

# Fixing the benefits: Integrating pulses in the rotation



@agricology www.agricology.co.uk

AGRICOLOGY  
SUSTAINABLE PRACTICAL FARMING





**Hodmedod's**  
Britain's pulse & grain pioneers

**Carlin peas in flower**





**Hodmedod's**  
Britain's pulse & grain pioneers

**Carlin peas ripening**





**Hodmedod's**  
Britain's pulse & grain pioneers



**Carlin peas**





**Hodmedod's**  
Britain's pulse & grain pioneers

**Lentil plants**





**Hodmedod's**  
Britain's pulse & grain pioneers



**Lentil / Camelina intercrop**



# Field (Fava) Beans



 **Hodmedod's**  
Britain's pulse & grain pioneers



# Fava Beans



 **Hodmedod's**  
Britain's pulse & grain pioneers







**LENTIL, HARICOT BEAN AND MUSHROOM ROAST**



**VEGAN LEMON MERINGUE PIES**



**ROAST CAULIFLOWER AND QUINOA SALAD**



**LEEKS WITH NAKED BARLEY FLAKES**



**SUMMER BEAN SALAD WITH UMAMI DRESSING**



**FAVA FARFA PINENUTS A**



**CHIA AND CHOCOLATE PROTEIN BITES**



**CAMELINA HALLOUMI BITES**



**BEAN AND BEETROOT BURGERS**



**CLASSIC MUSHY PEAS**

By Jenny Chandler - November 10, 2017



**FAVA BEAN BIRYANI**

By Nick Saltmarsh - October 15, 2017



**FAVA UMAMI SALSA VERDE**



**CARAMELISED LEEK, ONION AND VEGAN "CHEESE" QUICHE**



**BRITISH DAL MAKHANI**

By Jenny Chandler - March 11, 2018

1 Comment



**PLUM AND FRANGIPANE TART WITH YELLOW PEA FLOUR PASTRY**



**DAL SAAG - SPLIT YELLOW PEA AND SPINACH DAL**



**VEGAN SCOTCH PANCAKES WITH FAVA FLOUR**



**CROSTINI WITH FAVA AND EDAMAME**

By The Cook and the



**GINGERBREAD AND PUFFED QUINOA GRANOLA**



**MUSHY PEA AND MUSHROOM PIE**

By Jenny Chandler - November 10, 2017



**MOORISH MUSHY PEAS WITH HARISSA**

By Jenny Chandler - November 10, 2017



**SPROUTS WITH WALNUTS, SHALLOTS AND CAMELINA SEEDS**



**VEGAN CRANBERRY, ORANGE AND WALNUT CAKE**



**GLUTEN-FREE AND APPLE PIE**

By The Cook and the







**Hodmedod's**  
Britain's pulse & grain pioneers

**Phaseolus coccineus (Emergo)**





 **Hodmedod's**  
Britain's pulse & grain pioneers

**Pisum abyssinicum (Abyssinian Peas )**





# Benefits and challenges of grain legumes in cropping systems

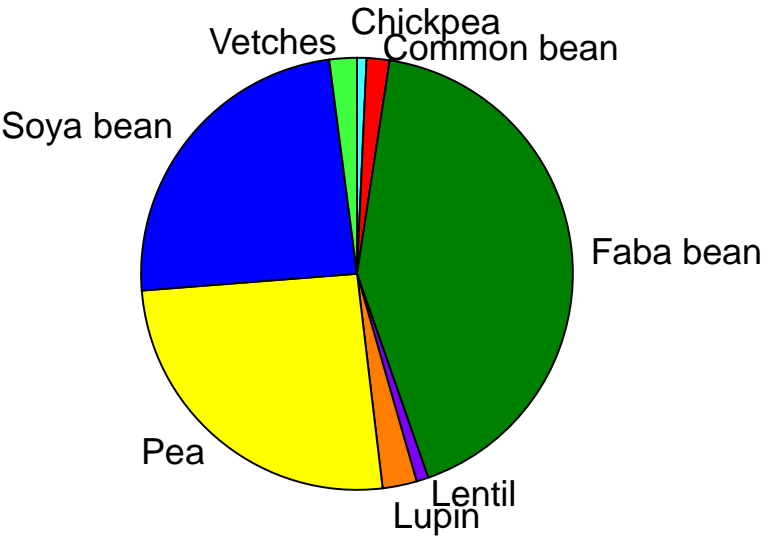
Christine Watson (SRUC/SLU)



# Some issues

- We need alternative protein sources for food and feed
- We can use legumes to reduce dependence on fossil fuel based fertilisers
- Legumes provide biodiversity benefits
- Nobody's perfect – achieving good and stable yields, losses of N and diseases, technology

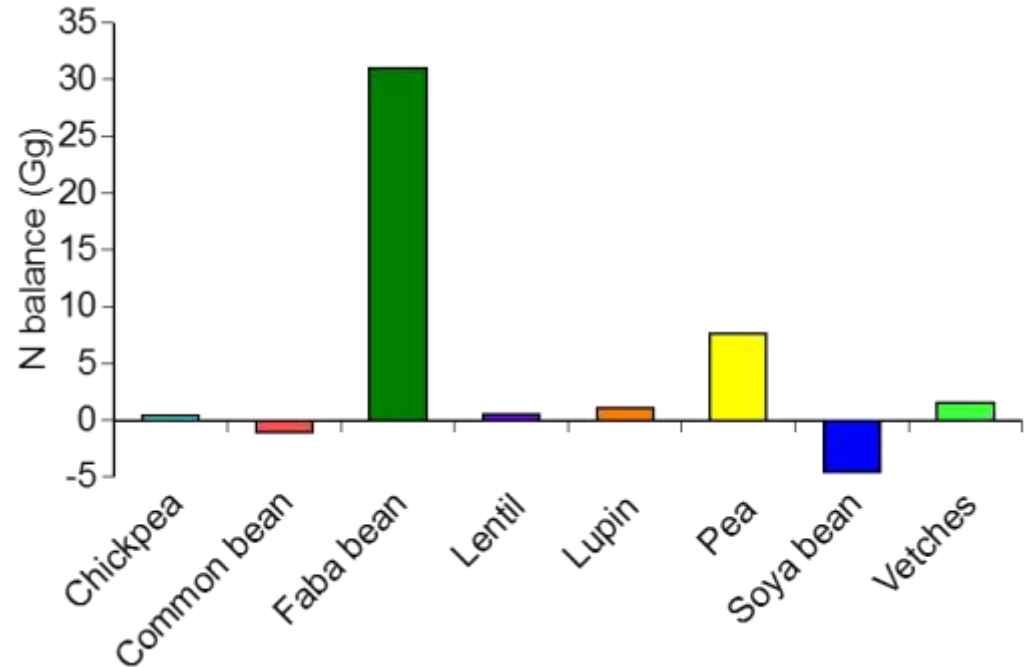
# Grain legumes in Europe



206 thousand t (Gg)  
of N fixed in Europe in 2009

586 thousand t N fixed  
by forage legumes in Europe  
In 2009

N balance across Europe (fixation – harvest, thousand t) in 2009: total 37 Gg



# Legume contributions.....

- Biological nitrogen fixation
- Not all about N - roots release organic acids (citric, malic) that can release bound forms of P
- Faba bean accessions differ 3x in P acquisition ability
- To inoculate or not to inoculate ..? That is the question!





# Legumes fix N– but also affect biodiversity and pest/disease management

- Break-crop effects
- Impact on soil biology
- Allow soil-borne diseases of cereals to die
- Different biology allows use of alternative weed & pest control chemistry & methods
- Support of pollinator populations



Fred Stoddard

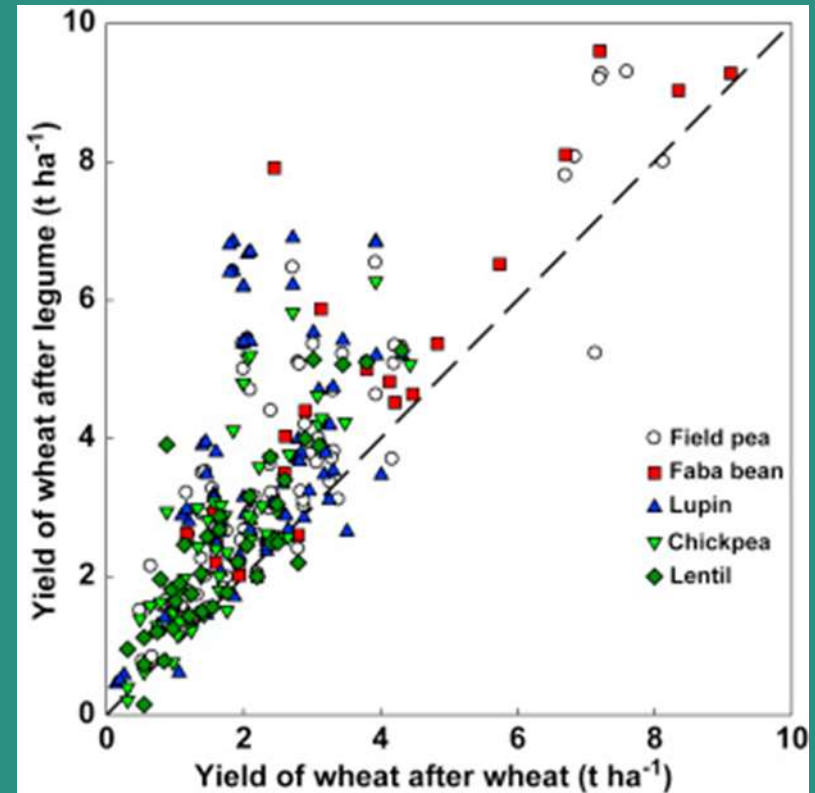


Fred Stoddard



# Pre-crop effects in rotations - Grain yields of wheat grown following a crop legume compared with a wheat after wheat treatment grown in the same experiment

The dashed line represents equal yields. Any points above the dashed line indicate yield improvements when a legume is the preceding crop. Fitted regression: Grain yield (wheat after legumes) =  $0.92 + 1.06 \times$  (wheat after wheat) [ $r^2 = 0.69$ ].

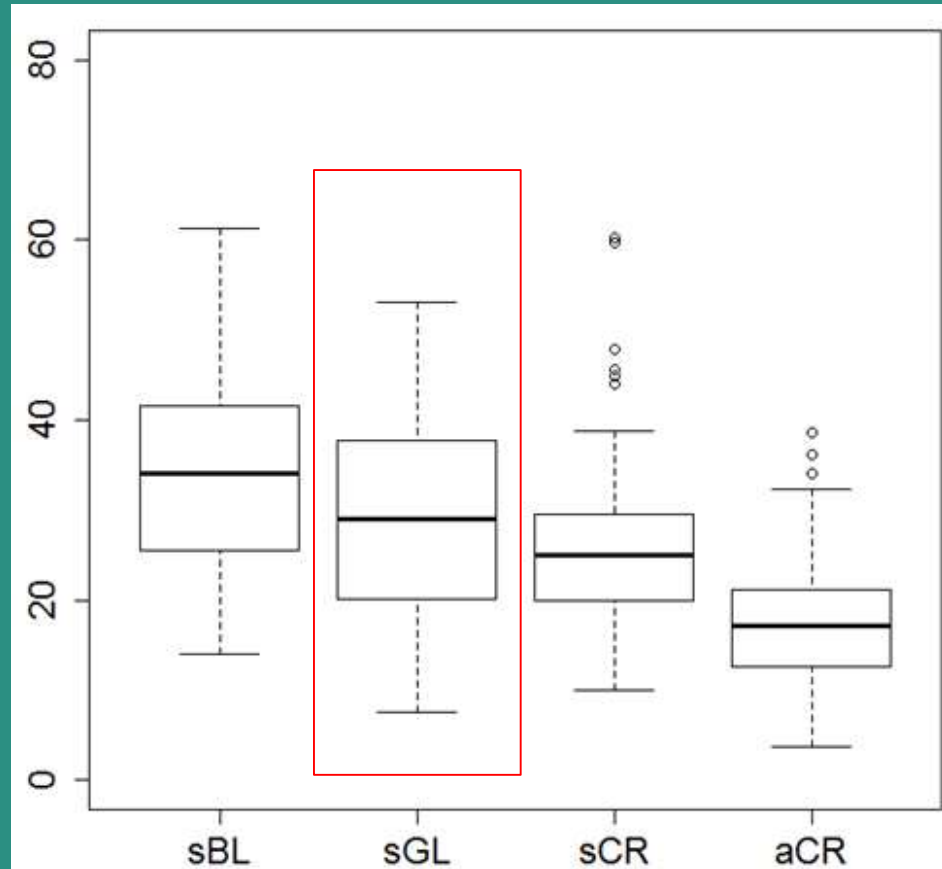


Peoples et al. 2019

# Are grain legumes yields inherently unstable?

Reckling et al. (2018)  
Grain legume yields are as stable as other spring crops in long-term experiments across northern Europe.  
*Agronomy for Sustainable Development* 38, 63.

Adjusted CV (aCV)



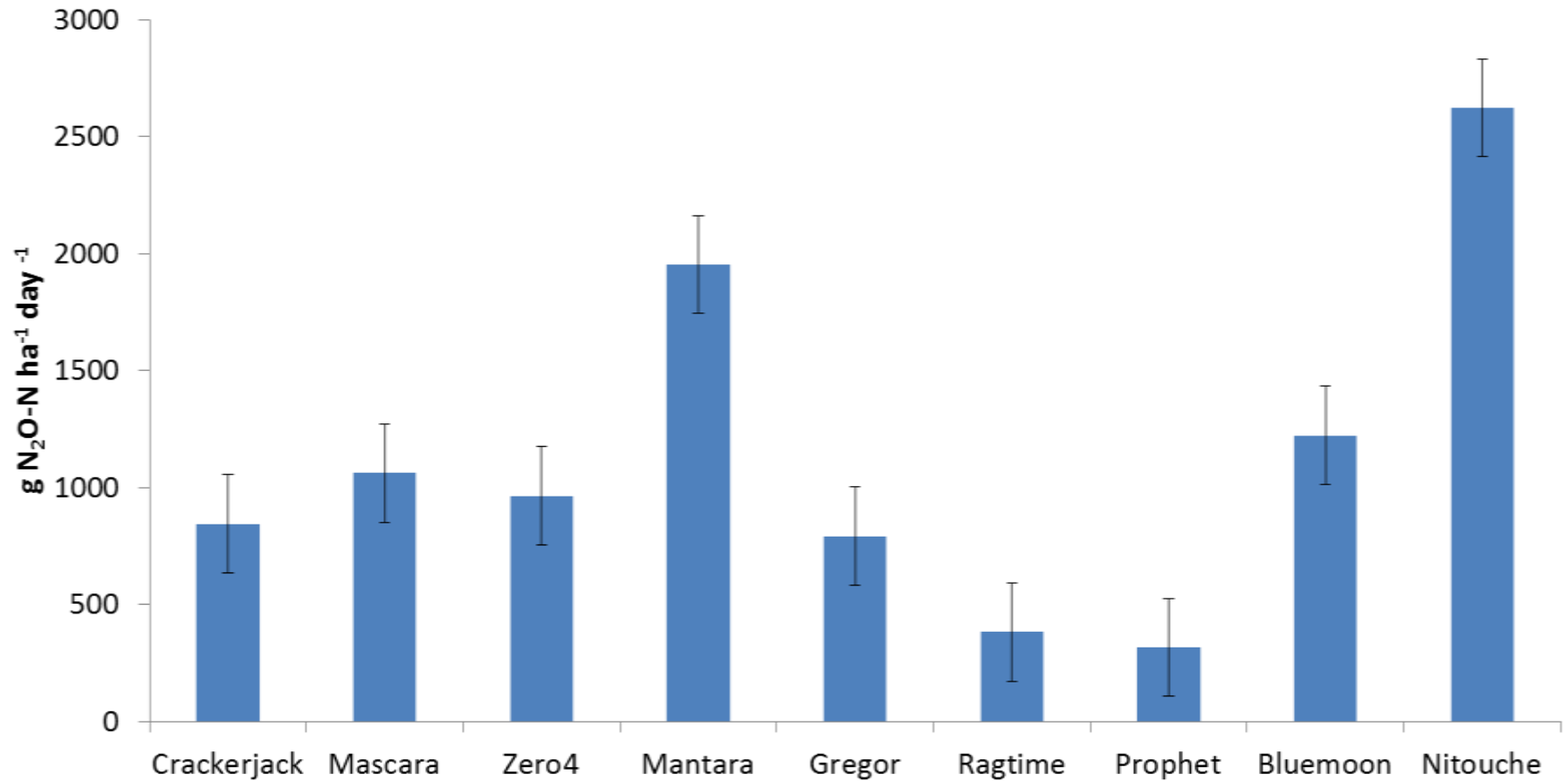
Comparison between spring-sown broad-leaved crops (sBL), spring-sown grain legumes (sGL), spring-sown cereals (sCR) and autumn-sown cereals (aCR)



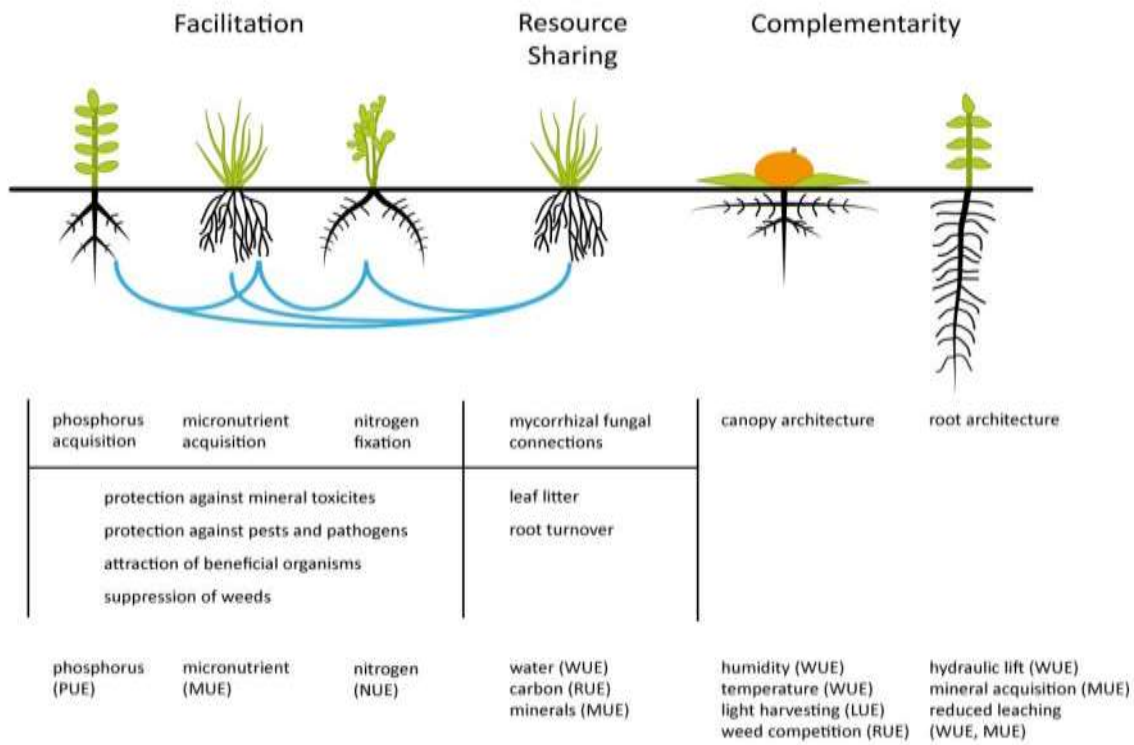
# Considerations and trade-offs

- Legume residues have a high N content, so a low C:N ratio, and break down rapidly
- Thus high potential for  $\text{NO}_3^-$  leaching,  $\text{N}_2\text{O}$  emission after the crop
- But Rhizobium bacteria with the *nosZ* gene for Nitrous oxide reductase reduce  $\text{N}_2\text{O}$  release as residues break down – exploit this?
- Need to measure the environmental and economic impacts over a whole rotation – captures system effects

# Nitrous oxide emissions- Pea cultivar matters - Edinburgh 2009



SRUC (Unpublished data)



Brooker et al. 2014 New Phytologist



# Why intercrop?

# Cereal/legume intercrops in Europe - challenges



Photos: Laurent Bedoussac

## Growing:

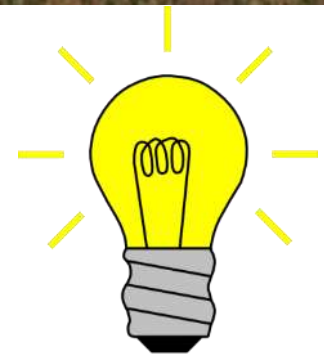
Reduced fertiliser  
Reduced agrochem  
LER > 1  
Yield stability +ve

## Harvest:

Efficient harvesting and separation  
Requires specialist machine settings  
Minimise broken grains

## In the mill:

Storage bins  
Drying  
Market



## Consumer:

Likes concept  
Allergy concerns

## Looking to the future

- Legumes provide a low cost alternative input of N to European agriculture
- Incentives to grow legumes sometimes work – CAP greening measures – EU area doubled over 7 years BUT production less than doubled
- Need to look at the systems level and from an interdisciplinary perspective – nutrition.....food security
- Prices are important and can fail to compensate for low yields
- Needs investment in breeding for yield, stress resistance, disease resistance, quality
- Needs education/KE - novice growers of grain legumes often have poor results



# Legume Gap Project

- We will be carrying out a survey of faba bean and soya bean producers to look at issues associated with the yield gap.
- 8 EU countries
- Please help us!



[christine.watson@sruc.ac.uk](mailto:christine.watson@sruc.ac.uk)



# Environmental Stratification of Europe



Environmental Zone (Metzger et al 2005)

- ALN - Alpine North
- BOR - Boreal
- NEM - Nemoral
- ATN - Atlantic North
- ALS - Alpine South
- CON - Continental
- ATC - Atlantic Central
- PAN - Pannonian
- LUS - Lusitanian
- ANA - Anatolian
- MDM - Mediterranean Mountains
- MDN - Mediterranean North
- MDS - Mediterranean South

**NORTH WEST**  
Autumn-sown pea, faba bean, white lupin; spring-sown pea, faba bean, potentially vetches and lupins

**NORTH EAST**  
Spring-sown, cool-season crops: Pea, faba bean, potentially narrow-leaved lupin, lentil and vetches

**SOUTH**  
Cool-season, autumn-sown crops: pea, faba bean, lentil, chickpea, vetches, lupins; *Irrigated* spring sown soybean, common bean, cowpea

**CENTRAL**  
Warm-season crops: soybean, common bean; Spring-sown pea, faba bean, potentially lupins, lentil and vetches





# FOBBING FARM



George Young – aka [@FarmingGeorge](#)

# Background to the farm

- ◆ Family farm, approx. 550ha
  - 480ha arable, 10ha herbal ley, 60ha rough grazing
  - This year putting 200ha into legume fallows and 50ha more into herbal leys
  - My farm is worn out and needs a rest!
- ◆ Been farming at Fobbing Farm since 1954
- ◆ Heavy blue London clay - mostly grade 4 land
- ◆ Historically did a lot of veg for the London markets (inc picking peas)
- ◆ Like everyone else, we were encouraged to specialise, leading to combinable cropping
- ◆ Dad still keeps a small herd of store cattle, but mostly they keep to rough grazing

# Key farm ethics

- ◆ Farming agro-ecologically - acting as close to nature as possible
- ◆ Zero-insecticides
- ◆ Low fertiliser use (about  $\frac{2}{3}$  of "conventional")
- ◆ Aiming for half fungicide use on cereals, with no fungicides used on pulses
- ◆ Currently zero-till (for six years)
- ◆ Beginning organic conversion this year - still with aim to keep tillage to the minimum, and ensuring good soil cover all year round
- ◆ Will be establishing agro-forestry and a "wilded seam" running through the centre of the farm (about 20ha out of 240ha at home)
- ◆ Aim to ensure that 25% of farm in permanent cover
- ◆ My view: in order to make organic work, there needs to be a wealth of diverse ecological areas hyper-close to every cropped part of the farm

# “Rotation”

◆ No actual rotation, but in the arable I grow:

- Modern wheat
- Oilseed rape
- Winter beans
- Spring peas
- Sometimes spring rape
- Sometimes spring linseed
- Heritage wheat
- Buckwheat
- Hemp
- Lentils
- Experimenting with heritage corn this year
- Keen to experiment with heritage “food” barley

# Decision making for what I grow

## ◆ What does the farm need (agronomically)?

- Heavy land doesn't suit early seeded spring crops
- Looking for crops I can establish up to end of May
- Good vigour & weed suppression ability
- Sensible harvest time

## ◆ What do we need to eat as humans?

- Nutritionally what do we need?
- Should be embracing the vegan movement (despite my belief in the "golden hoof")
- Hence...need for pulses for protein

# BUCKWHEAT





# HEMP



# Why pulses?

- ◆ Moving away from growing “second cereals” due to carbon loading
- ◆ Trying to reduce overall fertiliser use in my system: breaking with linseed or oilseed rape still means using fertiliser
- ◆ I don't believe in the adage that 40kgN is left behind after a dry combinable pulse crop, however the residue is very low in carbon and doesn't hamper the next crop

# LENTILS



# Issues...

- ◆ Lots of potential insect issues - bruchid, pea moth, pea & bean weevil
- ◆ Human consumption market very prescriptive (hence a move from green to yellow peas)
- ◆ Soil borne diseases and nematodes, etc:
  - Picking peas in close rotation during '60s and '70s mean can't grow peas any more on the home farm

# Questions I have...

- ◆ Could there be a human market for some of these less than perfect crops?
  - E.g., could we encourage the use of pulse flour?
- ◆ More research to be done on rotational gap between pulses
- ◆ What soil disease / pest commonalities are there between pulses?
  - E.g., I know that beans will tolerate pea cyst nematode
- ◆ Lots of benefits to intercropping of pulses, but more work needs doing on sorting technology

# Growing pulses: Opportunities, challenges and solutions



Lentil / camelina intercrop, Hodmedod

Steve Belcher, PGRO



# Alternate Pulses

- The FAO lists 11 types of pulses grown world wide
- High in protein & low in fat
- N - fixing
- **Dry pea**
- **Faba bean (dry)**
- Lupin
- Chickpea
- Lentil
- *Phaseolus*

Produce imports (t)			
			2019 to Au
Peas			58,378
Broad Beans			251
<b>Chickpeas</b>			39,241
Mung beans			8441
Small red beans			316
Kidney & White Beans			69,078
Cowpea			2543
<b>Lentil</b>			18,117
Pidgeon pea			910

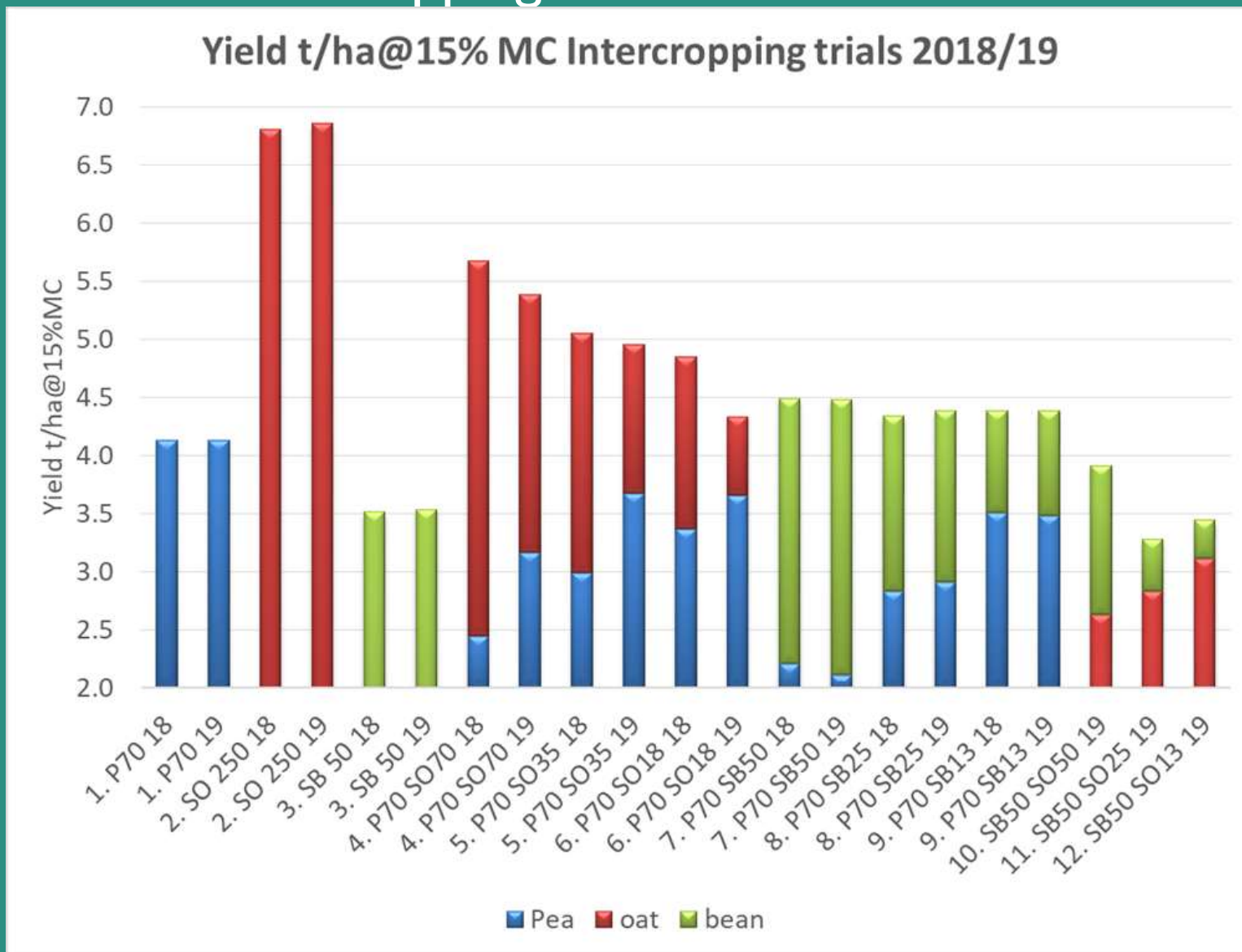
Source: Eurostat

# Rotational challenges

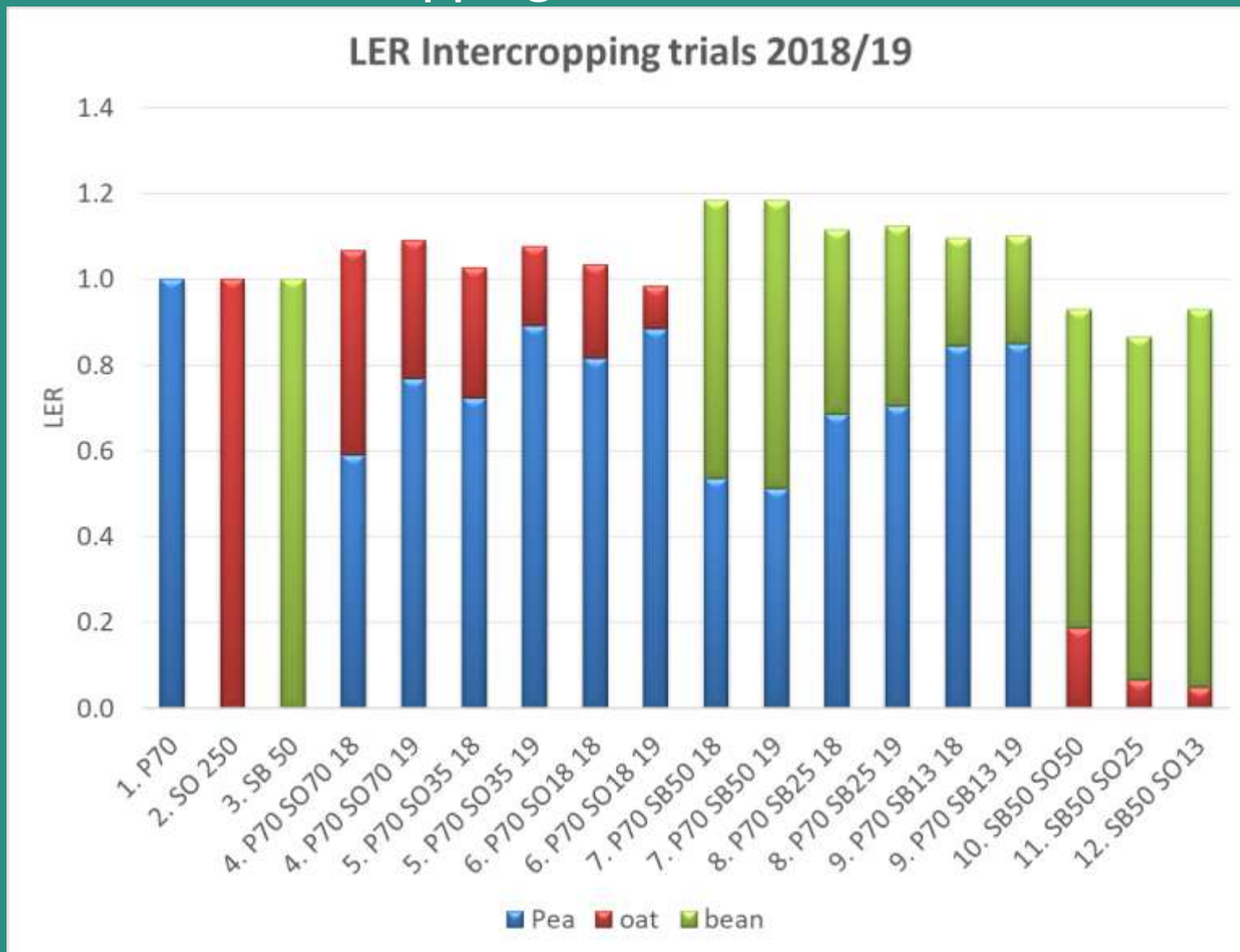
- Probably best to consider the same as we do with peas and beans stick to 1 in 5 years rotation
- “Pulses are best grown following a cereal rather than a crop that can harbor pulse diseases such as botrytis, powdery mildew, aphanomyces root rot, and fusarium root rot caused by species specific to pulses. Pulse crops are susceptible to diseases that can overwinter in the soil and in stubble”.
- Pest Management Strategic Plan for Pulse Crops (Chickpeas, Lentils, and Dry Peas) in the United States Summary of a workshop held on November 9-10, 2016 Bozeman, Montana



# Potential for intercropping



# Potential for intercropping



# Intercropping with pulses: Insights from UK and Sweden

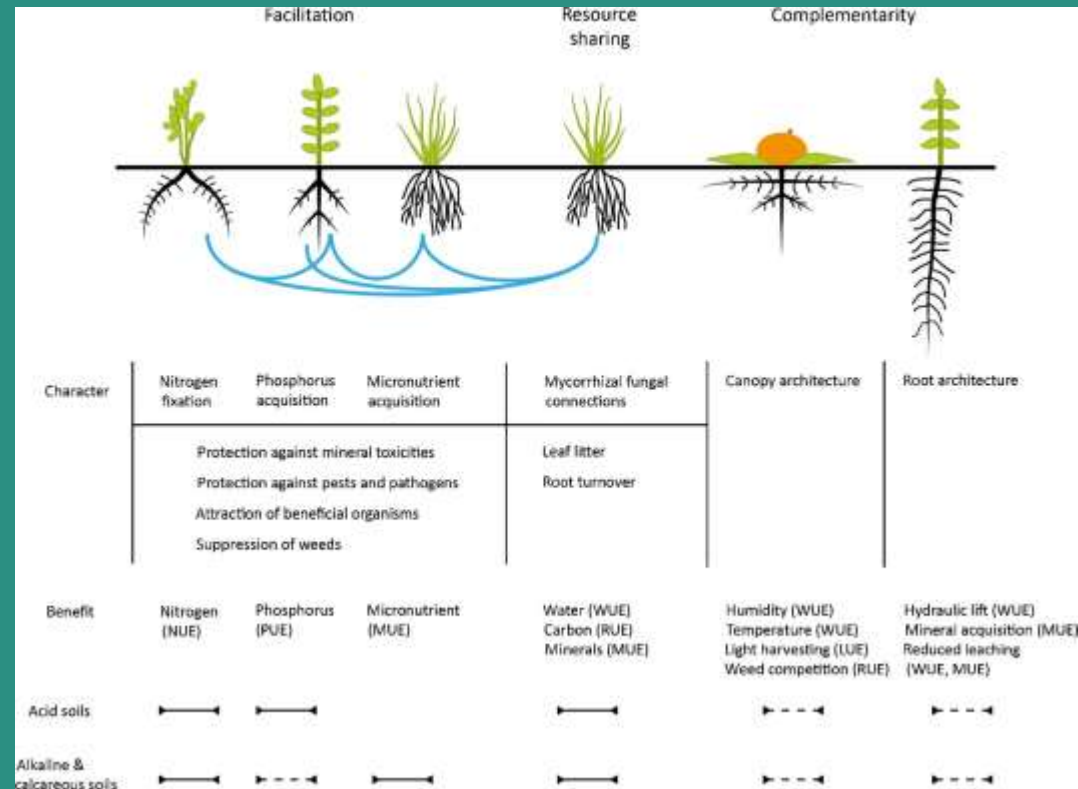


Katie Bliss, Organic Research Centre



# Potential benefits of Intercropping pulses

- For the pulses..
  - Scaffolding
  - Harvestability
  - Weed control
  - Pest and disease dilution
- For its companion..
  - N / Protein?
  - Pest and disease dilution



Facilitation, resource sharing and complementarity (Brooker et al, 2015)

# Triticale and Carlin peas, Greenacres Farm, Shropshire



**Motivations:** Scaffolding for peas; pea quality; weed suppression and harvestability

**Establishment:** 1 ha, 12m strips  
Drilled 25<sup>th</sup> April 2018 in 2 passes

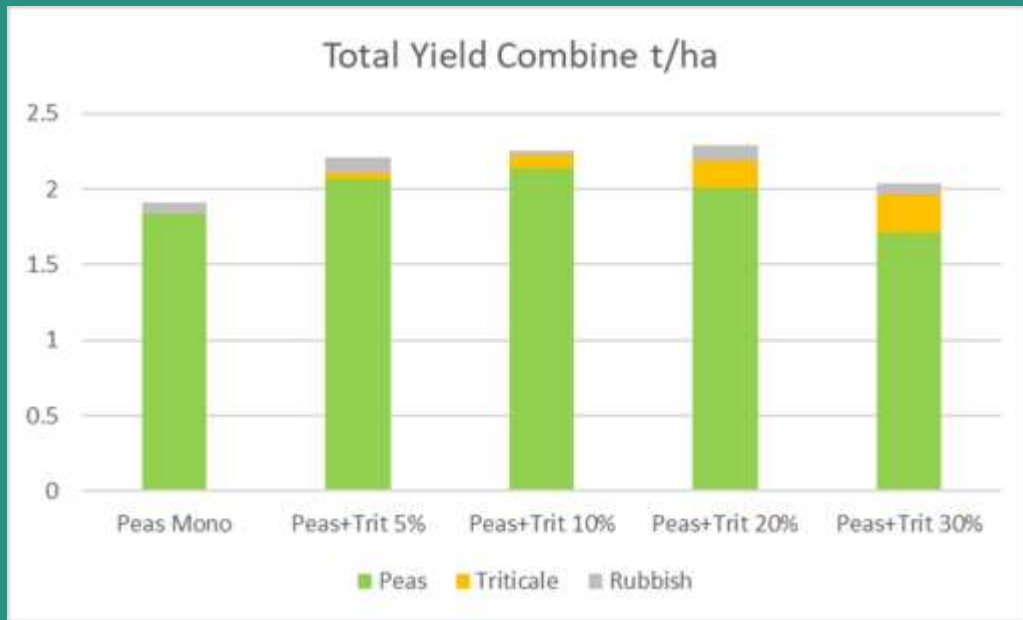
Peas 250kg/ha	Peas 250 Trit 5% RD (12.5kg/ha)	Peas 250 Trit 10% RD (25kg/ha)	Peas Trit 20% RD (50kg/ha)	Peas Trit 30% RD (75kg/ha)
------------------	---------------------------------------	---	----------------------------------	----------------------------------

**Processing and use:** Separated with cleaner on farm.

Carlin peas for Hodmedods and triticale for animal feed

# Triticale and Carlin peas, Greenacres Farm, Shropshire

## Results



30% RD  
triticale

- Best harvestability in 30% RD treatment (75kg/ha)
- Repeated in 2019 with triticale at 20 and 40% RD
  - Suffered low yields – 40% too high
  - Foot rot - due to increasing legume in rotation?



# Wheat and beans, Roundhill Farm, Wiltshire

**Motivations:** Weed suppression (especially wild oat), increase wheat protein, increase total yield (feed)

**Establishment:** 1ha strips, wheat and beans in two passes

2018  
*Tundra*  
*Malika*

<b>Beans</b> 125kg/ha	<b>Wheat</b> 174kg/ha <b>Beans</b> 125kg/ha
--------------------------	--

2019  
*Tundra*  
*Malika*

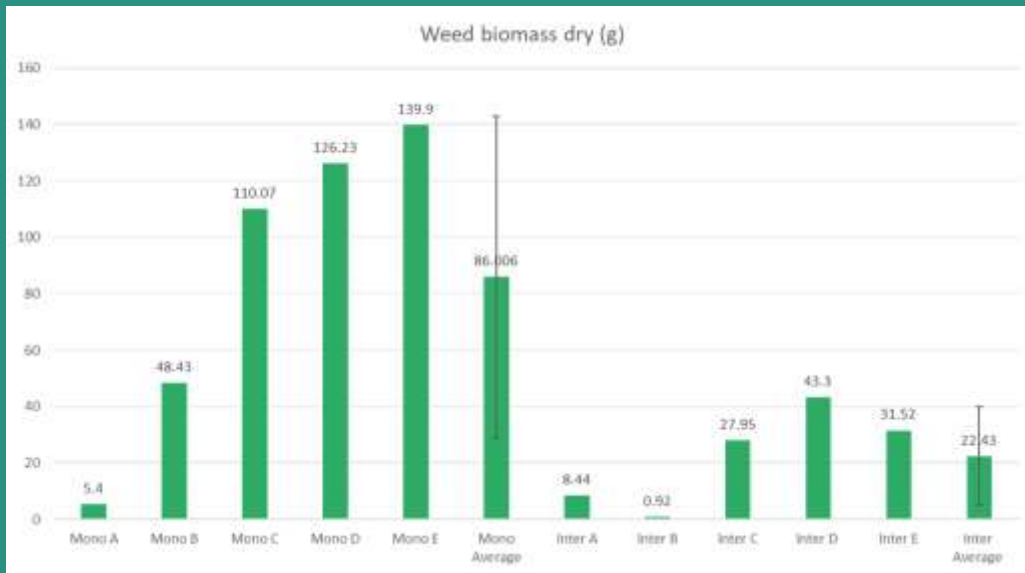
<b>Beans</b> 200kg/ha	<b>Wheat</b> 100kg/ha <b>Beans</b> 200kg/ha
--------------------------	--

**Processing and use:** Harvested together and used as mixed feed for livestock



# Wheat and beans, Roundhill Farm, Wiltshire

## Results



**Wheat protein:** Intercrop 10.94 vs 10.67 in monocrop

**Hagberg:** 411 Intercrop vs 384 in monocrop

Wild oats in intercrop (left) mono (right)

- 2018
  - **Weeds:** 74% less dry weed biomass in intercrop than monocrop
  - **Yield:** Mono Beans 0.59t/ha; Intercrop Beans 0.48t/ha beans 1.43t/ha wheat (wheat rate too high?)
  - 222% increase in total yield in intercrop– feed for livestock
- 2019
  - **Weeds:** 73% less dry weed biomass in intercrop than monocrop
  - **Yield:** Monoculture crop destroyed due to high weed burden





# Lentils and Oats, Fagraslätt farm, Skane, Sweden

**Motivations:** Oats for scaffolding and weed suppression

**Establishment:** Lentils (90kg/ha) and oats (40kg / ha) and monocultures

**Results:** Improved harvestability of lentils  
Reduced weed biomass.

Same / Slightly increased lentil yield vs mono - 1.5t/ha. Slight increase in moisture

Intercropped oats sown at 40% of mono density have produced 60% of mono yields.

**Processing and use:** On-farm separation – (provides service to others) Human consumption – Nordisk Ravara



# Other plant teams in the field....

## 2019

- **Beans and triticale** – Sonning Farm, Berks (Weeds, protein, yield)
- **Beans and oats** – Bockhanger Farm, Kent / PGRO (Weeds, bruchid, tissue analysis (N), LER, yield, RTV)
- **Lentils and linseed** – Bockhanger Farm, Kent (Lodging, weed control)
- **Peas and oats** – Sweden / SLU Remix (Manage In-field heterogeneity, yield)
- **Peas and beans / beans and oats** – PGRO Lincolnshire (Lodging, weeds, yield)
- **Carlin / Yellow peas and oats / barley / spelt** – Sonning Farm, Berks / ORC (Lodging, yield, weeds)



*Grey peas 190kg/ha and oats 150kg/ha drilled with system chameleon. Sweden*

## 2020

- **Peas and oats / Lentils and oats** – Bockhanger Farm, Kent

# In summary....



- No silver bullet – find what works on your farm
- Large yield variation year on year – Trend towards overyielding
- Set key objectives for mixture - Priority crop?
- Some challenges – e.g competition, rotation effects and separation
- Speak to others who are doing it – join the Intercropping Field Lab!



Find out more...[@agricology](http://www.agricology.co.uk) and YouTube channel! 😊

**Agricology @agricology** · 20 Sep 2017  
 Beans and wheat #intercropping a new look at an overlooked benefit  
[bit.ly/2zd5uu4](https://bit.ly/2zd5uu4) @OrgResCent #organic #sustainablefarming #Farming

**Combineable protein crop production**  
 Institute of Organic Training & Advice Research Centre

Download the PDF

**SECURITY EXPLAINED**

The open access available information allows researchers and interested organisations to combine protein crops in rotation or in an organic farming system. It also refers to the organic research on peas, field beans and lupins, their role in soil, disease, insect health, pest and weed control, and their contribution to crop production.

**ORGANIC RESEARCH CENTRE**  
 Institute of Organic Training & Advice (IOTA)  
 University of Exeter  
 Cornwall PL8 4AT  
 Cornwall, UK  
 Tel: +44 (0)1323 373333  
 Email: [info@iota-organic.co.uk](mailto:info@iota-organic.co.uk)

YouTube Search

**Intercropping carlin peas and triticale @ Green Acres Farm**

**INNOVATIVE FARMING**

Intercropping in arable systems

**Meet the Team**

**ELM FARM**  
 ELMAAC  
 ELM FARM

**Intercropping in Arable Systems**

Interest in intercropping has been growing amongst commercial and organic farmers for some time. This field will look at how farmers can use intercropping to make their arable systems more sustainable and productive.

**Field Lab Timeline**

10th November 2017

**Beans and wheat intercropping: a new look at an overlooked benefit**

Each year, intercropping research projects generate a wealth of information. This research project was funded by the Organic Research Centre, University of Exeter, Cornwall. The project was funded by the Organic Research Centre, University of Exeter, Cornwall. The project was funded by the Organic Research Centre, University of Exeter, Cornwall.

**SECURITY EXPLAINED**

The open access available information allows researchers and interested organisations to combine protein crops in rotation or in an organic farming system. It also refers to the organic research on peas, field beans and lupins, their role in soil, disease, insect health, pest and weed control, and their contribution to crop production.

**Field Beans and Lupins**

field beans

**SECURITY EXPLAINED**

With just a few acres being explored, basic production points in the form of crops such as field beans and lupins can be an alternative alternative. The Institute of Organic Training & Advice (IOTA) provides practical information on growing field beans and lupins. Please email at [info@iota-organic.co.uk](mailto:info@iota-organic.co.uk) or visit our website.

**View the website**

**SECURITY EXPLAINED**

The Institute of Organic Training & Advice (IOTA) provides practical information on growing field beans and lupins. Please email at [info@iota-organic.co.uk](mailto:info@iota-organic.co.uk) or visit our website.