Uthålliga odlingssystem i ett framtida svenskt lantbruk

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Content

• Challenges
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The global agenda for sustainable food production

Produce more healthy food with less climate and environmental impacts while inputs are decreased, regulations enhanced and the climate becomes more variable.
Which resources and what to do?

- Farmer knowledge and attitudes
- Cropping systems science incl systems approach
- Agroecological intensification
- Multifunctionality
- Model agriculture (role models – OiB/OF/?)
- Assessment of production systems
  - 4 E’s – economy, ethics, environment, energy
- Decision support systems
Agroecological intensification (Cassman, 1999)

• Exploitable gap between average farm yield and genetic yield potential is closing

• Requirements:
  – Improved soil quality
  – Precise management of production factors in time and space
  – Scientific advancement in plant physiology, agroecology and soil science

• Systems approach (2+2=5)
Cropping systems

Externalities
Weather/climate
Market
Government/EU
New tech./Info

Farmer goals
Production
Economic
Environmental
Social

Management
Yield/quality
Net returns
Soil/water/air quality
Resource conservation
Pest management

Cropping system
Economically viable
Environmentally sustainable
Socially acceptable

Farmer goals
Production
Economic
Environmental
Social
Cropping systems integrate:

- The nature of crops (species, varieties)
- Crop succession (rotation)
- Management techniques applied
Cropping systems for the future

• Integrated systems: account for both economical and environmental considerations
• Shift from emphasis on greater yields to cost reduction, improved quality of products and multifunctionality
• Substituting expensive and potentially polluting inputs (especially fertilizers and pesticides) by agricultural knowledge, labor (brain) and non-chemical cultivation techniques
• Systems include longer rotations and more perennial crops to increase cropping options and reduce risks
• Systems exploit synergism in time and space through crop succession to improve crops yields without additional inputs and deterioration of the environment and climate
Crop Rotation – the most important management tool?

Crop rotation

Prevention pests, weeds and diseases

Healthy crops

Soil fertility

Fertilization

Tillage

Cropping system

Crop protection

Ecosystem services

Quality production
Preceding value of pea and oat on winter wheat and winter OSR

Jensen and Haahr, 1990
Precropping effects on oilseed rape

After Sieling and Christen 2008
Response of crops following grain legumes and a catch crop

1st. Spring wheat

2nd. Winter triticale

Previous crop (- or + catch crop)

Source: GLIP Project; Hauggaard-Nielsen et al., 2010 in prep.
A theoretical framework for cropping systems science

Environmental conditions (Bio, Chem, Phys)

Crop\textsuperscript{n-1} yield

Climate and management methods on crop\textsuperscript{n-1}

Crop\textsuperscript{n-1} yield

Preceding effect

Sensibility of the following

Cumulative effect

after Sebillotte, 1990
Plant protection strategies for the future

Diversity, crop rotation, preventative control methods

Host resistance strategies

Cultural methods

Pesticides

After Wiik 2009
Nitrogen and phosphorus supply in Swedish agriculture (ton N yr\(^{-1}\))

38%
Fertilizer N use in Sweden

-2000 ton N year⁻¹

SCB, 2009
Spatial variability in soil N and % N derived from symbiotic N$_2$ fixation within 10 ha dry pea

Plant and Soil: Hauggaard-Nielsen et al 2010
Variability in pea $N_2$ fixation and yield

(a) N$_2$ fixation Kg N/ha

(b) Pea grain Ton DM/ha

Plant and Soil: Hauggaard-Nielsen et al 2010
Synchronization of nutrient supply and crop demand

- On-farm nutrient management research and extension
- Knowledge intensive technologies at the field level (cultivar, species and cultivar mixture, equipment)
- NUE increase by matching temporal and spatial nutrient supply with plant demand.
Prospective advances in cropping systems research for increased N use efficiency

Life cycle analysis of introducing pea in cropping systems


Source: http://www.grainlegumes.com/aep/r_d_projects/gl_pro
Crop rotation (Saxony-Anhalt, Germany)

Non-renewable energy consumption

Global warming potential (~100yr)

Terrestrial ecotoxicity potential

Source: Nemecek et al., 2008
Platform for Sustainable Cropping Systems Research and Education

Crop x Crop x Natural resources x Time x Space x Management

Inputs
Goods + other
Ecosystem services

Salix
Beet
Wheat
Pea

Integrated assessment
Agrotechnology
Animal science
Agroecology
Plant Nutrition
Plant genetics/breeding
Soil Science
Modelling
Economy
WPD management
Plant product biochemistry

Goods + other
Ecosystem services
Conclusions

- More knowledge about rotation effects to give farmers tools to enhance diversity of systems
- Multidisciplinary research teams are required to design, develop, test, model and assess cropping system on farms – integrating especially ecological and agricultural sciences
- Fundamental understanding of agro-ecology, biogeochemistry and biotechnology linked to breeding programmes will be essential for future sustainable crop production
- User friendly tools and assessment methods for economy, environmental impacts and quality of goods are required for assisting the farmer and the society in valuation of ecosystem services.