

IPM in Danish Winter Crops Based Cropping Systems

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Main photo: Loose silky-bent (*Apera spica-venti*) infestation in winter wheat. © Bo Melander, Aarhus University, Denmark. Right (from top): Barley leaf blotch (*Rhynchosporium secalis*). © Henny Rasmussen, Aarhus University, Denmark. Inter-row cultivation in winter oilseed rape. © Torkild Søndergaard Birkmose, Knowledge Centre for Agriculture, Denmark. Pollen beetle (*Meligethes aeneus*) in winter oilseed rape. © Ghita Cordsen Nielsen, Knowledge Centre for Agriculture, Denmark.

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Redesigning WCCS is needed to manage weeds, pests and diseases in line with EU-guidelines on Integrated Pest Management (IPM)

Winter wheat, winter barley and winter oilseed rape constitute the principal crops of many winter crops based cropping systems (WCCS) grown on Danish pig producing farms. While these crops produce larger profits than spring sown crops, the pesticide inputs required are also larger. Mainly, problems with annual grass weeds put pressure on pesticide use. This leaflet presents redesigned WCCS where crop sequences and pest control tactics and strategies have been modified to better suit IPM in WCCS.

Common crop sequences

Overwintering crops often compose 100% of WCCS whereas spring sown break crops are mostly grown in less than 25% of a crop sequence. Cropping of winter crops rarely follows fixed crop rotations but is rather a component of very dynamic crop sequences. Crop choice and the configuration of cropping systems are mainly driven by the prevailing commodity prices and the demand for forage grain and cereal staples. These are primary causes for the widespread cropping of winter wheat in particular, which covered 49% of the total area devoted to small grain cereals in 2009.

Spring sown break crops

Current WCCS are strenuous and favour specific pest problems. In addition, they do not support a wider adaptation of IPM. Crop sequences should ideally have a much stronger mixture of annual crops with varied sowing times (spring versus autumn) and periods with perennial crops to counteract unwanted and severe problems with pests, diseases and weeds, thereby limiting the need for pesticides. However, only moderate modifications of WCCS are likely to be accepted by Danish farmers because of the economic implications. We are suggesting two crop sequences that balance crop preferences among farmers and the inclusion of spring sown break crops for impeding severe pest problems:

Sequence I: W. barley – W. rape – W. wheat – W. wheat + catch crop – S. barley, especially designed to prevent the proliferation of annual grass weeds, cleavers and foliage diseases occurring at low levels.

Sequence II: W. barley – W. rape – W. wheat – W. wheat + catch crop – S. barley + catch crop / undersown ley – S. barley, especially designed to manage detrimental infestations of annual grass weeds and cleavers.

Applicable practices

A number of applicable tactics are listed below to supplement crop sequence changes and suppress pests.

Table 1: Different ready-to-use tactics in WCCS

Tactic	How	Why
Inverting tillage	Adjust the plough to ensure adequate burial of weed seeds, crop residues and vegetative propagules	Ploughing dilutes weed problems in general and causes a significant seed loss among short-lived annuals, notably grasses and cleavers. Vegetative propagules are exhausted, and diseases surviving on residues and slugs are hampered
Stubble cultivation	Tine cultivation in the upper 3-5cm soil layer stimulates weed seed germination	Reduces the weed seed bank and stimulates volunteers to germinate for subsequent control. Only advisable if no major weed seed shedding has occurred in the previous crop. If so, cultivation will preserve the seeds, barren brome being the only exception
Choice of crop variety	Choose varieties with high resistance against diseases, without compromising yield	Varieties with good resistance attributes against disease can reduce the need for fungicides. Choices must be based on reliable data (e.g. www.sortinfo.dk) and balanced against other cropping features
Sowing time	Delay sowing and increase seeding rate slightly of winter wheat in case of heavy weed infestations, especially with annual grasses and cleavers	Delayed sowing reduces weed density and the competitive ability of weeds. Note that injudicious delays may result in reductions in yields

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	Early sowing of winter wheat may increase the risk of barley yellow dwarf virus and take all	Aphids are attracted by early established fields, which also give them more time to transmit viruses. Early drilling gives longer time for take all to develop
	Early sowing of spring barley	Ensures early establishment and a greater ability to suppress weeds
Row cropping of winter oilseed rape	Winter oilseed rape is grown on 50cm wide rows to allow inter-row cultivation	Inter-row cultivation can provide satisfactory weed control without a yield penalty and without a need for supplementary herbicides

In addition to the tactics mentioned, we suggest *exporting straw* whenever possible and instead enhancing soil fertility through *catch cropping*. Any pesticide application is *optimised* in terms of *timing*, *dose* and *techniques* to minimise pesticide input while preserving crop yields. *Decision Support Systems* and *warning systems* for identifying the needs are important tools in this context.

Future practices

Several technologies and methods should be available in the future to supplement these tactics. Systems to manage logistics at farm level can improve timing, capacity and rounding off of areas when applying a control tactic. Precision technologies are gradually maturing with the creation of GPS systems to avoid overlapping treatments and to map weed occurrence for subsequent patch spraying. Breeding programmes can develop varieties with better disease resistance, and better exploitation of variety mixtures should help minimise disease attack and avoid high disease levels. Species mixtures can lead to less disease and aphid incidences in wheat. Trap cropping by means of flowering border zones may minimise pest outbreaks. Adjusting fungicide dose according to crop biomass sensing is a way to optimise fungicide use. There is still considerable scope for improving pesticide application technologies, Decision Support Systems and forecasting models, all technologies regarded as important tools in future IPM in WCCS.

Impact on TFI

The treatment frequency index (TFI) is an indicator of pesticide pressure. In Denmark, TFI is calculated taking account separately of each active ingredient in any product applied. TFI for a typical current WCCS and likely TFIs for the redesigned WCCS are presented in Table 2. Estimates are based on experiments and experts' judgements.

Table 2: Experts' judgement of TFI for current and redesigned WCCS with different levels of IPM

WCCS	Crop sequences	Average annual TFI
Typical WCCS, relying mainly on pesticides	W. barley – W. rape – W. wheat – W. wheat	2.50
Redesigned WCCS with applicable IPM practices	I. W. barley – W. rape – W. wheat – W. wheat + catch crop – S. barley	1.78
	II. W. barley – W. rape – W. wheat – W. wheat + catch crop – S. barley + catch crop / undersown ley – S. barley	1.68
Redesigned WCCS with applicable and future IPM practices	I. W. barley – W. rape – W. wheat – W. wheat + catch crop – S. barley	1.65
	II. W. barley – W. rape – W. wheat – W. wheat + catch crop – S. barley + catch crop / undersown ley – S. barley	1.57

Impact on farm economy

Thorough economic analyses of the impact of the redesigned WCCS on farm economies have not been conducted. This aspect needs further discussion before making wider recommendations. However, our proposals may serve as a starting point for such analyses. Danish pig producers have thus far shown no major interest in the suggested sequences, mainly due to their economic implications. Economic analyses should especially consider the need for sufficient supplies of forage grain of a high fodder value. Consequently, economic assessments must be made at the farm level before applying any of the principles proposed in this leaflet.

Further information

Go to www.endure-network.eu/endure_publications/deliverables for the complete report (Deliverable DR2.16) behind this leaflet, including guidance for the application of the different tactics and strategies proposed.

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Summary

Winter crops constitute the principal component of most crop rotations in arable cropping in Denmark because similar spring grown crops produce lower yields. Winter wheat, winter barley and winter oilseed rape are the primary crops grown among the winter crops but the pesticide input needed is higher compared to other crops, adversely affecting the environment. Previous case studies in ENDURE have predominately looked at tactics and strategies for pesticide reductions in only single crops. This case study is taking advantage of the knowledge amalgamated in previous ENDURE activities and brings it into a cropping system context. The aim is to change and redesign current winter crops based cropping systems (WCCS) in order to reduce the necessity of pesticides. Current WCCS in Denmark have relatively low treatment frequent indexes (TFI) already; 3-4 times lower than in England and France, for example. However, the case study has revealed further scope for reductions in pesticide use by employing agronomic methods and technologies that are already available to farmers, or are close to being so. The approaches suggested rely on a mix of preventive and curative pest management actions, such as modifying the existing systems, reducing pesticide use through the introduction of both low-tech practices (such as optimised/adjusted dosages, sowing densities and dates, cultivars, crop sequences, tillage etc.) and high-tech practices (such as GPS-guided applications, pesticide targeting, Decision Support Systems). The estimated maximum TFI reduction achievable by the most far-reaching proposal for a redesigned system in Denmark is 37%. The proposal should be more environmentally sustainable, but may be less profitable. Economic analyses, not undertaken here, are needed to further scrutinise its potential for implementation in practice.

For further information please contact:

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About ENDURE

ENDURE is the European Network for the Durable Exploitation of Crop Protection Strategies. ENDURE is a Network of Excellence (NoE) with two key objectives: restructuring European research and development on the use of plant protection products, and establishing ENDURE as a world leader in the development and implementation of sustainable pest control strategies through:

- > Building a lasting crop protection research community
- > Providing end-users with a broader range of short-term solutions
- > Developing a holistic approach to sustainable pest management
- > Taking stock of and informing plant protection policy changes.

Eighteen organisations in 10 European countries are committed to ENDURE for four years (2007-2010), with financial support from the European Commission's Sixth Framework Programme, priority 5: Food Quality and Security.

Website and ENDURE Information Centre:

www.endure-network.eu

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