deal with that.

Land use – where are the interfaces? We all have system models. If modellers meet they would better understand how to integrate the models.

The flexibility in models in silviculture would be useful in agriculture models. They could handle different land use, stands of forest, fields with different crops and other land use. A land use model could attach to other models to become a multi criteria model evaluating multiple ecosystem services, maybe with relative values for all criteria.

The urban rural interface is an important research field that could involve all disciplines.

We conclude that since all disciplines depend on the same processes and we are all working with systems that occur at the landscape scale we should benefit from collaboration at the landscape level. Synergies could be explored in the development of courses and around the concept of land use.

How can social and natural sciences be integrated in transdisciplinary research?

Many groups mentioned to use the same case involving a shared interest in resolving an identified problem requiring transdisciplinary research. One group mentions that early integration of disciplines is important, necessary balance in the partnership should be considered and that there is a training need for transdisciplinary research.

Some advice from the groups: have patience, it takes time, a facilitator is needed, the facilitator should always look for the best team, identify interest of stakeholders, and the stakeholders should be integrated from the beginning.

The career systems need to change. Recognize that it takes time to produce one paper in an interdisciplinary way. Start with the students and teaching across disciplines.

Work on the optimization of value, considering prices on the yield and externalities would be a possible case.

We conclude that to integrate natural and social sciences we need a case that is of interest for all parties and that involves stakeholders from the beginning.

Suggestions on important research tasks from the participants of the workshop

The first thing according to the groups is to identify key problems in need for transdisciplinary solutions and to identify areas for synergies between disciplines. The goal is to benefit from commonalities and relative strengths.

Arrange series of workshops involving key actors to identify research priorities (ASAP).

Targeted subsequent workshops will be organized to develop specific projects.

Project examples:

Carbon stabilization in Swedish soils

Integrated (sustainability) assessment of cropping systems

Reactive nitrogen input in terrestrial ecosystems

Diversification of systems in time and space – modelling requirements

Risk management of systems

Sustainable intensification

Sustainability assessments

Research on innovative systems

Create a culture for creating new collaborations

Dynamic growth modelling in forest systems

Integration of different models

Inventory of available models – and how they can be linked

We should link to the future platforms to achieve momentum in the transdisciplinary research.

Develop the tools of multi criteria analyses to assess ecosystem services in complex landscapes? We should have it in mind but it could be a too high hierarchal level. There could be problems with criteria and quantitative data. We still we need to do this in one way or the other, because we will be required to be able to answer this kind of questions.

How the interfaces between different systems affects flow of energy, nutrients and biological control and other ecosystem services.

In what way are the edges between the ecosystems (forest, agriculture, horticulture, etc,) important for ecosystem services?

Agroforestry is a way to increase the proportion and usage of edges. That may be a way to integrate horticulture, agriculture and forest, e.g. bioenergy forest in field edges. How should the agroforestry systems be designed to take benefits of trees in the agricultural landscape?

How to increase productivity and environmental friendliness of cropping systems?

Land-sharing versus land sparing dichotomy

Long term plan for the development of Cropping Systems research and education at SLU in a Cropping System Platform

There are a number of existing subject areas at SLU that relate to cropping systems research as described in this road map. When the professors responsible for these subject areas retire, strategic decisions need to be taken regarding the content of subsequent subjects for research and recruitment of new professors. We suggest that SLU in its strategy include the development of the subject area **Production Systems Ecology**, with the description "*The integrative study of plant production systems, encompassing environmental, economic and social dimensions. Research involves the design and assessment of plant production systems using principles of ecology and involving the landscape and societal perspectives*". In order to strengthen this field of research, which is a development of existing research in crop production and cropping systems at SLU, we need to establish positions as assistant professors within relevant subareas within the next few years. We suggest that this process starts in a Cropping System Platform. The Platform could be used to achieve synergies among disciplines, strengthen the SLU profile, and develop a common SLU profile. We suggest a step-wise development of Production Systems Ecology. Step 1 to 3 is described below and part of the Cropping System Platform. Step 4 would be the promotion of assistant professors to senior lecturers and step 5 the substitution of some present subject areas at SLU with new subject areas under the Production Systems Ecology umbrella. To facilitate the synergy in step 1 to 3, we suggest to work around a common problem and to create a common framework for research.

Research task for step 1-3 as suggested by the Committee for Cropping Systems

The landscape contains many cropping systems, boarders between systems and human settlements. The cropping systems require management including input of goods and services to sustain ecosystem services and the activity in the cropping systems will generate outputs that will affect other systems. Humans work to optimise some of the cropping systems for profitable production to satisfy human needs of food, fuel and fibre. Other systems are not deliberately managed for a specific purposes or systems are managed for something else than economic profit, e.g. non-commodity services such as climate change mitigation, increased biodiversity or reduced leaching of nutrients.

We argue that the cropping systems and the boarder zones between the systems are often not managed in a way that considers the connection between ecosystems in optimising the production and reducing environmental impact. In order to do that, we need to identify which ecosystems services that are desired, unravel the connections between the systems and to develop the systems considering systems interactions as well. ***The task of the team of researchers involved in the Cropping System Platform will be to redesign and assess (ex-ante) cropping systems, considering the production of commodity and non-commodity ecosystem services in agriculture, horticulture, silviculture and associated boarder zones.*** Assistant professors (biträdande lektorer) will be crucial for conducting the research task.

The redesigned systems and assessment must consider all dimensions of sustainable development, as well as multifunctionality. Local food production, a bio-based economy and the long-term ability of the system to supply ecosystem services should be considered. Stakeholders or stakeholder networks must be involved in identifying the needs and in the redesign of cropping systems.

Activity plan for step 1 to 3

Step 1 – conduct a literature review that summarize the state of the art regarding research on the design and assessment of cropping systems.

A suitable researcher will be identified in September 2015. The Subject Committee will act as co-authors. The suitable researcher will have four months full time funding from the Cropping System Platform to finish the task, and the manuscript should be submitted to a suitable peer-review journal by the end of May 2016.

Step 2 – establish sustainable cropping system research with inter- or transdisciplinary profile that involves agriculture, horticulture and silviculture, by appointing three assistant professors, one at each faculty, having cropping systems research profiles. Positions will be for four years and the major part of their salaries will be covered by the Cropping System Platform. The three assistant professors are expected to form a cross-faculty research group to be the stimulating link between the cropping systems research groups at the three faculties together forming the core of the Cropping Systems Platform.

The committee members formulate the documentation required for approval of assistant professors at the respective faculties during September 2015 to be presented at the Faculty board meetings in October 2015. The model used at the NJ-faculty should be used at all three faculties but adjusted to the requirements at the other faculties. The subject areas of the three assistant professors will be discussed and agreed within the Committee for Cropping Systems.

An international Advisory Board consisting of e.g. the invited guests from the Krusenberg meeting will be formed when the recruitment process has started. The Advisory Board will meet with the Committee for Cropping Systems and the assistant professors once a year during five years to make sure that the goals of the platform are met and decide focus areas for the coming year.

Step 3 – The Cropping Systems Platform arrange a post graduate course with the assistant professors as main organisers (not within budget, other funding must be arranged)

The Committee for Cropping Systems

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