Crops
Environment
& Land Use
Programme

National Tillage Conference 2020

'Minimizing risk, promoting sustainability'

Teagasc

Agriculture and Food Development Authority

NATIONAL TILLAGE CONFERENCE 2020

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Crops Environment and Land Use Programme

Oak Park Crops Research

Carlow

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Programme

09.00	Registration
09.45	Conference Opening
Session 1:	**Managing resistance** ***Chaired by Ewen Mullins, Teagasc***
10.00	How IPM is critical for managing pyrethroid resistance in aphids ***Michael Gaffney, Teagasc***
10.20	The occurrence of herbicide resistance in Irish grass weeds ***Ronan Byrne, Teagasc***
10.40	Managing cereal diseases with loss of CTL ***Steven Kildea, Teagasc***
Session 2:	**Environmental sustainability** ***Chaired by Siobhan Walsh, Agriland***
11.05	Environmental sustainability of the Tillage Sector- soils, GHG, carbon ***Karl Richards, Teagasc***
11.20	Oilseed rape systems: Impact on crop, GHG emissions and soil ***Dermot Forristal, Teagasc***
11.35	The story of cover crops in Denmark ***Nanna Hellum Kristensen, SEGES, Denmark***
12.05	Cover crops: an Irish perspective ***Richie Hackett, Teagasc***
12.20	**Panel Discussion**
12.35	Introduction to “Crop Report 2020- Agronomic Strategies; tailored for your business” ***Michael Hennessy, Teagasc***
12.45	Lunch *[1.45 Crop Report 2020 - demonstration workshop]*
Session 3:	**Research snapshots** ***Chaired John Spink, Teagasc***
2.20	Outputs from VICCI - The Virtual Irish Centre for Crop Improvement ***Dan Milbourne, Teagasc***
	Applying novel breeding approaches to tackle cereal diseases ***Adnan Riaz, Teagasc***
	The challenge of grass weeds: Co-developing solutions for Ireland ***Vijaya Bhaskar, Teagasc***
Session 4:	**Opportunities and challenges ahead** ***Chaired by Stephen Robb, Irish Farmers Journal***
2.55	Looking ahead, costs and returns ***Shay Phelan, Teagasc***
3.15	Enhancing the agronomy and management of beans ***Sheila Alves, Teagasc***
3.30	Panel discussion ***Rob Coleman, Tillage farmer*** ***Dermot Forristal, Teagasc*** ***John Crowley, Tillage farmer*** ***Michael McCarthy, Teagasc***
4.00	Conference Closing

Contents

How IPM is critical for managing pyrethroid resistance in aphids

Michael Gaffney
Teagasc, Ashtown

SUMMARY

The grain aphid *Sitobion avenae* (Fabricius) is a serious pest of cereal crops in Ireland, due to its ability to vector Yellow Dwarfing viruses, which stunts cereal crops and decreases yield. Pyrethroids are widely used insecticides to control this and other aphid pests in arable crops, both in Ireland and worldwide. In 2011, the first incidences of reported spray failures were reported in the UK. Subsequent testing suggested that a single clone of *Sitobion avenae*, (SA3), had developed a heterozygous mutation on the L1014F gene, resulting in the emergence of partial resistance or '*knock down resistance*'. This heterozygous resistance is almost exclusively associated with the SA3 clone. A limited survey in 2013 confirmed the presence of the SA3 clone in Ireland. In 2015, 38 fields (19 WB and 19 SB) were sampled, where reports of significant BYDV infection in crops treated with a pyrethroid insecticide were received. Testing revealed that 90% (132 /147) of the *S. avenae* collected in these fields tested positive for the kdr mutation (partial resistance or SR).

From 2016 to 2018 a randomised survey of arable fields was conducted. Crops with varying and no insecticide applications were sampled, with 50 random plants searched for *S. avenae*. These aphids were tested for the presence of the heterozygous mutation to indicate if they were partially resistant to pyrethroids. In 2016, 54% of aphids tested were resistant, falling to 25% and 20% in 2017 and 2018. This indicates that the SA3 clone is not only persisting in the Irish environment, but is now the dominant clone recovered. Also, the overall populations of *S. avenae* varied through the years, with 2017 returning fewer aphids per sampling effort, than in 2016 and 2018. This indicates an inter-annual variation in the size of the aphid population. Laboratory assays indicate SA3 clones from different locations display a range of responses to pyrethroids. LC_{50} values range from 3.85 g a.i./ha to 24.32 g a.i./ha, with 7 of the 10 SA3 populations tested displaying an LC_{50} higher than the equivalent field rate application rate of 5 g a.i./ha. While it is not appropriate to directly compare laboratory assays to field application rates, in general you would expect the response to pyrethroids in the assay to be more pronounced. Therefore, strong evidence exists that individuals of the SA3 clone can not only survive field rates of pyrethroids, but continue to reproduce after this exposure.

Given the decreasing diversity of insecticide active ingredients available to growers, with only two modes of action currently available for early crop application (BYDV control) for winter and spring barley, careful use of insecticides by the sector needs to continue. In order to minimise risk, and given the poor ability to predict both BYDV and SA3 clone levels from year to year in individual fields, it is prudent for growers to adopt precautions to minimise the over reliance on a single insecticide class while attempting to minimise the risk of BYDV infection. Current approaches such as minimising planting in highly susceptible locations, utilising planting dates and rotating insecticide classes is essential to protect the efficacy of the limited array of insecticides currently available. Given that approx. 50% of insecticide modes of action were lost from 2008 to 2018, and few new insecticides have been developed in the last decade, it is important to protect the efficacy of the existing insecticides available.

EPIC IPM

How IPM is critical for managing pyrethroid resistance in aphids

Michael Gaffney, Lael Walsh & Louise McNamara
Teagasc, Crops Environment and Land Use Programme

Teagasc

Introduction

- Barley Yellow Dwarfing Virus is spread by aphid feeding, particularly Grain, Bird Cherry Oat and Rose Grain Aphids
- Traditionally, good control was achieved with pyrethroid insecticides
- In 2011 (UK) and 2013 (Ireland) a partially resistant grain aphid clone (SA3) was detected
- To manage risk of BYDV, alternative insecticide options were used
- From 2019 onwards only 2 different '*modes of action*' available for BYDV control

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Available '*modes of action*' for aphid control

Active Ingredients Registered in 2012 (Pesticide Usage Survey 2012, DAFM)

Active Ingredient	Insecticide Class	IRAC Code
Chlorpyrifos	Organophosphate	1b
Cypermethrin	Pyrethroid	3a
Deltamethrin	Pyrethroid	3a
Dimethoate	Organophosphate	1b
Esfenvalerate	Pyrethroid	3a
Lambda -Cyhalothrin	Pyrethroid	3a
Pirimicarb	Carbamate	1a
Clothianidin / prothioconazole	Neonicintoid	4a

4 different *Modes of Action* (For BYDV control)

Active Ingredients Registered in 2020 (www.pcs.agriculture.gov.ie)

Active Ingredient	Insecticide Class	IRAC Code
Deltamethrin	Pyrethroid	3a
Esfenvalerate	Pyrethroid	3a
Lambda -Cyhalothrin	Pyrethroid	3a
Thiacloprid (Biscaya)[1]	Neonicinitoid	4a
Sulfloxaflor (Transform)[2]	Sulfoximines	4c
Flonicamid (Teppeki)	Pyridine	29

2 different *Modes of Action* (For BYDV control)

[1] Decision in Q4 by EU governments against renewal of license (timeline tbc)
[2] Application at Flag Leaf Ligule visible (GS39)

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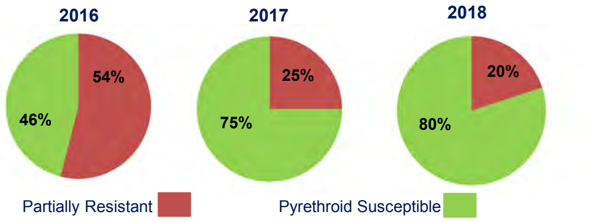
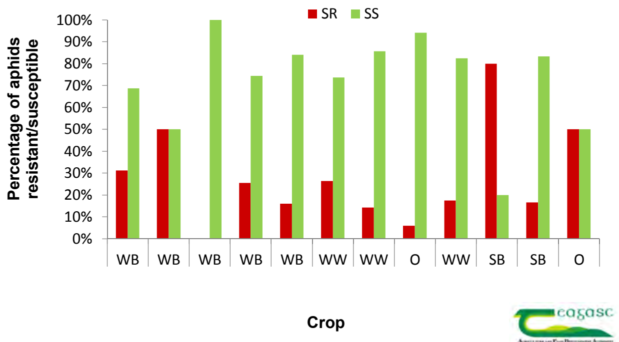
Prevalence of the SA3 clone from 2016-2018



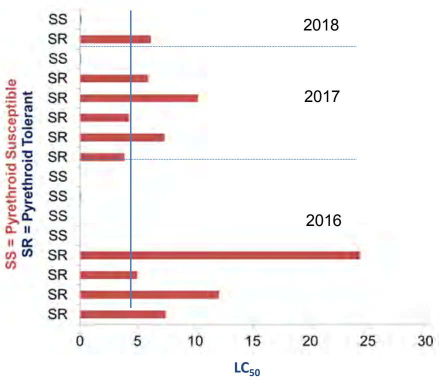
- The number of resistant clones detected in 2016 was statistically different to 2017 and 2018
- In 2017, field occurrence of grain aphid varied 15 - 27%
- Grain aphid (SA3) clone now the most common

Walsh *et al*, Submitted. *Biology and Environment*

Variation in the detection of the SA3 clone in Irish tillage fields 2016-2018

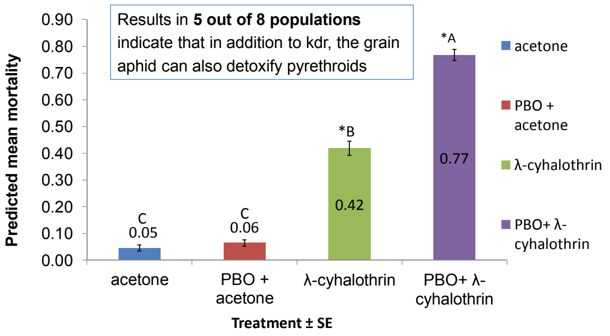


Variation in sensitivity of grain aphid clones to pyrethroid



- L-cyhalothrin sensitivity variable within and between clones
- SS populations highly susceptible to pyrethroids
- SR population is variable, with some susceptible to field application rate (5g a.i./ha) but majority surviving field rate & continuing to replicate

Additional resistance mechanisms in grain aphid



Mortality increased significantly with the addition of the synergist (PBO), which blocks enzyme-detoxification

Why using IPM approaches for resistance management is important

- The pyrethroid resistant grain aphid clone (SA3) is widespread
- Limited number of insecticide classes available
- While its response to pyrethroids is variable
- There is evidence that SA3 possess additional resistance mechanisms

Therefore, utilising existing IPM advice, such as planting date and rotating insecticide mode of actions is important

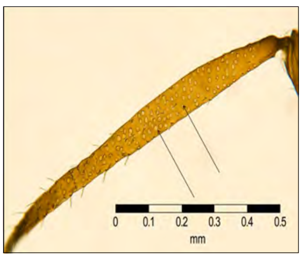
- *A survey of 45 fields and 460 tested aphids over 3 three years indicates that there was a significant relationship between the presence of the resistance clone and pyrethroid application (p=0.033)*

Potential implications of over reliance on a single insecticide class

(1) Potential development of homozygous resistance (Full resistance)

- SR population has the ability to form sexual forms
- However the SR clone produces female aphids at a lower rate to SS
- Similarly the SR clone produces male aphids at a lower rate to SS

While these assays were performed in the lab, they do indicate that the SA3 clone has retained sexual capacity (arrows indicate female scent organs)



Walsh *et al*, 2019. *IJAFR*

Potential implications of over reliance on a single insecticide class

(2) Development of pyrethroid tolerance in other BYDV vectors

- 2019 study compared the performance of 3 BYDV vectors to L-cyhalothrin
- *S. avenae, R. padi, M. dirhodum*
- Data indicated that *R.padi* clone had an LC_{50} of 3.7 g a.i /ha

While lower than the LC_{50} of SA3 clones, it possibly indicates an emerging issue

Photo Credit :Bayer Crop Compendium

Walsh *et al*, 2020.
Outlooks in Pest Management

Conclusions

- Partially resistant grain aphids (SA3) continue to be detected in Irish fields
- Number of active ingredients available is limited
- Field survey indicates an increased likelihood of locating a resistant aphid in a field previously treated with a pyrethroid (p=0.033)
- Research indicates several new issues which may emerge in time
- As our ability to predict the occurrence of both BYDV and the SA3 clone is limited, it is important to use IPM approaches to protect the efficacy of the pyrethroid class of insecticides
- Planting early for spring cereals is the most effective IPM measure, and if needed
- Apply aphicide at the 3-4 leaf stage (only one application) and only if warranted

Acknowledgements

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Sincere thanks to the cooperation of independent agronomists and farmers in allowing us access to fields and sharing agronomic information

The occurrence of herbicide resistance in Irish grass weeds

Ronan Byrne
Teagasc, Oak Park

SUMMARY

Wild oat (*Avena fatua*) is an arable grass weed species endemic in Irish cropped fields. A spring-germinating grass weed, *A. fatua* exhibits strong secondary dormancy. This results in a staggered germination profile, which makes the control of this species problematic in Irish spring cereal production. Herbicide resistance to ACCase-inhibiting herbicides is also an issue with control of *A. fatua*.

Until recently, the prevalence of resistance in Ireland was unknown and accurate large scale assays were needed. In this study, samples of *A. fatua* were taken from 102 fields in Co. Wexford, a prominent grain-producing county. Each field was visually scored for the density of weeds in that field. Populations with sufficient seed stocks were assayed for their resistance to the ACCase inhibiting herbicides, fenoxaprop and pinoxaden. Although it is now known that Irish wild oat populations have developed herbicide resistance, the mechanism of this resistance was unknown.

Our study aimed to determine whether resistance to the ACCase inhibiting herbicide, pinoxaden, was mediated through non-target site resistance mechanisms. To do this, known inhibitors of cytochrome P450 monooxygenases and glutathione *S*-transferases were applied to *A. fatua* individuals prior to herbicide application. DNA of individuals from these putative resistant populations was isolated and the gene coding for subunit 1 of Acetyl-CoA carboxylase (ACC1) was amplified and sequenced. Results of this experiment demonstrated the first report of non-target site herbicide resistance in *A. fatua*, as well as the first reports of target site point mutations in the Irish context. Spatial analysis of these putative resistant populations indicated that resistance tends to cluster geographically. We used a generalised additive model to explore the factors driving pinoxaden resistance. Of these, a number of key variables were identified.

Our study highlights the need for a landscape scale approach to herbicide resistance management.of action were lost from 2008 to 2018, and few new insecticides have been developed in the last decade, it is important to protect the efficacy of the existing insecticides available.

The occurrence of herbicide resistance in Irish grass weeds

Ronan Byrne, Walsh Fellow
Teagasc Crops Research

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IRISH SEED TRADE ASSOCIATION

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What is herbicide resistance?

The *evolved* ability of a plant to survive a herbicide dose that would normally kill it

What is causing resistance?

Target site resistance

- Where a simple mutation stops the herbicide from binding
- Can be quite specific

Non-target site resistance

- More complex
- Multiple minor genes contribute to a plant's ability to metabolise herbicides
- Accumulation of genes gradually leads to resistance
- Non-specific

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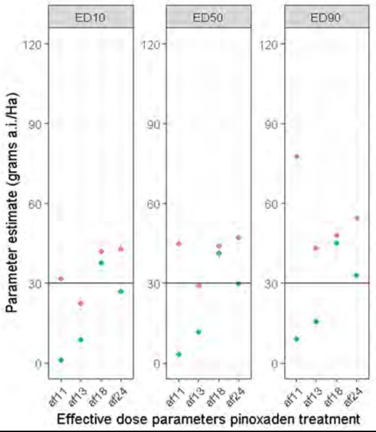
Non-target site resistance (NTSR)

- Malathion is a known inhibitor of CYP450s
- This gene superfamily is involved in herbicide metabolism
- If NTSR was mediated by CYP450s, then malathion should reduce resistance to herbicides, in NTSR populations
- NTSR can lead to unpredictable resistance profiles



What is causing resistance?

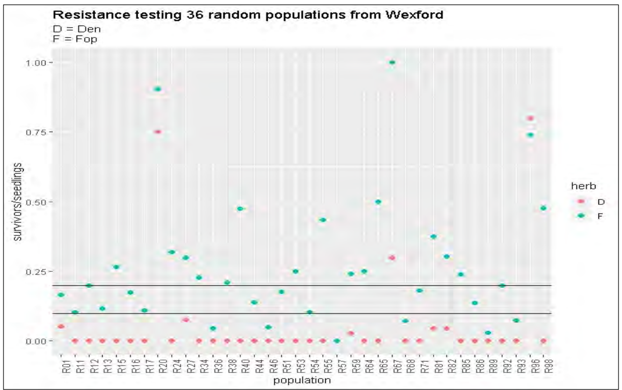
- Research carried out in Oak Park on the same populations shows the presence of target site mutations (TSRs).

Population	Mutation	Substitution	Frequency
Af11	I1781V	ATA->GTA/GTG	21/29
Af13	None	-	-
Af18	D2078G	GAT->GGT	35/36
	I1781V	ATA->GTA/GTG	6/36
	W1999L	TGG->(L)TTG/CTG	3/36
	W2027G	TGG->GGG	2/36
Af24	W2027C	TGG->TGC	12/12

- The susceptible population, Af13 was found to not carry any TSR point mutations.
- Population Af18 carried 4 separate point mutations at various frequencies.
- Resistance is complex

Data courtesy of Paula Byrne, UCD

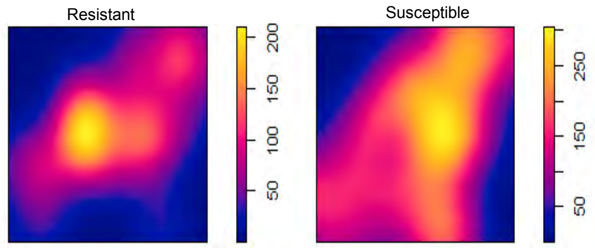
How prevalent is resistance?



- ~ 55% of samples resistant to at least one herbicide a.i.
- Herbicides tested - pinoxaden (axial) and fenoxaprop (foxtrot)

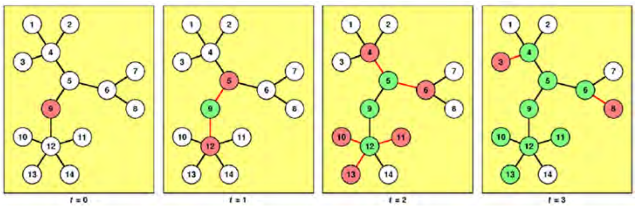
Localisation of resistance

- The distribution of sample sites at large is independent.
- The distribution of cross-resistant populations is not.
- This suggests that spatial correlation may be a factor with regards to resistance.



How do we explain these patterns?

Originally, thought that herbicide resistance was caused on farms solely by farmer behaviour



Resistant seeds can spread throughout the farming network, via machinery, straw, grain, natural migration etc.

What challenges we face? How do we overcome them?

- Reduced arsenal of herbicide products.
- Herbicide resistance.
- Weeds are adapting all the time.
- If management stays the same, the efficacy of control will decrease.
- Can only be combatted sustainably by using a variety of IPM tactics *as well as* using herbicides.

What does this all mean?

- Herbicide resistance in Irish wild oats can be caused by target site or non-target site resistance
- Complex resistance can be unpredictable
- Resistance is already present
- The spread of resistant seeds is a contributor to the prevalence of resistance
- Utilize a number of IPM tactics to effectively deal with resistant weeds

Thanks

- My supervisors: Susanne Barth and John Spink
- Advisors, growers and agronomists who helped acquire samples
- ECT project
- Everyone in Oak Park
- Funding partners:

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IRISH SEED TRADE ASSOCIATION
Founded in 1914

Managing cereal diseases with loss of CTL

Steven Kildea
Teagasc, Oak Park

SUMMARY

With an abundance of rainfall throughout the growing season, Irish cereal crops are often under attack from various fungal diseases that thrive in wet conditions. In winter wheat Septoria tritici blotch often dominates, whilst in winter and spring barley Ramularia leaf spot is becoming increasingly important. Both diseases are highly adapted to the Irish climate and current intensive production systems and if left unchecked have the potential to significantly impact yields of their respective host crops. Ideally, strategies for their control are integrative in nature, utilising equally variety, agronomy and chemistry, with each component aiding the other. Unfortunately, the epidemiologies of both diseases mean that these ideal approaches are often difficult to achieve without adversely impacting potential yields. For both diseases the multi-site fungicide chlorothalonil has become key in control programmes over the past two decades. For septoria this was initially as a tool in delaying the development and spread of fungicide resistance, but more recently in providing control. For Ramularia it has been essential for the control of the disease almost since the recognition of the disease in the late 1990s/early 2000s. As part of the EU Regulation 1107/2009 all pesticides to be registered for use within the European Union must meet rigorous standards. Unfortunately, as part of its review process chlorothalonil did not meet these standards and as such will no longer be permitted for use from May 20th 2020. Undoubtedly its loss is a significant threat to short term winter wheat and barley production in Ireland.

Key to all disease control strategies is understanding the risk of disease development and subsequently the impact this may have on the crop and its potential yield. Whilst the weather will fundamentally dictate the levels of disease that may develop, strategies can be put in place to buffer this to a certain extent. These will be different for each crop and disease. For Septoria, these include growing resistant varieties, delayed sowing, and to a certain extent canopy archicture. For Ramularia the impact of each of the above and others remains to be untangled, however minimising the stresses on the plant during the growing season is fundamental to delaying the development of the disease. However, for each of these the risks associated with suppressing final yields are often a barrier to their widespread uptake. Equally no individual component of disease control will provide the solution.

In addition to disease control chlorothalonil provided a key role in resistance management. As new fungicides make there way to the market if they are to be protected the above tactics will become essential components of disease control programmes and will need to be tailored to the crop grown. However, the role of altenative multi-sites must not be overlooked. Whilst they may not provide the same level of efficacy as chlorothalonil when compared individually, they do provide a level of disease control that ensures they provide a level of resistance management, but equally disease control when all else fails.

Managing cereal diseases with loss of CLT

Steven Kildea
Teagasc CELUP, Oak Park Crops Research

The application of chlorothalonil is not permitted from May 20th 2020

CTL based products include

Product*	PCS No.	Product	PCS No.	Product	PCS No.
Barclay Avoca	4458	Daconil	5748	Amistar Opti	5068
Jupital	4503	UNIPRO CTL	5944	Ortiva Opti	5992
Rover 500	4467	Spirodor	5934	Proceed	5519
Balear 720 SC	4411	Cavaterra	5059	Treoris	5310
Abringo	4239	Phyton	5019	Aylora	5311
Joules	4784	Orchid B	5058	Fielder SE	4251
Muti-Star 500	4812	Chlorthalis	5193	Fezan Plus	4468
Supreme	4841	Bravado	6013	Crafter	5345
CT 500	5302	Bravo 500	3452	Tonga	6285
Stefonil	5351	Curator	5069	Cigal Plus	6061
Renew Chlorothalonil	5362	Vertik	5071		
Farmco Chlorothalonil	5593	Perseo	5750		

*On PCRD database Nov 2019

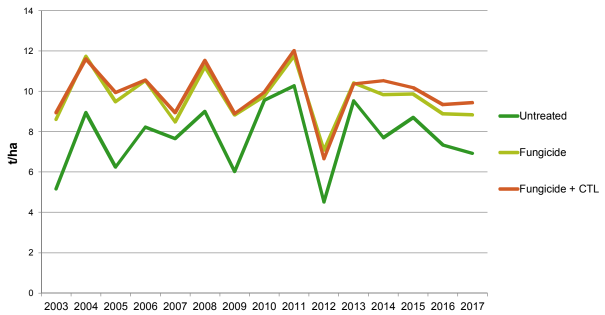
Should we be concerned?

1. **What diseases are a problem?**
   - Septoria tritici blotch of winter wheat
   - Ramularia leaf blotch of winter & spring barley
   - Chocolate spot of winter & spring beans

2. **Are there solutions?**
   - Variety
   - Agronomy
   - Chemistry

The problem – WHEAT

Yield responses (winter wheat) from fungicides 2003-2017



Teagasc Wheat Fungicide Trials 2003-2017

- 73 Trials
- 154 Direct comparisons
- Significant Year x CTL interaction (*P*<0.001)

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The problem – BARLEY

Kildalton 16/07/2019

Teagasc

Why is SEPTORIA a problem?

- **Varietal Resistance** – improving but still require protection
- **Agronomic practises** – cost/benefit (e.g. how late to we need to delay planting)
- **Nutrition** – limited capacity to impact disease development
- **Fungicides** – has demonstrated quite an ability to become resistant
- CTL has provided consistent/inexpensive “backup” to all of above

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Why is RAMULARIA a problem?

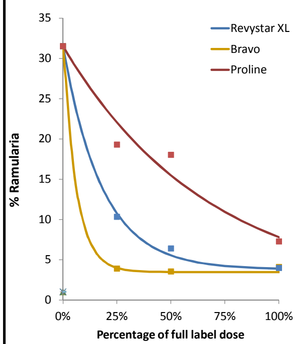
- **Varietal Resistance** – if available not in elite varieties
- **Agronomic practises** – don’t stress the crop….in the Irish climate??
- **Nutrition** – don’t stress the crop!
- **Fungicides** – has demonstrated quite an ability to become resistant
- CTL has provided consistent/inexpensive “backup” to all of above

So how will we manage without CTL?

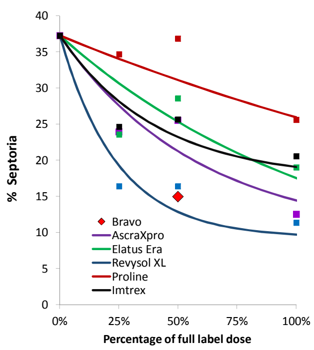
1. **Know your risk**
   - Strengths & weakness of variety?
   - When & where is it being grown?
   - Know strengths & weakness of fungicides
2. **Know your crop**
   - What growth stage – timings critical
   - What is disease pressure?
   - Is it under stress – Ramularia
3. **Know your fungicide**
   - What can I expect from the fungicide, new or old?
   - Alternative multsites do work!

How does new chemistry fit - 2019?

Ramularia - Protection



Septoria - Protection



Conclusions

- Loss of CTL will impact disease control
- Impacts can be minimised
  - Variety
  - Agronomy
  - Chemistry
- Need for resistance management to continue – multi-sites still required!

Acknowledgements

Teagasc Crops Research

Deirdre Doyle, Jim Grace, Liam Shepard

Farm staff

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

EPIC IPM

Environmental sustainability of the Tillage Sector - Greenhouse gases and soil carbon

Karl Richards, Dominika Krol, Patrick Forrestal and Gary Lanigan
Teagasc, Johnstown Castle

SUMMARY

There is increasing pressure on Irish agriculture to continue to improve its environmental sustainability through the implementation of best management practices. Unfortunately increases in greenhouse gas (GHG) have increased in recent years mainly due to dairy expansion, with agriculture accounting for ~32% of national emissions. Agricultural emissions are dominated by CH_4 and N_2O and tillage accounts for ~8% of agricultural emissions. The importance of GHG emissions nationally was highlighted when the Government recently announced a national climate and biodiversity emergency. This culminated in the publication of the National Climate Action Plan (NCAP) in 2019 which set very challenging targets for Ireland to 2030. Agriculture must reduce emissions of CH_4, N_2O and CO_2 by ~ 10% to 17.5 -19Mt CO2e and deliver carbon sequestration of ~ 10% (2.7 MT CO2e).

Teagasc produced the second Marginal Abatement Cost Curve (MACC) in 2018 which highlighted 27 measures that can contribute 1. Directly reducing emissions, 2. Increase carbon sequestration and 3. Offset fossil fuel use. Animals within tillage enterprises are the main source of GHGs. The C footprint of the main Irish tillage crops is generally low, ranging from 0.3 to 0.6 kgCO_2e per kg grain. The most relevant measures in the MACC for tillage farmers relate to reducing inorganic nitrogen fertiliser use and increasing soil organic matter.

Nitrogen fertiliser use and soil organic matter can be increasingly optimised through the application of organic manures, use of cover crops, straw incorporation, minimum tillage and expanded rotations. Tailoring fertiliser timing/use to yields will further improve N use efficiency. Use of grass and grass/clover leys can both increase soil nutrient availability and soil organic matter. Addition of organic manures to an arable system adds micronutrients and carbon in addition to N,P,K and S. This input can help maintain soil productivity in continuous arable rotations. However, organic manures do bring challenges in terms of timing, nutrient content and understanding nutrient release rates from organic manures. In general, the recommendation is to apply high N organic manures in the spring rather than autumn (making sure the nutrient content and spread rate are appropriately calibrated) and incorporate as soon as possibleThe measures for reducing GHG emissions, increasing soil organic matter will also benefit water quality in reducing nutrient and sediment loss to water. There are a lot of synergies between improving productivity and improving sustainability. The earlier farmers take action, the greater the cumulative benefits will be. Globally drivers of importance for the tillage sector are (i) the move to more plant based diets and (ii) the impacts of climate change on water availability. Thus there are opportunities for Ireland to produce plant based foods from soils with a plentiful supply of water.

Environmental sustainability of the Tillage Sector – Greenhouse gases and soil carbon

Karl Richards, Dominika Krol, Patrick Forrestal and Gary Lanigan
Teagasc, CELUP, Johnstown Castle

The Challenges

- Industry expanding to meet global food demand
- Economic viability in volatile world market
- Improving environmental sustainability
  - 12% increase GHG emissions since 2011
  - Agriculture = 32% national emissions
  - Water quality declines in south and east
  - Continuing decline in biodiversity

Agricultural GHG 2030 targets:

- Reduce emissions ~10% (17.5 -19Mt CO_2e)
- Deliver carbon sequestration ~ 10% (2.7 MT CO_2e)

Water quality targets:

- Good status for all waters 2027
- Free advisory service in areas of known poor water quality (ASSAP)

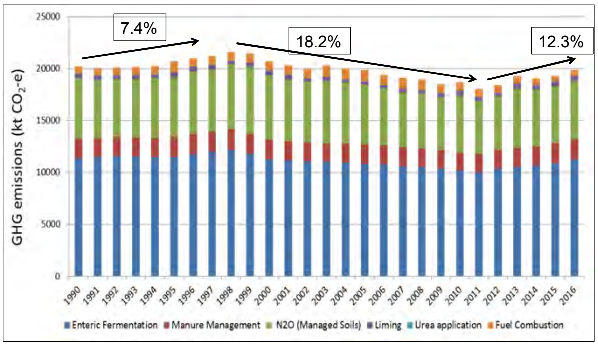

THE IRISH TIMES

Government must declare 'climate and biodiversity' emergency


News Politics

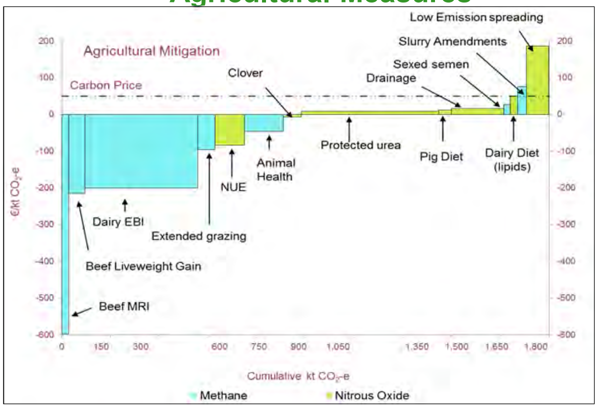
Ireland declares climate emergency: 'Things will deteriorate rapidly unless we move very swiftly'

Agriculture GHG emissions profile



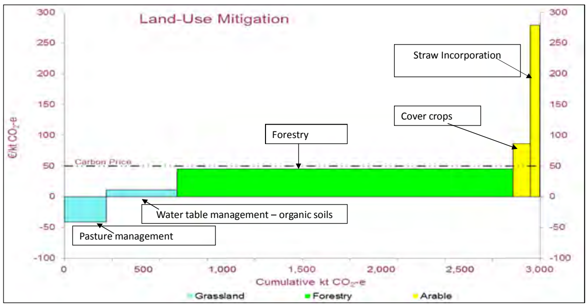
- Methane from EF and manure management comprise 66% and Nitrous oxide 32% of sectoral emissions
- Cattle account for 88.7 % of methane emissions and 90% of N_2O emissions

Agricultural Measures



Gary J. Lanigan G.J. & Donnellan T. (eds.) 2018 An Analysis of Abatement Potential of Greenhouse Gas Emissions in Irish Agriculture 2021-2030, Teagasc .

Land-Use C Sequestration



Measure	Abatement $MTCO_2e$
Pasture management	0.26
Water table mgt of organic soils	0.44
Forestry	**2.1**
Tillage mgt - Cover crops	0.1
Tillage mgt - Straw incorporation	0.06

Reducing tillage carbon footprint

The C footprint is already low

The C footprint of the main tillage crops is between 0.3 - 0.6 $kgCO_2e$ per kg grain

Reduce fertiliser N and improve soil organic matter

- Optimise soil pH, P and K
- Where possible use organic manures
- Optimise N application to growth
- Use cover crops to reduce winter fallow
- Utilise appropriate rotations

Measure	N_2O	Soil Organic Matter
Organic Manure	👍👍👍	👍👍👍
Cover Crops	👍👍	👍👍👍
pH, P and K	👍👍👍	-
Straw incorporation	👍	👍👍
Minimum tillage	👎	👍
Optimise N	👍👍	-
Rotations	👍👍	👍

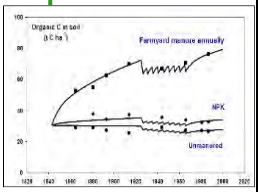
How can you increase soil organic matter? Practical tips

Add more carbon to the soil – but how?

- Organic manures

Retention coefficient of 14% in long-term trials (Fornara et al., 2016)

- Photosynthesis – green manures



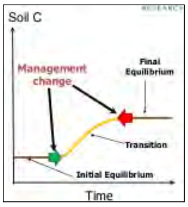
Jenkinson et al. 1990

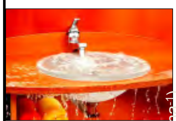
Manure type	% DM	Application rate*	Carbon addition (t/ha)
Cattle slurry	6	25 m³/ha*	0.6
Pig slurry	4	25 m³/ha	0.4
FYM	25	25 t/ha	2.5
Poultry (layers manure)	55	5 t/ha	1.1
Spent Mushroom Compost	32	20 t/ha	2.6

* Application rates are governed by SI 101 2009 and these rates may not be allowed in all circumstances.

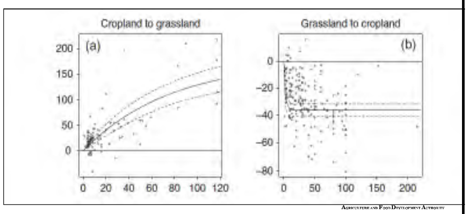
Land-use Change – C Equilibrium

- Sequestration is finite – move towards a new equilibrium
- **Its reversible** – depends on maintaining change in management practice
- When grassland/forestry is converted to arable – **C in lost quite rapidly and reaches a new equilibrium after 20-30 years**
- Measures that increase SOC tend to **take much longer to build stocks up**





Poeplau et al. 2011 GCB

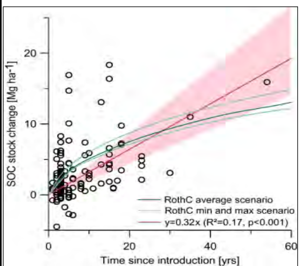


Cover crops

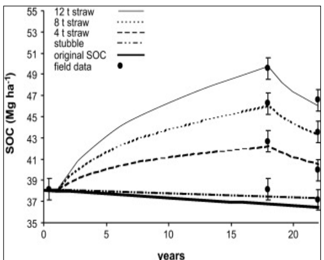
- Increases SOC 10-15 t C ha^{-1} over 20 - 40 years
- Reduces N leaching
- Stabilises soil particles

Straw incorporation

- ~20% straw C remains in soil
- 8% increase in soil C @ 4t straw over 20 years
- Increased soil biology (40%)



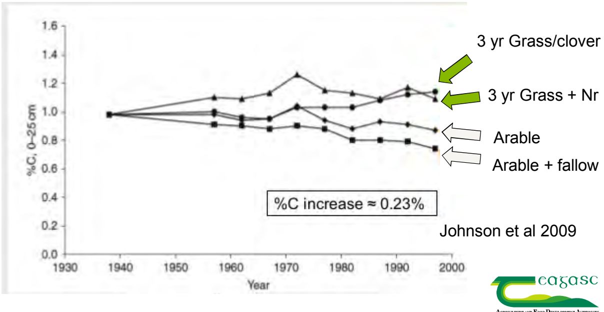
Poeplau & Don 2015 AGEE 200: 33-41



Van Groenigen et al. 2011 AGEE 140: 218-225

Rotations and grass leys

- Introducing rotations esp. with grass leys can increase SOC by 20% after 20-30 years



Conclusions

- Must reduce GHG emissions by 10% and deliver carbon sequestration of 10%
- Tillage has a good carbon foot print
- Opportunity to further improve through
  - Reducing N fertiliser – NMP, organic manure, cover crops
  - Increasing soil organic matter – cover crops, straw incorporation & rotation/grass leys
- Carbon footprint measures also improve soil and water quality
- Early implementation of measures leads to greater accumulated impact

Further Reading

- Gary J. Lanigan & Trevor Donnellan (eds.) *An Analysis of Abatement Potential of Greenhouse Gas Emissions in Irish Agriculture 2021-2030*. *Teagasc, Oak Park, Carlow. June 2018*
- Donnellan, T., Hanrahan, K and Lanigan G.J. *Future Scenarios for Irish Agriculture: Implications for Greenhouse Gas and Ammonia Emissions*. *Teagasc, Athenry. June 2018*
- Climate Action Plan *https://www.dccae.gov.ie/en-ie/climate-action/publications/Pages/Climate-Action-Plan.aspxAg-*
- *Ag-Climatise* https://www.agriculture.gov.ie/ruralenvironmentsustainability/climatechangebioenergybiodiversity/ag-climatiseadraftnationalclimateairroadmapfortheagriculturesectorto2030andbeyondpublicconsultation/

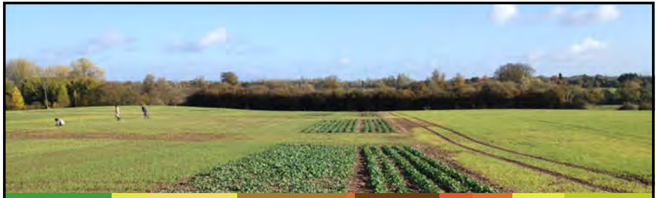
Oilseed rape establishment systems: Impact on crop, GHG emissions and soil

Dermot Forristal, Roisin Byrne, Macdara O'Neill, Ridhdhi Rathore
Teagasc, Oak Park

SUMMARY

Lack of rotation threatens future crop production sustainability, as monoculture leads to reduced yields and higher costs over time. The CROPQUEST project (2013 – 2015) concluded that oilseed rape (OSR) and beans were the most suitable broad acre break crops and both are now the focus of current Teagasc research. Non-inversion crop establishment systems such as min-till, strip-till and direct drill are being used by many growers. The performance of these systems is dependent on regional factors such as climate, soils, yield potential and weed pressure. Compared to plough-based establishment, reduced cultivation systems can save cost and time, which would benefit the OSR crop, where sowing occurs at the same time as cereal harvesting. While non-plough establishment for OSR has been evolving, little research, under our climatic conditions, has been conducted to date. The aim of the work described here was to determine the impact of soil cultivation and sowing system on OSR crop establishment, N management, growth and yield. Impact on greenhouse gas (GHG) emissions and soil microbiology were also studied.

The research was carried out over a three year period. Seeding row widths from 125mm to 750mm; seeding rates of 10 to 60 seeds and two variety biomass types were evaluated in one trial. A second trial compared establishment systems: plough-based with 125mm and 600mm row widths; a min-till system with 125mm and 600mm sowing widths and strip tillage with just 600mm row widths. A third trial compared plough-based and strip tillage with two autumn N rates and five spring N rates. Three different series of measuremnets were taken: (i) crop establishment, growth and yield were assessed; (ii) greenhouse gas measurements were taken at soil, plant and field scale and (iii) specific soil microbial species were studied in soil and plant samples using molecular techniques. The results indicate that using seeding row widths up to 500mm did not result in a negative impact on yield, although sowing at 750mm could reduce growth and final yield. While the use of different seed rates did not impact on the row width results, if spring green area indices proved to be low (<0.25) due to grazing or poor growth, higher seed rates would allow quicker recovery. While the plough-based establishment system often resulted in the highest plant populations, in 6 of 8 comparisons this had no effect on crop yield, but on two occasions plough established crops did yield better than strip-tillage. There was no response to N management strategies with non-plough systems. The use of non-plough systems result in reduced soil C loss at cultivation, but cumulative CO_2 losses differed little. Nitrous oxide losses were greater with low-disturbance tillage systems on account of slightly higher soil moistures. While seasonal differences in N_2O losses were recorded, the overall emission factor values were quite low. The microbiome studies revealed that changes in rotation and soil cultivation are reflected in the microbial communities associated with the crop and illustrate the complex mechanisms that can be involved in crop production.



Oilseed rape establishment systems: impact on crop, GHG emissions and soil.

Dermot Forristal, Roisin Byrne, Macdara O'Neill and Ridhdhi Rathore
Teagasc CELUP, Oak Park Crops Research Centre

Background: Why these studies

- Limited rotation, few break crops
- CROPQUEST: focus now on beans and OSR
- Crop establishment: Scope for savings?

Plough-based establishment systems

- Expensive and slow; prone to moisture loss in dry autumn
- May be less sustainable from C and soil perspective.

Non-inversion systems

- Min-till; Strip-till: commercial but little research in our climate.
- Low cost and fast but how will their use impact on:
  - Crop performance;
  - Sustainability of crop production.

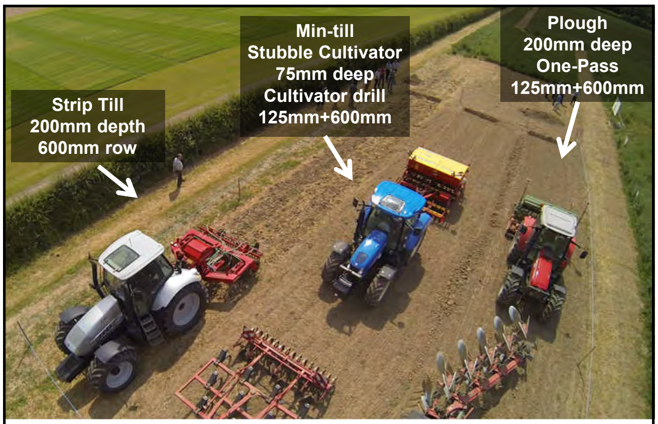
Aims

To evaluate alternative crop establishment systems

- Plough-based
- Min-till
- Strip-till.

Determine their impact on:

- Crop growth, development and yield.
  - The need for different crop management
- Greenhouse gas emissions
- Microbiome: microbial populations in soil and adjacent root and shoot areas.



The trials: 3 years

Row width, Seed rate and Variety type

- 125mm, 250mm, 500mm and 750mm rows
- 10 seeds/m², 15 seeds/m², 30 seeds/m², 60 seeds/m²
- Standard and Low biomass variety types

Systems and management

- Plough-based at 125mm
- Strip-till at 600mm

} N management strategies evaluated

- Min-till at 125mm and 600mm
- Plough at 600mm

N response

- Plough 125mm vs Strip-till 600mm

What was measured?

Crop performance

- All trials
- Establishment, Growth, Yield.

GHG emissions

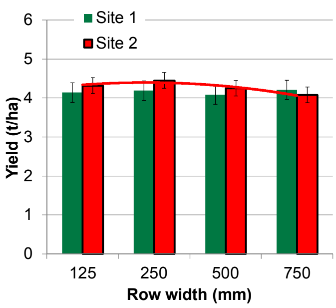
- Using some trials
- CO_2 and N_2O
- Ecosystem C exchange

Microbiome

- Using some trials
- DNA analysis of soil and plant samples (one trial)
- DNA analysis to check for rotation benefits from OSR

Results: Crop Performance (Roisin Byrne)

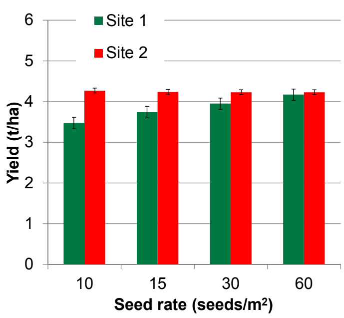
Results: Row widths and crop



Row width

- No difference from 125mm to 500mm.
- One site: significant yield drop at 750mm
- Some differences in establishment and GAI
- Little interaction with variety
- OSR can overcome wide plant spacing.
- Widths of 500 and 600mm give good results.

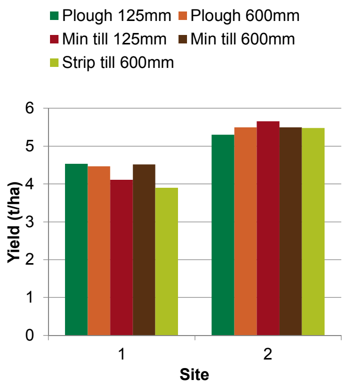
The results: Seed rates and row widths



Seedrate

- Site with spring GAI>0.5 : no impact on yield
- Site with spring GAI< 0.25: yield impact
- Lower yield associated with less GAI.
- Avoid very low seed rates if establishment /grazing risks.
- Little interaction between SR and RW or variety type

The results: Establishment Systems



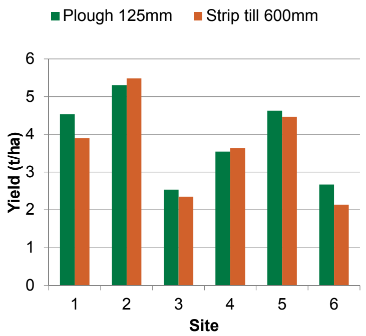
System

- No significant difference in yield.
- Plough 125mm had best establishment (up to 80% higher than poorest)
- The response to N management (fixed or canopy management) was not affected by system.

Results: Plough vs Strip Till : 6 trials

System

- Compared in six separate trials (sites/years).
- Compared across different N levels in three.
- No difference on 4 sites
- Plough was significantly better in two trials.



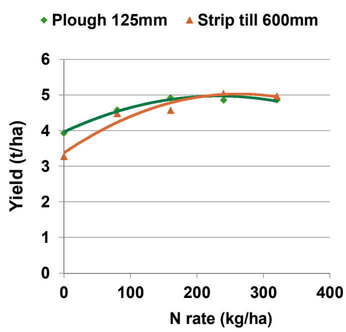
The results: N requirement

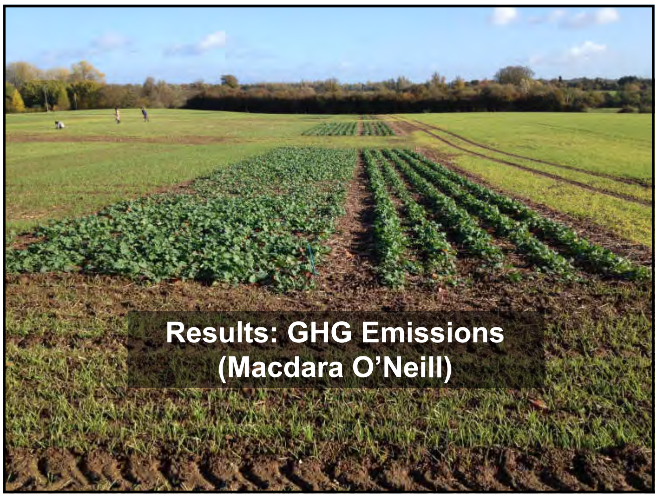
Evaluated

- 0 and 30kg N autumn
- 0, 80, 160, 240, 320kg N.

Results

- Autumn N resulted in more autumn growth but did not impact on yield
- Little difference in N response between cultivation systems.
- On two sites, economic optimum was close to 160kg N/ha

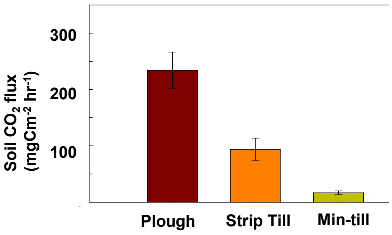




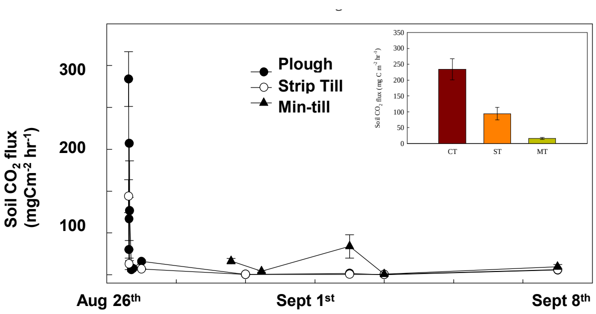
Results: Soil CO_2 loss- at sowing

Response to tillage

- 'De-gassing' of CO_2
- More disturbance – more loss.
- But very short term



Results: Soil CO_2 loss over 2 weeks



Results: Ecosystem C

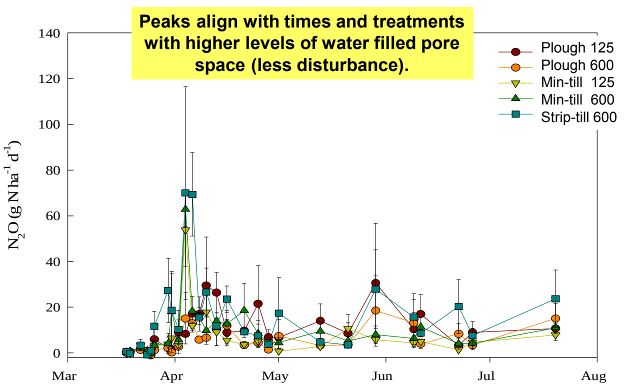
Measured

- Field level measurements NEE
- Net inflow and outflow of C at field level.
- Plant photosynthesis and respiration.

Results

- Over 6 months (Feb to July):
  - **5.3t** of C /ha net uptake. (vs 2.84t all crops)
- At harvest:
  - **2.46t** of C exported
  - **2.84t** of C residue remains in field.

The results: N_2O emissions



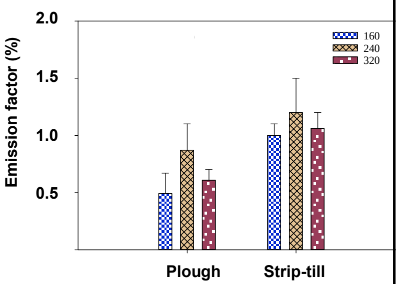
The results: N_2O emission factors

Emission Factors

- The proportion of N inputs lost as N_2O
- IPCC default is 1%.

Results

- Lots of variation
- Plough-based less than Strip-till and IPCC default value.
- But levels are low overall



Results: Microbiome and cultivations

Measured

- Soil and Plant samples from Plough and Strip Till established crops at three growth stages.
- DNA of the microbial population extracted and sequenced

Results

- Root, shoot and soil microbiome evolves over the season
- Tillage system impacts on the microbial communities
  - Particularly on root and shoot colonies; less on rhizosphere
  - Has the potential to impact on relationship between the microbiome and the OSR plants

Results: Microbiome and take-all

Measured

- Soils from wheat after wheat, wheat after OSR, and from OSR were taken form Ploughed and Strip-Tilled plots.
- Quantitative PCR was used to determine the presence of the pseudomonas spp which produce 2,4-DAPG (active against take-all)

Results

- Crop rotation (in combination with Strip-tillage) increased the population of pseudomonas species that produce 2,4-DAPG.

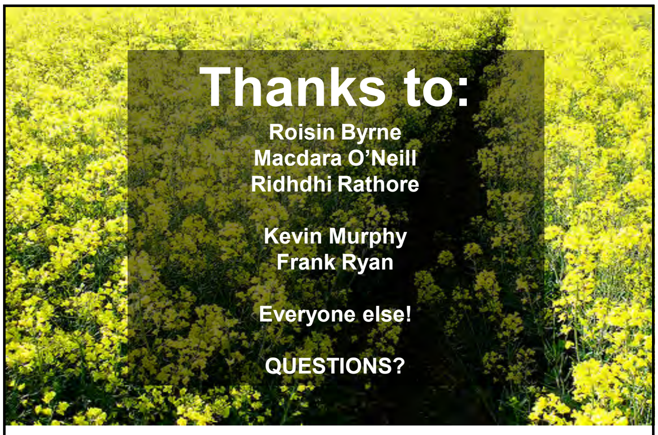
Conclusions

- Winter OSR can be successfully produced with non-plough systems
  - Row widths up to 600mm
  - Different cultivation methods

- Establishment and growth differences may not impact on yield.
- Non-inversion cultivation can be used across rotations
- **Scope to save costs and time when establishing OSR**

- OSR production captures and retains significant amounts of C
- Less tillage can:
  - reduce soil C loss but differences are small
  - increase N_2O emissions, but emission factors are still quite low.

- Soil microbiome studies have the potential to reveal the mechanisms through which management can impact on production.



The story of catch crops in Denmark

Nanna Hellum Kristensen
PlanteInnovation, SEGES, Denmark

SUMMARY

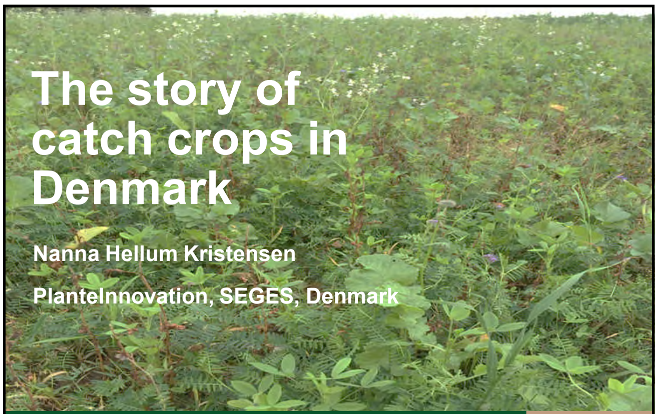
Since the 1980s, an effort has been made to minimize the loss of nitrogen from farmland in order to protect ground and surface water in agriculture. The focus has been on improving nitrogen utilization in manure, quotas for maximum supply of nitrogen on farm level and mandatory catch crops. The first mandatory catch crops were introduced in 1999, requiring all farmers to have at least 6% of their area covered by catch crops without any compensation. The area of mandatory catch crops has continued to increase and the requirement will be ~ 25% of total area by 2021, with some farmers achieving up to 50%. The state does compensate for some catch crops (e.g. seed cost).

There have been some challenges with catch crops (see table) in Denmark. One of the main challenges is early establishment of the catch crops due to late harvest of the main crop. Another issue is that a catch crop removes the option of growing a winter crop, which is especially a challenge on pig farms. To counter the challenges, farmers are allowed alternatives to meet the catch crop demand. For example, instead of establishing catch crops farmers are allowed to reduce nitrogen application to the main crop, sow some winter crops early to increase nitrogen uptake or fallow land.

System	Pros	Cons
Grass undersown in maize in spring	Allows early sowing of catch crop, enables maize production	Difficult to obtain good coverage of the grass or the grass will compete with the maize
Grass undersown in spring cereals	Well established catch crops with high success rates	Block the growth of winter crops
Spreading catch crop seeds 2-3 weeks pre-harvest of cereals (mainly brassicas and phacelia).	Early establishment of the catch crop	Low success rate, catch crops can complicate harvest of main crop
Sowing catch crops after harvest of cereals (species restricted to brassicas, phacelia, winter rye, barley, oat / mixtures of these)	High success rate	Late harvest of main crop leads to late sowing of catch crop

SEGES has completed several trials focusing on the effect of different species and mixtures of cover crops on the yield of the following spring barley. The results show that the catch crops do release nitrogen to the following crop; amount being highly dependent on the year and soil type. In 2018/2019 the amount of nitrogen saved after a mixture of fodder radish and phacelia was ~ 20 kg N/ha, as a mean of 7 trials. After mixtures, including nitrogen fixating species such as vetch, more nitrogen can be saved, up to ~40-50 kg N/ha on sandy soils. In general, we find yield increases in spring barley of around 0.1-0.2 tons per ha on the sandy soil after catch crops with brassicas, while yield increases are hard to find on clay soils.

In 2019 SEGES measured above ground biomass and N uptake in catch crops on 90 fields. Mean N uptake was 26 kg N/ha, which is lower than the expectation based on field trials. The biomass data will be combined with satellite data to establish an association between the satellite index and nitrogen uptake in catch crops, thereby enabling a more precise prediction of the nitrogen need for the following crop.



The story of catch crops in Denmark

Nanna Hellum Kristensen

PlanteInnovation, SEGES, Denmark

SEGES

Promilleafgiftsfonden for landbrug

gudp

Main production in Denmark

Total area	4.4 mill. ha
Agricultural area	2.6 mill. ha
Dairy cows	600,000
Pct. arable land	90 pct.
Produced pigs	25 mill.
Kg N in animal manure	85 kg N/ha
Kg N in mineral fertilizer	95 kg N/ha

SEGES

Main areas in legislation

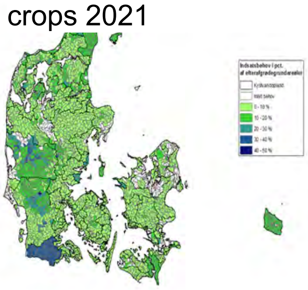
- Nitrogen quotas
- Animal manure
- Compulsory catch crops
- Restrictions in soil tillage
- Phosphorous quotas

SEGES

Catch crops in Denmark

- Mandatory since 1999
- Basis: 10 percent of the farm area with cereals, oilseed rape, maize for plant production farms and 14 percent for animal farms demands catch crop covering
- Extra demand for animal farms depending on geography
- Extra demand in specific areas to reduce outlet of N to specific recipients.
- Some of the catch crops are compensated by the state, who pays the expenses for seeds and sowing.

Demand for catch crops 2021



SEGES

Alternatives to catch crops

- Early establishment of winter cereals (latest 7th of September): 2 ha = 1 ha catch crops
- Set-a-Side (fallow land): 1 ha set-a-side = 1 ha catch crops
- Sow catch crops between two winter cereal crops: 2 ha = 1 ha catch crops
- Reduction of N-quota (application of N)
  - 95 kg N-reduction = 1 ha cover crops for plant producers
  - 150 kg N–reduction = 1 ha cover crops for animal farms

SEGES

Main species

- Brassicas (fodder radish)
- Spring barley
- Winter rye
- Phacelia
- Oat
- Mixtures…
- No nitrogen fixating crops

  (vetch, clover ect.)

SEGES

Conclusions from trials with new species

- Sun flower was poor
- *Malva was poor*
- Viper's bugloss and blueweed, seed did not germinate
- **Oat** (black oat and regular oat) performed well
- **Common corn-cockle** performed well
- Difficult to find new species as good as fodder radish

Corn-cockle 8. oktober 2017
trial 070111717-017, Ringsted.
By Nanna Hellum Kristensen,
SEGES.

SEGES

Main catch crop solutions in Denmark

System	Pros	Cons
Grass undersown in maize in spring	Allows early sowing of catch crop, enables maize production	Difficult to obtain good coverage of the grass or the grass will compete with the maize
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SEGES

Catch crop challenges in Denmark

SEGES

Sowing techniques

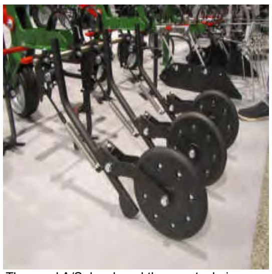
Demonstration trials with sowing before harvest

Sowing after harvest

- https://vimeo.com/285468730

SEGES

Grass in maize - alternative to spreading the seeds on the ground

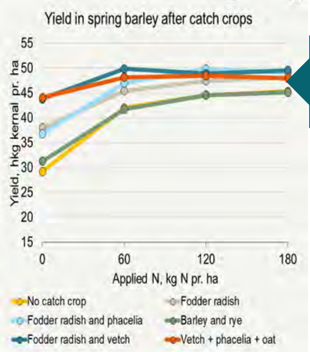


Thyregod A/S developed the new technique, which can be attached to a hoe. The seeds are sown in three lines with pressure from wheels. *Photo: Henning Sjørslev Lyngvig, SEGES.*

Some machine stations are developing equipment for sowing grass in maize using pressure from the wheel. Photo: *Henning Sjørslev Lyngvig, SEGES.*

SEGES

Yield effect of catch crops on sandy soils in following crop



Increased yield of 3,8 hkg pr. ha fodder radish and phacelia

- Do not see a large effect of catch crops on yield on clay soils
- You can gain 1-2 hkg/ha after well established catch crops – some times more (on sandy soils)
- Save 0-50 kg N per ha

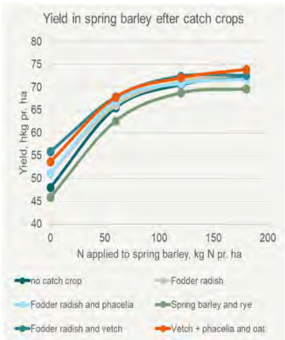
Soil types in Denmark

Sandy soil: > 65 % sand and ~ 5 % clay

Clay soil: < 90 % sand and > 10-15 clay

SEGES

Yield in spring barley after catch crops on clay soil (7 trials)



- Yield decrease of 2,4 hkg/ha in spring barley after rye as a catch crop
  - Is the yield decrease caused by nitrogen deficiency?
  - Is the yield decrease cased by allelopathic effect?

Soil types in Denmark

Sandy soil: > 65 % sand and ~ 5 % clay

Clay soil: < 90 % sand and > 10-15 clay

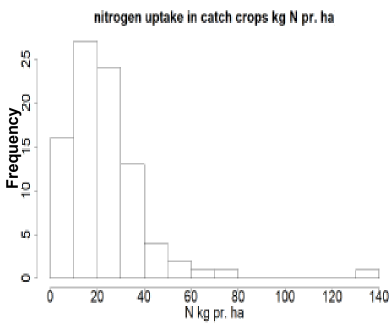
SEGES

Economy in catch crops

- Cheapest way is sowing fodder radish (harrowing and spray seeds)
  - Seeds: 2 euro per. kg x 10 kg per ha = 20 euro per ha
  - Sowing: 15-20 euro per ha
- Save 20 kg N per ha in the following spring crop (1 Euro per kg N) = 20 euros per ha
- Gain 2 hkg yield pr. ha = 30 euro per ha
- Healthy soil mixtures (with ex. vetch) will cost around 80 euros per ha in seeds

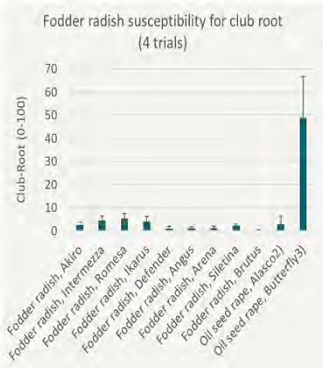
SEGES

Nitrogen uptake in catch crops in 2019 in 90 fields



SEGES

Clubroot in fodder radish?



Clubroot in fodder radish.
Photo by Morten Steg,
LandboSyd.

SEGES

Field sampling of clubroot in fodder radish - conclusion

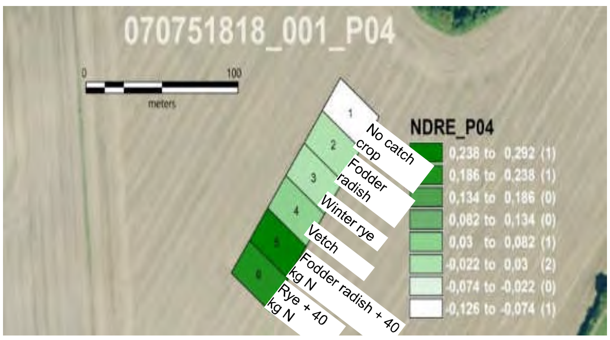
- Spill seeds was infected
- Very few fodder radish plants were infected

1) A number of oilseed rape free years (5 years in Denmark)

2) Avoid spilled seeds of oil seed rape

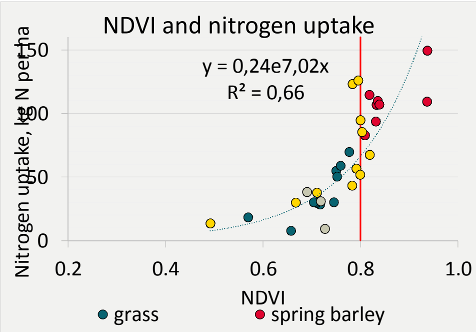
SEGES

Satellite picture in autumn 2018



SEGES

Association between satellite index and nitrogen uptake in catch crops



SEGES trials from 2018.

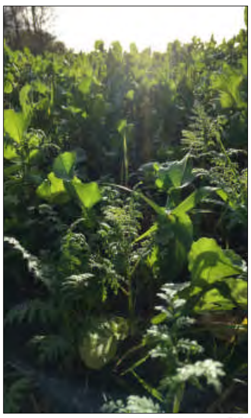
SEGES

Main experiences with catch crops in Denmark

- Intelligent use of catch crops can increase yield and soil health
- Save 0-50 kg of nitrogen in the following crop –
  - Plan nitrogen applications according to the size of the catch crop or take N-min samples
- Sowing should be reduced
- Negative economy on clay soils in the first year
- Flexible legislation may also be complicated (too complicated)

SEGES

Thank you for listening



SEGES

Cover crops – an Irish perspective

Richie Hackett
Teagasc, Oak Park

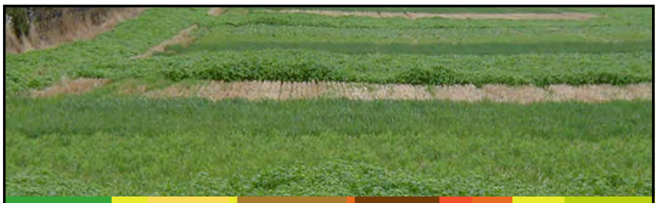
SUMMARY

There is much interst in the topic of cover crops currently. Cover crops have a range of potential environmental, agronomic and economic benefits but also introduce an additional cost so careful consideration is required before adopting cover crops to ensure that they do not have a negative effect on profitiability.

In many areas of the world with a similar climate to Ireland a reduction in nutrient, particularly nitrate, loss to water is the principal motivation for using covers crops. Irish work has demonstrated that overwinter covers, both of a sown species and natural regeneration, can substantially reduce nitate leaching on a leaching prone site. Cover crops can lead to a reduction in the effects of pests, disease and weeds in succeeding crops also. These effects are often variable and often require careful choice of the species used given the rotational position. The use of cover crops can increase the content of organic matter in the soil, and in particular the active pools of organic matter which are important for crop production but, as with any management effect aimed at increasing organic matter, changes will be slow. The effects of non-leguminous cover crops on the fertiliser N requirement of succeeding crops are small and it would be difficult to recommend reduced inputs of fertiliser N where non-legumes are used alone.

Research in Oak Park has shown that, in general, the effects of cover crops, compared to bare fallow or natural regeneration, on yield of succeeding cereal crops under Irish conditions are variable, often small and sometimes negative. Significant yield benefits in succeeding crops through the use of cover crops occurred infrequently. This concurs with findings in other European countries.

Given that sown cover crops incur seed costs, establishment costs and destruction costs and the limited effects on subsequent cereal yields the use of sown species of cover crops is often not economically justified (in the absence of financial incentives to do so). However management factors such as correct choice of species or species mixture, and good management in terms of sowing date and destruction date can improve the chances of achieving economically beneficial results. Initial experiments with leguminous cover crops suggest that they may have considerable potential to reduce the fertiliser N requirements of crops under Irish conditions.



Cover crops- an Irish perspective

Richie Hackett
Teagasc, Oak Park

Cover crops = multipurpose crops ?

- Different objectives
  - Cover crops – cover the ground
  - Catch crops – ‘catch’ nutrients preventing them from being lost
  - Green manures – improve soil characteristics or benefit succeeding crop
  - Forage crops – provide overwinter forage
- Different species or mixtures of species
  - Each species will have individual advantages and disadvantages
  - Effect of any species likely to be proportion dependent
  - Makes general recommendations difficult
- Most work at Oak Park (and abroad) on single species
  - Limited information on benefit of mixtures over single species
  - Legume/non-legume mixtures have been investigated

Potential benefits

- Reduction of nutrient loss (mainly nitrate)
- Reduction of pests, diseases, weeds
- Prevention of erosion
- Improvement of organic matter/*soil quality/health*
- Improvement of soil structure
- Increased nutrient supply to next crop
  - Potential to reduce fertiliser inputs
- (source of forage)
- Yield benefits

Nitrate leaching reductions (compared to bare stubble)

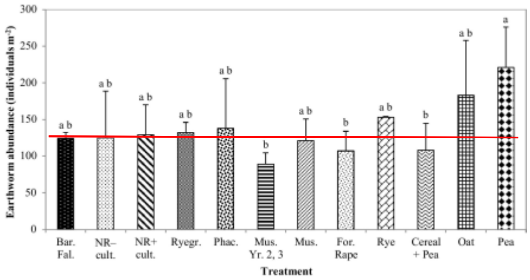
Overwinter cover	% reduction in N concentration in drainage water	% reduction in N load (kg NO_3-N/ha)
Mustard	74 - 86	19.4 - 52.3
Natural regeneration	11 - 42	6.7 - 21.4

- Experiment had both plough based cultivations and reduced tillage cultivations
- Experiment was on a very high leaching risk site (light sandy soil)

Premrov et al. 2014

Effect of cover crops on earthworm numbers

(after 3 years of cover crops - plough based system)



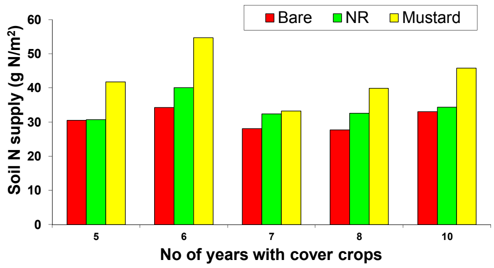
Roarty et al. 2017

Effect of cover crops on fertiliser N requirement

Cover crop N accumulation ≠ **Reduction in fertiliser requirement**

- Many factors involved
- Somewhat comparable to organic manures
- Variable and difficult to predict

Repeated use of cover crops doesn't always lead to increased soil N supply to succeeding crop



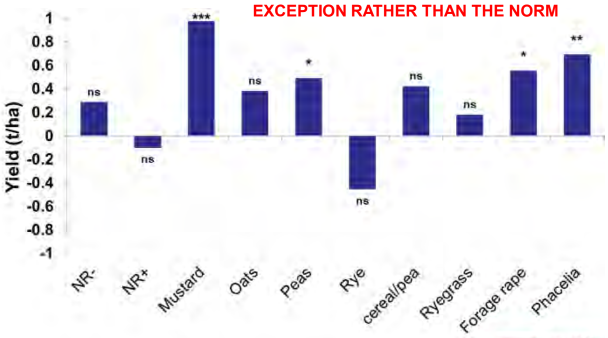
Seasonal effect often greater than cumulative effect:
note greater growth of cover crop in year 6 (and greater soil N supply above) compared to year 5 in next slide

Season effect on cover crop growth

Effect on yield 2004-2006 Light soil

(relative to bare stubble)

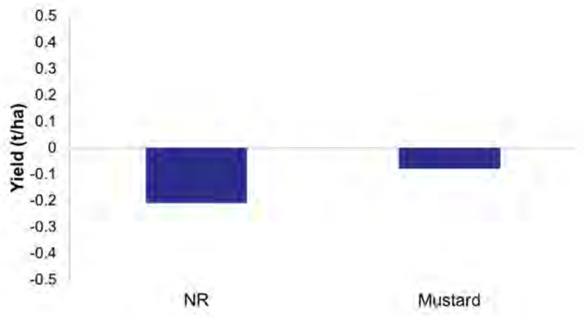
SIGNIFICANT YIELD INCREASES ARE THE EXCEPTION RATHER THAN THE NORM



NR- > natural regeneration without stubble cultivation
NR+ > natural regeneration with stubble cultivation

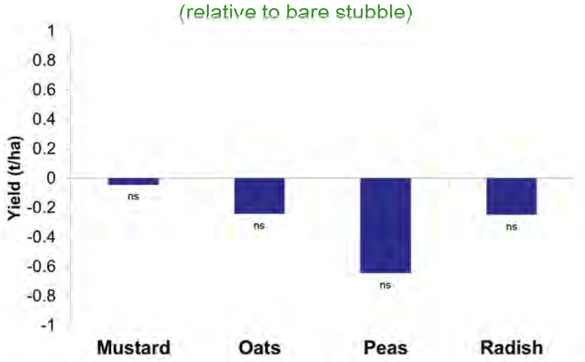
Effect on yield 2004-2006 Light soil

(relative to bare stubble)

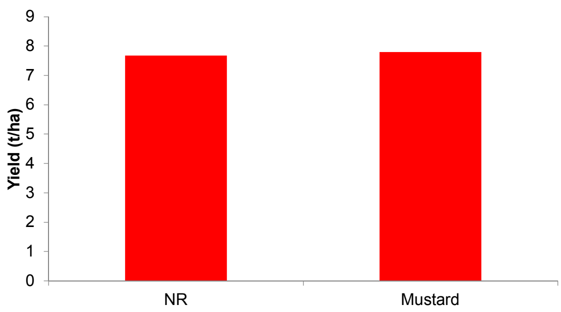


Effect on yield 2004-2006 Medium soil

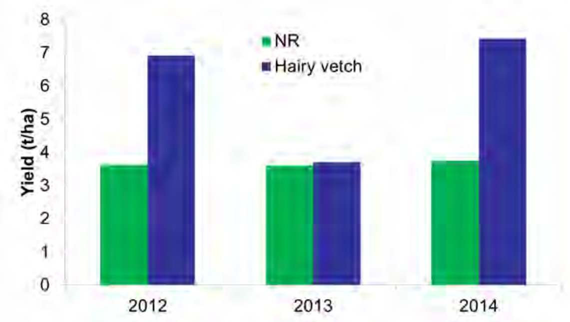
(relative to bare stubble)



Small effects of sown species compared to NR (2014)



Legume cover crops may have bigger effect on yield BUT benefit can vary between seasons



No fertiliser N applied

Conclusions

Cover crops

- Have positive environmental effects
  - Reduced N leaching (where leaching is a problem)
- Can improve soil structure/soil 'quality'
- Can increase or decrease pests and diseases
- Effect on yield variable and often small
- Effect on N requirement small (exception of legumes)
- Invoke additional costs (seed, sowing, destruction)
- Direct economic benefits can be small or negative
  - dependent on management, crop choice and year

Time of sowing effect

Photos: December 23

Cover growth is dependent on available N

Excessive growth can indicate excessive fertiliser N application to previous crop

Crop Report 2020 "Agronomic Strategies-Tailored for your business "

Michael Hennessy
Teagasc, Oak Park,

SUMMARY

The Teagasc Tillage Team is launching the Crop Report 2020 at the National Tillage Conference 2020 following a needs consultation with key users. The new report allows users to tailor the report information which is important to their business. This online solution allows agronomists find information quickly whether in the office or in a field. The Teagasc Crop Report has been serving the industry for over 25 years with up to date information and assembling the latest research into usable agronomic packages. The report has changed over time from an update over the season for agronomists to its current form combining agronomic strategies with updates through the year. It also provides detailed tables of agro-chem products, legislation implications, susceptibility guides, etc.

A stakeholder consultation process was set up during 2019 to get views of the current Crop Report and what types of changes were desirable to make the information more accessible. The feedback was broad and wide ranging but a number of key changes were identified. The users reported that the Crop Report provided excellent and timely information but was difficult to find the information quickly and many users were missing key elements due to the documents size. Although the crop report has recently changed to an easier to read format the sheer volume of information is making it difficult for users to access important information quickly.

The new Crop Report 2020 is designed to be viewed on the web and accessible with an app from a user mobile phone. The new Crop Report is designed with the user at its core, allowing the user to specify which crops/topics are most important to them. The dynamic website will load the technical information specific to the user, while the rest of the information can remain in the background, but this information can be accessed if necessary. The overall format of the Crop Report will also change to allow users get easier and quicker access to information. The Crop Report will have a number of new sections including: reference documents outline agronomic strategies for the major crops including cereals, oilseeds, legumes, grassland and forage crops; technical reference tables for nutrient and other advice; product reference tables which will collate product information into useable tables, and regular updates for all crops which will respond to ongoing growing conditions and modifying agronomic strategies as necessary.

Viewing the Crop Report on the mobile phone was identified as an extremely important area for users. Users will be able to search and deselect topics easily and also be able to modify how tables are displayed to maximise the relevant information while minimising the information not needed. We think users will immediately reap the benefits of this new format but we will strive to change elements not working well and with this in mind the Crop Report platform will enable tracking of activity on the website to enhance the user experience over time.The Crop Report can be obtained through the normal Teagasc ConnectEd channels at https://www.teagasc.ie/about/our-organisation/connected/join-today/ or just log into www.TeagascCropReport.ie and follow the link to sign up.

All users will be verified shortly after log in, using their Teagasc Customer number and email, providing they are a current ConnectEd customer or a farmer client (minimum client fee necessary). Signing up to the Crop Report gives each registered Pesticide Advisor 20 IASIS Continuous Professional Education credits.

Crop Report 2020

Agronomic Strategies; tailored for your business'

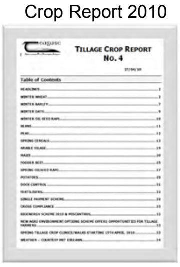
Michael Hennessy
Teagasc, Oak Park

Crop Report ~25 years

Crop Report 2001

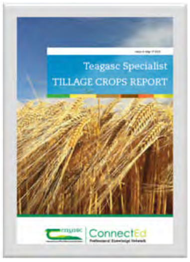
15 Pages

Crop Report 2010



50 Pages

Crop Report 2019



70 Pages

The Crop Report
-a subscription service

Review of Crop Report 2019

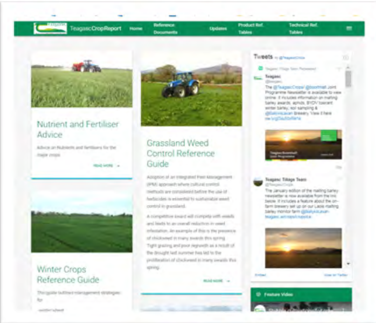
- Feedback from groups

Suggested top 5 priorities

1. Separate Appendices and issue 2-3 times per year. Keep regular report short with focused detail
2. Review navigation and signposting
3. Consider frequency of issue of both reports
4. Strengthen information exchange around regional differences
5. Look at potential differences in need between user types

Crops 2030
– Desktop and mobile

- Based on web platform (and print)

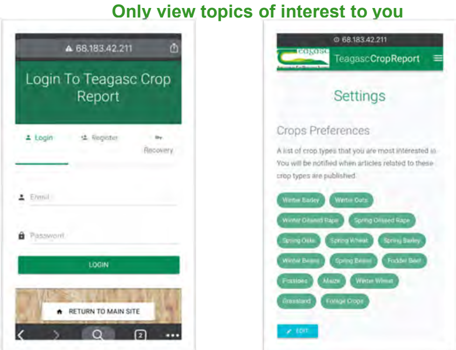


Desktop view

Mobile view

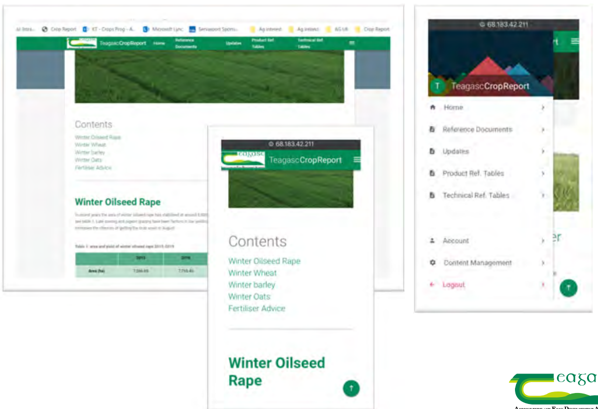
Crop Report 2020

Only view topics of interest to you



Screenshot from Mobile Phone

Content tailored to your needs



Crops 2030 – New Reports

- Reference documents
  - Winter Crops, Spring Crops, Forage Crops, etc.
- Technical Tables
  - Nutrients, growth stages
- Product Reference Tables
  - Fungicides, Cereal Herbicides, etc.
- Updates ~2 weeks (in main growing season)
  - Short format

Workshop session – registration, new features and navigation

here
@
1:45 pm

Access to the Crop Report at
www.TeagascCropReport.ie
Become a member at Teagasc ConnectEd on
https://www.teagasc.ie/about/our-organisation/connected/join-today/

The Virtual Irish Centre for Crop Improvement

Dan Milbourne
Teagasc, Oak Park

SUMMARY

The Virtual Irish Centre for Crop Improvement (VICCI) is a consortium of 15 groups led by principal investigators from Teagasc, University College Dublin, NUI Galway, Maynooth University and Trinity College Dublin. This consortium, established in 2014 through funding from the Department of Agriculture, Food and the Marine Research Stimulus Programme, seeks to exploit advances in plant breeding-related sciences to enable the development of crop varieties specifically adapted to challenges facing the Irish tillage sector in the future.

Despite the historical efficacy of plant breeding, the 21st century has seen a dramatic slow-down in the rate of genetic gain in major crops which averaged at between 2% and 3% yield gain per annum between 1960 and 1990, but is projected to drop to half, or even less than a quarter of these levels between now and 2050. However, against the backdrop of this drop-off, huge strides have been made in biotechnology-based sciences with the potential to address the problem.

Advances in areas such as genomics, transcriptomics, metabolomics, and high throughput phenotyping allow not only the elucidation of the control of many key characteristics that are required for successful varieties, but offer routes to fast-track their development. VICCI is using the above approaches to underpin the development of varieties that address four key challenges in Irish tillage and forage agriculture; fertiliser use, crop protection, abiotic stress and the potential to replace imported crop products with Irish grown alternatives. It would be impossible to address all of these topics for all of the crops and scenarios important to Irish agriculture, so VICCI research has focused on addressing specific challenges in six species: wheat, barley, oats, beans, potatoes and perennial ryegrass.

VICCI partners are combining field, glasshouse and controlled environment trials to identify plants exhibiting desirable characteristics relevant to Ireland, with a multi-layered “omics” based approach to identify the genes and pathways in these plants that are controlling the characteristics. Subsequently we develop and validate tools such as genetic markers and phenotyping tools that will provide cost effective selection for these characteristics in breeding programmes. In this presentation, we illustrate the development of such advanced selection tools for barley, wheat and potato. Large-scale commercial breeders now routinely use approaches such as marker assisted selection (MAS) to cut variety development time and incorporate difficult to breed for characteristics into varieties, so making these tools available to breeding programmes that target the Irish market means that improved varieties will become available to growers.

The Virtual Irish Centre for Crop Improvement

Dan Milbourne
Teagasc, CELUP, Oak Park Crops Research

Challenge

Q. Is the Irish tillage sector reliant on varieties bred for other agro-ecologies?

Q. What can we do to improve the targeting of varieties for Irish conditions?

Provide plant breeders with the tools to develop varieties to address needs of Irish tillage sector

VICCI

Fifteen of Ireland's top crop and plant science groups from five institutes

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

Six Crops — Four Challenges for Irish Agriculture

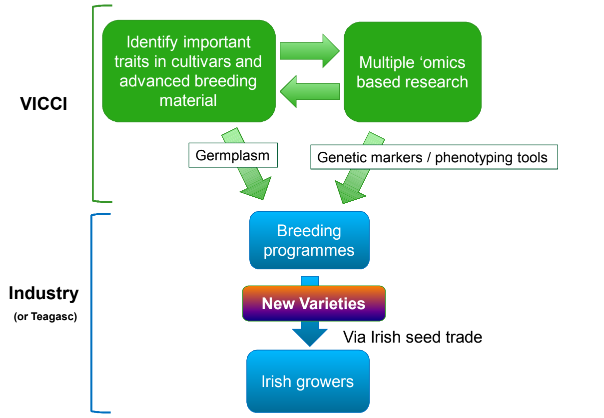
Nutrient Use Efficiency
Wheat, Barley

Disease Resistance
Wheat, Oats, Barley, Beans

Waterlogging Tolerance
Barley, Perennial ryegrass

Import Replacement
Beans, Potatoes

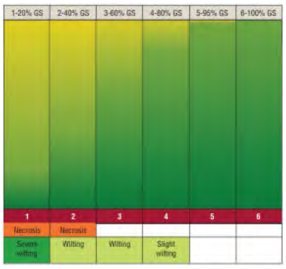
How does VICCI work?



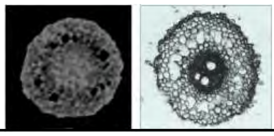
Waterlogging tolerance in winter barley

Flooding Trials at Oak Park demonstrate genetic variation for tolerance

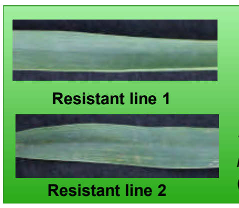
Developing a scoring chart to measure tolerance/sensitivity



Aerenchyma (air pockets) in the roots of flood tolerant barley using CT-scanning



Resistance to STB



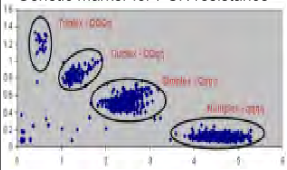
The mutant lines showing STB resistance (from Prof. F. Doohan, UCD)

Standard LED

Wheat breeding lines, sown 16.10.19

Impact: VICCI has contributed to development of disease resistant potato varieties

Genetic marker for PCN resistance



Buster (ware/prepack baker)

5 PCN resistance genes
Near immunity to both major PCN species

Java (ware variety)

Resistant genes to blight, PCN, Wart, Virus Y

Conclusions:

- VICCI addresses the need for Irish-adapted varieties, and is accompanied by a model to enable their delivery
- Critical Mass – Aligned large bulk of research community to work on common set of problems important to sustainability of tillage sector
- Research with defined pathways to impact – VICCI science has influenced variety development within the project timeframe

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

VICCI is funded by DAFM FIRM/Stimulus/CoFORD project 14S819

https://www.teagasc.ie/media/website/publications/2019/TResearch_Summer2019.pdf

Applying novel breeding approaches to tackle cereal diseases

Adnan Riaz[1], Petra KockAppelgren[1], Melanie Smith[1], Atikur Rahman[1], Nick Fradgely[2], Stephen Byrne[1], James Cockram[2], Richard Mott[3], Ewen Mullins[1]
Teagasc,Oak Park

SUMMARY

Zymoseptoria tritici is the causative fungal pathogen of *Septoria tritici* blotch (STB) disease of wheat (*Triticum aestivum* L.) that continuously threatens Ireland and Europe's wheat crop. Under favourable conditions, STB can cause up to 50% yield losses if left untreated. STB is mostly controlled by applying fungicides; however, this incurs an economic loss of more than €1bn annually to the EU. Also, the *Z. tritici* population is developing fungicide resistance, in addition to the increased restriction on fungicide use in the EU; thus, fewer active substances are available for farmers. Deployment of resistant varieties provides a more sustainable disease management strategy. However, there are no varieties currently on the market that offer an adequate level of resistance against STB. Therefore, innovative breeding methodologies such as marker-assisted selection are needed to develop new varieties with superior resistance.

In this study, we aimed to identify genetic regions (QTL) for *Stb* resistance in 16-way MAGIC wheat populations (termed 'NIAB Diverse MAGIC'). The 16-way MAGIC population, comprising of 600 recombinant inbred lines (RIL), was screened for septoria response at the seedling and adult plant stage in the controlled environment while currently subjected to multi-location field screening under natural infection. Using the 35K (SNP) genotyping data, we detected a QTL on chromosome 5B, providing resistance to STB at the seedling stage. We are also performing genomic selection (GS) on diverse MAGIC population to simultaneously estimate all loci, haplotype or marker effects and calculate Genomic Estimated Breeding Values (GEBVs). GEBVs will be then used to select individuals of interest for advancement in the breeding cycle without phenotyping in the field.

In addition, we will perform comparative whole transcriptome analysis of resistant and susceptible wheat lines to decipher the wheat-septoria interaction. We envisage the genomic regions identified and linked SNPs serve as useful markers for *Stb* resistance, enabling rapid introgression into future bread wheat cultivars. Furthermore, comprehensive understanding of the genetic response of wheat through the septoria interaction will provide the broader community with additional scope to improve wheat resistance to septoria.

Applying novel breeding approaches to tackle cereal diseases

Adnan Riaz, Post Doctoral Fellow
Teagasc, CELUP, Oak Park Crops Research

Septoria tritici blotch disease of wheat

- *Septoria tritici* Blotch (STB), is the single greatest threat to Irish & EU wheat
- Fungicide application to control disease
  - High cost
  - Fungicide resistance
  - Loss of chemistry
- Deploying durable genetic resistance is the most sustainable strategy

Challenges to develop resistant wheat cultivars

- **Lack of STB resistance in existing varieties**
- Phenotyping for durable forms of resistance is difficult (i.e. Adult plant resistance: APR)
- Introgression of effective resistance genes is a slow process

Speeding up for septoria resistance

Traditional septoria assessment

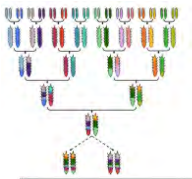
~ 1 year

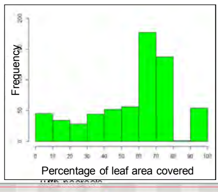
The 'Speed breeding' and septoria assessment

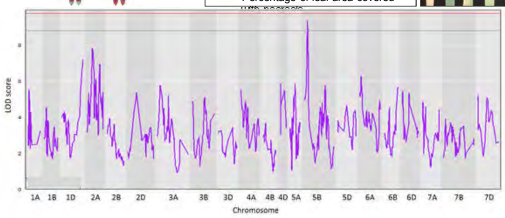
~ 4 months

QTL mapping for septoria resistance

- 16-founder MAGIC population comprising of > 600 F7 inbred lines

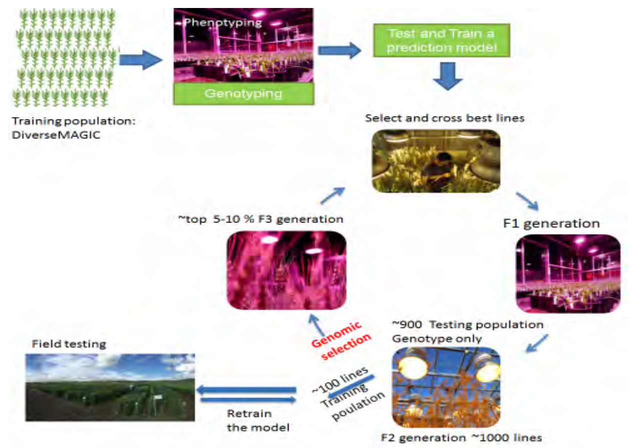






Teagasc

SpeedGS- combining speed breeding and genomic selection



Expected outcomes

- A set of **STB resistant lines** that can be used in future breeding programs
- A novel **phenotypic dataset on STB responses**
- **Optimised prediction models** to enable forward selection in breeding programs
- A database of **genomic regions and their effects to STB response**
- RNAseq analysis of resistant and susceptible lines to understand host pathogen interaction

The challenge of grass weeds: Co-developing solutions for Ireland

Vijaya Bhaskar A.V.
Teagasc, Oak Park

SUMMARY

The loss of key grass weeds herbicides due to EU legislation has been compounded by the over-reliance on the few remaining herbicides, which is causing the rapid evolution of herbicide resistance in a range of grass weeds. Resistance problems, if widespread, will increase individual growers spending on weed control and will reduce profit margins, while also reducing the opportunities to convert or stay with reduced- or no- tillage establishment systems. With few new herbicides expected on the market in the near future, growers and agronomists should use existing herbicides with caution by minimizing selection pressure, and ensuring the use of integrated weed management (IWM) (i.e. utilization of cultural and chemical control) techniques on farm.

To help growers' upskill in solving specific grass weed(s) challenges for different establishment systems, the EIP-DAFM funded 'Enable Conservation Tillage (ECT)' programme has set up a network of 10 focus farms (FF), where trans-disciplinary stakeholders jointly develop site-specific IWM solutions. A significant part of the first year has concentrated on ensuring the correct identification of grass weeds to as many growers as possible across the country. In the FFs, the work has largely moved from design and development phase (i.e. weed diagnosis and co-designing process) to operational phase (i.e. application of control measures). Samples of spring wild oat, bromes, black-grass and canary grass were collected prior to the 2019-harvest, and subsequently tested for herbicide resistance. Initial results suggest that ~ 25 % of wild oat populations were cross-resistant to all three chemical families ('den', 'dim' and 'fop') of ACCase inhibitors. No herbicide-resistant sterile brome has been detected so far, although some populations are suspected to be resistant to ALS inhibiting herbicides. Sterile brome populations resistant to ACCase and ALS inhibitors have already been found in France and Germany.

Meanwhile, some UK populations of sterile brome are showing reduced glyphosate sensitivity, and are in the process of evolving resistance. From work carried over the last 12 months, black-grass populations are widespread across the country and there is high likelihood that herbicide resistance is in some if not all the populations. For 2020, we will conduct a grass weed survey for different establishment systems to establish why some growers have grass weed problems, while others with equivalent systems do not. We will also sample grass weeds and test for herbicide resistance for those survey farms.

The challenge of grass weeds: co-developing solutions for Ireland

Vijaya Bhaskar A.V
Teagasc, CELUP Oak Park Research Centre

Integrated control strategies to combat grass weeds- Why?

Loss of herbicides | **Increase in non-inversion**

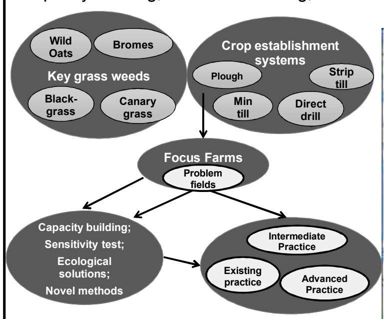
Earlier cereal sowing | **Resistance problems**

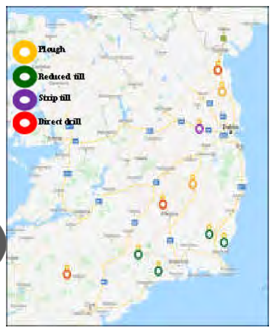
Enable Conservation Tillage (ECT) project

Co-design grass weed solutions for different crop establishment systems.

How?

Capacity building, resistance testing, on farm demos, survey, decision support

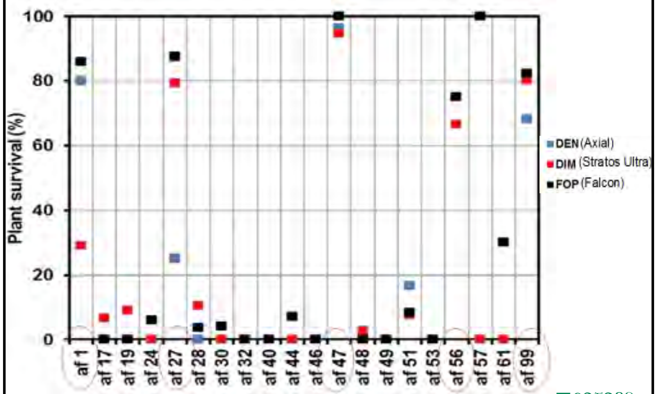




Herbicide resistance in wild oats

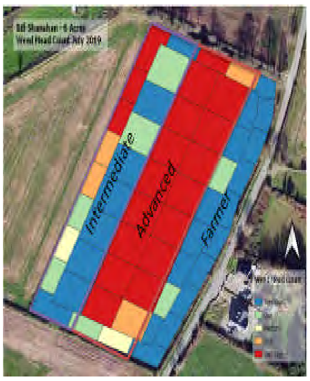
- Building on R. Byrne work (2019)
- 20 populations selected from problem fields.
  - Pinoxaden (Axial®)
  - Cycloxydim (Stratos® Ultra)
  - Propaquizafop (Falcon®)
- Populations with plant survival > 20 % considered to be resistant.
- 25 % samples resistant to all three chemistries of ACCase inhibitor
- Do ‘Fops’ select for resistance faster?

Herbicide resistance in wild oats



Co-designing with farmers

Marking weed affected areas in problem fields.



Each field split into:
‘**farmer practice**’
vs. ‘**recommended practice**’

Take home message ?

- We cannot rely on herbicides as resistance is increasing.
- Weed identification and knowledge of weed biology is critical.
- Utilising all Integrated Weed Management tools is essential.

Grass weed survey – We need your help

- **Evaluate** how management drives grass weed pressure
- **Identify** and assess grass weed levels on farm
- **Sample and Test** for herbicide resistance

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Decisions for 2019 Autumn Planted Crops

Shay Phelan
Teagasc, Oak Park

SUMMARY

Autumn 2019 provided many growers with significant difficulties in planting winter cereals, nationally Teagasc estimates that approximately 51% of the area that was planted in 2018 was planted in 2019. This reduction in the area of winter crops planted will result in extra spring crops being planted in 2020 which will increase, significantly in many cases, the amount of spring work that will need to be completed.

Of the area planted many crops have suffered losses from waterlogging due to persistent rainfall and poor soil conditions at planting. These crops will need to be assessed to establish if the affected areas should be persisted with or whether alternative actions need to be considered. In some cases where there has been complete failure, the decision is simple, and most growers will opt to re-sow with spring crops.

However in many instances the decision as to what to do with the crops in situ can be difficult due to partial emergence of the crops. In these cases growers and agronomists need to consider the financial, agronomic, workload and scheme implications of their decisions, these may not always be easy to calculate but nonetheless these must influence the final decision. These crops or areas within them will need to be carefully assessed over the coming weeks, only then can the final decisions be made.

Decisions for 2019 Autumn Planted Crops

Shay Phelan
Teagasc Crops Specialist

Teagasc

Focus

- What to do with poorly established autumn sown crops?
- Specifically crops where some establishment has occurred

Teagasc

Autumn 2019

	2020*	2019**	Diff (ha)	% Diff
Winter Wheat	25,884	58,387	32,503	-56
Winter Barley	44,770	81,381	36,611	-45
Winter Oats	5,855	16,355	10,500	-64
Total Winter Cereals	76,509	156,123	79,614	-51

Teagasc survey in November 2019 estimates ~ **50%** reduction in autumn planting compared to 2018

Total cereals harvested in 2019 = 261,000ha
Potentially **184,000** ha to plant in spring

Teagasc

Assess the crop

- Measure the area
- Do multiple plant counts
- Don't count tillers!!
- Take the average figure
- Are there areas with no crop at all?
- Estimate if crop is viable

Crop Assessment

Winter Cereal Plant Count / m²				
Plant count	**Wheat**	**Barley (2 row)**	**Barley (6 row)**	**Oats**
Target	200+	250+	170+	275+
Viable	90 – 200	150 – 250	90 – 150	150 - 275
Not viable?	< 90	< 150	< 90	< 150

* Based on relatively even plant distribution

Garrus Nov. 2018 60-80 plants/m²

DAFM Winter Wheat Rec list trial 2019 Garrus as % of Control Varieties

- Garrus established 60-80 plants due to low seed germination
- Important to note, plants were **Evenly Distributed** within plots
- Mean of controls (JB Diego & Bennington) 11.82t/ha (4.78t/ac)
- Garrus 85% of controls – **10t/ha (Plot yields)**

	Mean	BN	KN	MK	CW	CK	CCK	LH	TY
Mean (t/ha)	11.82	11.74	10.95	12.03	11.72	10.74	12.38	11.85	13.14
Mean (t/ac)	4.78	4.75	4.43	4.87	4.74	4.35	5.01	4.79	5.32
Garrus (% of C)	**85**	**82**	**89**	**90**	**79**	**94**	**80**	**80**	**89**

Manage expectation

- Reduce inputs for crops with low yield potential

Winter wheat fertiliser requirements			
Yield T/ha	*Nitrogen (Kg/ha)	**Phosphorous (kg/ha)	***Potassium Kg/ha
8	190	31	91
10	230	38	110

* Index 1 for N (SI No. 605/2017)
** Index 3 for P (SI No. 605/2017)
***Index 3 for K (Teagasc Green Book)

Difference in Fertiliser costs = **€70/ha**

Teagasc

Is re-sowing an option?

Things to consider

- Spring crop has to carry the cost of the autumn crop
- Extra work to be done
- Timing of work to be done
- Availability of seed
- Reduce inputs on winter crops

Potential returns (€/ha) Spring re-sow v. Crops in-situ			
Yield	WHEAT	FEED BARLEY	
T/ha	Winter	*Spring	Winter
7.5	59	16	149
7.75	97	51	184
8.0	134	86	219
8.25	172	121	254
8.5	209	156	289
8.75	247	191	324

* Spring crops include normal costs associated with growing of that crop + the cost of the work completed in autumn

Note; Figures based on 2020 Teagasc costs and returns

Other options

Fallow	
No extra workload	No income
2 or 3 crop rule	Weeds will need to be controlled
BPS will cover costs so far	BPS won't cover fixed costs
Opportunity to fix issues e.g. weeds, compaction, drainage	Extra short term cost but may be beneficial in the long term

Catch Crops	
Trap existing nutrients	Costs may not be recovered
May help to suppress weeds	May complicate weed control
May be grazed	Fencing required
Plenty of species options	Be careful with rotations

Questions?

Enhancing the Agronomy and Management of Beans

Sheila Alves
Teagasc, Oak Park

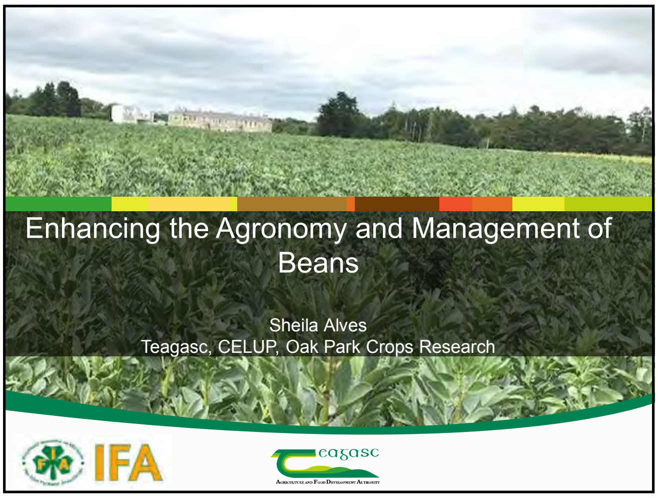
SUMMARY

Field beans (Vicia faba) are a high protein legume well-suited to the Irish climate with a relatively high yield potential. Nonetheless, the crop was only grown on a limited scale until 2014, with an average of 17,650 tonnes produced from 3,183 ha annually in the period of 2009-2014. The perceived variability in yield, inadequate varietal development and limited Irish-specific agronomy (including disease control) were the main reasons associated with the lack of interest in the crop.

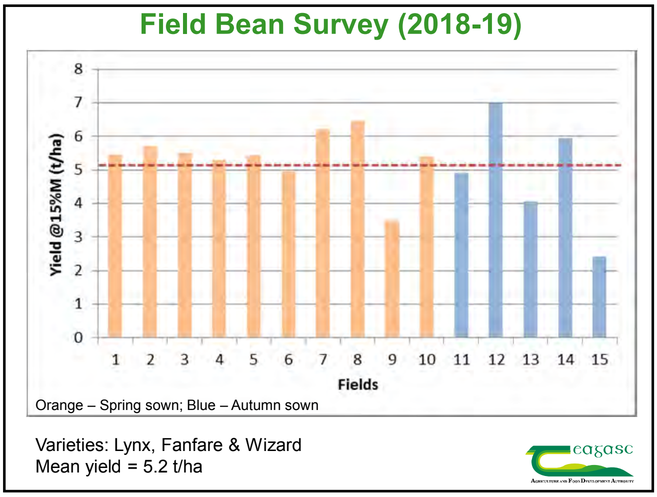
In 2015, as part of the EU Agreement on CAP Reform the Protein Aid Scheme for nitrogen fixing crops (or protein crops) was introduced in Ireland. As a consequence, the harvested area of field beans quadrupled (c.11,467 ha/year for the period of 2015-2017). However, the area of spring beans decreased again in 2019 to 6,483 ha as a reaction to the poor yield performance under the drought conditions of 2018 (~2 t/ha). In order to promote the agronomic potential of field beans and increase production, detailed information on the specific factors causing variability in crop performance must first be identified.

The current field bean research programme at Oak Park involves both autumn and spring sown crops and covers a range of important issues for the crop's performance including seed rate, sowing date, establishment system, crop nutrition, disease control, lodging and grain quality. Other topics also being studied are the development of rapid screening methodologies for assessment of disease resistance; evaluating European varieties/collections for adaptability to Irish conditions and disease resistance; Use of recurrent selection to achieve rapid re-adaptation of faba bean to the Irish agro-climate. Furthermore, a grower survey (2017 – 2020) is focussed on identifying the range of commercial beans crop's performance with a view to identifying the factors associated with that performance. Once complete, the results of this research will be published as a comprehensive field bean growers guide.

The results to date indicate: (i) the yield potential of spring sown beans is lower than that of autumn sown beans, (ii) currently recommended spring varieties perform well, but are not adapted to the Irish agro-climate, (iii) seed rates between 35-45 seeds/m^2 give the best compromise between yield and production cost but unfavourable soil conditions may require higher rates, (iv) non-plough and strip-drill perform as well as conventional systems, (v) timing and number of fungicide applications for Botrytis fabae infection have a significant impact on disease control but not necessarily on yield and a full cost/benefit analysis should be completed when considering a fungicide plan.


Enhancing the Agronomy and Management of Beans
Sheila Alves
Teagasc, CELUP, Oak Park Crops Research
IFA
Teagasc


Why should you grow beans in Ireland & what challenges will you face?
• Protein crop
• Feed & food
• Good combinable break crop
• Nitrogen fixing crop
• High yield in Irish agro-climate conditions
• Late harvest
• Lodging
• No breeding program
• Crows
• Climate change
• Lack of genetic resilience
• Bravo?
• Glyphosate?
Ambition is to deliver solutions that:
▪ Increase field bean production
▪ Increase field bean resiliance (diseases, pests, climate)
▪ Decrease production costs


Field Bean Survey (2018-19)
Yield @15%M (t/ha)
0
1
2
3
4
5
6
7
8
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Fields
Orange – Spring sown; Blue – Autumn sown
Varieties: Lynx, Fanfare & Wizard
Mean yield = 5.2 t/ha
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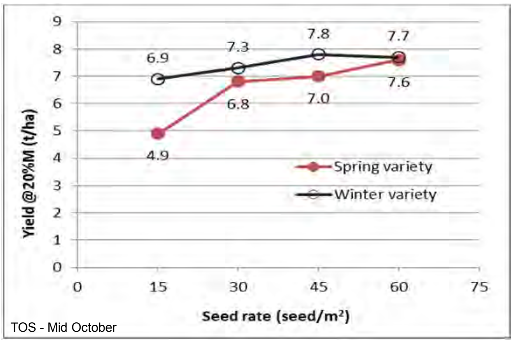
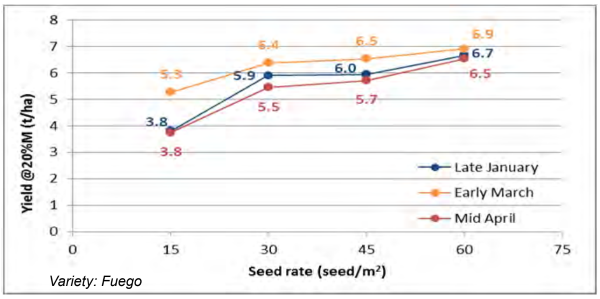
Identification of best yielding seed rates for winter and spring varieties



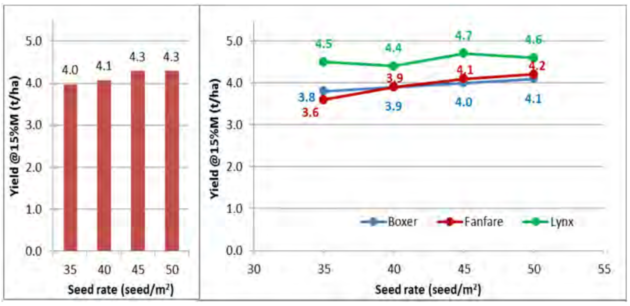
- Spring varieties should be sown above 30 seeds/m^2
- Winter varieties can be sown at lower seed rates

Identification of best yielding seed rates and sowing date for spring varieties of field bean



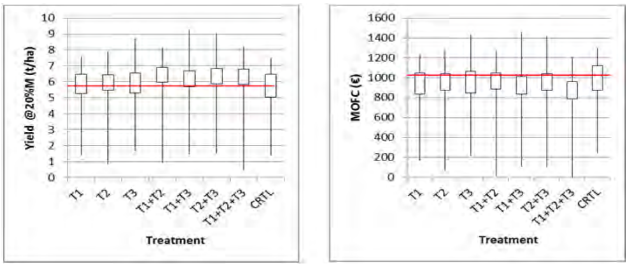
- Spring varieties should be sown above 30 seeds/m^2 and within the first half of March

Identification of best yielding seed rates for different spring sown varieties



- Recommendation on seed rate should consider the variety
- In less favourable conditions a small increase in seed rate could be considered

Response to fungicide for control of chocolate spot



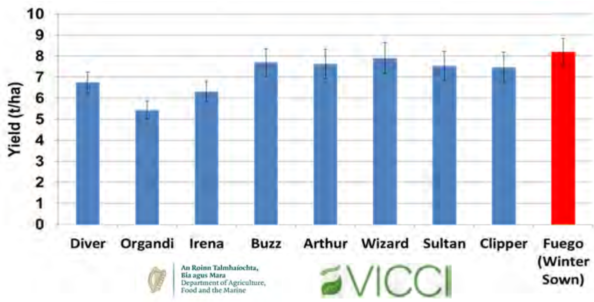
Fungicide: Signum @ 0.75 kg/ha
T1 – early flowering; **T2** = T1 + 3 weeks; **T3** = T1 + 3 weeks

MOFC calculation: Beans Net Price = 173 €/t; Fungicide Cost = 73 €/ha (per application)

- For above experiment, yield increases were observed
- Overall, no increase in MOFC recorded

Breeding winter/spring varieties

- **Problem:** (1) Autumn sown spring varieties v. winter varieties (2) Frost and disease sensitivity in spring varieties
- **Action:** Develop a field bean ideotype for optimal yield in autumn-sown Irish growing conditions, combining high yield with improved disease resistance

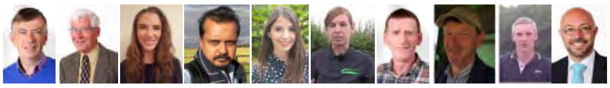


Legumes Translated		PROFABA	
Aim	• To increase the production and use of grain legume crops	Aim	• Develop improved field bean breeding practices and varieties to drive protein production in the EU
How	• Compile existing knowledge at farming system and value chain level	How	• Genotype & phenotype a collection of 200 lines • GWA and prediction
Output	• Internet-based knowledge platform (technical notes, videos, etc.)	Output	• Dataset of geno- and phenotyping available in a web portal

https://www.legumestranslated.eu/

https://www.suscrop.eu/projects-first-call/profaba

Acknowledgements



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